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Fracture and fluid-flow in low permeability materials

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Transport processes in low permeability materials are likely to be dominated by fracture flow as found in fluid production in shale oil and gas reservoirs and in crystalline-rock geothermal systems. Fracture behavior in these systems is typically studied using saw-cut, laboratory fractured or "natural"fractured specimens that provide useful data on idealized fractures but that do not provide insights into fluid transmissivity of fractures as exist in the subsurface. In this study, we use an experimental approach to characterize subsurface fracture transmissivity using triaxial direct-shear coreflood measurements combined with x-ray radiographic and tomographic observations. We examined fracture formation in impermeable dolomite, anhydrite, and shale from unconventional hydrocarbon reservoirs. The direct-shear method creates shear fractures through the specimens at reservoir conditions allowing simultaneous measurement of transmissivity and observations of fracture geometry. Data were collected on initially intact specimens that were fractured and characterized without releasing the reservoir conditions. Measurements were collected as a function of effective confining stress and fracture displacement. All of the materials studied formed relatively high-transmissivity fractures at low stress and transitioned to relatively impermeable fractures at high stress. In addition, continued fracture displacement was found to result in significant increases in transmissivity at low stresses but resulted in little change at high stress. These observations indicate that critical stresses exist above which fractures show little transmissivity and are difficult to reactivate. The results have implications for understanding the production or lack of production of fluids from fractured materials and suggest laboratory-based methods for evaluating or predicting production from fractured formations.

References

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