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Research Methods of Fault Sealing

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Abstract: Faults play a dual role in hydrocarbon migration and accumulation, which provides migration paths or close hydrocarbon, so that the evaluation of fault sealing has a great significance in oil and gas exploration and development. There are many ways to study fault sealing at present, and they can be summarized as lithology, mechanics, fluid nature, fluid inclusions and comprehensive evaluation. These different research methods and some study cases from experts are selected to elaborate the principles, characteristics and application of various types of research methods in detail, in order to evaluate fault sealing reasonably.
Keywords: fault sealing, lithology joint, shale smear, fuzzy mathematics, connectivity probability.

THE LITHOLOGY ANGLE

Study of fault sealing condition is to determine the fault of the basic parameters, such as fault, fault displacement tendency with dip Angle, fault broken formation lithology and section stress distribution by these parameters to the qualitative or quantitative analysis of fault sealing ability. Mainly from fault broken formation lithology and lithologic Angle fault zone to study fault sealing filler lithology.

The lithology joint of both sides of a fault model

When the reservoir sandstone layer and lateral sealing ability of fault when docking with the plate of mudstone layer (figure 1 a); When the reservoir sandstone layer and docking, the plate sandstone layer on the lateral could not fault closeness (fig. 1 b). Fault two sets of sand shale will butt, the fault slip and offset the influence of formation lithology. If the fault slip is greater than the thickness of sandstone, sandstone layer itself is completely wrong, the possibility of sand - mud docking; whereas less likely. If the offset of formation lithology mainly mudstone or mud ratio is higher, then the fault is the possibility of two sets of sand mud butt is big, the lateral sealing ability; On the other hand, the fault is likely to be two sets of sand clay and docking, lateral sealing ability is poor.

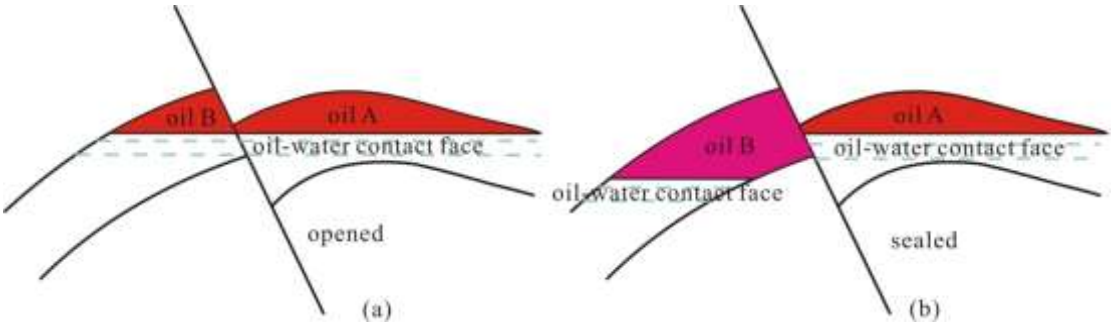

Fig-1: Sketch map showing fault sealing and oil-bearing properties of two walls

At present, the relations between the two plates of sand-shale docking studies fault often use Allan fault section diagram and the calculation methods of mudstone percentage to study sand mudstone juxtaposition relations [5]. Allan figure is based on section of lens, the fault of two sets of sand shale projection onto the cross section geometry, intuitively show, footwall sand mudstone layer along the cross section vertical and direction of the contact relationship. As shown in figure 2 blue and green stripe for fault rising disc and fall plate sandstone layer in the horizontal projection section, gap between sandstone stripe for mudstone layer in the cross section of the horizontal projection, shown in the figure, in 950-998 line area of sandstone layer of sand - sand contact relationship is good, poor lateral sealing ability of fault, sand other areas - the contact relation between the mud is good, good lateral sealing ability of fault. Lithology

joint of both sides of the diagram method is fault qualitative direct-viewing analysis method of lateral sealing ability of fault is only applicable to evaluation.

Section of mudstone smear

Mudstone smear is through the mud of the mudstone layer and formed into a developing fault zone. When the displacement of fault rupture, mudstone smear on, footwall cutting section sandstone layer formed on a thin layer of argillaceous, closed on the reservoir. Mudstone smear on reservoir development degree directly affect the fault sealing ability, this is because the mudstone smear produced along the fault plane distribution is a continuous low permeable clay material belt, and thus the fault itself is very high, given the expulsion pressure, sealing effect on oil and gas. Because single mudstone bad break in the process of mudstone smear thickness along with the increase of slip thinning [2], the mudstone smear space continuity and mudstone layer thickness ratio is closely related to fault displacement, based on the quantitative evaluation of mudstone smearing on.

