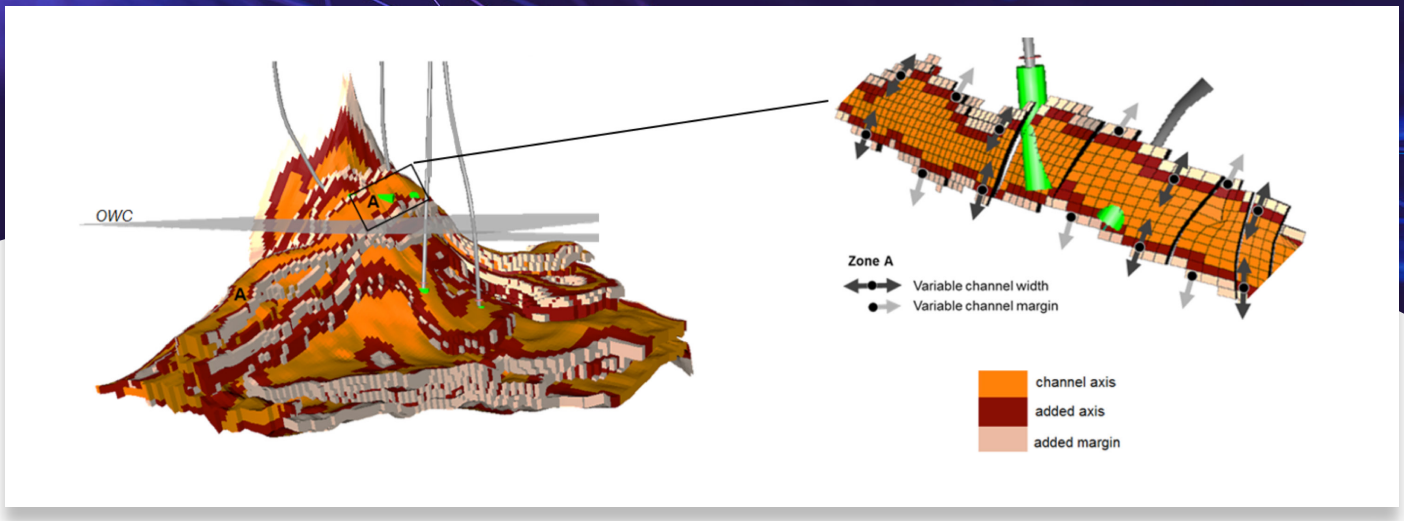
Resoptima

Ensemble Based Reservoir Modeling



Complex channelized two million cell reservoir model, Courtesy of Eni

Creating consistent geological models with a solution that integrates geological and engineering understanding

Objective

Model and history match (HM) a complex turbidite reservoir with large uncertainties in faulting and channeling

Solution

Implementation of an interdisciplinary modeling workflow to create an ensemble of matched models using ResX

Outcomes

Reliable reservoir models that offer geologically consistent explanations of static and dynamic data where uncertainty is quantified in the forecast and model parameters

History Matching Challenges

Typical challenges in traditional reservoir modeling and history matching include:

