

Research on the Impact of Sedimentary Environment on the Development of Oil and Gas Reservoirs and the Accumulation of Oil and Gas

Jing Liu

Xi'an Petroleum University, Xi'an, Shaanxi, 710065, China

Abstract

The sedimentary environment is a crucial geological factor influencing the formation, development and enrichment of oil and gas reservoirs. The composition, sedimentary structures and spatial distribution characteristics of sediments vary significantly in different sedimentary environments, which have significant impacts on reservoir properties and oil and gas accumulation. This paper adopts a method combining literature review and theoretical analysis to systematically expound the basic characteristics of sedimentary environment and oil and gas reservoirs, focusing on analyzing the effects of river, delta, lake and marine sedimentary environments on reservoir lithology, pore structure, porosity and permeability, and exploring the control role of sedimentary environment on oil and gas enrichment from aspects such as reservoir properties, caprock combination, oil and gas migration and reservoir heterogeneity. At the same time, taking the Yanchang Formation of the Ordos Basin as an example, the relationship between sedimentary facies distribution and oil and gas reservoir conditions is analyzed. Comprehensive analysis shows that the sedimentary environment affects the formation of favorable reservoirs and the conditions for oil and gas migration and accumulation by controlling the spatial distribution of sediments, reservoir structure and sandstone-siltstone configuration, while the degree of oil and gas enrichment is also influenced by diagenesis, tectonic conditions and oil and gas filling factors. Therefore, strengthening the research on the relationship between sedimentary environment and the development of oil and gas reservoirs is of great significance for the prediction of favorable reservoirs, the understanding of oil and gas enrichment laws and the selection of oil exploration targets.

Keywords

Sedimentary Environment; Oil and Gas Reservoir; Sedimentary Facies; Reservoir Properties; Oil and Gas Accumulation.

1. Introduction

1.1. Research Background and Significance

Oil and gas resources are important energy sources and chemical raw materials in modern society, playing a significant role in industrial production, transportation and the development of the national economy. With the continuous deepening of oil and gas exploration and development, the formation conditions of reservoirs and the laws of oil and gas enrichment have gradually become important contents in petroleum geological research[11-13]. Oil and gas reservoirs are important sites for the accumulation and storage of oil and gas. Their lithology, pore structure and physical properties directly affect the storage capacity and development effect of oil and gas. Sedimentary environment, as an important geological factor controlling reservoir formation, determines the original lithology, thickness, grain size and distribution characteristics of the reservoir by influencing the source, transport mode,

sedimentation process and spatial distribution of sediments. Reservoirs formed in different sedimentary environments show significant differences in porosity, permeability and heterogeneity, which in turn affect the migration, accumulation and preservation of oil and gas[9, 12, 13]. Therefore, studying the influence of sedimentary environments on the development of oil and gas reservoirs and the enrichment of oil and gas is conducive to understanding the formation mechanism of reservoirs and the distribution pattern of oil and gas, which is of great significance for reservoir prediction, the selection of oil and gas exploration targets, and the improvement of the efficiency of oil and gas resource development.

1.2. Research Content and Methods

This paper adopts a method combining literature review and theoretical analysis to study the influence of sedimentary environment on the development of oil and gas reservoirs and the enrichment of oil and gas. Firstly, introduce the basic concepts, main types of sedimentary environments and the basic characteristics of oil and gas reservoirs, and analyze the relationship between sedimentary environments and reservoir formation; Secondly, the focus is on studying the development characteristics of reservoirs in river, delta, lake and Marine sedimentary environments, and exploring the influence of different sedimentary conditions on the lithology, pore structure and physical properties of reservoirs. Then, the control effect of the sedimentary environment on the enrichment of oil and gas is analyzed from aspects such as reservoir physical properties, reservoir cap combination, oil and gas migration, and reservoir heterogeneity. Finally, taking the Yanchang Formation in the Ordos Basin as an example and combining the characteristics of typical sedimentary reservoirs, the relationship between the distribution of sedimentary facies zones and the enrichment of oil and gas is further discussed, providing a theoretical reference for the evaluation of oil and gas reservoirs and the prediction of favorable exploration areas[1-8][14-18].

