Cretaceous Climate Transitions Along the Northwest African Margin: Implications for Source-to-Sink Systems and Reservoir Distribution

Joss Smith, Benjamin Gréselle, Andrew Davies
Halliburton

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Abstract

In frontier settings where data are limited or non-existent, exploration often relies on predictive models to inform and de-risk decisions. However, predicting the spatial and temporal extent of petroleum systems elements in ancient systems is challenging and requires a multi-disciplinary methodology. Here, we outline the benefits of following a holistic Earth System Science approach to global-scale prediction of petroleum system elements and present results from eight Cretaceous paleodrainage and paleoclimate simulations. Building on a spatial framework provided by plate modelling and temporal framework provided by sequence stratigraphic modelling, Palinspastic Gross Depositional Environment maps are integrated with numerous datasets to generate Paleo Digital Elevation Models (PDEM) for discrete time slices of the Earth's history. With a reliable depiction of ancient landscapes and bathymetry, these global PDEMs are instrumental in enabling the identification of sediment source areas, which facilitates modeling of paleodrainage pathways. Second, the PDEMs are used as the essential input to run global paleoclimate simulations which provide a wide range of useful parameters. In combination, the paleodrainage and paleoclimate outputs allow a predictive source-to-sink approach providing insights away from data constraints. To highlight the predictive capabilities of this approach, we focus on the geomorphological and climatic evolution of the north western African margin throughout the Cretaceous. Through eight Cretaceous time-slices, ranging from the

Valanginian to the Maastrichtian, we display broad regional trends such as an intensification of precipitation along the equatorial margin and a progressive aridification in North Africa. For each of the Cretaceous time-slices we show predictions of sediment flux, submarine fan dimensions, and hinterland composition which give insight into potential reservoir extent and quality along the margin. Within the Mauritania, Senegal, The Gambia, Guinea Bissau, Guinea Conakry (MSGBC) Basin, we use the predictions to assess the likelihood of extending the successful mid-Cretaceous turbidite play. Predicted submarine fan lengths and sediment flux are both greater in the south than in the north. This suggests the presence of mid-Cretaceous turbidite reservoirs is more likely in the ultra-deep-water license blocks in the southern MSGBC Basin.

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