Research Article

Oil Accumulation Model and Its Main Controlling Factors in Lower Yanchang Formation, Wuqi-Dingbian Area, Ordos Basin, China

Jintao Yin,1,2 Chao Gao,1,2 Mingjun Zhu,3 Hui Wang,1,2 Peng Shi,1,2 Yi yi Chen,1,2 Qianping Zhao,1,2 Lixia Zhang,1,2 and Bo Yu1

1Shaanxi Yanchang Petroleum (Group) Corp. Ltd., Xi’an 710075, China
2Shaanxi Key Laboratory of Lacustrine Shale Gas Accumulation and Exploitation, Xi’an 710075, China
3The Third Institute of Resources and Environment Survey of Henan Province, Zhengzhou 253000, China

Correspondence should be addressed to Chao Gao; ygaochao@qq.com

Received 3 March 2021; Revised 23 March 2021; Accepted 15 April 2021; Published 6 May 2021

Academic Editor: Feng Xiong

Copyright © 2021 Jintao Yin et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Based on the studies of sedimentary facies, oil-source correlation, formation pressure structure, homogenization temperature of fluid inclusions, etc., the oil and gas accumulation model and main controlling factors in lower Yanchang Formation in Wuqi-Dibian area have been discussed. It is believed that two sets of source rocks, C7 and C9, are developed in study area, and hydrocarbon produced from layers of C8 and C9 is mainly from C7 source rock, followed by C9, according to oil-source correlation; hydrocarbon-generating pressurization of C7 source rock is the main driving force for the downward migration of oil. The high value area formed by the low value of overpressure difference between C7 and C8 is the main hydrocarbon accumulation area; deltaic front subaqueous distributary channel and mouth bar in lower Yanchang formation are the main accumulation spaces due to their good porosity and permeability; besides, C8 reservoir shows the characteristics of "episodic filling and continuous accumulation," and they both are the undersource reservoir-forming combination; it is believed that the distribution of oil reservoir in Triassic series is controlled by the factors of "near source, low pressure, superior facies."

1. Introduction

Ordos Basin is a cratonic hydrocarbon-bearing basin with polycyclic sedimentary, and it is also the second largest sedimentary basin in China due to its prolific hydrocarbon resources [1–3]. Chang10 (C10)-Chang1 (C1) reservoir groups in Triassic, Mesozoic, are the main oil-bearing series within the basin with a wide distribution area in the horizontal direction and multiple oil-bearing combination series in vertical direction. And Chang7 (C7)-C10 reservoir groups are called lower combination.

In recent years, commercial oil flow has been obtained through the lower reservoir group combination prospecting within the structural belt of Shaanbei slope and Tianhuan depression in Ordos Basin, such as reservoirs of Xifeng, Jiyuan, Wuqi, and Dingbian, among which the main production layer is the Chang8 (C8) reservoir group. The discovery of lower combination shows the prolific hydrocarbon resources in the layer and has been paid much attention. However, the previous research was mainly focused on the sedimentary facies and reservoir characteristics of lower Yanchang formation [4–6], and migration and accumulation mechanism of oil and gas was not studied thoroughly. Thus, accumulation mechanism and controlling factors of reservoir groups in lower Yanchang formation will be discussed in this paper through the study of geochemical characteristics, pressure structure characteristics, and of reservoir forming characteristics and model. The further understanding of reservoir-forming mechanism of lower combination in lower Yanchang formation would help to improve reservoir-forming theory of Yanchang formation and guide the future oil and gas exploration in lower combination fields.
2. Geological Setting

Wuding area is mainly located in the middle zone of western part of Yishaan slope in Ordos Basin and across over the eastern edge of Tianhuan depression (Figure 1). Several mild nose-shaped uplifts in different scales have developed in Yishaan slope dipping from east to west [7–10]. Dip angles of both the limbs are relatively low, usually less than 1.5°.

