Controls on Reservoir Quality of Sandstones, Cotton Valley Group (Upper Jurassic), East Texas Basin, Texas

Sandstones in the Cotton Valley Group are poor-quality gas reservoirs that require massive hydraulic fracturing for economic production. Burial diagenesis of these rocks has resulted in extensive cementation and grain replacement that, with few exceptions, has reduced porosity to less than 10% and permeability to less than 0.1 md. Major diagenetic minerals are quartz and carbonates (calcite, ankerite-dolomite) with clay minerals, albite, and anhydrite present in subordinate amounts. The abundance of cement is related in part to initial sandstone composition. Cotton Valley sandstones are very fine to fine-grained, moderately to well-sorted quartzarenites and subarkoses. In quartzose sandstones, pore-filling cements average between 15 and 20% of the rock volume, whereas in feldspathic sandstones cements usually comprise over 20% of the rock volume. These cements eliminate most of the primary intergranular porosity leaving a series of nearly isolated voids connected by submicron-size pore throats. Although blockage of pore throats by authigenic clay minerals locally contributes to low permeability, quartz and carbonate cements usually line pores and appear to more effectively block pore throats.

Porosity preserved in the Cotton Valley consists of primary intergranular and secondary dissolution voids. Most secondary porosity results from dissolution of feldspar and chert; a sparse amount of secondary voids originate from dissolution of shell fragments and possibly calcite cement. Dissolution porosity is locally the most abundant type of porosity, particularly in feldspathic sandstones, but is usually associated with inadequate permeability to improve reservoir quality. Secondary voids are not interconnected because their distribution depends on the presence of soluble grains, which are dispersed in the sandstones. Highest permeability is present where primary intergranular porosity forms over 50% of the total porosity.

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Computer-Aided Offshore Reservoir Delineation

Delineation of discrete reservoirs is essential in the development of a petroleum field. This may be especially complex in offshore situations where numerous wells deviate from one or more platforms. An offshore field in southern California is an example where reservoir delineation was needed prior to designing a secondary flooding program.

A data base, containing directional survey data and measured depths of stratigraphic horizons, was used to generate structural cross sections at user-defined planes. These cross sections aided in the structural interpretation by outlining the plunging anticline, identifying faults, and revealing the variability in zone thicknesses.

Digital well-log data were used by the Stacked Curves System to assist in the stratigraphic interpretation. Color stratigraphic cross sections were generated on a zone-by-zone basis to compensate for the changing locations of the deviated boreholes. Lithology and porosity variations were easily determined from the color cross sections.

Merging the information obtained from structural and stratigraphic cross sections provided a detailed geologic picture of the field allowing the strategic location for injection wells.

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Sedimentology and Petroleum Geology, Spirit River Formation (Lower Cretaceous), Deep Basin, Alberta

The Spirit River Formation is subdivided into three members in northwest Alberta. The basal Wilrich Member consists of two 50 to 100-m thick upward-coarsening cycles of marine shales, siltstones, and sandstones. The Falher Member consists of nonmarine clastics and coals in the southern part of the area. Around the Elmworth gas fields, it is composed of five transgressive and regressive cycles in which marine and nonmarine conditions alternated. Each cycle can be traced northward into a laterally extensive upward-coarsening marine cycle.

The gas reservoirs are complexly interbedded fine conglomerates and sandstones. Conglomerates interpreted as fluvial deposits have sharp bases, moderate to poor sorting, some cross-bedding, and variable amounts of sandy matrix. Those interpreted as beach deposits are moderate to well-sorted, horizontally bedded, and may lack matrix entirely. A complete gradation exists between the types, which are closely interbedded. Shoreface and beach sandstones are fine grained, well sorted, burrowed, and have near horizontal laminations and truncation surfaces. On a large scale, this shore-zone complex is best considered a wave-dominated delta. The Notikewin Member is the final seaward progradation of this system.

Most sandstones in the Falher have less than 6% porosity and 1 md permeability whereas the reservoirs may have 20% porosity, much of which is secondary, and several darcys permeability. Early cementation, then formation of secondary porosity in the delta complex followed by deep gas generation have created a combined stratigraphic-diagenetic trap.

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Depositional Environments in Lower Cretaceous Gates Member, Northeastern British Columbia

The Lower Cretaceous Gates Member, which outcrops in the Rocky Mountain Foothills of northeastern British Columbia, consists of approximately 300 m of marine and nonmarine clastic sediments. The lower unit consists of several coarsening-upward marine cycles, which thicken and increase to the north. Thin coal seams at the top of some of these cycles thicken to the south and pinch out northward. Sediments in the middle unit of the Gates were deposited in a nonmarine environment and include several thick coal seams which are economically important. Fluvial sandstones and conglomerates in this interval were deposited in rivers which flowed in general to the north, subparallel to the tectonic strike and into a paleocoastline which was trending approximately east-west. Three major fluvial conglomerates are recognized and are interpreted as indicating three pulses of tectonic activity in the source area to the southwest. During the deposition of the upper unit of the Gates, a marine transgression occurred which reworked part of the underlying section and deposited locally a thin marine lag conglomerate. The overlying marine sandstones were deposited in a marine shelf and tidally influenced coastal environment. Coastal sand bodies include fining-up subaqueous channel deposits which grade laterally into coarsening-up sandstone units interpreted as marine shoals. The orientation of these sand bodies is at right angles to the paleocoastline.

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Depositional Environments of Ratcliffe Interval, Mississippian Madison Group, Williston Basin, North Dakota