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Research Article

Gas-Water Distribution of He-8 Section in Sulige X Block and the Effect of Reservoir Characteristics on it

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Abstract

In order to deepen the study of gas-water distribution of He-8 section in Sulige X block and the effect of reservoir characteristics on it, based on log interpretation and single well facies data analysis, the comprehensive research methods of sedimentology, sequence stratigraphy, petroleum geology and other disciplines are used in this paper. The study shows the formation water in the he-8 section is mainly distributed in the zone where the sand bodies in distributary channel margin are thin and the physical properties are poor. The natural gas accumulates in the main distributary channel and mouth bar zone with large thickness and good physical properties. Natural gas is easy to enter and form gas reservoirs in sandstone reservoirs with relatively high porosity and permeability. In the reservoir sands with low porosity and permeability, it is easy to form, dry layer, gas-water layer or water layer. In this paper, the study of gas-water distribution law and reservoir characteristics ofhe-8 section in Sulige X block has important guiding significance for the favorable development zone of natural gas selection in the later stage of Sulige gas field.

Keywords: Gas-water distribution; He-8 section; Sulige X block

Introduction

With the increasing energy consumption, it is difficult for conventional oil andgas to meet the needs of human development. The development of unconventional oil and gas in many countries in the world, and the United States and Canada have entered the commercial stage [1]. Overseas, some scholars have combined seismic interpretation and geological statistics methods to establish 3D structural model to identify the structure in strata [2,3]. In addition, the various characteristics of rocks have been analyzed, three-dimensional rock physical model has been established, and reservoir physical properties have been evaluated in more detail. These studies are of great importance to the development of oil and gas reservoirs[4]. These studies are of great significance to the development of oil and gas reservoirs in the world. In China, more and more attention has been paid to dense gas. China has abundant reserves ofdense gas, which will occupy a large proportion of national production in the future [5,6]. Due to the rich reserves and great development potential of tight gas in Sulige gas field, many scholars have paid close attention to it [7]. Among them, Fu Chengde [8]., Zhu Rong, et al [9]., Wang Jiping, et al [10]., Wang Bo, et al [11]., have studied the gas-water distribution in Sulige area and made detailed statistics on formation water chemistry. Based on the production distribution plane of gas and water in a single well, the origin and distribution of formation water are analyzed by comparing with the distribution of sedimentary microfacies and the structural characteristics of the top surface. It is considered that the distribution of formation water is controlled by reservoir physical property and structure. The research in this paper is of great significance for the exploration and development of Sulige gas field.

Regional Geological Survey

The Ordos Basin is the second largest sedimentary basin in China [12,13], located in the western margin of the North China Platform. It is a large superimposed basin developed on a stable craton basin. The first-order tectonic units in the area include the Yimeng uplift, the western margin thrust belt, the Tianhuan depression, the Weibei uplift, the Yishan slope and the flexible fold belt in western Shanxi (Figure 1). The structure of the area is flat and there is no great fluctuation. Sulige gas field islocated in the north of Yishan slope and has many rows of low nasal uplift structures [14]. The Permian strata are from the old to the newly developed Benxi Formation, Taiyuan Formation, Shanxi Formation, Shihezi Formation, Shiqianfeng Formation [15] (Figure 2), the main gas-bearing strata is the he-8section and the shan 1 section, and the sedimentary facies of the he-8 section have been controversial all the time. There are two views of the fluvial facies and the delta facies [16-21]. The present paper combined the previous research results, and found that the he-8 section belongs to the sedimentary facies of the braided river delta.

Relationship between Gas-Water Distribution and Sedimentary Microfacies

In order to delineate the distribution of small layer sand body in detail, the he-8 section of the study area are divided into four small layers: upper 1 of he-8 layer, upper 2 of he-8 layer, lower 1 of he-8 layer, lower 2 of he-8 layer.

Upper 1 of he-8 layer

From the gas-water distribution and sedimentary facies superposition plan of upper 1 of he-8 layer (Figure 3), the channel width is large, and it is a multi-stage superimposed channel. The distribution

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of sand body is basically the same as that of braided channel. The distribution of sand body is in a north-south direction, and the thickness of sand body is generally between 6 and 9 meters, and the maximum thickness of sand body can be more than 12 meters. There are 3 to 4 distributary channels developed from north to south. With the increase of branches of distributary channels from south to north, the thickness, development scale and spatial distribution of sand bodies are controlled by sedimentary facies belts [22,23].The upper 1 of he-8 layer in Sulige X block is delta plain sedimentary environment. The main sedimentary microfacies are distributary channel, mouth bar and diversion bay.

