

GEOLOGIC INTEGRATION, PETROLEUM SYSTEM EVALUATION AND PROSPECTIVITY OF COLOMBIAN FRONTIER BASINS: NORTHERN MIDDLE MAGDALENA AND CESAR – RANCHERÍA

Presentation Outline

Introduction

E. Velásquez

Stratigraphy

G. Bayona

Seismic interpretation and structural framework

G. Montenegro

Petroleum systems, play fairway and YTF

P. Chajin

Wrap up

E. Velásquez

DIRECTOR
Enrique Velásquez

UPTC LIAISON
Carlos Julio
Rodríguez

SIG
Oscar Rodríguez

**DATA
MANAGER**
Sonia Ponguta

STRATIGRAPHY
Germán Bayona

PETROPHYSIC
Helman Bonilla

STRUC. GEOL.
Martin Morales

SEISMIC INTERP.
Gustavo
Montenegro

**PETRO. SYSTEMS &
PLAYS**
Cesar Mora

Carlos Rojas

María Alejandra
Joya

Angela
Navarrete

Paula Arcila

Catherine
Jaimés

Yet to Find
Claudia Posada

Catalina Niño

Patricia Chajín

Cristian
Peñafort

GEOLOGIC INTEGRATION, PETROLEUM SYSTEM EVALUATION AND PROSPECTIVITY OF COLOMBIAN FRONTIER BASINS: NORTHERN MIDDLE MAGDALENA AND CESAR – RANCHERÍA

ANH Supervisor= Maria Cecilia Ruiz

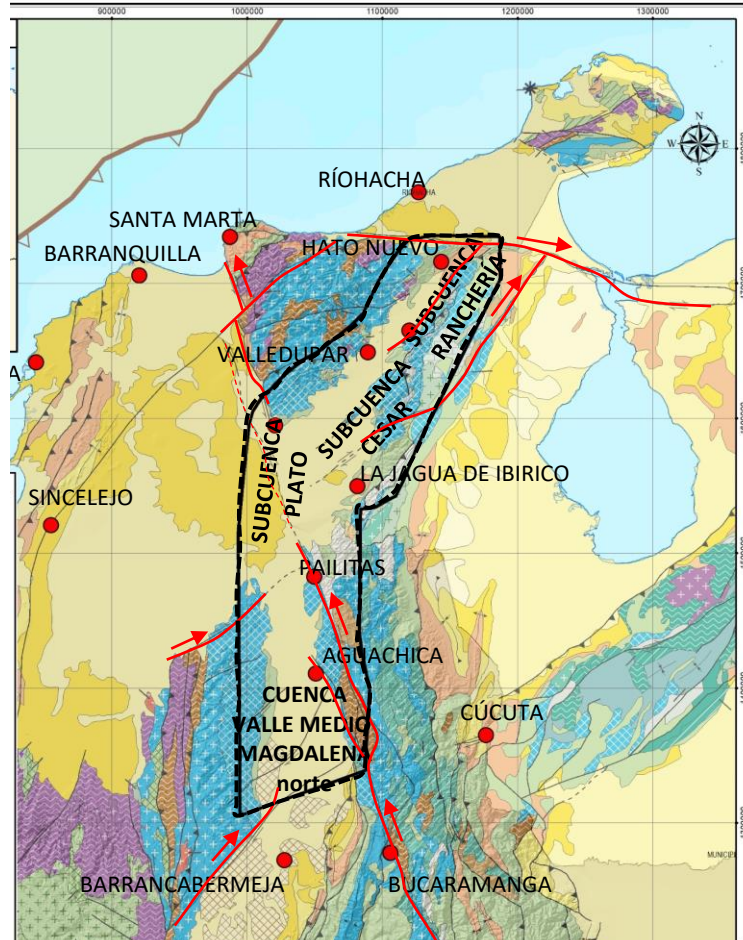
Content of chronostratigraphy and paleogeography

- Geologic setting
- Tectonostratigraphic evolution
- 2D basin geometry evolution
- Paleogeographic evolution
- Lithofacies distribution in present position
- Conclusions

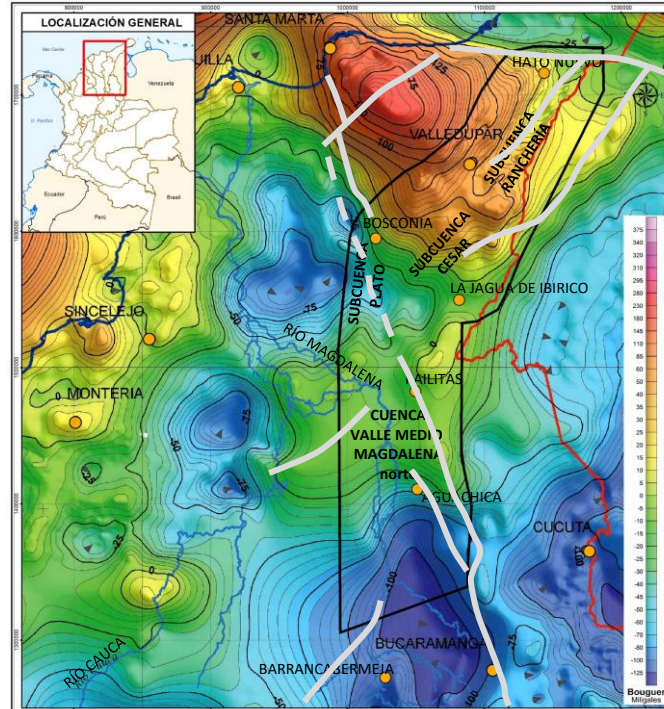
GEOLOGIC INTEGRATION, PETROLEUM SYSTEM EVALUATION AND PROSPECTIVITY OF COLOMBIAN FRONTIER BASINS: NORTHERN MIDDLE MAGDALENA AND CESAR – RANCHERÍA BASINS

Geologic setting

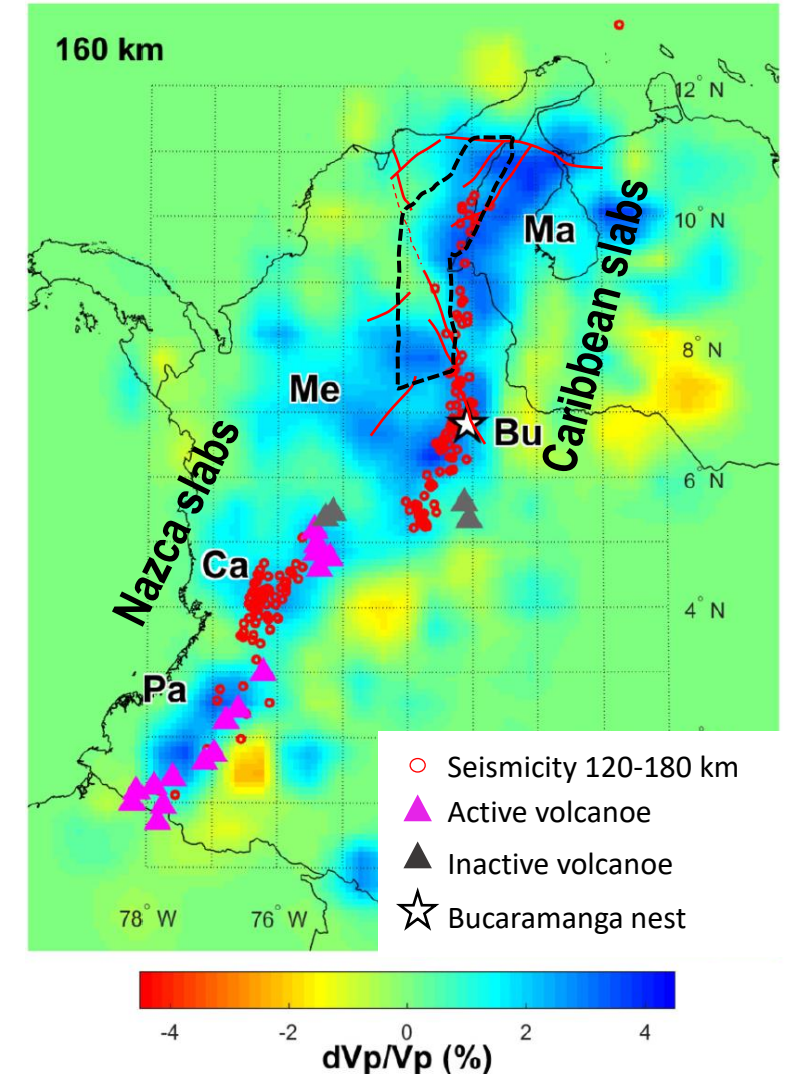
Surface geology (SGC, 2019; 2020)



Gravimetry (ANH, 2010)

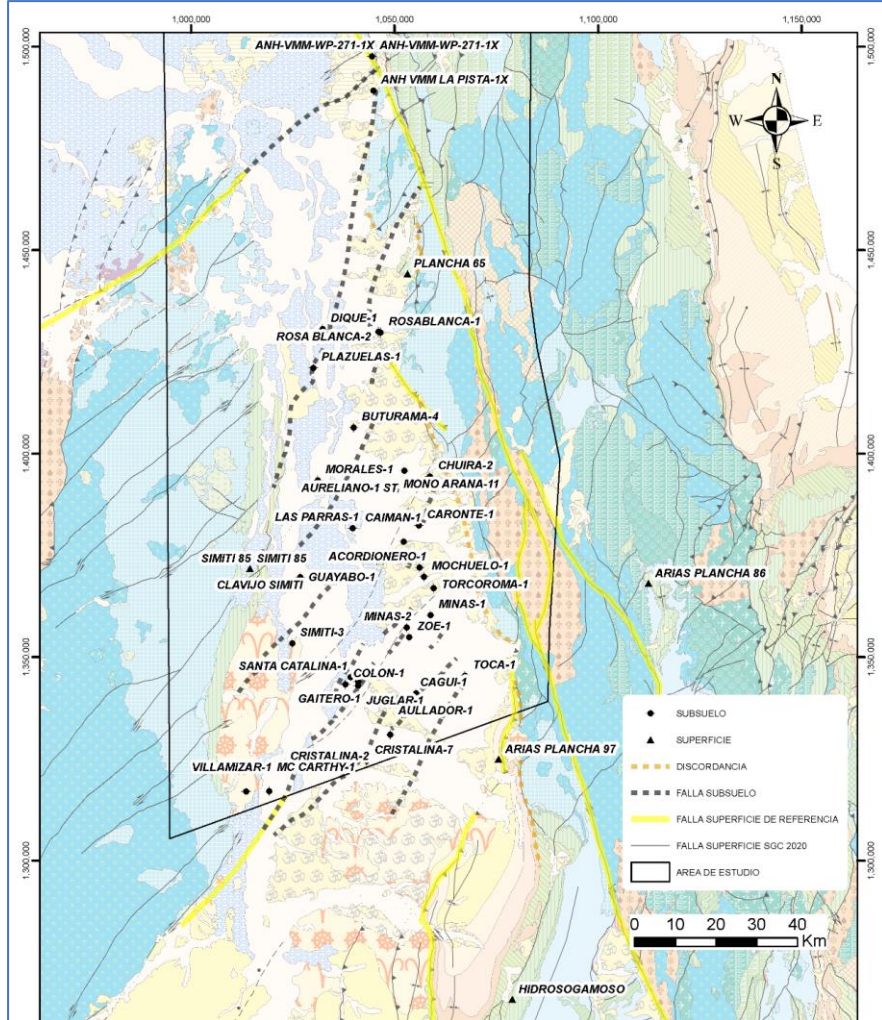


Tomography at 160 km; subduction slabs (Sun et al., 2021)



