Dynamic Evaluation of Leaking Fault and Top Seals

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Abstract

Many of the techniques commonly used to evaluate both fault and top seal capacity are static in nature, based primarily on the definition of threshold capillary entry pressure. Measured capillary pressure data suggest that extremely large column heights are theoretically possible behind fine-grained mudstones and shale smears. This kind of data has led to the idea of the "perfect seal". However, the large volumes of petroleum which have migrated across thick mudstones in many petroleum systems indicate the potential for substantial petroleum leakage on relatively short geological timescales. Furthermore, diverse evidence suggests that at least when petroleum leaks into seals, the wetting state of the pore system changes from water-wet to oil-wet. In this case, there is no capillary entry pressure for the petroleum to overcome; seals are now imperfect and charge rate, seal thickness, relative permeability and fluid viscosity are controlling factors on accumulation and leakage. Simple charge – leakage models show that substantial petroleum columns are still possible in many (but by no means all) cases, as long as petroleum continues to be supplied from an active source. The models also show (a) how gas and oil can be effectively segregated by migration through low permeability units and (b) that if charge ceases, columns will be lost on short geological timescales unless they are held behind thick seals with very low permeabilities. Our models and data show that a full seal analysis should include dynamic seal properties as well as the commonly applied static methods.