The characteristics of fracture dense belt and its effect on hydrocarbon accumulation in the Putaohua reservoir, Xingnan oilfield, Daqing

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ABSTRACT: Through the analysis of the Putaohua oil layer of Xingnan area's geological information, sums up the fault form in section and the main form in the plane. Analyze the influence of different fracture dense belt for oil and gas migration and enrichment of sand body ,and controlling action on hydrocarbon accumulation. It's found that the Xingnan Putaohua oil layer have mainly developed 4 fracture dense belts，which are divided into horst-graben type belt and stepwise fracture belt. Two kinds of dense belt with *A - SGR* values are more than 30%, showing that both have a certain sealing property, and the stepwise fracture dense belt sealing is stronger than that of the horst-graben type fracture, but it is weak in ability of channel. The horst-graben type fracture dense belt of sand-controlling ability is stronger than that of the stepwise fracture dense belt, and it's favorite for the formation of oil and gas reservoirs.

INTRODUCTION

Fault is the most common structure style in sedimentary basin. In sedimentary basin which includes many faults, the faults can make up various styles in plane, and different styles of combined faults have different influence on oil and gas reservoir [1-2]. The previous researchers' study about fracture dense belt was almost qualitative. The innovative point of this paper is that based on SGR evaluation method, *A-SGR* evaluation method is established, and sealing characteristic is determined through quantitive method, which can research influence on oil and gas reservoir in further.

GEOLOGICAL BACKGROUND

Daqing Placantieline belongs to the secondary structural zone of the central depression in Song-Liao Basin, which consists of seven anticline structures that are Lamadian, Saertu, Xingshugang, Taipingtun, Putaohua, Gaotaizi and Aobaota[3]（Fig.1）. Xingnan area is located in the central part of Placanticline, whose Cenozoic stratigraphy consists of Huoshiling Formation, Sahezi Formation, Yingcheng Formation, Denglouku Formation, Quantou Formation, Qingshankou Formation, Yaojia Formation, Nenjiang Formation, Sifangtai Formation, Mingshui Formation, Yian Formation, Daan Formation, Taikang Formation, and Quaternary from below to above, of which the Putaohua oil layer in Upper Cretaceous Yaojia Formation is important oil-bearing horizon in which the faults are developed and constitute many fracture dense belts in plane.

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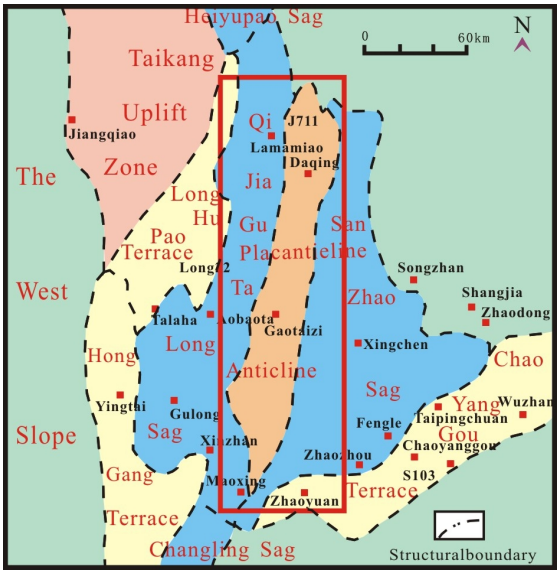

Fig. 1 Tectonic location of Placantieline，Daqing

THE TYPE OF THE FRACTURE DENSE BELT

The fracture dense belt consist of a series of faults, which have genetic connection and are strip-shaped [4]. There are 648 faults that are recognized, 1.06 faults being in one square kilometer. The faults are mainly developed in anticlinal axis while less in slope and depression, of which the main trends are NNW, some running NE or NNE, and extended length is usually not long than 3 Km. The section of the faults presents horst-graben type, "Y" type or stepwise type(Fig. 2).