Tectonostratigraphic evolution

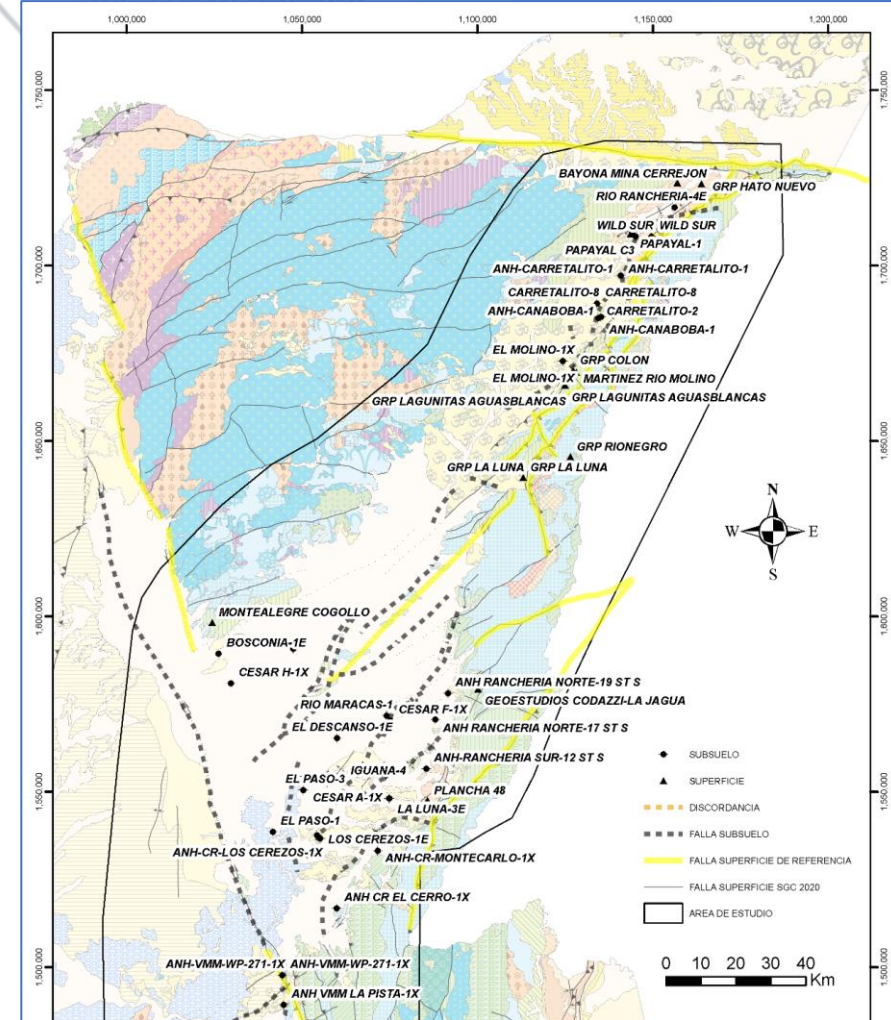
VMM NORTE



21 ANH-wells (core description, sedimentological, biostratigraphic, petrophysical analyses):

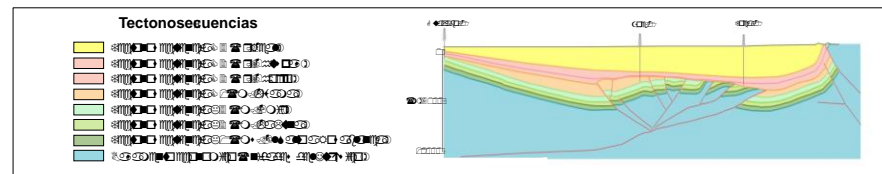
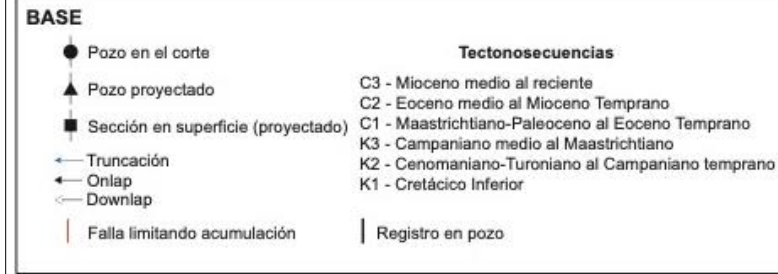
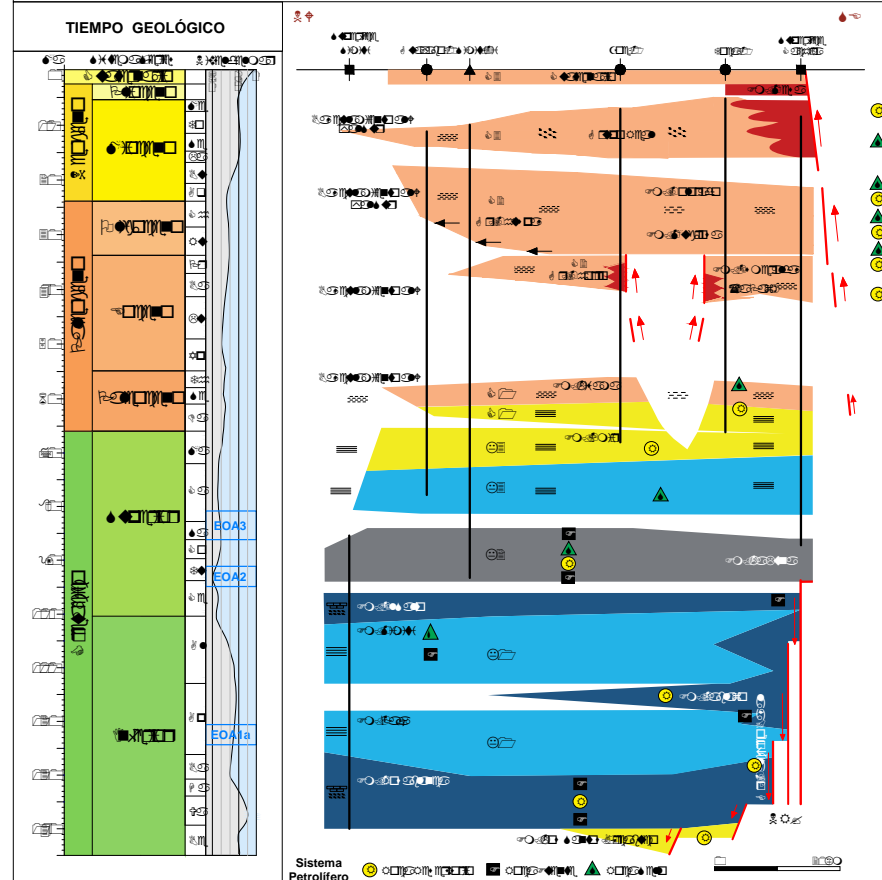
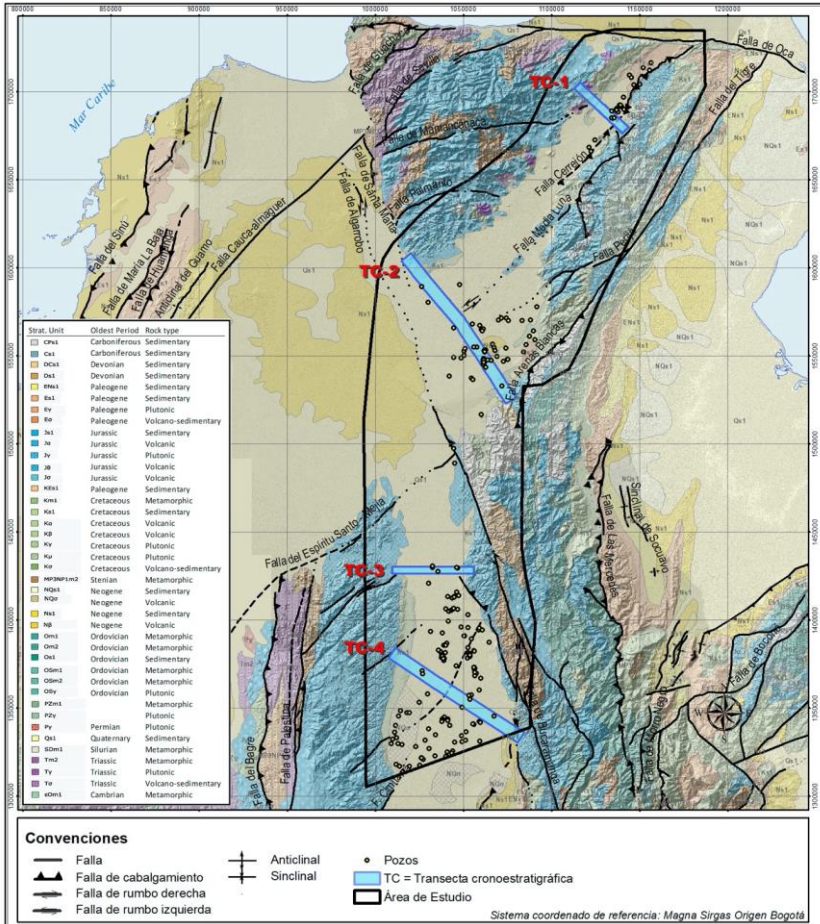
- Rancheria
- Cesar
- Northernmost VMM

CESAR - RANCHERIA



	CESAR	RANCHERIA	VMM North	Total
WELLS	23	10	35	68
SURFACE SECTIONS	3	10	6	19
Total	26	20	41	87

TC4 – SUR VMM NORTE



REFERENCIAS

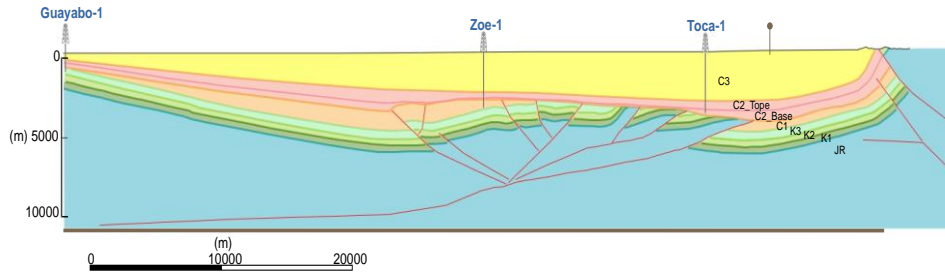
Tabla de tiempo geológico tomada de: Cohen, K.M., Finney, S.C., Gibbard, P.L. & Fan, J.-X. (2013; actualizada). The ICS International Chronostratigraphic Chart. Episodes 36: 199-204.

Curva del nivel del mar para el Cretácico tomada de: (HAQ, 2014)

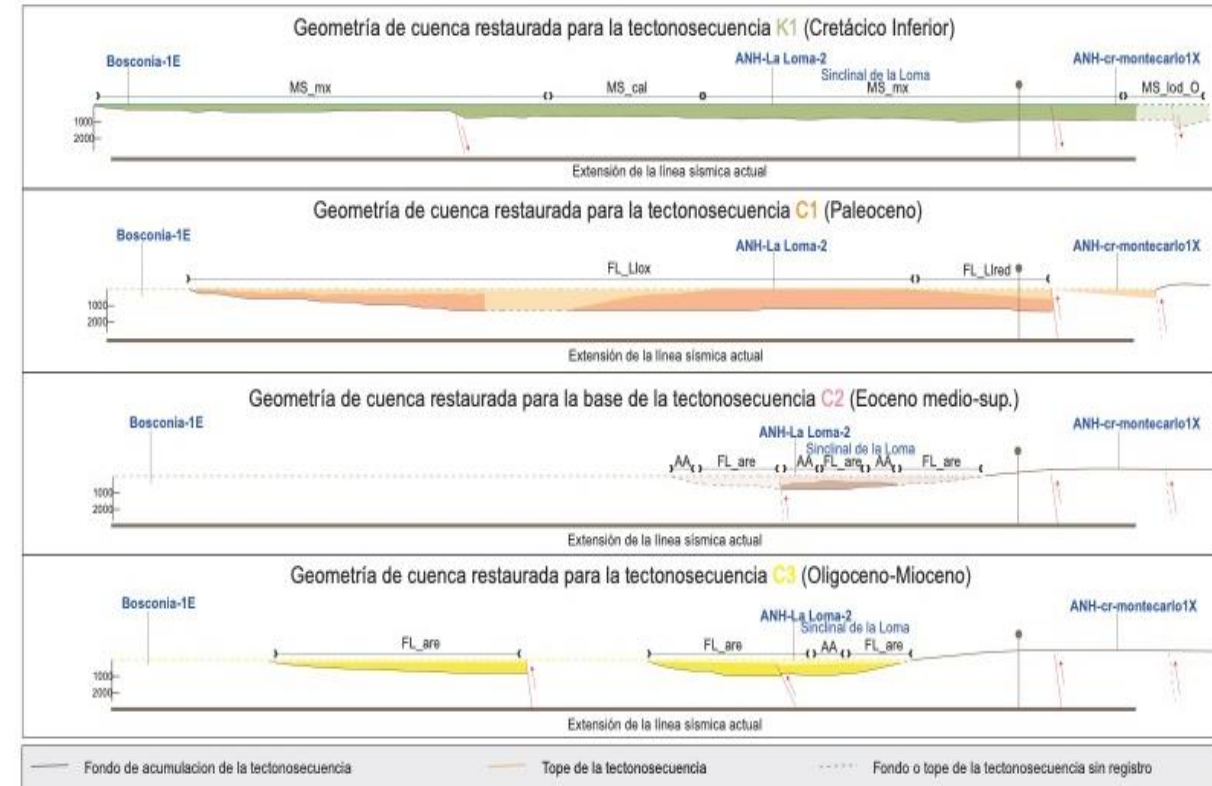
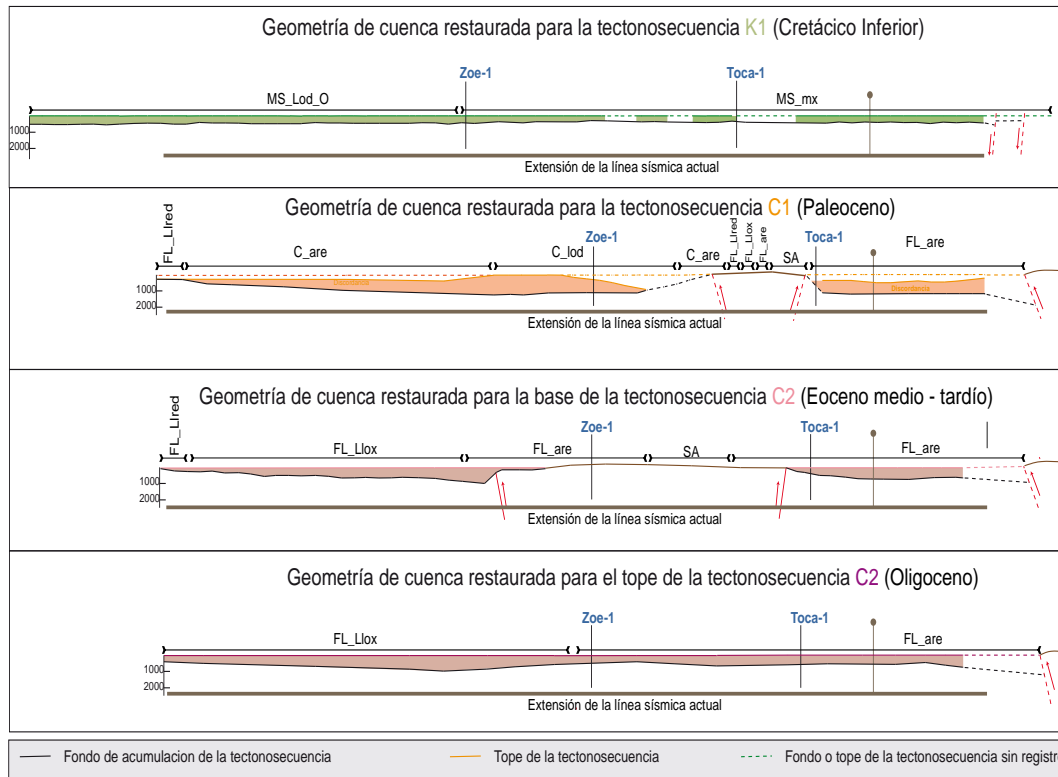
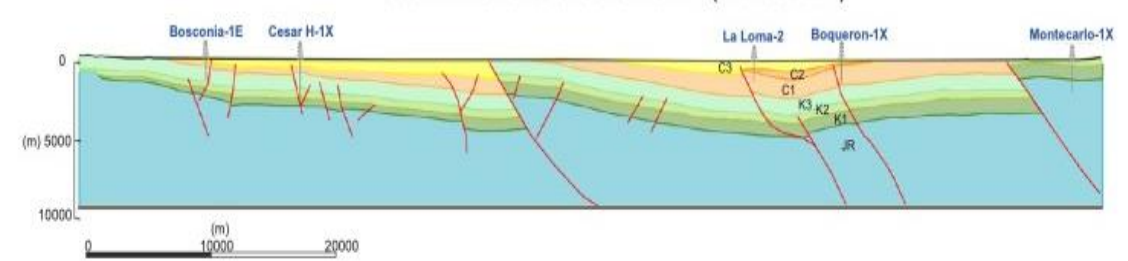
Curva del nivel del mar para el Cenozoico tomada de: (Hamberbol et al., 1998)

EOA = Eventos Oceánicos Anóxicos (tomado de Hu et al., 2012)

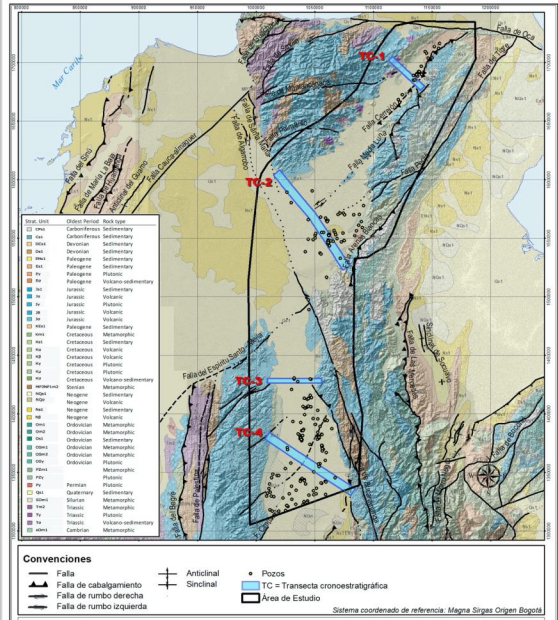
CORTE SUR VMMN



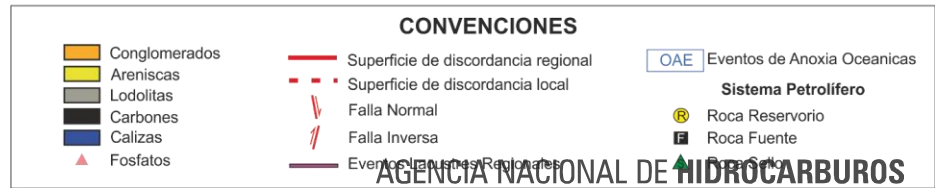
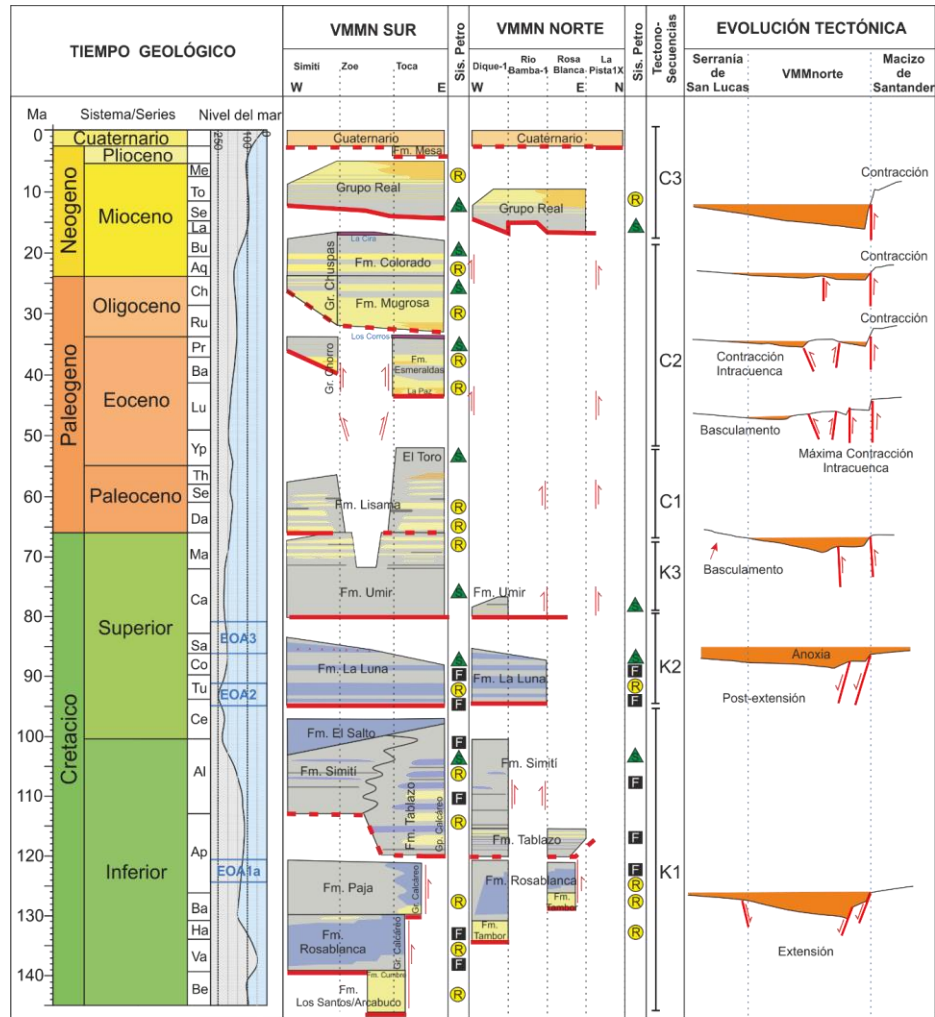
CORTE CESAR



