Analysis of Shale Oil Productivity Difference in an 83 and Xi 233 Well Blocks in Ordos Basin

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Abstract. The An 83 well block and the Xi 233 well block are both shale oil blocks in the Changqing Oilfield. The main producing layer is the Chang 7 reservoir, with strong heterogeneity and no obvious oil-water interface. Both are typical low porosity, low permeability-extra low permeability reservoirs. The An 83 block and the Xi 233 block adopt the same volume modification method for production, but the output data of the two are quite different. The output of the Xi 233 block is significantly better than the An 83 block, and the water content is also lower. Finding out the reasons for the production differences and proposing a targeted shale oil reservoir volume modification model is the key to increasing the production of Block An 83. On the basis of the analysis of production influencing factors, it combines geological factors such as gamma, interval transit time, porosity, saturation, etc., geomechanical factors such as Young's modulus, Poisson's ratio, horizontal stress, and Engineering factors such as displacement, liquid volume, sand ratio, etc. Using Pearson and Spearman correlation analysis methods to clarify the main controlling factors of output and capacity, on this basis, complete the research on the output difference of the two blocks. The final results show that the physical properties of the two blocks are the same, the water content is quite different, and the geomechanical basis is different. It is necessary to formulate targeted reservoir transformation and production methods based on the pore throat structure, relative permeability and geomechanical distribution characteristics of Block An 83.

1. Introduction
Changqing An 83 shale oil block has the largest average thickness of Chang 7-1 layer 25.9 m, Chang 7-2 layer 18.8 m, and Chang 7-3 layer is thin at 8.0 m. The Chang 7 layer in the west 233 well area is divided into 3 oil layer groups longitudinally, namely Chang 7-1, Chang 7-2, and Chang 7-3. Among
them, Chang 7-2 is the main oil-bearing formation in the area, and it is also the purpose of the volume fracturing test of the Chang 7 horizontal well. Both are typical low-porosity, low-permeability, ultra-low permeability reservoirs.

Guo Peng [1] and others found through research that the volume fracturing provides a new light for large-scale economic and effective development of tight sandstone gas reservoir. Zhao Bo [2] proposed that development of Longdong area long 7 reservoir characteristic research, especially the research of micro pore structure reservoir control factors for clear relatively high quality reservoirs, the optimization of reservoir reconstruction, has the important guiding significance to establish high efficiency development technology countermeasure. According to the characteristics of non-Darcy seepage flow in ultra-low permeability reservoirs, Dong Wenbin [3] proposed that volume fracturing is an effective development mode for increasing reservoir development under the depletion development mode. In order to investigate the dynamic characteristic of reservoir formation and hydrocarbon migration in Yanchang Formation of Ordos Basin, Yao Jingli [4] and others established a suitable normal mudstone compaction equation, studied the compaction characteristic of Yangchang Formation, analyzed the distribution of the fluid overpressure and discussed oil migration rule in Chang 7 and Chang 8 subsections. Pores in the Chang7 shale oil reservoir in the Xin’anbian oil field were divided into three categories, namely intergranular pores, dissolution pores and microfractures [5].

Block An 83 and Block Xi 233 use the same volume transformation method for production, but the output data of the two are quite different. As of the end of 2019, the average daily production of horizontal wells in the An 83 well block was 1.22 t/d, and the average daily production of the Xi 233 block was 8.49 t/d. The Xi 233 well block was significantly better than the An 83 well block.

2. Research on Correlation Analysis of Geological Engineering Data and Main Control Factors of Productivity

Correlation can be divided into linear correlation and nonlinear correlation. When two continuous variables are linearly related, use Pearson product difference correlation coefficient. When the applicable conditions of product difference correlation analysis are not met, using Spearman rank correlation coefficient to describe. The Spearman correlation coefficient is also called the rank correlation coefficient. It does not require the distribution of the original variables. It is a non-parametric statistical method and has a wider range of applications.

The Kendall rank correlation coefficient is used to reflect the index of the correlation of categorical variables, and it is suitable for the situation that both categorical variables are in ordinal classification. The non-parametric correlation test is performed on related ordinal variables, and the value range is between -1 and 1. This test is suitable for square tables.

![Figure 1. Correlation analysis result parameter table.](image)

Taking the correlation analysis between cumulative oil production and permeability as an example, it can be seen from the figure below that the correlation between the two is not significant. Among them, the scatter plot does not show a good linear or nonlinear law, and the correlation coefficient is also low. The Pearson correlation coefficient is only 0.008, and the Spearman correlation number is 0.107.
Taking the correlation analysis between average daily output and single-stage sand volume as an example, it can be seen from the figure below that the two are moderately correlated. Among them, the scatter plot shows a certain non-linear law, and the correlation coefficient is also high. The Pearson correlation coefficient is 0.397, and the Spearman correlation number is 0.439.

