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Effect of Relative Sea-Level Changes on Carbonate Reservoir Geology: Example from Permian North Cowden Field, West Texas

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Response of carbonate system-tracts to relative sea-level changes has a significant control on development and distribution of facies, pore networks, and permeability barriers. The Blakeney Lease in the North Cowden field has reservoirs in the Lower San Andres Holt Limestone, Glorieta Formation, and Upper Clear Fork Formation. Each unit was deposited during different stands of sea level resulting in different facies, pore network types, and permeability barrier distributions.

Upper Clear Fork subtidal dolopackstones and dolograinstones were deposited during early highstand and were later dolomitized by seepage refluxation from Glorieta tidal-flat brines. The highly permeable pore network consists of intercrystalline and moldic porosity. No internal vertical permeability barriers are present. Glorieta tidal-flat dolowackestones and dolopackstones developed during late highstand. Most of the pore network consists of microporosity in mud and peloids except for one laterally extensive zone of interparticle porosity in a subtidal lime grainstone. Local vertical permeability barriers are common and are associated with multiple tidal-flat cycles.

A tight terrigenous siltstone layer, deposited at the beginning of the next third-order, relative sea-level cycle (lowstand), forms a significant vertical permeability barrier. The deeper water Holt Limestone was deposited during early transgression and the pore network in bryozoan grainstones consists of connected interparticle porosity and in fusulinid grainstones consists of poorly connected intraparticle and microporosity. The McKnight Shale, deposited during a late transgressive drowning unconformity, forms an effective seal over these reservoirs.

Understanding the controls of relative sea level on deposition, along with data about mineralogy, grain types, and burial history, improves correlating and mapping facies, pore network types, and permeability barriers.