

Hydrodynamics and Seal Evaluation

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Abstract

Hydrodynamic conditions affect the sealing capacity of caprocks, intraformational seals, and faults, and consequently influence the holding capacity of hydrocarbons of structural, stratigraphic and combination traps. Hydrodynamic conditions may also create additional regions of minimum potential energy for hydrocarbons, i.e. purely hydrodynamic traps.

The most common types of regional groundwater flow system in sedimentary basins are the topography-induced system in subaerial exposed – parts of – basins, and burial-induced groundwater system (such as compaction flow system) in filling and subsiding basins. Significant influences on the sealing capacity of low-permeability stratigraphic units occur in parts of regional groundwater flow systems where large groundwater potential gradients (large overpressure gradients) prevail over these units. Large vertical groundwater potential gradients occur over laterally extensive low permeability units in recharge and discharge areas of topography-induced groundwater flow systems and in intermediate and deep overpressured subsystems of burial-induced flow. Large lateral groundwater potential gradients occur across low permeability faults crossing regional carrier rocks and across juxtaposition faults in deep overpressured parts of sedimentary basins. Each type of groundwater flow system modifies the accumulation and trapping conditions for hydrocarbons in a sedimentary basin in a specific way in comparison with theoretical hydrostatic conditions for that basin.

Most conventional methods of top seal and fault seal evaluation rely on hydrostatic assumptions. These methods can be enhanced with hydrodynamic analysis. Ongoing research has developed into methods for seal evaluation that integrates knowledge and understanding of hydrodynamic systems in sedimentary basins with conventional geological methods for seal evaluation.

This paper will review the current understanding and approaches for recognizing the influence of hydrodynamics on sealing capacity of caprocks and faults.