

# Characteristics of the Chang 7 Tight Sandstone Reservoir in the Luopangyuan Area, Ordos Basin

Guanghua Zhu

Xi'an Petroleum University, Xi'an, China

---

**Abstract:** This study aims to systematically characterize the Chang 7 tight sandstone reservoir in the Luopangyuan area of the Ordos Basin to provide a geological foundation for tight oil exploration and development. Core samples from three wells were analyzed using an integrated suite of experimental techniques, including conventional thin-section petrography, field-emission scanning electron microscopy (FE-SEM), constant-rate mercury intrusion capillary pressure (MICP) analysis, and micro-computed tomography (micro-CT) scanning. Results indicate that the reservoir lithology is predominantly lithic arkose and feldspathic sandstone, characterized by fine grain size, moderate sorting, and subangular to angular grain roundness. The average porosity is 8.2%, and the average permeability is  $0.32 \times 10^{-3} \mu\text{m}^2$ —consistent with an ultra-low-permeability reservoir classification. Pore space is dominated by dissolved intergranular pores (37.3%) and feldspar dissolution pores (34.5%). The pore-throat system is typified by fine pores coupled with fine to micro-fine throats. Compaction and cementation are the primary diagenetic processes responsible for reservoir densification, whereas feldspar dissolution plays a critical role in enhancing reservoir quality. Based on comprehensive petrophysical and diagenetic evaluation, the reservoirs are classified into three types: Type IVa, IVb, and V. Effective reservoir intervals account for 54% of the total net sand thickness, with Type IVa being the most prevalent. These findings offer actionable geological insights for tight oil exploration not only in the Luopangyuan area but also in analogous tight sandstone systems.

**Keywords:** Ordos Basin, Yanchang Formation, Chang 7 Member, tight sandstone reservoir, reservoir characterization, diagenesis.

---

## 1. Introduction

In recent years, escalating global demand for hydrocarbons—coupled with the progressive depletion of conventional oil and gas resources—has intensified focus on unconventional petroleum systems. Tight sandstone reservoirs have emerged as a pivotal domain for reserve growth and a major frontier in petroleum geoscience research [1–3]. Within the Ordos Basin, exploration efforts are predominantly directed toward low-porosity, low-permeability tight sandstones, which collectively harbor substantial resource potential. With advancing exploration maturity, the Chang 7 Member of the Upper Triassic Yanchang Formation in the Dingbian Oilfield has become a strategic target for reserve replacement and sustained production. Estimated technically recoverable tight oil resources in this interval exceed  $2.0 \times 10^9$  tons, underscoring its significant developmental prospect [4, 5]. In the Luopangyuan area, the Chang 7 Member hosts extensive deltaic and gravity-flow sand bodies, interbedded with lacustrine mudstones and diagenetically dense layers—favorable conditions for the genesis and preservation of tight oil accumulations. Building upon prior sedimentological frameworks, this study conducts a systematic characterization of the Chang 7 reservoir's petrology, microscopic pore-throat architecture, and petrophysical properties using thin-section analysis, FE-SEM, micro-CT, and constant-rate MICP. Furthermore, the reservoir formation mechanism is evaluated through the integrated lens of structural evolution, depositional setting, and diagenetic history—thereby delivering a robust geological basis for targeted exploration and efficient development of tight oil in the study area.

## 2. Regional Geological Setting

The Ordos Basin is a large-scale, asymmetric intra-cratonic syncline, featuring a broader, gently dipping eastern flank and a narrower, steeper western margin. Tectonically, it comprises six major structural units: the Western Margin Thrust Belt, Tianhuan Depression, Yishan Slope, Jinxi Flexure Belt, Yimeng Uplift, and Weibei Uplift. The Luopangyuan area lies within the southern segment of the Yishan Slope and exhibits a simple, gently west-dipping monocline with an average dip angle of  $<1^\circ$  and a topographic gradient of 7–10 m/km. Locally, differential compaction has generated subtle nose-like structures [6] (Fig. 1). Basin initiation dates to the Late Triassic. During the Early Paleozoic, the region formed part of the North China epicontinental sea, with Cambrian–Ordovician strata dominated by shallow-marine carbonate rocks. The Late Paleozoic witnessed marine–terrestrial transitional deposition (Carboniferous–Permian). In the Late Triassic, regional subsidence across the Shaanxi–Gansu–Ningxia area led to the accumulation of up to 1,000 m of lacustrine–deltaic clastic sediments—the Yanchang Formation—which constitutes the basin's principal hydrocarbon-bearing sequence. The Yanchang Formation is subdivided into ten informal oil-bearing members (Chang 10 to Chang 1), numbered upward from the base [21]. The Chang 7 depositional phase represents the maximum lake expansion stage, marked by intense peripheral tectonic activity. Compressional stress from the southwest and uplift in the northeast induced rapid, spatially heterogeneous subsidence, resulting in a “steep-south–gentle-north” basin morphology [7]. At this time, the lake reached its greatest areal extent, forming a vast semi-deep to deep lacustrine environment. Thick ( $>100$  m) organic-rich dark mudstones and shales were deposited, constituting the main Mesozoic source rock

interval of the basin [8-11].

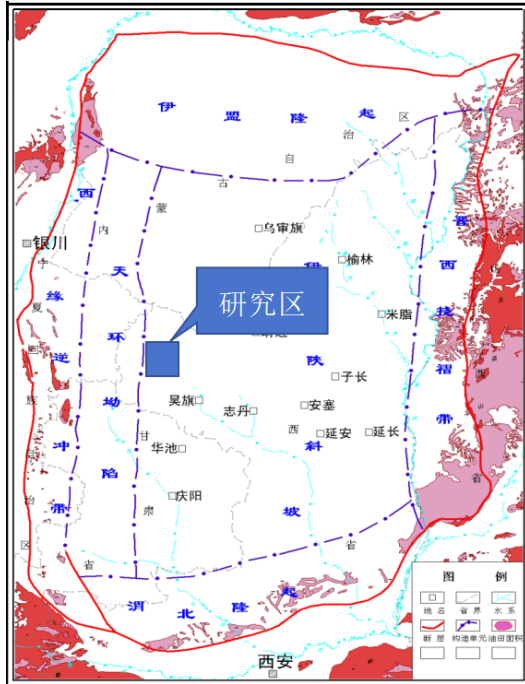


Figure 1. Regional Location Map of Luopang Plateau Area

### 3. Reservoir Characteristics

#### 3.1. Petrological Characteristics

Based on the petrological data from the study area and adjacent areas, the thin section data of 22 samples were analyzed: The lithology of the Long7 oil layer group in the study area is mainly lithic feldspar sandstone, followed by feldspar sandstone (Figure 2). The main rock type is fine-grained sandstone, with particle sizes mainly ranging from 0.1 to 0.21 mm, with an average of 0.11 mm. The sorting of the clastic particles is moderate, and the particle rounding is poor. The sandstone is mainly cemented by porosity, and phenomena such as film-pore cementation, pressure-filling cementation, film cementation, and siliceous cementation can be observed. The supporting property of the clasts is particle support.

