The Informed Prediction of Petroleum Systems Elements in Frontier Plays

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ABSTRACT

The informed prediction of petroleum systems elements is a vital but challenging component of a successful exploration strategy. In frontier plays, where data are limited or non-existent, this prediction becomes even more difficult. The continued decline in exploration success implies that more could be done to meet this challenge. Using a robust geological model integrating geodynamics, paleoclimate, source-to-sink analysis, and sequence stratigraphy provides an effective means to make informed predictions with limited data. Predictions are best made if data are observed in their original paleogeographic context using a geodynamic model. This allows non-intuitive relationships to be identified, such as sediment source areas that have been subsequently separated from the sediment sink by wide ocean basins. These insights are further developed using paleo digital elevation models (DEMs). If data are available to categorize hinterland areas, it becomes possible to assess sediment provenance and reservoir quality. Power-law scaling relationships and more general predictive models allow for the semi-quantitative approximation of sediment yield and the geometry of depositional features. A sequence stratigraphic framework allows the depositional architecture and lithofacies to be anticipated and also provides insights into the temporal distribution of petroleum systems elements. Paleo DEMs can also be used as an input for paleoclimate simulations. These provide insights into the distribution of climatically sensitive sediments, allowing the likelihood of encountering potential source rocks, reservoirs, and seals to be predicted. They can also be used to enhance source-to-sink studies. The precise temporal framework provided by a sequence stratigraphic model can be used to enhance this technique, allowing simulations to be performed for discrete time slices using temporally precise boundary conditions. The model results can be tested against stratigraphically precise data, reducing uncertainty. This study shows that the combination of these approaches is crucial for the prediction of the Late Cretaceous reservoirs along the African margin and highlights areas of good potential. The Early Jurassic source rock potential of the central Atlantic is also analyzed, showing that the paleoclimatic conditions were more favorable for the deposition of organic-rich facies on the African margin.