

Re-Thinking Reservoirs: The Case of the T2 Sands in the Southern Llanos Basin of Colombia*

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Abstract

The southern Llanos basin comprises one of the most prolific heavy oil provinces in Colombia where the main exploratory target is a thick (> 300 ft) sequence of sandstones operatively known as the T2 unit, considered as a single chronostratigraphic unit of Eocene age and as a single flow unit. Recent comprehensive studies, which include sedimentology, stratigraphy, biostratigraphy, petrology, and geochronology, using surface columns and cores, showed that the operational T2 actually consists of three different geochronological intervals that include Upper Cretaceous, Paleocene and Eocene sandstones separated by regional unconformities. Geochronological divisions of T2 suggest a strong structural control in the deposition related to successive extensional and contractional events, generating lateral west-to-east variations in thickness for each time interval. Reservoir time divisions also explain changes in rock quality, hydrocarbon production, and pressure trends that are directly related to the differences in depositional environment and provenance and to the existence of regional intra-T2 seals associated with the Cretaceous-Paleocene unconformity.

Chronological and quality reservoir variations have been recognized and interpreted also through stochastic seismic inversion in which differences in reservoir properties are reflected in the “elastic behavior” of the seismic data. Finally understanding the T2 unit as a multistage reservoir has led to the ongoing proposal of a new play concept in which the reservoirs of Upper Cretaceous, Paleocene, and Eocene age may conform to a regional giant stratigraphic trap, charged during multiple Paleogene events.

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Introduction

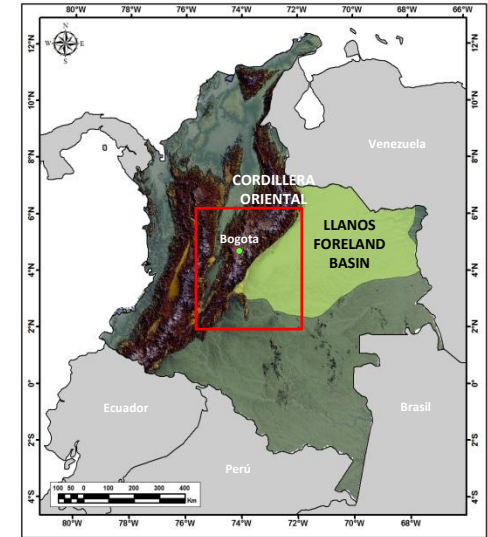
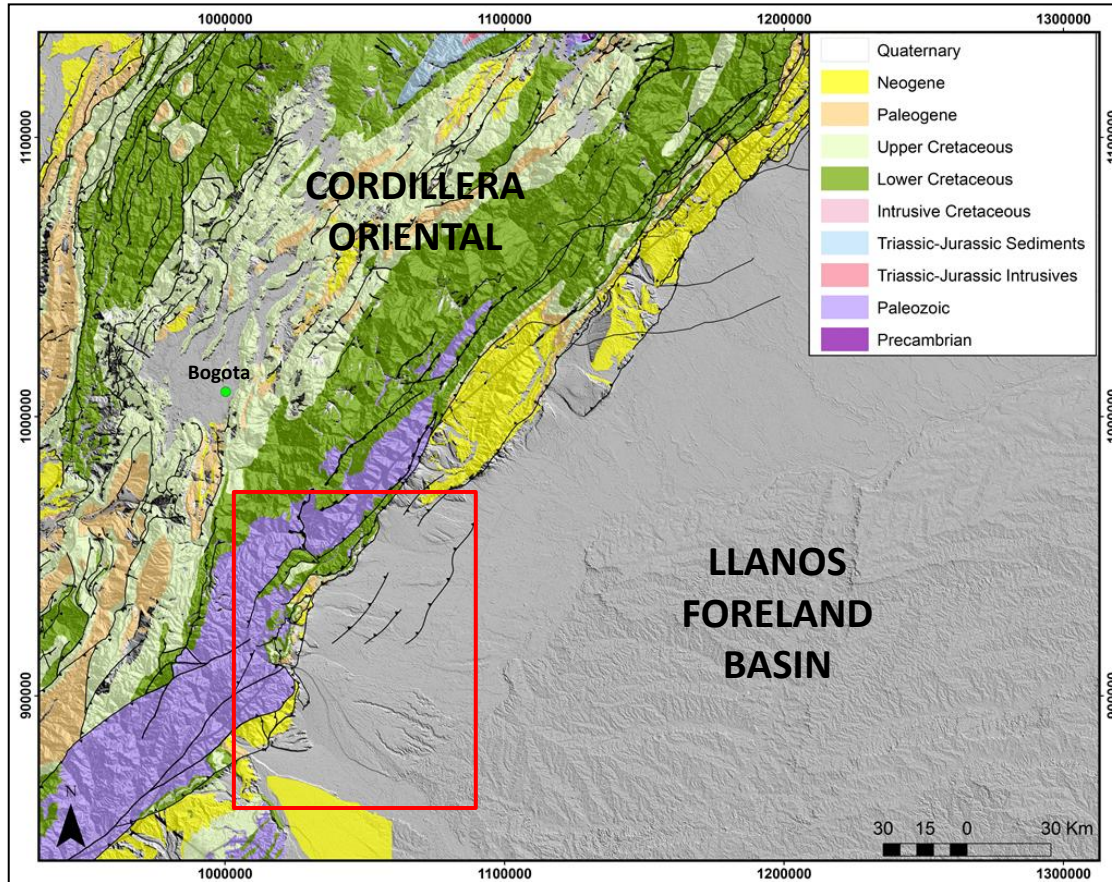


- A comprehensive study of the main reservoir in the southern part of the Colombian Llanos Foreland Basin
- Redefines age and depositional and structural evolution.
- Understands reservoir variations and production behavior in terms of chronological and sedimentological properties.
- Proposes a new play concept for the major heavy oil accumulation in southern Llanos Basin (Mora et al., Velasquez et.al., Castillo et al., ICE-2016).



