Design of well seismic combined with horizontal well and tracking adjustment while drilling in block A

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Abstract. Based on the accurate understanding of the reservoir, oil-water distribution and structure of block A, the main oil layers are locally developed in well blocksA, B and C, the favorable parts of the structure are optimized, and the horizontal wells are deployed according to the principle of "increasing the production of horizontal wells in the main layer, not adding new platforms, and the horizontal section is not easy to be too long". Apply new drilling data to carry out fine structure interpretation and reservoir inversion prediction, update geological model, and guide horizontal well trajectory optimization design and tracking adjustment.

1. Introduction

The trial production of well A began in June 2018. At present, the daily oil production is x tons and the cumulative production is x tons, which has achieved good results. In order to further improve the single well production in this area, based on the accurate understanding of the reservoir, oil-water distribution and structure of block a, the main oil layers are locally developed in well blocks A, B and C, the favorable parts of the structure are optimized, and 8 horizontal wells are deployed. In order to ensure the "three 100%" goals of drilling success rate, sandstone penetration rate and cementing quality qualification rate, and achieve the purpose of increasing production of horizontal wells in Denglouku reservoir, the trajectory design and adjustment while drilling are the key and difficult points of the whole work. This paper selects and controls the design scheme of horizontal wells from two technical directions of structural interpretation and reservoir prediction, Accurately adjust the drilling trajectory of horizontal well through on-site tracking while drilling to ensure the drilling encounter rate of horizontal section of horizontal well.

2. Block overview

2.1 Structural overview

Area s is located in the southeast fault depression of Songliao basin. From the perspective of shallow structure, it successively crosses Qingshankou anticline belt, Binxian Wangfu sag, Changchun ridge anticline belt and Chaoyang ditch terrace from south to north. From the perspective of deep structure, two NNE trending depressions and ancient bulges are developed in s area, namely Yingshan depression, Shuangcheng depression and duqingshan uplift. S area is a fault depression superimposed basin on the whole. Since the Cretaceous, it has experienced four main tectonic evolution stages: fault depression stage, fault depression transformation stage, depression stage and structural inversion stage.

Table 1. Stratigraphic information of Shuangcheng depression.

System	Series	Formation	Member	Thickness (m)	Facies	Contact
Quaternary				15	fluvial	
Tertiary		Taikang		63	fluvial	
Cretaceous	Upper	Yaojia	II, III	28	shallow lacustrine	
			I	26	shallow lacustrine	
		Qingshankou	II, III	264	shallow lacustrine	
			I	44	deep lacustrine	
	Lower	Quantou	IV	100	fluvial	
			III	264	fluvial	
			II	274	fluvial	
			I	46	fluvial	
		Denglouku	IV	120	delta	
			III	**80**	**delta、fluvial, alluvial fan**	
		Yingcheng	IV	150	alluvial fan	
			I	100	volcanic	
		Huoshiling		550	volcanic	

The strata in the southern trough of s Sag have strong inheritance, and the overall performance is a compound dustpan like fault depression with west fault, East super fault and North-South distribution. The T31 reflector on

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the top surface of Dengsan section presents a structural pattern of alternating concave and uplift in a north-north-east direction, between - 900m and - 1750m above sea level, and the T3 reflector on the top surface of Dengsi section is between - 800m and - 1600m above sea level. Among them, 134 fault block type, fault nose type, fault anticline and other types of traps are developed on the top surface of Dengsan member (T31). The local structure of block a has the following characteristics: (1) the structure is obviously segmented by faults, and the structural types are fault nose, fault block and fault anticline. (2) The structure has the characteristics of inherited development, and the main structures are distributed along both sides of the fault with strong activity in the area. Block a is a large-scale structural anticline, which is divided by NNE faults and develops fault block traps. Well block a: it is a fault nose structural trap. The West and south sides are blocked by NW and NS conjugate faults. The trap height is -965m, the trap line is -1130m, the closure height is 165m, the trap area is x km^2, and the structural trend is nearly north-south.

