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Fine Reservoir Description and Modeling

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Abstract

Reservoir fine description refers to the multidisciplinary comprehensive study of reservoirs in order to clarify reservoir characteristics and improve residual oil and gas recovery in the late stage of oilfield development. Reservoir architecture is a study of the size, geometry and superimposition relationship between reservoir units of different grades. Nowadays, in the development stage of strongly heterogeneous reservoirs, it is important to describe and characterize reservoirs precisely. The core and ultimate method is reservoir modeling technology. This paper introduces the concepts of reservoir fine description and reservoir architecture and the development process in China and abroad, and compares the advantages and disadvantages of different reservoir modeling. Finally, on the basis of a single well data, the sequential indicator simulation method is used to construct the sedimentary microfacies model of Zhao30 Block in the eastern area of Sulige Gas Field, which verifies the accuracy of the model and improves the accuracy of reservoir fine description.

Keywords

Fine reservoir description, Reservoir architecture, Stochastic modeling.

1. Introduction

Most of the early developed oilfields have entered the late stage of development, with low recovery, facing many problems such as high composite water cut and low production. Research shows that there is a lot of oil and gas remaining in the sand body, which are controlled by complex reservoirs, and are the important target for the next development and excavation of oilfields [1]. However, the research based on small layers or sand formations is insufficient to describe the reservoir more precisely, and more detailed hierarchical division is needed, which results in the formation of reservoir architecture.

Reservoir fine description is often called reservoir characterization in foreign countries. Many scholars, in China and abroad, have carried out immense research on this aspect. Nowadays, the focus of foreign research has changed from conventional outcrop analysis, experimental analysis, numerical simulation to seismic inversion reservoir prediction, micro-seismic reservoir characterization, artificial intelligence neural network and other new technologies and new methods. Meanwhile, the research object has also changed from traditional sandstone and carbonate rocks to tight oil gas reservoirs [2, 3]. In the research methods, the synthesis, seismic technology and computer technology have been further strengthened; In China, a set of mature reservoir fine description procedures and methods have been developed from the initial simple imitation of foreign reservoir description research methods, and the research contents are relatively comprehensive and perfect, covering almost all aspects of reservoir geology research [4].

The final result of reservoir description is to establish a quantitative reservoir geological model as the basis of reservoir simulation, reservoir engineering and oil recovery engineering [5, 6].

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2. Fine reservoir description

Fine reservoir description is the quantitative description and characterization of reservoir parameters in three-dimensional space, that is, to establish reservoir models reflecting reservoir structure, sedimentation, diagenesis, fluid and other characteristics. The purpose of this work is to deepen the understanding of reservoirs and identify potential distribution. If the model results are consistent with actual production, it has the potential to guide effective water drive development [7, 8]. Fine reservoir description is of guiding significance to the formulation, adjustment of development plan and comprehensive planning of the oilfield, and can fundamentally improve the effect of reservoir development. It is also the basis and key to further improve the recovery of old oilfields. Shi et al. (2004) considered that the fine reservoir description in the middle and late stages of oilfield development refers to that after the oilfield enters the middle and high water cut stage and the extra high water cut stage [9], with the deepening of the degree of reservoir exploitation and the increase of production performance data, in order to make the oilfield develop economically and effectively and improve the oil recovery rate, the aim is to clarify the distribution characteristics, rules and control factors of remaining oil in the oilfield and to continuously improve the reservoir geological model and quantify the distribution of remaining oil for fine geological study of oilfields.

At the same time, reservoir characterization technology is a key technology in the field of oil and gas field development. In 1985, the United States Department of Energy held the first International Congress on Reservoir characterization in Texas, formally put forward the concept of "reservoir characterization", which is defined as the process of quantitatively determining reservoir properties (characteristics), identifying uncertainties of geological information and spatial changes. Its geological information includes two elements: 1) physical characteristics of reservoirs, mainly referring to the heterogeneity of physical characteristics (porosity, permeability, oiliness) within reservoirs; 2) spatial characteristics of reservoirs, namely, the change or extension range of lithology in three-dimensional space, also known as architecture [10]. Well logging, petrophysics, geochemistry, engineering and other disciplines, starting from wells, can provide various fine reservoir parameters, and its lateral expansion depends on seismic data, especially three-dimensional seismic data. Even so, the obtained data and reservoir parameters can only show some correlation, but it is difficult to directly calculate the precise values of various reservoir parameters [11].