Introduction

Geological Setting



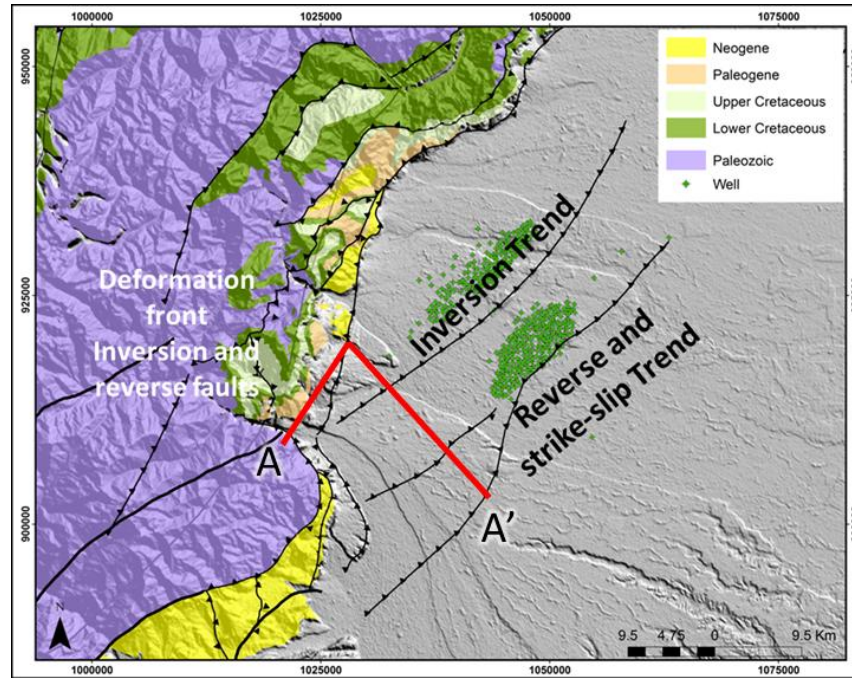
Geologic Map



Introduction

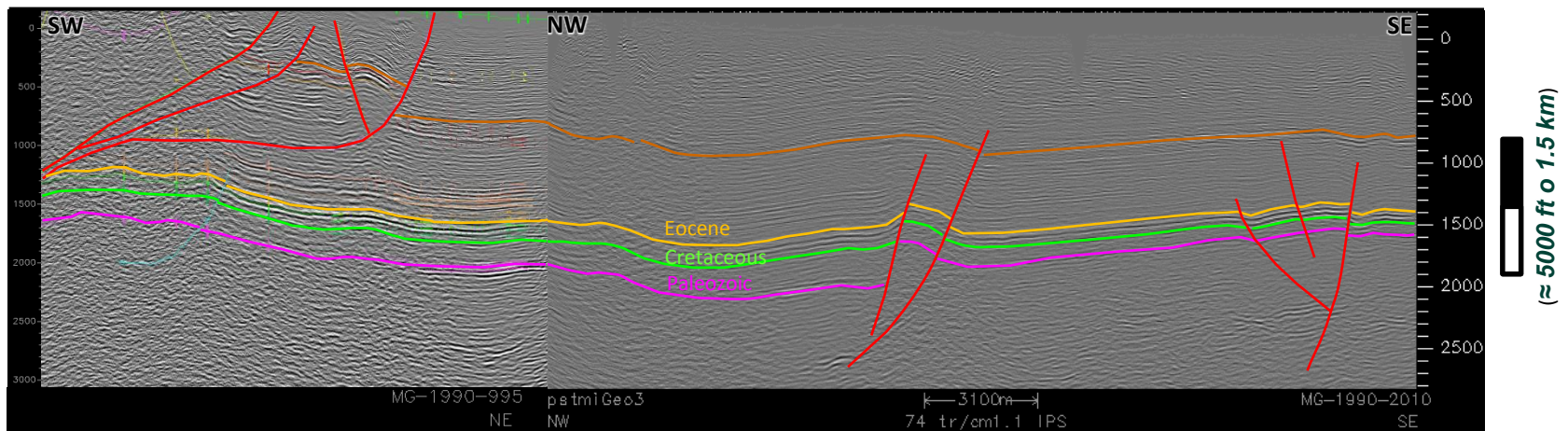
Structural Framework

Detailed Geologic Map



A

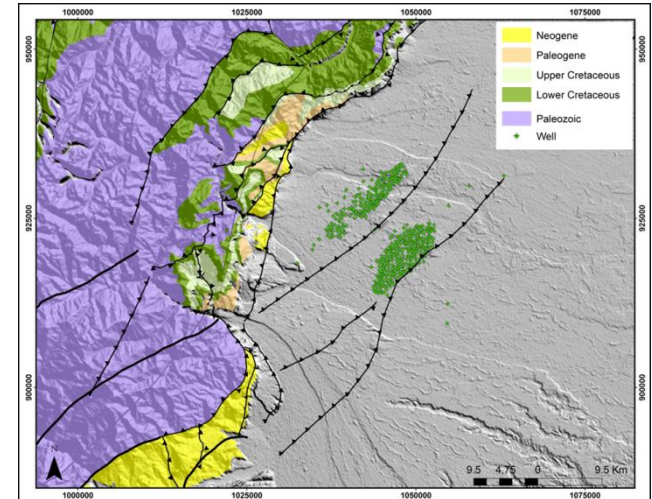
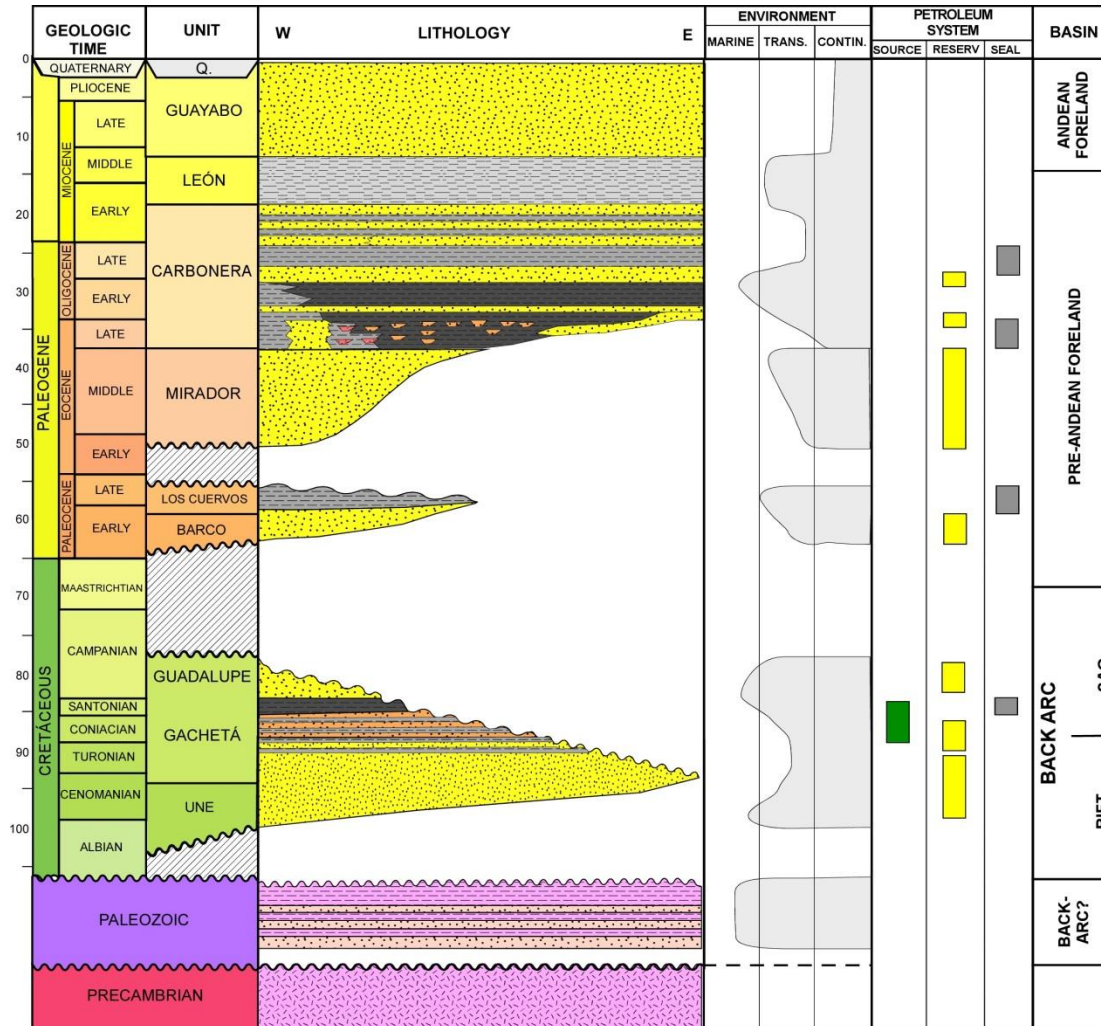
A'



