

Inspiration and application value analysis of Chang 4+5 reservoir geological characteristics for exploration and development

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Abstract: This paper takes the Chang 4+5 oil formation as the research object, and explores its implications and application value for exploration and development through the analysis and research of its geological characteristics. Firstly, the geological background of the Chang 4+5 oil formation is introduced, and its stratigraphic, structural, sedimentary and lithological characteristics are analyzed. Secondly, combined with practical cases, the influence of the geological characteristics of the Chang 4+5 oil formation on exploration and development is discussed, as well as how to use these characteristics to improve the efficiency and quality of exploration and development. Finally, the application value of the geological characteristics of the Chang 4+5 oil formation is summarized, and the future research direction and focus are pointed out.

Keywords: Chang 4+5 oil formation; Geological characteristics; Exploration and development; Application value.

1. Introduction

1.1. Research Background

With the development of the global economy and the increasing population, the demand for energy is also increasing. As a major fossil energy, oil is of great significance to global energy security and economic development. However, the development and utilization of oil resources face increasingly severe challenges, including the depletion of global oil resources, the rise in oil production costs, and environmental pollution. In this context, exploration and development of oil resources are particularly important. The Chang 4+5 oil layer is one of the common oils and gas formations in the western region of mainland China, with a wide distribution and rich oil and gas resources. However, due to the complex geological characteristics and high-risk exploration and development conditions, there have long been problems such as difficult exploration and development and unsatisfactory results [1].

Therefore, in-depth study of the geological characteristics of the Chang 4+5 oil layer and exploring its insights and application value for exploration and development has important practical significance and scientific value. By analyzing and studying the geological characteristics of the Chang 4+5 oil layer, it can provide important references and guidance for petroleum exploration and development, and promote the effective development and utilization of energy resources.

1.2. Research Purpose

The aim of this article is to explore the insights and application value of the geological characteristics of the Chang 4+5 oil layer, in order to provide scientific guidance and technical support for oil field development.

Analyze the geological background, stratigraphic characteristics, structural characteristics, sedimentary characteristics, and rock characteristics of the Chang 4+5 oil layer to fully understand its features and laws.

Explore the exploration insights of the Chang 4+5 oil layer,

including the laws of oil and gas accumulation, exploration method selection, and exploration risk assessment, providing scientific theoretical support for the exploration of the Chang 4+5 oil layer.

Study the development insights of the Chang 4+5 oil layer, including the selection of oil reservoir development methods, oil reservoir management strategies, and improving oil and gas recovery, providing guidance and recommendations for the development of the Chang 4+5 oil layer.

Analyze the application value of the Chang 4+5 oil layer, including its economic value and social value, and explore the contribution of the Chang 4+5 oil layer to energy security and local economic development.

Provide prospects and recommendations for the exploration and development of the Chang 4+5 oil layer, providing guidance for the exploration and development of the Chang 4+5 oil layer, and promoting the effective development and utilization of energy resources.

Through this research, we can further understand the geological characteristics of the Chang 4+5 oil layer, gain a deep understanding of the laws of oil and gas accumulation and development characteristics, and improve the efficiency and results of the exploration and development of the Chang 4+5 oil layer, promoting the development of the field of petroleum exploration and development.

2. Analysis of geological characteristics of Chang 4+5 oil formation

The Chang 4+5 oil formation is located in the western oilfields of China, including areas such as Shaanxi, Gansu, and Ningxia. It is the upper second section of the Yan Chang formation, which is a sandstone sedimentary rock series composed of the Chang 4 layer and Chang 5 layer. The sedimentation of the Chang 4+5 oil formation occurred in the early Jurassic period, forming approximately 160 million years ago, and it is one of the important oils and gas resources in western China. The upper part of the Chang 4+5 oil formation is composed of sedimentary rocks from the Lower and Middle Neogene, mainly consisting of shale, sandstone,

mudstone, and conglomerate. During the Late Cretaceous to Paleocene period in this region, it was the most active tectonic period of the North China Block, and the basin underwent intense tectonic changes and sedimentation, resulting in abundant oil and gas resources [2].

