Distribution characteristics and development potential of single sand body in tight reservoir in a well area

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Abstract: The distribution characteristics of single sand body are mainly used to identify the underground single sand body with geological techniques. With the help of core data and well logging data, the sedimentary microfacies of single sand body are studied in detail, so as to study the distribution characteristics of single sand body in plane and vertical. This paper mainly studies the distribution characteristics of single sand body of tight reservoir in a well area in detail, and actively discusses its development potential, aiming at obtaining more scientific and reasonable sedimentary research results, so as to provide effective reference for the subsequent production of the oilfield.

Key words: a well area; Tight reservoir; Distribution characteristics of single sand body; Development potential

1. Introduction

Detailed reservoir description is the basic guarantee for realizing effective block development, and the development characteristics of sand bodies have a direct impact on the later development and deployment work, which fully reflects the important role of single sand body distribution characteristics and development potential research. A well area contains rich and diverse lithology types and complex diagenesis, showing poor permeability, strong heterogeneity and other characteristics, which increases the difficulty of fine characterization of spatial distribution of sand bodies to a certain extent. In addition, in the process of development, problems such as imprecise characterization of distribution of single sand bodies in tight reservoirs, unclear distribution characteristics of single sand bodies, and inaccurate analysis of development potential are gradually shown. Therefore, the distribution characteristics and development potential of single sand body of a tight reservoir in a well area are discussed, which provides a new idea and a new path for the study of the distribution of residual gas controlled by single sand body in a well area and the subsequent potential exploration.

2. Depositional background analysis

The core in one well area is brown siltstone, which has the characteristics of oil bearing and grain size difference in vertical distribution, showing abrupt top surface, including horizontal bedding. Meanwhile, the analysis of box type and bell type logging curve is generally channel sand body. In addition, based on the vertical analysis of a well area, from the bottom of the purple mudstone, mainly developed in relatively shallow or oxidizing environment, gradually upward transition to the bluish-gray mudstone, developed in relatively deep water, reducing environment. Based on the analysis of the logging characteristics of a well area and the detailed observation and description of the core data, combined with the previous research results, it is considered that the study area belongs to the shallow water delta deposit, and contains delta plain subfacies and front subfacies.

The underwater distributary channel is mainly an important part of the underwater extension of the water channel. In the underwater extension, it is affected by a variety of factors, such as slow velocity, easy to increase the river bifurcation, widen the river, reduce the river depth, and accelerate the river accumulation speed. In general, in the logging response process, the underwater distributary channel generally has various forms, such as bell type and box type, and the appearance of these forms is mainly affected by the strength of the sedimentary hydrodynamic.

(2) Sheet sand, which is generally well developed in the outer front of the delta, mainly presents finger shape in the logging response process. Meanwhile, due to the large differences in fluid properties and calcium content in its interior, the finger amplitude in logging response is different [1]. Sheet sand is generally contiguous on the plane, and its thickness is relatively thin, but it shows good continuity.

⑶ Underwater shunt. Interdistributary mud mainly refers to the transverse barrier of tight reservoir in delta front. It is mainly composed of mudstone, silty mudstone and other lithologies, with relatively low porosity and poor permeability. It develops in relatively quiet water bodies. The logging curve is mainly near linear, mainly due to the calcium inside, resulting in a certain amplitude on the logging curve, but other than that, most of them do not have amplitude.
(4) The distributary channel, which is the key microfacies in the delta plain, mainly contains the sediment brought by the distributary channel. In the logging response process, there are high and extremely high amplitude and medium thickness layers on the whole. The spontaneous potential is mainly flat box and bell shape. The microelectrode and potential logs are typical box or bell type, with poor high amplitude and smooth - micro - tooth characteristics.
⑸ The water diversion room mainly contains grayish green, purple mudstone, silty eye, the internal thin layer of oil siltstone. The fluctuation of microphase spontaneous potential curve between water shunt is not significant, and the natural gamma curve is high. Based on the analysis of sedimentary characteristics of a well area, the sedimentary microfacies types of a well area are divided in detail (as shown in Table 1).
⑹ Abandoned river course. During the development of delta, many factors such as river diversion exert certain influence on distributary channels, resulting in abandoned distributary channels. The whole process presents diversified characteristics. The formation of abandoned channel is mainly due to a variety of abrupt factors such as slow slope, sediment blockage, channel energy strength change and so on. The logging response of abandoned channel shows that the bottom and the middle and upper parts of the channel have high amplitude and medium amplitude respectively, with features such as abrupt bottom and gradual top and toothing [2].
It overflowed the shore sand. In the flood process of the channel, some fine grained materials pass over the channel together with the flood, and then deposit in the low-lying area in the middle of the distributary channel, forming a fine grained mass. In the logging response, the curve presents a tooted low-flat curve above and below, and a high amplitude in the middle.

