Petroleum Systems Modeling and Hydrocarbon Charge Assessment in Pie De Monte Boomerang Province, Bolivia*

Guillermo Pérez-Drago¹, Frederic Schneider¹, Stephane Rousse¹, Jean-Luc Faure¹, and Olvis Padilla²

Search and Discovery Article #30600 (2019)**
Posted March 25, 2019

*Adapted from poster presentation given at AAPG Latin America & Caribbean Region, Optimizing Exploration and Development in Thrust Belts and Foreland Basins, Santa Cruz de la Sierra, Bolivia, June 6-8, 2018

**Datapages © 2019. Serial rights given by author. For all other rights contact author directly. DOI:10.1306/30600Perez-Drago2019

¹Beicip-Franlab, Rueil-Malmaison, France (guillermo.perez-drago@beicip.com)
²YPFB, Santa Cruz, Bolivia

Abstract

An active petroleum system is recognized by producing fields in Boomerang Pie de Monte foreland basin in stratigraphic up-dip and structural traps of Silurian-Devonian and Cretaceous formations. The area is considered as one of the most prolific gas provinces in Bolivia. However, the timing of hydrocarbon expulsion and migration versus trap formation remains unclear as confirmed by dry wells showing low gas shows of residual by-passed hydrocarbons. To reduce this uncertainty, we built a basin model that honors seismic structural interpretation and well data to simulate burial history, temperature, source rock maturity and pressure regimes through geological time. Hydrocarbon expulsion from source-rocks and further HC migration was simulated using 3D basin fluid flow modeling based on Darcy flow equation, followed by a map-based fetch area trap charge assessment. The main source rock units correspond to Silurian-Devonian sequences with influence of continental-marine environments (kerogen Type II/III). Maturity trend increases from north to south due to higher burial. Two phases of hydrocarbon expulsion were recognized: one early expulsion phase from Silurian source rocks during Late Triassic and a second expulsion phase from Early Devonian source rocks during Late Jurassic-Early-Cretaceous times. Lateral long distance up-dip migration through Robore Formation occurred before Andean deformation, following a northward fill and spill trap charge accumulating below Late Jurassic erosive unconformity. The Cretaceous plays were charged by vertical and lateral migration above the unconformity. The Andean deformation resulted in enhancing the structural closures and vertical migration towards Cretaceous plays. The results of this study provided to YPFB a model-based approach to predict yet to find volumes in place for undrilled prospects and leads and a proposition for a future drilling strategy.
Petroleum Systems Modeling and Hydrocarbon Charge Assessment in Pie de Monte, Boomerang Province, Bolivia

Guillermo Pérez-Drago1, Frederic Schneider1, Stephane Rousse1, Jean-Luc Faure1, Olvis Padilla2
1 Beicip-Franlab, Rueil-Malmaison, France
2 YPFB, Santa Cruz, Bolivia

1. OBJECTIVE
The objective of this study was to evaluate the petroleum systems and petroleum potential of Boomerang Province in order to assess:

- Source rock potential
- Expulsed HC quantities
- Timing of migration mechanisms and trap charge
- Definition of leads and prospects
- Yet To Find

Workflows integrates available E&P data from YPFB in collaboration with Beicip-Franlab from ECAT Project into a 3D Basin Model for structural, sedimentary depositional model and geochemical analysis.

2. GEOLOGICAL SETTINGS
The Boomerang Pie de Monte foreland basin, is characterized by a Paleozoic sedimentary wedge developed during Ordovician-Carboniferous age, thinning northward onto the Precambrian Brazilian shield. Paleozoic mega sequence (Silurian-Devonian) corresponds to deep marine, coastal, fluvo-deltaic deposits (0-6000 m) with an erosive unconformity in the north created during Triassic-Jurassic orogeny. Main reservoirs are Robore and El Carmen Fm.

3. GEOCHEMICAL ASSESSMENT
Geochemical source rock characterization was carried out in order to identify the source rock initial potential and kerogen type. The main source rock units correspond to Silurian-Devonian sequences with influence of terrigenous and marine siliciclastic environments (kerogen type II and III).

4. THERMAL BURIAL HISTORY
Well temperature and maturity indicators were used to calibrate present day geothermal gradients and constrain paleo-temperature thermal gradients for maturity trend. Maximal burial of source rocks was reached before Triassic-Jurassic orogeny event giving place to major thermal gradients and maturity expulsion peak.

5. HYDROCARBON EXPULSION, MIGRATION & CHARGE
Maturity trend increases from north to south where higher burial occurs, from dry gas areas in the south to oil in window in the northern erosive front. Two phases of hydrocarbon expulsion were identified:

- one early expulsion phase from Silurian source rocks (Pridolian and Kairasillas) during Late Triassic,
- a second phase from Lower Devonian source rocks (Givetian to Lochkovian) during Late Jurassic-Early Cretaceous times.

Upper Devonian source rocks remain in the heavy oil window below peak of oil expulsion.

6. CONCLUSIONS
The results of this study provide a petroleum systems understanding in HC migration mechanisms, charge and synchrony of events.

The results of this study provided YPFB with a model based approach predicting yet to find volumes in place for undrilled prospects and leads, allowing to delineate a future drilling strategy.

Main recommendations are to focus in less explored Northeastern area which encompasses favorable timing of hydrocarbon expulsion and migration versus trap formation in stratigraphic wedge below erosive unconformity.