

Silurian Pinnacle Reefs, Michigan Basin

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A detailed sequence stratigraphic analysis of Silurian (Niagaran) reefs in the Michigan Basin provides insight into the lateral and vertical variability of reservoir facies observed in the subsurface. In depth core analysis tied to wireline logs show that reefs consist of at least two orders of cyclicity. This sequence hierarchy is manifested by large order sequences (10's of meters thick) controlled by globally recognized sea level changes, and thinner cycles (few meters thick) driven by relative sea level variations. Local changes in relative sea level are likely controlled by the combination of higher frequency eustatic variations along with subsidence and autocyclic mechanisms related to reef growth. The higher frequency cyclicity plays a major role in controlling the vertical heterogeneity of these reservoirs. For example, skeletal grainstones exhibit porosity and permeability values depending upon their position within the higher frequency cycles. Grainstones deposited during transgressive phases retain higher porosity and permeability values relative to those deposited in regressive phases due to preferential cementation and porosity occlusion that occurs at or near cycle boundaries. In contrast, higher porosity and permeability values occur in the regressive intervals of the framework reef in response to exposure related preferential dissolution and porosity enhancement, although in some reefs this porosity may be rapidly occluded by deposition of overlying evaporites. Understanding of the sequence hierarchy in these Silurian reefs provides additional insight into the episodic growth of the reefs relative to sea level fluctuations, and provides a means to better explain, and thus predict, the vertical heterogeneity observed in reservoirs.