Reservoir characterization is accompanied by the whole process of oil and gas field development. With the continuous improvement of development degree, the water cut of oil field inevitably improves. Because of the existence of a large number of undetected or unutilized layers, inadequate or unperforated layers, by improving the accuracy of reservoir characterization, these oilfields still have tremendous potential for excavation [12]. In reservoir description, there are many methods and techniques to characterize reservoirs, such as fine sedimentary microfacies study, high resolution sequence stratigraphy, seismic reservoir characterization technology and reservoir stochastic modeling technology [13, 14].

2.1 Study on Fine Sedimentary Microfacies

Sedimentary microfacies is an important factor to control reservoir anisotropy and indispensable for reservoir characterization and prediction. The internal distribution of sedimentary microfacies is an important factor in reservoir characteristics and dynamic prediction [15]. Therefore, fine sedimentary microfacies research is an important means of fine characterization of reservoirs. The purpose of this study is mainly to illustrate the sedimentary environment of reservoirs and the changes occurring under various geological processes over time. However, in most oilfields, microfacies distribution is mainly described as a two-dimensional deterministic map using limited core data and logging data [16]. This is a simplified method to describe the phase distribution in complex space, rather than reflecting the internal changes of a layer. With the rapid development of oilfields, simple sedimentary facies analysis has been unable to meet the needs of current research. It is very important to establish three-dimensional microfacies model to characterize reservoir heterogeneity [14, 17], and using

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logging curves to simulate sedimentary environment has become a crucial technology for oilfield exploration and development.

Different from the focus of conventional sedimentology, fine reservoir characterization requires the analysis of sedimentary microfacies to understand the distribution law of each reservoir sedimentary microfacies, such as macro and micro quantitative and semi-quantitative characteristics of distribution direction, width-thickness ratio, length-width ratio and reservoir heterogeneity. The determination of these characteristics usually needs to be combined with outcrop, underground or logging characteristics [18]. Especially for the study of phase change characteristics, for continental strata, the lateral phase change of reservoir is fast, and the clarification of phase change characteristics also solves the structural characteristics of reservoir distribution and its provenance direction, which is necessary for understanding the distribution, shape and change of reservoir, and is very important for establishing high-resolution sequence framework and reservoir geological knowledge base [19]. But these characteristics of reservoir can only be described qualitatively, and it is difficult to express these laws quantitatively. If combined with the dynamic data of oilfield development, the shape and size of reservoir sand body can be established, which shows the advantage of fine sedimentary microfacies analysis.

2.2 Reservoir architecture

Reservoir architecture refers to the structural characteristics of sandy units and discontinuous "thin interbeds" in sedimentary sand body internal defined by sedimentary interfaces at different levels, such as geometry, size, arrangement and contact relationship. Its application in reservoir sedimentology can be traced back to the 1970s. In 1977, Allen, J.R.L. presented the concept of reservoir architecture clearly at the first International Conference on Fluvial Sedimentology to describe the geometry and internal combination of channel and overbank deposits in river sequences [20]. In 1985, Miall., A.D. proposed the reservoir architecture analysis method of fluvial facies for the first time [21]. The concepts of interface grade, lithofacies type and structural unit in this method were introduced comprehensively, which represented the birth of the reservoir architecture analysis method. In 1988, Miall., A.D. improved the four-level classification method and added it to six-level classification scheme [22]. With the development of reservoir architecture research, the research field of reservoir architecture is also expanding.

The ultimate goal of reservoir architecture research is to accurately characterize the internal structure of reservoir and predict the distribution of remaining oil. It is one of the important means to study the relationship between sand body distribution and reservoir sand body superimposition [23]. By dividing the stratigraphic structural units, the top and bottom constrained interfaces of the architecture units are determined, and a fine three-dimensional geological model is established, which conforms to the geological model and geological conditions. The model established by this method can be in good agreement with well data and outcrop anatomy in the field. Zhou et al. (2011) summarized that future research on reservoir architecture should develop towards multi-point geological statistical modeling [24]. The fine modeling of reservoir architecture can be achieved by using training images. Reservoir architecture theory can provide a basis for classification of hierarchical system and identification of genetic units. It can also be used to analyze the space-time coupling relationship between tight sandstone reservoir and reservoir formation history by combining diagenetic characteristics and pore throat structure characteristics [25]. The study of reservoir architecture has not formed a unified system for fine anatomy of sand bodies in different sedimentary environments, and the resolution of model building for complex structural units in sedimentary environments needs to be improved. With the further utilization of logging facies, single well facies and the application of three-dimensional geological modeling in oilfields, reservoir architecture is gradually developing towards three-dimensional and refined development, providing assistance for the next development of oilfields.