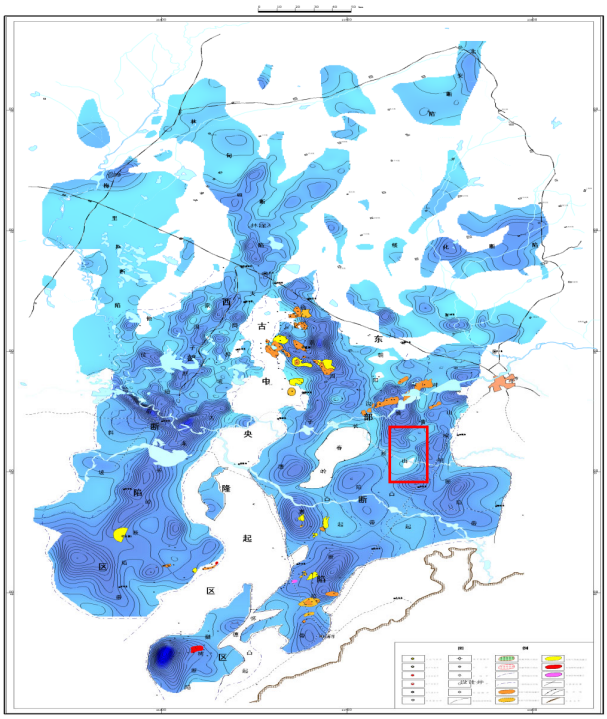

Figure 1. Prediction of strata thickness in Songliao Basin during fault depression (the research area is marked in red matrix).

2.2 Overview of block A

Block A is structurally located in Yingshan Shuangcheng fault depression in the southeast fault depression belt of Songliao basin. This area is a new discovery of risk exploration in the "four new" field of the oilfield. In 2018, Denglouku formation of well a obtained x m3 of high-yield oil flow, and the first exploration well with natural production capacity exceeding x m3 after Daqing placanticline. In 2019, block a is the main production capacity block of the integration of increasing reserves and building production of the oilfield company. At present, around the Western uplift belt, the proved reserves are x million tons. According to the idea of "overall research, zoning deployment and production increase of horizontal wells", x oil and water wells are deployed, including x horizontal wells, with a built capacity of x tons. Large platform cluster well design is adopted, with 19 platforms and 19 wells at the largest platform. At present, 6 drilling rigs are arranged to carry out drilling work, and a total of x development wells have been drilled, with an average effective thickness of x m; Up to now, x wells have been put into operation, with an average shooting effective thickness of x m, a daily oil production of x tons and a cumulative oil production of x tons, which has achieved good results.

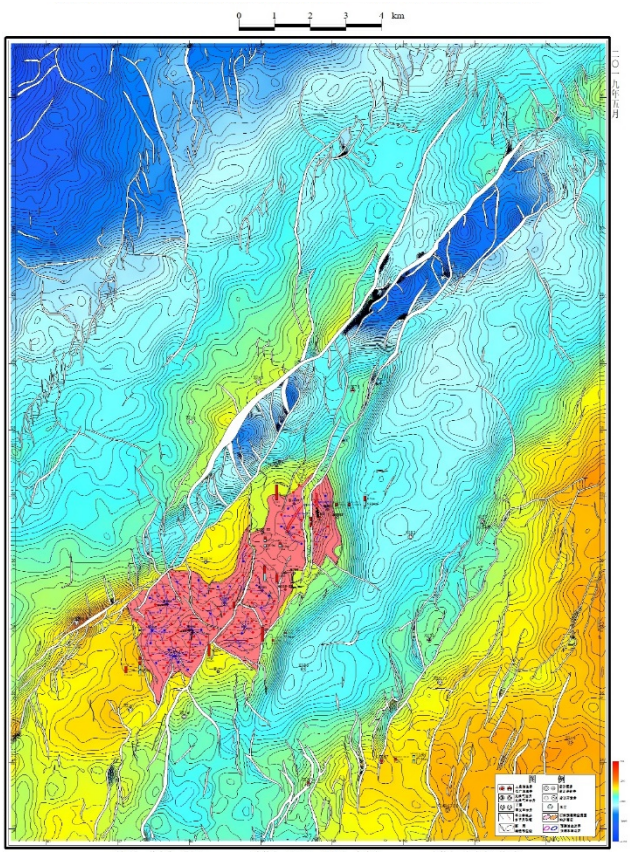

Figure 2. Structure map of Dengsan Section in Area S.