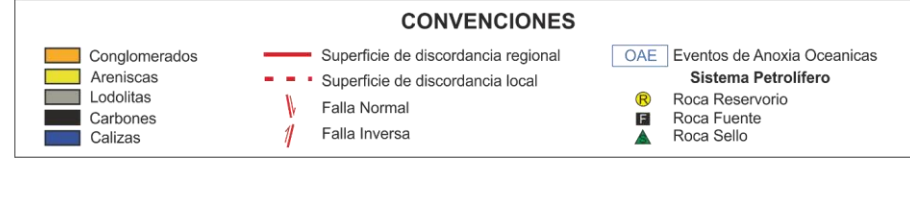
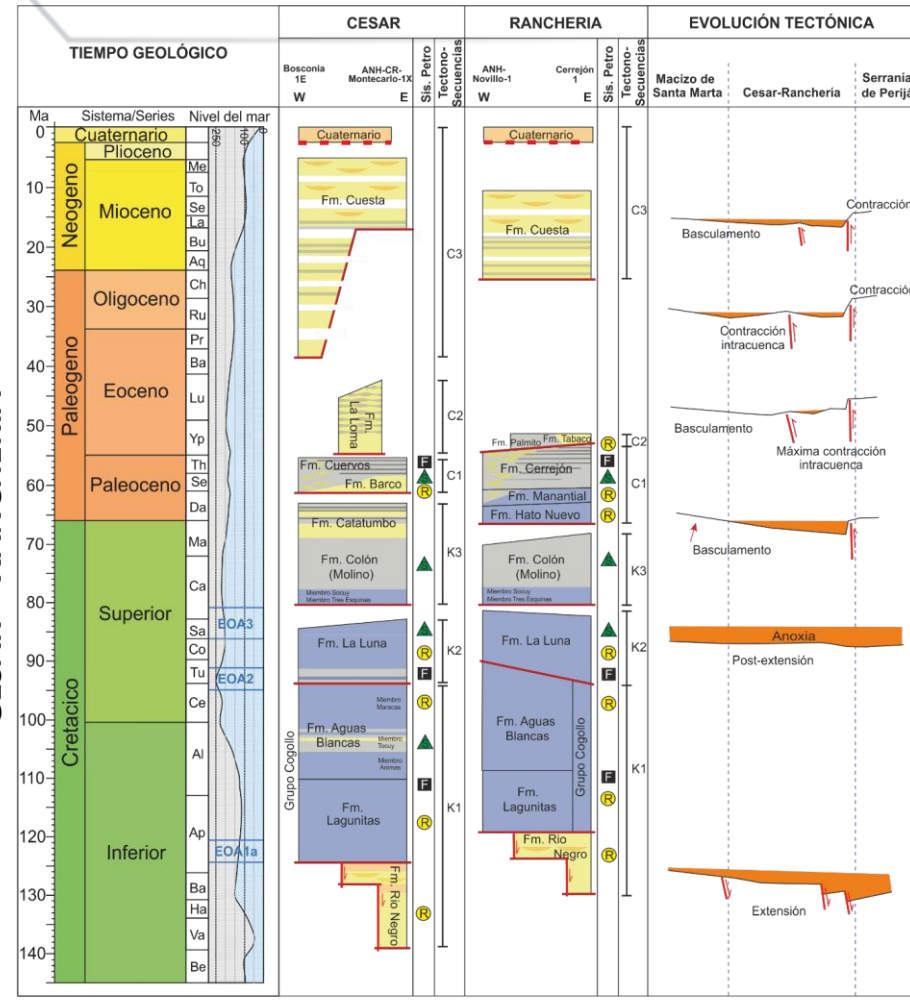
Tectonostratigraphic evolution



VMM NORTE

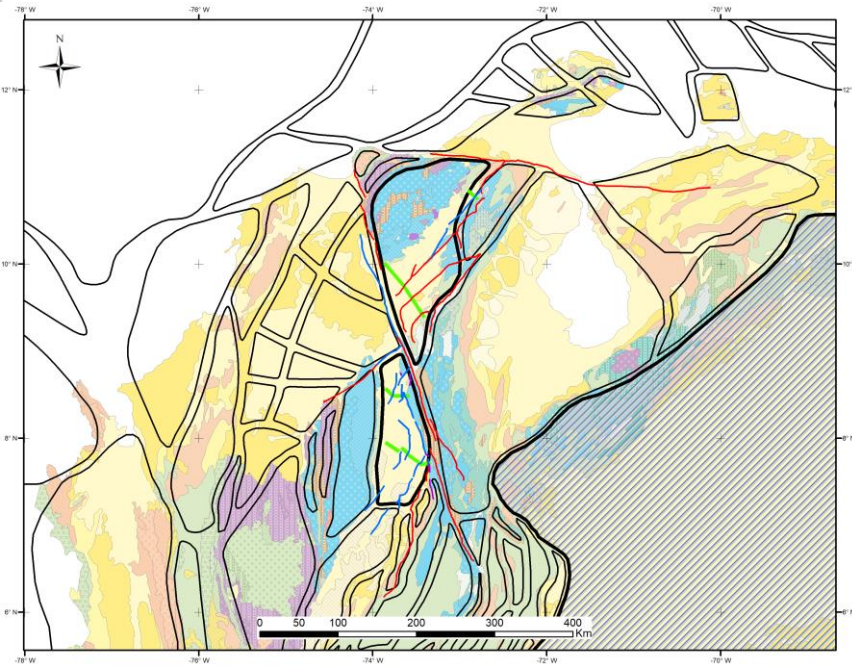


CESAR - RANCHERIA

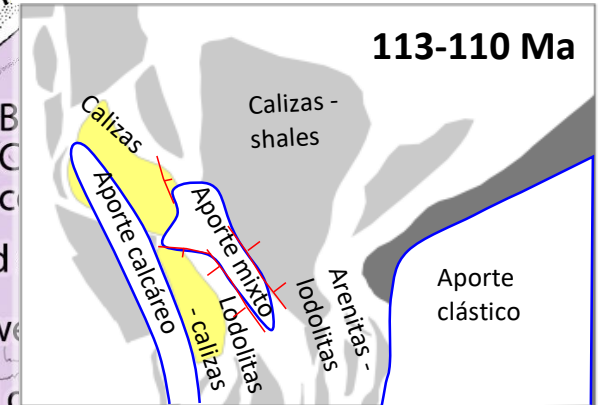
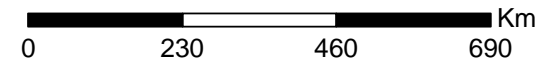
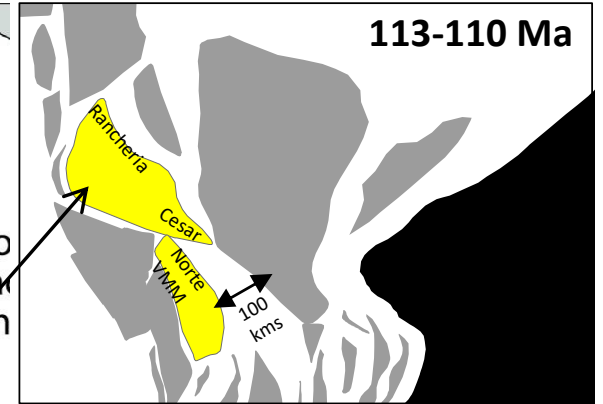
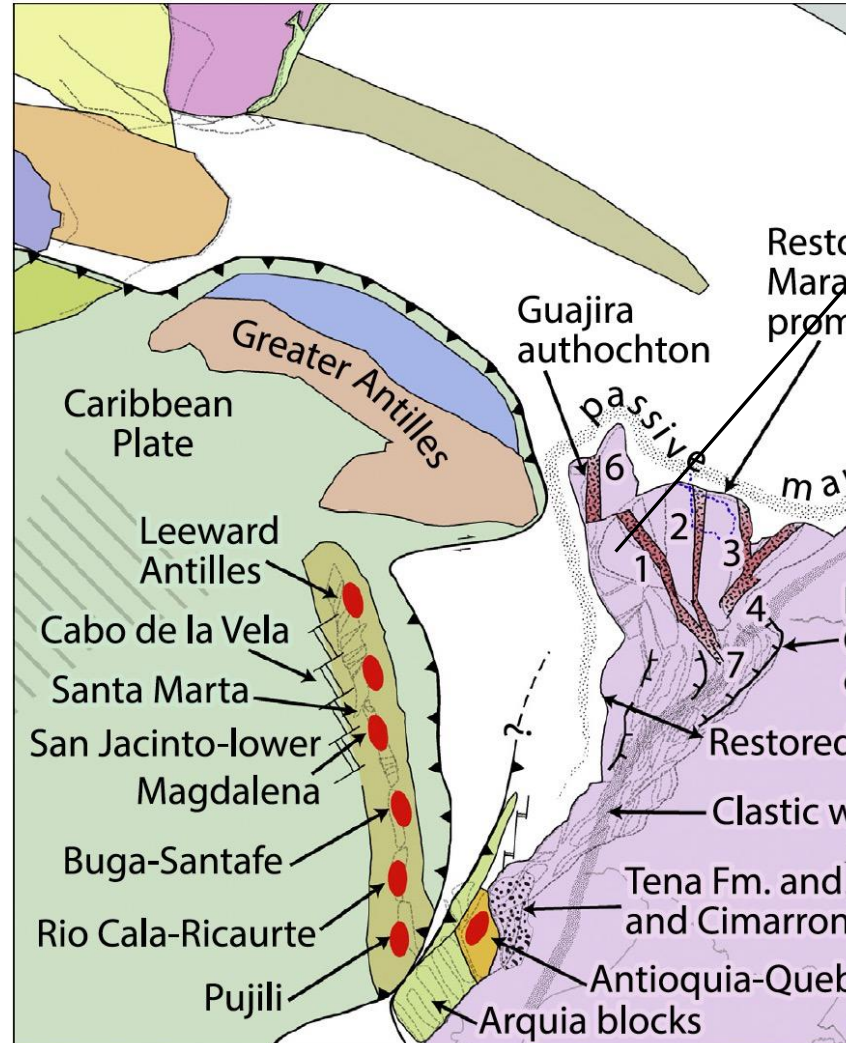


Paleogeographic evolution Albian (Tablazo – Cogollo units)

Montes et al. (2019)



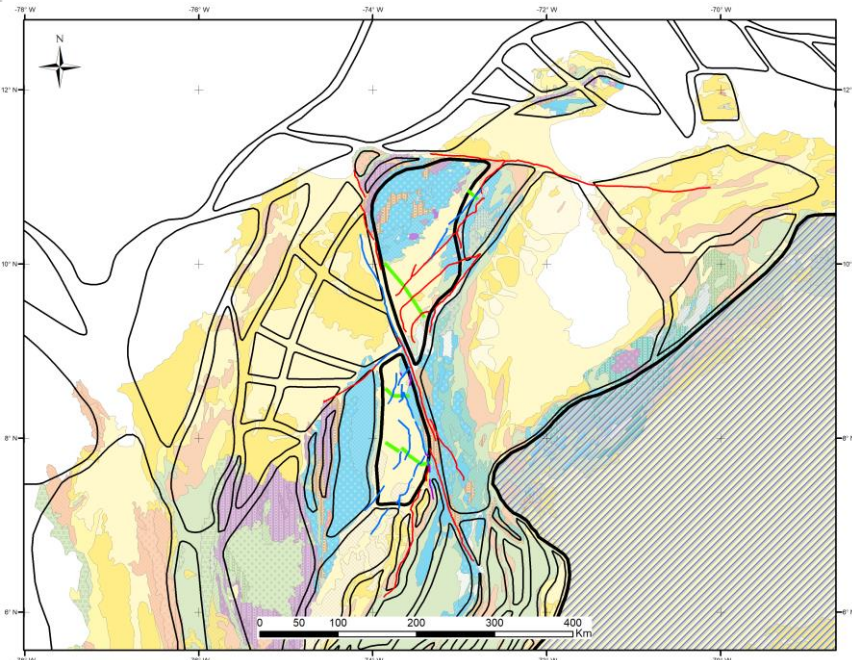
Montes et al. (2019)



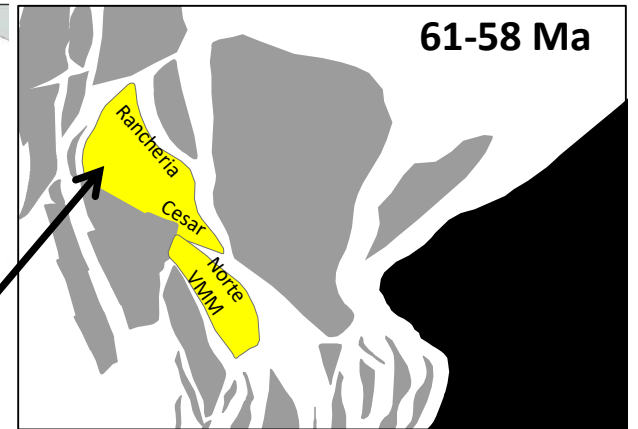
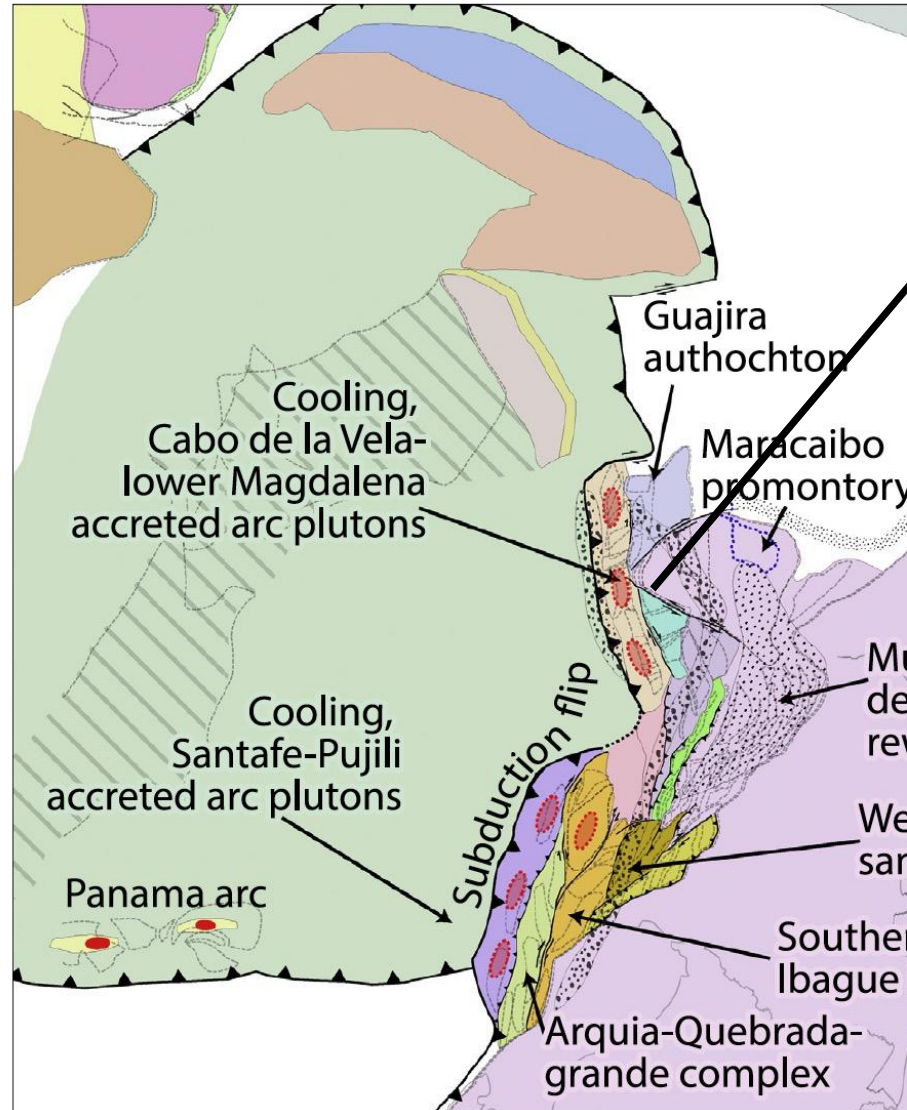
Fallas normales