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3. Reservoir modeling

3.1 Reservoir Modeling Method and Principle

Reservoir geological model is a high generalization of reservoir type, geometric shape, scale, internal structure, reservoir physical parameters and fluid distribution. It is a process of quantitative research on reservoir in three-dimensional space and establishment of three-dimensional quantitative model to predict and describe reservoir in multi-disciplinary integration, three-dimensional quantification and visualization. Generally, it includes reservoir structure model, lithofacies model, porosity model, permeability model, effective reservoir model, etc. In order to establish static and dynamic reservoir models, predict remaining oil relative enrichment areas and improve oil recovery, it is necessary to involve geology, logging, seismology and other disciplines. More importantly, production dynamic data must be integrated into the comprehensive description of reservoirs [26, 27]. The purpose of reservoir modeling is to describe and predict reservoir characteristics through seismic, logging, testing and drilling data acquired in oil and gas exploration and development, and to obtain three-dimensional data volume and image display of reservoir attributes.

Reservoir models can be divided into two categories: reservoir discrete variable models (such as sedimentary microfacies, lithofacies, fracture, flow unit, etc.) and continuous variable models (such as porosity, permeability, saturation, etc.) [28]. To construct reservoir models, it is necessary to integrate different types of data with a certain mathematical framework. The change of mathematical framework is often the starting point of important progress in reservoir modeling technology. Geostatistics is the mathematical framework adopted by most reservoir modeling techniques, which consists of four parts: regionalized variable theory, variogram function model, Kriging estimation technology and stochastic simulation technology [29]. The variogram function model solves the spatial variability structure of discrete or continuous variables; Kriging estimation is an optimal unbiased estimation. But the variogram statistics is the difference between two points in space, so it can not reflect the spatial form of complex geological bodies. This technology is used to calculate the probability distribution function model of random variables and assign mathematical expectations to unknown spatial random variables.

In order to better describe the spatial distribution characteristics of geological bodies, an object-based geostatistics reservoir simulation method is proposed. The core idea of this method is to parameterize the geological body shape with the existing data as constraints, so as to simulate the spatial distribution shape of geological body through these parameters. After obtaining the spatial distribution contours of geological bodies, the attributes of geological bodies are simulated by using variogram-based modeling method in the interior of geological bodies. Random simulation technology is based on the probability distribution function model of random variables obtained by Kriging technology, the random variables in unknown spaces are assigned by Monte Carlo technique [30]. In recent years, multi-point geostatistics has emerged, which takes into account the relationship between more spatial locations when describing spatial variability structure models. In addition, some mathematical methods have been introduced into this field [31].

With the development of oil and gas fields and the accumulation of data, the establishment of quantitative reservoir three-dimensional geological model has become one of the most effective means of fine reservoir description. Modern reservoir geological modeling is based on the basic theory of geostatistics, using deterministic and stochastic modeling methods, to obtain three-dimensional data volume reflecting the spatial variability of reservoirs [32, 17, 33].

3.2 Comparison and optimization of modeling methods

At present, the development trend of reservoir modeling technology is from qualitative to quantitative, from unidisciplinary modeling to multidisciplinary comprehensive modeling, and from static data modeling to dynamic and static data combined modeling. Its methods are mainly divided into two categories: deterministic modeling and stochastic modeling.

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The deterministic modeling is to give deterministic prediction results for the unknown area between wells, that is, to infer the deterministic, unique and real reservoir parameters from the control points of known deterministic data. Because of the complexity, local randomness and variability of reservoir spatial distribution, it is difficult to obtain reliable results in reservoir prediction using deterministic modeling method [34].

Stochastic modeling is based on the known information, using the random function as the theory, applying the stochastic simulation method to obtain an alternative, equal probability and high-precision model for reflecting the spatial distribution of variables. The advantage of this method is that the spatial structure characteristics of reservoir distribution can be established by statistical of reservoir information with point distribution, and these characteristics can be used to estimate the quantitative distribution of the reservoir in three-dimensional space under the condition of equal probability. The disadvantage is that the reliability of information in the process of modeling is limited [35].