2. Sedimentary Environment and the Basic Theory of Oil and Gas Reservoirs

2.1. Basic Concepts and Classification of Sedimentary Environment

Sedimentary environment refers to the natural geographical conditions, physical, chemical and biological environments where sediment forms, is transported and accumulates during a certain geological period. Different sedimentary environments have different hydrodynamic conditions, material sources and sedimentation processes, thus forming sedimentary strata with specific lithological combinations and sedimentary structures[10, 11]. According to the location and environmental characteristics of the sedimentary environment, sedimentary environments are generally classified into three types: terrestrial, marine-terrestrial transitional, and marine.

Terrestrial sedimentary environments mainly include rivers, lakes and alluvial fans, among which river sedimentation is mainly composed of sand, gravel and other debris materials, often forming river channel sand bodies with a certain thickness and extension range; lake sedimentation is affected by water depth and hydrodynamic conditions, forming different lithological combinations such as sandstone, siltstone and mudstone[13, 14]. Marine-terrestrial transitional sedimentary environments are typically characterized by delta sedimentation, which is influenced by factors such as river input, waves and tides, forming sedimentary systems with interbedded sand and mud rocks. Marine sedimentary environments include coastal, shallow sea and deep-water sedimentation, and different water depths and hydrodynamic conditions can form sedimentary rocks such as clastic rocks or carbonate rocks. In general, there are significant differences in grain size, sorting and sedimentary structures of

sediment in different sedimentary environments, and these differences directly affect the original structure and spatial distribution characteristics of the reservoir.

2.2. Basic Characteristics of Oil and Gas Reservoirs

Oil and gas reservoirs refer to rock layers with certain pore spaces and permeability that can store and produce oil and gas under certain conditions, and are the important geological basis for the formation of oil and gas reservoirs. The development degree and physical properties of reservoirs directly affect the storage scale, flow capacity and development effect of oil and gas. According to the type of rock, common oil and gas reservoirs include clastic rock reservoirs and carbonate rock reservoirs, among which sandstone reservoirs and carbonate rock reservoirs are widely distributed and have important value for oil and gas exploration and development. Sandstone reservoirs are mainly composed of quartz, feldspar and rock fragments, and their storage space is mainly composed of intergranular pores and secondary dissolution pores. The physical properties of reservoirs are affected by factors such as particle size, sorting, cementation degree and diagenesis. Carbonate rock reservoirs are mainly composed of limestone and dolomite, and the storage space types are relatively complex, including not only primary pores but also dissolution cavities and fractures.

Porosity, permeability and pore structure are important parameters for evaluating reservoir quality. Porosity reflects the proportion of pore volume in the total volume and is an important indicator for measuring the size of reservoir storage space; permeability characterizes the ability of rocks to allow fluid flow and reflects the permeability performance of the reservoir; pore structure mainly includes pore size, morphology, distribution and pore throat connectivity. Generally, reservoirs with higher effective porosity and better pore throat connectivity have better oil and gas storage and flow conditions, but the actual performance of the reservoir is still affected by factors such as pore structure and fluid properties.

Table 1. Main reservoir evaluation parameters and geological significance

Parameter	Meaning	Reservoir significance	Main controlling factors
Porosity	Proportion of pore volume within total rock volume.	Indicates storage space for hydrocarbons.	Grain size, sorting, cementation, compaction and dissolution.
Permeability	Ability of rock to allow fluid flow.	Controls migration, production and deliverability.	Pore-throat connectivity, clay content, fractures and diagenetic alteration.
Pore structure	Size, shape, distribution and connectivity of pores and throats.	Determines effective storage and flow capacity beyond simple porosity values.	Primary sediment fabric, secondary dissolution, cementation and tectonic fracturing.
Heterogeneity	Spatial unevenness of lithology, pore structure and physical properties.	Influences hydrocarbon distribution and later development efficiency.	Facies change, sand-body stacking, mudstone interlayers and multi-stage diagenesis.

