ABSTRACT

The impact of structural deformation in a 2D basin and petroleum system model of the East Coast Basin, New Zealand

Blair Burgreen, Stephan A. Graham, and Kristian Meisling

Department of Geological and Environmental Sciences, Stanford University

The East Coast Basin of New Zealand is a petroliferous forearc basin that has eluded commercial development largely because of challenges related to its complex structural and tectonic history. Basin formation is associated with three tectonic phases: 1) a Cretaceous convergent margin phase, 2) a Late Cretaceous to Paleogene rifting to passive margin phase, and 3) a Neogene to present convergent margin phase. Beginning in Neogene time, the basin underwent multiple stages of structural deformation including low angle thrust faulting, listric normal faulting, and inversion. This complex basin history provides an ideal situation to test the influence of tectonics on petroleum system development.

This study focuses on offshore Hawke Bay where a regional 2D seismic line has been interpreted, palinspastically reconstructed, and incorporated into a basin and petroleum system model. In the model, several paleo-heat flow scenarios are developed to represent the tectonic evolution of the basin. Higher heat flow is modeled during the rifting to passive margin phase, and a reduction in heat flow is modeled during the Neogene phase to account for cold slab subduction. Heat flow scenarios are calibrated to temperature, apatite-fission track data, and vitrinite-intertinite reflectance and fluorescence data from the Hawke Bay-1 and Opoutama-1 wells. The palinspastic reconstructions are integrated into the basin and petroleum system model to assess the impact of different styles of deformation. Faults play a key role in the burial history/rate of burial, fluid migration, and pressure compartmentalization.

The relative timing of paleo-heat flow and structural events are tested in the model to understand how they enhance and/or negate effects on petroleum generation. For example, models with early Miocene low angle thrusts (i.e. structural thickening) contemporaneous with remnant high heat flow from the passive margin phase create a scenario for mid-Miocene petroleum generation. While basin and petroleum system models are often simplified in tectonically complex areas, we find that integration and testing of structural events in frontier regions can highlight structurally favorable scenarios for prospectivity and help assess their associated risks.