Lithologic and Diagenetic Controls of Reservoir Properties, Devonian Frisco Limestone, Hunton Group, Oklahoma

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Abstract

Devonian carbonate mounds in the Frisco Limestone are important oil- and gas-bearing reservoirs in a number of oil and gas fields producing from the Hunton Group in Oklahoma. These reservoirs, which were typically called Bois d' Arc and produced large volumes of petroleum, are now known to be Frisco Limestone. In this study, the lone Frisco Formation outcrop in Pontotoc County, Oklahoma and several cores of the Frisco from producing oil and gas fields were analyzed to establish mound lithofacies and determine the post-depositional modifications that influenced reservoir and seal formation. The preservation and evolution of porosity in mound rocks was controlled by depositional facies. Bryozoan content strongly influenced diagenesis of Frisco limestones. Packstones and grainstones containing more than 25% bryozoan fragments evolved into reservoirs, whereas pelmatozoan-rich grainstones with <20% bryozoan grains were cemented by early syntaxial calcite cement to become intraformational seals. Primary porosity preserved in the zooecia of bryozoa provided conduits for corrosive fluids to dissolve grains and generate moldic pores. Facies within and proximal to the Frisco mound complexes include (1) mud-rich bafflestone within mound-core regions, (2) thinly interbedded skeletal packstones/grainstones and wackestones of flanking facies and (3) capping grainstone formed across the tops of mounds. Porosity preferentially developed in bryozoan-rich beds in flanking facies containing lesser amounts of carbonate mud. These beds are recognized on wireline log by higher porosity values, filtercake accumulation and microresistivity separation. Intervening calcite-cemented pelmatozoan-rich beds exhibit lower porosity and fail to show positive microresistivity separation indicative of permeable zones. High volume oil production from the Hunton Group in Fitts Pool is closely tied to thickness of porous Frisco facies above the oil-water contact. High-volume productivity does not occur where the Frisco is absent and the Woodford Shale rests on older units. The vertical variability in porosity and permeability evident in core and wireline log surveys should be considered when planning boreholes to produce these heterogeneous carbonate reservoirs.