Study area locates in the middle zone of western edge of the basin, and the lower Yanchang formation belongs to fluvial-lacustrine-deltaic deposit system where mainly develops shallow water delta and deltaic front subaqueous distributary channel deposits. The most favorable sedimentary facies belts are deltaic front subaqueous distributary channel and channel mouth bar sands. Sand bodies from delta front are relatively high in both the structural and compositional maturity due to the fluvial and lacustrine transformation effect. Besides, in addition to corrosion effect, these sand bodies were high in original porosity before sedimentary happens, and thus, secondary dissolution pore developed forming accumulation spaces with good porosity and permeability.

3. Methods

Because of the irreversibility of the sediment compaction effect, the fluid pressure calculated by the equilibrium depth method from the compaction curve reflects the formation pressure distribution under the state of maximum buried depth in this area. Due to the influence of regional-sedimentary history, most areas of the Ordos Basin had the maximum burial depth at the end of the Early Cretaceous, so the calculated excess pressure more reflected the situation of this period. In this study, the acoustic time difference values of 16 representative Wells in each area were selected, and the normal compaction trend line was drawn on the curve of relation between acoustic time difference and buried depth. In this paper, the acoustic time difference values of 160 Wells were read, of which 9 Wells had no abnormal pressure. Combined with the parameters of C value in each zone, the acoustic time difference values of 151 Wells were calculated by the recovery of equilibrium depth, formation pressure, hydrostatic pressure, and excess pressure. According to the maximum formation pressure of a single well, the overpressure plane and profile of Chang 7 are compiled.

4. Results

4.1. Geochemistry of Source Rocks. Mesozoic source rock series in Ordos Basin are mainly Triassic mudstone, and shale in Yanchang formation distributed within the area of \(10 \times 10^4 \text{ km}^2\) in southern part of the basin (Figure 2). Hydrocarbon source rocks of C7 are the main oil-bearing strata, the thermal evolution degree of which has reached the oil generation peak [11–13], followed by the source rocks of Chang9 (C9), the black mud shale of which has distributed in a relatively small scale compared to that of C7.

According to the maturity evaluation index of organic matter and tested data (Table 1), Ro values of C7 Shale are 0.85%–1.18%, while the maximum pyrolysis peak temperatures, \(T_{\text{MAX}}\), are 450–470°C. Conversion rate of asphalt “A” is relatively high, and average value of odd-even carbon ratio (OEP) of organic matter is between 1.00 and 1.02, meaning that the most parts of Wuding area with distribution of C7 have reached the peak stage of mature-highly mature oil generation phase when hydrocarbon generation potential is high.

4.2. Oil-Source Correlation. The following conclusions are made after the C7 sample test of hydrocarbon source rock: (1) rearrangement hopanoid \(C_{29} < \text{hopanoid } C_{35}\) (2) \(T_m < T_s\) (Ts represents 18 Ah-22.29.30-norhopane; \(T_m\) represents 17 Ah-22.29.30-norhopane); (3) \(C_{27}\) regular sterane and \(C_{28}\) and \(C_{29}\) regular sterane show asymmetric V-shaped distribution (Figure 3), with a relatively high content [14–17].

It is seen from the comparison graph of the symbol compounds, terpane and sterane biomarkers, that hopanoid \(C_{30}\) is predominant in C8 crude oil, and the amount of \(T_m\) is relatively high while that of gammacerane is relatively low. \(C_{27}\) regular sterane is high in amount, and \(C_{28}\) and \(C_{29}\) show the distribution of asymmetric V-shaped [18–20]. Geochemical parameters of crude oil show that both C7 and C8 shales are high quality source rocks. They both are relatively high in the amount of hopanoid \(C_{30}\) and \(T_m < T_s\). Their sterane distribution patterns are similar with high amount of \(C_{27}\) regular sterane, and \(C_{28}\) and \(C_{29}\) regular steranes show the asymmetric V-shaped distribution (Figure 4). These characteristics are obviously different from those of C8 crude oil, meaning that crude oil of C8 formation in Wuding area is derived from hydrocarbon source rock in C7 formation [21–23].

4.3. Hydrocarbon Accumulation Stage. Homogenization temperature test of fluid inclusions has been conducted to analyze the hydrocarbon filling time in study area showing that the homogenization temperature continuously distributes in a wide area and between 70 and 170°C; this means that during the filling process, none of big tectonic events have happened, showing the characteristics of continuous hydrocarbon filling. An obvious temperature peak zone is shown between 80–100°C and 120–130°C (Figure 5) meaning hydrocarbon migration and filling in study area is a continuously episodic filling process and has changed from strong to weak and then again from weak to strong. Two peaks mean that episodic filling has happened twice [24, 25].