Table 1: Classification of sedimentary microfacies in a well area

subphase	Microphase type
Delta front subfacies	Underwater distributary channel
	Sheet sand
	Shunt room
Delta plain subfacies	Distributary channel
	Underwater distributary channel
	Abandoned river channel
	Overflowed shore sand

3. Create logging phase patterns

The relationship between single sand body and single sedimentary microfacies of a tight reservoir in a certain well area is corresponding to each other. The analysis combined with logging curves can provide a more comprehensive understanding of lithology, physical property and oil-bearing relationship, argillite content, lithologic interface and top-bottom contact relationship. At the same time, the fine petroelectricity of different well areas can be compared and analyzed, and a variety of logging curves can be effectively combined to explain sedimentary microfacies. In a well area, the delta diverging plain subfacies and front subfacies are analyzed in detail by combining the difference of curve shape and the difference of thickness ratio between sandstone and stratum.

3.1 Delta front subfacies

The microfacies of underwater distributary channels are analyzed. A class of underwater distributary channels mainly contain sandstone, and the formation thickness is mainly 0.8-0.7. They generally show high magnitude bell shape and box shape, with smooth characteristics. The second type of underwater distributary channel contains sandstone, and the formation thickness is mainly 0.7-0.5. It generally presents a high amplitude bell shape and box shape, with the characteristics of micro teeth. The content of mud is relatively low, but the energy is strong. The third type of underwater distributary channel, with sandstone and strata thickness of 0.6-0.4, presents high amplitude, middle amplitude box type, bell type, low mud content and strong capacity.
According to the analysis of sheet sand microfacies, on the whole, it presents the interbedding of thin siltstone and thin mudstone with low and medium amplitude difference, which is finger shaped. According to the thickness of sandstone, it is classified reasonably, mainly including first and second class sheet sand, with the thickness of sandstone and stratum being 0.5-0.2 and 0.3-0.1 respectively. The log curve of sheet sand is relatively poor in low amplitude and relatively high in mud content, which generally presents finger shape and tooth shape. The second type of sheet sand has a higher content of mud [3].
The microphase analysis between the shunt shows the lowest amplitude and the linear shape.

3.2 Delta distributary plain subfacies

The analysis of distributary channel microfacies is mainly divided into one, two and three distributary channel microfacies.
1. A type of distributary channel microfacies, as a whole, presents high, extremely high amplitude, medium thickness. The logging curve is mainly representative of thick box type, with smooth characteristics, high amplitude abrupt change at the bottom, and gradual - abrupt change at the top.
⑵ The microfacies of the second-class distributary channel are of high amplitude and extremely high amplitude on the whole. The middle layer, microelectrode

and potential curve are bell type or typical thick box type, with smooth and micro-gear characteristics. The thickness of sandstone and strata is about 0.7-0.9.

(3) The three types of distributary channel microfacies, as a whole, are fine intermediate, high and extremely high amplitude, microelectrode and potential curve are thin box type, thick box type and bell type, with smooth and toothed characteristics, sandstone and formation thickness between 0.5 and 0.7.

According to the analysis of the abandoned channel microfacies, the microelectrode and microunit curve are mainly bell or thin box type, fine middle layer, with smooth and toothed characteristics, and the thickness of sandstone and strata is about 0.2-0.5.

Based on the analysis of the microfacies of the overspill bank sand, it is divided into one and two kinds of overspill bank sand according to the thickness of the sandstone. The former presents a single finger or multi-finger shape of medium amplitude with multiple teeth. The latter is medium to low amplitude, finger shape, multi - serrated. The thickness of sandstones and strata are 0.5-0.3 respectively. 0.3-0.1; The content of mud is higher.

4. Distribution characteristics and development potential analysis of residual gas

4.1 Distribution law of residual gas and tight reservoir evaluation

In some distributary channels of a well area, the reservoir has good permeability, the contact relation of single sand body is generally cut and overlap, and the argillaceous laminae are not developed, which has a high degree of recovery and less residual gas. On the other hand, the reservoir outside the distributary channel presents a low permeability, which is an isolated single sandbody contact relationship and the development of argillaceous laminae, which reduces the degree of recovery and increases the residual gas. Therefore, the remaining gas in a well area is mainly distributed in the unused and undeveloped areas between Wells, which are mainly composed of cut stack sand bodies and isolated sand bodies.