Paleogeographic evolution Paleocene (Lisama – Cuervos/Cerrejon)

Montes et al. (2019)

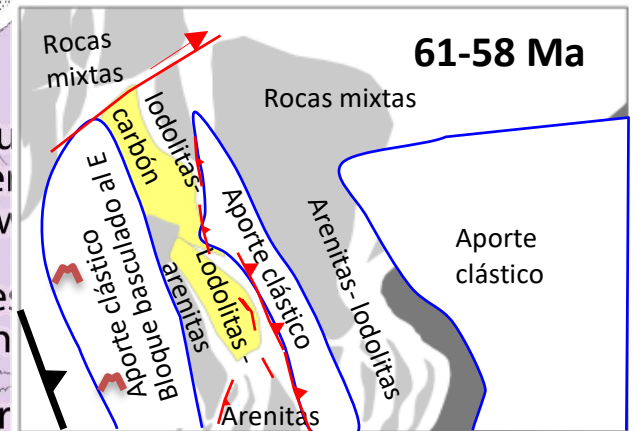


Montes et al. (2019)



61-58 Ma

0 230 460 690 Km



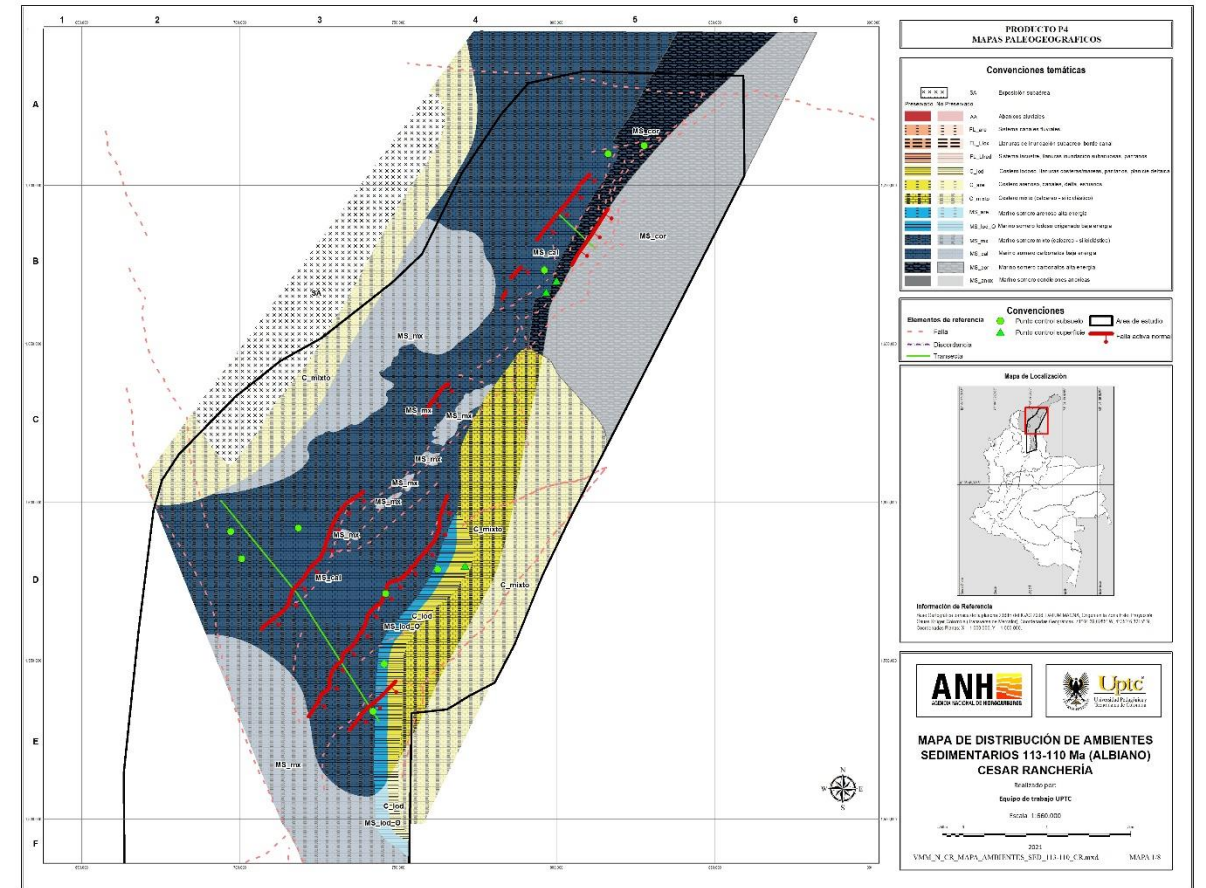
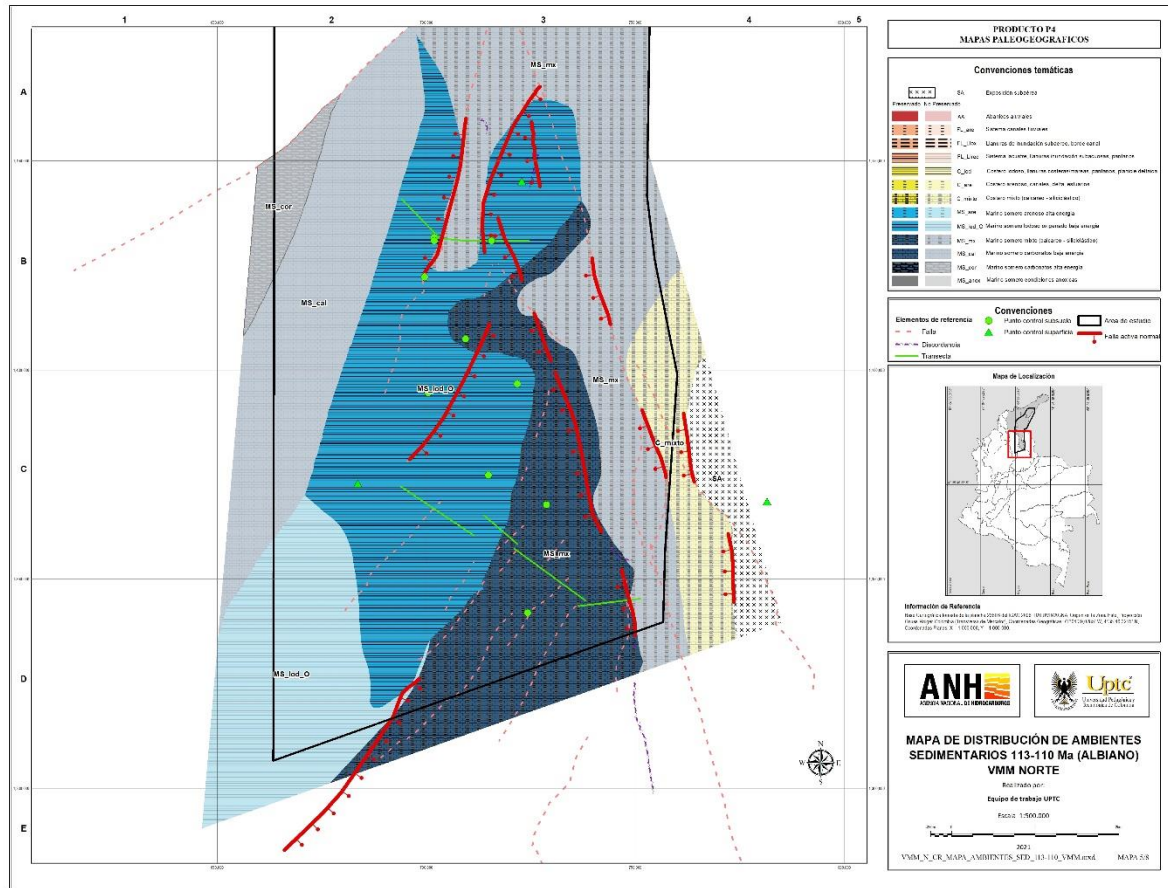
61-58 Ma

- Fallas inversas
- Fallas de rumbo
- Arco magmático
- Zona de subducción

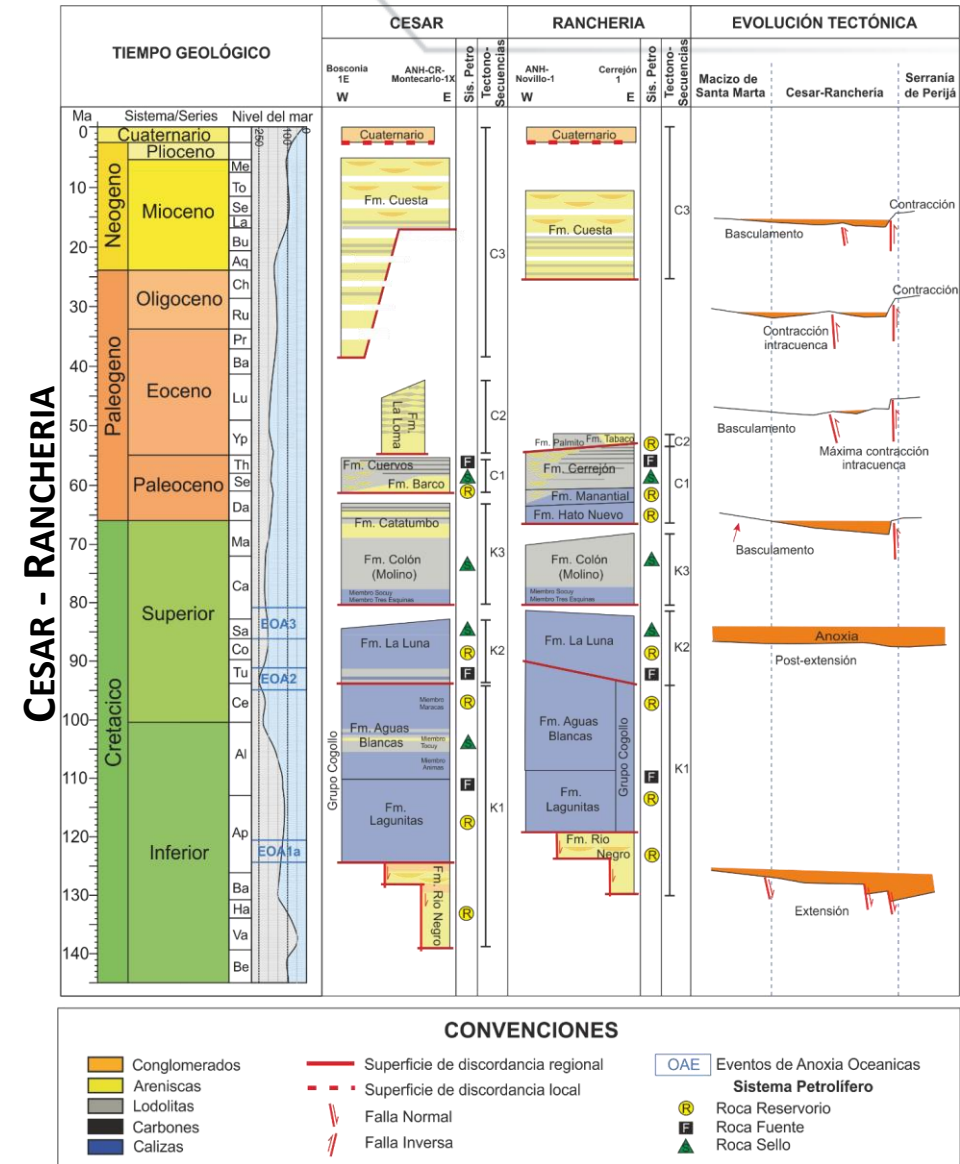
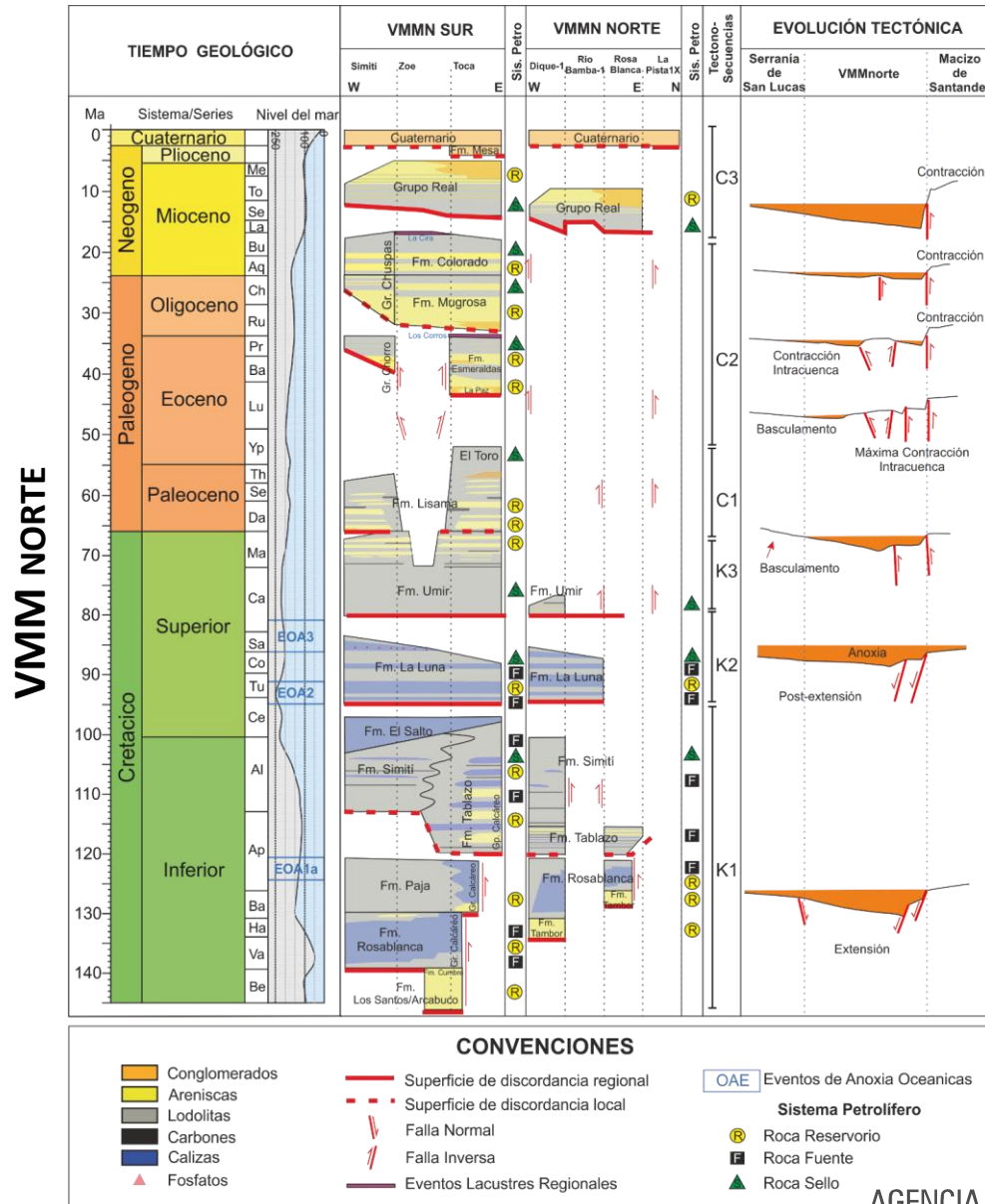
Lithofacies distribution in present position Albian (Tablazo – Cogollo units) RESERVOIR 1 - Intraformational seal - Source