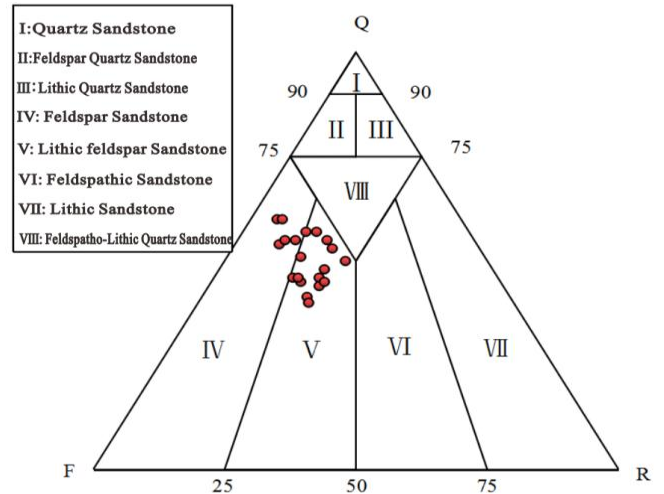


Figure 2. Triangular diagram of the composition of the Long7 sandstone in the Luopang Plain area

The fraction of debris ranges from 40% to 90%, with an average value of 81.27%. After statistics, the contents of quartz, feldspar and rock fragments are as follows: quartz: content ranges from 14% to 46%, with an average content of 23.97%, mostly in single crystal form; feldspar: content ranges from 13% to 67%, with an average content of 47.73%; rock fragments: content ranges from 1% to 22%, with an average content of 9.9%. Feldspar is the main debris particle component of the Long7 oil layer group, while the contents of quartz and rock fragments are relatively less. The total amount of mica and heavy minerals is less than 2.0%. The metamorphic rock debris and magmatic rock debris in the rock fragments account for a smaller proportion, while the proportion of sedimentary rock debris is relatively larger.

The filling material composition of the Long7 reservoir is between 10% and 60%, with an average content of 18.73%. The filling material composition mainly includes kaolinite, chlorite, calcite, quartzaceous cement, illite and pyrite, etc. (Table 1). Among them, kaolinite cement is widespread, calcite fills the pores in a continuous crystal state, chlorite films are in a cushioning form, and occasionally secondary enlarged edges of quartz are developed, and illite is in a sheet-like aggregate form, etc. (Figures 3 to 6).

Table 1. Distribution Table of Fillers in the Long7 Oil Layer Group

interstitial matter component	Kaolinite		Vermiculite		Calcite	
	Mean	Range	Mean	Range	Mean	Range
Range (%)	0~8.0%	3.16%	2~33%	6.10%	0~38%	5.84%
interstitial matter component	Quartzaceous cement		Illite		Pyrite	
	Mean	Range	Mean	Range	Mean	Range
Range (%)	0~2%	0.06%	0~5.0%	0.55%	0~4.0%	0.23%

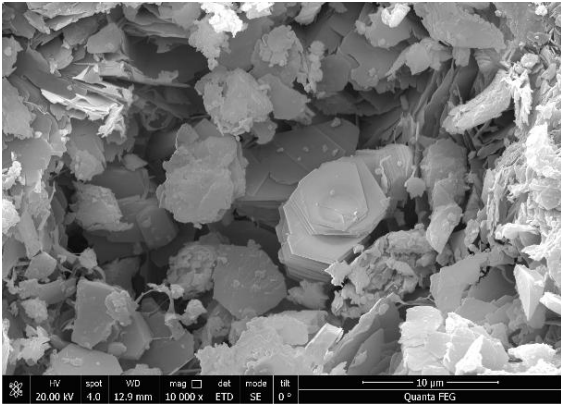


Figure 3. DT1383, 2534.8m, Kaolinite cementation

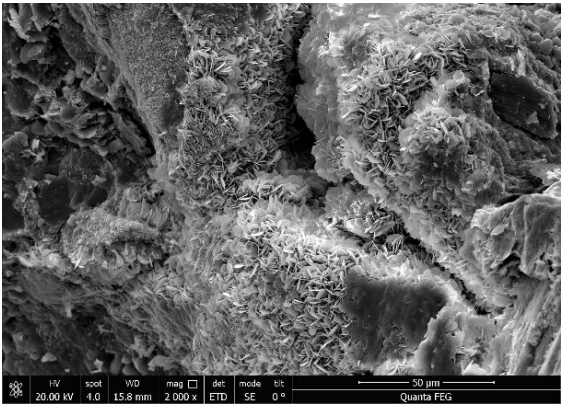


Figure 4. DT1391, 2566.2m, chlorite cemented

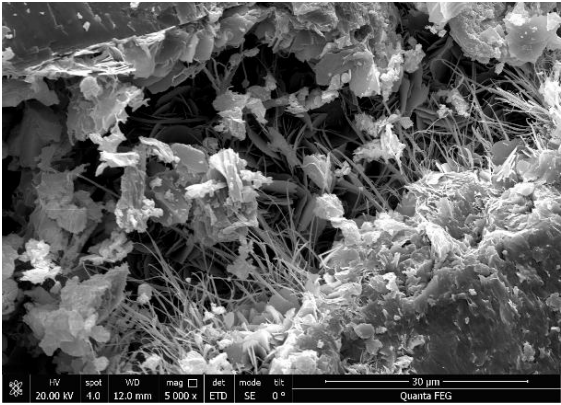


Figure 5. DT1394, 2465.82m, illite cementation

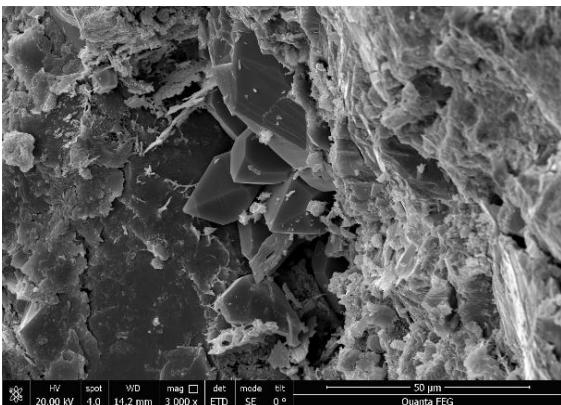


Figure 6. DT1391, 2566.79m, Quartz secondary enlargement

### 3.2. Reservoir Physical Property Characteristics

The debris group conducted a statistical analysis of the petrophysical data of the long 7 reservoir rock cores from 3 wells in the Jingqu area of Luopang Ridge region of Dingbian Oil Production Plant. The porosity distribution range of the long 7 reservoir was between 5.5% and 10.6%, with an average value of 8.2%, and the frequency distribution was mainly concentrated in the range of 6% to 8% (Figure 7); the permeability distribution range was between 0.17 and  $0.99 \times 10^{-3} \mu\text{m}^2$ , with an average value of  $0.32 \times 10^{-3} \mu\text{m}^2$ , and the frequency distribution was mainly concentrated in the range of 0.2 to  $0.4 \times 10^{-3} \mu\text{m}^2$  (Figure 8). Through the pore-permeability intersection diagram, it was found that porosity and permeability have a positive exponential correlation (Figure 9). The reservoir as a whole presents low porosity and ultra-low permeability characteristics, and the storage space is mainly composed of inter-grain pores and dissolution pores.