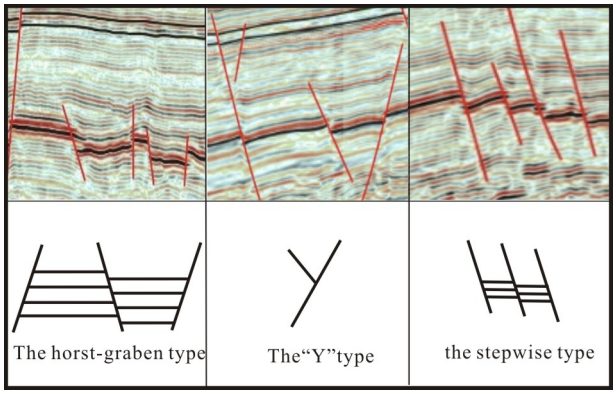

Fig. 2 The group of fault combination profile styles of the Putaohua oil layer ,Xingnan

The faults are developed in this study area, which constitute 4 main fracture dense belts(Fig. 3). The fault combination types of 4 main fracture dense belts are mainly horst-graben type and stepwise type, of which the fault combination types in the axis of the anticline are mainly horst-graben type and the fault combination types in slope zone are stepwise type(Fig. 4).Therefore the fracture dense belt in this area can be divided into the horst-graben type belt and the stepwise fracture belt.

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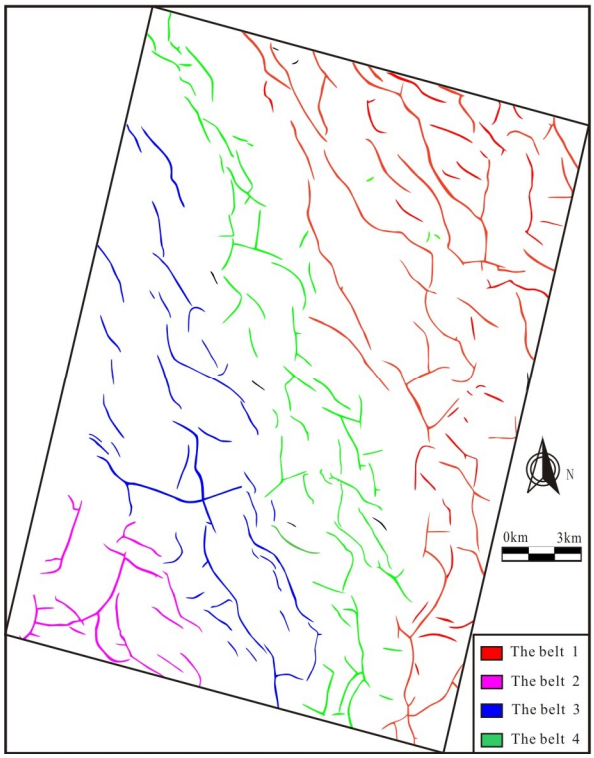

Fig. 3 The fracture dense belt of the Putaohua oil layers,Xingnan

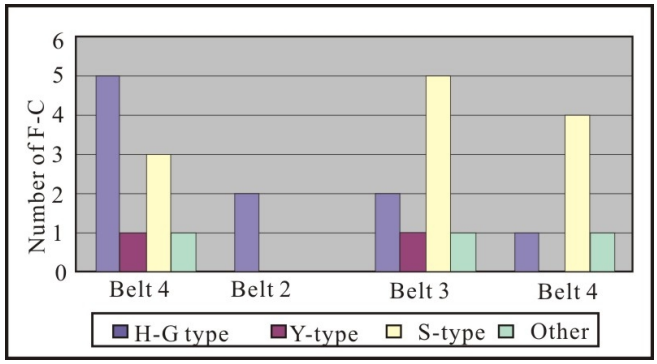

Fig. 4 The Fault combination of statistical in the fracture dense belt,Xinnan

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SEALING EVALUATION OF THE FRACTURE DENSE BELT

In past, the method of shale gouge ratio, namely *SGR*, is in common use and its result is best in the application of fault sealing analysis of the commonly used quantitative algorithm [5]. Today there is not a common method for quantitative evaluation of the sealing property of the fracture zone. For the fracture dense belt of quantitative evaluation, we use the method that is in based *SGR* algorithm on, calculate average value of the *SGR* in the fault , namely *A-SGR*, to evaluate sealing property of the fault .

