

Key techniques for carbonate reservoir modeling: Examples from the Permian, Williston, and Wind River Basins, USA

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Five techniques from diverse carbonate reservoir models are presented. 1) Facies distributions guided by proportion curves are critical for imposing stratigraphic trends on geostatistical distributions of both pay and non-pay facies. 2) Matrix permeability estimation using facies-based “cloud transforms” preserves the realistic phi-k cloud shapes of most carbonate facies, while still honoring the concept of changes in slope for different rock fabric classes. This approach conserves the highs and lows within a facies’ permeability distribution—often more critical for fluid flow modeling than the mean... Additionally, the shape of the transform provides feedback on up-scaling—if the cloud collapses toward a simple regression line there is a risk that up-scaling may have eliminated critical model heterogeneities. 3) When deriving aerial domains for fracture permeability multipliers we integrate curvature analysis derived in three ways: curvature (usually kmax) based on model grids; highly smoothed model grids reanalyzed for long-wavelength curvature; and discrete curvature classes. 4) Ideally seismic attributes such as impedance can be directly input to geomodels as “hard” constraints on reservoir porosity; in practice, softer seismic constraints are frequently more appropriate. In thin, high lateral continuity carbonate reservoir intervals below direct seismic resolution we apply a pseudo-stochastic inversion technique that melds low vertical (but high aerial) resolution inverted impedance trends with high vertical log resolution. 5) We routinely use net pay vertical proportion curves as efficient up-scaling guides. Proportion curves contrast vertical intervals most important for fine vertical cell preservation with other intervals where more aggressive up-scaling can be applied.