Composite seismic section

Introduction

Geological Setting

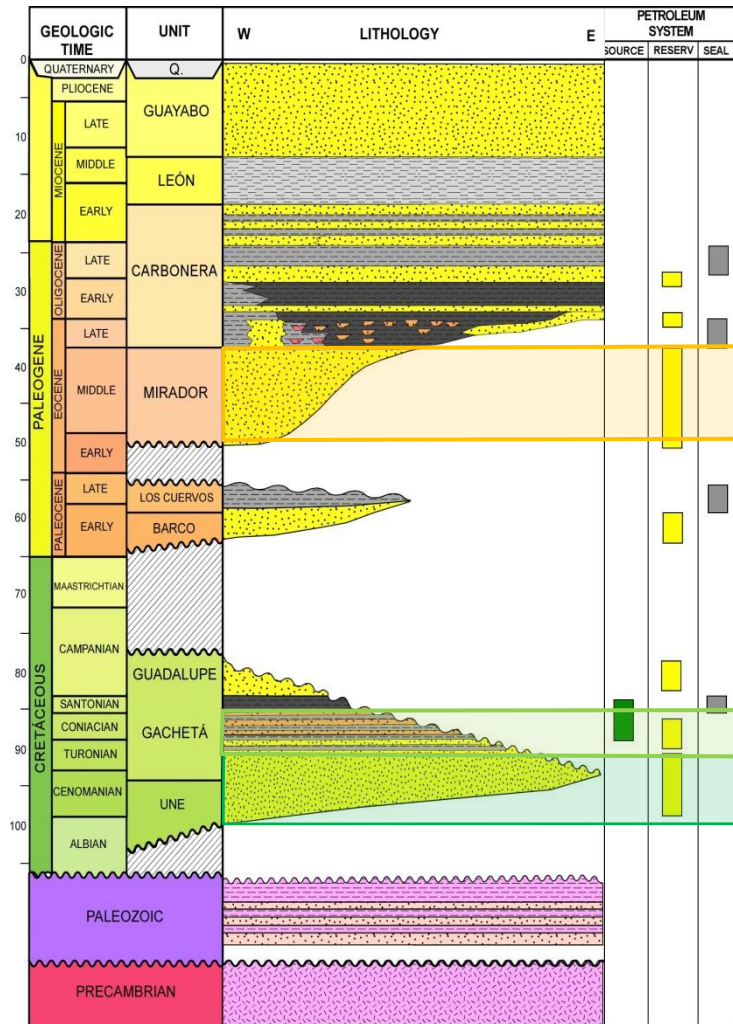


Chronostratigraphic chart for southern Llanos Foreland Basin

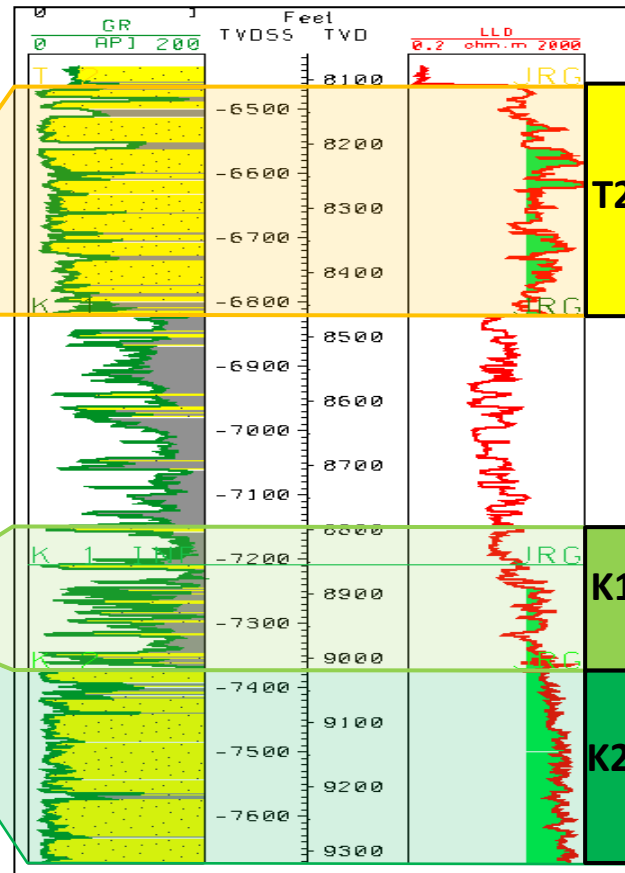


T2 Reservoir

Traditional Operational View



Chronostratigraphic chart
Southern Llanos Foreland Basin



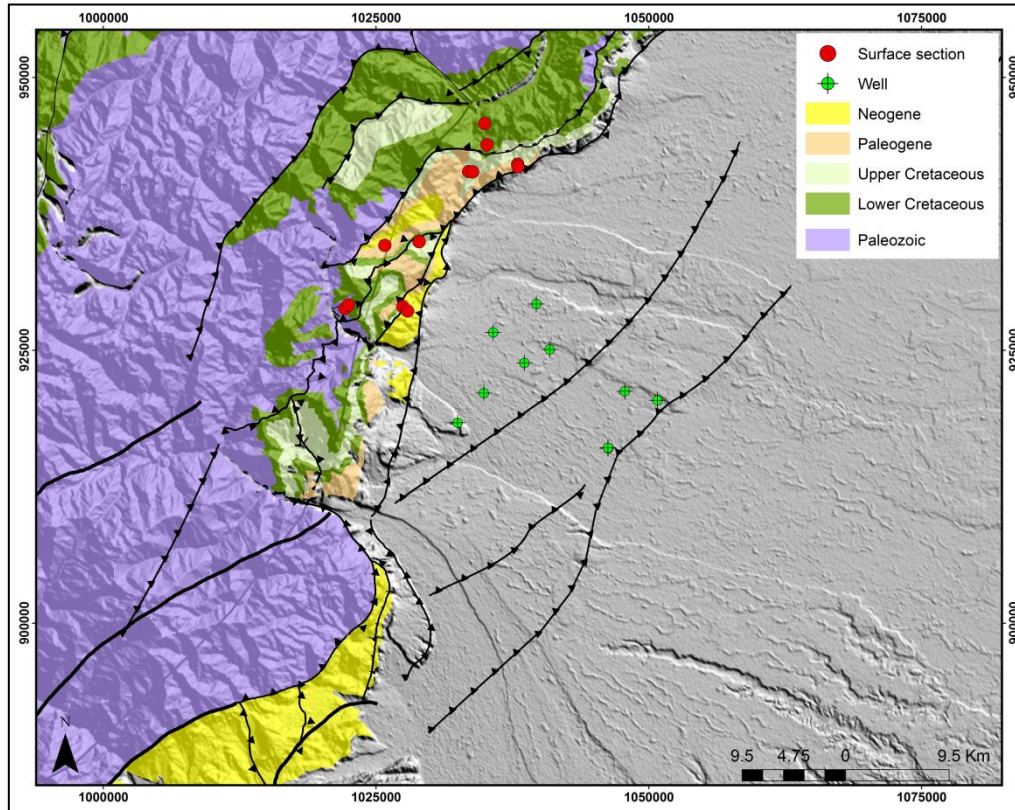
Type Log

9° API
300 ft
5.0 MMBLS Probed
1.0 MMBLS Potential



T2 Reservoir

