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Quantification of Model Uncertainty by Automated Calibration of Dynamic Models to Multiple Geostatistical Realizations

Determining static model uncertainty from dynamic models is one of the major challenges facing geoscientists. Typically, uncertainty determination is done through one of two approaches. One involves dynamic modeling of multiple geo-statistical representations with single sets of porosity permeability transforms and relative permeability relations and selecting the realizations that best fit historical performance. Another involves dynamic calibration of a deterministic model with varying absolute and relative permeability relationships and then making appropriate adjustment in the deterministic model to match performance.

A much larger range of possibilities and a better estimate of uncertainties can be made if a combination of approaches is used, i.e. where geological and absolute and relative permeability uncertainties are simultaneously incorporated in the dynamic modeling process. This approach is facilitated by partially automating the dynamic model calibration of several geostatistical realizations. This calibration involves regression on absolute and relative permeability parameters to fit a historical production profile.

This approach is illustrated on a fluvial-deltaic system in the eastern part of Venezuela. Nine geostatistical realizations composed of 2.6 million cells each were generated, based on the expected range of structural interpretations and static parameters. . These realizations were then upscaled to 90,000 cell models and history matched in parallel.

The automated history matching procedure involved the determination of the gradient sensitivity for key absolute and relative permeability parameters. The regression on the most sensitive and independent of these was used to obtain a minimum of the objective function. The realizations that resulted in the best matches of field pressure and water production were each used to produce forecasts. The difference in the forecasts defined an estimate of uncertainty for various field development options.