VMM NORTE

CESAR - RANCHERIA

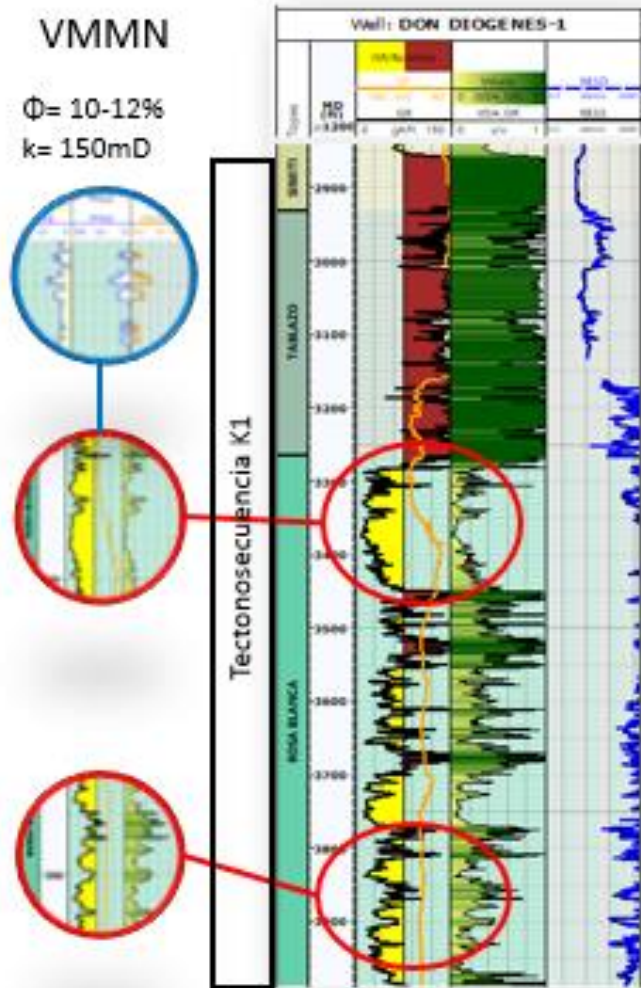


Conclusions

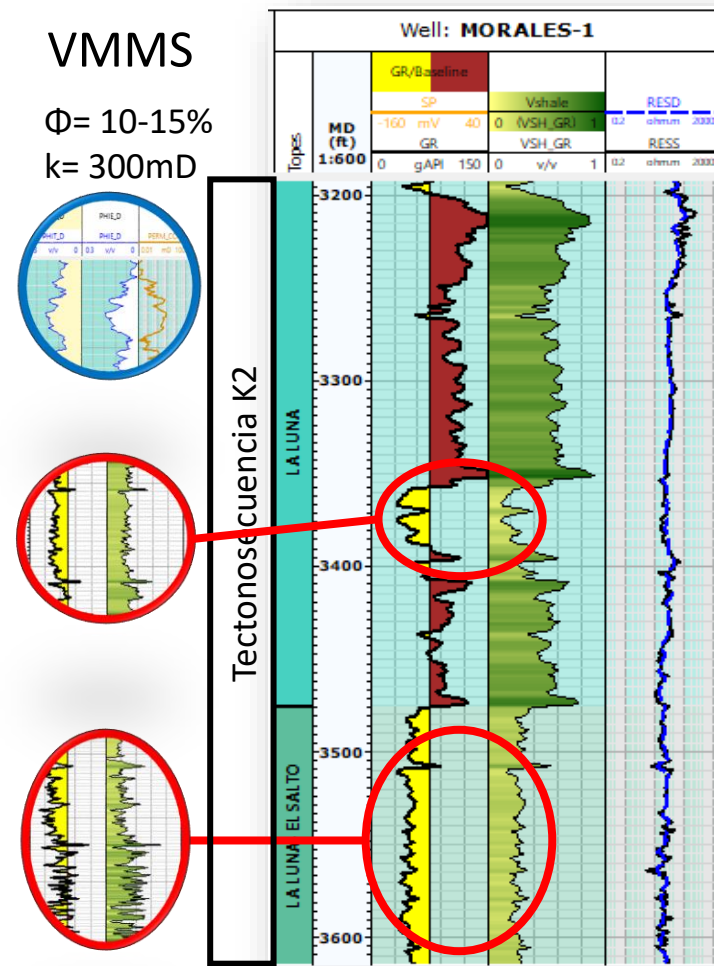


ROLE OF CRETACEOUS UNITS IN THE PETROLEUM SYSTEM

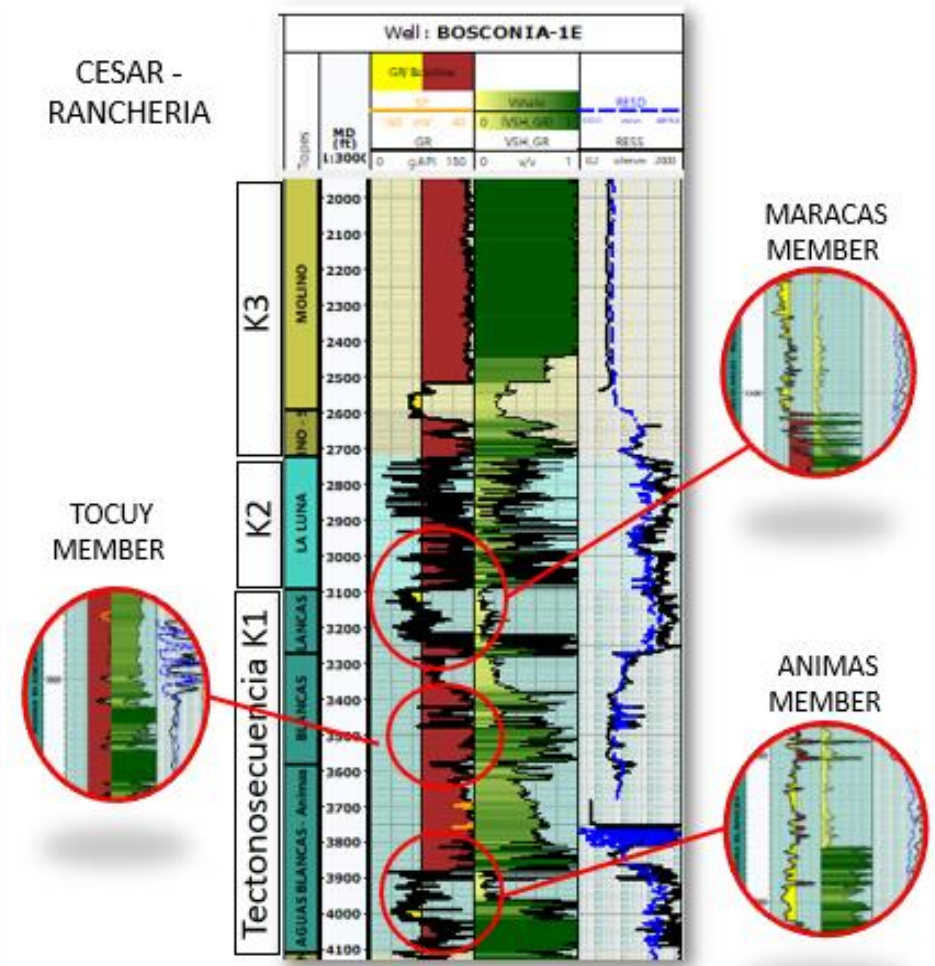
ROSA BLANCA - TABLAZO – SIMITI (K1)



LA LUNA – EL SALTO (K2)



AGUAS BLANCAS (K1) – LA LUNA (K2)



ROLE OF PALEOGENE UNITS IN THE PETROLEUM SYSTEM

LISAMA (C1)

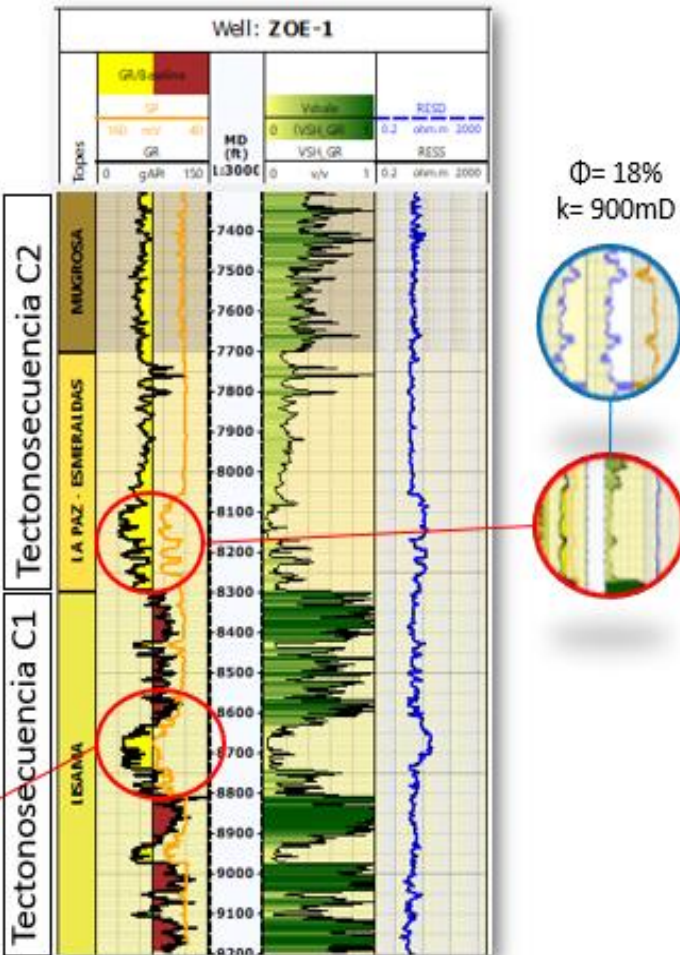
LA PAZ-ESMERALDA (C2) – MUGROSA-COLORADO (C2)

HATO NUEVO-MANANTIAL

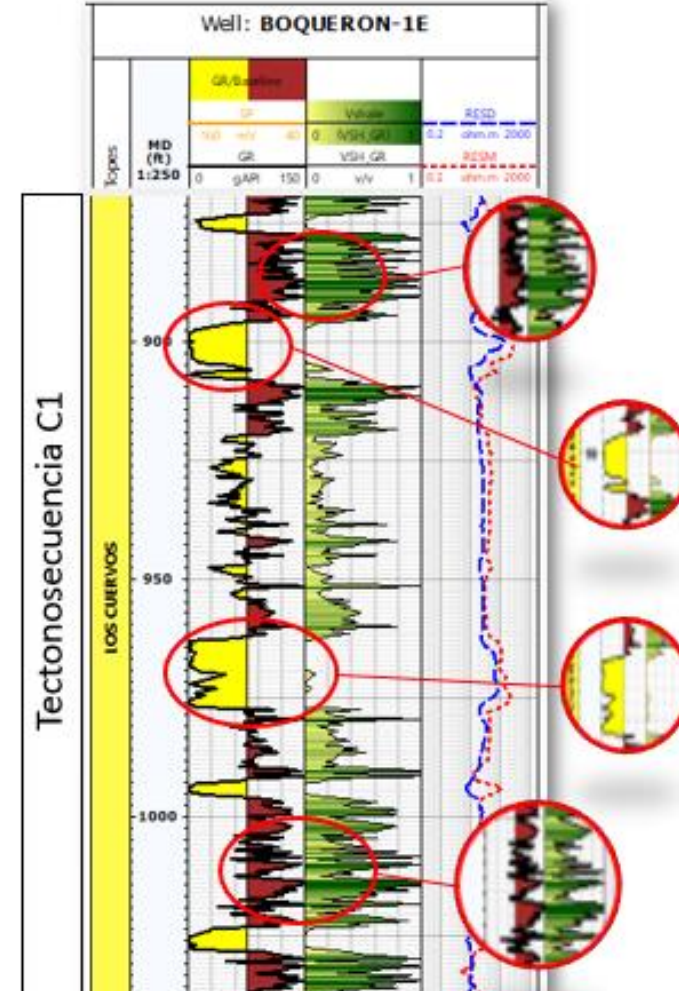
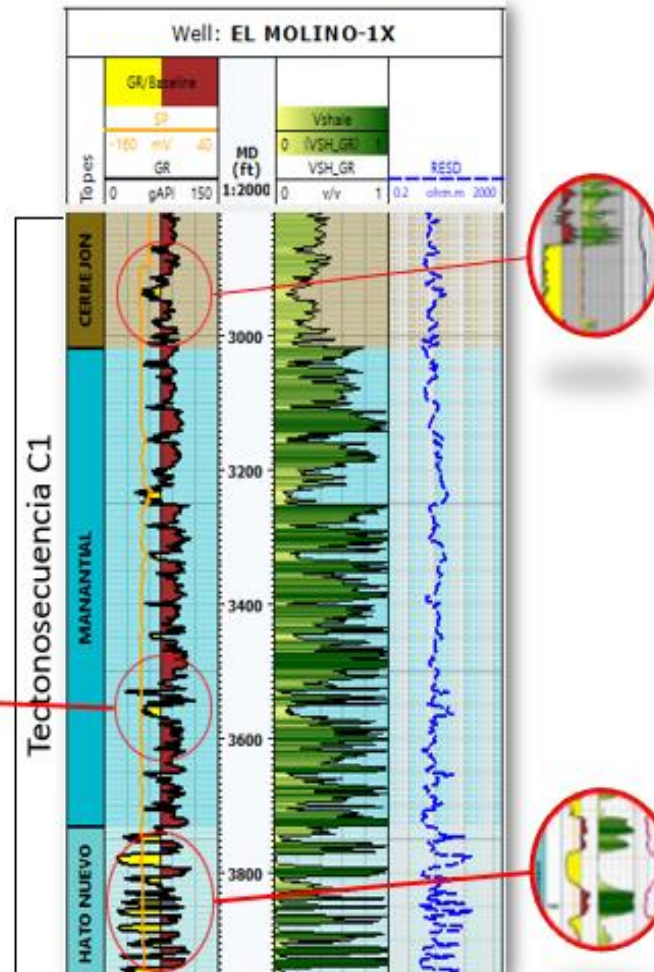
CERREJON (C1)

LOS CUERVOS (C1)

VMMS



CESAR -
RANCHERIA

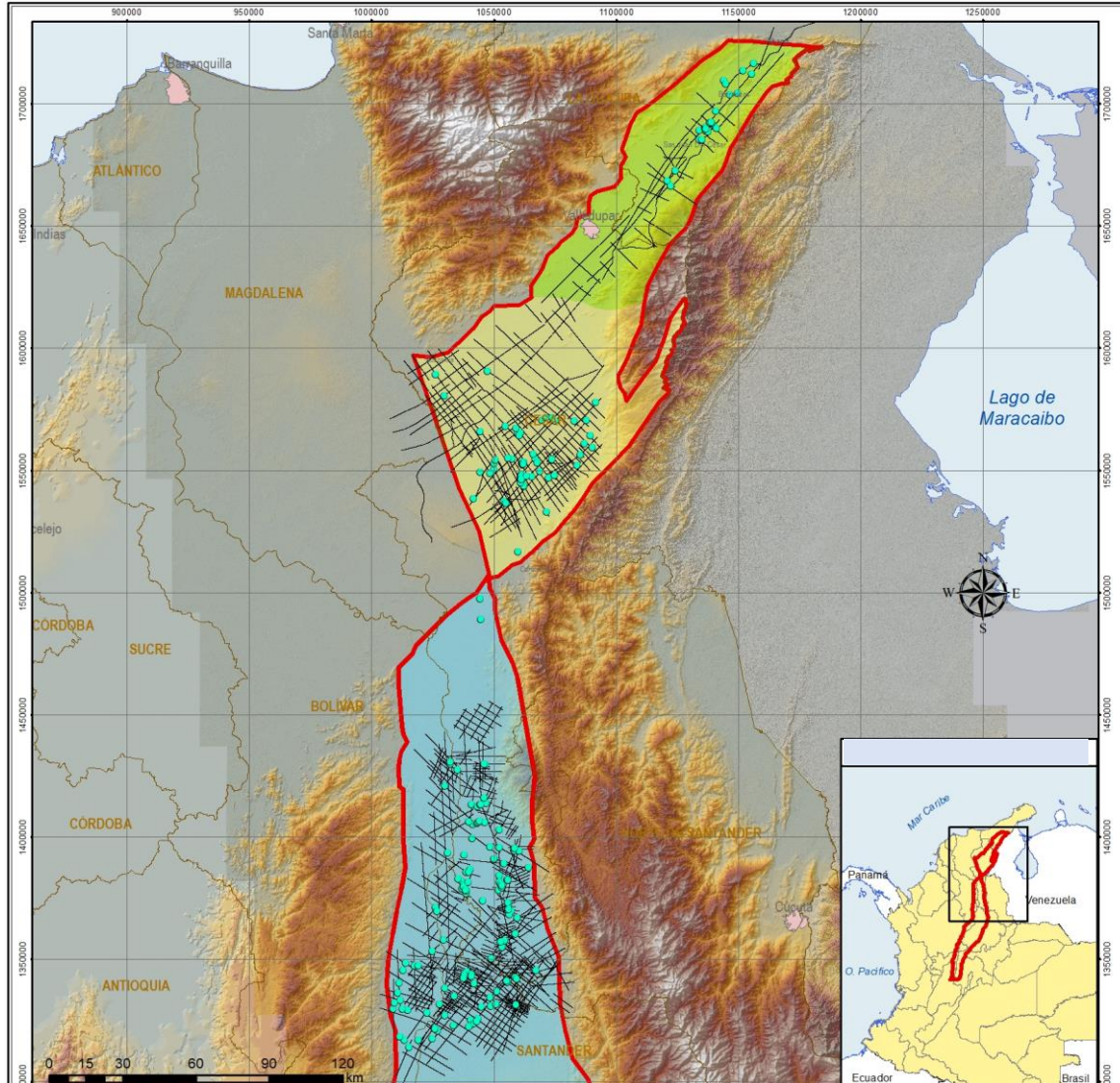


GEOLOGIC INTEGRATION, PETROLEUM SYSTEM EVALUATION AND PROSPECTIVITY OF COLOMBIAN FRONTIER BASINS: NORTHERN MIDDLE MAGDALENA AND CESAR – RANCHERÍA BASINS

