

Constraining Rift-to-Drift Paleo-Topography Using a Deformable Crustal Architecture Workflow in the Gulf of Mexico

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Abstract

Crustal architecture and paleo-topography are fundamental drivers of petroleum systems, especially in syn-rift plays. Here, we present an integrated, iterative approach to deriving relative paleo-topography using present day crustal architecture and a deforming plate model in the Gulf of Mexico. The inputs to this process are derived from public-domain potential fields and seismic data. Our layered crustal architecture model (crustal geometry, type, and properties) provides critical constraints for a coupled deforming (203 - 164 Ma) and rigid (164 - 152 Ma) plate model. Rifting initiates ca. 203 Ma, and transitions to sea floor spreading diachronously from 164 (W. GOM) to 161 (E. GOM). The model suggests there are areas in the northern GOM with little to no felsic crust as well as possible exhumation of lower continental crust and mantle resulting from hyper-extension late in rift phase (post 169 Ma). Because of the complex transition from rift to exhumation to drift, there is a significant period of time (most of the middle to late Jurassic) during which 3D back-stripping of present day "basement" does not provide a complete paleo-topographic solution. To fill this gap, we forward model the evolution of crustal thickness using syn-rift extension directions, targeting the modern-day crustal architecture. Relative paleo-topography is estimated using simple air-loaded Airy isostasy of the crustal thickness map through time, and statically adjusted to minimize the errors between the forward modeled topography and flexural back-stripped topography at the end of drift. The robust nature of our workflow enables further sub-regional refinement using proprietary data and models. This fully-integrated multi-phase crustal architecture and paleo-bathymetry

workflow provides fundamental input into play and prospect risk, specifically for heat flow prediction and potential syn-rift source rock and reservoir paleo-environments.

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