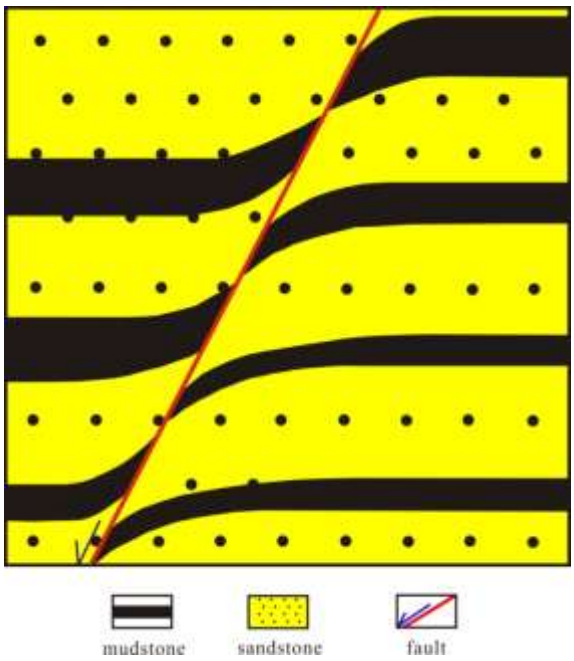

Fig-2: Sketch map showing shale smear on fault section

At present, the commonly used quantitative research mudstone smear sealing ability of the algorithm has 3 kinds: shale smear factor (SSF: slip ratio and the thickness of mudstone layer), clay smear potential (CSP: thickness of mudstone layer square and the ratio of mudstone smear distance), fault gouge ratio (SGR: the ratio of thickness of mudstone layer and vertical fault throw) (figure 2).The mudstone smear algorithms to a certain extent, reflects the longitudinal mudstone smear, is one of the important quantitative evaluation method of fault sealing, but these methods require mudstone in the yi plastic flow state. Early diagenetic mudstone easy plastic flow, along the cross section can be a large number of drag, lead to a wide range of ground daub section; Late diagenetic mudstone layer in a fragile state, fault fractured rocks, and difficult to appear mudstone smear. So the study on quantitative fault sealing in using the above algorithm, the first thing to consider state of rock is a plastic or brittle.

Fault zone filler

Rupture is the external stress exceeds the rock ultimate strength, expansion and concentrated form microcracks, lead to macro on rock burst. When stress more than rock frictional resistance, two sets the relative sliding, broken rock fill in fault open space formation fracture filling [1] from the fault zone can be divided into fault rock zone, fracture zone and fracture development zone three parts. Fault rock belt is located in the center of the fracture, the broken seriously, small particles; Mixed small broken belt metamorphic grade, particle size and most uncemented; Fracture development zone rock is not broken, accompanying the development of low level and order more fractures.

Due to the fault zone within the different zoning, its lithology and metamorphic grade differences lead to different physical characteristics, influence the fault sealing ability. Fault rock zone due to the small particles and mineral deposition, make it compared with the adjacent areas have lower porosity and permeability; Fracture zone caused by different metamorphic degree and degree of consolidation property differences; If in the fracture development zone cracks in an open state, a lot of crack form the network, does not favor the fault sealing. Therefore, a necessary condition for fault vertical sealing is broken

belt need to fill a large number of fault gouge make pore permeability is lower than the surrounding rock, and the fracture development zone in the crack in the closed state. From internal fault structure study of fault sealing ability is the most direct method, but the research of this method is more complicated, data acquisition is difficult.

MECHANICS

Section pressure

Vertical open degree of closed cross section is fault or not one of the key factors. If the section is closed, the fault vertical sealing ability is good, is difficult along the cross section vertical hydrocarbon migration; Otherwise, the fault, fault can be used as oil and gas migration channel. Degree of closed cross section usually depends on the size of the cross section by positive pressure, the larger the positive pressure makes the section on both sides of the formation to deformation in the process of fault activity, reduce the pore on the level of end, and even cause fault fracture closure fault plane by positive pressure (P) basically has two: one is from the regional principal compressive stress the role of sigma (P1); The other one is from the overburden static and the effect of rock pressure (P2) (figure 1).

The rock stress deformation theory, the pressure on the mudstone after reaching its elastic limit, will occur plastic deformation. Based on the predecessors to human, western hubei argillaceous rock compressive experiment research shows that when the pressure is more than 5 MPa, mudstone occurred plastic deformation flow, left over from jam fault plane closed after leakage form vertical closed space. Otherwise, although fault surface can be closed under the action of pressure, but mudstone flow cannot occur plastic deformation, leakage of fault are still left space, cannot be formed in the vertical sealing. According to the above research results, the positive pressure by calculating section to quantitatively evaluate the fault sealing or not, but in different areas and horizon of mudstone plastic deformation of the elastic limit stress is not the same, the specific research needs to be determined.