4.4. Reservoir Characteristics. According to the analysis of rock samples, the lithology of the C8 reservoir in Wuqi-Dingbian Oilfield is mainly light to dark gray, fine to very fine-grained lithic arkose, and less arkose and feldspathic litharenite. The average content of quartz, feldspar, and debris is 31.05%, 34.18%, and 17.54%, respectively. The main composition of debris is metamorphic debris, followed by igneous debris, and the content of unstable and plastic debris is high. The fillings in the reservoir sandstone are high, with an average content of 15.41%. The fillings are mainly iron calcite (4.55%), followed by chlorite (3.65%) and kaolinite (2.78%) (Figure 6). Most of the rock samples are fine
sandstone. The particle size is 0.03-0.60 mm, and the maximum is 0.85 mm. The rock particles are better or moderately sorted, subprismatic, and poor in roundness. The cementation types are pore, enlarged pore, and membrane pore types (Figure 6).

According to core data from 145 wells, the porosity of the C8 reservoir is 6%-17.12%, mainly 8.0-12.0%, average 7.9%, and median 9.1%; the permeability is $0.1-5 \times 10^{-3} \mu m^2$, mainly $0.1-1.18 \times 10^{-3} \mu m^2$, and average $0.62 \times 10^{-3} \mu m^2$. The permeability of most samples is less than $5 \times 10^{-3} \mu m^2$, and the samples with permeability less than $1 \times 10^{-3} \mu m^2$ account for 71.7%.

4.5. Characteristics of Overpressure. Formation pressure structure is the vertical development characteristics of overpressure system and the transition relationship between overpressure system and overlying normal pressure system. Formation pressure structure is closely related to oil-gas accumulation and preservation [26–29]. The pressure structure of overpressure basin is divided into three types: mutant pressure structure (Type A), gradually varied pressure structure (Type B), and superimposed pressure structure (Type C). Yanchang formation in study area mainly develops mutant and superimposed pressure structures. The paleopressure and residual pressure calculations using sonic time difference and resistivity log are limited to mudstones. This study mainly uses the AC log to study the abnormal pressure.

Using the abovementioned method, the paleopressure and residual pressure at the key accumulation period (late Early Cretaceous) were calculated. Figure 7 shows the ancient residual pressure profile in the late Early Cretaceous from well Ding1188 to well Dingtan 4986. It is seen from pressure structure profile (Figure 7) that, from well Ding1188 to Dingtan 4986, C7 is the formation where the maximum residual pressure distributes (>20 MPa), usually higher than 25 MPa, and the pressure is mainly locates in lower C7 formation with good continuity and extending more than 110 km; the residual pressure of C8 fluid is lower, most of which is <15 MPa. Overpressure of C7 and C8 is usually higher than 10 MPa, providing driving force for oil downward migration.
5. Discussions

5.1. Controlling Factors of Hydrocarbon Accumulation.
Through the study of source rock distribution, reservoir distribution, abnormal pressure, and reservoir forming mechanism, it is concluded that the controlling factors for oil-gas accumulation are “near source, superior facies, low pressure.”

5.1.1. Near Source. Source rock is the material basic for reservoir forming. It is believed that the dark mudstone deposited during C7 period of the Yanchang group in Ordos Basin is the main hydrocarbon source rock with the characteristics of high thickness, wide distribution, high organic matter amount, good in organic matter types, and high maturity [30, 31]. Widely spread deep and semideep lacustrine mudstone in C7 formation is the main oil-generation rock series in study area providing oil source.

Controlled by hydrocarbon source rock, sandstone deposited during C8 period, which is close to C7 dark mudstone, captures relatively high amount of oil and gas and thus more reservoir forms. It is seen from the number of wells in C8-C10 in the Yanchang group obtaining commercial oil flow (Table 2) that the closer the well to C7 source rock, the more reservoir distributes. That is, the number of wells in C7-C10 obtaining commercial oil flow is inversely proportional to the distance it is away from C7 bottom.

