

Selection of Geological Models for Uncertainty Assessment with a Novel Streamline Approach

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Exploration and appraisal efforts are progressively migrating to deeper and more poorly understood reservoir systems. Costs to assess commerciality alone can be extremely high. Consequently, the uncertainty space of geological features impacting in-place hydrocarbons and reservoir performance must be thoroughly evaluated for sound investment decisions.

Limited numbers of wells may be the only data source for pre-test reservoir characterization if seismic is of little use in mapping rock properties and architecture. The extremely small volume sampled by wells emphasizes the need to thoroughly investigate uncertainty distributions of reservoir properties. Numerous models may be required to fully capture geological uncertainty affecting economic evaluation. Available tools permit efficient batch running of many models once uncertainty ranges for input variables are established.

Our approach to dynamic ranking involves use of streamline simulation to characterize the spectrum of geological conditions influencing flow behavior. The simulations are simple single phase cases requiring minimal resources. Analysis of streamline data are performed with proprietary code. Results of the analysis include storage capacity, flow capacity, and sweep efficiency vs. time for each model. Furthermore, a Lorenz coefficient (a standard measure of heterogeneity under dynamic conditions) is determined for each geological scenario. Models are ranked by the Lorenz coefficient, so that realistic distributions are included in economic uncertainty analysis.

Results are conditional to injector-producer schemes, net-to-gross, depositional architecture, facies relations, and permeability-porosity structure. Consequently, a reasonable conceptual understanding of local depositional and diagenetic settings is necessary. Sensitivity of results to conditioning information is useful in discerning relative contributions of inputs and, if necessary, tuning the workflow.

We consider ranking the dynamic behavior of geological models as a recommended practice. Straightforward workflows provide effective distillation of large numbers of earth models to a select few for detailed flow simulation. Time consuming model recycling between simulation engineers and earth modelers is substantially reduced as well due to embedded quality control and a priori knowledge of flow characteristics.