ISSN: 2710-0723

Research on the Sedimentary Microfacies Characteristics of the C8 Member in the E Basin

Shaodong Liang[1], Xinyan He[2,3], Hualong He[4]

[1] School of Petroleum Engineering, Xi'an Shiyou University, Xi'an, Shaanxi, 710065, China

[2] Drilling and Production Technology Research Institute, CNPC Chuanqing Drilling Engineering Company, Deyang, Sichuan, 618300, China

[3] National Engineering Laboratory for Low-Permeability Oil and Gas Field Exploration and Development, Xi'an, Shaanxi, 710018, China

[4] The first oil production plant of PetroChina Changqing Oilfield Branch, Yan'an, Shaanxi, 717502, China

Abstract

Currently, China's dependence on foreign oil has exceeded 70% and continues to rise, underscoring the urgency to intensify domestic oil and gas exploration and development efforts. The C8 oil layer group in the E Basin represents a critical stratigraphic unit for research. However, to date, no comprehensive and systematic study has been conducted on the sedimentary microfacies of the C8 section, significantly impeding the progress of subsequent oil and gas exploration and development. This study integrates lithologic markers and well-logging facies indicators to conduct an in-depth investigation of the sedimentary microfacies profiles and planar distribution in the study area. The findings indicate that the C8 oil layer group belongs to a deltaic depositional system, specifically classified as a delta front subfacies. Key developed microfacies include subaqueous distributary channels, subaqueous distributary bays, and subaqueous natural levees. Further analysis reveals that the sand bodies within the delta front are relatively well-developed, identifying them as one of the favorable layers for reservoir formation.

Keywords

Delta Front; Sedimentary Microfacies; Reservoir Characteristics; Subaqueous Distributary Channel.

1. Introduction

The E Basin's Y Formation reservoir boasts abundant oil reserves, with the X region exhibiting high production and excellent economic returns. The C8 segment, in particular, serves as a key target layer in this area, characterized by high physical properties, favorable oil-bearing potential, and distinct facies-controlled sand bodies, making it highly valuable for research. However, detailed and in-depth studies on the sedimentary microfacies of the C8 segment in the X region have yet to be conducted. Based on extensive core, logging, and analytical test data, this study examines the core color, lithology, sedimentary structures, sedimentary facies indicators, and logging facies markers in the research area. It clarifies the types of sedimentary microfacies and the planar distribution characteristics of sedimentary facies in the X segment, providing theoretical support for future exploration and development.

2. Summary of Geological Exploration in the Study Area

The E Basin is a large Meso-Cenozoic inland sedimentary basin formed after the disintegration of the North China Platform during the Indosinian cycle. It generally presents as a dustpan-

ISSN: 2710-0723

shaped basin with an east-west width greater than its north-south length, featuring fault-fold structures at the margins and gentle internal slopes with dips less than 1°. This structural framework defines six tectonic units: the Western Thrust Belt (I), Western Depression Zone (II), Eastern Slope Zone (III), Western Shanxi Flexural Fold Zone (IV), Yimeng Uplift (V), and Weibei Uplift (VI). The J area spans two tectonic units: the Northern Shaanxi Slope and the Tianhuan Depression.

The E Basin, situated on the western margin of the Sino-Korean Platform, is a multi-cycle, multi-depositional-type cratonic basin with a complex tectonic framework. It evolved through several stages: a Meso–Neoproterozoic aulacogen phase, an Early Paleozoic shallow marine platform phase, a Late Paleozoic coastal plain phase, and ultimately entered an inland basin evolutionary stage during the Mesozoic era[1]. The Triassic Y Formation represents a clastic reservoir deposited throughout the entire process of the lake basin's formation, development, and eventual extinction during this period.

The W Block of J Oilfield is one of the multi-oil layer development areas in the Mesozoic strata of the E Basin. Multiple oil-bearing formations have been discovered, including the Triassic Y Formation layers C2, C4+5, C6, C8, and C9, as well as the Jurassic Y Formation layers Y9 and Y10. The main producing layers are the Triassic Y Formation C4+5, C6, and C8, followed by C2, Jurassic Y Formation Y9, Y10, and C9. The development of the C9 reservoir is currently in the evaluation stage.

3. Sedimentary Facies Research Process

Depositional facies is a fundamental core concept in sedimentology and petroleum geology, referring to the integrated expression of specific depositional environments and their genetically related sedimentary (rock) characteristics and biological features. Simply put, it is a unified entity of "environment + material manifestation". Sedimentary (rock) characteristics are the material representation of depositional environments[2], including lithology (sandstone, mudstone, limestone, etc.), texture (grain size, sorting, roundness), structures (bedding, bedding plane structures), and mineral composition. Biological features serve as "indicators" of depositional environments, encompassing the types of paleontological organisms, ecological categories, and fossil preservation states. For example, coral fossils indicate warm, clear shallow marine environments, while freshwater bivalve fossils suggest lacustrine or fluvial environments. Depositional facies are historical products of the formation, evolution, and extinction processes of sedimentary basins. They not only reflect the formation conditions, spatiotemporal distribution, and evolutionary patterns of related strata and rock types but also serve as a basis for analyzing the nature of sedimentary basins and their tectonic settings. A detailed analysis was conducted on the depositional microfacies of each sand layer group and sublayer within the C8 oil reservoir unit, with the research workflow summarized in Figure 1. Reservoir sedimentology theory posits that depositional facies are the material expression of depositional environments. The depositional environment and conditions of sand bodies control their distribution patterns and internal structural characteristics. Extensive experiments, simulations, and production dynamics studies have shown that sand bodies of different genetic origins exhibit distinct reservoir properties, fluid flow behaviors, and development characteristics. Therefore, starting from the genesis of sand bodies, reconstructing the paleoenvironment during their deposition, and identifying their depositional facies are essential for accurately understanding sand body characteristics and their development dynamics[3].

