Study on distribution characteristics of cracks in aonan oilfield

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Abstract: In this paper, the combined method of laboratory experiment and theoretical analysis is applied to the research process of Characteristics of cracks. Through analyzing the dynamic response of the oil and water wells in the block, the characteristics of the fracture development are studied. The size and direction of ground stress are obtained through indoor experiments, such as sound velocity, differential strain analysis and Paleomagnetism, and combined with the experimental test of the outcrop. establishing the rock fracture criteria in Aonan oilfield, giving relative logic formula of the deduced stress and fracture parameters, so as to accurately describe the characteristics of crack distribution of different wells.

Keywords: AoNan oilfield; rock cracks; crustal stress; differential strain.

1. Introduction
The Aonan oilfield is affected by the development of fractures and cracks. During the development process, the water injection is not uniform, and the water-temperature rising rate of the east-west oil well is fast. At this time, how to adjust the injection and production system and establish the oil-water well injection-production relationship with the crack system is very important. The core analysis method can be used to judge the magnitude and direction of the ground stress. On this basis, the stress field model and the rock failure criterion are established, and the relationship between the ground stress and the crack opening and density is analyzed, and the ground stress and fracture permeability and porosity are derived[1-3]. The calculation method finally describes the crack distribution and provides a basis for the adjustment of the block well network and the optimization of the measures.

2. Research on crack distribution characteristics

2.1. Laboratory experiment research
In view of the impact of cracks on waterflooding development, the study of crack distribution characteristics was carried out. Firstly, four well core sections were extracted, and the magnitude and direction of ground stress were studied by applying core analysis experiments[4-7].

2.2. Paleomagnetic experiment
The purpose of the paleomagnetic experiment is to determine the relative orientation of the core marking line and the geographical north pole. By alternating the demagnetization of the sample under a magnetic
field of 25, 50, 75, 100 Oe, the remanence after each alternating demagnetization is measured, and the relative orientation of the marker line to the geographical north pole is finally determined.

2.3. Wave velocity anisotropy experiment
Through this experiment, the maximum horizontal ground stress is measured relative to the core orientation, and combined with the paleomagnetic experiment results, the maximum ground stress is 94.975° relative to the geographic north pole (Table 1).

### Table 1. Differential strain test results

| Core number | Maximum horizontal stress | Minimum horizontal stress |
|-------------|---------------------------|---------------------------|
|             | value (MPa) | gradient (MPa/m) | value (MPa) | gradient (MPa/m) |
| A           | 31.84       | 0.0253           | 21.90       | 0.0174           |
| B           | 31.90       | 0.0266           | 22.90       | 0.0191           |
| C           | 24.18       | 0.01953          | 19.71       | 0.01592          |
| D           | 23.14       | 0.0205           | 19.07       | 0.0169           |

3. Differential strain method for measuring geostress
The maximum horizontal stress of each group is between 23.04MPa-31.9MPa, the average value is 26.69MPa, the minimum horizontal ground stress is between 19.07MPa-22.9MPa, and the average value is 20.87MPa.

3.1. Triaxial compressive strength test
The triaxial compressive strength test aims to test rock mechanics parameters such as elastic modulus and Poisson's ratio. After the experiment, the following experimental results were obtained (Table 2).

### Table 2. Triaxial experiment results

| Core number | A1 (MPa) | A2 (MPa) | A3 (MPa) | B1 (MPa) | B2 (MPa) | B3 (MPa) | C1 (MPa) | C2 (MPa) | C3 (MPa) | D1 (MPa) | D2 (MPa) | D3 (MPa) |
|-------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| Confining pressure (MPa) | 10       | 20       | 30       | 10       | 20       | 30       | 10       | 20       | 30       | 10       | 20       | 30       |
| Elastic Modulus (GPa)     | 9.96     | 11.97    | 11.61    | 8.43     | 9.16     | 9.32     | 10.27    | 10.45    | 11.03    | 18.89    | 23.08    | 28.75    |
| Poisson ratio             | 0.315    | 0.33     | 0.248    | 0.174    | 0.336    | 0.356    | 0.251    | 0.304    | 0.359    | 0.161    | 0.175    | 0.204    |

3.2. Establish quantitative relationship between crack opening, density and stress field
Based on the indoor core experiment, the stresses of the rock in different directions of space are analyzed, and according to the rock failure criterion, it is judged whether cracks form cracks. Based on the results of core experiments, the relationship between crack parameters and stress-strain under different stress states is derived[8-10].

3.3. Establish quantitative relationship between fracture permeability, porosity and stress field
Based on the calculation of crack opening, bulk density and linear density, the relationship between ground stress and fracture porosity and permeability is derived.

4. Quantitative description of crack parameters
On the basis of establishing the geological model, the finite element method is used to numerically simulate the geostress field during the crack development period, and the stress-strain calculation result is substituted into the quantification formula of the stress field and the crack parameter to calculate the fracture porosity and permeability. Spatial distribution. [11-14]
4.1. Distribution characteristics of crack plane

The crack opening of Weinan Oilfield is between 0.03-0.13mm. Among them, the high part of the anticline structure is more developed due to the sandstone, the rock is brittle, and is affected by the tensile stress. The crack is more developed and the crack opening is above 0.075mm. Due to the development of mudstone, the brittleness of the two sides of the anticline is relatively weak, the opening degree is less than 0.04mm; the crack density is between 0.8-2.9 strips/m, and the crack of the high slope is developed, and the density is greater than 1.8 strips/m.

The fracture porosity distribution is between 0.2% and 0.95%, the high point fracture porosity is greater than 0.65%, the fracture permeability is distributed at 5-35md, the high point is greater than 23md, and the depression zone permeability is less than 15md.

4.2. Vertical distribution characteristics of cracks

Judging from the distribution of crack parameters in different small layers, the PI1-PI7 layer is relatively developed due to sandstone, and the rock is brittle, resulting in relatively developed cracks. The opening and density of cracks are above 0.08mm and 2.1 strips/m, respectively. The degree and permeability are above 17md and above 0.69%, respectively.

5. Conclusion and understanding

1). Through the paleomagnetic experiment, wave velocity anisotropy experiment and differential strain method experiment and other core analysis methods, the magnitude and direction of ground stress can be measured. Finally, the maximum geostress direction of Weinan Oilfield is 94.975°.

2). The high-structure part of the Minnan Oilfield is relatively developed compared with the low-level part, mainly due to the large tensile stress caused by differential settlement near the anticline, and because of the shallow depth, the high-point part has small cracking strength and is prone to cracks.

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