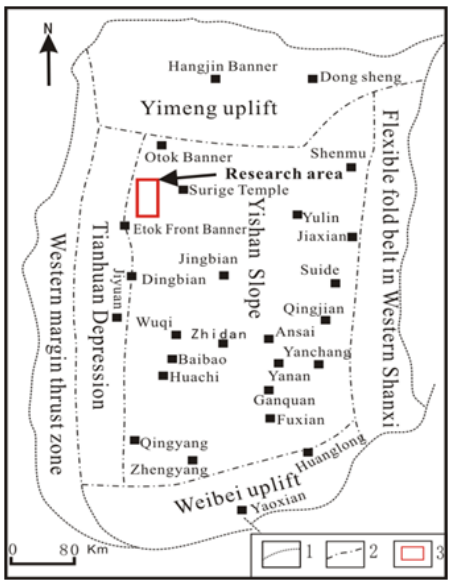

Figure 1: Regional structure and regional location diagram of Sulige X block.

Series		Lithostratigraphy		Major Marker Layer
		Formation	Section	
Permian	Upper Permian	Shiqianfeng	Qi-1	Marlite, calcareous nodules, bright red sandstone, mudstone
			Qi-2	
			Qi-3	
			Qi-4	
			Qi-5	
		Upper shihezi	He-1	Siliceous (chert), marlite, calcareous nodules, bright red sandstone
			He-2	
			He-3	
			He-4	
	Middle Permian	Lower shihezi	He-5	Peach Blossom Mudstone
			He-6	
			He-7	
			Upper he-8	
			Lower he-8	
	Lower Permian	Shanxi	Shan-1	Upper Coal Formation
			Shan-2	

Figure 2: Stratigraphic Division of Permian in Sulige X Block.

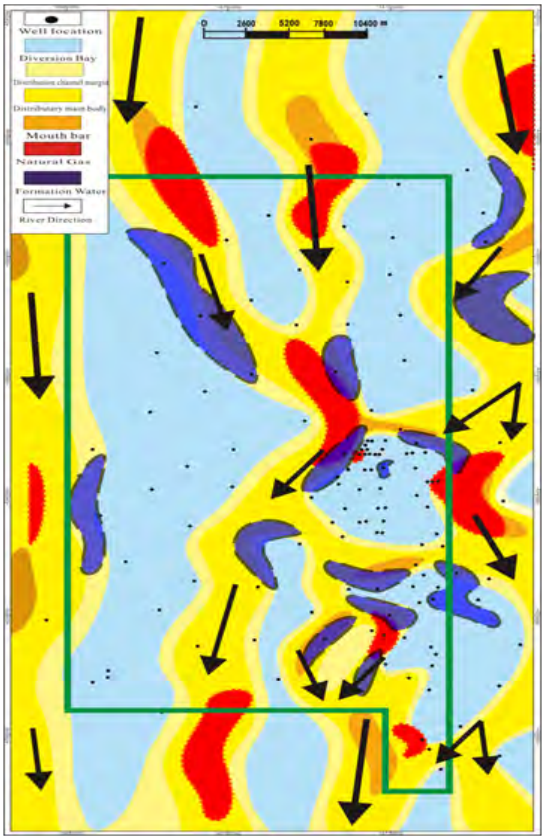

Figure 3: Gas-water Distribution on upper 1 of he-8 of Sulige X Block.

Upper 2 of he-8 layer

Compared with the upper 1 of he-8 layer, the thickness of sand body and the area of gas-water development in the upper 2 of he-8 layer are larger (Figure 4), but the source direction, braided channel and gas-water distribution are basically unchanged. Because the distribution law of gas and water in lower 1 of he-8 layer and lower 2 of he-8 layer has the same characteristics, this paper will not describe it in detail.

Taken together, there is a strong heterogeneity of sand bodies in Sulige X block, and there is no obvious boundary between gas and water distribution in the plane. The distribution area of gas and water in the East is more than that in the west. The distribution of sand body is strictly controlled by sedimentary microfacies, while the distribution of sand body affects the distribution law of gas and water, therefore, the sedimentary microfacies controls the distribution of gas and water on the plane. The gas-bearing areas in Sulige X block are distributary main body and mouth bar with strong hydrodynamic action, coarse sediment grains and good reservoir physical properties, which distribute in a north-south strip, basically consistent with the direction of braided main channels. The aquifer area is mainly located in the distributary channel margin, where the hydrodynamic force is weak, compaction is strong, relatively dense and reservoir physical properties are relatively poor. It distributes sporadically and has poor connectivity.