Abnormal formation pressure

Mud shale formation if have abnormal pressure, reduces its elastic limit, so as to make it flow plastic enhancement occurred When the mudstone with abnormal pressure on both sides of the fault, the fault surface caused by the plastic flow of mudstone filling is easily blocked. On fault gouge and argillaceous components are usually exist, the argillaceous components in the burial diagenetic process if there is abnormal pressure, so it may cause the fault plane near shale plastic deformation filling pore, form a larger displacement pressure, resulting in fault sealing Therefore, on both sides of the seal of the fault and fracture mudstone formation abnormal pressure has a positive correlation Fault on both sides of the mudstone abnormal pressure, the greater the mudstone plastic deformation, the more the better fault sealing [3] to fault zone based on whether pressure is overpressure mudstone layer can be more intuitive to judge fault sealing ability, using the well logging information can more easily obtain formation pressure data, therefore is a kind of simple quantitative judgment method of fault sealing.

FLUID INCLUSIONS

Sediment in the process of sedimentation, diagenesis, due to temperature rising, the sedimentary mineral on crystallization and recrystallization, fluid can capture is activity, make the fluid inclusions. Very active fault in the process of open activities, fluid, at this time in fracture if the presence of mineral crystallization and recrystallization is easy to capture the fluid and fluid inclusion is formed. By means of fracture fillings, the study of fluid inclusions in the cement system, quantitative or qualitative to judge fault time.

Based on the above principle, along the fault zone to extract the different depth of fluid inclusions, the determination of the homogenization temperature, and according to the inclusion fluid properties determine the fracture fluid activities in time, and then obtain the fault opening and closing time. If fluid flow time continuous, long-term open fracture; If the time gap fluid activity, to show that the fracture fluid flow pulsation period closed. By this method is to use the fluid in the fault activity to determine the inclusion traces of the fault sealing ability, is a direct method, but it is not mature enough in the practical application.

COMPREHENSIVE EVALUATION

Due to the influence factors of fault sealing is more, such as fault dip, fault displacement and fault gouge, fault activity, such as, of these factors are often one or two does not represent or evaluation of the fault sealing ability, how to combine these factors comprehensive evaluation will be a fault sealing research direction cannot be ignored.

Fuzzy mathematics comprehensive evaluation

Fault sealing performance may be different in different geologic period, it is, with the development of fault geometry, kinematics and dynamics characteristics of the fault itself parameters are closely related Xin-gui zhou to Bi Jia Ling oilfield as an example, on the basis of field fault characteristics, research status, and the maneuverability of the evaluation method, to extract the oil fields in the eight major factors affecting the fracture closed performance, determines the evaluation standard, its and according to the experience of the experts, in turn, given the index weight, using the fuzzy

mathematics principle has carried on the quantitative evaluation to the seal of the fault.

Influencing factors of fault sealing were considered in the study method of the multiple, the more accurate evaluation of fault sealing (larger workload) but the elements of statistical data. In actual application, you first need to select the main factors of influence on the work area has the fault sealing and the weights of various factors, and fuzzy mathematics comprehensive evaluation.

Connectivity probability evaluation

Fault connected probability method is li-kuan zhang Cheng north fault terrace zone fault in dagang oilfield as the research object, put forward a new method for quantitative evaluation of the fault characteristics of opening and closing This method will influence the fault boils down to the main factors to be opened and mudstone (delta), the section normal stress fluid pressure (P) and fault gouge ratio (SGR) three representative parameters, according to the influence of fault opening and closing mechanism construct a fault opening and closing of dimensionless coefficient C, namely C = delta p. SGR.

On this basis, a large number of random cross section of the fault known typical reservoir, according to its upper and lower two sets are oil and gas in reservoir to determine its opening and closing cross section of the opening and closing at different location of the coefficient calculation, the statistical scope of coefficient of different opening and closing of connected probability (will open/close coefficient between the minimum and maximum uniform, statistical proportion of open reservoir in every parts, namely the corresponding coefficient of uniform opening and closing connected probability), and establish fault connected probability and fault in the study area coefficient correlation between the opening and closing. Unknown reservoir fault zone in the studied area, the fault opening and closing by calculation coefficient C, plug connected with the opening and closing coefficient formula of calculating the Duan Ceng Chu connected probability, thus quantitative for the seal of the fault.

CONCLUSIONS

In fault zones, fault sealing research of oil and gas exploration, block evaluation, reserves calculation, well location selection and making correct development strategy is of great significance. The seal of the fault are controlled by many factors, such as fault occurrence, fault mechanics properties and fault filling materials, etc., but in different areas, different horizon of the main control factors of fault sealing is different. So for fault sealing study, you will first need to optimizing the work area of main control factors to determine the fault sealing research Angle, and in view of the existing material condition, choose the most appropriate method in the previous five categories are studied. In addition, with the deepening of the research on the work area, the existing data conditions gradually improve, find the most appropriate research method is a process of constant exploration and update.

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