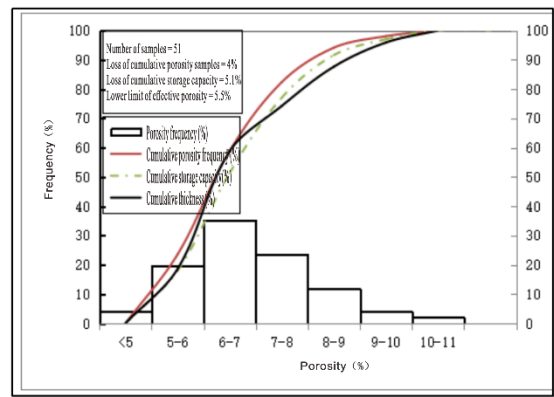


Figure 7. Histogram of porosity distribution of the Long7 oil layer group in the Luopang Plain area

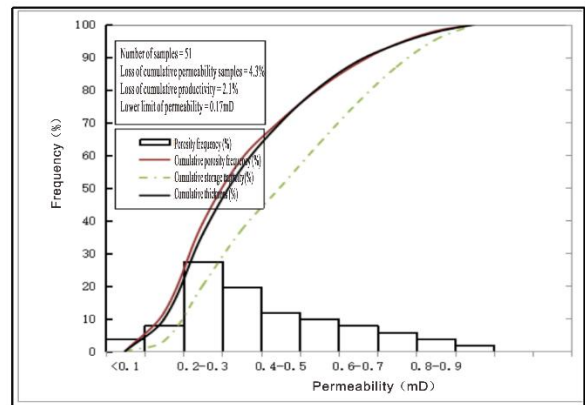
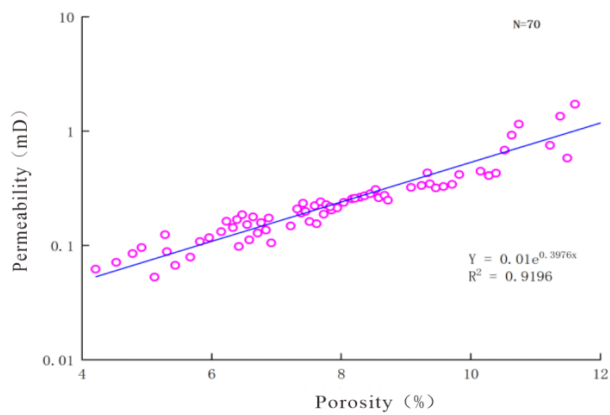


Figure 8. Histogram of permeability distribution of the Long7 oil layer group in the Luopang Plain area

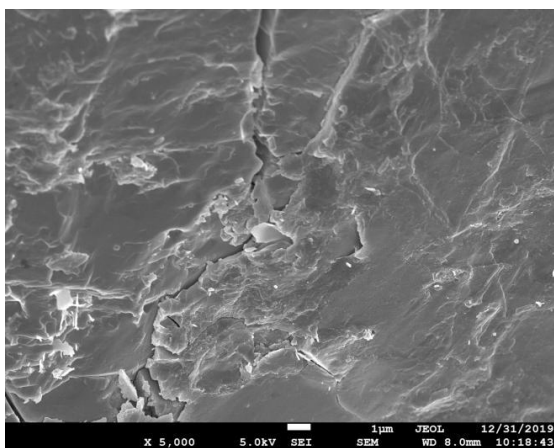


**Figure 9.** Cross-sectional diagram of porosity and permeability of the Long7 oil layer group in the Luopang Plain area

### 3.3. Reservoir Pore Structure Characteristics

The types of fractured pores can be classified into three major categories based on their origin: primary pores, secondary pores, and micro-cracks. Primary pores mainly refer to the inter-particle pores of sedimentary particles, as well as inter-layer pores and gas pores. Secondary pores refer to the pores and fractures formed in the rock after its formation due to processes such as leaching, dissolution, replacement, dissolution, and recrystallization. During the diagenesis process, through processes such as compaction, cementation, and pressure dissolution, primary pores will gradually decrease. At the same time, soluble sedimentary particles and easily soluble cements will dissolve and undergo replacement as the burial depth increases, thereby promoting the development of secondary pores in clastic rocks [12-13].

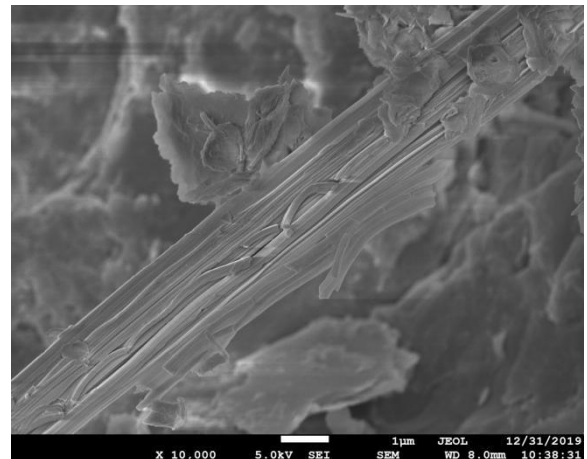
Based on the analysis of core cast thin sections, core observation, and electron microscope scanning, the pore types of the Mesozoic Yan'an Formation reservoir in this area mainly include three types (Figure 10): inter-particle pores, dissolution pores (feldspar dissolution pores, sedimentary particle dissolution pores), and intraparticle pores, etc. The Yan'an Group Member 7 reservoir has relatively developed dissolution pores. The Yan'an Group Member 7 oil layer has a small amount of inter-crystalline pores, inter-base dissolution pores, and micro-cracks.



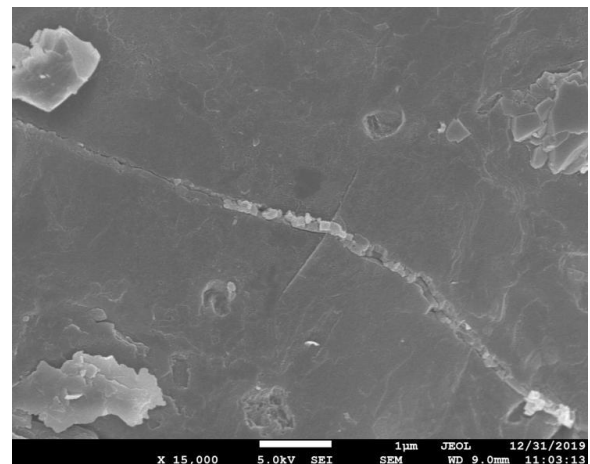
**Figure 10.** Surface erosion of particles

Dissolution pores are the main pore types developed in the Yan'an Group Member 7 of this area during the diagenesis process. During the diagenesis process, at different diagenetic

stages, the pH of pore water varies. When the acidity of pore water increases, some acid-soluble minerals are dissolved by pore water, often forming dissolution pores, mainly including feldspar dissolution pores (Figure 11, Figure 12).