ISSN: 2710-0723

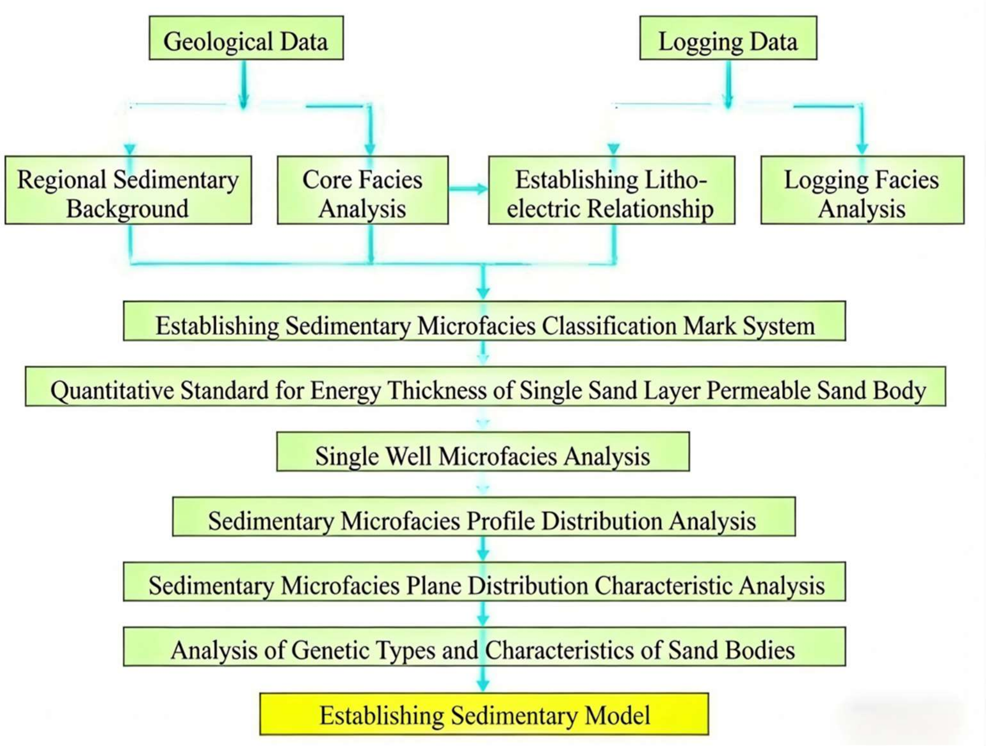


Figure 1. Research flowchart of sedimentary microfacies in the study area

4. Sedimentary Facies Indicators

4.1. Color Features

L Well, C8, black mudstone C Well ,C8, gray sandstone

Figure 2. Sedimentary Color Characteristics

Color is the most intuitive and conspicuous indicator of sedimentary rocks[4]. The primary color of rocks effectively reflects the physicochemical conditions of the water body during their formation. Rocks formed in shallow water or oxidizing environments exhibit light and oxidized colors, primarily light gray, grayish-yellow, gray, and purplish-red. In contrast, rocks formed in deep water or reducing environments display dark colors, such as gray, dark gray, grayish-green, grayish-black, or black. Sand bodies in rivers and deltas are predominantly light gray, grayish-yellow, and gray, while mudstones and argillaceous siltstones in interdistributary bays and shallow lakes range from grayish-black to black. In this region, sandstone colors are mainly

ISSN: 2710-0723

light gray, gray, and grayish-brown, indicative of fluvial and deltaic sedimentary sand bodies. Mudstones, argillaceous siltstones, and silty mudstones are predominantly dark gray and black[5-7], reflecting deposits from interchannel and interdistributary bay environments (see Figure 2).

4.2. Lithological Characteristics

Based on statistics from 30 thin sections of core samples from 9 wells in this area, the C8 reservoir in Block X primarily consists of feldspathic lithic sandstone, followed by lithic feldspathic sandstone[8-10]. The sandstone mineral composition maturity index Q/(F+R) is 0.34, indicating relatively low mineral maturity, which reflects the relatively short transport distance of the sediments. The C8 oil layer group is dominated by fine-grained and fine-to-medium-grained sandstones, with moderate particle roundness (mostly subangular), predominantly linear contacts, and moderately poor sorting[11].

4.3. Grain Size Characteristics of Rocks

The grain size distribution of sediments is controlled by hydrodynamic conditions during deposition[12]. It serves as a direct indicator of the original sedimentary state and provides insights into the hydrodynamic conditions at the time of deposition. This includes understanding the properties of the transporting medium, assessing the energy and capacity of the transporting agent, and determining the mode of transport. Consequently, it offers critical evidence for the analysis of depositional environments[13].

The probability cumulative curve of the study area reflects different sedimentary environments. A two-segment grain size probability cumulative curve is commonly observed in the subaqueous distributary channel microfacies of this area (see Figure 3). The two-segment curve is dominated by saltation (generally accounting for 90–95%), with a minor suspended load component (<10%) and an abrupt truncation point[14]. The low content of suspended components indicates relatively strong hydrodynamic conditions[15] that remain stable, making it difficult for suspended materials to deposit. Such features typically occur in the central part of subaqueous distributary channels.

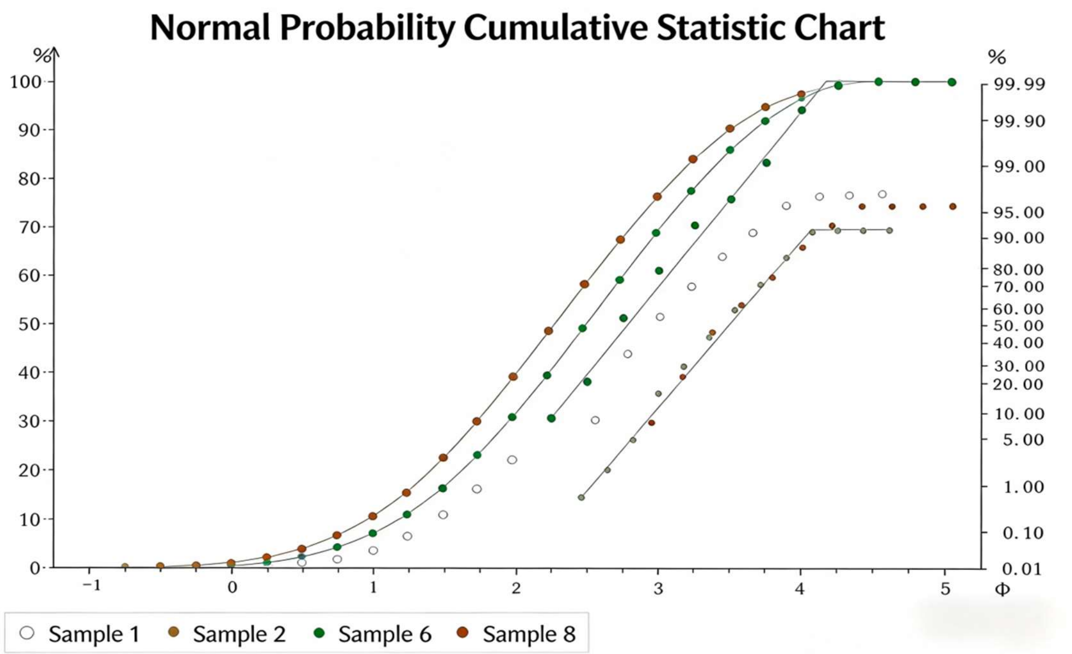


Figure 3. Two-segment grain size probability cumulative curve of subaqueous distributary channel microfacies

