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Big LoopTM - An Innovative Approach To Ensure Consistency Between Static And Dynamic Models For Reliable Reservoir Predictions

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ABSTRACT

Investment decisions in E & P companies depend a lot on forecasting recoverable reserves - one of the key outputs of a reservoir model. Hence it is vital to integrate and ensure consistency in reservoir models across all domains - petrophysical, geological, geophysical and reservoir engineering.

Inconsistency in reservoir models exists due to embedded uncertainties at every stage of the reservoir characterization process. Therefore, the simulation model can end up with local modifications of the geology and a large number of multipliers. Eventually the simulation model loses consistency with the original reservoir model used for reserve estimation with a negative impact on reservoir forecasting and investment decisions.

The BIG LOOP workflow that will be introduced in this paper produces geologically consistent history matched ensembles that lead to optimized production ranges for better returns on investment. The automated workflow enables the modeler to capture and quantify uncertainties at every stage of the static model and propagate uncertainties to the dynamic model. The result is multiple history match ensembles for reliable forecasting.

In this paper, the big loop workflow has been applied to a test project duplicating the modeling workflows followed in a real world project. The reference is a clastic reservoir dominated by a fluvial channels depositional system in an extensional regime.

The following static uncertainties were considered for the study: i) Structure; ii) Facies Volume fractions and width, thickness, and azimuth of the channel facies in relation to connectivity; iii) Petrophysical properties – net sand and porosity; and iv) Kv/Kh ratio. The dataset had additional dynamic uncertainties related to i) Fault transmissibility; and ii) Relative permeability end points for water.

As part of the workflow, uncertainty ranges and prior distributions are defined for both static and dynamic domains, creating a multi-dimensional solution space.

After defining uncertainty modifiers, the model’s validity can be analyzed by comparing scoping run results with the observed history data and investigating if the scoping run bracket the history and whether the trends of the simulator responses are similar to the observations (or not).

After completing the validation process, the history match criteria within allowable tolerances were specified and refinement runs launched in batches. As more and more refinement runs are submitted, the proxy model gets updated and gradually improved until multiple good history match cases were achieved that are geologically consistent and have different facies distributions. The Big Loop workflow will then integrate the effect of these acceptable facies models on future field performance and optimization.

The paper will conclude that the Big Loop workflow can play a key role in capturing and using reservoir uncertainties as input parameters to the reservoir simulator, thereby generating a better understanding of the reservoir model, more reliable estimations of reserves, and better informed investment decisions.