Prediction of Petrophysical Properties of Trenton-Black River (Ordovician) Reservoirs by Comparing Pore Architecture and Permeability to Sonic Velocity

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Reservoir characterization of carbonate rocks is complicated by heterogeneous pore architecture related to primary depositional facies and subsequent diagenesis; this is especially true in diagenetically-altered and structurally-influenced Trenton-Black River reservoirs of the Michigan Basin. Accurate and reliable prediction of reservoir properties within hydrothermal dolomite (HTD) reservoirs through the use of acoustic properties would significantly aid exploration and reservoir characterization efforts in HTD reservoirs both within and outside of the Michigan Basin.

Results indicate that digital image analysis of thin sections and laboratory measures of sonic velocity both quantify pore architecture of carbonate rocks. Integration of measures of pore architecture and physical properties into multiple variable linear regression can accurately predict permeability of core plugs. Additionally, use of minipermeametry and comparison of core plug and whole core measures of porosity and permeability indicate that Trenton-Black River textures are petrophysically heterogeneous from the millimeter to meter scale. This is due to the influence of bioturbation on primary depositional textures and their subsequent diagenetic pathways as well as facies stacking patterns within a 1-D sequence stratigraphic framework.

Integrating modern borehole measures of physical properties and measures of pore architecture derived from cuttings data may increase the predictability of permeability within hydrothermal dolomite reservoirs over log data alone. Care must be taken when upscaling petrophysical measurements from core plugs to reservoir flow units in highly-heterogeneous carbonate reservoirs.