ISSN: 2710-0723

4.4. Sedimentary Structures

Sedimentary structures in clastic rocks, particularly primary sedimentary structures, most accurately reflect the hydrodynamic conditions during sediment formation. Moreover, they are less affected by diagenetic processes, making them crucial indicators for analyzing and interpreting sedimentary facies[16]. The well-preserved sedimentary structures in the core sections of the Y Formation within the study area provide essential evidence for investigating sedimentary facies.

(1) Blocky bedding

Massive bedding exhibits no internal structural variation, presenting a uniform structural characteristic, predominantly developing at the base of thick sand layers. In mudstone, massive bedding forms in relatively tranquil environments due to homogeneous sediment composition. In sandstone, it reflects strong hydrodynamic conditions, ample sediment supply, and rapid deposition (see Fig. 4a).

(2) Horizontal bedding

Parallel lamination is characterized by thin laminae arranged in straight, parallel lines that align with the overall bedding plane. This type of bedding is generally believed to form under relatively weak hydrodynamic conditions through the settling of suspended or dissolved materials. The laminae may be revealed by variations in grain size, the distribution of opaque or heavy minerals, or the oriented arrangement of mica flakes and carbonaceous fragments. It primarily develops in siltstone, claystone, and micritic limestone, commonly found in environments such as deep marine and lacustrine zones, tidal flats, enclosed bays, lagoons, marshes, and oxbow lakes.

(3) Parallel lamination

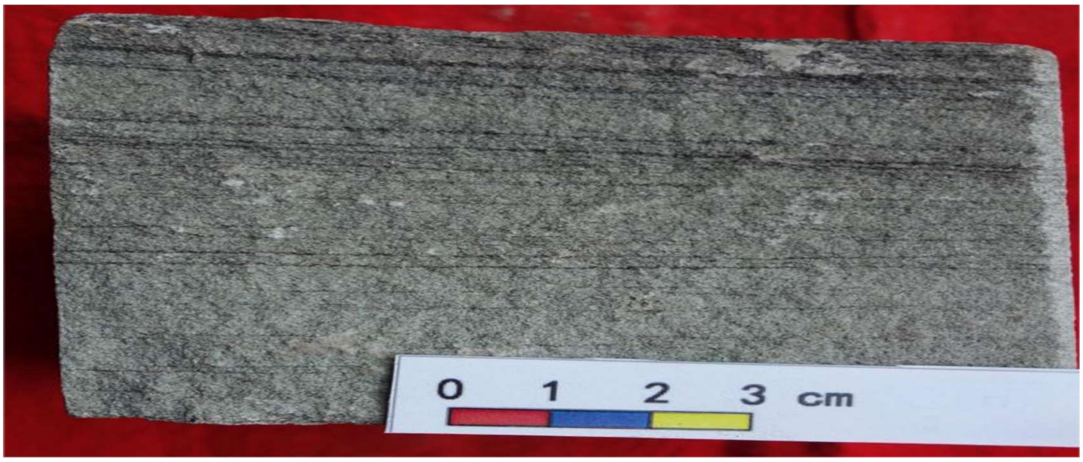
It reflects the depositional characteristics of high-flow fluid currents, with laminae parallel to each other, distinguished by variations in dark mineral content or grain size, typically observed in fine siltstone and silty sandstone. The observed parallel bedding sometimes exhibits distinct laminae, while at other times the laminae appear indistinct. Parallel bedding intervals generally develop above graded bedding sandstone or massive bedding sandstone, likely formed by the continued reworking of the lower bed after the fluid has partially deposited its sediment load, representing a high-energy hydrodynamic condition. This feature is commonly found in depositional environments such as distributary channels (see Figure 4b).

(4) Cross-bedding and inclined bedding

Lamination structures commonly found in sediments such as underwater distributary channels and mouth bars, where inclined laminae intersect bedding surfaces or laminaset boundaries (see Fig. 4c-d).

