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Facies-Based Rock Typing in Complex Carbonates

Moustafa Dernaika[1]

[1]Ingrain Inc.

ABSTRACT

The complexity of carbonate reservoirs necessitates having a consistent approach in defining rock types. Core data on a rock-type basis is required as input for modelling reservoir flow performance and saturation distribution. The objective of this study is to evaluate carbonate rock types based on four main parameters: porosity (type), permeability, capillary pressure and textural facies.

Over 1000 core plugs were studied from 10 different carbonate reservoirs across the Middle East region. The plugs were carefully selected to represent main property variations in the cored intervals. The data set available included laboratory-measured helium porosity, gas permeability, thin-sections and high-pressure mercury injection. Plug-scale X-ray CT imaging was acquired to ensure the samples were free of induced fractures and other anomalies that can affect the permeability measurements. Rock textural facies were analyzed in the thin-section photomicrographs and were classified based on their content as grainy, muddy and mixed. Special attention was given to the diagenesis effects mainly compaction, cementation and dissolution. Porosity was defined as interparticle, intercrystalline, moldic, intraparticle or vuggy.

The texture information was plotted in the porosity-permeability domain, and was found to produce three distinct porosity-permeability relationships. Each texture gave unique porosity-permeability trend. Rock types were defined along the porosity-permeability trends, and showed strong link to the capillary pressure (Pc) and pore-throat size distribution (PTSD) curves. For each porosity-permeability trend, the rock types were distinguished by porosity and pore-throat size ranges.

A new rock typing approach is presented in this research study. Carbonate rock types were successfully classified based on rock porosity, permeability, capillarity and textural facies. Conclusive porosity-permeability relationships were obtained from textural rock properties, which were linked to rock types using Pc and PTSD curves. The texture-based rock types provided more insight into the effects of geology on fluid flow and saturation. Geological textures/facies can be derived along cored intervals, which give upscaling options for permeability and rock types in the reservoir.