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Eric A. Erslev[1], Peter H. Hennings[2] (1) Colorado State University, Fort Collins, CO (2) ConocoPhillips Petroleum Co, Houston, TX

Kinematic Evolution of Detachment Folds, Offshore Brunei, Indonesia

Understanding kinematic development can constrain predictions of hydrocarbon reservoir continuity and trap integrity in thrust belt structures within continental toe-of-slope settings. A 10,000 km2 3-D seismic survey of the continental slope off Brunei shows a series of detachment folds in Miocene to Holocene, mud-dominated sediments. A bedding-parallel detachment zone separates planar basement reflectors from overlying arcuate folds which, in cross section, define a wedge of detached strata with an apex angle of 3 degrees. Folds form localized patches with systematic wavelengths that range from 3 to 18 km, average 9 km, and show no obvious relationship with wedge thickness. Fold amplitudes range to 1.5 km and decrease with distance from the continental margin. Fold shortening and anticlinal excess area are not simply related to detachment depth, indicating penetrative shortening and stratal thickening throughout the wedge and invalidating simple depth-to-detachment geometric calculations.

Fold stages can be documented changes in individual fold geometries as they change amplitude laterally. Initial folding is characterized by symmetric buckling, with stratal thickening in anticlinal cores by penetrative bed shortening and imbricate thrust faulting. A second stage of asymmetrical fault-propagation folding, where major thrusts break through fold forelimbs, is seen in many, but not all intermediate-sized folds. Folds then build upward symmetrically as rocket folds, utilizing thrust ramps and detachments. Land sliding of material off anticlinal crests is common as they emerge from the sea floor. Assessment of the stage of fold evolution can assist in the prediction of trap integrity in prospective structures.