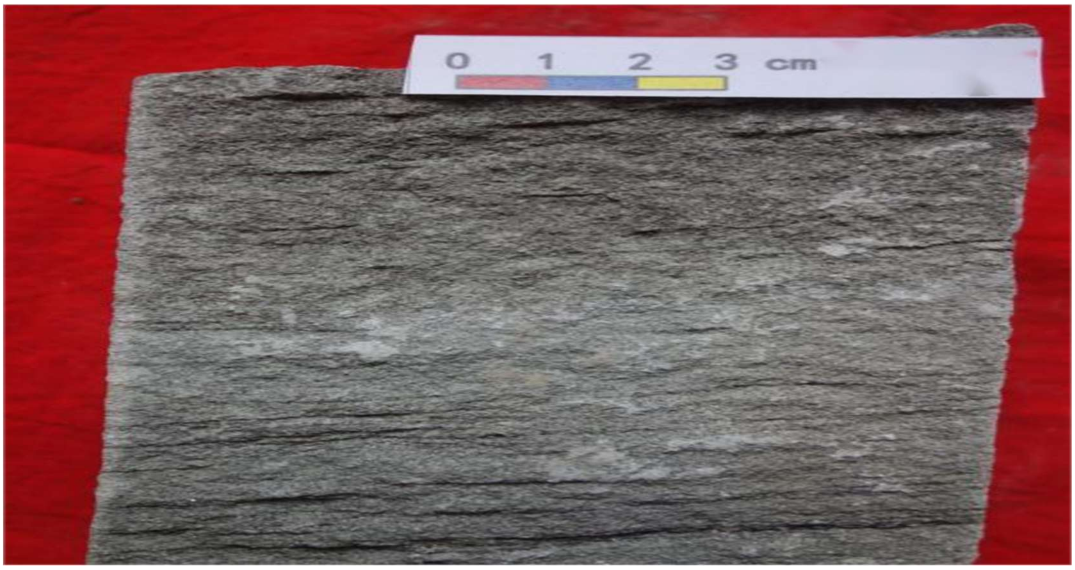
(a) C Well , massive bedding

ISSN: 2710-0723



(b) L Well, parallel bedding

(c) J well, oblique bedding



(d) C Well, cross-bedding

Figure 4. Common types of bedding structures in sediments

4.5. Paleontological Markers

Paleontological remains include body fossils and trace fossils. Certain fossils in sedimentary rocks can not only determine the geological age of the strata but also identify the depositional environment, as the distribution and ecological characteristics of biological communities are strictly controlled by environmental factors such as water temperature, water depth, light, water turbidity, mineralization, oxygen, carbon dioxide, hydrogen sulfide, and other physical and chemical factors. Additionally, the preservation state and completeness of body fossils, as

ISSN: 2710-0723

well as the morphology of trace fossils, can reflect the depositional environment and hydrodynamic conditions at the time. In the core samples of the C8 oil layer group in the study area, small amounts of plant carbon fragments transported by rivers are often observed in siltstone, argillaceous siltstone, and silty mudstone (Figure 5).

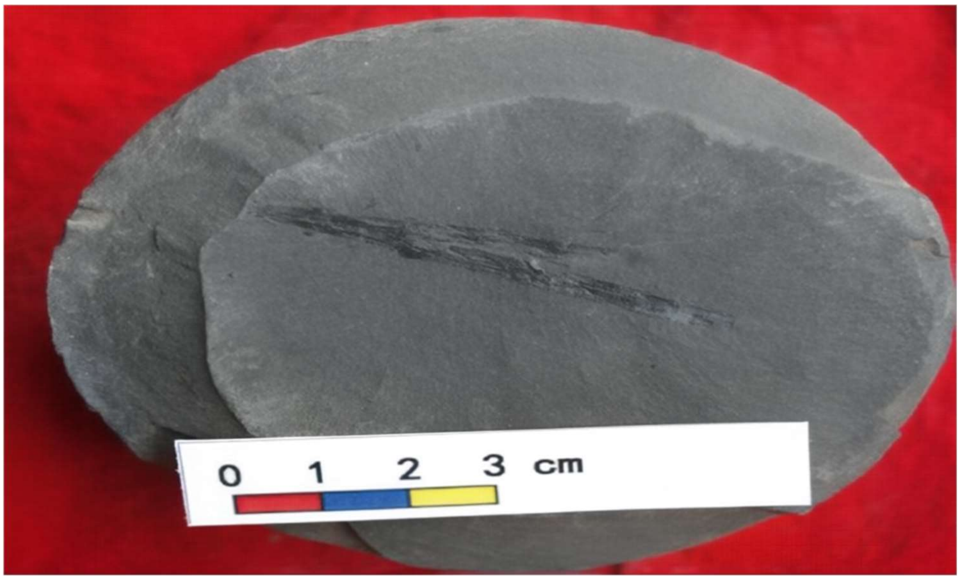


Figure 5. L Well, black mudstone with plant carbon debris

4.6. Geophysical Logging Facies Indicators

Facies analysis using geophysical logging data involves utilizing the qualitative characteristics and quantitative parameters of various logging responses to interpret sedimentary facies of formations. Sedimentary facies are represented by specific facies indicators[17], while logging facies are characterized by distinct logging responses. There exists a close relationship between logging responses and depositional environments as well as sediments. Different depositional environments exhibit unique logging responses, and distinct sedimentary facies display varied logging curve characteristics, lithological associations, and corresponding response features. Approximately ten types of logging data, such as apparent resistivity, natural gamma, acoustic interval transit time, and induction, can be employed for sedimentary facies analysis. Among these, spontaneous potential and natural gamma logs are the most commonly utilized in facies interpretation.

Table 1. Logging Curve Characteristics of the C8 Oil Reservoir in the P Area

SP Curve Morphology	Sedimentary Microfacies	Top-Bottom Contact Relationship
	Subaqueous Distributary Channel	Normal grading, gradual upper contact, abrupt basal contact
	Subaqueous Natural Levee	Transition between interdistributary bay and main subaqueous distributary channel; finger-like or dentate shape
	Interdistributary Bay	Transition between interdistributary bay and main subaqueous distributary channel; finger-like or dentate shape

ISSN: 2710-0723

Table 2. Logging facies characteristics of the C8 oil layer group in Area A

Logging Facies	Sedimentary Characteristics	Sedimentary Structures	Sequence	SP Curve Morphology
Subaqueous distributary channel	Thick to medium-thick fine-grained sandstone, gradually fining upward into fine sandstone and siltstone, with argillaceous fine sandstone intervals. It shows an abrupt contact with the underlying strata, and scour surfaces are commonly developed.	Cross-bedding, massive bedding, parallel bedding, etc.	Normal rhythm or composite rhythm	Bell-shaped, box-shaped, stacked bell-shaped, dentate box-shaped
Subaqueous natural levee	Mainly medium- to thin-bedded siltstone and argillaceous siltstone, with moderate sorting.	Small-scale cross-bedding and ripple bedding	Normal grading and reverse grading	Funnel-shaped, dentate
Interdistributary bay	Primarily consisting of thin-bedded siltstone, argillaceous siltstone, and mudstone, with interbeds of thin-bedded fine sandstone, exhibiting gradational contact with the underlying strata.	Small-scale cross-bedding, ripple bedding, horizontal bedding	Composite rhythm	Relatively flat, locally serrated, low-relief finger-like

In this study, the sedimentary microfacies were initially determined by analyzing rock color, composition, rock type assemblages, texture, and sedimentary structures in the cored intervals. Subsequently, these findings were correlated with corresponding well log curves to identify the characteristic well log responses of the study area (see table), thereby enabling the determination of sedimentary microfacies for uncored target formations within the study area. Integrating field core descriptions and sedimentary structure data, the characteristics of the electrofacies for the C8 reservoir group in Area A of J Oilfield were summarized.