3. Existing problems and Counter-measures

3.1 The structural dip angle is large, and it is difficult to control the target and horizontal section

The structural dip angle of block a is large. Due to the surrounding inclined wells, the structural error is relatively large. The stratum thickness of Dengyi section is only 30m, and there is no obvious marker layer. At the same time, the low part of the structure is water layer, so it is difficult to control the target and horizontal section.
First, when the logging cuttings, gas logging and MWD curve change during drilling, the logging and drilling control personnel shall communicate in time, predict and feed back in time according to the field data, and give

drilling adjustment suggestions. The logging personnel shall take rock samples in strict accordance with the requirements of cuttings logging and describe them in time. The key positions such as marker layer and target entry point shall be taken intensively. At the same time, the relevant data of logging and drilling while drilling shall be provided to the earthquake prediction personnel of the Research Institute in time to calibrate the horizon, and improve the accuracy of target entry and horizontal section adjustment through the combination of Geology and earthquake.

Second, in case of difficult and complex guidance conditions on site, the modeler shall timely summarize relevant information and report to the relevant leaders of No. 10 oil production plant and Exploration Division to determine the next adjustment opinions.

Third, the combination of geological guidance and drilling engineering provides better conditions for wellbore safety and cementing quality. The adjustment of horizontal well trajectory shall be carried out within the safety allowable range of drilling engineering, so that the dogleg degree of trajectory is within the allowable range of engineering, so as to ensure the smooth implementation of horizontal well drilling.

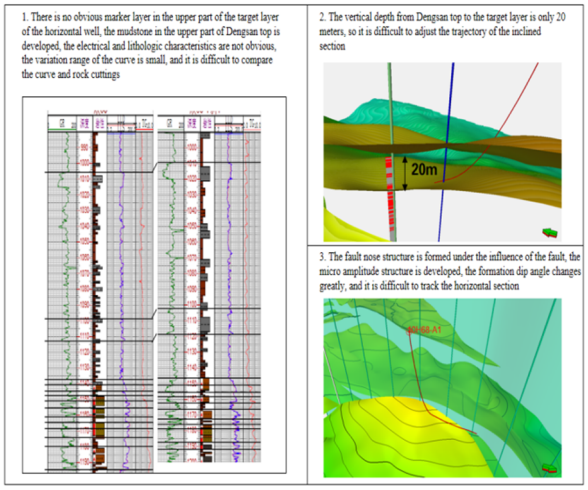

Figure 3. Difficulties in tracking while drilling.

3.2 There are errors in coordinates, and there is a risk of collision between horizontal wells and surrounding inclined wells

Well A-4-xie1 passes through the upper part of well a-ping1, and the nearest distance is 39.11m (Design). At the same time, there is a certain error in the inclination orientation of well a-4-xie1. The original loading is that the magnetic orientation does not correspond to the overall grid orientation of the block, and the collision risk is high.

First, the magnetic azimuth of the well curve provided by the logging company is corrected to the grid azimuth and introduced into the seismic work area for trajectory design scheme quality control.

Second, strengthen the deviation and azimuth measurement with the drilling, drill according to the design, and replace the instrument in time to retest in case of any abnormality of the guiding tool.

The third is to strengthen the measurement and adjustment of well deviation orientation in key well sections, and closely communicate with geological guidance personnel and trajectory control personnel to stay away from the trajectory of deviated wells as far as possible within a reasonable range.