The remaining gas between Wells in a certain well area is generally due to the low permeability of tight reservoir outside the underwater distributary channel, the low productivity of single well, and the relatively small well control range. Under the condition of the current low well pattern density, the remaining gas in the unused area between Wells is more. Based on relevant numerical simulation analysis, corresponding results are obtained, indicating that the operation range of a single well is mainly 0.25-0.5 inter-well distance, and inter-well gas saturation is 42%, which has corresponding encryption potential [4].

The residual gas of a well area is generally distributed in the central and southern well areas. According to the analysis of the actual situation of gas well deployment, the reserve control degree of the side gas well is better than that of the central gas well. The main reason for the accumulation of residual gas in the south of a well area is that the gas well deployment is relatively small, which reduces the degree of reserve utilization. Therefore, combined with the distribution characteristics of sedimentary microfacies and single sand body, the analysis shows that some areas of the gas reservoir have not been drilled, and generally present an isolated model with enriched residual gas.

Superimposed sand bodies at the main position of the river channel show high permeability. After perforating and putting into operation, tight reservoirs not only contain natural gas flows along the horizontal direction, but also some flow along the vertical direction, resulting in a relatively large range of gas well pressure drop wave, which reduces the seepage resistance in tight reservoirs and promotes the continuous decline of horizontal residual gas saturation. Combined with the numerical simulation analysis, it is found that the range of a single well is 0.25-0.5 Peking Opera, and finally the degree of natural gas recovery is 40%. Combined with the numerical results, it is predicted that the recoverable reserves of a single well are 0.3 × 108-1.1 ×108 m3, which indicates that the remaining gas is less. In addition, the isolated multi-phase thin-bed single sand body outside the main river channel presents cross-bedding development, with relatively high shaliness content, which has a corresponding blocking effect on horizontal and vertical seepage flow in tight reservoirs, narrowing the influence range of pressure drop, reducing gas well productivity and recovery degree, so that the horizontal residual gas saturation remains basically unchanged, and more residual gas is enriched. It has good development potential.

4.2 Analysis of development potential

Based on the discussion of drilling control degree and gas distribution characteristics, it is considered that some areas of a well area show large edge expansion potential, so multiple potential areas with edge expansion are selected for a well area, gas thickness tape, low drilling control degree, reservoir classification mainly includes I reservoir, showing high gas well productivity. The average daily gas production is about 5. 0×104 m3 /d, so rolling edge expansion is carried out in this area. In addition, for the isolated sand body in the south of a well area, the gas reservoir thickness is large, the drilling control degree is low, mainly I reservoir, gas well productivity is high, rolling edge expansion is also recommended. In addition, according to the analysis of the potential of interwell encryption, combined with the residual gas distribution characteristics of each sand body in a well area, the residual reserves in some areas are large, and gas Wells are drilled into reservoirs, combined with the relevant information and statistical analysis, it shows that the Shan 1 member and Shan 2 member encryption is the most important production layer in a well area. Based on the analysis of the vertical potential of a well area, the corresponding countermeasures to stabilize production are put forward. The thickness of each small gas layer in a well area is no less than 4 meters vertically, and the distribution of completed drilling without perforating is relatively large, which belongs to the most critical potential layer. It is suggested to effectively improve the development quality and efficiency and obtain more development benefits [5].

5. Conclusion

The delta front subfacies in a well area mainly develop underwater distributary channel sedimentary microfacies, and have good reservoir permeability in the main channel of distributary channel, mainly with cut and laminated single sand body, while the argillaceous laminae are relatively undeveloped, with a high degree of recovery, resulting in a small amount of residual gas in this area. The tight reservoirs outside the main channel of distributary channel have poor permeability and are dominated by isolated single sand bodies. The shale laminae are developed inside the single sand bodies, and the recovery degree is low, so there is more residual gas. Therefore, the horizontal and longitudinal superposition relationship of single sand body in a well area is analyzed, and it is clear that it and the perforation position have a certain influence on the distribution characteristics of residual gas. The unperforated production generally belongs to the initial gas reservoir state, with more residual gas, and has relatively large development potential. Therefore, the single sand body of tight reservoir, which is mainly isolated type, in a well area, is taken as the target of follow-up exploration.

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