Evolution of a Deep-Water Fold-Thrust Belt: Use of 3-D Seismic Data, Northwest Borneo

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Abstract

The deep-water fold-thrust belt (DWFTB) of NW Borneo located adjacent to the NW Palawan Basin to the north, NW Sabah Trough to the west and the Baram Delta province to the south. The DWFTB elongated northeast-southwest direction parallel with the Sabah coastline at the eastern side of the South China Sea. The opening of South China Sea during Oligocene - Middle Miocene times led to a southeastward rifting of thinned continental crust of the Dangerous Grounds, which actively subducted beneath NW Borneo continental margin and finally ceased around 16 Ma. The collision resulted in uplift and erosion of the Crocker Range. The present-day shelf and coastal plain of NW Borneo is a prolific petroleum province of clastic reservoirs that were deposited when denudation of Borneo's rising highlands (Crocker Range) shed huge volumes of sediment into the basin. Gravity loading and thin-skinned deformation has resulted in a complex fold and thrust belt in the inboard area. This fold and thrust belt, which hosts up to 8 Km thick Mid-Miocene to Recent turbidite reservoirs within anticlinal structures, has been the major focus and most successful play area in the basin to date. In this study, new balanced interpretations of regional, crustal-scale, three-dimensional (3-D), multichannel seismic-reflection profiles are presented that provide for the quantitative data on tectonic shortening throughout the deepwater fold-and-thrust belt of NW Borneo. A key result of this study is the recognition of three phases of fold evolution that have been spatially and temporally defined using these new high-resolution 3D seismic data sets. Phase one records South China Sea floor spreading, from Eocene to Middle Miocene. This phase solely influenced by the subduction of the Dangerous Ground towards Borneo in northwest-southeast direction. This is marked by asymmetrical fold vergence

towards southeast and tectonic thickening in the pre-growth stage. Phase two from End of Middle Miocene to End of Late Miocene is characterized by symmetrical fold geometry. This phase is identified as the early onset of gravitational sediment loading and sediment supply from the shelfal and coastal plain of NW Borneo. Phase three records continued fold growth from the End of Late Miocene until Recent and is characterized by strong asymmetrical fold growth with northwestward vergence and abrupt upward growth. Phase three folds are solely influenced by gravitational sediment loading and strongly influence routing of the channelized turbidite flows. This research highlights the importance of creating accurate spatial and temporal frameworks to reconstruct fold growth in complex deepwater fold-thrust belts and particularly where there are very large volumes of sediment deposited in the basin from proximal shelfal margins.