SEALING AND NONSEALING FAULTS [1]

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ABSTRACT

Differentiating between sealing and nonsealing faults and their effects in the subsurface is a major problem in petroleum exploration, development, and production. The fault seal problem has been investigated from a theoretical viewpoint in order to provide a basis for a better understanding of sealing and nonsealing faults. Some general theories of hydrocarbon entrapment are reviewed and directly related to hypothetical cases of faults as barriers to hydrocarbon migration and faults as paths for hydrocarbon migration. The phenomenon of fault entrapment reduces to a relationship between: 1) the capillary pressure within the reservoir; and 2) the displacement pressure of the reservoir rock and the boundary rock material along the fault. Capillary pressure is the differential pressure between the hydrocarbons and the water at any level in the reservoir; displacement pressure is the pressure required to force hydrocarbons into the largest interconnected pores of a preferentially water-wet rock. Thus the sealing or nonsealing aspect of a fault can be characterized by pressure differentials and by rock capillary properties.

Theoretical studies show that the fault seal in preferentially water-wet rock is related to the displacement pressure of the media in contact at the fault. Media of similar displacement pressure will result in a nonsealing fault to hydrocarbon migration. Media of different displacement pressure will result in a sealing fault, provided the capillary pressure in the reservoir rock is less than the opposing boundary displacement pressure. The trapping capacity of a boundary, in terms of the thickness of hydrocarbon column, is related to the magnitude of the difference in displacement pressures of the reservoir and boundary rock. If the thickness of the hydrocarbon column exceeds the boundary trapping capacity, the excess hydrocarbons will be displaced into the boundary material. Dependent on the conditions, lateral migration across faults or vertical migration along faults will occur when the boundary trapping capacity is exceeded. Application of the theoretical concepts to subsurface studies should prove useful in understanding and in evaluating subsurface fault seals.

[1] This paper will be published in the Bulletin of the American Association of Petroleum Geologists.