2.3. Relationship between Sedimentary Environment and Reservoir Formation

Sedimentary environment is an important factor controlling the original material composition, lithological characteristics and spatial distribution of oil and gas reservoirs. Its influence mainly manifests in hydrodynamic conditions, sediment composition and distribution of sedimentary facies belts [9-11]. There are differences in hydrodynamic intensity and transportation methods under different sedimentary environments, which directly affect the grain size, sorting

and accumulation mode of sediment. Generally, stronger hydrodynamic conditions are conducive to the transportation and separation of fine particles, forming relatively coarse-grained and well-sorted sediments, while low-energy environments are more likely to deposit fine sand and mud. However, the final sorting degree of sediment is also affected by factors such as source supply, transportation distance and sedimentation process.

The mineral composition and particle structure of sediment have an important role in the original development of reservoir pores. Sandstones with good particle separation and low mud content usually have better original inter-particle pore conditions, while sediments with high mud content or tightly arranged particles often have certain limitations on their effective pore space. At the same time, the spatial distribution of sedimentary facies controls the thickness, continuity, and connectivity of reservoirs between sand bodies. For example, river channel sand bodies usually show a strip-like distribution, and delta front sand bodies can form reservoir layers with certain lateral continuity. While areas with well-developed mud deposits often form reservoir interlayers or caps.

In addition, after the formation of reservoirs, they will undergo diagenetic processes such as compaction, cementation, dissolution, and replacement, which change the original pore structure. Among them, compaction and cementation usually lead to a reduction in pore space and a decrease in permeability, while dissolution can form secondary pores under certain conditions, improving reservoir properties. Therefore, the final quality of oil and gas reservoirs not only depends on the original sedimentary characteristics formed by the depositional environment, but is also jointly controlled by the subsequent diagenetic evolution. Studying the relationship between depositional environment and diagenesis helps to understand the formation mechanism of high-quality reservoirs and provides geological basis for the prediction of favorable reservoirs[4, 5, 12, 17].

3. Impact of Different Sedimentary Environments on Reservoir Development

3.1. Influence of Fluvial Depositional Environment on Reservoir Development

Fluvial depositional environments are key settings for the formation of continental clastic reservoirs, with sedimentation processes primarily controlled by fluvial hydrodynamic conditions, sediment supply, and channel migration. A typical fluvial depositional system includes units such as channels, point bars, natural levees, and floodplains, among which channel sands and point bar sands represent the most significant reservoir bodies. Channel sandstones are mainly composed of sandstone and conglomerate, characterized by relatively coarse grain size, well-developed trough cross-stratification, and scour structures, providing certain pore spaces. Point bar sands typically form on the inner side of meandering rivers and develop progressively through lateral channel migration, exhibiting an upward-fining grain-size trend.

Reservoir properties of fluvial deposits are closely related to grain size, sorting, and clay content. Generally, better-sorted sands with low clay content possess favorable primary porosity, enhancing oil and gas storage and flow capacity. However, due to frequent channel migration and episodic changes in deposition, fluvial sand bodies often display rapid lateral thickness variations and unstable continuity. Sand bodies from different phases may overlap or be separated by clay-rich sediments, resulting in strong reservoir heterogeneity. Therefore, while fluvial environments can generate high-quality sandstone reservoirs, discontinuous sand distribution and development of clay interlayers may hinder fluid migration and reduce reservoir effectiveness.

3.2. Influence of Deltaic Depositional Environment on Reservoir Development

Deltaic depositional environments occur where rivers enter lakes or seas, forming a sedimentary system in which fluvial-derived clastics gradually accumulate under changing hydrodynamic conditions. The formation and evolution of deltas are jointly controlled by factors including sediment supply, water body energy, relative sea level changes, and available accommodation space. Based on depositional position and environmental characteristics, deltas are generally divided into subfacies: delta plain, delta front, and prodelta. Among these, distributary channels on the delta plain, submarine distributary channels at the delta front, and mouth bars are critical zones for sand body development.

Sand bodies in distributary channels of the delta plain are predominantly composed of medium- to fine-grained sandstones, often occurring in ribbon-like patterns with considerable thickness and vertical extent. Submarine distributary channel sands at the delta front are influenced by both fluvial input and marine modification, showing distinct variations in grain size and sorting; some of these sand bodies can develop favorable pore structures. Mouth bars form in areas where river velocity decreases upon entering lakes or seas, typically appearing as lobe-shaped or lens-shaped deposits with an upward-coarsening sequence. Under suitable depositional conditions, mouth bar sands exhibit good lateral continuity, facilitating the formation of substantial reservoirs.

