

Time-dependent Flow Partitioning in Weakly Deformed, Giant Carbonate Reservoirs

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The flow behavior of carbonate rocks in the shallow crust is influenced by the combined impacts of primary and diagenetic textures and deformation overprints. These processes create and destroy permeability, influencing time-dependent flow paths on both exploration and production timescales. As production from several giant carbonate reservoirs over several decades has shown, the heterogeneous permeability structure of carbonate rocks can have a significant and changing impact on production as reservoir conditions change. A key aspect of effective, long-term strategies to sustain production in giant carbonate fields requires early recognition of the potential flow systems that could evolve during their lifespan.

By combining insights from field analogs in Oman, published industry data and flow simulations we discuss different types of flow systems that might evolve and their potential impact on recovery. Features that tend to focus flow or introduce strong permeability anisotropy are clearly of interest. For example, fracture corridors, low-displacement faults, and regional fracture arrays are commonly difficult to resolve in seismic data but can extend vertically and laterally for hundreds of meters-to-kilometers as permeable conduits. Laterally persistent zones of intense pressure solution influenced by stratigraphic textures can influence flow anisotropy. Hierarchical fracture systems can provide the critical links among fracture sets otherwise confined to single beds. Preliminary experiments that explore the impacts of fracture corridors on flow predictions are used to illustrate both the sensitivity of flow predictions to structural geometries and the impact of reservoir conditions on flow system development. While the results of these studies rely on assumptions inherent to the modeling software, they indicate the need to develop a deeper understanding of the detailed geological controls on flow partitioning on production timescales.

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