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Inferring Spatial Variation of Transmissibility of Faults in an Aquifer Using Spatial and Temporal Pressure Data From Westbay Multilevel Monitoring Wells

The fault-partitioned, Hickory siliciclastic aquifer system in central Texas provides a unique field laboratory to determine the spatial fluid-flow attributes of faults from core- and field-scale, fluid flow data. The study fault is a normal fault system with 20 m of net displacement that impedes cross-fault flow. We constructed a high-resolution stratigraphic and fault structure model based upon 1050 m of core and a suite of geophysical logs from eleven, closely-spaced (3 - 10 m), continuously cored boreholes drilled through the study fault to depths of 125m. Westbay multilevel monitoring systems installed in eight boreholes provide 94 hydraulically isolated, pressure measurement zones distributed in a region 40m by 20m by 70m encompassing the faults. The quasi-steady state, 3-D distribution of hydraulic head in the vicinity of the fault network quantitatively demonstrates the impediment of flow across the faults. Head differences across the faults, hence local fault conductance, vary with structural and stratigraphic position. First-order models indicate fault-rock permeability up to three to four orders of magnitude smaller than adjacent reservoir strata. Core-scale hydraulic conductance properties are roughly consistent with field-scale estimates. Transient pressure histories and spatial patterns for pumping and recovery tests of two irrigation wells straddling the fault provide excellent additional details of the effect of the faults on fluid flow. Data analyses using simple fault/reservoir response models are of limited utility for inferring fault properties. Currently, we are analyzing the dynamic data using a 3-D finite element reservoir model coupled with geophysical inversion.