Workflows for Fault Seal Prediction in Siliciclastics and Carbonates

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Abstract

Fault-bound traps represent an important class of hydrocarbon-bearing structure. Whether a fault can seal hydrocarbons on a geological time-scale may be controlled by one or more of three conditions: (i) whether the fault slip has juxtaposed reservoir against sealing intervals; (ii) whether the fault slip has created new fault rock with sealing capability where reservoir is juxtaposed against reservoir; and (iii) whether the in situ stress state is conducive to up-fault leakage out of the trap.

A key first step in evaluating these conditions is a structurally-robust interpretation of the sub-surface geometry of the reservoir layers and the faults. A three-dimensional framework model should be constructed where fault-fault and horizon-fault intersections are built in a way that honours established structural-geological rules, particularly in regard to fault geometry and displacement patterns.

If reservoir-reservoir juxtapositions occur, the fault displacement and stratigraphic profile can be used together to estimate the nature of the fault-rock which might be present. In reservoir-shale sequences, clay smears provide a mechanism to introduce sealing material between juxtaposed reservoirs. A variety of predictive techniques have been developed for clay smears, all dependent in some way on the number and thickness of clay beds in the faulted section and the amount of fault displacement. In shale-poor sequences, whether siliciclastic or carbonate, the stress and temperature conditions during and after faulting play an important part. In intra-sandstone faults, the processes of cataclasis and diagenetic overprinting are now well understood, but only now is comparable progress being made to determine permeability behaviour in intra-carbonate faults. Routine prediction of fault transmissibilities in carbonate reservoirs is the goal of this research.