Based on the above methods, the correlation analysis of geological data and engineering data in An 83 well area has been completed. The specific analysis results are shown in the table below. Due to space limitations, no relevant data on the Xi 233 well area is provided.

### Table 1. Correlation analysis results of geological data in An 83 well area and Correlation analysis results of engineering data in An 83 well area

| Parameter | Xi 233 | An 83 |
|-----------|--------|-------|
| Dynamic reserve (100m) | 3.27×10³ | 1.52×10³ |
| Water content | 38.95% | 52.75% |

### 3. Study on the difference between An 83 well area and Xi 233 well area

From the three aspects of geological parameters, geomechanical parameters and engineering parameters, the main control factors of productivity in the An 83 well block and the Xi 233 well block are compared, and the reasons for their production differences are analyzed at the same time. The average horizontal section length of Xi 233 block is 1666.81m, which is significantly higher than the average horizontal section length of An 83 block of 884.45m. In order to eliminate the influence of the length of the horizontal section on the production difference, the dynamic reserves and the length of the horizontal section are normalized to obtain the 100-meter dynamic reserves of a single well for comparison. The average dynamic reserve per 100m in the Xi 233 block is 3.27×10³ t/100m, which is also significantly higher than the 1.52×10³ t/100m in the An 83 block. However, the average water content of the Xi 233 block is 38.95%, which is significantly lower than the 52.75% of the An 83 block.
Comparing the physical parameters of the two blocks, it can be seen that the reservoir thickness, porosity and oil saturation of the two blocks are not much different. The average reservoir thickness of Xi 233 block is 21.85m, and that of An 83 block is 20.86m, which is basically the same; The average porosity of Xi 233 block is 9.54%, and that of An 83 block is 9.41%, which is basically the same; The average oil saturation of Xi 233 block is 52.13%, and that of An 83 block is 53.75%, which is basically the same. To sum up, the physical properties of the reservoirs in Block West 233 and Block An 83 are basically the same, and the difference in production is not controlled by geological parameters.

Comparing the geomechanical parameters of the two blocks, it can be seen that the brittleness index, horizontal stress and closing pressure of the two blocks are quite different. The average brittleness index of the Xi 233 block is 0.62, and the An 83 block is 0.53. The Xi 233 block is significantly better than the An 83 block. Therefore, the volume transformation of the West 233 well block is easier to form a complex fracture network system, and the productivity effect after transformation is better. The average minimum horizontal stress in the Xi 233 block is 24.71 MPa, the An 83 block is 26.46 MPa, and the An 83 block is larger; The average closing pressure of Xi 233 block is 31.51MPa, An 83 block is 34.61 MPa, and An 83 block is larger. It can be seen that the minimum horizontal stress and closure pressure of the Xi 233 block are significantly smaller than that of the An 83 block. It is less difficult to compress the reservoir and form an effective fracture network system in the Xi 233 well block, and it is better to comprehensively judge its compressibility. In summary, the geomechanical parameters of the Xi 233 block and the An 83 block are quite different, the An 83 block is more difficult to reform, and the Xi 233 block has a better fracture network system after the volume reform.

In summary, using the same volume modification technology and optimized parameters, the output of the Xi 233 well block is significantly higher than that of the An 83 well block. Although the average
horizontal section length of the Xi 233 well block is about twice that of the An 83 well block, after comparison with the normalization of the horizontal section length and productivity, the Xi 233 well block still has obvious advantages. At the same time, the water cut in the Xi 233 well area is significantly lower than that in the An 83 well area, which is an important reason for the difference in production between the two. The geomechanical parameters of the two well areas are quite different, and the Xi 233 well area is significantly better than the An 83 well area. Therefore, there should be obvious differences in the optimization design of construction parameters for volume reconstruction.

4. Conclusion
West 233 well block and An 83 well block are both shale oil reservoirs in Changqing Oilfield. The main controlling factors for the productivity of the two blocks are geological factors such as lithology, porosity and oil saturation, geomechanical factors such as brittleness index and horizontal stress, and engineering factors such as cluster number, liquid volume, and sand ratio. After volume reformation, the output of the Xi 233 well block is significantly better than that of the An 83 well block, and the water cut is lower.

There is a big difference in production in the West 233 well area and An 83 well area. The geological conditions and physical properties of the two blocks are basically the same, but the water content is quite different, which may depend on their pore throat distribution and relative permeability. The geomechanical parameters of the Xi 233 well area are significantly better than those of the An 83 well area, and the fracturing operation is likely to form a better fracture network system. When designing fracturing parameters, it is necessary to increase the number of clusters, displacement and fluid volume in the An 83 well block.

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