Controls on Dolomitization of the Upper Ordovician Trenton Limestone in South-Central Kentucky

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The Late Middle Ordovician Trenton Limestone is a highly productive carbonate hydrocarbon reservoir across the eastern United States. Enhanced secondary porosity and permeability within the Trenton Limestone generated by hydrothermal dolomitization (HTD) in Michigan and New York have allowed for extensive hydrocarbon reservoirs to be developed. In these areas, carbonate facies assemblages have been shown to significantly control the distribution of diagenetic alterations and influence the geometry and lateral continuity of reservoir-grade porosity and permeability. South-central Kentucky provides an exploratory region for post-depositional hydrothermal alteration due to its vicinity to the Appalachian-forming orogenic tectonism. This study tests the hypothesis that HTD within the Trenton Limestone of Kentucky may be more extensive in facies that exhibit high primary permeabilities and tests the hypothesis that HTD has influenced historically productive fields of south-central Kentucky.

Results from outcrop analyses indicate that HTD is preferential to relatively low-porosity packstones with interbedded shales that overlie low-porosity wackestones. Altered zones exhibit significant vuggy and interparticle porosity with distinct streaks of HTD extending laterally into the unaltered host packstones. Cores from south-central Kentucky exhibit variable HTD in the form of saddle dolomite filling large isolated vugs. Host facies are primarily moderate to thinly bedded skeletal packstones that directly underlay wackestones or shales. Petrographical analysis with the use of Alizarin red S, blue-dyed epoxy, and Potassium-Ferricyanide allows for the development of detailed facies descriptions and for the determination of HTD extent through matrix-replacive dolomite on outcrop and in core samples. Observed cores display poorly developed matrix-replacive HTD with more prevalent large, isolated vugs of saddle dolomite yielding poorly developed secondary permeabilities.

Investigation of fluid inclusion freeze-thaw and stable isotope analyses allow for the determination of the nature and extent of HTD occurrences. Comparisons to previous publications through northern portions of the Appalachian and Michigan Basins allow for conclusions of approximate timing and sources of dolomitization to be developed and compared. Results of the analysis may provide a new predictive tool to be utilized for hydrocarbon exploration through the southern Appalachian foreland.