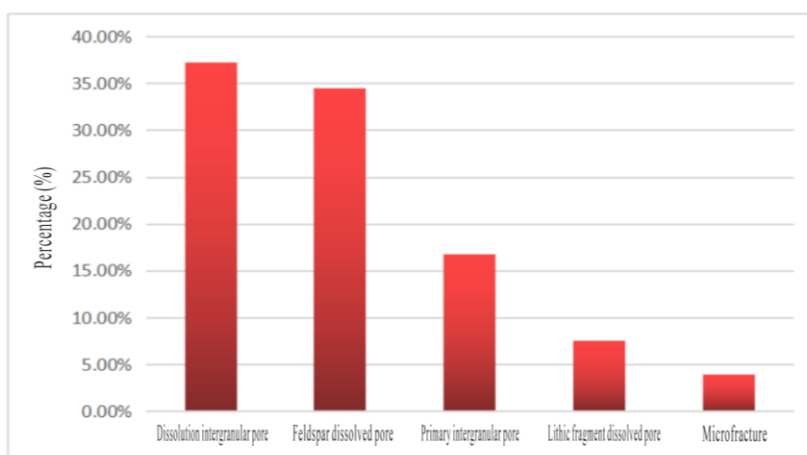
**Figure 11.** Dissolution of feldspar particles



**Figure 12.** Natural Cracks

The porosity of the reservoir sandstone in the Long 7 reservoir layer group is mainly distributed between 0.1% and 2.6%, with an average of 1.7%. The main reservoir space is the intergranular pores due to dissolution and the feldspar dissolution pores, accounting for 37.3% and 34.5% of the total pores respectively. The secondary intergranular pores, rock debris dissolution pores, and a small amount of mold cavities and micro-cracks also exist.

Most of the reservoir space types in this area of the Long 7 oil layer are feldspar dissolution pores, accounting for 36.36% - 66.67% of the porosity. The secondary intergranular pores account for 20.00% - 40.00% of the porosity. Some reservoir layers are mainly composed of secondary intergranular pores, with the intergranular pores accounting for 31.25% - 56.91% of the porosity. The various types of dissolution pores, mainly feldspar dissolution pores, account for 10.00% - 15.46% of the porosity. Some reservoir layers also have intercrystalline pores, inclusions dissolution pores and micro-cracks. The porosity is generally between 2% and 6.5%, with an average value of 4.83% (Table 2). The pore combination is mainly dissolution pores - intergranular pores.



**Figure 13.** Histogram of pore type distribution in the 7-long section of the Luopang Depression area

**Table 2.** Pore type table of the Long 7 reservoir group in the Luopang Depression area

Layer	Intergranular porosity after dissolution%	Quartz dissolution porosity%	Primary intergranular porosity%	Residual rock dissolution porosity%	Minor fractures%	Aspect ratio%	Porosity combination
Chang7	37.3	34.5	16.8	7.5	3.9	1.7	Intergranular pores - dissolution pores

### 3.4. Reservoir Diagenesis Characteristics

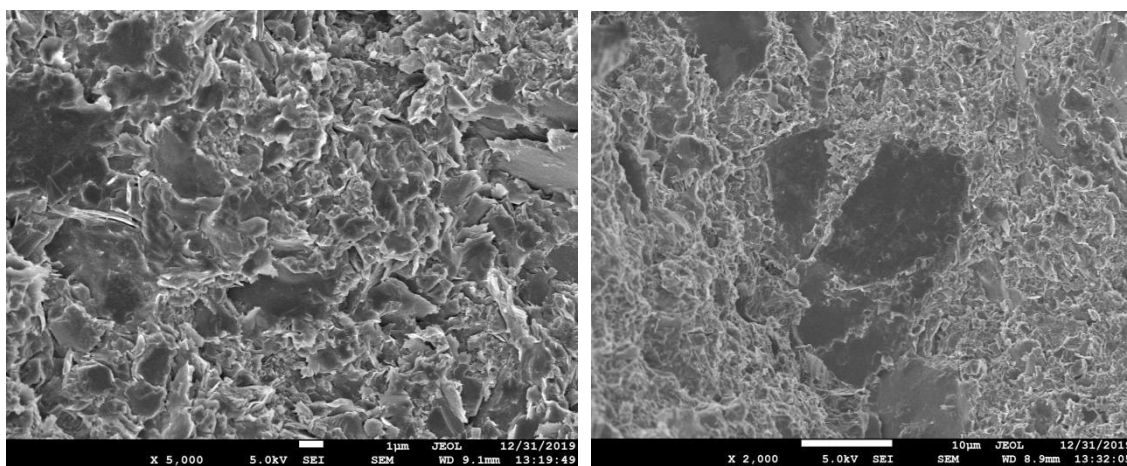
#### 3.4.1. Reservoir Diagenesis Type Pore Evolution

The diagenesis of the 7 reservoir layer in this area is intense and complex. The main diagenetic processes include: compaction and dissolution, dissolution, cementation, etc.

##### (1) Compression and dissolution

Compression is manifested by the close arrangement of clastic particles, which reduces the pore volume and leads to a deterioration in porosity and permeability. Based on

microscopic and thin section observations and analyses, the compression effect in this area is mainly characterized by close contact between particles, plastic particle deformation, fracture of rigid particles such as quartz and feldspar, deformation of mica and chlorite, directional arrangement of particles, and contact of points, lines, and depressions. Dissolution is mainly manifested by the secondary enlargement of quartz particles and contact along the long axis (Figure 14).

