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The lower limit prediction method of fault lateral sealing and its application in the sand-shale interbed

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Abstract: Based on the fault lateral seal mechanism of oil and gas, By using lithologic juxtaposition class fault trap evaluation method Knipe diagram method and fault rocks fault trap evaluation method of SGR algorithm, establish a set of fault lateral seal oil and gas minimum standards In the sand mud thin interbed, the results showed：that the lithologic juxtaposition class trap risk of throw to 10m, namely when the fault throw is greater than the risk of throw, fault sealing is helpful to mining of oil and gas; Fault rocks trap sealed limit of hydrocarbon is 35%, namely when SGR is greater than 35%,fault can seal the hydrocarbon. The evaluation method is benefit of accurate evaluating the sealing oil-gas ability and reducing the oil and gas drilling risk of fault trap and has practical and theoretical significance to enrich and perfect the theory of fault controlling the petroleum reservoir..

Keywords: *fault sealing; sealing hydrocarbon column height; quantitative analysis*

I. INTRODUCTION

Lateral sealing ability of fault is unavoidable problem and an hot issue in the oil and gas exploration. It plays a crucial role in lateral gathering oil and gas. At present, many research results including theory and evaluation methods of the lateral sealing ability has been made by many geologists in the all world[1]-[4].It developed from the early qualitative evaluation method into the semi-quantitative and quantitative evaluation method[5]-[9].Allan proposed Allan graphical method in 1989[5] and Knipe graphic method was proposed by Knipe in 1997[6]. All of them are the main evaluation methods of lithology juxtaposition sealing type .In 1989,Bouvier proposed the concept of "mud stone smear potential (CSP)"[7].In 1993,Lindsay put forward the method that "mud stone defiled factor (SSF)" discriminates the degree of relatively sealing[8].In 1997,Yielding put forward the calculation method of fault gouge ratio (SGR)[9]. All of them mainly evaluate the sealing ability of fault rock closed trap and SGR algorithm is the most popular method.However, there is no specific evaluation method to predict the lower limit of fault trap sealing oil ability in thin sand-shale interbed.Therefore, to establish a set of evaluation methods that predict the lower limit of fault sealing oil and gas in lateral in thin sand-shale interbed is benefit for accurate evaluating the sealing oil-gas ability and reducing the oil and gas drilling risk of fault trap and has practical and theoretical significance to enrich and perfect the theory of fault controlling the petroleum reservoir.

II. THE PREDICTION METHOD

According to the size of fault displacement and quantitative relationship between the thickness of the overlying mudstone layer and the purpose, the lateral seal types of fault can be divided into two patterns, namely lithology juxtaposition sealing type and fault rock lateral sealing type. The average thickness of local cap rocks overlying G3 groups in Xingbei area of Daqing oilfield is about 28 m. The fault displacement of 32 fault traps is calculated respectively. According to the quantitative relationship between the thickness of the overlying mud stone and fault displacement, six of the fault traps belong to lithology juxtaposition sealing and the others belong to fault rock lateral sealing. Therefore, according to the different sealing types to choose different evaluation methods, and the corresponding standard of lateral sealing oil and gas by fault is established.

1. THE RISK DISPLACEMENT

The risk displacement is the standard to discriminate the lithology juxtaposition trap sealing oil and gas ability. The fault displacements of lithology juxtaposition traps are less than 28 m which is the average thickness of the overlying mud stone .Usually the sealing oil and gas ability of lithology juxtaposition is very strong, but the sealing height depends on the quantitative relationship between the thickness of reservoir and the displacement. Under the condition of lithology juxtaposition,while the displacement is greater than the thickness of reservoir, the oil and gas sealing height is bigger ,which can achieve the standard of industrial exploitation of oil and gas.When the displacement is less than the thickness of reservoir, the oil and gas sealing height is smaller ,which cannot achieve the standard of industrial exploitation of oil and gas.

