

Forward Tectonic Modeling of Newfoundland and its Conjugate Margins: A New Approach to Exploration in Deep Water Basins

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Abstract

A new 3D tectonic model for the Newfoundland continental margin and its conjugate Ireland and Iberia margins charts the complex evolution from rift initiation to hyperextension, continental breakup and the formation of oceanic crust. Hyperextended basins such as the East and West Orphan, Porcupine and Rockall basins have been well-documented around the Newfoundland margin and its conjugates and in these hyperextended basins and on the hyperextended continental margins the initial rifting phase is followed by correspondingly rapid rates of tectonic subsidence, resulting in deep-water basin development and sediment loading. Rapid thermal subsidence continues for several million years after the cessation of tectonic activity and the basins continue to fill. Flexural isostatic uplift on the margins of these subsiding hyperextended basins can result in uplift and erosion that provides additional sediment fill into the basins. As continental extension propagates northwards, these tectonic processes migrate with them. Newly developed modelling techniques provide input to the 3D model that can better determine the timing and amount of these tectonic processes. The 3D tectonic model was constructed using detailed basin geometry evolution and crustal thickness through time as input into the forward modelling of tectonic subsidence and flexural uplift and determination of the volume of available sediment due to erosion. The basin geometry and crustal thickness inputs are derived from a palinspastic deformable plate model that quantifies the amount, timing and direction of crustal extension across a margin by employing retro-deformed beta grids to restore the history of crustal stretching. The

deformable plate model has in some areas quantitatively restored up to several hundred kilometers of Mesozoic-Cenozoic extension. The central part of the West Orphan basin has increased approximately two-fold from Kimmeridgian to Late Cretaceous, with the most of this extension taking place in latest Jurassic to Early Cretaceous. Hydrocarbon discoveries in the Flemish Pass are located on the margins of the hyperextended Orphan Basin on the Newfoundland margin. We have modelled basin geometry and connectivity in these basins and in basins on the conjugate margins through time in addition to tectonic subsidence rates, and amounts and timing of flexural uplift and erosion.