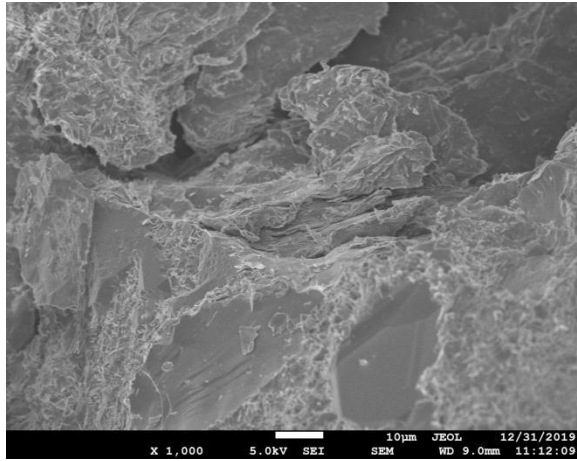
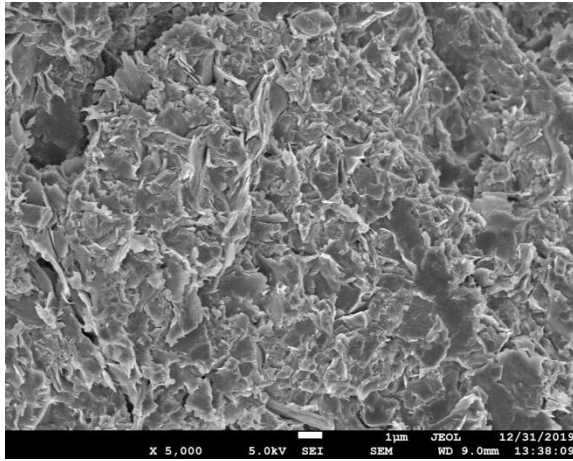


a. Secondary pores and fissures develop    b. The quartz particles have undergone slight secondary enlargement

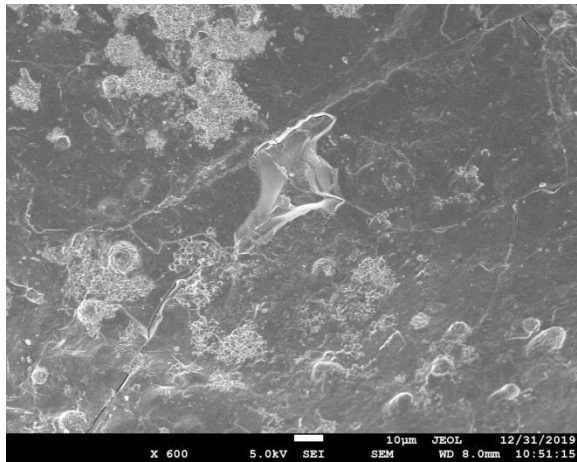
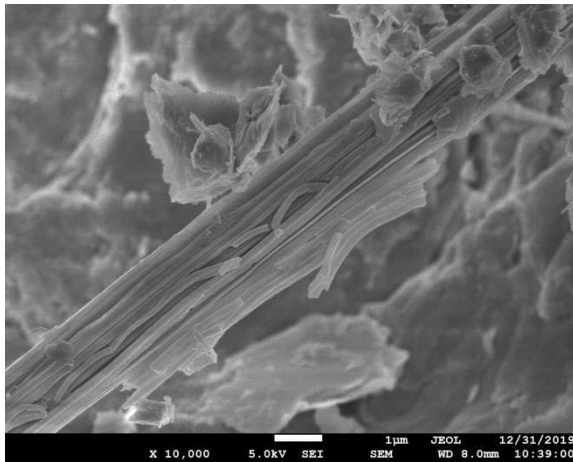
**Figure 14.** Scanning Electron Microscopy of Well Area in Luopang Plain Block

Weathering occurs at all stages of diagenesis and forms secondary pores in clastic rocks, which is an important constructive effect on the storage space. In the reservoir rocks of the oil layers in the study area, the weathering of feldspar is the most common, and the weathering of zeolite is also relatively common. The weathering of volcanic rock fragments of intermediate basaltic nature can also be observed, but due to the low content of such fragments, the weathering

phenomenon is not common. The weathering of feldspar is common, and the weathering of feldspar often begins from the interior of the sedimentary particles. The cleavage fissures or twin planes within the feldspar particles first undergo mechanical fracture, forming micro-cracks, and the intergranular solution penetrates along the micro-cracks, dissolving the feldspar, to some extent, forming many intragranular weathered micro-fissures (Figure 15).



a. Secondary dissolution of micro-pores develops (Identification No. 40241, Chang7) b. Erosion of the feldspar surface (drilling 40241, Chang7)



c. Surface dissolution of particles (Test No. 40241, Chang7) d. Dissolution of feldspar particles (Survey No. 40241, Chang7)

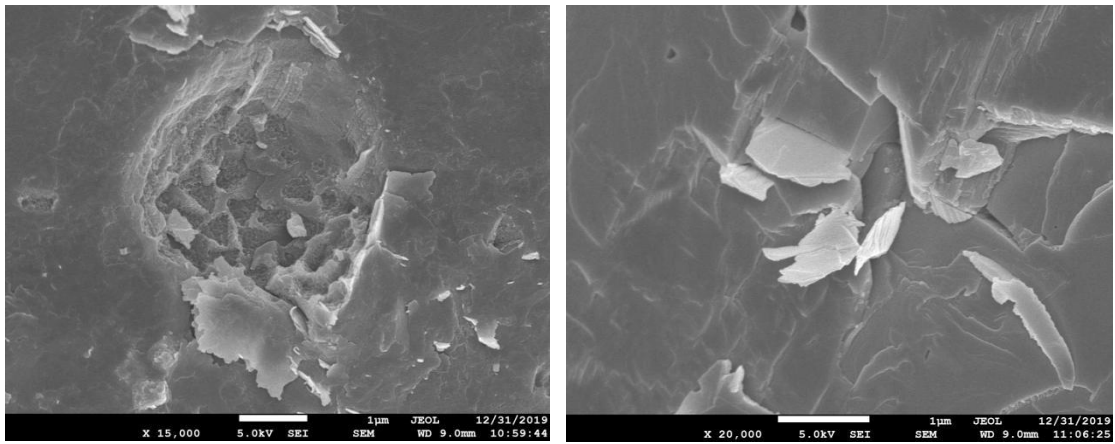
**Figure 15.** Scanning Electron Microscopy of Well Area in the Rongpang Depression Block

The dissolution effect and the formation of secondary pores mainly involve the dissolution effect of CO<sub>2</sub> and carbonates, organic acids on the framework particles, and the dissolution of the framework particles by atmospheric water. The Long7 oil layer rocks in the study area have a strong dissolution effect, forming a large number of weathered secondary pores.

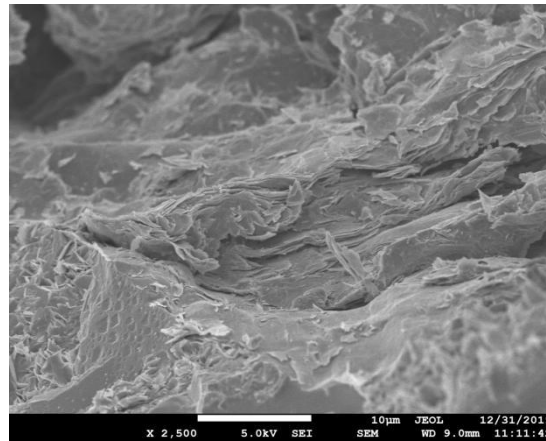
(2) Cementation

Cementation refers to the process by which minerals (cement) precipitated from the pore solution solidify the loose

sediment to form rocks. Cementation is an important process in the transformation of sediment into sedimentary rocks and is also the main reason for the reduction of porosity and permeability in sedimentary layers. The main cements of the Long7 reservoir layer in the extension section of the study area include calcite, silica, chlorite, mud, tuff, silica, illite, etc.; the cementation is strong and the cementation types are diverse.



a. Calcite fills the pores (Determination Probe 40241, Chang7) b. Kaolinite fills the pores (Dingtou 40241, Chang7)



c. Calcite fills the pores (Determination Probe 40241, Chang7)

**Figure 16.** Scanning Electron Microscopy of Well Area in the Rongpang Depression Block

### 3.4.2. Diagenetic Sequence and Pore Evolution Characteristics of Sandstone

#### (1) Rock-forming sequence

Based on the comprehensive analysis of the characteristics of each rock-forming process mentioned above, the sequence of the rock formation in the study area is approximately as follows:

A: In the early rock-forming stage, mechanical compaction occurs and chlorite films precipitate, causing the original intergranular pores to sharply decrease.