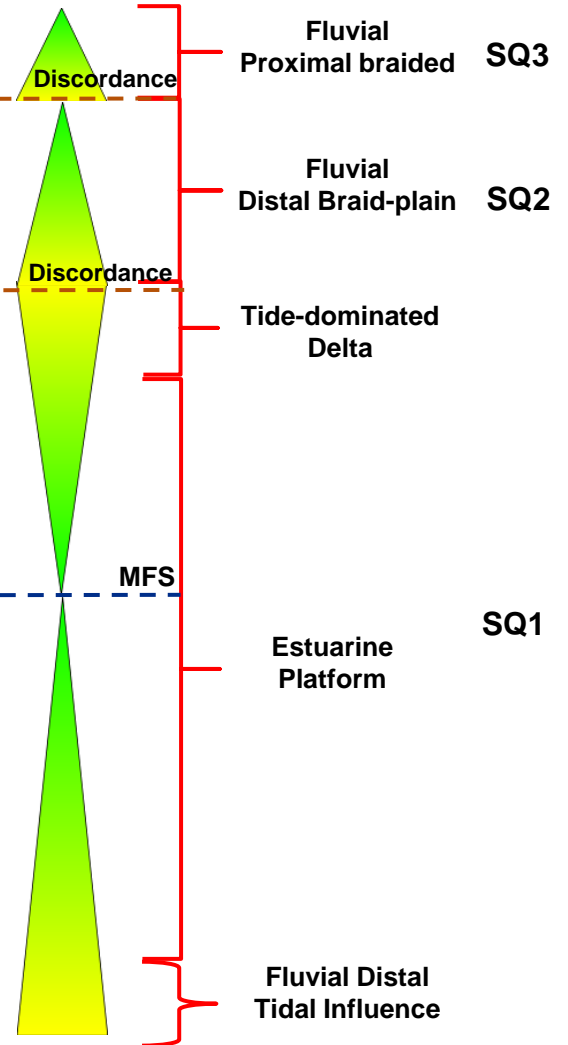
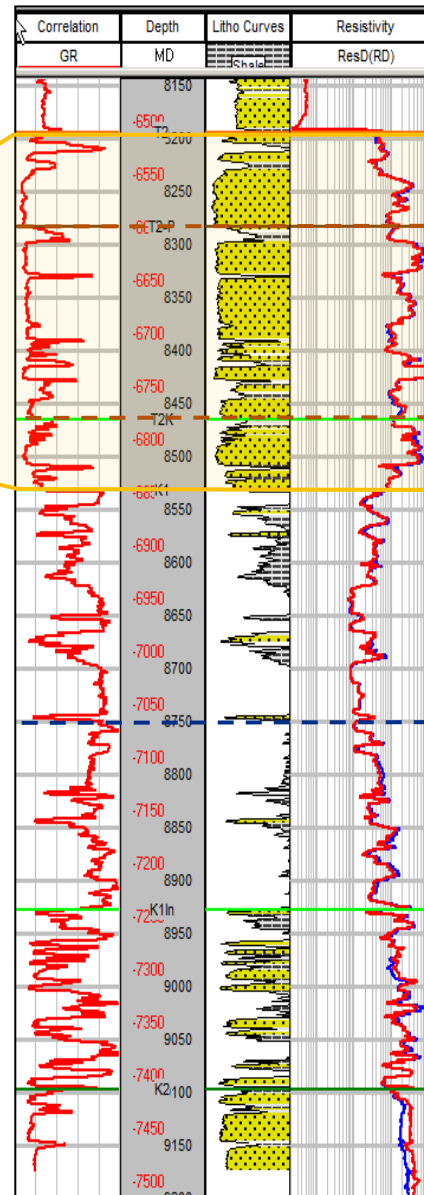
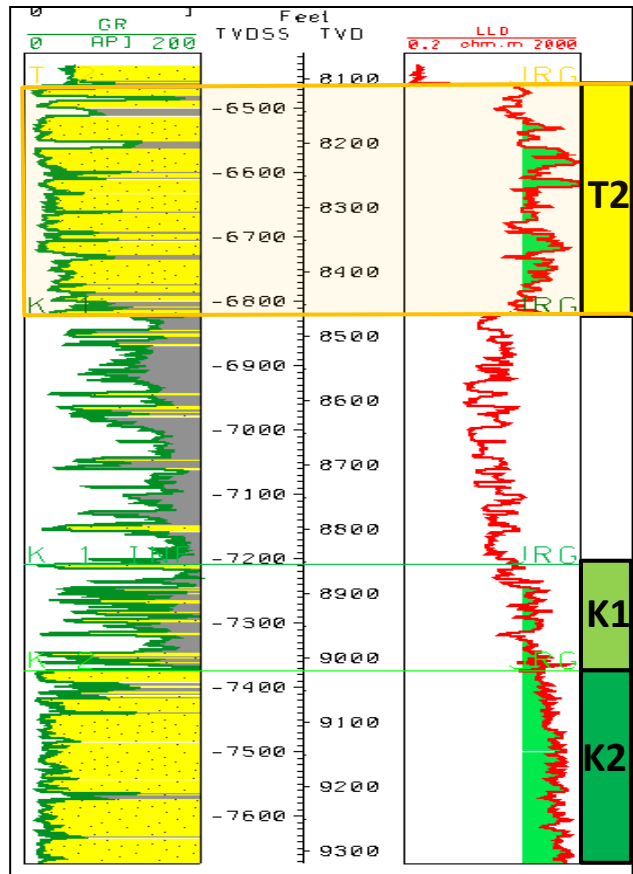
Reevaluation



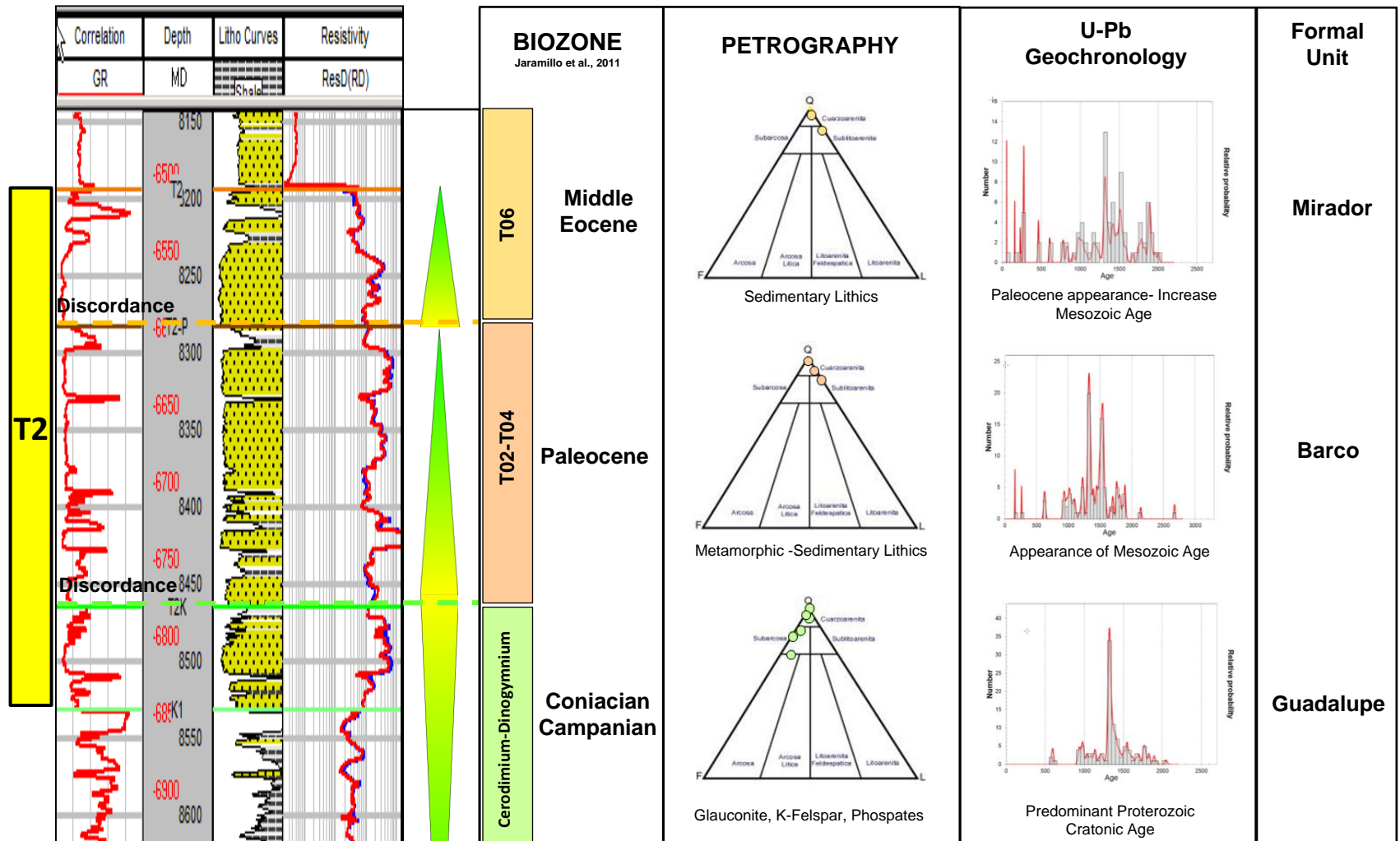
- Sedimentological analysis (surface sections and cores) and environmental definitions.
- Biostratigraphic (palynological) analysis.
- Petrographic analysis.
- U-Pb analysis.
- Integration with seismic and structural interpretation and production data.



