Slope Heterogeneity of a Steep Upper Paleozoic Isolated Carbonate Platform Reservoir, Karachaganak Field, Kazakhstan

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Slopes that flank steep carbonate platforms are depositionally complex due to a spectrum of autochthonous and allochthonous deposit types that exhibit vertical and lateral variability. Karachaganak Field, northern Pricaspian Basin, Kazakhstan, is a reef-rimmed, Permo-Carboniferous isolated carbonate platform with a hydrocarbon column that resides primarily within steep foreslope strata. Historically, the distribution of reservoir properties at Karachaganak has been poorly understood owing in part to the depositional heterogeneity common in slope environments. These uncertainties were assessed by integrating seismic facies analysis, high-quality outcrop analogues, core, log data, and forward seismic models to produce a detailed depositional model of Karachaganak slopes that predicts compositional and architectural variability.

Seismic facies analysis with support from outcrop analogues and forward models reveals multiple styles of clinoforms, slope and basin sediment wedges, margin configurations, and secondary features (i.e. reentrants), each defined by reflector characteristics, such as continuity, intensity, and geometry. Seismic mapping of the abovementioned elements with corroboration from other subsurface data identifies heterogeneity at well, flow unit, and field scales, including 1) bedset-scale variations internal to clinoforms and wedges, 2) along strike and temporal variations in clinoform or wedge style, and 3) platform-scale asymmetry.

Integration of core and log data, combined with insights from outcrop analogues, allows for prediction of the depositional rock types and depositional regions internal to the slope elements mapped at Karachaganak. Upon incorporation into a sequence stratigraphic framework, spatial and stratigraphic trends regarding reservoir properties and connectivity are extractable based on the mapped geographic distribution of different clinoform styles, wedge types, and secondary features. For example, anomalies in porosity-to-depth trends occur only in middle-lower slope settings of particular clinoform styles, reflecting the associated sediment types that are susceptible to certain diagenetic processes. Overall, this approach links seismic-scale architecture, petrophysical behavior, and geographic distribution, thereby providing insights for future reservoir development and modeling at Karachaganak.