Structural and Kinematic Model of the Piedemonte Area, Eastern Cordillera Fold and Thrust Belt, Colombia

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Frontal thrusts sheets in the Eastern Cordillera fold and thrust belt host the prolific fields of Cusiana and Cupiagua, producing from naturally fractured reservoirs of the Paleogene Mirador, Barco and Upper Cretaceous Guadalupe Formations. Additional hydrocarbon producing potential in these units has been established north of these fields in the Piedemonte area by a few wells.

Interpretation of a new 3D seismic survey, combined with new detailed surface mapping and limited well data yielded a new model of the structure and kinematics of this complex frontal deformed zone in the Piedemonte area. The deeper structural elements are poorly imaged, thus demanding iterative structural modeling to aid in developing a robust interpretation. Interpretation of sections that are constrained by the wells yielded a balanced and admissible fault network. The network of 2D sections provided an interpretation template for the 3D seismic volume.

Key shallow to surface structural elements include the El Morro anticline and Nunchia syncline, both of tens of km strike extent. These two elements overlie the antiformal stack of repeated reservoir units. The El Morro anticline, consisting of Oligocene lower Carbonera through upper Cretaceous units, detaches under the Nunchia syncline of Carbonera to Guayabo Formations, and folds the NW limb of the syncline. Eventually a fault propagates through the base of El Morro, detaches Nunchia syncline in the lower Carbonera Formation, and carries the Nunchia syncline as a unit on the Yopal fault that breaks to the surface. The antiformal duplex stack of the reservoir units occurs below and forward of the El Morro anticline, and the combined fault displacement of this stack uplifts and translates the Nunchia syncline without significant internal deformation. The antiformal stack comprises two to four duplexes containing hydrocarbon-bearing units, as established by the wells. The style progressively changes to the northeast of the Cupiagua field area and the shortening accommodated in these frontal units increases progressively to the NE.

The combination of 2D and 3D balancing, with kinematic forward modeling, insures that the model is valid. The 3D structural model allows reservoir estimates with a range of uncertainty and serves as a robust, structurally tested guide to further drilling.