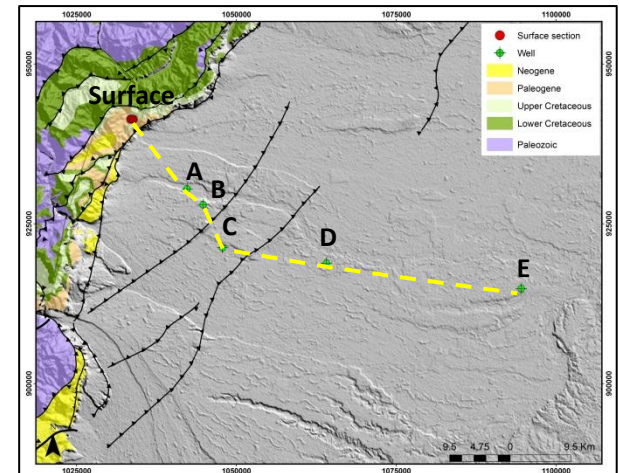
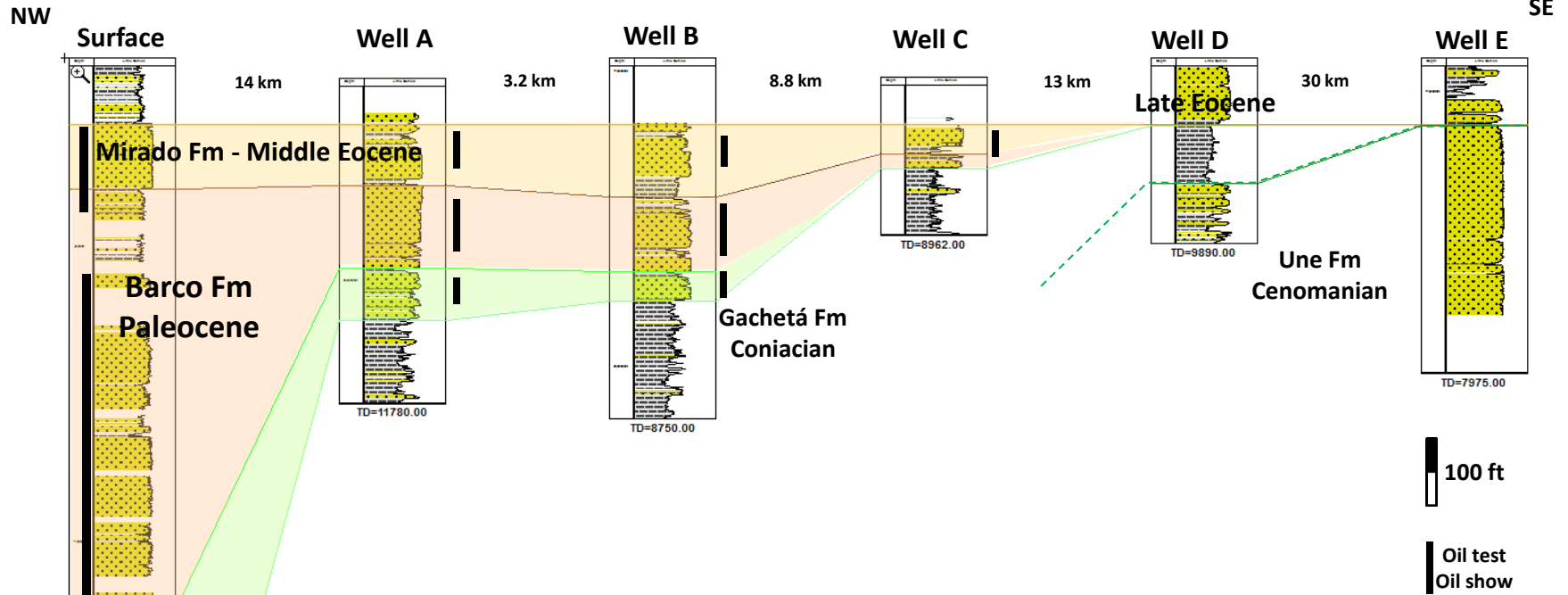
Sedimentological and depositional analysis



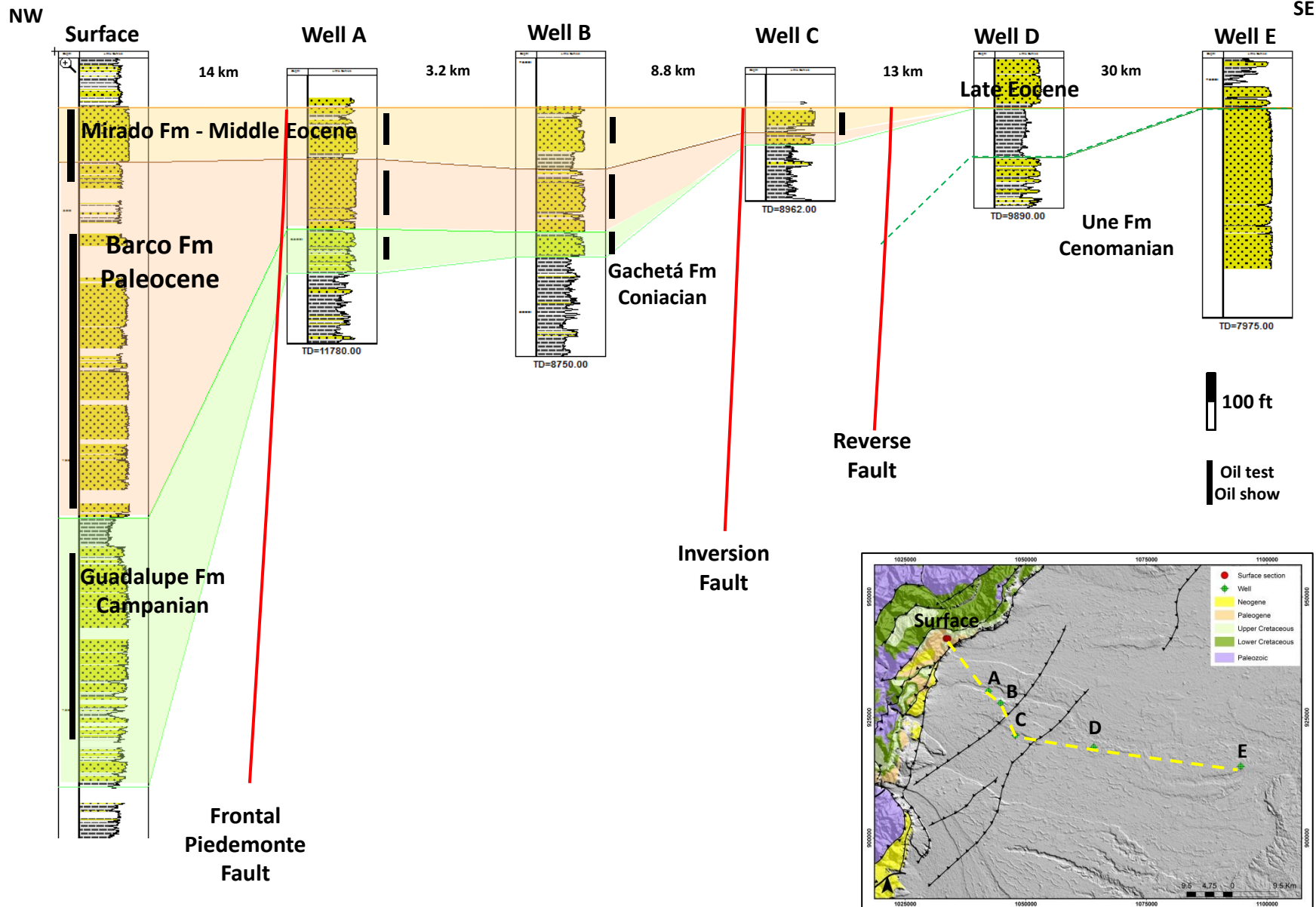
Biostratigraphic-Petrographic-Isotopic analysis