B: During the early rock-forming stage (B period) and the late rock-forming stage (A period), due to the secondary increase of feldspar and quartz as well as the growth of calcite auto-formed minerals, the original pores further decrease, which is a major reason for the densification of the rock structure.

C: In the late rock-forming stage (A period), under the leaching and dissolution action of acidic formation water, feldspar, carbonate, zeolite, and rock fragments undergo intense weathering, generating a certain number of secondary pores.

D: During the early period of the late rock-forming stage (A period) and the early period of the late rock-forming stage (B period), a small amount of iron calcite, dolomite, kaolinite, and auto-formed albite appeared, filling some pores and also causing the rock structure to become more dense.

Rock-forming sequence: Formation of clay films in the early stage → mechanical compaction → secondary increase of quartz → precipitation of calcite → formation of zeolite → injection of organic fluids → dissolution of feldspar particles → dissolution of calcite → dissolution of zeolite →

petroleum infiltration → filling of late iron calcite → filling of late dolomite or metasomatism of debris particles.

#### (2) Rock-forming stage division and characteristics of rock-forming pore evolution

Based on a large amount of analytical and laboratory test data and the study of the rock-forming characteristics of the elongate clastic rocks in the study area, combined with previous research results, the following comprehensive division marks of rock-forming stages were obtained:

① Reflectance of the vitreous body (RO), this value is the indicator of organic matter maturity and can also reflect the degree of rock-forming evolution. According to the data from adjacent areas, the RO value of the Long7 oil layer group in the elongate formation is 0.76-1.26%, reflecting the characteristics of organic matter being in the mature stage.

② Test of inclusion temperatures: In the fractures of the sandstone in the elongate group, the liquid hydrocarbon inclusions in the quartz particles are brown and semi-transparent, with an average uniform temperature of about 70°C.

③ Evolution of clay minerals: The content of chlorite in the sandstone is generally high, and the montmorillonite component in the iomontomeric mixed layer is below 35%, with local presence of kaolinite, indicating that the clay minerals have exceeded the disordered mixed layer zone and entered the ordered mixed layer zone or approached the superlattice ordered mixed layer zone.

④ Composition, structure and pore types of sandstone cement: The elongate group sandstone is mainly of line contact, combined with point-line contact and convex-concave contact, the secondary increase of quartz is mostly in

grades I-II, the cement is calcite, silica, chlorite, mud, tuff, silica, illite, kaolinite, with the pore combination mainly being intergranular pores - solution pores.

According to the above marks, in accordance with the national petroleum and natural gas industry standard "Specification for Rock Formation Rock-forming Stage Division of Clastic Rocks", the rock formation evolution of the elongate group in the study area has undergone the early rock-forming stage A - early rock-forming stage B - late rock-forming stage A - late rock-forming stage B. Currently, it is mainly in the early stage of the late rock-forming stage A - late rock-forming stage B.

### 3.5. Reservoir Comprehensive Evaluation Classification

#### 3.5.1. Reservoir Pore and Throat Structural Characteristics

This study mainly conducted statistical analysis based on the capillary pressure curve data of 12 samples from wells 4010, 4012, and 40241. Additionally, it combined the analysis data of cast-fragment thin sections to analyze the pore structure characteristics of the reservoir sandstone in the Long7 oil layer group of the study area.

Based on the analysis results of the capillary pressure curves of the Long7 reservoir, the expulsion pressure ranged from 0.01 to 3.548 MPa, with an average expulsion pressure of 1.462 MPa; the median radius of the throat channels ranged from 0.045 to 9.337  $\mu\text{m}$ , with an average value of 4.32  $\mu\text{m}$ ; the pore throat sorting was generally uneven, with a sorting coefficient ranging from 0.076 to 6.596, and the average value

was 2.37; the mercury removal efficiency ranged from 12.567 to 37.811%, with an average of 24.54%; the maximum mercury saturation ranged from 24.101 to 90.66%, with an average value of 42.35% (Table 3). Overall, the Long7 reservoir in this area is average. According to the pore and throat classification standards of the Yanchang Formation in the Ordos Basin (Table 4), the microscopic structure of the Long7 reservoir in this area belongs to small pores and fine throats to fine throats to fine pores and micro-throats [19-20] (Figure 17).

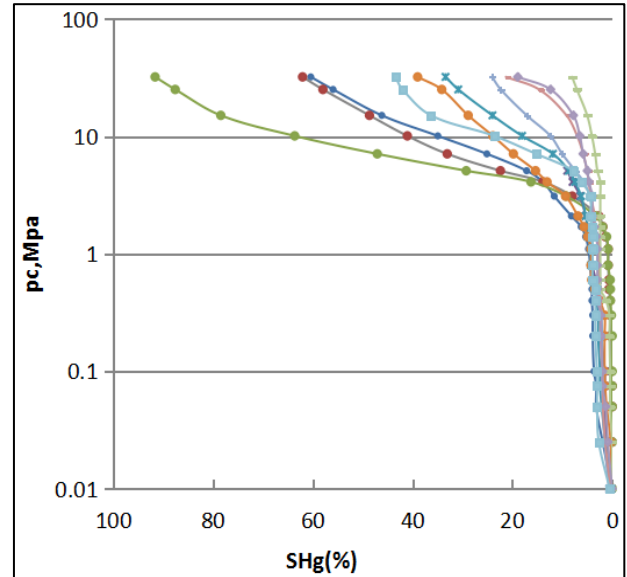


Figure 17. Schematic diagram of capillary pressure curve for the Long 7 oil layer group

Table 3. Grading Standards for Pores and Channels in Sandstone

Pore size level	Average aperture ( $\mu\text{m}$ )	Laryngeal level	Average laryngeal diameter ( $\mu\text{m}$ )
Large pores	>80	Coarse laryngeal passage	>3.0
Medium pores	80~50	Medium and fine laryngeal passage	3.0~1.0
Small pores	50~10	Fine laryngeal passage	1.0~0.5
Fine pores	10~0.5	Very fine laryngeal passage	0.5~0.2
Micropores	<0.5	Micro laryngeal passage	<0.2