Therefore, the risk displacement is put forward. Four wells pertaining to lithology juxtaposition sealing trap of G3 group have been chosen to analyze their risk displacement in Xingbei area and an evaluation standard is established to evaluate sealing ability of lithology juxtaposition sealing trap of G3 group in Xingbei area.The oil layer of Xing 69 Well is G3-45. Through mapping the Knipe diagram (Fig 1) found its risk displacement is 10 m.The oil layer of Xing 71 Well is G3-45. Through drawing the Knipe diagram found its risk displacement is 7m.The oil layer of Xingfu 70-3 Well is G3-13, the Knipe diagram shows its risk displacement is 2.3 m. The oil layer of Xing1-330-822 is G3-13,the Knipe diagram shows its displacement is 3.3 m.In conclusion,the risk displacement of G3 in Xingbei area is 10 m.

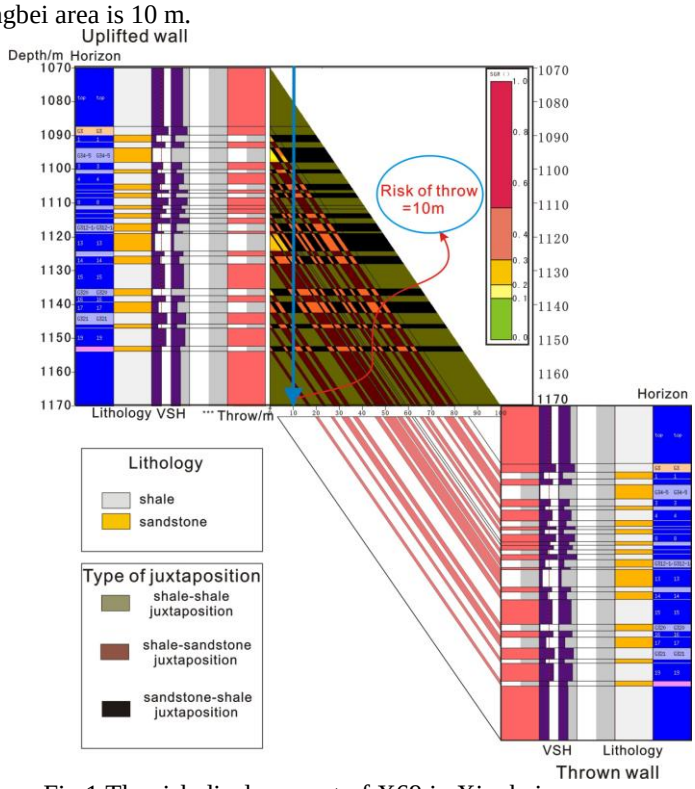

Fig 1 The risk displacement of X69 in Xingbei area.

2. THE MINIMUM OF SGR

The minimum of SGR is the standard to discriminates the fault rock lateral sealing oil and gas ability.Fault rock lateral closed trap sealing oil and gas mainly depends on the size of SGR values of fault in the trap. But not any SGR values can be closed oil and gas, so you need to determine a minimum SGR value as the lower limit of the fault sealing oil and gas. An evaluation standard is established to evaluate the capacity of fault rock closed trap sealing oil and gas of G3 in Xingbei area. For different regional, the minimum SGR value of the fault rock closed trap sealing oil and gas is different.More than 20 Wells in fault rock closed type trap in different strata are selected to calculate the SGR value of the oil bearing formations of G3 in Xingbei area.The result shows when fault SGRmin value of the fault rocks closed trap is greater than 35%, the fault can seal oil and gas.When fault SGRmin value of the fault rocks closed trap is less than 35%, the fault is not closed oil and gas.Ultimately the SGRmin = 35% is determined as the lower limit of fault rock closed trap sealing oil and gas of G3 in Xingbei area(Fig 2).