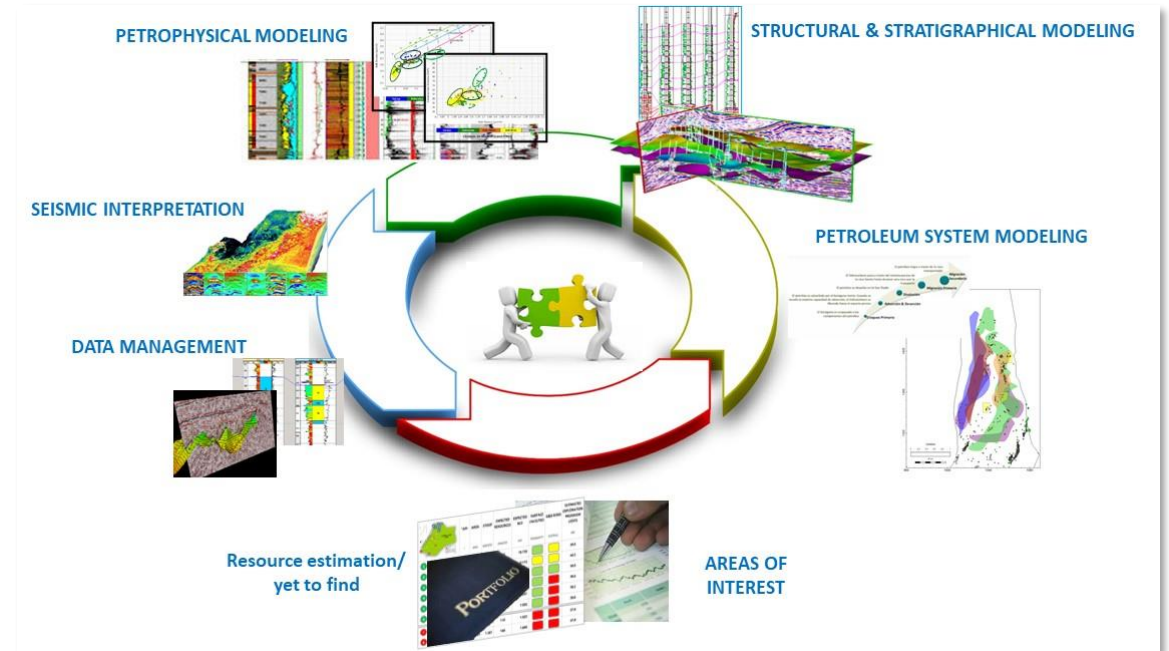
SEISMIC INTERPRETATION STRUCTURAL SECTIONS

UPTC INTERPRETATION TEAM

LOCATION.



INTEGRATED WORKFLOW

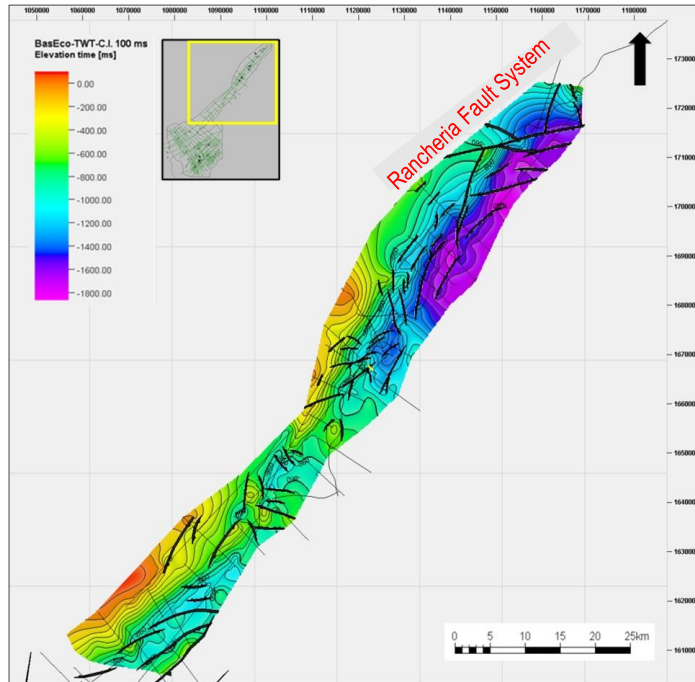


AVAILABLE INFORMATION

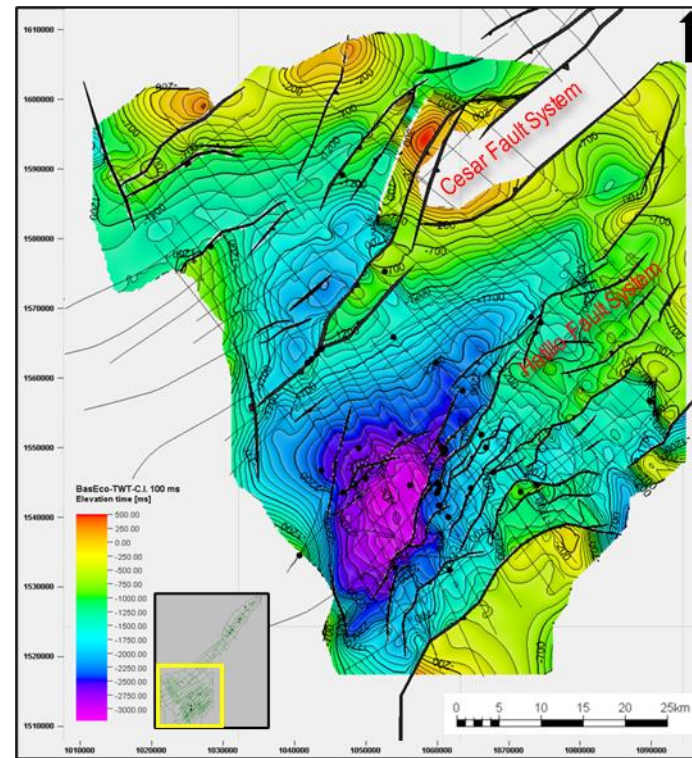
BASIN	WELLS	SEISMIC LINES	2D Km
Cesar Ranchería	95	132	3,366 Km
Norte VMM	150	421	5.507 Km

ECONOMIC BASEMENT MAPS

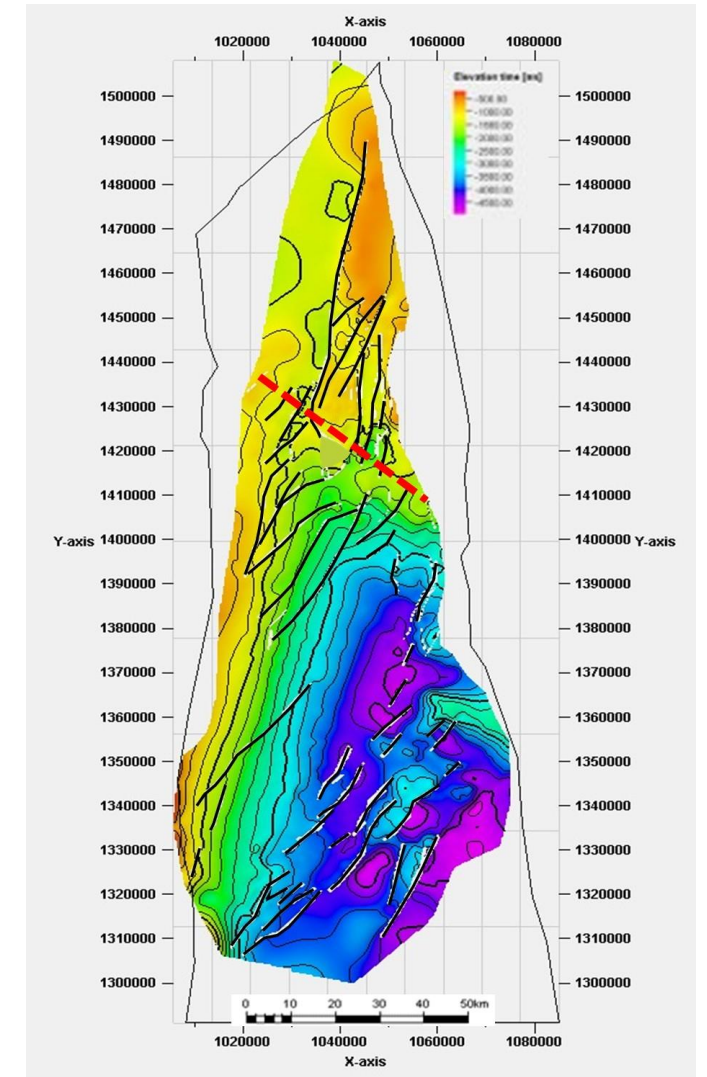
RANCHERIA BASIN



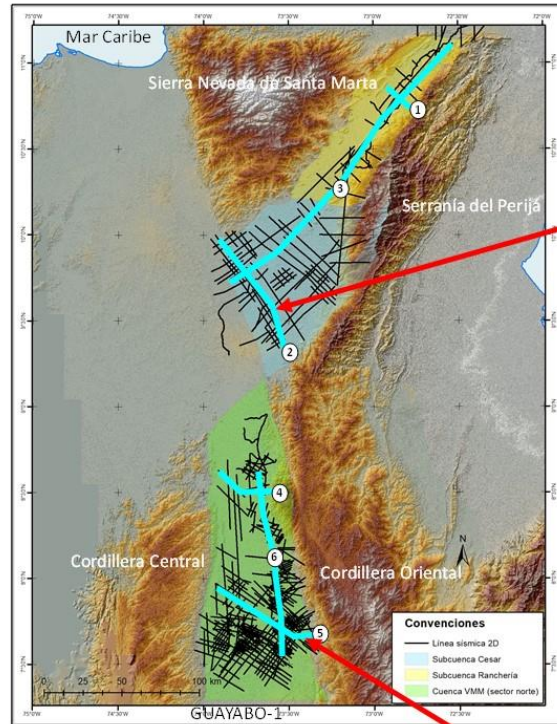
CESAR BASIN



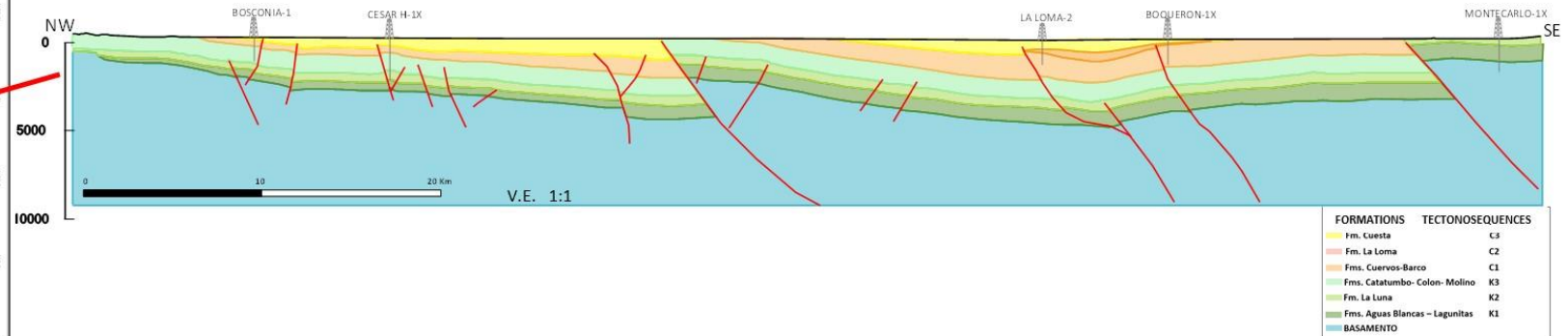
NORTH OF VMM



STRUCTURAL SECTIONS



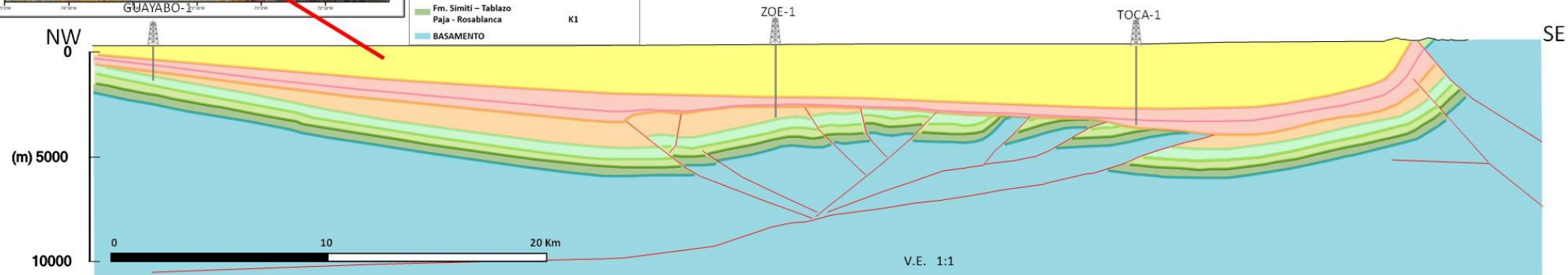
Thick Skin Structural Style



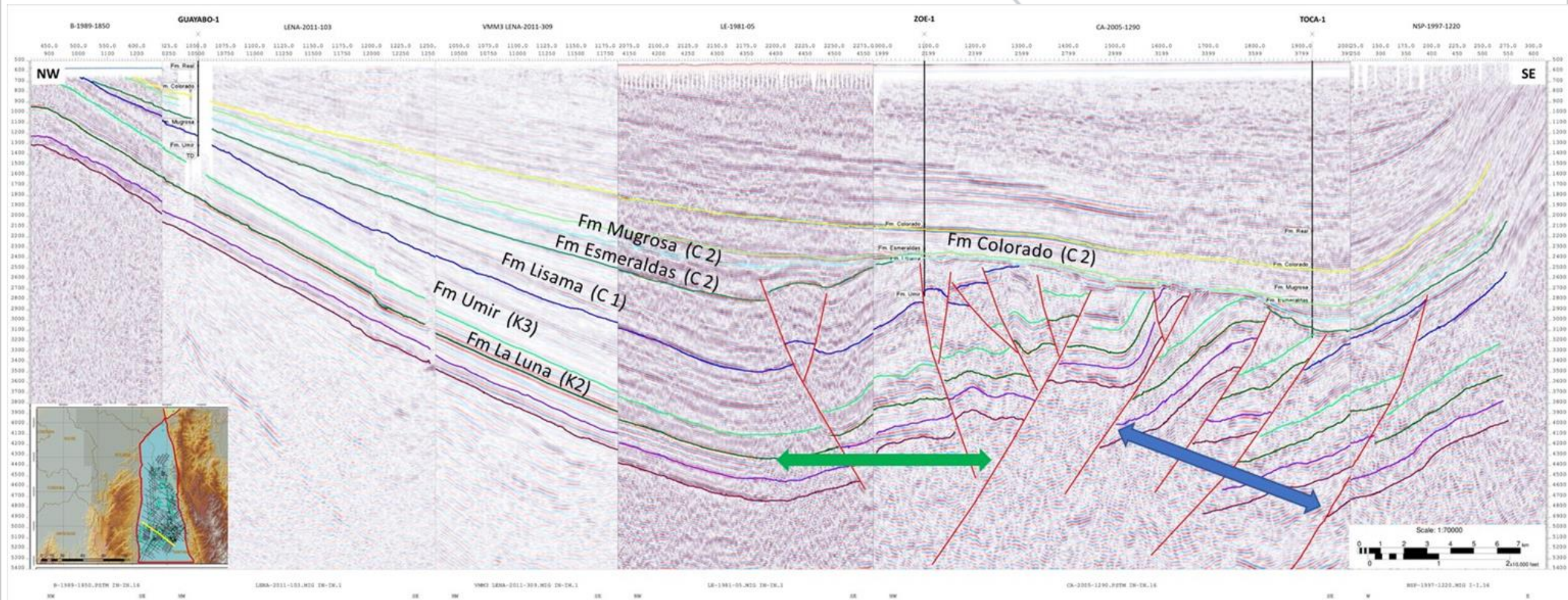
FORMATIONS	TECTONOSEQUENCES
Fm. Cuesta	C5
Fm. La Loma	C2
Fms. Cuervos-Barco	C1
Fms. Catatumbo- Colon- Molino	K3
Fm. La Luna	K2
Fms. Aguas Blancas - Lagunitas	K1
BASAMENTO	