4.7. Paleontological Markers

Logging facies can reflect vertical variations in grain size and sorting[18], as well as changes in hydrodynamic conditions and sediment supply during sandbody deposition. Based on their morphology, they can be further classified into four types.

(1) Bell-shaped: The curve amplitude is large at the bottom and gradually decreases upward. This indicates a gradual weakening of water flow energy and a diminishing sediment supply. Typically deposited in channels or abandoned channel environments.

(2) Box shape: The upper and lower curve amplitudes are generally consistent. This pattern results from abundant sediment supply and stable hydrodynamic conditions, typically found in channel deposits.

(3) Funnel-shaped: The curve amplitude is smaller at the bottom and larger at the top, reflecting an environment where flow energy gradually increases and sediment supply becomes more abundant. It exhibits an inverse grading sequence vertically, typically representing deposits of mouth bars and crevasse splays.

(4) Serrated linear type: The mudstone baseline exhibits a low-amplitude anomaly with minor serrations, typically indicating deposition in an interdistributary bay environment.

5. Depositional Microfacies Types and Characteristics

5.1. Single Well Facies Analysis

Single-well facies analysis involves determining sedimentary facies types for individual wells based on facies indicators obtained from core observations and thin-section data, combined with analytical and logging data, to create single-well facies analysis diagrams[19]. It serves to

ISSN: 2710-0723

identify facies types and vertical facies sequences, as well as to select facies-indicating logging curves. Its reliability directly impacts the final outcomes of facies analysis.

Building upon previous research, this study conducted single-well facies classification for all wells in the area based on lithological characteristics, sedimentary structure indicators, and logging facies markers, analyzed through existing mud logging and logging characteristic responses.

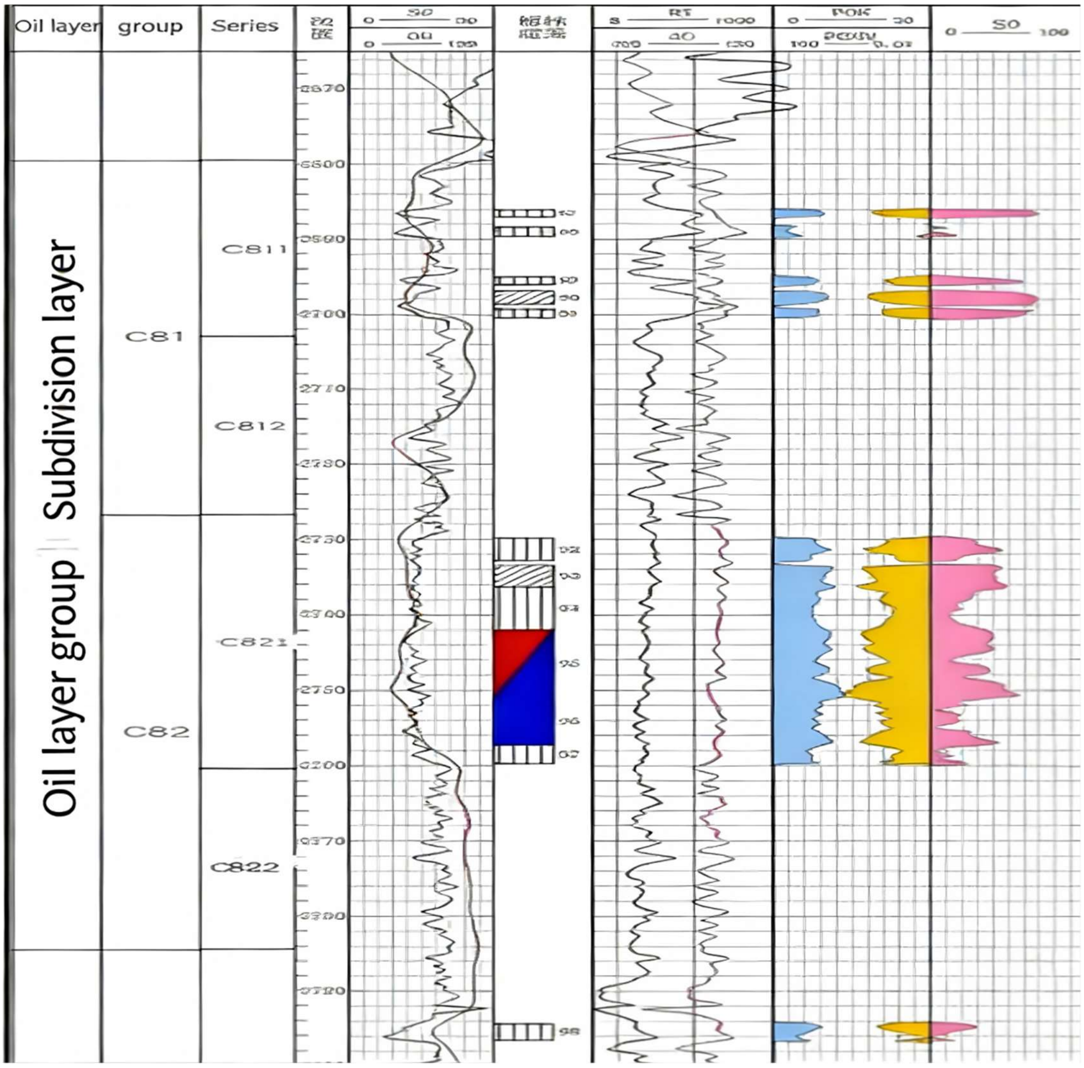


Figure 6. Single Well Facies Classification Diagram for Well C

Taking Well C96 (Figure 6) as an example, located in the northeastern part of the study area, the target interval during the C8 period primarily represents a delta front depositional environment, developing three main sedimentary microfacies: subaqueous distributary channels, channel flanks, and interdistributary bays. At the base of C8, specifically during the $C8_2^2$ period, the natural gamma curve exhibits relatively high values with a slightly serrated, nearly straight shape, and the spontaneous potential curve shows a positive amplitude difference in a straight form, characteristic of typical interdistributary bay mud deposits. During the $C8_2^1$ period, both the natural gamma and spontaneous potential curves display a box-shaped pattern, with rock colors predominantly gray, indicating reducing conditions. The structural features are massive and cross-bedded, representing typical stacked multi-phase channel sands with significant sand thickness and strong hydrodynamic energy[20], characteristic of subaqueous main distributary channel deposits. In the $C8_1^2$ period, the natural

ISSN: 2710-0723

gamma curve again shows relatively high values with a slightly serrated, nearly straight shape, and the spontaneous potential curve exhibits a straight positive amplitude difference, indicative of typical interdistributary bay mud deposits. During the $C8_1^1$ period, the natural gamma curve presents a finger-shaped pattern, representing a typical sand-mud interbedded sequence. Core observations reveal denser sandstone with noticeably increased mud content, characteristic of typical channel flank deposits.