In deltaic systems, sandstone and mudstone alternate extensively, creating complex reservoir architectures. The thickness, continuity, and connectivity of sand bodies directly affect oil and gas storage and permeability, whereas clay layers may impede fluid flow. Moreover, deltaic environments exhibit marked facies differentiation, leading to significant differences in reservoir quality across subfacies. Thus, identifying the spatial distribution and stacking relationships of favorable sand bodies is crucial for assessing reservoir quality and predicting hydrocarbon enrichment zones.

3.3. The Impact of Lake Sedimentary Environment on Reservoir Development

The lake sedimentary environment is a common sedimentary type in terrestrial sedimentary basins, and its sedimentary characteristics are mainly controlled by factors such as lake basin structure, lake water level changes, source supply, and hydrodynamic conditions. According to different water depths and sedimentary conditions, the lake sedimentary environment can be divided into coastal, shallow lake, semi-deep lake, and deep lake sedimentary areas. The sediment composition in different areas shows significant differences, with the coastal and shallow lake areas mainly developing sandstone, siltstone, and mudstone, while the semi-deep lake and deep lake areas usually have fine-grained mudstone deposits as the main type.

The coastal and shallow lake sand bodies mainly form near the lake shore, influenced by wave action, coastal currents, and river input, and the grain size and sorting of the sand bodies have certain differences. Under suitable hydrodynamic conditions, the coastal and shallow lake sand bodies can form reservoirs with good pore structure. The lake bottom fan is mainly formed by gravitational flow and other sedimentary processes, often distributed on the lake basin slopes and deeper water areas. The morphology and continuity of the sand bodies are controlled by sediment supply and lake bottom topography. The rise and fall of lake water levels can change the position and range of sedimentary facies, thereby affecting the thickness, distribution, and stacking relationship of the sand bodies.

In addition, the lake sedimentary environment not only affects reservoir formation but is also closely related to hydrocarbon generation and preservation. Organic-rich lacustrine mudstone, under suitable burial and thermal evolution conditions, can form source rocks, and thick and continuous mudstone can also serve as cap rocks for hydrocarbon reservoirs[1, 2, 6, 8, 16]. Therefore, the reasonable configuration of sandstone reservoirs with mudstone source rocks

and cap rocks in the lake sedimentary system is conducive to the formation of favorable hydrocarbon accumulation conditions.

3.4. The Impact of Marine Sedimentary Environment on Reservoir Development

Marine sedimentary environments have a wide distribution and complex types, mainly including coastal, shallow sea, shelf, and deep-water sedimentary environments. Their sedimentary processes are jointly influenced by factors such as waves, tides, ocean currents, sea level changes, and source supply [11, 13]. Different marine sedimentary environments can form various types of reservoirs, including clastic rocks and carbonate rocks. Coastal sand bodies, shallow sea sand bodies, and carbonate platform deposits have significant significance for hydrocarbon storage.

The coastal sedimentary environment usually has strong wave and coastal current effects, and the sediment undergoes repeated transportation and modification, easily forming well-sorted sand bodies with lower mud content. Under weak or favorable diagenetic conditions in the later stage, these sand bodies can retain some original intergranular pores, forming good sandstone reservoirs. The water dynamic conditions in the shallow sea are relatively complex, and the grain size, thickness, and continuity of the sand bodies change with the sedimentary position and water dynamic intensity. Some sand bodies can form reservoirs of a certain scale.

