

The Role of Sedimentary Fabric for Rock Typing and Model Upscaling in Carbonate Reservoirs

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Hydrocarbon storage and flow through the matrix of carbonate reservoirs is fundamentally influenced by variations in pore types on a scale much below that of normal static and dynamic reservoir models. Commonly this heterogeneity occurs on a millimeter to centimeter scale and relates to the sedimentary fabric of the reservoir rock accentuated by its diagenetic overprint. This heterogeneity scale is often the cause for data clouds in facies based assessments introducing considerable ambiguity in data classes and model building. With the goal of building reservoir-size dynamic models this also constitutes a significant upscaling problem for static and dynamic properties.

Heterogeneities must be understood in their architecture (the piping system) and quantified in terms of porosity, permeability and dynamic properties. A strategy must be at hand that allows small and intermediate heterogeneities to be represented in larger sized simulation models to better understand reservoir flow and recovery. An approach is presented to define and model heterogeneities hierarchically. Small scales heterogeneities are captured and simulated in dedicated "mini-models" (< 1 m³ in size) which provide pseudo properties for larger volume cells in reservoir size models.

Principle Rock Types (PRT's) are the fundamental building blocks of the matrix system. They cover and categorize the full range of pore types, sizes, pore-throat size distributions, capillary entry pressures and relative permeability characteristics. PRT's are organised into Rock-Type Associations (RTA's) based on sedimentary fabric (bioturbation, cross-bedding, layering, etc.). The construction of mini-models can be based on conceptual considerations or driven by high resolution log data such as image logs. The distribution of RTA's in the reservoir in turn is driven vertically by depositional cyclicity and laterally by facies dimensionalities. Key tools to distribute RTA's in the larger reservoir models are seismic, image logs and analogue data, which provide control on both fabric and property heterogeneity.

The concept is illustrated using examples and data from some giant reservoirs of the Middle East.