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Tectonic Drivers and Structural Deformation in Campeche Basin: Implications for Hydrocarbon Exploration in Deep Water Blocks 1 and 3

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Summary

Deformation in the Campeche area of the southern Gulf of Mexico Basin was caused by tectonic events along the plate boundary between the Cocos and North American plates. The deformation history of prospects and timing of hydrocarbon migration can be understood in the context of these events in the deep water of Campeche. Multiple phases of deformation have led to the formation of fold and thrust belt structures with different styles and varying degrees of complexity.

Throughout the Tertiary, subduction of the Cocos plate underneath the North American plate, translation of the Chortis block, and indentation of the Chiapas terrane have generated distinct orogenic pulses. Two main uplift phases are associated with thin- and thick-skinned contractional deformation. These events have caused nearly perpendicular structural fabric orientations in the deepwater area of the Campeche Basin. The northern and western area of the Basin is dominated by NE-SW structures while the eastern area is dominated by NW-SE trending structures. In addition, the presence of salt in the basin has helped to control fault and fold geometries.

Onshore uplift caused by subduction of the Cocos plate together with the thermal subsidence of the Gulf of Mexico, has resulted in an overall NW tilting of the Campeche margin. This has led to the development of a large gravity slide with up-dip extension and down-dip contraction, and to shelf instability on the proximal part of the margin (in shallow water). Large-scale extensional faulting which occurs up-dip is linked to a well-developed, down-dip deep water fold and thrust belt (Catemaco FB) that is oriented NE-SW. However, the onshore Chiapanecan orogeny also caused regional contraction and not all of the outboard contraction is accommodated by the extensional basins. Gravity sliding occurs above a single extensive regional ductile detachment layer in most of the Campeche area (Louann salt), but in some areas gravity sliding has occurred along multiple, complex detachment layers.

Contractional structures in Blocks 1 and 3 show several styles that are detaching along different stratigraphic units (ductile shales or salt). These weak detachment units have different spatial distributions and partly controlled the structural style. A change in accumulated strain along the length of the Catemaco FB is thought to be due to a change in the length (i.e. areal extent) of the Louann salt detachment layer. A high degree of accumulated strain is observed in the area of shorter length of the basal detachment level and is characterized by complex structure styles and subsequent hydrocarbon migration uncertainties.

The structural complexity and deformation history in deep water Campeche and in Blocks 1 and 3 influenced trap formation as well as hydrocarbon generation timing and migration and therefore play a crucial role in the general hydrocarbon prospectivity of the basin.