5.1.2. Superior Facies. Reservoir development is closely related to the sedimentary system and sedimentary facies. Superior sedimentary and diagenesis facies are advantages of forming thick reservoir with good physical properties which favors oil accumulation. Research shows that the high thickness and strong anticompaction capacity of sand body favor the preservation of intergranular pores resulting in high surface porosity, good connectivity among pore throat, and good physical properties, and these are the main areas for oil-gas accumulation. In study area, deltaic front subaqueous distributary channel and channel mouth bar are where deltaic sand body develops, especially the deltaic front subaqueous distributary channel where the sand granularity is relatively coarse, and the sand has been through the fluvial and lacustrine transformation effect leading to good sorting. Thus, pores are well developed, and permeability is good leading to good reservoir physical properties.

5.1.3. Low Pressure. High overpressure difference is prevalent in C7 and C8 formation in study area, and it is the main driving force for oil migrating downward. Under the control of
Table 1: Organic geochemical parameters of C7 members in study area.

| Layer  | "A" (%) | Tmax (°C) | Total organic carbon TOC (%) | Potential hydrocarbon generation amount $S_1, S_2$ (mg/g) | Saturated hydrocarbons (%) | Aromatic (%) | Conversion rate of asphalt "A" (%) | Ro (%) | OEP |
|--------|---------|-----------|-------------------------------|------------------------------------------------------|----------------------------|--------------|-----------------------------------|--------|-----|
| Chang7 | 0.1 ~ 1.0 | 450 ~ 470 | 2.45 ~ 5.28                   | 2.51 ~ 7.10                                         | 142 ~ 65.5                 | 19.57 ~ 21.8 | 3.60 ~ 41.59                      | 12.86  | 0.85 ~ 1.18 | 1.07 | 0.99 ~ 1.09 | 1.02 |

Hydrocarbon (saturated and aromatic) amount of asphalt "A" of the source rocks in C7 is between 45% and 70%, while the ratio of saturated and aromatic hydrocarbon is between 0.72 and 3.7 (Table 1), meaning that the kerogen of C7 in Wuding area is mainly type II$_2$ (sapropelic-humic type), which is a good hydrocarbon source rock.
overpressure, oil migrates from high pressure zone to low pressure zone. Thus, low pressure zone with a high pressure background is the main space for oil and gas accumulation.

5.2. Migration and Accumulation Model. During middle and late early cretaceous, research has been through regional great subsidence, and the new deposition happened reaching its maximum until early late cretaceous [32]. Meanwhile, thermal evolution of hydrocarbon source rock in C7 formation has reached its hydrocarbon generation peak, large amount of oil and gas forms and moves downward under the control of overpressure and thus forms reservoir.

**Figure 3:** Characteristics of terpene hydrocarbon and sterane distribution of C7 source rocks of Dingtan3155 well in study area: (a) terpane; (b) sterane.

**Figure 4:** Comparison graph of biomarker terpene and sterane hydrocarbon of crude oil of C8 of C46 well: (a) terpane; (b) sterane.

**Figure 5:** Histogram showing homogenization temperatures of fluid inclusions of C8 in study area.
Figure 6: Cement and pore characteristics. (a) Kaolinite cements, D 1184 well, 20(-), C8. (b) Ferric calcite cement, 10(+), D 1729 well. (c) Turbidite cementation, 10(+), C 3604 well, C8. (d) Ingranular and intergranular, (-) 10, 81, D 4225 well. (e) Intergranular solution hole, 10(-), 4267 well, C8. (f) Intergranular solution pore of zeolite, 3604 well, C8.
Through the study of abnormal pressure, it is proved that the reservoir in the Yanchang group in middle zone of the southern part of Ordos Basin is "upper source and lower reservoir formation" [33]. Abnormal pressure is not only the driving force for oil-gas migration and accumulation but an important factor controlling the oil-gas distribution [34]. In Wuding area, C7 and C8 formation, located below C7, usually show relatively high overpressure difference which is usually 8 ~ 12 MPa and higher than 12 MPa in some area. Overpressure difference is the driving force for hydrocarbon downward migration.

