Stratigraphic Controls on Diagenesis and Reservoir Quality in a Saline Reservoir Geological Carbon Sequestration Target: the Middle Ordovician St. Peter Sandstone, Michigan Basin, USA.

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The Middle Ordovician St. Peter Sandstone is present throughout much of the North American mid-continent and is represented in the Michigan basin subsurface by up to 1,200 ft of shallow marine, dominantly coarse-grained, sandy clastics. Saline reservoir, geological carbon sequestration potential in the St. Peter is supported by significant hydrocarbon production in over 80 fields in Michigan.

Three lithofacies are typically present in the Michigan subsurface. Although there is a general inverse relationship between burial depth and reservoir quality in the St. Peter, complex diagenetic alteration and reservoir quality due to mineral dissolution are templated by primary lithofacies and not strictly related to burial depth. Upper, quartzo-feldspathic, typically authigenic clay-rich lithofacies have moderate to good reservoir quality resulting from dissolution of primary and secondary minerals and ubiquitous secondary porosity. The middle and thickest lithofacies is very pure quartz sandstone, which retains little porosity due to abundant quartz cement and pressure solution at moderate burial depths.

Analysis of core and logs from the upper lithofacies in Northern Lower Michigan indicates that the upper St. Peter was deposited in shoreface to offshore shelf depositional environments near and below normal wave base in a storm influenced, epieric sea. Tempestite bedding is the norm in intensely burrowed, normally graded, and scour based sandstone to silty-micritic mudstone hemicycles. Noteworthy in core are thin shale beds that directly overlie sandstone at sharp contacts. These surfaces are useful for intra-regional correlation and are interpreted as marine flooding surfaces.

Petrographic observations indicate that strata adjacent to flooding surfaces experienced early, carbonate and phosphate, sea floor cementation. These marine hard grounds may have formed due to prolonged residence at the sediment–water interface during periods of slow sediment accumulation rates associated with the marine flooding events. The significance of early, carbonate and phosphatic cements is that these cements preserve intergranular pore volume through the zone of quartz burial diagenesis. Subsequent dissolution of these intergranular cements is a major mechanism for the formation of reservoir quality in the St. Peter Sandstone in the Michigan basin.