The reliability of information depends largely on the reliability of technical methods and the perfection of technical routes, besides the limitation of data conditions. For example, the statistical requirement for structural characteristics of reservoirs requires variation functions within the same sedimentary unit to truly reflect the spatial variation characteristics of reservoirs, which is the first condition to reduce the uncertainty of stochastic models, and the establishment of reservoir original sedimentary units is the advantage of high-resolution sequence stratigraphy [36, 37]. At the same time, because the reservoir physical parameters are continuously changing in the reservoir skeleton and distributed discontinuously or discretely between the skeletons, it is necessary to recognize the two-step reservoir skeleton simulation and reservoir parameter simulation based on sedimentary microfacies, so that the deterministic parameters such as reservoir morphological characteristics and scale can be taken as constraints, especially the spatial information of seismic reservoirs, and can constrain the spatial variation of the reservoir simulation process (the degree of constraints depends on the reliability of seismic reservoir information) [38].

Only under the above constraints, the uncertainty of reservoir stochastic modeling results will be greatly reduced. The most reliable reservoir model under the existing data conditions will be selected through the test of geological laws and development dynamic parameters. Reservoir stochastic modeling technology is widely used because it can combine dispersed raw data to provide multiple implementations for reservoir production and risk management [39].

4. Application example

The Sulige gas field in the Ordos Basin is the largest gas field in China. It is a typical gas reservoir with low permeability, low pressure and low abundance. It has the characteristics of strong reservoir heterogeneity, small effective sand body scale, poor connectivity, low single well production and rapid pressure drop. The fine description of reservoirs and 3D geological modeling are difficult, and development faces many difficulties [40].

Therefore, we should make full use of the static and dynamic data of tight well pattern area in Sulige gas field to carry out reservoir architecture dissection, clarify the size and superposition relationship of sand bodies, search for sandstone reservoirs with better physical properties and describe it in detail, construct reservoir geological knowledge base, form the characterization technology of tight sandstone reservoirs, and establish three-dimensional geological model of tight well pattern area and some blocks, to provide technical support for gas field well pattern optimization and infill adjustment, well location deployment, stable production and enhanced recovery. Taking the Upper Paleozoic of Zhao30 Block in the eastern area of Sulige Gas Field as an example, this paper establishes a three-dimensional sedimentary model based on the existing data.

4.1 Geological setting

3.1.1 Tectonic setting

The Ordos Basin is a large multi-cyclian cratonic basin developed on the ancient crystalline metamorphic basement. The basement is metamorphic crystallization of the Archean and Early Proterozoic. The overlying depositional cap rocks of Middle-Upper Proterozoic, Paleozoic and Mesozoic-Cenozoic, with stable settlement, migration of depression, and obvious writhing [41].

According to the structural morphology of the Ordos Basin, it is divided into six first-order structural units: the Yimeng uplift, the Weibei uplift, the Jinxi flexural belt, the Yishan slope, the Tianhuan depression and the western margin thrust belt [42, 43]. The Zhao30 block is located in the north-central part of the Yishan slope in the Ordos Basin, with an area of about 260 km^2. It is a western-sloping monoclinic structure with northeast high and southwest low (Figure.1) [44-46].

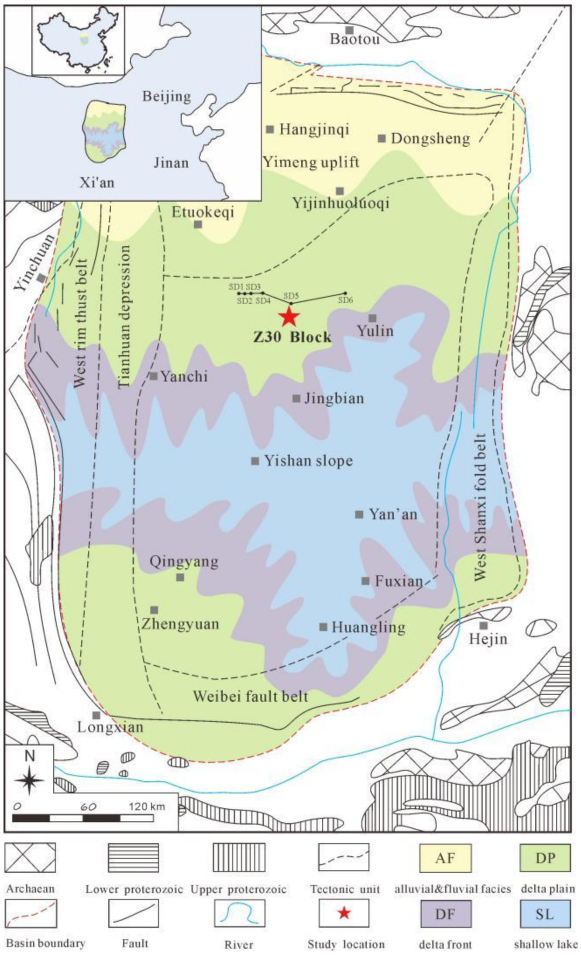

Figure 1. Geological map of the Permian Ordos Basin, showing tectonic divisions, extent of the residual Ordos Basin, distribution of sedimentary facies, and well locations [47]

