GPR, EM, AND BOREHOLE GEOPHYSICAL INVESTIGATIONS OF THE BEE CREEK FAULT ZONE, CENTRAL TEXAS

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The Bee Creek fault zone in central Texas is a northeast-trending, overall down-to-the-east fault zone with up to 15 m of estimated throw in Cretaceous strata. This fault zone is part of the Miocene Balcones Fault Zone, but occurs as an outlier about 15 km west of the edge of the primary Balcones Escarpment. The fault zone offsets units of the Middle and Lower Trinity aquifers, intersects a large reservoir, and may influence aquifer recharge and groundwater flow. We are characterizing the fault zone using high-resolution, lidar-derived topographic expression, field geologic and structural observations, and geophysical methods. Geophysical methods include borehole geophysical logging (EM conductivity and spectral gamma) and profiling across the known and suspected fault trace using ground-penetrating radar (GSSI SIR-3000, 200 MHz antenna) and frequency-domain EM (GF Instruments CMD Explorer, 10 kHz primary frequency, 1.5, 2.8 and 4.5 m coil separation, vertical dipole orientation) instruments. Lidar data reveal fault traces and apparent offset in places. GPR data clearly show stratal discontinuities to exploration depths of a few meters, confirming the location of fault strands where they are hidden from direct view by vegetation, soil, and thin alluvial and lacustrine sediments. Geophysical logs of a recently drilled, 91-m-deep well on the upthrown side of the fault zone show a hydrostratigraphic succession from the Lower Trinity Aquifer from the deepest depth logged (91 m) to the base of the Hammett Shale aquitard at 46 m. The 9-m-thick Hammett Shale is overlain by strata of the Middle Trinity Aquifer, which extends from 37 m depth to the ground surface. Low gamma counts and conductivity values were measured in the sandstone and gravel in the lower part of the Lower Trinity. Higher gamma counts and conductivity values were measured in the clay and sand in the upper part of the Lower Trinity and the Hammett Shale. Low gamma and conductivity values were measured through the limestone, clay, and silty clay of the Middle Trinity section. EM profiles crossing the fault zone perpendicular to fault strike generally show higher conductivities on the downthrown side of the fault than the upthrown side. A series of antithetic (down to the west) faults evident from field studies may manifest as local modifications to that general conductivity pattern. Combined field, remote sensing, and geophysical methods aid the characterization of the fault system and future studies of the hydrogeological influence of the fault zone on the aquifer and surface water systems.