Table 4. Statistical Table of Porosity Characteristics of Each Oil Layer Group in the Luopang Plain

Layer	Porosity (%)	Permeability (10 <sup>-3</sup> um <sup>2</sup> )	Throat Mean Value $\mu\text{m}$	Homogeneity Coefficient	Sorting Coefficient $\mu\text{m}$	Porosity Structure Coefficient	Median Pressure (MPa)	Median Radius (um)	Displacement Pressure (MPa)	Maximum SHg (%)	Mercury Retention Efficiency (%)	
Chang7	Maximum value	12.71	0.67	2.13	3.727	6.596	0.829	16.514	9.337	3.548	90.66	37.811
	Minimum value	5.70	0.09	0.06	0.01	0.076	0	0.02	0.045	0.01	24.101	12.567
	Average value	8.03	0.32	0.87	0.40	2.37	0.42	8.24	4.25	1.46	42.35	24.54

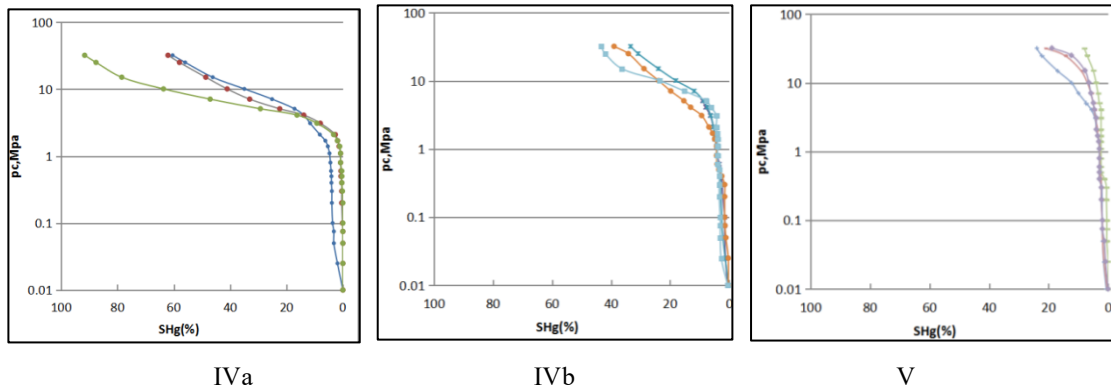
#### 3.5.2. Reservoir Classification and Evaluation

Based on the comprehensive analysis of reservoir properties, micro-pore structure characteristics, capillary pressure curve characteristics, and reservoir heterogeneity characteristics, combined with lithology and oiliness analysis, in accordance with the reservoir classification standards of the Shaanxi North region [14] (Table 5), the Long 7 reservoir mainly consists of types IVa, IVb, and V. The pore throat

combination is mainly small pores and fine throats to fine micro-throats type reservoirs, and the reservoir type belongs to ultra-low permeability layer to super-low permeability layer reservoirs [15]. The type V reservoirs belong to non-effective reservoirs. The other types of reservoirs are limited by core sampling and have not been observed in the study area. The characteristics of each type of reservoir will be described separately below, and the brief characteristics are as follows:

**Table 5.** Classification Criteria for Mesozoic Sandstone Reservoirs in the Ordos Basin (Zhao Jingzhou, 2007)

Classification parameters	Medium permeability layer	Low permeability layer	Very low permeability layer		Ultra-low permeability layer		Dense layer
	Class I	Class II	IIIa	IIIb	IVa	IVb	V
Permeability/ $10^{-3}\mu\text{m}^2$	500-50	50-10	10-5	5-1	1-0.3	0.3-0.1	<0.1
Porosity (%)	30-17	17-15	15-13	13-10	10-8	8-6	<6
Extraction pressure (MPa)	0.04	0.04-0.11	0.11-0.16	0.16-0.37	0.37-0.72	0.72-1.31	>1.31
Median pressure (MPa)	0.27	0.27-0.68	0.68-1	1-2.49	2.49-4.90	4.90-9.10	>9.10
Maximum pore throat radius / $\mu\text{m}$	16.96	16.96-7.05	7.05-4.63	4.63-2.01	2.01-1.03	1.03-0.57	<0.57
Median radius ( $\mu\text{m}$ )	2.73	2.73-1.10	1.1-0.74	0.74-0.3	0.3-0.15	0.15-0.08	<0.08
Mean throat diameter ( $\mu\text{m}$ )	4.18	4.18-1.77	1.77-1.22	1.22-0.52	0.52-0.27	0.27-0.15	<0.15
Hole-Channel Assembly	Large pore coarse larynx	Medium pore coarse larynx	Medium pore medium fine larynx	Small pore medium fine larynx	Small pore fine larynx	Fine-pore extremely fine larynx	Fine-micro-pore extremely fine larynx - micro-larynx
Estimate	Good	Good	Excellent Good	Medium	Bad	Worst	Not



**Figure 18.** Characteristics of capillary pressure curves of the Longpuan Depression area's Long7 reservoir layer

Type IVa reservoir: This type of reservoir is developed in the microfacies adjacent to the main channel, mainly composed of fine sandstone, with a sandstone thickness generally greater than 12 meters. The porosity is 8-11%, the permeability is  $0.3-0.67 \times 10^{-3} \mu\text{m}^2$ , the heterogeneity is moderately strong, and the pores are mainly intergranular pores - dissolution pores. The displacement pressure is 0.35-0.75 MPa, the throat mean diameter is 0.29-0.54  $\mu\text{m}$ , and the pore structure type is small pores - fine throat.

Type IVb reservoir: This type of reservoir is developed in the microfacies adjacent to the main channel, mainly composed of fine sandstone, with a sandstone thickness generally between 8 and 15 meters. The porosity is 6-8%, the permeability is  $0.1-0.3 \times 10^{-3} \mu\text{m}^2$ , the heterogeneity is strong, and the pores are mainly dissolution pores. The displacement pressure is 0.70-1.40 MPa, the throat mean diameter is 0.30-0.20  $\mu\text{m}$ , and the pore structure type is fine pores - very fine throat.

Type V reservoir: This is the ineffective reservoir of the Long 7 oil layer group in the area. The rock is dense, mainly

composed of siltstone and silt - fine feldspar sandstone. This type of reservoir is developed in the microfacies adjacent to the main channel, mainly composed of fine sandstone, with a sandstone thickness generally less than 8 meters. The porosity is less than 8%, the permeability is less than  $0.1 \times 10^{-3} \mu\text{m}^2$ . The displacement pressure is greater than 1.40 MPa, the throat mean diameter is less than 0.20  $\mu\text{m}$ , and the pore structure type is fine - very fine pores - very fine throat (Figure 18).