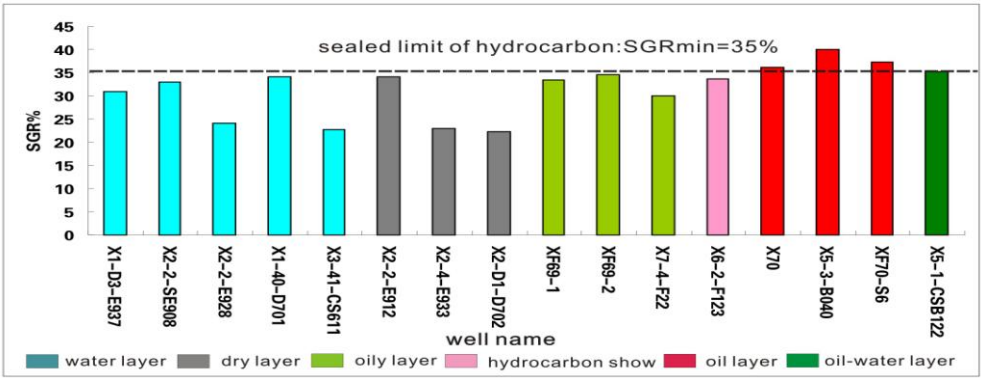

Fig 2 The minimum SGR value of fault rocks closed trap sealing oil and gas of G3 in Xingbei area

III. APPLICATION

On the base of the sealing standard as determined above in accordance with the lithology juxtaposition type and fault rock enclosing type, some loss wells in the research are analyzed.

1. LATERAL SEALING CAPACITY ANALYSIS OF LITHOLOGY JUXTAPOSITION SEALING TRAP TYPE

Xing 1-1 - E918 well is located in the central anticline belt and is obstructed by the fault F100, whose displacement is between 5 to 15 m that less than 28 m-the thickness of the overlying mud stone. Therefore, according to the standard of lithology juxtaposition closed trap sealing oil and gas- risk displacement to evaluate the risk well.The displacement- distance curve shows at the location that across Xing 1-1 - E918 and is perpendicular to the fault,the displacement of fault is 8 m which is less than risk displacement.So the sealing ability of oil and gas is poor and this is the failure reason.

2. SEALING CAPACITY ANALYSIS OF FAULT ROCK LATERAL SEALING TRAP

Xing 69-1 well is located in the central anticline belt and is shaded by the fault F612, whose displacement is between 30 to 40 m which is greater than the thickness of the overlying mud stone - 28 m.So the sealing oil and gas standard of the fault rock sealing trap -the minimum SGR value is suit to evaluate this well.From calculating SGR value of F612 fault ,at the point which is across Xing69-1 well and is perpendicular to the fault, the SGR value of fault is minimum-33%,and is less than the lower limit for fault rock closed trap sealing oil and gas -SGRmin = 35%. So the main reason of the well loss is the fault lateral seal ability.

IV. CONCLUSION

According to the quantitative relationship between fault displacement in fault traps and the thickness of the overlying mud stone in the the research, the fault lateral seal types are determined as lithology juxtaposition sealing or fault rock sealing, but mainly fault rock closed.According to different sealing types, two different methods of predicting the sealing oil and gas ability of fault traps in thin sand-shale interbed are build. For lithology juxtaposition sealing type, the risk fault displacement is the standard and the minimum SGR value is the method to predict the lower limit of fault rock lateral sealing oil and gas ability.

According to the studying on the risk fault displacement of lithology juxtaposition type trap and the minimum SGR value of fault rock sealing type trap sealing oil and gas in research area, eventually the risk displacement is determined 10 m and fault SGRmin-lower limit of the lateral seal ability is 35%. For the lithology juxtaposition sealing trap, oil and gas can be closed when fault displacement is more than 10 m but the opposite is not.For fault rock sealing type trap, oil and gas can be closed when fault SGR is greater than 35%,but the opposite is not.Ba group, Gh group, Za group and AG group are developed delta sedimentary system. According to lithology type, sand body shape, core analysis and other features, delta depositional system is divided into delta plain, delta front and delta front subfacies.

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