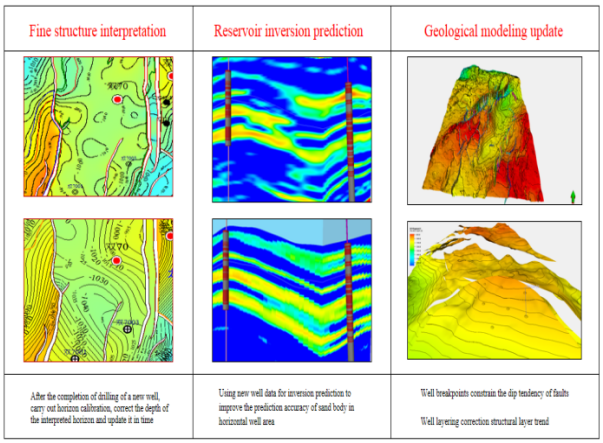

Figure 4. Well seismic geological modeling.

3.3 Influence of drilling tools

The drilling tools commonly used in horizontal wells are rotary steering and LWD. Rotary steering is expensive and has strong deflecting ability. It can distinguish the location of drill bit in the formation. LWD has low technical cost and weak adjustment ability.

In the research area, due to the large thickness and the rapid change of sand body in horizontal direction, rotary steering drilling should be used to ensure the penetration rate of sandstone. During drilling, the characteristic changes of GR curve shall be observed at any time. When the upper GR rises and the lower GR does not change, it indicates that the bit reaches the mudstone at the top; On the contrary, the lower GR value increases and the upper remains unchanged, indicating that the bottom is out of layer(see Figure 5.).The well deviation should be adjusted in time to make the trajectory return to the formation.

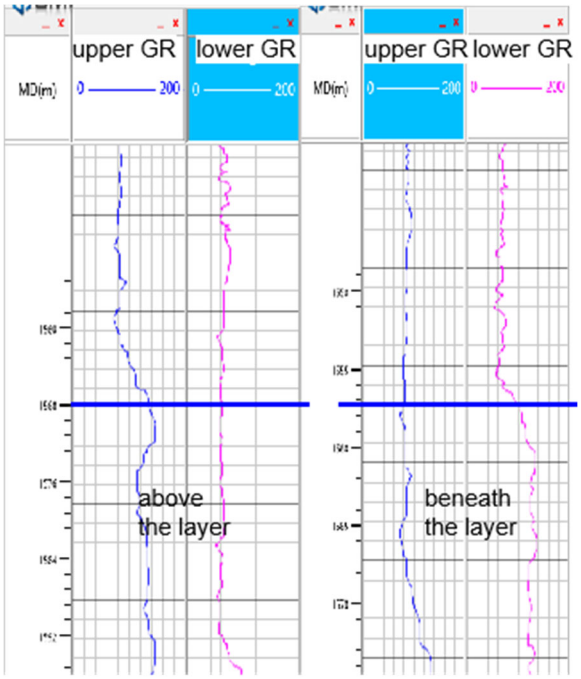

Figure 4. Typical GR curve change drilling out of layer.

4. Conclusion and understanding

The well deviation curve provided by logging company is magnetic azimuth, which can be applied to seismic work area only after it is corrected to grid azimuth.

The main sub layers in the well area of horizontal well a are DI6 and D II 1-D II 2.

Fine structure interpretation and reservoir inversion prediction are the basis of high-precision geological modeling.

The more new infill wells are drilled between wells, the finer the corresponding relationship between the calibrated synthetic record calibration time domain seismic data and depth domain layered data, the more accurate the velocity model established for time-depth conversion, and the error caused by man-made horizon tracking between wells is reduced.

Fine structure interpretation is the basis of well seismic combination research, and its accuracy determines the prediction reliability of reservoir prediction and geological modeling.

In the case of less well control and uneven distribution in the initial development block, the application of waveform indication inversion for reservoir prediction is more reliable.

Using the logging data of horizontal well before and during drilling to update the velocity field and inversion results in time can provide a strong basis for tracking and adjustment while drilling and ensure the penetration rate of horizontal well.

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