Integrate more Geology in the Geostatistical Simulation of Reservoir Heterogeneity and Uncertainty Quantification, Examples from Incised Reservoirs

Renjun Wen

Geomodeling Research Corporation, T2P, 3E5, Calgary, Canada

e-mail: renjun@telusplanet.net. http://www.geomodeling.com

Abstract

Geostatistics is presented as a simple formalism for quantifying geology and a communication language between reservoir engineers and geologists. Stochastic simulation is illustrated as a powerful technique for uncertainty quantification in reservoir simulation. The talk will focus on real-world applications, rather than mathematical details and simulation algorithms. Pitfalls of using conventional geostatistical methods will be discussed.

The talk begins with a brief introduction to geostatistics, and then explains why geostatistics is getting more popular in petroleum industry and how it can contribute to reservoir heterogeneity modeling and uncertainty quantification in production forecasting.

Various 'new' geostatistical methods have been proposed in the last decade, but not all of them can be adapted to solving problems in reservoir management. A straightforward application of geostatistical software often results in unrealistic results, if the local geology and the needs of reservoir engineers are not properly considered. Petrophysical parameter, such as permeability and porosity, are controlled by geological heterogeneity, which can be modeled by stochastic methods. In terms of heterogeneity modeling, a hierarchy of geological heterogeneity at different scales should be explicitly included in geostatistical models. Each scale of heterogeneity requires a specific geostatistical model. This is exemplified by faulted fluvial reservoirs, where heterogeneity exists in various scales: from reservoir boundaries, fluvial channels, litho-facies within channels, cross-bedding structures, down to pore-space structures. But *which heterogeneity matter most*? This can be answered through sensitivity studies in combination with stochastic and reservoir engineering simulations. On the other hand, the up-scaling of permeability can be made for typical reservoir facies using results of stochastic simulations.

Nothing is certain in reservoirs. A smooth picture of reservoir properties provided by geologists to reservoir engineers will results in unrealistic prediction of reservoir production profile. Stochastic simulation techniques can generate a sequence of pictures of reservoir properties, each of which honor all available data from a reservoir. These simulated realizations can be used in reservoir simulators, so that a range of reservoir forecasting values can be obtained. Scenarios with a given probability of outcome can be calculated. These results should improve the decision making for reservoir management. Furthermore, uncertainty in the parameters used in the stochastic simulation should be addressed. Otherwise the uncertainty range of final results are often under-estimated.

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