3.1.2 Sedimentary and stratigraphic setting

The Upper Paleozoic in Block Zhao30 in the eastern area of Sulige Gas Field is dominated by fluvial facies. The strata of the Upper Paleozoic is built, from bottom to top, by the Benxi Formation, the Taiyuan Formation of the Carboniferous, the Shanxi Formation, the Shihezi Formation and the Shiqianfeng Formation of the Permian, which belong to marine-continental transitional facies-continental clastic rock deposits [48]. The Benxi Fm. of the Upper Carboniferous is dominated by bauxite as the bottom boundary, with the coal seam as the top boundary and the thickness is 35-45m. The Taiyuan Fm. is continuously deposited on the Benxi Fm., with the Miaogou limestone as its bottom and the Beichagou sandstone as its top, with a thickness of 25-40m, which gradually thickens from west to east.

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The Permian is divided into upper, middle and lower Triassic. The Lower Shanxi Fm. is integrated contact deposited on the Taiyuan Fm., the Beichagou sandstone is the bottom, the Luotuobo sandstone is the top, and the thickness is 90-110m. According to the sedimentary sequence, the Shanxi Fm. can be divided from bottom to top into the 2nd member (P_1s_2) and the 1st member (P_1s_1). The thickness of P_1s_2r is 45-60 m, and a set of coal-bearing clastic rocks is developed. The thickness of P_1s_1 is 40-50 m, mainly consisting of gray fine-medium grained sandstone with carbonaceous mudstone and mudstone deposits;The Middle Permian Shihezi Fm. is composed of Luotuobo sandstone as its bottom and a layer of mixed mudstone as its top, which is divided into lower and upper Shihezi Fm. from bottom to top. The lithology of Lower Shihezi Fm. is composed of light gray conglomerate coarse-medium coarse grained sandstone, grey green debris quartz sandstone and mudstone interbedded with different thickness, 120-160m thick, and is of medium thickness and thin in North and south. According to the sedimentary cycle, it can be divided into four sections from bottom to top, of which the lithology of P_2h_8 is composed of coarse-fine sandstone and siltstone with a thickness of 80-100m; The sandstone of Upper Shihezi Fm. is undeveloped, and a set of red mudstone and sandy mudstone interbedded with thin sandstone and siltstone is deposited, with a little siliceous layer at the top and a thickness of 140-160m. The Upper Permian Shiqianfeng Fm. is mainly composed of a set of purple-red conglomerate sandstone and sandy mudstone interbedded with a thickness of more than 200 m.

With the deepening of exploration and development of gas fields, it is urgent to strengthen the research on further exploration and development potential of key reservoirs in the Upper Paleozoic. The main gas layers of the Upper Paleozoic in this study area are P_2h_8 and P_1s_1, mostly low-permeability reservoirs with rapid lateral variation, which is a typical sandstone lithologic trap gas reservoir and is also the target interval of this study.

4.2 Geological Modeling Preparations

3.2.1 Sedimentary facies analysis

Sedimentary facies is a combination of sedimentary environment and the characteristics of sediments or sedimentary rocks formed in this environment [49]. Sedimentary facies zone is the primary factor to control reservoir distribution and characteristics, and also an important research object of reservoir evaluation. Through the observation and study of a large number of drilling cores, the detailed study of lithologic facies, logging curves, paleontology and other phase markers, combined with previous research results, a more comprehensive and systematic study has been carried out on the Zhao30 Block in the eastern area of Sulige Gas Field. The main sedimentary facies types of the P_2h_8 and the P_1s_1 in the study area are fluvial facies, of which the P_2h_8 belongs to braided river deposits facies and the P_1s_1 belongs to meandering river sediments facies, which can be further divided into corresponding sedimentary subfacies and sedimentary microfacies types (Table 1).

