EGU2020-18902
https://doi.org/10.5194/egusphere-egu2020-18902
EGU General Assembly 2020

Source-to-Sink Systems in the Central Atlantic: Cretaceous Climate Transitions and the Consequences for Reservoir Distribution

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In frontier settings where data are limited or nonexistent, exploration often relies on predictive models to define uncertainty and derisk decisions. However, helping predict the spatial and temporal extent of geological elements in ancient systems is often challenging and requires a combined multidisciplinary methodology and mindset. The benefits of following a holistic Earth system science approach to the global-scale prediction of petroleum system elements are discussed.

Building on spatial and temporal frameworks provided by plate tectonic and sequence stratigraphic modelling, palinspastic gross depositional environment maps can be integrated with numerous data sets to generate useful 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 identifying sediment source areas, which facilitates modelling of paleodrainage pathways. These PDEMs form an essential input to run global paleoclimate and paleotidal simulations, which, in turn, provide a wide range of useful parameters. In combination, paleodrainage and paleoclimate outputs allow for a predictive source-to-sink approach, which provides useful insights away from data constraints.

To highlight the predictive capabilities of this approach, the focus is on the Cretaceous paleo-margin from Guyana in northeast South America to Morocco in northwest Africa. The generation, quality, and distribution of clastic and carbonate systems related to the changing geomorphological and climatic evolution of the central Atlantic domain are discussed.

Within this prospective region, climatic trends are demonstrated (i.e., an intensification of precipitation along the equatorial margin and a progressive aridification in northern Africa) and their implications are discussed. For a range of Cretaceous time-slices, predictions of sediment flux, submarine fan dimensions, and hinterland composition, which provide useful insight into potential reservoir extent and quality along this margin, are demonstrated. By integrating climate, sediment flux, and sediment composition predictions, a margin-wide screening for clastic reservoir potential highlighting areas where existing plays could be extended (MSGBC) and where climatic controls add significant potential risk to reservoir presence and quality (Morocco) are presented.