Influence of Fault Zone Deformation on the Permeability of the Glen Rose Formation: Hidden Valley Fault Zone, Comal County, Texas

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The Canyon Lake Spillway Gorge (the Gorge) is located near New Braunfels, Texas in northeast Comal County. The Gorge was created in the summer of 2002 when flood waters from the Guadalupe River breached the Canyon Lake emergency spillway and erosionally exposed over 800 m of the “seismic-scale” Hidden Valley normal fault. Numerous year-round seeps and springs in the Gorge issue from the fractured carbonate strata of the Glen Rose Formation in association with the Hidden Valley fault zone. In addition, surface flow locally infiltrates into the fault zone, locally recharging the ground water system. Surface flow in the Gorge merges downstream with the Guadalupe River, the main discharge system in this region.

High permeability discharge and recharge features in the Gorge are localized in areas of enhanced porosity including the following porosity types: (i) vuggy porosity formed by dissolution of sedimentary burrows, (ii) fractures, (iii) faults, and (iv) dissolution-enhanced fractures and faults. Complex permeability structure is common in determining fluid flow through faulted carbonate aquifers and hydrocarbon reservoirs around the world. The Hidden Valley Fault Zone and Glen Rose Limestone, which it cuts in the Gorge, are part of the regional Trinity Aquifer system, and most of the gorge exposure is below the normal level of nearby Canyon Lake.

Measurement and monitoring of water temperature, conductivity, and flow rates from the Gorge indicate that springs and seeps in the Gorge are sustained by seepage from Canyon Lake with additional contributions from the Trinity Aquifer. Surface water flow measurements along the Gorge indicate that flow increases from the upper Gorge to the lower Gorge consistent with an increase in hydraulic head as the Gorge elevation decreases. Results of numerical modeling of groundwater flow indicate that the primary hydraulic influence of the fault is due to juxtaposition of lower-permeability layers in the upper Glen Rose, against higher-permeability layers in the lower Glen Rose. Along the fault trace, however, extensive fracturing near the fault zone causes water to travel preferentially along the fault zone. This baseline investigation has improved understanding of the impact of the Hidden Valley fault zone on the large-scale permeability of the Trinity Aquifer, and provides context for more focused future analyses of permeability architecture and fluid flow in this reservoir field analog.