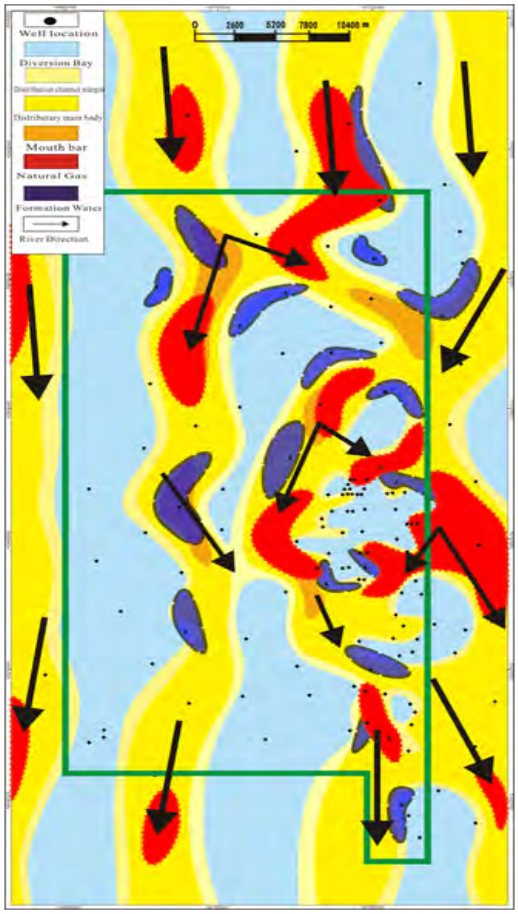

Figure 4: Gas-water Distribution on upper 1 of he-8 of Sulige X Block.

Longitudinal Reservoir Analysis

Su X-1 single well analysis

Two typical wells in Sulige X block are selected for analysis. There is an abrupt contact relationship between the top and bottom of the logging gr curve in A segment of well Su X-1 (Figure 5), which shows the characteristics of coarse upper fine and positive rhythm as a whole, reflecting frequent changes of hydrodynamic conditions during sedimentation, resulting in vertical superposition of multi-stage sand bodies. The lithology is mainly composed of gravelly coarse sandstone, coarse sandstone, with strong heterogeneity of sand body structure, which is a sedimentary feature of distributary channel of braided river delta. During Taiyuan period, Benxi period, and Shanxi period, Sulige gas field has extensive hydrocarbon generation. This paper considers that the influence of source rocks and structures on gas-water distribution is the same under the condition that the vertical depth of the same set of sand body does not change much. The interior A-2 layer of the sand body is filled with gas and water, and the gas and water are mixed to form a Gas-water interlayer. The porosity and the permeability of the section are relatively good, and the A-1 layer and A-3 layer are free of gas-water filling, and the porosity and permeability of the sand body are poor.

