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Matrix-Fracture Connectivity in Eagle Ford Shale

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Despite micro- to nano-Darcy matrix permeability, shales and mudrocks have become highly productive sources of hydrocarbons owing to advanced horizontal drilling and multi-stage hydraulic fracturing techniques. Production is attributed to an interconnected network of induced fractures that accesses the hydrocarbons stored in the rock matrix. It has been postulated that the induced fracture network results in part from reactivation of natural fractures. Natural fractures in these reservoirs are either lined or completely occluded with mineral cement with little to no connectivity among fracture pores or between the fracture and matrix pores. However, reactivation of natural fractures during hydraulic fracture stimulation may allow the interface between mineralized fracture and matrix to be broken, potentially resulting in increased well performance.

A variety of natural fractures are present in the Eagle Ford Formation, varying in orientation, in-filling composition and appearance. Long/tall sub-vertical calcite-filled fractures are the most spatially-extensive fractures observed in core, and the most likely to affect hydraulic fracture propagation and subsequent production/injection. In this investigation we used scanning-electron microscopy (SEM) imaging in conjunction with ion-milling techniques to study pore space connectivity between the matrix and reactivated sub-vertical calcite-filled natural fractures. We observe open nano-fractures in the fracture-fill that suggest the fracture-fill is not impermeable.

The implications of permeable/impermeable fracture-fill for production are studied from the pore-scale to the core- and gridblock-scale. At the pore-scale, a multiple-relaxation-time lattice Boltzmann model (MRT-LBM) is used to estimate fracture-fill permeability. The results of which are upscaled to the core- and gridblock-scale under a variety of scenarios using a combination of "gray" LBM and finite-element methods.