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# Advances and Future Trends in Geomodeling Techniques to Populate Facies and Petrophysical Properties

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## Introduction

In the last two decades several advances in the world of geomodeling have taken place, several new advanced methods were developed to populate facies and petrophysical properties. In this abstract two techniques will be discussed that have been developed and implemented within ConocoPhillips to better represent and more accurate model facies and petrophysical properties. The described techniques are examples of data integration, especially data at different scales.

## Methods

The first technique discussed is the Bayesian updating techniques which consist of combining multiple attributes at various scales. There are many geometric, kinematic, mechanical, geomechanical, petrophysical, sedimentary, geological and geophysical attributes that correlate parameters, typically only the attribute with the highest absolute value correlation is chosen to be carried forward to influence prediction. A common technique used is co-simulation to create the resulted predicted parameter using a single correlation coefficient. A geostatistical Bayesian Updating approach is employed that quantitatively accounts for multiple important attributes together impacting the prediction. The resulting models are more representative of the true geological complexity.

Bayesian Updating is a statistical theory relating conditional probabilities through multivariate correlations. In considering the prediction of a primary event A with several secondary events (B, C, …, N), Bayesian Updating provides the conditional probability of A given events (B, C, …, N). This is done by combining (B, C, …, N) into a likelihood that updates A. Inside ConocoPhillips a Bayesian Updating Petrel plug-in is developed to quantify the relationships and update the models. This has been successful deployed to populate fracture intensity, as well populate permeability.

The second technique discussed is a Multipoint simulation method with an existing reservoir model as training image. The multipoint simulation (MPS) method has been increasingly used to describe complex geological features of petroleum reservoirs. This method is based on multipoint statistics from training images that represent geological patterns of the reservoir heterogeneity. However, the traditional MPS algorithm requires the training images to be stationary in space, although the spatial distribution of geological patterns/features is usually non-stationary. Building geologically realistic but statistically stationary training images is somehow contradictory for reservoir modelers. In recent research work on MPS, the concept of training image has been widely extended. The MPS approach is no longer restricted by the size or the stationarity of training images. A training image can be a small geometrical element or a full-field reservoir model.

We focus on the case where the training images comprise patterns that are non-stationary, in the sense that they are location dependent. These training images can be built by process-based, object-based or any other type of reservoir modeling approach. In general, they can be constrained by depositional environment, seismic data or other trend maps. However, it is often difficult to condition them to hard data from wells. We propose a new MPS algorithm that can use an existing model as training image and condition it to well data. This allows the MPS approach to represent geology more realistically.

## Examples

We will present both results of the Bayesian updating technique to better represent and predict fracture intensity, as well encouraging results of conditioning an existing reservoir model used as a training image.


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