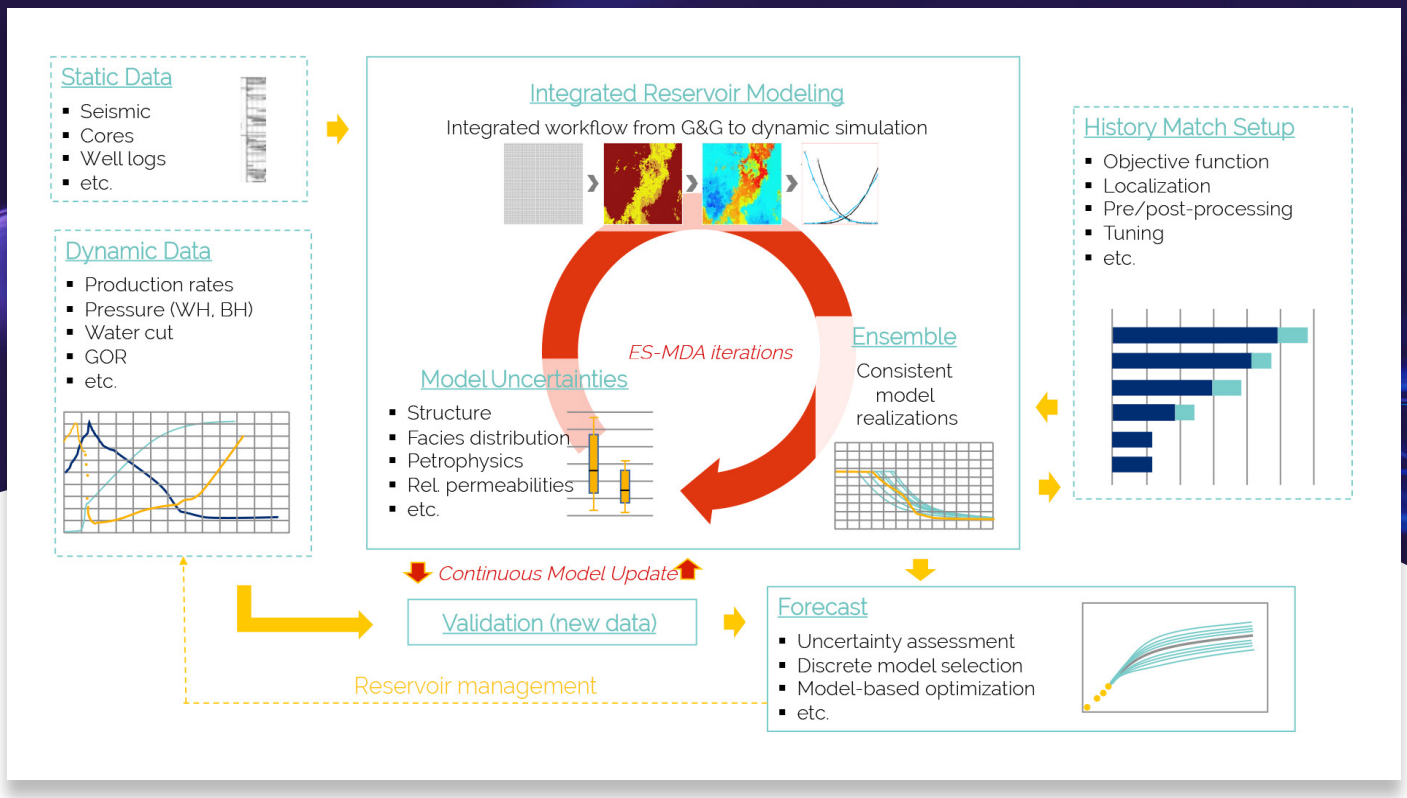
- Intensive, often manual, iterations
- Consistent integration of G&G and engineering understanding
- Capturing and propagating uncertainty
- Multiple, equally likely solutions
- Updating model(s) with new data

The way in which these challenges are approached can directly affect the commercial outcome of projects. As a result, there are a wide variety of approaches in methodology and asset team workflows.

The trial-and-error HM method continues to be prevalent in most projects, but alongside this there is increasing use of more automated techniques such as design of experiments or adjoint-based approaches. These methods explore larger solution spaces, but they are still constrained by practical or algorithmic constraints which limit the number of uncertainty parameters.

Ensemble Based Modeling

The Ensemble Kalman based method makes it possible to generate multiple matched models using any size of parameterization. It is an efficient solution when it is tied in with an appropriate reservoir modeling approach, suitable parameterization, and repeatable workflows. For Eni's complex reservoir, ResX's integrated methodology made it possible to retain the necessary geological consistency.



Conceptual representation of the ensemble based integrated workflow.

Solution Highlights

- 100 equally probable reservoir models were created that consistently honor the current measurements of both static and dynamic data, while capturing and propagating the uncertainty in the modeling and data assimilation process.
- ResX was integrated into five workflows covering the entire reservoir modeling process including: 1) reservoir modeling; 2) ensemble generation; 3) data assimilation; 4) validation; 5) forecast (see figure above).
- The reservoir modeling workflow consists of three main processes: structural modeling and gridding, facies modeling, and petrophysical modeling.
- The chosen parameterization includes both scalar variables and 3D grid properties, for a total of almost 10 million parameters.
- The approach ensured geological consistency and workflow repeatability in the reservoir modeling and data assimilation process.
- The repeatability makes it possible to easily integrate new static and dynamic data and to re-parametrize the model when the match quality is unsatisfactory.
- Through the analysis of the updated model properties, new reservoir insights were identified including flow barriers in certain areas and in-place volume constraints.

For more details check out SPE 186049

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