The geological structure of the Chang 4+5 oil formation is complex, mainly distributed in different terrain types such as mountain front, mountainous areas, and depressions. Oil reserves are generally located in structural uplift zones such as faults, folds, and lithological change zones, with oil and gas migration mainly occurring along channels such as faults, fractures, and pores.

The Chang 4+5 oil formation is mainly composed of rocks such as sandstone, mudstone, and conglomerate, with sandstone being the main oil and gas reservoir. The sandstone reservoir of the Chang 4+5 oil formation has good physical properties, mainly including parameters such as porosity, permeability, and saturation. The rock composition, pore structure, and reservoir characteristics have an important influence on the exploration and development of the Chang 4+5 oil formation.

3. Inspiration from exploration and development of Chang 4+5 reservoir

3.1. Location of exploration areas

The geological characteristics of the Chang 4+5 oil reservoir provide significant guidance for exploration and development site selection. Based on research results, the following guidance can be obtained: priority should be given to selecting relatively stable sedimentary environments for exploration and development, as the sedimentary environment of the Chang 4+5 oil reservoir is relatively stable. This can reduce exploration and development risks and increase the success rate of exploration. It is important to choose areas with abundant oil and gas source rocks, as the oil and gas of the Chang 4+5 oil reservoir mainly come from the thermal cracking and mercury release of oil and gas source rocks [3].

Therefore, when selecting exploration and development sites, areas with abundant oil and gas source rocks should be given priority to increase the success rate of exploration. Active tectonic areas should also be prioritized for selection, as the sedimentary materials of the Chang 4+5 oil reservoir were primarily deposited under tectonic movement. Choosing areas with well-developed structural traps is also important, as the Chang 4+5 oil reservoir mainly accumulates in structural traps. By comprehensively considering these factors, site selection for the exploration of the Chang 4+5 oil reservoir can be optimized, resulting in higher success rates and lower exploration risks.

3.2. Exploration method selection

The geological characteristics of the Chang 4+5 oil reservoir provide significant insights into the selection of exploration methods. Based on research results, the following insights can be gained.

Use a combination of exploration methods: Due to the complex geological structure of the Chang 4+5 oil reservoir, it is necessary to use a combination of exploration methods, such as seismic exploration, logging exploration, geophysical exploration, and surface geochemical exploration. This can improve the efficiency and success rate of exploration [4].

Emphasize refinement of exploration methods: The

reservoir type and geological structure of the Chang 4+5 oil reservoir are relatively complex, therefore, it is necessary to emphasize the refinement of exploration methods, such as logging interpretation, 3D seismic interpretation, and core analysis. This can help determine the distribution and properties of oil and gas reservoirs more accurately.

Strengthen technological innovation in exploration: The exploration and development of the Chang 4+5 oil reservoir has entered a deep stage, so it is necessary to strengthen technological innovation in exploration, such as 3D seismic imaging and new oil and gas detection technologies. This can improve exploration efficiency and reduce exploration costs.

3.3. Exploration risk assessment

Analysis of geological characteristics of the Chang 4+5 oil reservoir can provide important insights for exploration risk assessment. Exploration risk assessment is an essential part of the exploration and development process, which aims to evaluate the geological risks of exploration targets, develop reasonable exploration plans, reduce exploration risks, and improve exploration success rates. In the exploration and development of the Chang 4+5 oil reservoir, geological exploration risks mainly include oil finding risks, drilling risks, testing risks, etc. Among them, the oil finding risk is the greatest, as the distribution of oil and gas resources is uncertain, and oil and gas reservoirs need to be found in a large area. By analyzing the geological characteristics of the Chang 4+5 oil reservoir, potential areas with oil and gas can be identified, and exploration target areas can be determined, thereby reducing exploration risks.

In terms of testing risks, analysis of the geological characteristics of the Chang 4+5 oil reservoir can also provide guidance for the design of testing plans. For example, by analyzing the reservoir space and oil and gas migration rules, appropriate testing methods and parameters can be determined to improve testing success rates and reduce testing risks.