Hydrocarbon has migrated both vertically and horizontally. Under the abnormal pressure, oil-gas produced from C7 source rock partially moved upward forming reservoir of which C6 is its main accumulation space, and the other part moved downward forming C8 reservoir and even reached C9 where overpressure is high. Further research shows that there are four reservoir forming types: (1) the reservoir comes into direct contact with source rock, (2) oil and gas are transported and accumulated by superimposed permeate sand body, (3) oil and gas are transported and accumulated through fluid pressure cracks, and (4) oil and gas are transported and accumulated through superimposed permeate sand body and fluid pressure cracks.

6. Conclusions

(1) Oil source correlation shows that oil and gas in C8 and C9 formation in Wuding area mainly come from hydrocarbon source rocks in C7 followed by that in C9.

(2) Pressure increase due to hydrocarbon generation in C7 formation in the Yanchang group in study area is the main driving force for oil downward migration. The relatively low pressure zone developed during C7 and C8 period of early cretaceous is the favorable direction of oil and gas migration. The high value area of C7 and C8 with a background of low overpressure difference is the main space for oil and gas accumulation in lower combination of the Yanchang group.

(3) C8 and C9 reservoirs in the Yanchang group in study area show the characteristics of "episodic filling and

---

**Table 2:** Relationship between the number of commercial oil wells of C8-C10 and the distance of C7.

| Distance to C7 bottom (m) | 0 ~ 15 | 15 ~ 30 | 30 ~ 45 | 45 ~ 60 | 60 ~ 75 | 75 ~ 90 | 90 ~ 105 | 105 ~ 120 | Total |
|--------------------------|--------|---------|---------|---------|---------|---------|----------|-----------|-------|
| The number of commercial oil wells | 19 | 12 | 12 | 8 | 5 | 6 | 3 | 2 | 67 |

---

**Figure 7:** Residual pressure profiles of well Ding1188-well Dingtan4986 of Yanchang Group in Wuqi-Dingbian.
continuous accumulation,” and they both belong to the same reservoir-forming combination, that is, undersource reservoir-forming combination. Four main reservoir forming types are developed in lower combination: the reservoir comes into direct contact with source rock, oil and gas are transported and accumulated by superimposed permeate sand body, oil and gas are transported and accumulated through fluid pressure cracks, and oil and gas are transported and accumulated through superimposed permeate sand body and fluid pressure cracks

(4) Through the research of sedimentary, reservoir, abnormal pressure and reservoir-forming mechanism, etc., it is concluded that reservoir distribution in the Yanchang group in study area is mainly controlled by factors of “close source, low pressure, superior facies”

Data Availability
The data used to support the findings of this study are included within the article.

Conflicts of Interest
The authors declare that no conflicts of interest exit regarding the submission of this paper.

Acknowledgments
This study was supported by the Major national science and technology projects (no. 2017ZX05039001-005) and the Research project of Yanchang Oil Field Co., Ltd. (ycsy2020ky-B-10).