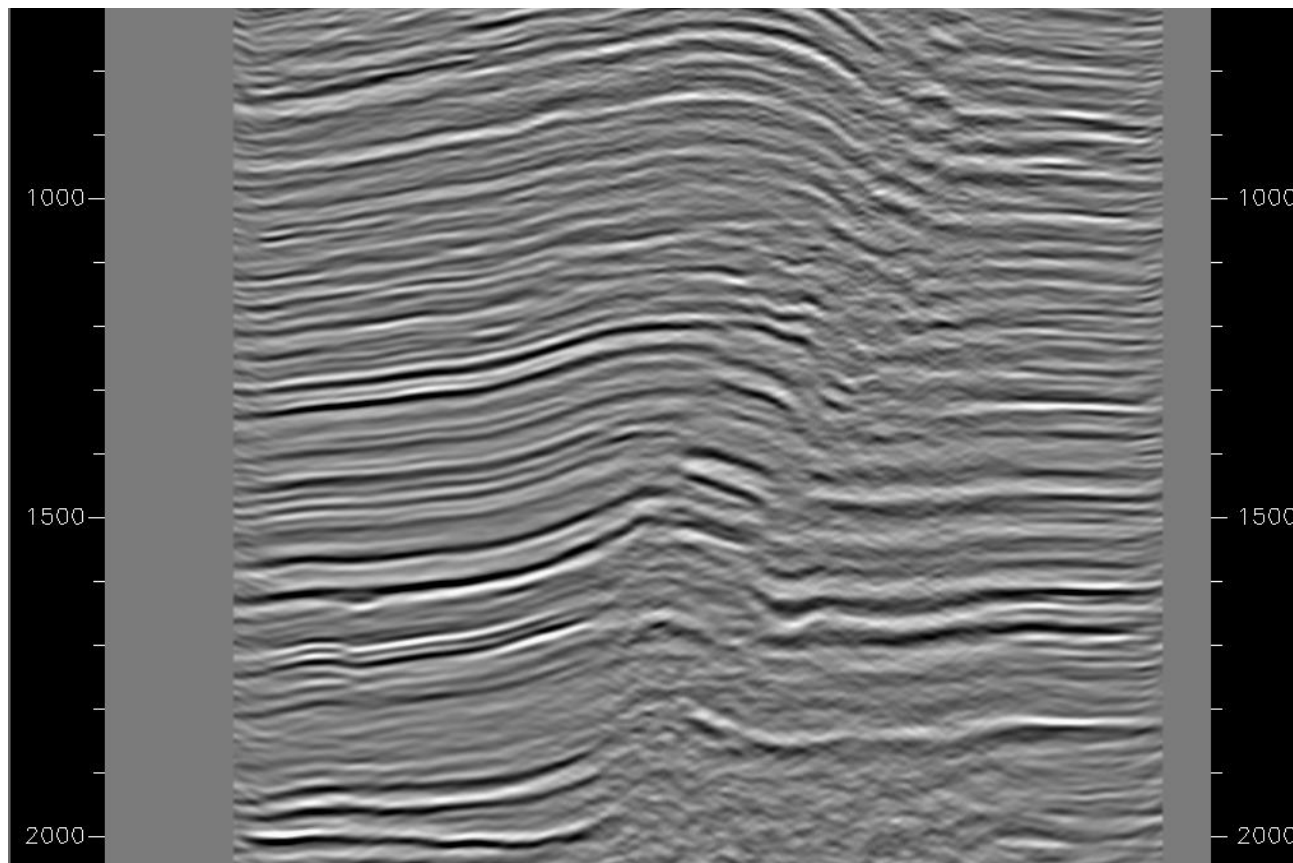
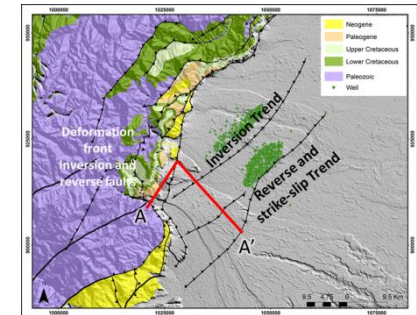
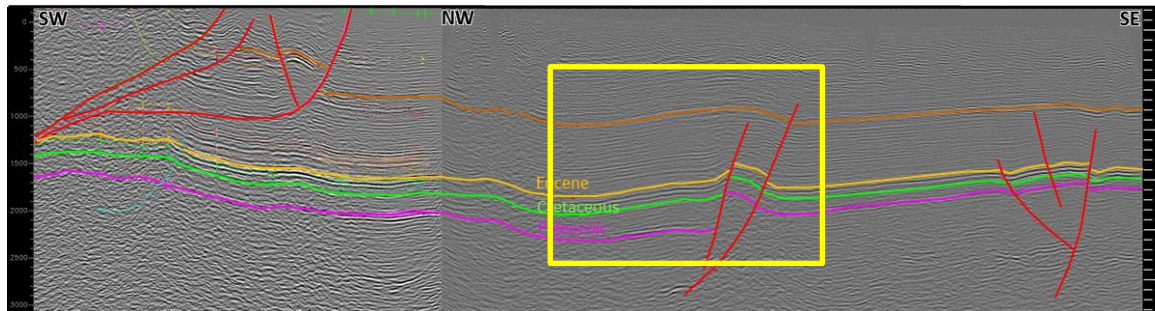
Regional Correlation



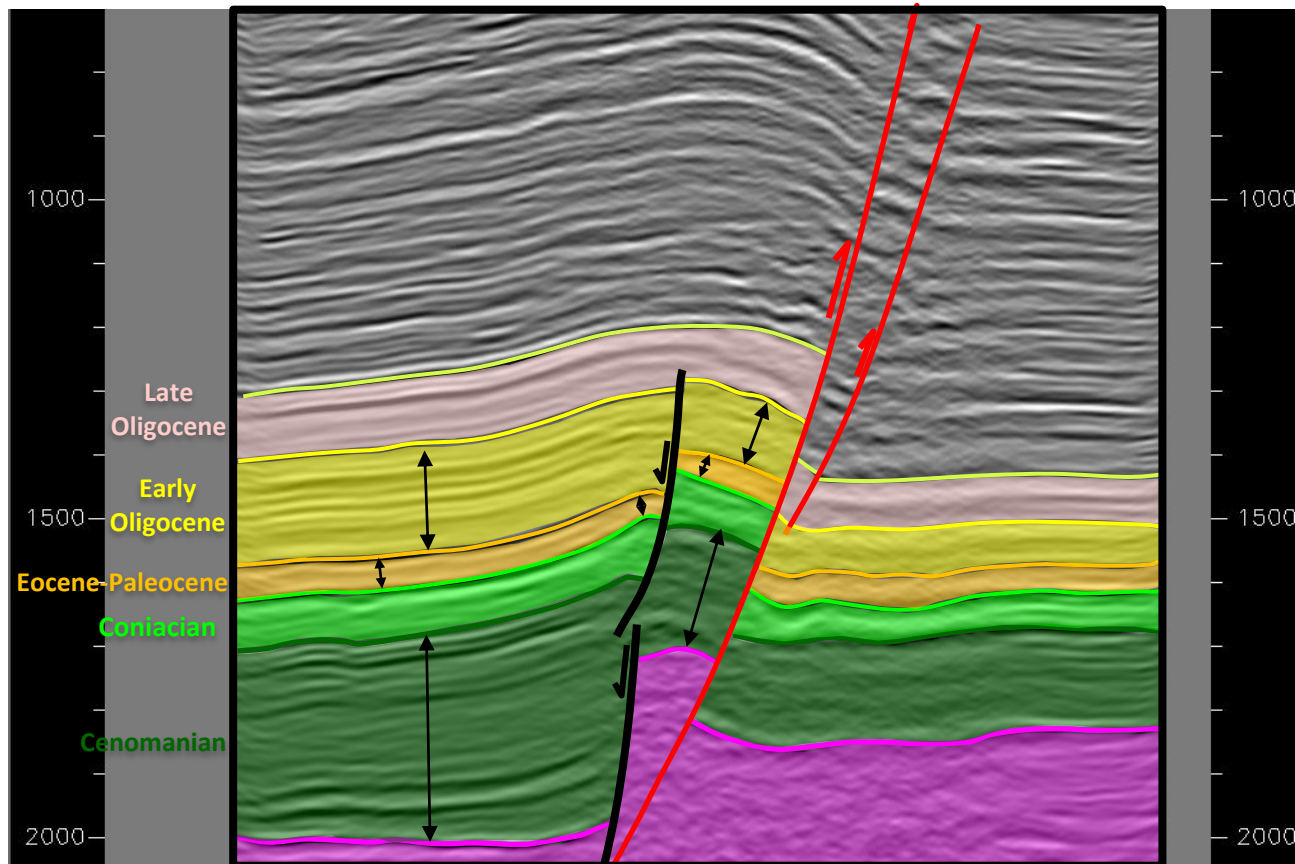
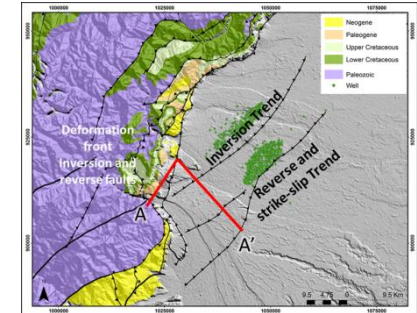
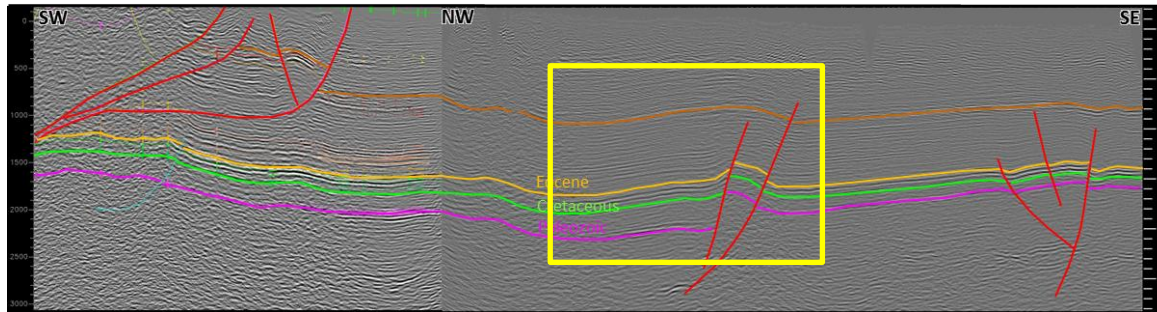
Regional Correlation



