LEACHED POROSITY IN OVERPRESSURED SANDSTONES—FRIO FORMATION (OLIGOCENE), SOUTH TEXAS

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Secondary porosity has been developed in overpressured sandstone reservoirs of the Frio Formation at depths ranging from 9,000 to 14,000 feet. Frio sandstones in Hidalgo, Willacy, and Nueces counties were deposited in deltaic and marginal strike system environemnts. Sandstones in the high-sand facies are fine grained, moderately well sorted, low in quartz, rich in feldspar, and volcanic rock fragments.

Frio reservoirs have gone through stages of cementation, leaching, and recementation. Early cementation occurred within the normally pressured zone. During burial under normal fluid pressure conditions the sands were cemented initially by quartz and later by sparry calcite which also replaced feldspars. Precipitation of these early cements prevented further compaction and probably reduced primary porosity to less than 5 percent and permeability to several millidarcies or less. At greater depths of burial and within the overpressured zone, calcite was leached and secondary porosity created. Retainment of high fluid pressures prevented subsequent compaction, resulting in porosities greater than 30 percent and permeabilities up to several hundred millidarcies at depths of 10,000 feet and greater. A stage of recementation occurred after the leaching, involving the precipitation of ferroan calcite, dolomite, ferroan dolomite, analcime, and kaolinite. Where recementation has been extensive, secondary porosity has been substantially reduced, and permeability has decreased by an order of magnitude.

The complexity of subsurface diagenesis in the Frio Formation is due to the mineralogical immaturity of the sandstones, increased temperatures and pressures at greater depths, and changes in the fluid chemistry and reservoir hydrodynamics in overpressured zones. Thus, in mineralogically immature sandstones, reservoir quality is dependent not only on the primary intergranular porosity remaining after compaction and early cementation, but also on complex late diagenetic reactions involving replacement and leaching of grains and cement.

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