References
[1] H. Yang and W. Z. Zhang, “Leading effect of the seventh member high-quality source rock of Yanchang Formation in Ordos Basin during the enrichment of low-penetrating oil-gas accumulation: geology and geochemistry,” Geochimia, vol. 34, no. 2, pp. 147–154, 2005.
[2] W. Li and C. Panfeng, “Study on the sedimentary facies of Chang 8 oil-bearing bed in Xifeng oilfield, Erduosi basin,” Journal of Xi’an Petroleum Institute: Science & Technology Edition, vol. 18, no. 6, pp. 26–29, 2003.
[3] W. T. Wang, R. C. Zheng, C. Y. Wang, H. H. Wang, Y. L. Han, and C. Y. Wang, “Provenance analysis of the 8th oil-bearing member of Yanchang Formation, Upper Triassic, Jiyuan area, Ordos Basin,” Lithologic Reservoirs, vol. 21, no. 4, pp. 41–43, 2009.
[4] D. Yi, Y. Wexiu, L. Xianyang et al., “Oil migration and accumulation rules of Chang-9 oil-bearing formation in the Ordos Basin,” vol. 83, no. 6, pp. 855–857, 2009.
[5] M. Fangxia, L. Xiaolu, Z. Qing, C. Yiguo, and D. Xinting, “Exploration of lithologic reservoirs in Chang8 oil-bearing formation of Jiangiachuan area in the Fuxian oilfield,” Special Oil & Gas Reservoirs, vol. 25, no. 4, pp. 18–23, 2018.
[6] B. Li, R. Bao, Y. Wang, R. Liu, and C. Zhao, “Permeability evolution of two-dimensional fracture networks during shear under constant normal stiffness boundary conditions,” Rock Mechanics and Rock Engineering, vol. 54, no. 1, pp. 409–428, 2021.
[7] L. Yuan-hao, The Oil Reservoir Forming Mechanisms and Its Main Controlling Factors of the Lower Yanchang Formation in the Middle of the West Ordos Basin, Northwestern University, Xi’an, 2008.
[8] D. Weitan, H. Mingcai, and C. Hongde, “A research on the conditions of the reservoir formation and the main controlling factors of Upper Triassic Yanchang Formation in Ordos Basin,” Journal of Chengdu University of Technology (Science & Technology Edition), vol. 35, no. 6, pp. 686–692, 2008, (in Chinese with English abstract).
[9] G. Yanqin, L. Wenhou, C. Quanhong, C. Hongxia, and Z. Daofeng, “Geochemical behaviors of oil and oil-source correlation in Yanchang Yan Formations in Ansai-Fuxian area, Ordos basin,” Oil & Gas Geology, vol. 27, no. 2, pp. 218–224, 2006.
[10] H. Zong-yuan, M. I. Jian-yu, and B. U. Zhan-qi, “The comparative study on organic geochemical characters of the mesozoic source rocks in T3y and J2y of Zhenyuan in Ordos Basin,” Geoscience, vol. 21, no. 3, pp. 532–537, 2005.
[11] L. Lei, H. J. Qu, J. Y. Miao, Y. H. Fan, and Y. Z. Wan, “Oil-source correlation of source rocks in Wuding Area, Ordos Basin,” Inner Mongolia Petrochemical Industry, vol. 19, pp. 64–66, 2009.
[12] Z. G. Tao, C. Zhu, M. C. He, and M. Karakus, “A physical modeling-based study on the control mechanisms of Negative Poisson’s ratio anchor cable on the stratified toppling deformation of anti-inclined slopes,” International Journal of Rock Mechanics and Mining Sciences, vol. 138, p. 104632, 2021.
[13] Q. X. Meng, W. Y. Xu, H. L. Wang, X. Y. Zhuang, W. C. Xie, and T. Rabczuk, “DigiSim – an open source software package for heterogeneous material modeling based on digital image processing,” Advances in Engineering Software, vol. 148, p. 102836, 2020.
[14] H. J. Wang and X. M. Huang, “Pressure structure and petroleum distribution in Tazhong area,” Experimental Petroleum Geology, vol. 21, no. 3, pp. 242–245, 1999.
[15] Y. Yang, G. Zhengquan, H. Jinxiu, and D. Jin-liang, “Overpressure relation to oilfields in Yanchang Formation SW Ordos Basin,” Journal of Earth Sciences and Environment, vol. 28, no. 2, pp. 49–52, 2006.
[16] C. Liu, J. Wang, X. Qiu et al., “Geodynamic environment and tectonic attributes of the hydrocarbon-rich sag in Yanchang Period of Middle-Late Triassic, Ordos Basin,” Acta Petrologicas Sinica, vol. 36, no. 6, pp. 1913–1930, 2020.
[17] W. Z. Zhang, H. Yang, J. F. Li, and J. Ma, “Leading effect of high-class source rock of Chang 7 in Ordos Basin on enrichment of low permeability oil-gas accumulation—hydrocarbon generation and expulsion mechanism,” Petroleum Exploration and Development, vol. 33, no. 3, pp. 289–293, 2006.
[18] H. Huang, T. Babadagli, X. Chen, H. Li, and Y. Zhang, “Performance comparison of novel chemical agents for mitigating water-blocking problem in tight gas sandstones,” SPE Reservoir Evaluation & Engineering, vol. 23, no. 4, pp. 1150–1158, 2020.
[19] Q. Wang, H. K. Gao, B. Jiang, S. Li, M. He, and Q. Qin, “In-situ test and bolt-grouting design evaluation method of underground engineering based on digital drilling,” International Journal of Rock Mechanics and Mining Sciences, vol. 138, article 104575, 2021.
[20] W. Xiangzeng, G. Shengli, and G. Chao, "Geological features of mesozoic continental shale gas in south of Ordos Basin, NW China," *Petroleum Exploration and Development*, vol. 41, no. 3, pp. 294–304, 2014.