Table 2. Reservoir development characteristics in different sedimentary environments

Environment	Main reservoir bodies	Favorable conditions	Potential limitations
Fluvial	Channel sandstones and point-bar sandstones	Coarse grain size, good sorting and low clay content can preserve primary pores.	Rapid lateral thickness change, discontinuity and clay interlayers may increase heterogeneity.
Deltaic	Distributary channels, underwater distributary channels and mouth bars	Sand bodies may be thick, laterally continuous and well connected, especially in delta-front zones.	Frequent sandstone-mudstone alternation causes complex architecture and flow barriers.
Lacustrine	Nearshore-shallow lake sand bodies and gravity-flow sand bodies	Sandstone reservoirs may be closely associated with organic-rich mudstone source rocks and cap rocks.	Semi-deep and deep lake areas are dominated by fine-grained mudstone with limited sand development.
Marine	Coastal/shallow-sea sand bodies and carbonate platform reservoirs	Repeated reworking can produce well-sorted sands; carbonate platforms may develop diverse pore types.	Compaction, cementation and uneven dissolution or dolomitization may strongly modify reservoir quality.

Carbonate platform deposits mainly form in suitable carbonate sedimentary marine environments, and their reservoir types include particle limestone, reef platform limestone, and dolomite, etc. Compared with clastic rock reservoirs, carbonate rock reservoirs have more complex pore types, including intergranular pores and biological cavity pores formed during deposition, as well as secondary pores formed by dissolution and fractures formed by tectonic processes. The connectivity and interconnection of different pore types jointly determine the storage capacity and permeability of the reservoir.

The final physical properties of marine reservoirs are significantly influenced by diagenetic processes. Among them, cementation and compaction usually reduce pore space, reducing reservoir porosity and permeability; dissolution processes may expand existing pores or form secondary pores, thereby improving reservoir storage performance. In addition, dolomitization processes under certain conditions may also change the pore structure of carbonate rocks, but the impact is not uniform. Therefore, the development of marine reservoirs not only depends on the original sedimentary environment but is also jointly controlled by the later diagenetic evolution process. Comprehensive analysis of sedimentary facies distribution, pore types, and diagenetic process characteristics is an important basis for evaluating the quality of marine reservoirs and predicting favorable reservoir areas.

4. The Control of Sedimentary Environment on Hydrocarbon Accumulation

4.1. Control of Sedimentary Environment on Reservoir Physical Properties and Hydrocarbon Storage Capacity

Sedimentary facies is an important factor influencing the physical properties and storage capacity of hydrocarbon reservoirs. Reservoirs formed by different sedimentary facies have significant differences in lithology, thickness, porosity, and permeability. Generally speaking, sedimentary facies such as river channels, delta front, and coastal areas are prone to form sand bodies of certain scale. Some of these sand bodies have good particle sorting and low mud content, which are conducive to the preservation of primary pores and hydrocarbon storage. In contrast, in low-energy sedimentary environments, the content of fine-grained sediments is higher, and the pore connectivity of the reservoir is usually poor, limiting the hydrocarbon permeability.

Favorable sedimentary facies not only control the formation of high-quality reservoirs but also affect the spatial distribution of hydrocarbon accumulation. For example, underwater distributary channels and estuary sand bodies at the delta front usually have better storage conditions. When there is sufficient hydrocarbon supply, unobstructed migration channels, and suitable sealing conditions, they are likely to become favorable locations for hydrocarbon accumulation. Therefore, clearly identifying the types of sedimentary facies and their spatial distribution characteristics is helpful for identifying the development areas of high-quality reservoirs and providing geological basis for the prediction of hydrocarbon accumulation areas.

4.2. The Influence of Sedimentary Environment on the Formation of Reservoir-Capping Combinations

Reservoir-capping combinations are important geological conditions for the formation and preservation of hydrocarbon reservoirs, and their formation is closely related to the distribution patterns of sandstone and mudstone in sedimentary environments. In sedimentary systems such as rivers, deltas, and lakes, due to differences in water dynamic conditions and sediment supply, alternating sandstone and mudstone rock formations are often formed [9,10,14]. Sandstone usually has certain pore spaces and permeability, which can serve as hydrocarbon reservoirs; while mudstone, due to its narrow pore throats and low permeability, can form an effective cap layer when it has sufficient sealing capacity.

The sedimentary environment controls the vertical stacking and lateral changes of sand and mudstone, affecting the spatial configuration relationship between reservoirs and caps. For example, when thick mudstone is overlaid on the delta front sand body, a favorable reservoir-capping combination can be formed; in river sedimentary systems, the sand body in the river channel and the mudstone in the floodplain may also form a local sealing condition. In addition, when the sand body laterally truncates and transitions to mudstone, under suitable structures

and sealing conditions, a lithologic trap can be formed. Therefore, proper sand-mudstone configuration and effective cap layer development are important factors controlling hydrocarbon accumulation and preservation.