A-SGR value calculation formula:

$$SGR = \sum (Vsh \cdot \Delta Z) / D * 100\%$$

$$A - SGR = SGR / N$$

Where *Vsh* = gouge content of the layer (%); ΔZ = thickness of the layer (m); *D* = fault throw of the fault (m); *SGR* = shale gouge ratio; *A-SGR* = average value of the *SGR* in the fault; *N* = number of faults in fracture dense belt.

Threshold value of evaluation of the sealing property, SGR, is usually 25%-30%, the bigger which is, the better sealing property of the fault is[6]. Because *A-SGR* stands for sealing property of the fault in fracture dense belt, the bigger the value of *A-SGR* is, the better sealing property of the fracture dense belt is. According to the evaluation criteria for the closure of the cover layer established by Yang Zhi et al. (1996) [7] , the *A-SGR* value evaluation criteria were determined (Table 1).

Table 1. *SGR* and *A-SGR* value evaluation criteria

Sealing property evaluation	Bad	Medium	Good	Better
SGR value（%）	<50	50~60	60~75	>75
A-SGR value（%）	<50	50~60	60~75	>75

Through the value of the thickness of the layer, the thickness of the mudstone, the ratio of the mud to layer and the fault throw, the *SGR* values of the different faults are calculated, then *A-SGR* values of the different fracture dense belt are obtained(Table 2). The analysis results show that the A-SGR values of the 4 fracture zones are more than 30%, which indicates that these faults have a certain sealing ability, that the sealing ability of the horst-graben type fracture dense belt is bad and that sealing capacity of the stepwise fracture belt is better. But the draining capacity of the horst-graben type fracture dense belt is better than that of the stepwise fracture belt.

Table 2. The value of *SGR* and *A-SGR* in the Putaohua reservoir, Xingnan

Fracture belt	*A-SGR*	Evaluation
Dense belt 1	47	Bad
Dense belt 2	46	Bad
Dense belt 3	71	Better
Dense belt 4	69	Better

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CONTROLLING EFFECT OF FAULT ZONE ON SAND BODY

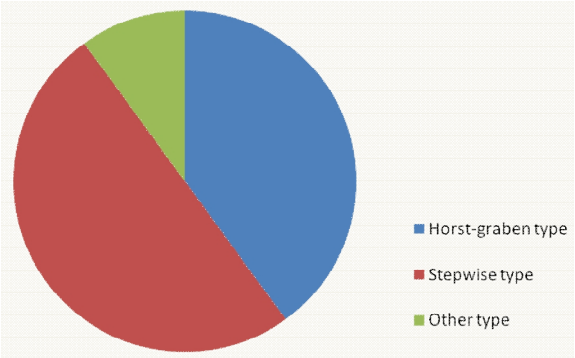

Fig. 5 Distribution of well number in the fault combination .

We ascertain thickness of the layer, sandstone thickness of the Putaohua reservoir that is contained in the 20 wells that contain the Putaohua reservoir and the trend of the fracture dense belt, then the fault combination type on stratigraphic section of each well or near layers can be determined (Fig. 5). It is showed that the sand-controlling ability in fault combination type of the horst-graben type is strong, and that in the fault combination type of the stepwise type is weak. That is because the sand-controlling ability in fault footwall than that in hanging wall, and the normal faults on both sides of the fault combination type of the horst-graben type constitute relatively big downthrown sides which make accommodation space become bigger, which is in favor of enrichment of sand bodies. The story in the fault combination type of the stepwise type is the opposite.

CONCLUSIONS

(1) It's found that the Xingnan Putaohua oil layer mainly developed 4 fracture dense belt， which is divided into horst-graben type belt and stepwise fracture belt.
(2) The *A-SGR* value of the horst-graben type belt and the stepwise fracture belt in the Xingnan Putaohua oil layer is more than 30%. The horst-graben type belt and the stepwise fracture belt have certain sealing property, which the sealing property of the horst-graben type fracture belt is weak and that of the stepwise fracture belt is good. But the channel ability of the horst-graben type fracture belt is better than that of the stepwise fracture belt.
(3) The sand-controlling ability of the horst-graben type fracture dense belt is stronger than that of the stepwise fracture dense belt, and it's favorite for the formation of oil and gas reservoirs.

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