Table 1. A brief table of classification types of sedimentary facies, subfacies and microfacies in the study area [50]

Sedimentary facies	Sedimentary subfacies	Sedimentary microfacies
Braided river	Channel	Braided channel、Channel bar
	River diffuse	Flood lake、Flood plain
Meandering river	River bed	Point bar
	Embankment	Natural levee、Crevasse splay
	River diffuse	Flood plain
	Abandoned Channel Filling	Oxbow lake

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3.2.2 Sedimentary microfacies analysis

In order to grasp the distribution law of sedimentary facies belts in the research area, based on logging interpretation and single well facies analysis, the contrast diagram of sedimentary microfacies in East-West and North-South directions are compiled, taking an East-West sedimentary microfacies comparative profile as an example. The profile is located in the north of the study area, which is distributed in East-West direction. The sequence from West to East is: well SD1, well SD2, well SD3, well SD4, well SD5 and well SD6 (Figure. 2).

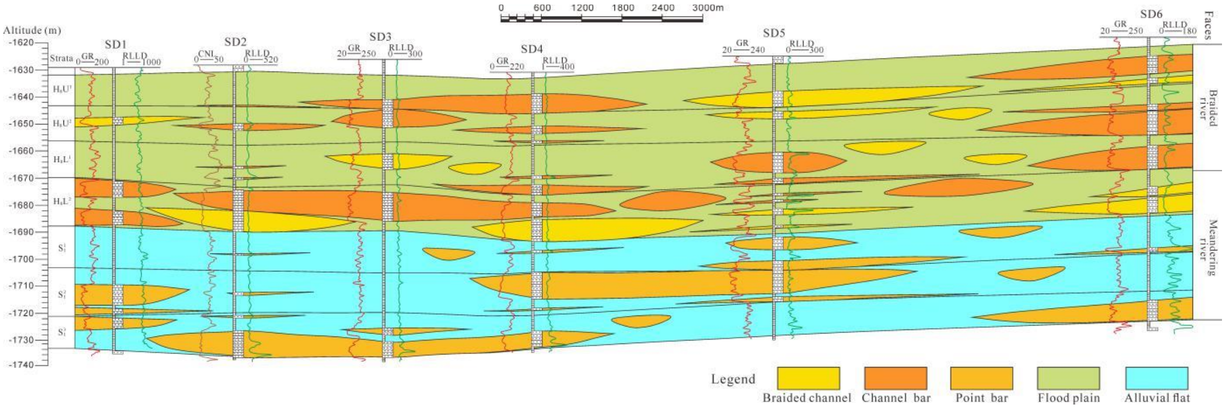

Figure 2. E-W profile showing the sedimentary microfacies in Zhao30 block, eastern Sulige Gas Field

The period of P_1s_1 is meandering river sedimentary environment, the point bar sedimentary microfacies of the well SD2, the well SD3, the well SD4 and the well SD5 are developed, the thickness of the sedimentary sand body is relatively thick and the continuity is general; The oxbow lake sedimentary of the well SD5 is developed.

The period of H_8L is braided river sedimentary environment with braided channel, channel bar, flood lake and flood plain sedimentary microfacies. The braided channel and channel bar sedimentary microfacies of well SD1, well SD2, well SD3 and well SD4 are well developed, and the vertical thickness of sand body is relatively large, especially H_8L^2, but the continuity of sand body is general as a whole, only in local areas.

The period of H_8U is braided river sedimentary environment with sedimentary microfacies such as flood lake, braided channel, channel bar and flood plain. The flood lake sedimentary microfacies of well SD1 and well SD2 are well developed, the channel bar sedimentary microfacies of well SD3 and well SD4 are well developed, and the thickness and continuity of sand bodies are worse than those of H_8L.

4.3 Geological modeling

Previous studies on geological modeling of Sulige tight sandstone gas field and its surrounding blocks have been carried out. The main modeling methods include target-based method, pixel-based sequential method and multiple-point geological statistics method [51]. Although the target-based method reproduces the geometry of braided channel and beach, it can not be completely accurate to well point information, and the single well coincidence rate of the model is low. Sequential method based on pixels can not describe the geometric shape and contact relationship between braided channel and beach, and can not quantitatively predict effective sand bodies. Multiple-point geological statistics method are controlled by hand-drawn training images, which are difficult to meet the prior geological knowledge of microfacies percentage content, sand body length and width/thickness ratio, spatial architecture distribution and vertical changes [52-54].

The above methods have defects in geological modeling of Sulige tight sandstone gas reservoir. In order to ensure the accuracy of well point data, the authenticity of prediction and reflect the idea of stochastic modeling, the sequential indicator simulation method is selected in this paper. Sequential instruction simulation can conditionalize data as an integral part of the simulation, without processing

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as a single step; the distribution of variables does not need to make any assumptions; co-variance function or variation function is not limited to certain special types; and it can synthesize soft data.