4.3. The Impact of Sedimentary Environment on Oil and Gas Migration and Accumulation

The migration and accumulation of oil and gas are influenced by various factors such as reservoir connectivity, sedimentary facies changes, and structural conditions. The sedimentary environment controls the morphology, distribution range, and connectivity of sand bodies, thereby affecting the formation of oil and gas migration pathways. Sand bodies with better continuity and higher permeability can provide favorable pathways for oil and gas migration, while mudstone interlayers and low-permeability rock layers may hinder the flow of oil and gas, causing changes in the direction and location of oil and gas migration.

The lateral changes in sedimentary facies can also form favorable conditions for oil and gas trapping. For example, when river sand bodies or delta sand bodies gradually taper off towards mudstone, lithologic pinch-out traps may form; when the porosity and permeability of the reservoir change significantly, physical sealing conditions may be formed, causing oil and gas to accumulate at suitable locations. However, sedimentary conditions are not the only factor determining oil and gas accumulation; structural morphology, fault activity, and the process of oil and gas injection also play important roles. High-structural areas may provide favorable space for oil and gas accumulation, faults may become oil and gas migration channels, and they may also form seals. Therefore, the reasonable configuration of sedimentary facies distribution and structural conditions jointly controls the direction of oil and gas migration and accumulation patterns.

4.4. The Impact of Reservoir Heterogeneity on Oil and Gas Accumulation

Reservoir heterogeneity refers to the phenomenon where the characteristics of reservoir rock, physical properties, and pore structure are unevenly distributed in space. It is an important factor affecting oil and gas accumulation and development efficiency. The complex changes in sedimentary environment are one of the main reasons for the formation of reservoir heterogeneity. Differences in hydrodynamic conditions, source supply, and sedimentary processes during different sedimentary periods can easily cause changes in grain size, mud content, and pore-filling characteristics within the reservoir.

In river and delta sedimentary systems, sedimentary rhythms, mudstone interlayers, and the stacking relationship of sand bodies from different periods usually lead to significant differences in physical properties within the reservoir. For example, the presence of mudstone interlayers in sand bodies may hinder vertical migration of oil and gas, causing uneven distribution of oil and gas in different layers; differences in connectivity between sand bodies from different periods may affect lateral migration and accumulation range of oil and gas. At the same time, changes in reservoir porosity and permeability can cause different fluid flow capabilities, causing oil and gas to preferentially migrate along high-permeability areas.

Reservoir heterogeneity not only affects the degree of oil and gas accumulation but also has significant impacts on later development. Strong heterogeneity in reservoirs is prone to problems such as preferential flow of injected fluids along high-permeability layers and insufficient utilization of low-permeability layers, thereby affecting oil recovery rate. Therefore, strengthening the study of reservoir heterogeneity is helpful for accurately understanding the distribution laws of oil and gas and providing a basis for detailed reservoir evaluation and reasonable development of oil and gas reservoirs.

Table 3. Control mechanisms of sedimentary environment on hydrocarbon accumulation

Control aspect	Mechanism	Effect on hydrocarbon accumulation
Reservoir physical properties	Sedimentary facies control lithology, grain size, sorting, mud content, porosity and permeability.	High-quality sand bodies provide storage space and flow capacity for hydrocarbons.
Reservoir-cap combination	Vertical and lateral sandstone-mudstone configuration is controlled by depositional systems.	Mudstone above or around sandstone may form effective cap rocks or lithologic traps.
Migration and trapping	Sand-body morphology, continuity and connectivity determine migration pathways.	Continuous permeable sand bodies favor migration, while facies pinch-out and low-permeability layers promote trapping.
Reservoir heterogeneity	Facies transition, sedimentary rhythm, interlayers and diagenesis cause uneven reservoir properties.	Oil and gas may preferentially accumulate in high-permeability zones, causing uneven enrichment and development response.