In summary, analysis of the geological characteristics of the Chang 4+5 oil reservoir has important implications for exploration risk assessment, providing a scientific basis for developing reasonable exploration plans, reducing exploration risks, and improving exploration success rates.

3.4. Selection of reservoir development mode

The geological characteristics of the Changqing 4+5 oil reservoir also provide some insights for the selection of development methods. Based on the geological features of the Changqing 4+5 oil reservoir, techniques such as horizontal wells, multi-stage fracturing, and reservoir fracturing can be considered to improve the development efficiency and economic benefits of the oil reservoir [5].

3.4.1. Horizontal well technology

Horizontal well technology is a technique that involves drilling horizontal wellbore segments in the reservoir and then conducting formation fracturing and oil and gas extraction. The Long 4+5 oil reservoir is thick and has well-developed sand bodies, making it difficult to exploit using traditional vertical wells. Horizontal well technology can extend the wellbore into the oil reservoir, increasing the exploitation area, while also reducing the impact of the reservoir on the wellbore and avoiding problems such as reduced productivity. Therefore, for the Long 4+5 oil reservoir, horizontal well technology can be considered to improve the development efficiency of the reservoir.

3.4.2. Multi-stage fracturing technology

Multi-stage fracturing technology refers to the operation of fracturing multiple sections of the wellbore, thereby increasing the production area and recovery rate of the reservoir. The storage space of the Chang 4+5 oil formation mainly consists of pores, fissures, and micro-cracks, which makes oil and gas migration difficult. Therefore, it is necessary to use multi-stage fracturing technology to increase the oil and gas migration channel and improve the recovery rate of the reservoir. At the same time, multi-stage fracturing technology can also reduce well interference, increase mining efficiency, and improve economic benefits.

3.4.3. Reservoir Fracturing Technology

The Long 4+5 oil reservoir has a large thickness, making it difficult to extract oil and gas from a single well. Therefore, reservoir fracturing technology is needed to improve oil and gas recovery rates. Reservoir fracturing technology is a technique that directly fractures the reservoir in the wellbore, improving the reservoir's physical properties and increasing the oil and gas recovery rate by creating additional pathways for fluid flow. With the well-developed sand bodies and favorable physical conditions in the Long 4+5 oil reservoir, reservoir fracturing technology can be used to improve the physical properties of the reservoir and increase the oil recovery rate.

3.5. Oil reservoir management strategy.

Effective reservoir management strategies are crucial for maximizing the production and recovery of oil from the Chang 4+5 oil reservoir. Based on the geological characteristics and development conditions of the reservoir, the following insights can be drawn regarding reservoir management strategies.

3.5.1. Comprehensive Reservoir Characterization

Comprehensive reservoir characterization is a key step in reservoir management. The reservoir characterization process should include detailed geological, petrophysical, and engineering analyses. The geological analysis should focus on the reservoir structure, sedimentary facies, and diagenetic features. The petrophysical analysis should include the determination of reservoir properties such as porosity, permeability, and fluid saturation. The engineering analysis should focus on well performance, reservoir pressure, and fluid flow dynamics. By integrating these analyses, a comprehensive understanding of the reservoir can be obtained, which can guide the selection of appropriate reservoir management strategies.

3.5.2. Optimization of Hydraulic Fracturing Design

Hydraulic fracturing is a commonly used method for improving the productivity of tight oil reservoirs. However, the effectiveness of hydraulic fracturing depends on the design parameters such as fracturing fluid, proppant concentration, and pumping rate. Therefore, optimization of hydraulic fracturing design is essential for maximizing the productivity of the Chang 4+5 oil reservoir. In particular, the selection of suitable fracturing fluids and proppants should be based on the reservoir properties and production goals.

