3D MODELING OF PETROLEUM SYSTEM OF LLANOS BASIN (COLOMBIA): PREDICTION OF PETROLEUM COMPOSITION

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The Llanos basin (LBC) refers to the most prolific hydrocarbon continental basin in Colombia, with more than 70 fields in production and reserves of about 1600 million bbl. The basin covers an area of approximately 200,000 km^2, bounded by the Eastern Cordillera to the West; the Guyana shield to the East; the Apure basin and Cordillera de Merida in Venezuela to the North and by the Amazon basin to the South from which it is limited by the Macarena mountain range. The geological history of the LBC is very complex and the contribution of several petroleum systems (Paleozoic series for example) as well as the filling history (Gonzalez-Penagos et al., 2014; Sanchez et al., 2015; Moreno-López, 2015; Mora, 2015) remain uncertain. The basin is mainly oil-prone and contains several giant medium and heavy oil fields such as Cusiana, Cano Limon, and Rubiales. The physico-chemical properties of Llanos oils significantly fluctuate throughout the study area in sandstone reservoirs of Cretaceous and Tertiary age (from 8 to 30° API). They are believed to result from the variations in source rock types, thermal maturity, oil mixing, water-washing and biodegradation.

As basin modeling integrates main geophysicals, geological, geochemistry and engineering data types and, makes it possible to rapidly test different geological scenarii, it is considered as one of the most effective tool to decrease the high level of uncertainties and risk for exploration and production of hydrocarbons. The present study consists in better understanding and predicting oil accumulations distribution and hydrocarbon composition in the Llanos area based upon the building of a 3D basin model with TemisFlow®. The results derived from the 3D model contribute to clarify the role of the different petroleum system elements and the reservoir petroleum charge timing. A special attention is paid to oil mixing and biodegradation processes since strong geochemistry evidences point out biodegradation as the first order mechanism controlling the hydrocarbons quality in many fields (Gonzales-Penagos, 2016).

The sedimentary sequence of the proposed model mainly consists of siliciclastic rocks of Paleozoic, Cretaceous and Tertiary age which lie on a Pre-Cambrian age basement made up of crystalline and metamorphic rocks. It reaches its maximum thickness (about 9000 m) towards the western boundary, near the orogenic front of the Eastern Cordillera showing a typical asymmetrical profile of a foreland basin. Towards the East, the sequences are thinner while the facies are coarser. Two Mesozoic rifting events and a Cenozoic crust thickening event are defined in the model. The considered facies and fault distributions are presented in Figure 1. The model is calibrated in terms of temperature and pressure based on well data (vitrinite reflectance/temperature and pressure values at present day). The migration scenarii suggest that a contribution of Paleozoic source rock and/or a source rock located in the Eastern Cordillera (Fomeque Formation) is required to explain the volume in place. Finally, different biodegradation scenarii were tested. The simulated data at present day are compared to the bulk and compositional characterization data (API°, GOR, SARA) of different wells in the studied area.

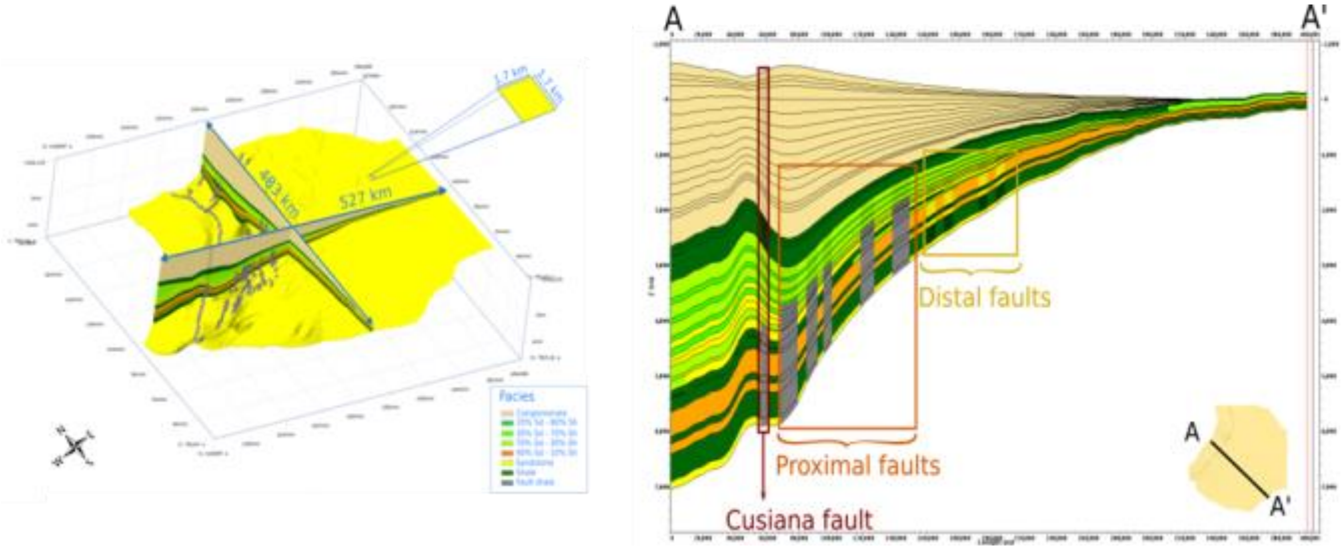

Figure 1 *3D TemisFlow model of Llanos basin.*

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