5.2. Facies Analysis

To investigate the distribution patterns of sedimentary microfacies in profiles, based on single-well facies analysis, logging facies analysis was applied to classify sedimentary microfacies types in non-cored wells, establishing comprehensive longitudinal and transverse sedimentary microfacies profiles covering the entire study area. Profile facies analysis not only reconstructs the vertical and horizontal distribution of sedimentary microfacies along profile lines, providing a basis for studying planar distribution of sedimentary microfacies[21], but also reflects depositional environments and their vertical variations. Additionally, it serves to validate the accuracy of single-well facies analysis.

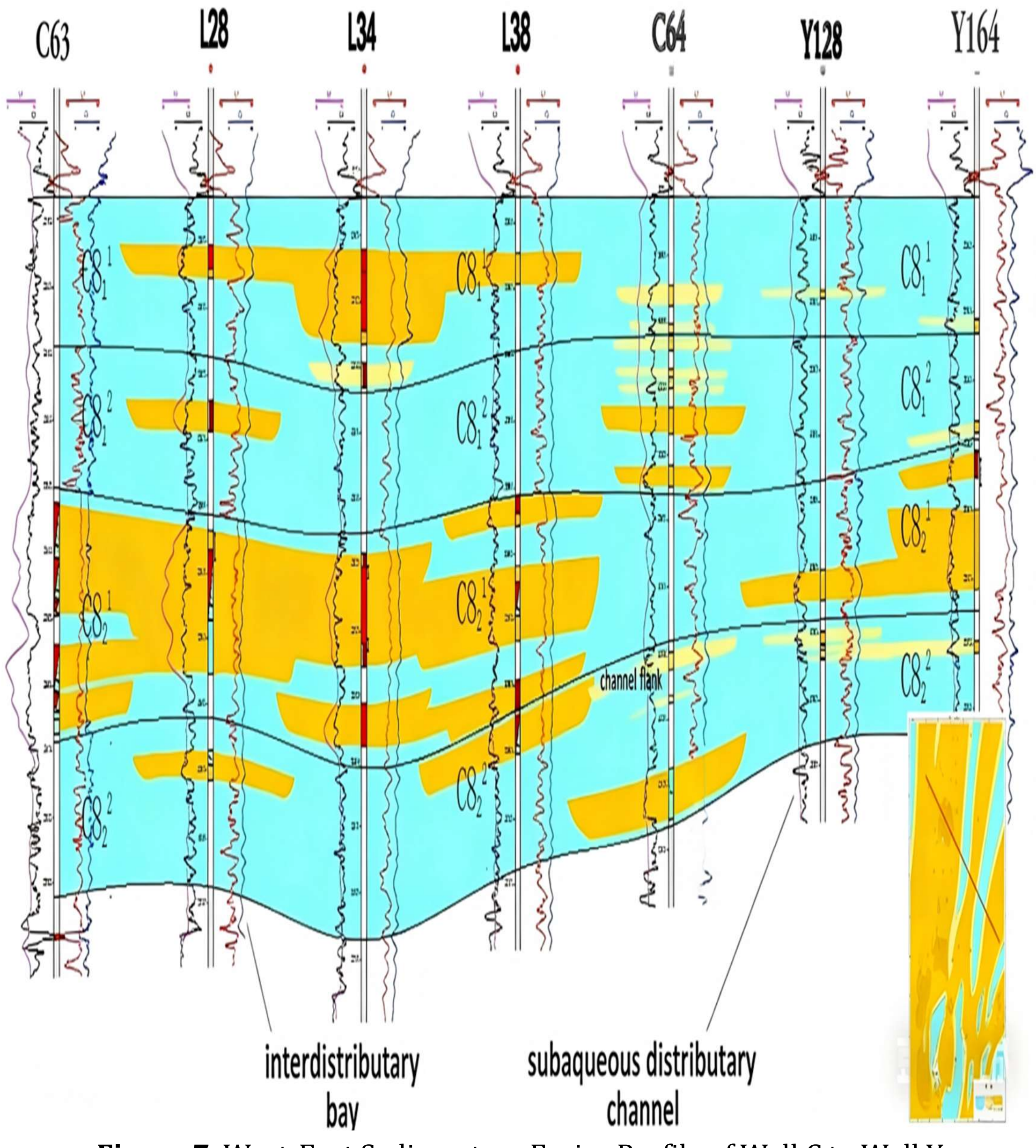


Figure 7. West-East Sedimentary Facies Profile of Well C to Well Y

ISSN: 2710-0723

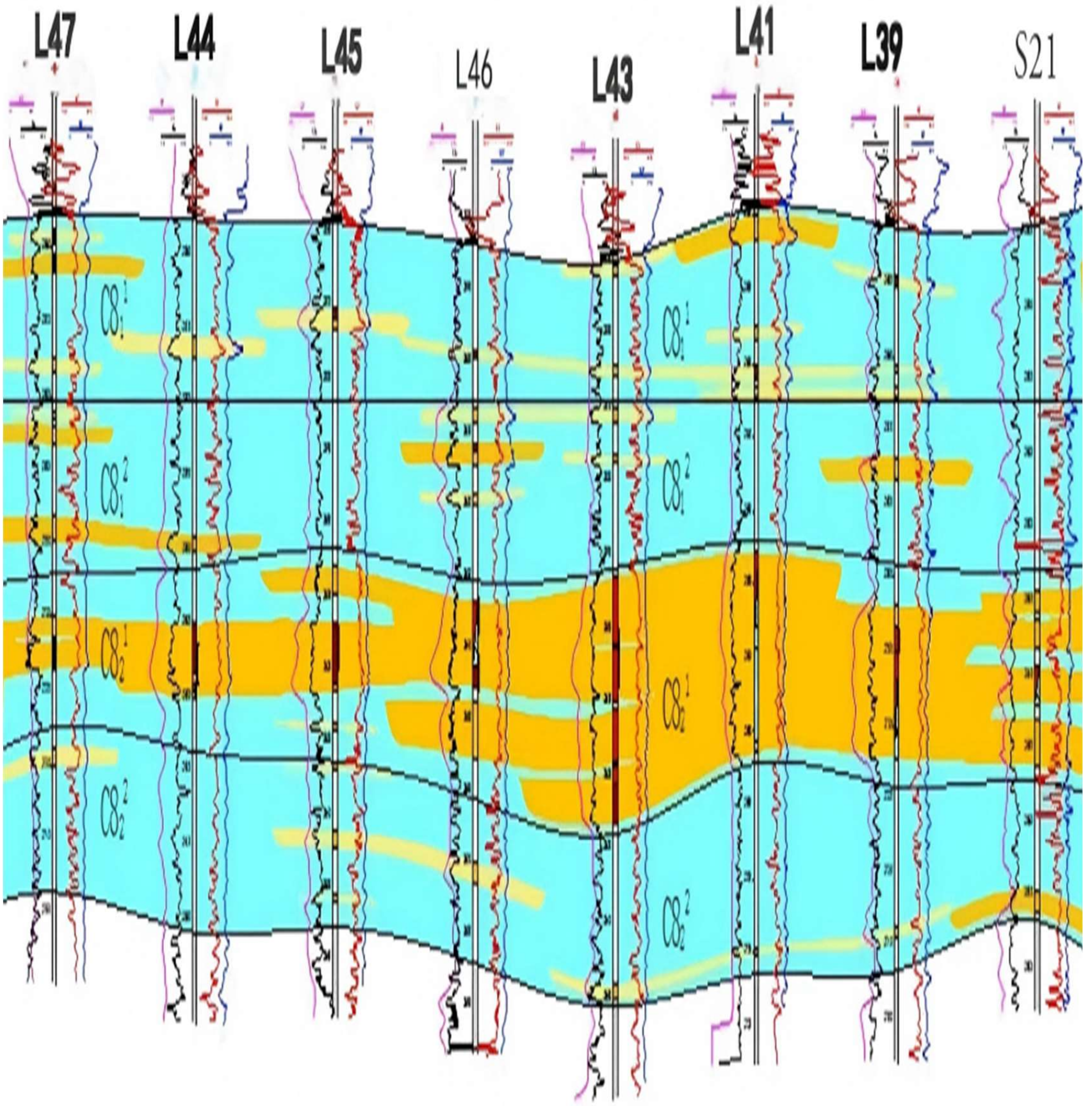


Figure 8. North-South Sedimentary Facies Profile of Well L to Well S

Based on the results of single-well facies division and sublayer correlation, four backbone cross-sections were established in this study. As observed from the cross-sectional diagrams (Figures 7-8), the subaqueous distributary channels in the $C8_2^1$ sand layer of the C8 oil reservoir group in Area A are most developed, primarily consisting of multi-phase subaqueous distributary channel deposits. Vertically, these channels are mutually superimposed. Along the provenance direction, the channel sand bodies exhibit good continuity and extend over long distances, whereas perpendicular to the provenance direction, the sand bodies show poor continuity. Other sublayers are dominated by interdistributary bay mud, with sand bodies perpendicular to the provenance direction exhibiting lenticular distributions and strong segmentation. The continuity of channels along the provenance direction is generally moderate.

6. Planar Distribution Characteristics of Sedimentary Microfacies

Different sedimentary environments exhibit distinct distribution characteristics of sedimentary facies[22]. Through the application of mud logging, core data, well logging data, regional geological background, and sequence stratigraphy characteristics as described above,

ISSN: 2710-0723

combined with the analysis results of single-well facies and cross-well profile facies in the study area, the method of inferring the unknown from the known was employed to predict and compile the sedimentary microfacies planar maps for each sublayer of C8 in the study area (Figure 9).