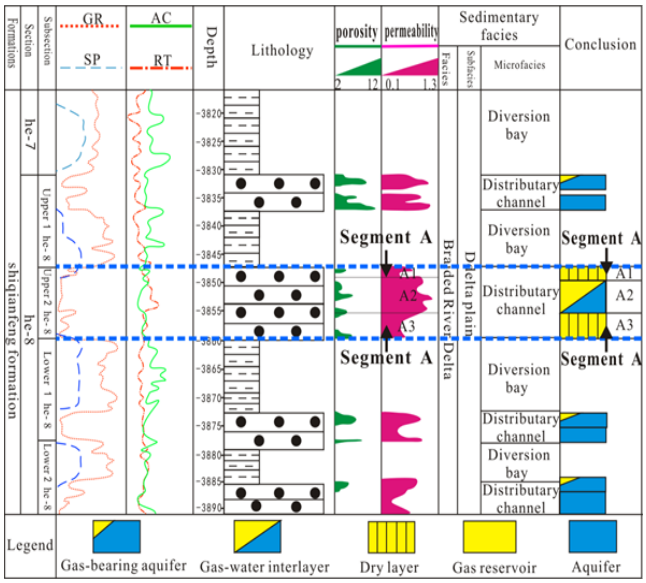

Figure 5: Analysis of Well Su X-1 in Sulige X Block

Su X-2 single well analysis

The top of the bell-box type combination of middle and high amplitude in GR segment B of Well Su X-2 (Figure 6) shows a gradual contact, while the bottom shows a sudden contact relationship, and the depositional thickness is large, showing positive rhythm characteristics as a whole. The lithological section is composed of gravel-bearing coarse sandstone, coarse sandstone and medium-coarse sandstone, which are overlapped vertically in positive rhythm. The hydrodynamic conditions are strong and the strength alternates frequently. The sand body structure is strongly heterogeneous, which is the overlap of multi-stage braided river distributary channel deposits. The B-2 layer of sand body is filled with gas to form gas reservoir. The porosity and permeability of this section are relatively good. The B-3 layer has poor porosity and permeability, forming aquifer. The B-1 layer has no gas-water filling. The porosity and permeability of this section are also poor.

Combining well Su X-1 and well Su X-2, it is found that natural gas is easy to be filled in places with good porosity and permeability. Natural gas is mainly concentrated in sandstone reservoirs with relatively high porosity and permeability. This is due to the low initial pressure, low migration resistance and easy displacement of water by gas in high permeability sandstone reservoirs. In reservoir sands with low porosity and permeability, gas filling initiation pressure is high, migration resistance is high, gas is difficult to enter, and it is easy to form poor gas layer, dry layer,gas-water layer or water layer.

Discussion

In the study of sand body distribution, gas layer distribution and water layer distribution overlapping of upper 1 of he-8 layer and upper 2 of he-8 layer, it is found that distributary channel margin is water-bearing, distributary channel main body and mouth bar are gas-bearing, but there is no obvious gas-water boundary. The gas-bearing and water-bearing areas in the eastern part of the study

area are larger than those in the western part.This paper considers that in the same set of sand bodies with little change in vertical depth, the influence of source rocks and structures on gas-water distribution is the same. On this basis, the gas-water characteristics of typical single wells (Su X-1 and Su X-2 wells) are analyzed. The conclusion is consistent with the plane research conclusion. In places with poor porosity and permeability, it is easy to be filled by formation water. Natural gas is mainly concentrated in places with good porosity and permeability.

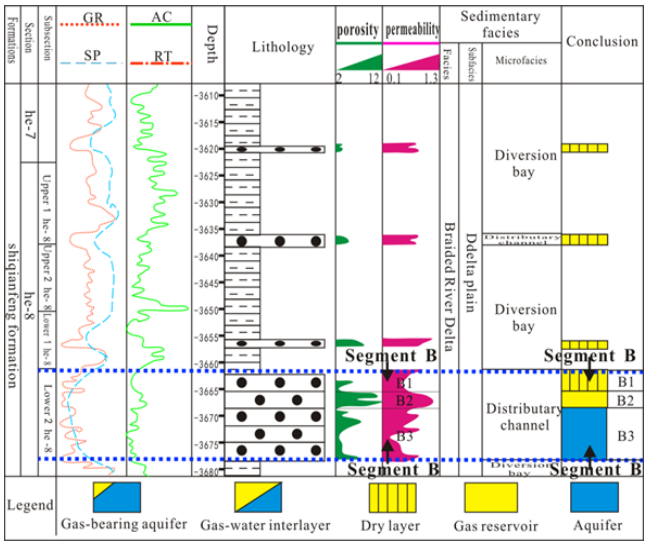

Figure 6: Analysis of Well Su X-2 in Sulige X Block.

Conclusion

1. The sedimentary microfacies in the he-8 section of Sulige X Block have a certain influence on the distribution of gas and water. Formation water is enriched in the distributary channel margin, while natural gas is enriched and formed in the distributary channel main body and mouth bar. There is no obvious boundary between gas and water distribution and the connectivity is poor.

2. The physical properties of reservoirs control the distribution of gas and water. Natural gas is easy to enter and form gas reservoirs in sandstone reservoirs with relatively high porosity and permeability. In the reservoir sands with low porosity and permeability, it is easy to form, dry layer, gas-water layer or water layer.

References

1. Jia CZ, Zheng M, Zhang YF (2012) Unconventional hydrocarbon resources in China and the prospect of exploration and development. Petroleum exploration and development 39: 139-146.

2. Qadri SMT, Islam MA, Shalaby MR, Haque AKMEU (2017) Seismic interpretation and structural modelling of Kupe field, Taranaki Basin, New Zealand. Arabian Journal of Geosciences 10: 295.