3.5.3. Implementation of Enhanced Oil Recovery (EOR) Techniques

Enhanced oil recovery (EOR) techniques can significantly increase the ultimate recovery of oil from the reservoir. The selection of appropriate EOR techniques depends on the reservoir characteristics and development stage. For the

Chang 4+5 oil reservoir, thermal EOR techniques such as steam injection and in-situ combustion may be effective due to the high viscosity of the oil and low permeability of the reservoir. However, the implementation of EOR techniques requires careful evaluation and planning to ensure their economic feasibility.

3.5.4. Integration of Reservoir Monitoring Technologies

Reservoir monitoring technologies such as pressure and temperature sensors, tracers, and seismic imaging can provide valuable information on reservoir performance and fluid movement. Integration of these technologies into the reservoir management strategy can improve production forecasting, optimize well placement, and detect early signs of reservoir depletion. Additionally, the use of artificial intelligence and machine learning algorithms can aid in the analysis and interpretation of reservoir monitoring data.

In conclusion, the effective management of the Chang 4+5 oil reservoir requires a comprehensive understanding of its geological characteristics and development conditions. By implementing appropriate reservoir management strategies such as reservoir characterization, hydraulic fracturing optimization, EOR techniques, and reservoir monitoring technologies, the production and recovery of oil from the reservoir can be maximized.

4. Application value analysis of the exploration and development of the Changqing 4+5 oil reservoir

4.1. Economic Value

The economic value of the Chang 4+5 oil formation is significant, as it is one of China's largest onshore oil fields with abundant oil and gas resources. Economic value analysis is one of the important methods for evaluating whether oil field development is worth pursuing, which involves multiple aspects such as oil and gas production, exploration and development costs, market demand, and prices. Although the exploration and development of the Chang 4+5 oil formation require significant investments in funds and technology, its oil and gas resources and production potential can bring substantial economic benefits to the country. Therefore, when formulating the development plan and decision-making for the Chang 4+5 oil field, its economic value and development potential must be comprehensively considered to ensure its rationality and sustainability.

Moreover, the exploration and development of the Chang 4+5 oil formation can also drive the development of related industries such as petroleum equipment manufacturing, exploration technology and services, and petroleum processing, thus promoting the development of local economies and increasing employment opportunities. At the same time, the development of the Chang 4+5 oil field can also reduce external energy dependence, improve the country's energy security level, and is of great significance to the country's energy strategy and long-term development. Therefore, the comprehensive and in-depth exploration and development of the Chang 4+5 oil field not only has important economic value but also has significant significance for the country's energy security and sustainable development.

4.2. Social Value

The exploration and development of Changqing 4+5 oil reservoir has significant social value. Firstly, as one of the

largest onshore oil fields in China, its development can provide abundant energy resources for the country, helping to meet domestic energy demand, reduce dependence on foreign energy and improve national energy security. In addition, the development of the oil reservoir can also contribute to the improvement of regional infrastructure construction, such as roads, communications, and power facilities, which will facilitate the development of the oil field and promote economic growth in the surrounding areas. Lastly, the exploration and development of Changqing 4+5 oil reservoir can also promote environmental protection and safety management. During the exploration and development process, strict monitoring and management of the environment are necessary to ensure the safety and integrity of the surrounding ecological environment. At the same time, it is also necessary to strengthen safety risk management and emergency measures during exploration and development to ensure personal and property safety.

5. Conclusion

In conclusion, the exploration and development of the Changqing 4+5 oil reservoir, as one of China's largest onshore oil fields, has significant implications for the country's energy security and economic development. With modern exploration and development technologies such as horizontal drilling, multi-stage fracturing, and reservoir fracturing, the field's production capacity and development efficiency can be effectively improved. Moreover, the exploration and development of the Changqing 4+5 oil reservoir can also drive the development of related industries, promote local

economic growth, create job opportunities, and reduce reliance on foreign energy, thus enhancing the country's energy security. However, it is also necessary to strengthen environmental and safety management during the exploration and development process to ensure personal and property safety. Therefore, comprehensive and in-depth exploration and development of the Changqing 4+5 oil reservoir not only has significant economic value but also important social value and strategic significance.

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