Geological Modeling of Outcrop Successions to Assess Analog-Based Predictions of the Sedimentary Heterogeneity in Fluvial Reservoirs*

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Abstract

In the generation of static reservoir models, it is common to apply quantitative information derived from outcrop analogs, especially in techniques for well correlation and stochastic modeling. Sand-body well correlations can be guided by reference to ‘correlability’ models, which quantify the likelihood of correlation of sand-bodies across well arrays, based on analog sand-body width distributions. Pixel-based geostatistical simulations of reservoir architecture can be conditioned by indicator variograms that are parameterized using empirical relationships based on geologic properties, whereas object-based reservoir models are commonly constrained using analog data on the geometry of sedimentary units. Through application of such geostatistical techniques, analog information also enables the construction of training images for conditioning reservoir models based on multi-point statistics. This study applies these techniques to model large-scale fluvial architecture of extensively exposed outcrops of various successions, as constrained by data from outcrops of analog successions. A typical subsurface workflow has been replicated, the aim being to test the value and limitations of the methods mentioned above, and to assess the impact of analog choice in workflows involving their use. Vertical ‘dummy’ wells (minimum spacing = 50 m) were placed across outcrop architectural panels representing km-wide exposed sections; the intervening architecture was predicted by correlability models and geostatistical simulations, constrained on outcrop-analog data drawn from an architectural database (FAKTS). The relevant FAKTS output was filtered to obtain composite analogs that match with the outcrop successions being modeled in terms of key system parameters (e.g., river discharge regime) and architectural properties (e.g., net-to-gross ratio). The value of the predictive methods was assessed by quantifying the degree of match between forecasted and known outcrop architecture, in terms of channel-complex correlability and static connectivity. Comparisons of correlability and geostatistical models vs. outcrop observations highlight the effectiveness of the different methods and demonstrate the influence of well density on the confidence assigned to predictions. Results support modeling approaches based on the use of a varied range of analogs as a way to consider uncertainty in analog choice, and on alternative modeling methods to account for potential algorithm-related pitfalls.
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Case study 1: Blackhawk Formation (Campanian, Utah, USA)

FAKTS analog selection

Correlation analysis

SIS outcrop models

METHODS

OUTCROP vs MODELS COMPARISONS

ASSESSMENT OF GEOSTATISTICAL MODELS

ANALYSIS OF GEOSTATISTICAL PARAMETERS