Sea Level and Diagenetic Controls on Dolomite Reservoir Compartmentalization: Evidence from the Niagaran Racine Formation of the Sangamon Arch, West-Central Illinois

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Several prolific dolomite petroleum reservoirs occur in the upper part of the Racine Formation (Silurian) in the southeastern part of the Sangamon Arch. The reservoirs are characterized by a porous dolomitized lime mudstone to grainstone and reef/reef rudstone facies. The reservoir rocks contain partially dolomitized echinoderm fragments and molds of crinoids, brachiopods and corals, suggesting deposition in a normal shallow marine environment. The dolomite reservoirs are generally interlayered with laterally extensive, impermeable limestone beds displaying cyclic reservoir- non-reservoir packages. They formed during sea level highstand and constitute the upper parts of 4^{th}- to 5^{th}-order transgressive-regressive cycles, suggesting sea level fluctuations and percolating seawater as the primary controls for early dolomitization of the compartmentalized Silurian reservoirs.

Dolomitization was probably caused by reflux of normal to slightly evaporated sea water in an inner ramp setting. The initial porous ramp margin and the adjacent open marine facies acted as conduits for the dolomitizing fluid. Dolomitization took place mainly during the regressive phase of a depositional cycle when vast quantities of sea water could have circulated through sediments over a long period, thus, overcoming the kinetic barriers to dolomitization. This interpretation is supported by: (1) gradual loss of porosity laterally; (2) the sharp upper contacts and gradational lower contacts of the reservoir bodies, and (3) resistance of the early-formed dolomite to chemical compaction during burial diagenesis, thus preserving the early original porosity. Reservoir porosity enhancement also occurred during prolonged subaerial exposure at the sequence boundaries. This proposed dolomitization model, tied to sea level fluctuations and paleoenvironments, provides an important predictive tool for petroleum exploration.