FORMATIONS	TECTONOSEQUENCES
Fm. Real	C3
Fm. La Paz - Esmeraldas	C2
Mugrosa - Colorado	C1
Fm. Lisama	K3
Fm. Umir	K2
Fm. La Luna	K2
Fm. Simiti - Tablazo	K1
Paja - Rosablanca	K1
BASAMENTO	

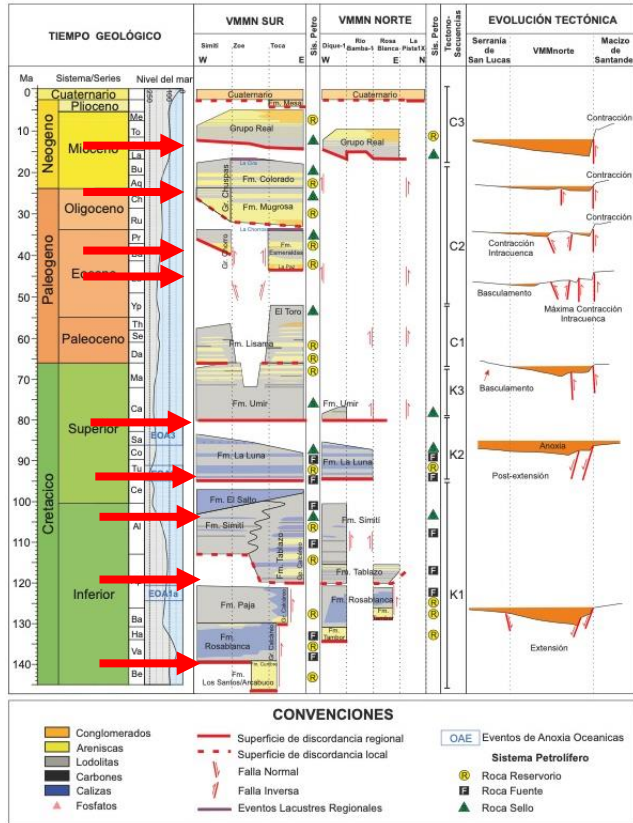
Thin Skin Structural Style



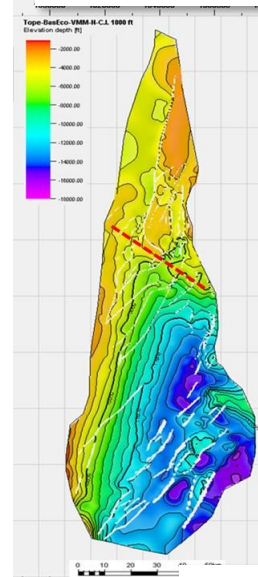
STRUCTURAL PROVINCES North VMM



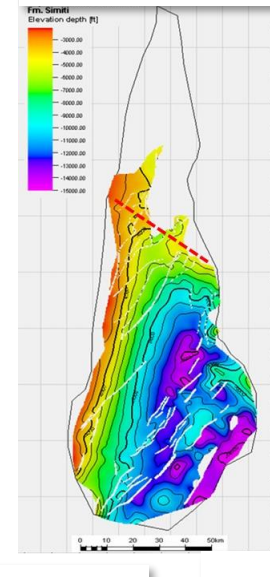
STRUCTURAL DEPTH MAPS NORTH – WWW



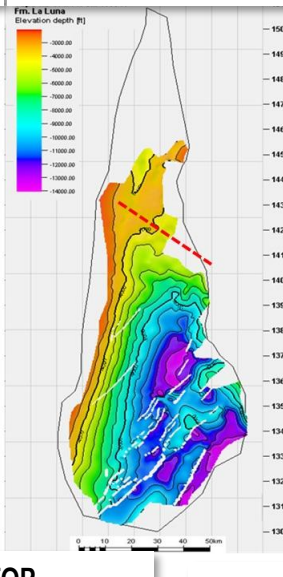
ECO BASAMENT



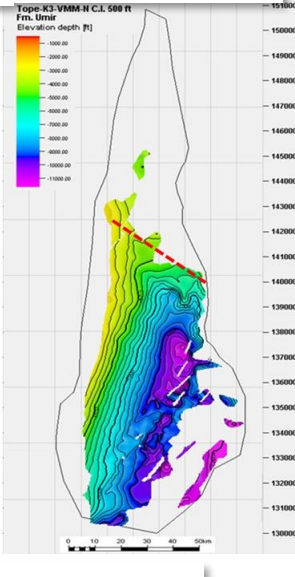
TOP SIMITI (K1)



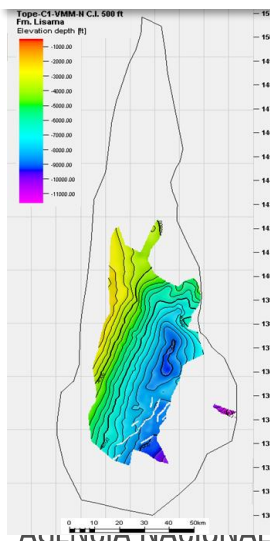
TOP LA LUNA (K2)



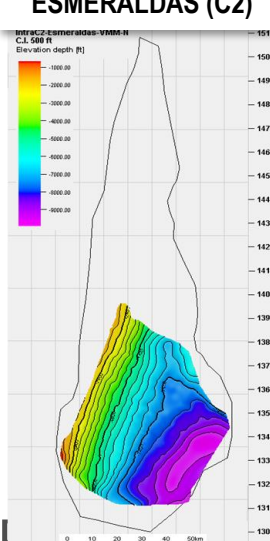
TOP UMIR (K3)



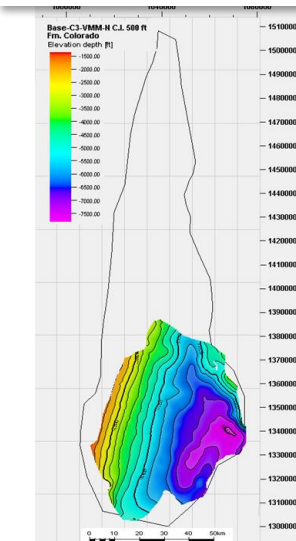
TOP LISAMA (C1)



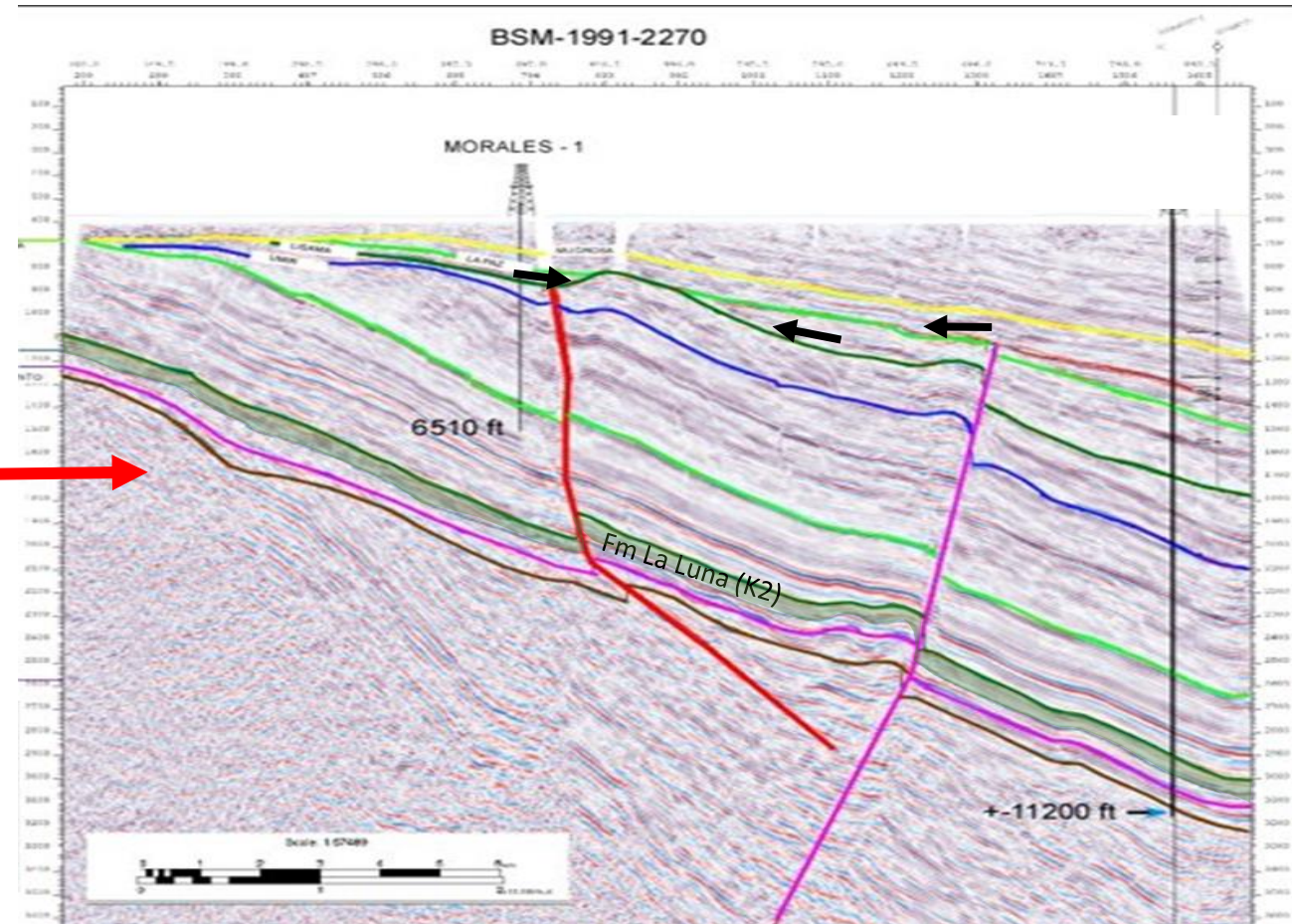
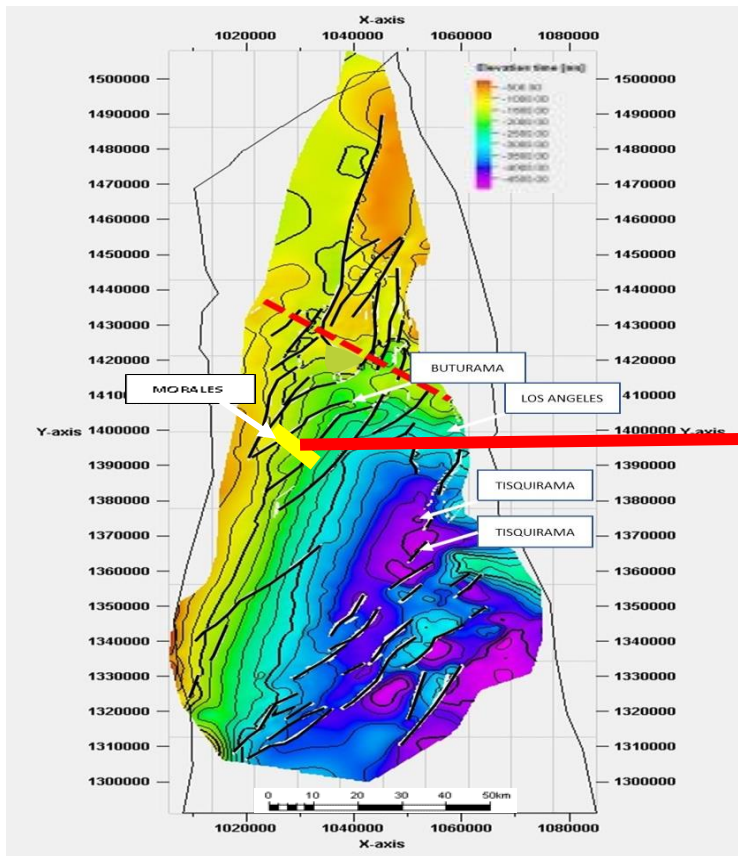
TOP ESMERALDAS (C2)



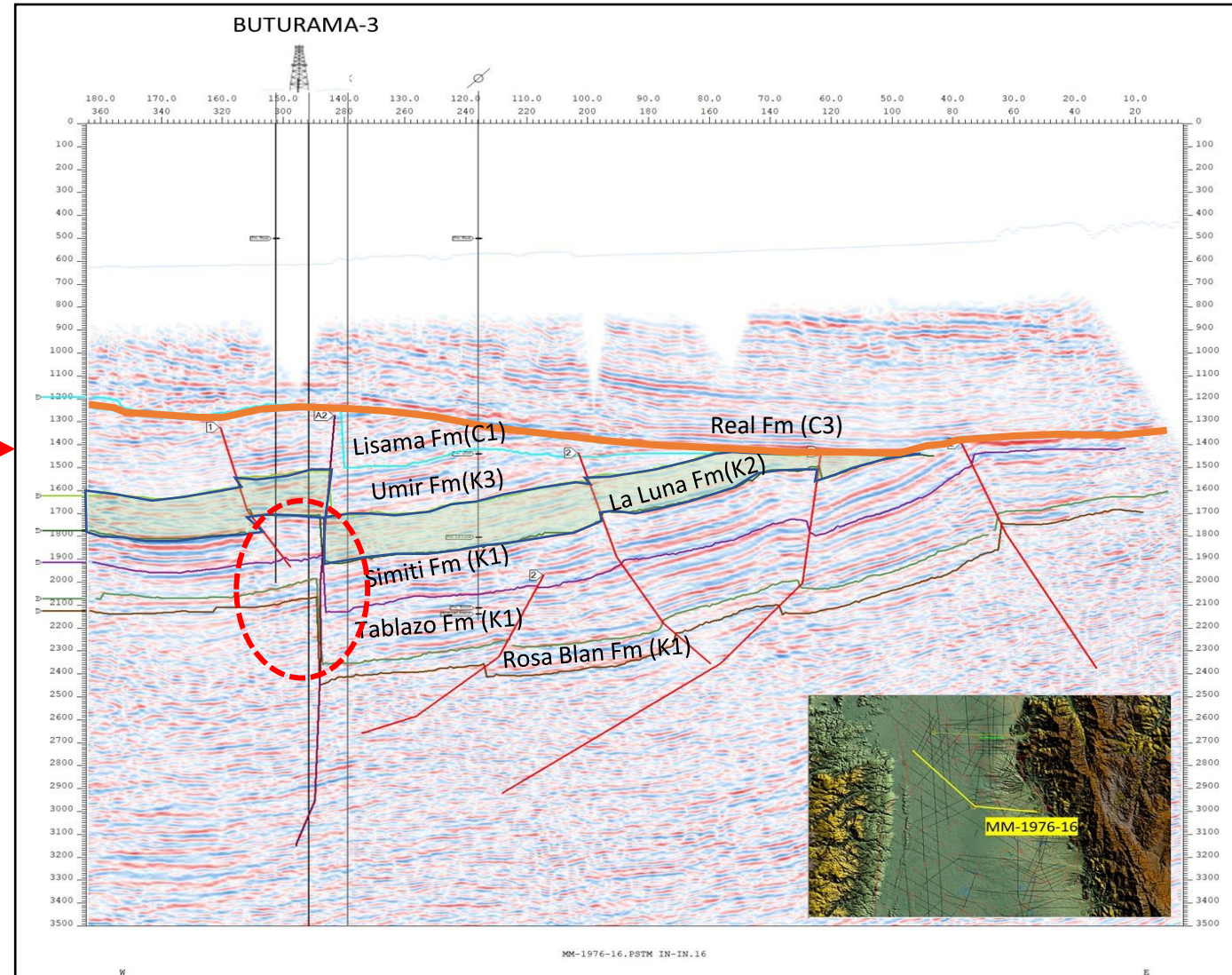
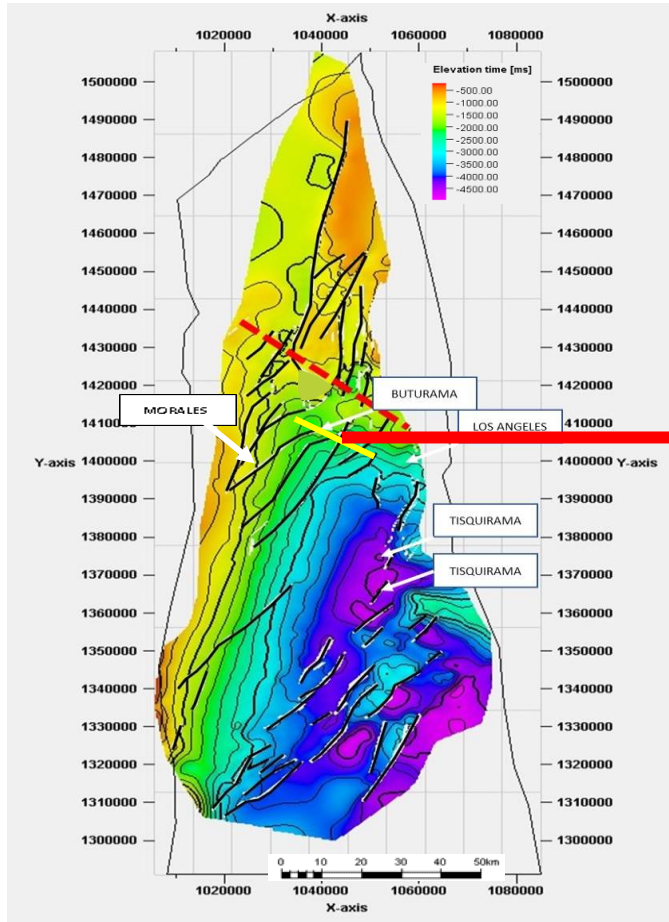
TOP COLORADO (C2)



