

Beyond the Bad-Water Line—A Model for the Occurrence of Brackish Water in Upper Coastal Plain Aquifers in Texas

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ABSTRACT

Brackish water in the Edwards aquifer in south-central Texas is hypothesized to occur in a zone of convergent flow with hydrodynamic and transient mixing mainly between hydropressed freshwater moving downdip by gravity and saline water migrating updip from depth by a geopressure drive. Another source of water and dissolved mass is upward-directed cross-formational flow into the Edwards Group. Composite plan-view maps of a potentiometric surface and total dissolved solids (TDS) document the convergence zone. Two versions of a potentiometric surface are drawn from hydraulic-head data from the freshwater and brackish-water zones and pressure data from oil and gas wells: (1) an equivalent freshwater hydraulic-head map with constant water density = 1000 kg/m³ and (2) a point-water hydraulic-head map with variable saltwater densities assigned to each well. The hydraulic-head maps honor equipotential contours from a 2004 synoptic map of high-stand water levels in the freshwater aquifer. Pressure data from gas wells are corrected for capillarity. The TDS map uses reported analyses of chemical composition of water samples from water wells, monitoring wells, and hydrocarbon production wells, and TDS estimates calculated from resistivity well logs. A relation between TDS and specific conductance was extended from the freshwater-to-brackish-water range to include saline water with TDS >100,000 mg/L.

A hydraulic-head minimum lies downdip of the bad-water line where the lateral gradient in hydraulic head reverses and fluid pressure climbs toward geopressure at depth. Deep geopressure in the Edwards Group drives flow of saline water updip toward the freshwater aquifer. The likely source of geopressure in the Edwards Group was fluid leakage from the geopressed Cenozoic section that overlies the Edwards Group beyond the Cretaceous shelf margin. Convergent flow implies a significant amount of vertical cross-formational discharge, which otherwise is typical of confined aquifers. The conceptual model of Edwards groundwater movement might be improved by accounting for vertical flux across the confined aquifer. Convergent flow with a vertical-discharge component might be typical of brackish-water zones in other coastal-plain aquifers in the western Gulf of Mexico Basin.

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