The A Block of J Oilfield belongs to a delta-front sedimentary environment[23], characterized by the development of sedimentary microfacies such as underwater distributary channels, channel flanks, and interdistributary bays, with the favorable facies belt being the underwater distributary channels. The sediment source in the plane is from the northeast, and the channel sand bodies extend from the northeast to the southwest, where multiple channels[24] converge. During the $C8_2$-$C8_1$ period, the lake basin was in an expansion phase. In the $C8_2$ period, the lake basin shrank, leading to large-scale deposition of channel sand bodies, while in the $C8_1$ period, the lake basin expanded significantly.

Figure 9. Depositional microfacies of C821 sublayer in X area

7. Conclusion

The X area structure is located in the western part of the central Shaanbei Slope, characterized by gentle and broad westward-dipping terrain. The average slope angle is less than 1°, with an average gradient of 6 m/km to 7 m/km. Within this regional framework, near-east-west trending nose-shaped uplifts have developed. For the C8 reservoir in the study area, structural controls on hydrocarbon trapping are minimal, as trapping is primarily governed by lithofacies variations and changes in reservoir physical properties.

During the deposition of the C8 oil layer group, the environment had transitioned into lacustrine and deltaic settings. The formation thickness is approximately 90–100 meters, with conformable contact to the underlying C9 oil layer group. The lithology is predominantly interbedded sandstone and mudstone. Sandstone compositions mainly consist of medium to fine-grained feldspathic quartz sandstone and feldspathic lithic sandstone. Delta front sand bodies are relatively well-developed, making this one of the favorable intervals for reservoir formation.

ISSN: 2710-0723

The total formation thickness is approximately 80-90 meters. The C8 layer primarily consists of subaqueous distributary channel sand bodies deposited in a delta front environment, with large-scale development of these sand bodies. The sediment source is from the northeast direction. The C8 segment develops two reverse cyclothems, $C8_1$ and $C8_2$, from bottom to top. The C8 oil layer group is divided into two sand layer groups: $C8_1$ and $C8_2$.

References

[1] Wei Qinlian, Wang Chonghuan, Liu Junfeng, et al. Characteristics and main controlling factors of Triassic Chang 63 reservoir in Fanjiachuan area, Ordos Basin[J]. Lithologic Reservoirs, 2022, 34(2): 31-44.

