Stratigraphic Surface-Based Modeling of Deep-Water Reservoirs: Application to an Ultra-Deep Gulf of Mexico Wilcox Asset

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Abstract

Stratigraphic heterogeneity in clastic reservoirs is mainly driven by the process-evolution of depositional systems; the collective stratigraphy being the result of deposition and erosion over time. While deepwater reservoirs are often high-net, recent studies have indicated that fine-scale heterogeneities such as hierarchical facies distributions, shale drapes, and high permeability streaks can impact reservoir performance predictions. Areas where seismic resolution can be low and well data is sparse, such as the Paleogene Wilcox reservoirs of the Gulf of Mexico (GOM), it is paramount to integrate subsurface data and outcrop analogs to appropriately characterize and model the reservoir heterogeneities that are crucial for constraining field development strategies and estimated ultimate recovery (EUR) forecasts. The issue of appropriately modeling multi-scale reservoir heterogeneity is addressed here using a process-mimicking (PM) approach to model the surface-based evolution of deep-water channels and fans and their associated multi-scale distribution of rock properties. The limitations of geostatistical approaches that require stationarity and volumetric importance of stratigraphic features are bypassed by representing heterogeneity through surface-based models. As a result, the models capture the fine-scale features that control connectivity. These methods were applied to a Wilcox asset located in >4000’ of water in northwest Keathley Canyon, GOM. The target intervals exhibit a shift from deposition in unconfined fans to weakly confined channels, to channel-levee environments, each with their own distinct and hierarchical heterogeneities (e.g., facies distribution, shale drapes). Well data were analyzed within depositional

context and calibrated to well-studied deep-water outcrop analogs. Quantitative outcrop and subsurface inputs were used to constrain the PM models and ensure that the heterogeneity observed in the wells was appropriately modeled away from well control. Analysis of these models reveals robust representations of deep-water heterogeneities and highlights the importance of surface-based approaches for capturing reservoir heterogeneity and forecasting performance.