### 3.5.3. Reservoir Comprehensive Evaluation Results

Based on physical property parameters, a preliminary classification and evaluation of the Longjiang Group 7 reservoir was conducted. The results showed that the Longjiang Group 7 reservoir consists of three types of reservoirs: IVa, IVb, and V. The reservoir properties are moderate, and the effective reservoirs are mainly IVa, followed by IVb. The pore throat combination is mainly small pores and fine throats to fine micro-throats, belonging to extremely low permeability - ultra-low permeability tight reservoirs [16-18] (Table 6).

**Table 6.** Comprehensive Evaluation Results of the Long 7 Reservoir in the Luopang Plain Area

Reservoir type	Class I	Class II	IIIa	IIIb	IVa	IVb	V
Chang7	\	\	\	\	30.6%	23.4%	46.0%

## 4. Conclusion

(1) The Long7 oil layer group is mainly composed of lithic

feldspar sandstone and feldspar sandstone, with fine grain structure, moderate sorting and poor rounding; the filling materials are mainly chlorite, calcite and kaolinite, and the

cementation types are diverse.

(2) The average porosity of the reservoir is 8.2% and the average permeability is  $0.32 \times 10^{-3} \mu\text{m}^2$ , which is an ultra-low permeability and dense reservoir; the pores are mainly intergranular pores and feldspar dissolution pores, and the pore throats are small and fine throat - fine micropore type.

(3) The diagenesis is complex. Compression and cementation are the main controlling factors for densification, and dissolution is the key to improving physical properties; the reservoir is currently in the late diagenetic A period - early stage of the late diagenetic B period.

(4) The reservoir is divided into three types: IVa, IVb and V. The effective reservoir accounts for 54%. Exploration should prioritize the development areas of IVa and IVb reservoir types.

## References

- [1] Jia, C. Z., Zheng, M., & Zhang, Y. F. (2012). China's unconventional oil and gas resources and exploration and development prospects. *Petroleum Exploration and Development*, 39(2), 129–136.
- [2] Li, G. X., Lei, Z. D., Dong, W. H., et al. (2022). Progress, challenges and prospects of China's unconventional oil and gas development. *China Petroleum Exploration*, 27(1), 1–11.
- [3] Zou, C. C., Yang, Z., Zhang, G. S., et al. (2023). Theoretical and technical aspects of unconventional oil and gas geology. *Earth Sciences*, 48(6), 2376–2397.
- [4] Zou, C. C., Zhao, Q., Wang, H. Y., et al. (2021). Theoretical and technical aspects of unconventional oil and gas exploration and development facilitate oil and gas reserves increase and production enhancement in China. *Petroleum Science and Technology Forum*, 40(3), 72–79.
- [5] Yao, J. L., Deng, X. Q., Zhao, Y. D., et al. (2013). Characteristics of tight oil in the Yanchang Formation of the Ordos Basin. *Petroleum Exploration and Development*, 40(2), 150–158.
- [6] Yang, H., Li, S. X., & Liu, X. Y. (2013). Characteristics of tight oil and shale oil in the Ordos Basin and resource potential. *Acta Petrolei Sinica*, 34(1), 1–11.
- [7] Fu, J. H., Yu, J., Xu, L. M., et al. (2015). New progress and scale accumulation factors of tight oil exploration and development in the Ordos Basin and the main controlling factors for large-scale accumulation. *China Petroleum Exploration*, 20(5), 9–19.
- [8] Jia, C. Z., Zou, C. C., Li, J. Z., et al. (2012). Evaluation criteria, main types, basic characteristics and resource prospects of tight oil in China. *Acta Petrolei Sinica*.
- [9] Wang, Q., Zhu, X. Z., Chen, G. J., et al. (2005). Petrogenetic evolution characteristics and distribution of high-quality reservoirs of the Long4+5 sandstone in the Salt Pool-Ji Yuan Area of the Ordos Basin. *Journal of Sedimentology*, 23(3), 397–405.
- [10] Wen, H. G., Zheng, R. C., Chen, H. D., et al. (2007). Characteristics of Long6 sandstone reservoirs in the Bai Bao-Huachi Area of the Ordos Basin. *Acta Petrolei Sinica*, 28(4), 46–51.
- [11] Zhang, W. Z., Yang, H., Li, J. F., et al. (2006). On the dominant role of high-permeability source rocks in the accumulation of low-permeability oil and gas in the Long7 section of the Ordos Basin — Analysis of strong hydrocarbon generation characteristics and mechanism. *Petroleum Exploration and Development*, 33(3), 289–293.
- [12] Zhang, Z. H., Wei, X. S., Gong, H. J., et al. (2020). Petrogenesis and pore evolution laws of the Long7 tight sandstone reservoirs in the Dingbian Oilfield. *Oil Geology and Recovery Rate*, 27(2), 43–52.
- [13] Zhao, J. Z., Gao, Z. D., Meng, X. G., et al. (2026). Gravity flow sedimentary characteristics and exploration potential of the Long7-Long9 oil layers in the Shaanxi North Area of the Ordos Basin and the petroleum exploration paradigm of orogenic depression-type lake basins. *Oil and Gas Geology and Recovery Rate*, 1–25.
- [14] Zhao, J. Z., Wu, S. B., & Wu, F. L. (2007). Classification and evaluation criteria of low permeability reservoirs — Taking the Ordos Basin as an example. *Lithologic Oil and Gas Reservoirs*, (3), 28–31, 53.
- [15] Bai, Y. W., Zhang, G., Li, C. S., et al. (2020). Analysis of fractal characteristics of tight oil reservoirs based on mercury intrusion experiment — Taking the Long7 oil layer of the Dingbian Oilfield of the Ordos Basin as an example. *Journal of Guilin University of Technology*, 40(1), 60–67.
- [16] Xiao, L., Tian, J. C., Wei, Q. L., et al. (2007). Pore structure characteristics of Long6 reservoirs in the Wuqi Area of the Ordos Basin. *Xinjiang Geology*, (1), 101–104.
- [17] Liu, J. Y., Chen, S. M., Shen, Z. Y., et al. (2025). Microscopic pore structure characteristics of tight reservoirs and their influence on flow characteristics: A case study of the Chang6 reservoir in Jiyuan area of Ordos Basin. *Journal of Jilin University (Earth Science Edition)*, 55(5), 1434–1444.
- [18] Xu, Y. Q. (2019). Research on Microscopic Pore Throat Characteristics and Classification Evaluation of Chang7 Tight Sandstone Reservoirs in Longdong Area of Ordos Basin [Master's thesis]. Northwest University.
- [19] Zheng, Q. H., & Liu, Y. Q. (2015). Diagenesis and diagenetic facies of the Chang4+5 tight oil layers in Huacun Area of Ordos Basin. *Advances in Earth Science*.
- [20] Yu, C. Y. (2021). Pore structure characteristics and formation mechanism of Chang8 tight sandstone reservoirs in Fuxian Area. *Unconventional Oil and Gas*.
- [21] Zou, C. C., Yang, Z., Zhang, G. S., et al. (2014). Understanding and practical significance of the "Ordered Aggregation" theory of conventional-nonconventional oil and gas. *Petroleum Exploration and Development*.