A New Workflow of Modeling Sub-Seismic Reservoir Heterogeneities to Improve Production Forecasting

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In a conventional reservoir modelling workflow, only absolute permeability is modelled at the geocellular grid scale. The underlying assumption is that permeability is isotropic at the scale equivalent to the cell size (> ~25 × 25 × 0.5 m^3), which is far from true for most reservoirs. This "isotropic permeability" assumption ignores the impact of geologic features with dimension less than the geocellular cell size on fluid flow. This omission can result in a difference in the production rate prediction of up to 20%. To reduce uncertainties in predicting reservoir performance and production profiles, we have developed a new workflow to derive directional permeability from sub-seismic heterogeneity models.

This study demonstrates a two-step workflow used to deriving directional permeability from sub-seismic heterogeneity models. The first step applies a geologic process-oriented methodology to capture high resolution heterogeneity in models with dimension less than the cell size of geocellular grid. A library of sub-seismic heterogeneity models were created with different bedforms, bioturbations, mud drapes, and features indicative of inclined heterolithic stratification. Property statistics at lamina or even smaller scale were used as input to these high resolution models. The second step in the workflow involved fluid flow-based upscaling of each high-resolution property model to the next scale in the geologic model.

Both synthetic and real-world examples in heterolithic reservoirs are used to illustrate the workflow of deriving directional permeability from sub-seismic heterogeneity models. The results demonstrated a 10-20% improvement in predicting recoverable reserves by including directional permeability derived from sub-seismic heterogeneity models compared with conventional models that assumes isotropic permeability at the geocellular grid scale.