5. Analysis of Oil and Gas Accumulation Cases in Typical Sedimentary Environments

5.1. Characteristics of Sedimentary Reservoirs in the Yanchang Formation of the Ordos Basin

The Ordos Basin is one of the important oil and gas-bearing basins in China. The Triassic Yanchang Formation in this basin formed in a large inland lake basin environment and developed various sedimentary systems such as deltas, lakes, and gravity flows. Influenced by factors such as lake basin evolution, material supply, and lake level changes, the Yanchang Formation sandstone and mudstone exhibit distinct longitudinal interbedding and lateral facies transition characteristics. Among them, the delta front is an important sand body development area, mainly forming underwater distributary channels, estuary dams, and far sand dams, etc. The sand bodies on the plane have certain continuity, but their thickness, grain size, and connectivity show significant differences.

Different sedimentary facies belts have important control over reservoir development. Underwater distributary channels and estuary dams usually have strong hydrodynamic conditions, with relatively coarse sediment particles and good sorting, providing favorable original sedimentary foundations for the formation of reservoir space. In contrast, the pre-delta and deep lake mudstone sedimentary areas are dominated by fine-grained sediments, and the sand body development is relatively limited. In addition, the Yanchang Formation sandstone generally undergoes diagenetic processes such as compaction, cementation, and dissolution, and the reservoirs show low porosity and low permeability characteristics [3-5,15,17]. Therefore, the formation of favorable reservoirs not only depends on the type of sedimentary facies, but is also influenced by factors such as later diagenetic modification and the development of structural fractures. Meanwhile, the rich organic matter-bearing mud shale developed in the deep water area of the extensional basin is an important source rock for hydrocarbons. The local mud rock layers can also play a sealing role. The rich organic matter-bearing mud shale developed between the sand and mud rocks is also an important source rock, and the local mud rock layers can also perform the sealing function. The spatial configuration between the sand and mud rocks is of great significance for the formation of oil and gas.

6. Conclusion

This article focuses on the influence of sedimentary environments on the formation and enrichment of oil and gas, and analyzes the sedimentary characteristics, reservoir development conditions, and their relationship with oil and gas enrichment in different sedimentary environments. Taking the Triassic Lengyuan Formation in the Ordos Basin as an example, it discusses the controlling role of sedimentary environments on oil and gas enrichment. Through analysis, the following conclusions are drawn.

(1) Sedimentary environments are important geological factors affecting the formation and distribution of oil and gas reservoirs. Different sedimentary environments differ in hydrodynamic conditions, sediment sources, particle composition, and sedimentary styles, resulting in different types of sedimentary facies and reservoir bodies. Among them, deltaic, fluvial, and some lacustrine sedimentary systems can form sandstone reservoirs of certain scale, while the grain size, sorting degree, and continuity of sediment, as well as other characteristics, have significant impacts on the original pore structure and later physical evolution of the reservoir.

(2) The spatial distribution of sedimentary facies belts has a significant controlling effect on the development of favorable reservoirs. Taking the Lengyuan Formation in the Ordos Basin as an example, submarine distributary channels at the delta front, estuary bars, and gravity flow sand bodies of lacustrine facies are important reservoir types. The sand bodies formed by different sedimentary microfacies vary in thickness, lateral continuity, and reservoir performance, thereby affecting the migration and accumulation conditions of oil and gas. However, reservoir properties are also affected by diagenetic processes such as compaction, cementation, and dissolution, and cannot be judged solely based on sedimentary facies types.

(3) Oil and gas enrichment is the result of the combined action of multiple geological factors. Favorable sedimentary environments can provide necessary reservoir space for oil and gas accumulation, but whether oil and gas can form effective enrichment also depends on factors such as the development degree of source rocks, oil and gas supply conditions, reservoir-cap combination, migration channels, and the timing of formation. Therefore, although there is a certain connection between sedimentary facies belts and oil and gas enrichment areas, the two are not a simple single causal relationship.

In conclusion, sedimentary environment research is of great significance for understanding reservoir distribution patterns and predicting favorable oil and gas enrichment areas. In actual oil exploration, sedimentary facies analysis should be combined with reservoir property evaluation, source rock research, and formation conditions analysis to comprehensively judge favorable exploration targets, thereby improving the scientificity and accuracy of oil exploration.

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