3. Qadri SMT, Islam MA, Shalaby MR (2019) Three-Dimensional petrophysical modelling and volumetric analysis to model the reservoir potential of the kupe field, Taranaki Basin, New Zealand. Natural Resources Research 28: 369-392.

4. Qadri SMT, Islam MA, Shalaby MR (2019) Application of well log analysis to estimate the petrophysical parameters and evaluate the reservoir quality of the Lower Goru Formation, Lower Indus Basin, Pakistan. Geomechanics and Geophysics for Geo-Energy and Geo-Resources 1-18.

5. Qiu ZJ, Zhao WZ, Deng ST (2012) Development prospects and strategic significance of tight sandstone gas and shale gas in China. Chinese engineering science 14: 4-8+113.

6. Guosheng Z, Wenzhi Z, Cheng TGB, Songtao D (2012) Potential, distribution and future development status of tight sandstone gas resources in China. Chinese engineering science 14: 87-93.

7. Fei X (2017) Talking about the current status and future development potential of China's tight gas development technology. Petrochemical technology 24: 176.

8. Fu CD (2001) Study on deep basin gas in Ordos. Petroleum Industry Press, Beijing, China.

9. Ronglou Z, Huajin Z, Aimin, Xinshan W (2003) Fluid dynamics characteristics and accumulation process of the upper paleozoic deep basin gas reservoir in the ordos basin. Chinese journal of geology 38: 31-43.

10. Wang JP, Li YG, Wang H, Wang Y, Liu P, et al. (2012) Study on formation water distribution law in tight sandstone gas reservoir of Su X block in west area of Sulige, Ordos Basin, China. Journal of chengdu university of technology (Science technology edition) 40: 387-393.

11. Wang B, Was CY, Xiaojuan L, Fengyang H, Novosti L (2010) Gas-water distribution and its controlling factors in the 8th segment of Sulige gas field 33: 29-33+5.

12. Tian JC, Wu Q, Wang F, Lin XB, Zhang JQ, et al. (2011) Research on development factors and the deposition model of large area resevoir sandstones of He8 section of Xiashihezi Formation of Permian in Ordos basin. Acta Petrologica Sinica 27: 2403-2412.

13. Yao JL, Bao HP, Ren JF, Sun LY, Ma ZR (2015) Exploration of ordovician subsalt natural gas reservoirs in ordos basin. China petroleum exploration 20: 1-12.

14. Huijun L, Wencai Z, Lei Z(2007) High-quality reservoir control factors in Sulige gas field. Natural gas industry 27: 16-18+158.

15. Jianhui D (2012) Sulige stratigraphic division and comparison study. Science Technology and Engineering 12: 3443-3445.

16. Honghong W, Huiqun P, Jingqun L, Zhengwen X, Good L (1999) Distribution of sedimentary facies belts and sandstone bodies of permo-carboniferous in the central part of ordos basin. Acta sedimentologica sinica 17: 403-408.

17. Zhijun Y, Yun Y, Yong L (2006) Study on sedimentary facies of block 8 of block su 6 in sulige gas field. Natural gas industry 26: 26-27.

18. Yong W, Xiaorong X, Xiaoyan F, Thick L (2007) Study on sedimentary facies characteristics of upper paleozoic in su 6 well area of sulige gas field. Journal of Northwest University (Natural Science Edition) 37: 266-272.

19. He ZX, Fu JH, Xi SL, Fu ST, Bao HP (2003) Geological features of reservoir formation of Sulige gas field. Acta petrolei sinica 24: 6-12.

20. Fu ST, Tian JC, Chen HD, Hou ZJ, Zhang JQ, et al. (2003) The delta depositional system distribution of late paleozoic era in ordos basin. Journal of chengdu university of technology (Science technology edition) 30: 236-241.

21. Shen YL, Guo YH, Li ZF, Wei XS, Shao YB (2012) Deposition mechanism of delta Carboniferous-Permian in Ordos area. Journal of China University of Mining technology 41: 936-942.

22. Chunying W, Huiping H, Rui K, Hong Y (2014) Sedimentary facies of the member 8 of the southern part of Sulig, Ordos Basin and its significance. Journal of earth sciences and environment 36: 77-86.

23. ZhaorongC (2009) Reservoir characteristics of Block 8 and Shan 1 in the northern Sulige gas field, Ordos Basin. Chengdu University of Technology. Pg no: 87.