3.3.1 Sedimentary microfacies model

It is very important to study the spatial distribution of reservoir microfacies for oil and gas development and prediction, so it is very important to establish a sedimentary microfacies model that can characterize heterogeneity. According to the constraints of sedimentary microfacies thickness distribution, horizontal well drilling, facies sequence and other geological conditions, a three-dimensional grid model of sedimentary microfacies is established (Figure.3). It can be seen from the map that the sedimentary environment of the P_1s_1 in the study area is mainly meandering river deposits, and the sedimentary microfacies mainly develops point bar deposits, flood plain deposits and crevasse splay deposits. The point bar deposits are distributed in a N-S direction, with better connectivity in the N-S direction than in the E-W direction, and better connectivity and development scale in the S_1^2. The sedimentary environment of the P_2h_8 is braided river deposit. The main sedimentary microfacies are channel bar deposit, braided channel and flood plain. The braided channel deposits and the channel bar deposits distribute in the N-S direction with better connectivity in the N-S direction than in the E-W direction, and the H_8L^2 is the most developed.

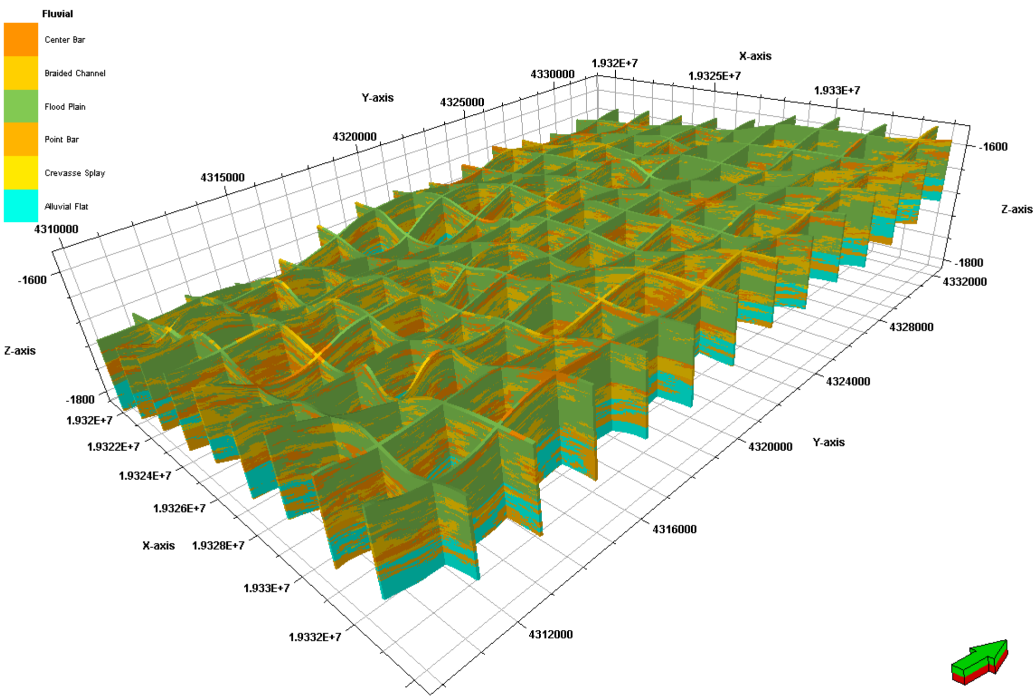

Figure 3. Three-dimensional grid model of sedimentary microfacies in Zhao30 block of Sulige gas field

4.4 Model verification

Under the constraints of sedimentary facies and geology, the Sequential Stochastic Simulation method was used to establish the sedimentary microfacies model. In order to accurately understand the three-dimensional structural model of reservoir, the three-dimensional model slices are extracted from the comparative section of sedimentary facies analysis, and the reservoir characteristics are analyzed.

Based on the geological study and analysis of the study area, it is concluded that the main development of the study area is a set of braided river-meandering river sediments. The main sedimentary sand bodies are channel bar sediments, point bar sediments, braided channel sediments, crevasse splay sediments, flood plain sediments, oxbow lake sediments and flood lake sediments. We compare the sediment microfacies map (Figure.2) with the slice of the model established by Petrel software (Figure.4). It can be seen that the three-dimensional geological model controlled by geological background, facies sequence, sedimentary facies and high resolution sequence stratigraphy

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is consistent with the results of geological recognition. Therefore, the relative section of sedimentary microfacies and the slice of sedimentary microfacies model have better matching, and the simulation reliability is high.