[2] SHI Xuefeng, DU Haifeng, ZHONG Mijian. Sedimentary facies analysis and petroleum geological significance of the Chang 1 member of Yanchang Formation in Qiaozhen area, Ordos Basin[J]. Land and Resources Information, 2022, 27(4): 1-6.

[3] Wu Dongxu, Yu Jian, Zhou Jingao, et al. Sedimentary characteristics and reservoir-controlling effects of the fourth member of the Ordovician Majiagou Formation in the Ordos Basin[J]. Journal of Palaeogeography, 2021, 23(6): 1140-1157.

[4] Wu Feng, Ren Peigang, Tan Mingxuan, et al. Sedimentary facies evolution and main controlling factors analysis of Pinghu Formation in Kongqueting area, Xihu Sag, East China Sea [J]. Marine Geology & Quaternary Geology, 2022, 42(2): 119-130.

[5] Liu Yini, Hu Mingyi, Zhang San, et al. Characteristics of carbonate ramp microfacies and their constraints on reservoir development: A case study of the Middle-Lower Ordovician in Gucheng area, Tarim Basin[J]. Petroleum Exploration and Development, 2022, 49(1): 93-105.

[6] JIAO Tao, CUI Yingmin, WANG Botao, et al. Study on sedimentary microfacies of Yan 9 oil reservoir in Yan’an Formation in Shijiawan–Baoziwan area[J]. Fault-Block Oil & Gas Field, 2021, 28(4): 487-492.

[7] He Hui, Zhou Yongqiang, Long Weijiang, et al. Micro pore-throat structure characteristics of low-ultra low permeability reservoirs and its influence on water flooding characteristics: A case study of Chang 3 reservoir in Weibei Oilfield, Ordos Basin[J]. Petroleum Geology and Recovery Efficiency, 2021, 28(4): 23-34.

[8] Zhang Pei, Qian Qihao, Jiang Mingzhong, et al. Sedimentary characteristics and depositional model of shallow-water deltas at the margin of arid lake basins: A case study of the VI oil member of the Lower Youshashan Formation in the Gasikule Oilfield, Qinghai [J]. Acta Sedimentologica Sinica, 2022, 27(4): 1-19.

[9] Li Jiaguang. Fine-grained sedimentary system and depositional model of terminal meandering rivers in arid lake basins [J]. Earth Science, 2018, 43(S1): 264-276.

[10] Hui Xiao, Hou Yunchao, Yu Jian, et al. Seismic stratigraphic characteristics and sandbody distribution patterns of progradational sequences in deep lacustrine areas of large continental downwarped lake basins: A case study from the middle Yanchang Formation in the Longdong area, Ordos Basin [J]. Acta Sedimentologica Sinica, 2022, 27(4): 1-19.

[11] Zhong Mijian, Guo Qingzheng, Ge Yan. Sedimentary facies characteristics of the Yan'an Formation, Jurassic, in the 10th member of the Ordos Basin: A case study of the Wuqi area [J]. Petrochemical Industry Technology, 2022, 29(2): 174-175.

[12] Guo Weipeng. Study on Sedimentary Facies of He 8 Member in Ordos Basin [J]. China Metal Bulletin, 2021, (6): 149-150.

[13] LI Lu, LI Fengjie. Sedimentary facies characteristics and depositional model of the fourth member of Leikoupo Formation in Pengzhou Gas Field[J]. Journal of Xi'an Shiyou University (Natural Science Edition), 2021, 36(3): 9-15, 31.

[14] Fu Xin, Du Xiaofeng, Guan Dayong, et al. Application of seismic sedimentology in the study of fluvial-shallow water delta sedimentary facies: A case study of Guantao Formation in Penglai A structure area, Bohai Sea[J]. Bulletin of Geological Science and Technology, 2021, 40(3): 96-108.

ISSN: 2710-0723

[15] Wang Qian, Wei Fan, Zhang Yan, et al. Sedimentary facies of the Chang 81 sub-oil layer in the Heshui area of the Ordos Basin and their influence on reservoir physical properties [J]. Sedimentary Geology and Tethyan Geology, 2021, 41(1): 88-99.

[16] ZHAO Xiaochun. Study on sedimentary facies of Chang 4+5~(2-1) reservoir in Xinzhai oil area of Wuqi oilfield[J]. China Petroleum and Chemical Standard and Quality, 2021, 41(2): 133-135.

[17] Zhang Lei. Division and Characteristics of Sedimentary Facies in Some Areas of Ordos [J]. China Petroleum and Chemical Standard and Quality, 2021, 41(1): 148-150.

[18] Li Lusheng, Wang Jiage, Guo Mengyan. Study on sedimentary facies of Chang 7 oil reservoir in Wuqi area, Ordos Basin[J]. Journal of Yan'an University: Natural Science Edition, 2020, 39(4): 37-40.

[19] Gao Rongjie. Sedimentary facies characteristics of Chang 61 reservoir in Huanjiang-Heshui area, Ordos Basin [J]. Chemical Enterprise Management, 2020, (32): 189-190.

[20] Li Jing. Sedimentary Facies and Hydrocarbon Accumulation Characteristics of the Fourth Member of the Quantou Formation in the Gulong Area, Northern Songliao Basin [J]. West-China Exploration Engineering, 2020, 32(11): 97-99, 106.

[21] Yang Cheng, Wang Haijun, Wang Dong, et al. Sedimentary facies and depositional model of the Dengying Formation in the Jingyan area, southwestern Sichuan Basin[J]. Journal of Northeast Petroleum University, 2020, 44(5): 59-69.

[22] Wang Meng, Gao Wanchao, Yang Yudong. Study on sedimentary facies characteristics of Chang 2~1 oil layer group in Jiayao-xian oil area of Ordos Basin [J]. Liaoning Chemical Industry, 2020, 49(9): 1155-1158, 1161.

[23] Chen Xu, Ou Rongsheng, Si Shanghua, et al. Sedimentary Facies Division and Model of Wave-Dominated Delta in Block N, Pakistan [J]. Acta Sedimentologica Sinica, 2022, 40(1): 255-266.

[24] Lu Zhiyuan, Ma Shizhong, Fei Fanxu, et al. Analysis of sedimentary facies in fan delta front and their impact on single well productivity: A case study of the Baikouquan Formation in the Ma 18 well area, Mahu Depression[J]. Henan Science, 2018, 36(8): 1256-1261.