

Himalayan Frontal Fold-Thrust Belt, Northwest India: Geometry, Structural Evolution and Hydrocarbon Prospects

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The Himalayan frontal fold-thrust belt (FTB) is one of the longest FTBs in the world. Several oil/gas fields have been discovered during the last 125 years in the Himalayan FTB in Pakistan and Assam-Arakan FTB in northeastern India. However, no commercial oil/gas discovery has taken place in the intervening areas in India, Nepal and Bhutan although many oil and gas seeps are known from this area since historical times. We have constructed five serial balanced cross sections in the northwestern Himalayan FTB, using surface geological data and well data. Departing from usual practice, we restore deformed-state cross sections in discrete steps; at each step we restore only one fault and ensure that the section remains admissible and viable at every step of restoration. This allowed us to work out the admissible geometry, sequence of thrust development and also estimate slip on each fault at each stage of fault development. Variation in structural geometry of the FTB can be segmented into three longitudinal zones. In the frontal zone towards the foreland, structural geometries are simple with widely spaced ramps and related folds. The structural geometries become relatively more complex in the middle part of the FTB with low ramp spacing, interference of axial surfaces and folded thrusts. A number of horses dominate towards the hinterland. The structural evolution can be best described in terms of forward-breaking in-sequence thrusting, followed by out-of-sequence thrusting in an approximately break-back style. In an area with such structural complexity, a thorough understanding of subsurface structural geometry is essential for hydrocarbon exploration. Based on our sections, a number of play-types have been identified, where detailed exploration for hydrocarbons may be taken up.