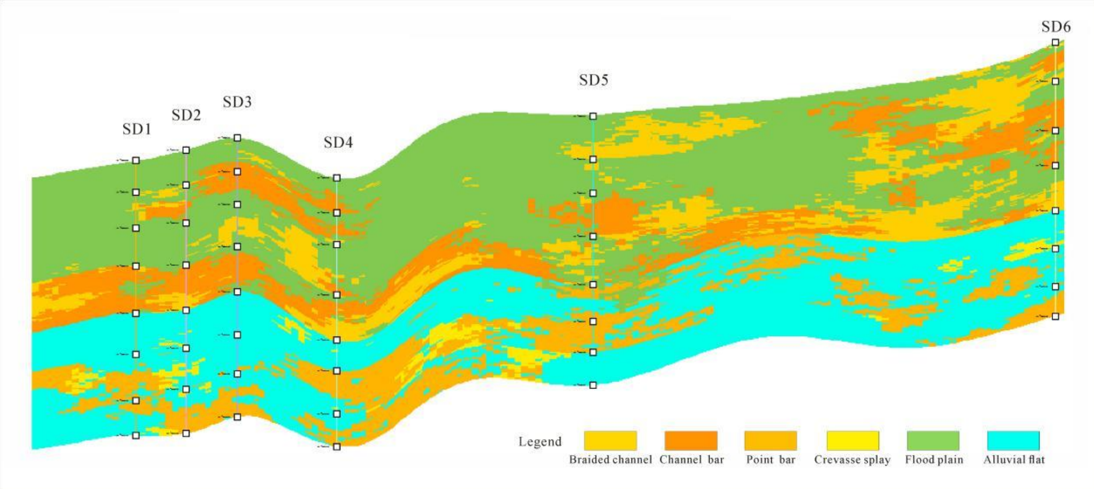

Figure 4. E-W profile showing the sedimentary microfacies relative slices in Zhao30 block, eastern Sulige Gas Field

5. Discussions

1.According to the research status of reservoir architecture, its development trend is mainly reflected in the following aspects: continuing to carry out outcrop fine research of various types of reservoirs; developing stochastic modeling methods based on outcrop fine anatomy and dense well pattern anatomy; developing high resolution sequence stratigraphy, applying basic theory of sequence stratigraphy and combining outcrop, well logging and seismic information to improve the accuracy of subdividing flow units by using downhole data; based on comprehensive modeling, it combines geology with geophysics and other disciplines.

2.Reservoir description and characterization should adhere to the direction of single discipline to multi-disciplinary synergy, qualitative to quantitative and prediction. It should be said that multi-disciplinary synergy is the core cause of the emergence of reservoir description technology, and qualitative to quantitative development is the driving force of reservoir characterization.

3.Sedimentary microfacies directly control the spatial distribution of reservoir sand bodies. Therefore, accurate sedimentary microfacies analysis is the key to finding reservoirs. The sedimentary microfacies model of Zhao30 block in eastern Sulige gas field reflects the overall distribution and characteristics of sedimentary microfacies in this area. The sandstone reservoirs of braided river channel bar, braided channel and meandering river point bar have the best physical properties in this area. Accurate prediction and fine characterization of these sedimentary microfacies should be emphasized in the exploration and development process.

4.On the basis of ensuring the accuracy of single well data, taking high-precision single well data as the benchmark, such as the application of sequential indicator simulation method, manual drawing and various parameters to reservoir modeling in Zhao30 block, the running model is consistent with geological reality, and the predictability is more reliable. The selected sequential indication simulation method is one of the popular stochastic modeling methods. This method is not only loyal to the existing data, but also can clearly reflect the variation law of sedimentary microfacies distribution, and can further establish the three-dimensional spatial model of reservoir parameters.

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6. Conclusion

With the deepening of oil and gas exploration and development, the geological problems faced in the later stages of development are increasing and becoming more and more complex. The technology of various disciplines is developing rapidly, and new technologies and methods for reservoir description and reservoir characterization are emerging. The characteristics of reservoir characterization development are that the management mode is developing towards multi-disciplinary and the application software is developing towards intergration. The reservoir description process is developing towards being more precise and the research of reservoir is developing towards visualization, systematization and prediction. Geological modeling technology has become the core technology of oil and gas exploration and development, and a variety of geological modeling methods go hand in hand. Its development prospects are very broad, and it is the core means of reservoir fine description and reservoir characterization. It is also the higher challenge we are facing in the study of oil and gas reservoirs.

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