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Dynamic Validation of a Multi-Point Statistics Model using Extended Well Test Data

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SUMMARY

In Field A, an extended well test carried out over 5 months was used to validate 5 facies models generated with Multi-Point Statistics, each declined into a set of petrophysical models.

The geological context of Field A is that of low NTG fluvial deposits which include channel and bar sandstones, alluvial splay siltstones and flood plain shales. Sparse static conditioning data, limited spatial information and naturally complex 3-D channel networks imply that various models can be equi-probable. Multipoint statistics (MPS) approaches were used to model sedimentary bodies in order to ensure the consistency between the model and the geological understanding.

Simulation of the conditioned MPS models enabled to reproduce a set of extended well test responses and hence compare the dynamic behaviour of the models against that of the reservoir. Successive comparisons enabled to extract 2 MPS models which matched respectively the early and late time well test data. To obtain a better match over the whole well test data, an engineering-based hybridisation algorithm was used to combine the 2 better-fit models. The successful implementation of this algorithm resulted in promising results and enabled to obtain a quality match with the real well test data.

Ensuring the dynamic coherency of geological models generated with multi-point statistics methods can be conducted *a priori* by inputting a 3D mini-block extracted from a training image for which both facies and connectivity between wells are honoured (Ronot C. *et al*, 2012), and/or *a posteriori* by dynamically simulating the models and comparing the result with well test data. In Field A, an extended well test carried out over 5 months was used to validate 5 facies models. Each of them was declined into a set of petrophysical models.

The geological context of Field A is that of low NTG fluvial deposits which include channel and bar sandstones, alluvial splay siltstones and flood plain shales. Sparse static conditioning data, limited spatial information and naturally complex 3-D channel networks imply that various models can be equi-probable. The difficulty lies in selecting the most consistent reservoir models to produce reliable production profiles. Multipoint statistics (MPS) approaches were used to model Field A sedimentary bodies in order to ensure the consistency between the model and the geological understanding. These methods can better preserve the spatial connectivity of the reservoir facies. In contrast to conventional two-point statistics, the multiple-point statistics are based on training images which represent the spatial relation of the reservoir facies as built from an analogue and/or derived from geological concept. The analogue can be a satellite image, seismic map, or an outcrop analogue. 3D training images were built based on modern analogues along the Parana and Magdalena rivers in South America (example of one training image in figure1).

Simulation of the conditioned MPS models enabled to reproduce a set of extended well test responses and hence compare the dynamic behaviour of the models against that of the reservoir. Petrophysical parameters (porosity, permeability) were modeled using a sequential gaussian simulation approach and various hypotheses on variograms and on sandstones porosity-permeability transforms. Successive comparisons enabled to extract 2 MPS models which matched respectively the early and late time well test data. To obtain a better match over the whole well test data, an engineering-based hybridisation algorithm was used to combine the 2 better-fit models. The successful implementation of this algorithm resulted in promising results and enabled to obtain a quality match with the real well test data (figure 2). Only a few MPS models and hybridization attempts were necessary to develop a reservoir model fully coherent with all available observations. Effective integration of geology and dynamic data using modern methods can lead to better reservoir characterization and modelling. In a broader sense, this workflow can be named a “geoengineering” workflow (Corbett, 2009) as it integrates the available dynamic and static data within a unified geological framework.

Figure 1: A layer-wised 3-D training image for one of the reservoir units. The training image has 180×205×3 cells.

Figure 2. The final match obtained using the hybridization algorithm.

References:

Corbett, P.W.M. [2009] Petroleum Geoengineering: Integration of Static and Dynamic Models, *EAGE/SEG*, 90 p.

Ronot C., Ruelland P., Wirbel E., Laugier F. and Biver P. [2012] A Pre-processing Workflow for Multi-Point Statistics Modelling involving Training Image Construction and Well Validation, *presented at EAGE St Petersburg conference 2012*.