[21] L. I. M. Cheng, S. H. A. N. Xiuf-Qin, M. A. Cheng-Hua, and H. U. Guo-Yi, "An approach to hydrocarbon accumulation period," *Xinjiang Petroleum Geology*, vol. 26, no. 5, pp. 587–591, 2005.

[22] L. Yuanhao, L. Chiyang, W. Xiujuan, and D. Yuguo, "Episodic migration and accumulation of hydrocarbon in lower Yan-chang Formation of the northwestern Ordos Basin," *Acta Petrolei Sinic*, vol. 30, no. 1, pp. 61–67, 2009.

[23] H. Fang, *Kinetics of Hydrocarbon Generation and Mechanism of Petroleum Accumulation in Overpressured Basins*, Science Press, Beijing, 2005.

[24] M. Zha, J. X. Qu, and W. H. Zhang, "The relationship between overpressure and reservoir forming mechanism," *Petroleum Exploration and Development*, vol. 29, no. 1, pp. 19–22, 2002.

[25] H. J. Qu, R. H. Pu, S. Chen, S. L. Gao, and Y. R. Zheng, "Controls of facies-potential coupling on oil accumulation in the Mesozoic Ordos Basin," *Oil & Gas Geology*, vol. 44, no. 4, pp. 752–762, 2019.

[26] W. Chongjun and X. Shuhao, *Sedimenology of Petroliferous Basins in China*, Petroleum Industry Press, 1993.

[27] X. Wang, S. Gao, and C. Gao, "Geological features of Mesozoic continental shale gas in south of Ordos Basin, NW China," *Petroleum Exploration and Development*, vol. 41, no. 3, pp. 294–304, 2014.

[28] Y. Wang, C. H. Li, H. Liu, and J. Q. Han, "Fracture failure analysis of freeze-thawed granite containing natural fracture under uniaxial multi-level cyclic loads," *Theoretical and Applied Fracture Mechanics*, vol. 110, p. 102782, 2020.

[29] D. Ren, F. Yang, R. Li, D. Zhou, D. Liu, and Y. Li, "Insight into the pore structures and its impacts on movable fluid in tight sandstones," *Geofluids*, vol. 5, 11 pages, 2020.

[30] Q. Wang, Q. Qin, B. Jiang et al., "Mechanized construction of fabricated arches for large-diameter tunnels," *Automation in Construction*, vol. 124, article 103583, 2021.

[31] D. Ren, H. Huang, J. Qi, and P. Zheng, "One-pot template-free cross-linking synthesis of SiOx–SnO2@C hollow spheres as a high volumetric capacity anode for lithium-ion batteries," *Energy Technology*, vol. 8, no. 7, article 2000314, 2020.

[32] D. Pengfei, Z. Gang, and A. Shan, "Characteristics of reservoir and accumulation model of 9th member of Yan’an Formation in Fanxue Area, Dingbian Oilfield," *Unconventional Oil & Gas*, vol. 4, pp. 16–22, 2020.

[33] Z. Chuanjiang, L. Yurong, W. Chenglong et al., "Hydrocarbon accumulation conditions and enrichment regularity of Chang-6 reservoirs in Sancaowan Region of Zhidan Oilfield," *Unconventional Oil & Gas*, vol. 5, pp. 1–10, 2019.

[34] W. Caixia, L. Danfeng, and C. Lijun, "Reservoir-forming characteristics and exploration direction of north of Gaotai-Maojihae reservoir in Zibeif Oilfield," *Unconventional Oil & Gas*, vol. 2, pp. 26–34, 2020.