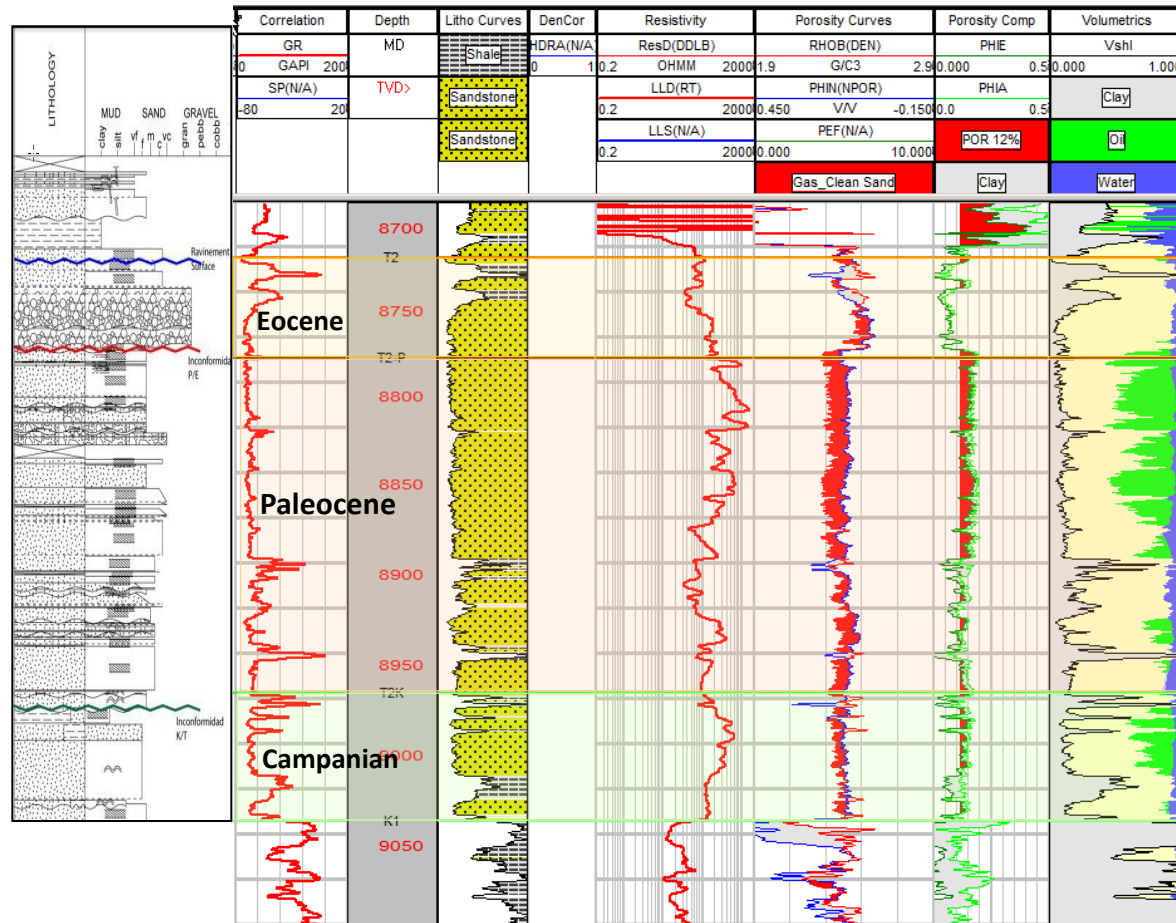
Seismic and structural interpretation



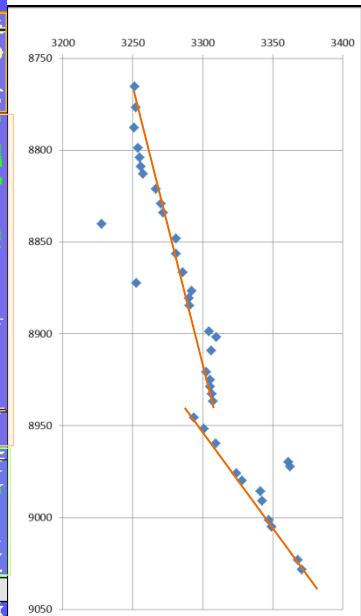
Seismic and structural interpretation



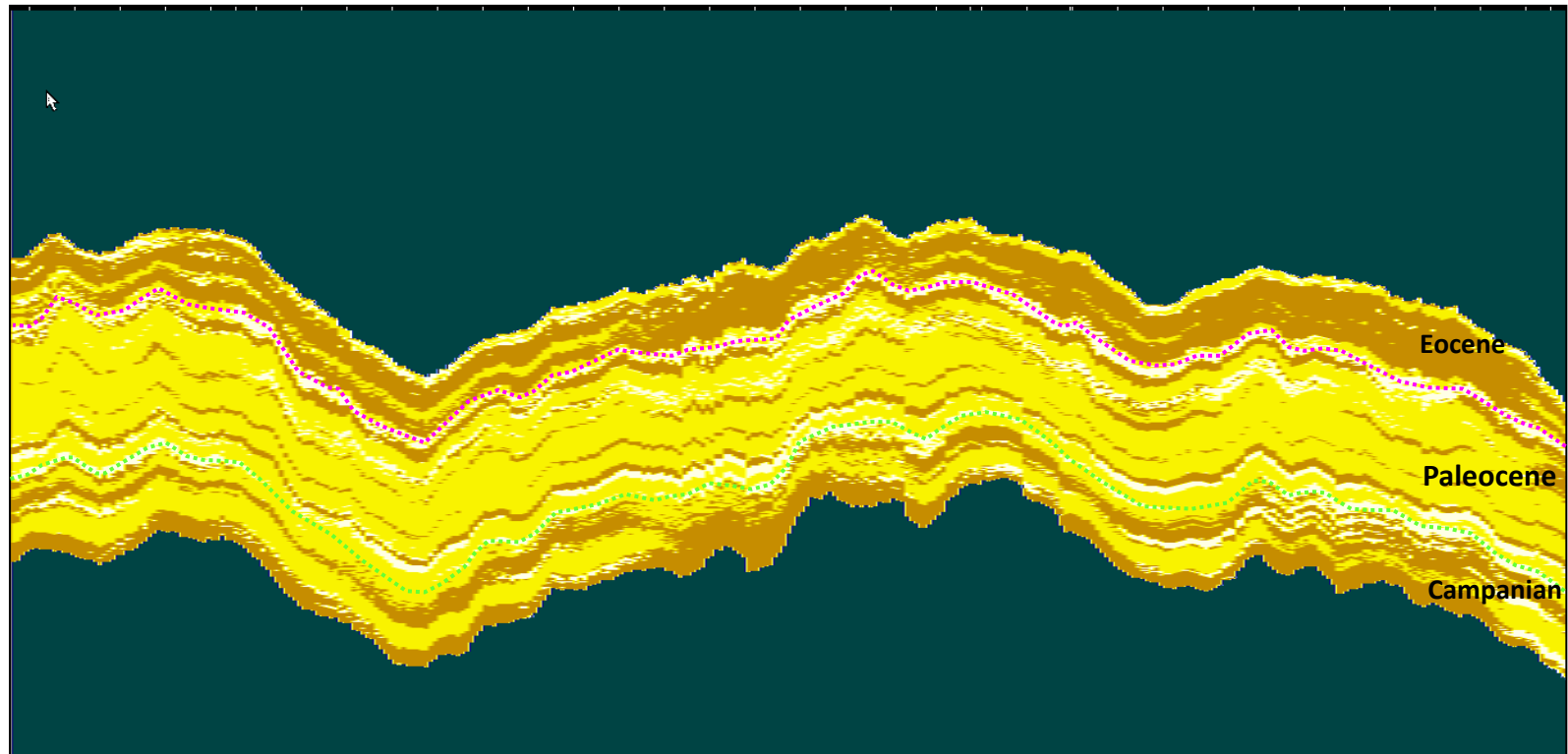
Reservoir Properties and Productivity




Pressure





Stochastic seismic inversion



Most Probable Lithology

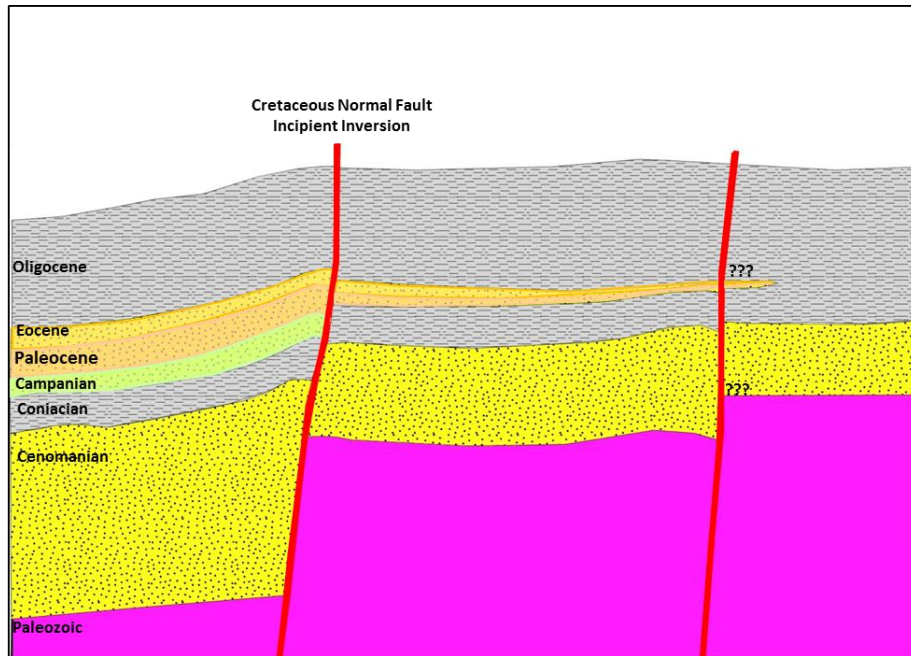
 **Good Sands**
Vshale < 0.25
Por > 0.1
Perm > 480 md

 **Poor Sands**
Vshale < 0.25
Por > 0.1
Perm < 480 md

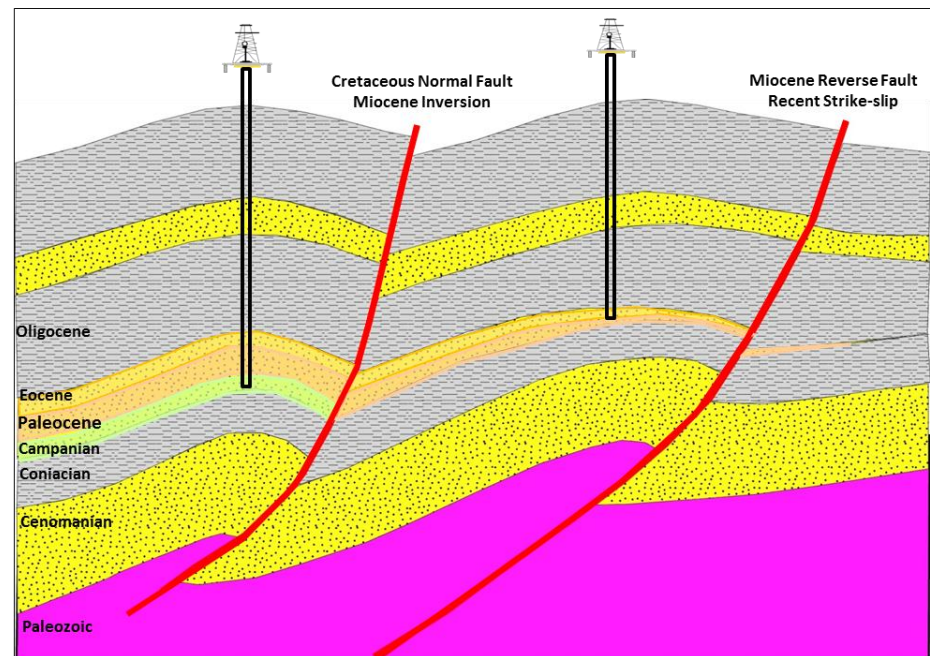
 **Shale**
Vshale > 0.25
Por < 0.1



Play Concept



Late Oligocene configuration
Early charge of stratigraphic trap formed after
Oligocene seal deposition and compaction



Present-day configuration
Passive deformation of old stratigraphic trap



Concluding Remarks

- The main reservoir in the southern Llanos Foreland Basin, operationally known as T2, consists of 3 chronostratigraphic intervals:
Eocene Mirador Formation
Paleocene Barco Formation
Campanian Guadalupe Formation

According to chronostratigraphic subdivision the T2 nomenclature should be avoided.

- Chronostratigraphic intervals are evident in depositional, petrographic and provenance features, as well as in the seismic data.
- Geochronological divisions reflect a strong structural control in the deposition related to successive extensional and contractional events.
- Reservoir time divisions also explain changes in rock quality, hydrocarbon production and pressure trends.
- Understanding the T2 unit as a multistage reservoir allows proposal of new play concept: Upper Cretaceous, Paleocene, and Eocene reservoirs may conform a regional giant stratigraphic trap, charged during multiple Paleogene events.





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