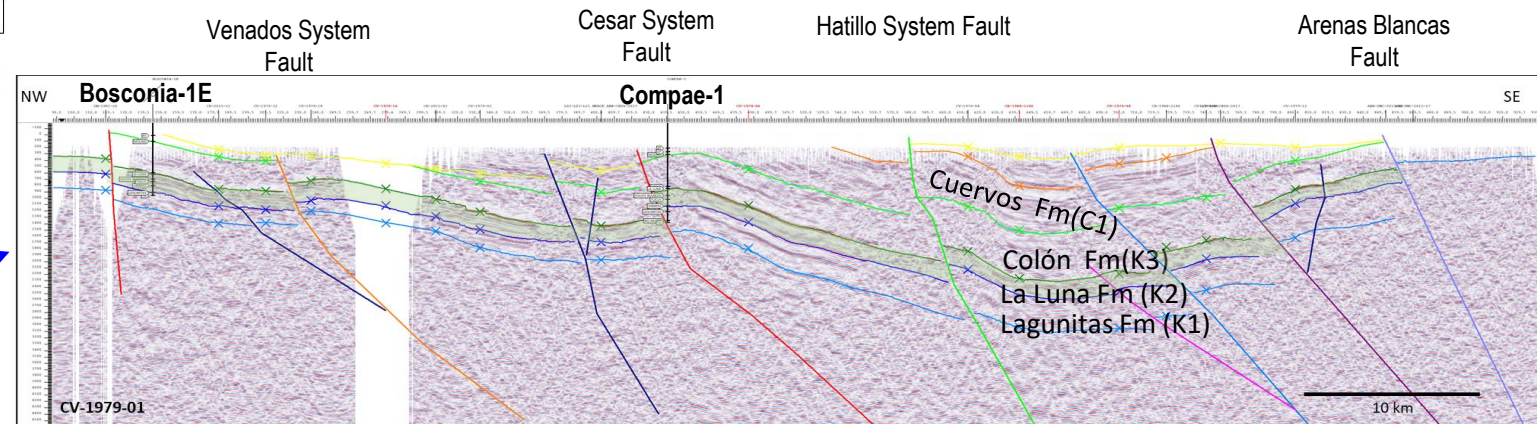
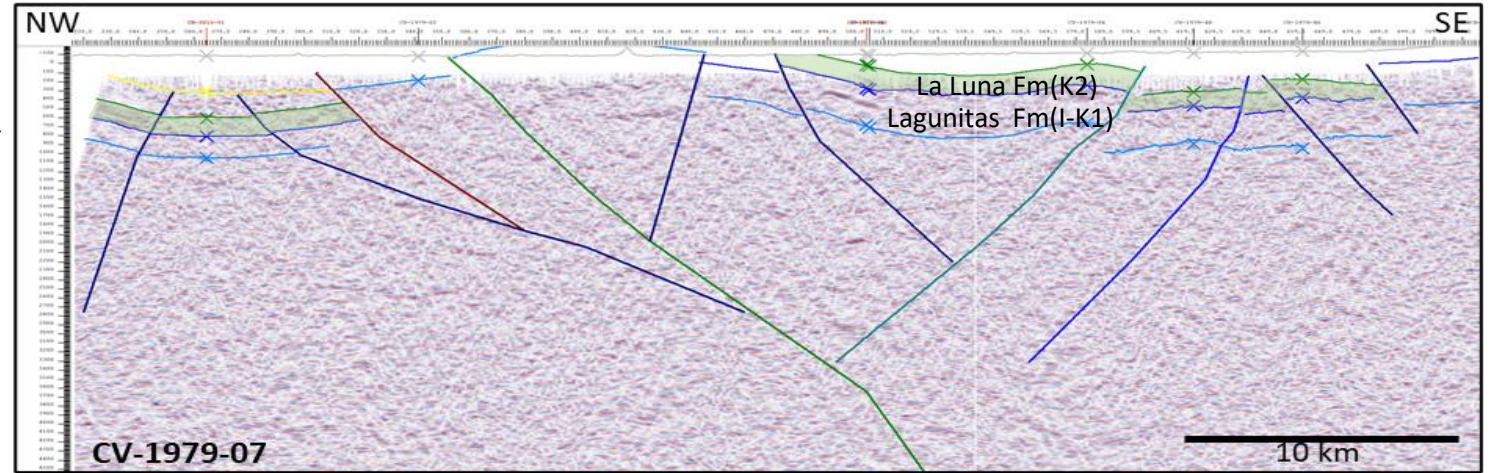
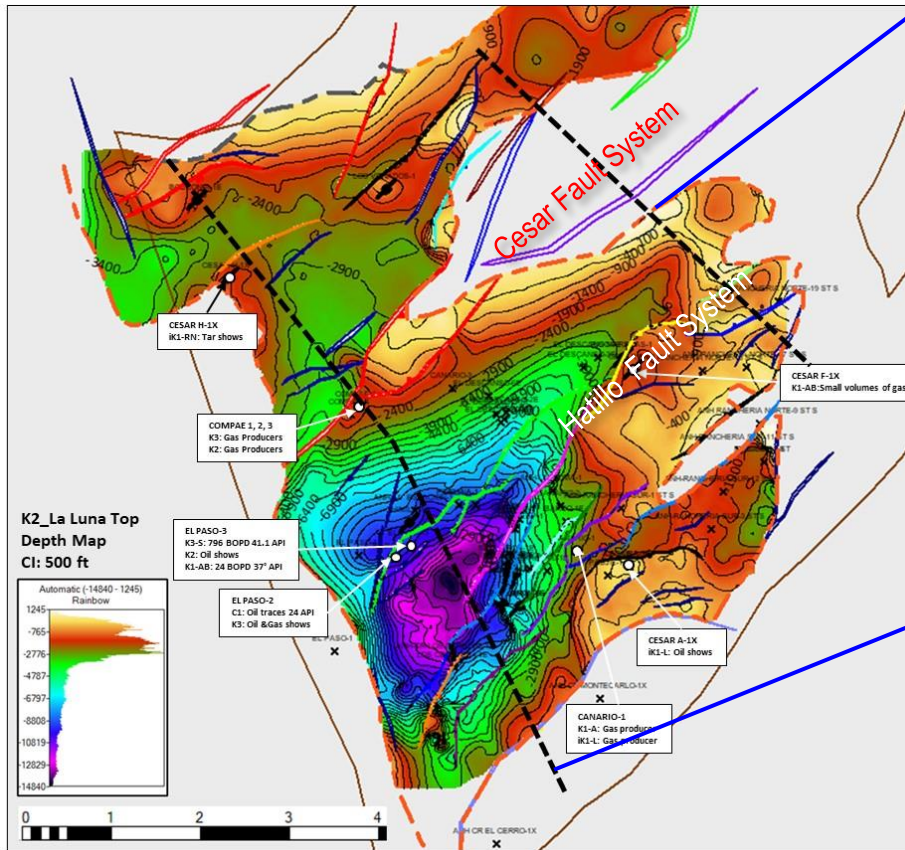
POTENTIAL PROSPECTIVE STRUCTURES North VMM



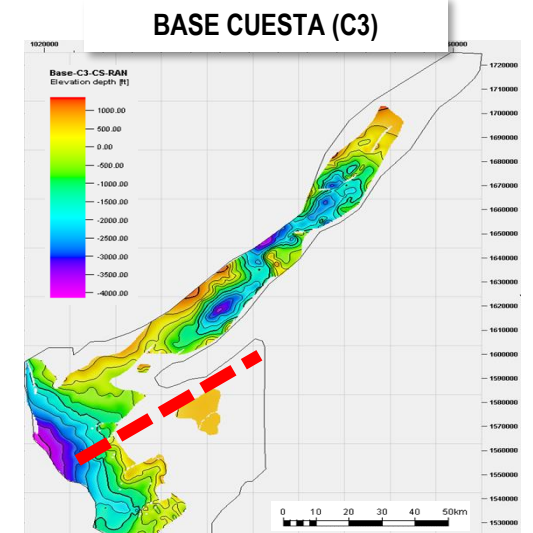
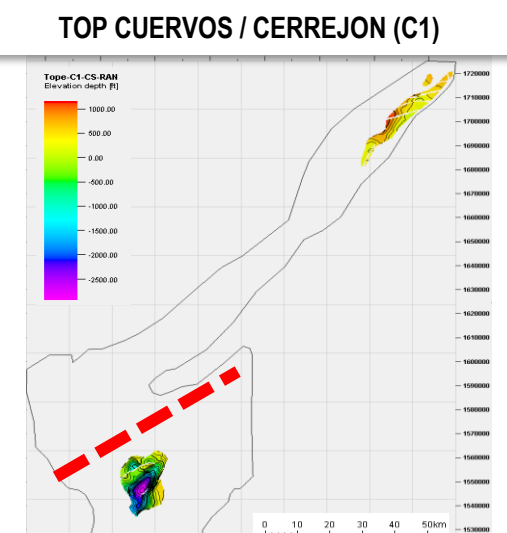
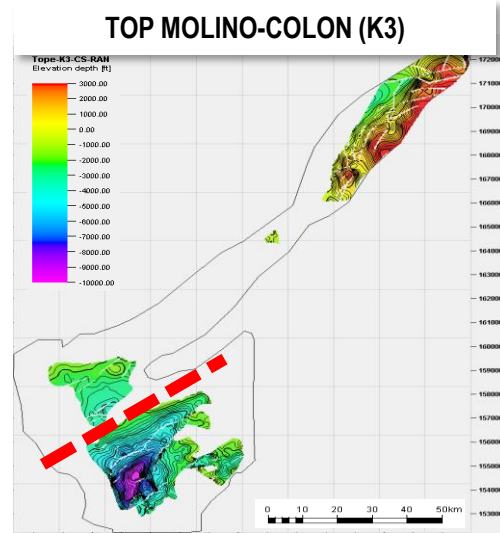
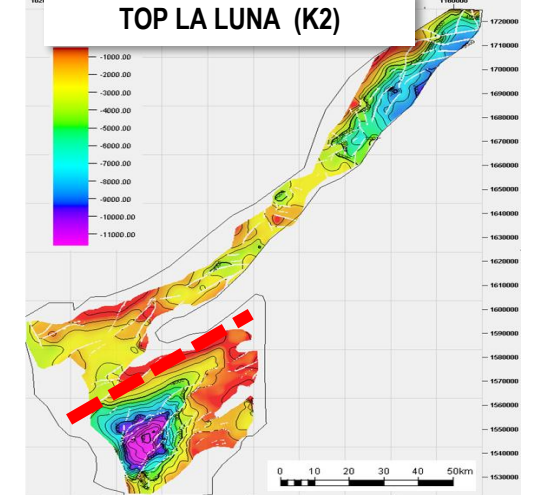
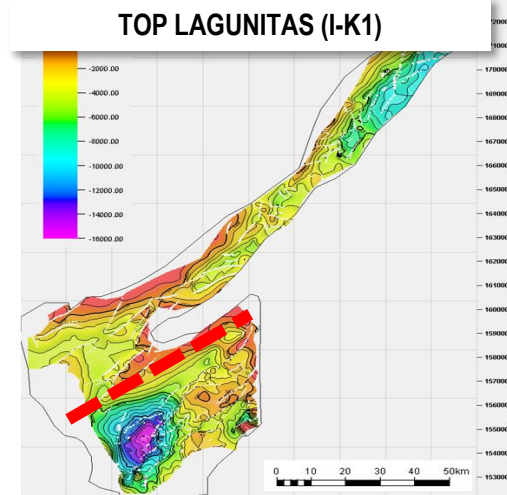
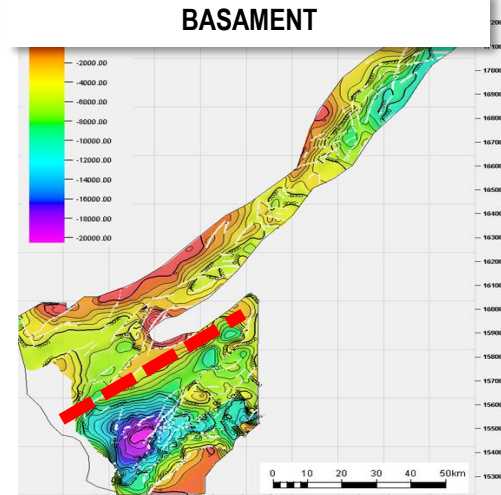
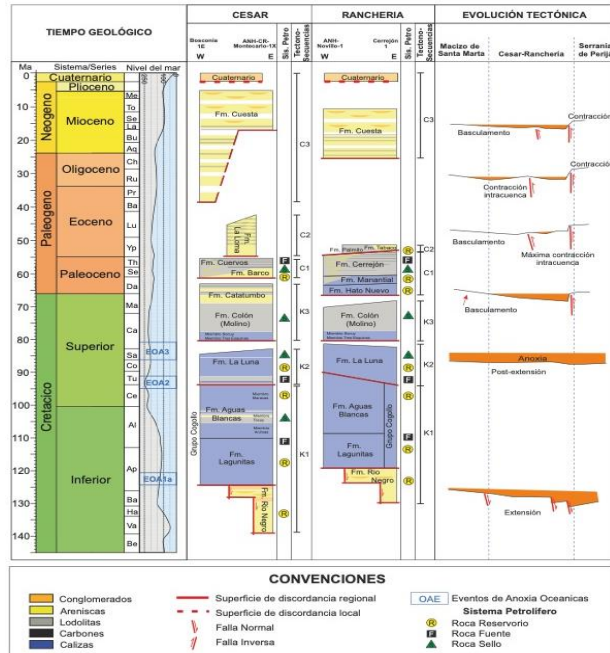
POTENTIAL PROSPECTIVE STRUCTURES North VMM



STRUCTURAL PROVINCES CESAR - RANCHERIA



CESAR RANCHERIA STRUCTURAL DEPTH MAPS



- Two structural provinces are identified in the Cesar Ranchería basin; west and east separated by Cesar fault system. East province shows hydrocarbon manifestations in; El Paso-3, Compae-1 and Canario-1 wells. (Potential for NFR)
- A structural high is identified in the northern part of VMM, which is genetically related to the high angle basement faulting. The southern part of the study area corresponds to an east-dipping monoclinial affected by thrust faulting involving from Jurassic to pre-Eocene sequence.
- Two kinds of conventional exploration opportunities are established for the north of the VMM basin; sedimentary wedges, Lisama (C1 pre-unconformity) (ACORDIONERO) and /or Esmeraldas (C2) with folding (TOCA) Overlapping sequences of Mugrosa Colorado (C2) over the unconformity (AULLADOR)
- NFR in Cretaceous rocks (Buturama - Cagui) is considered an exploratory potential.

GEOLOGICAL INTEGRATION, PETROLEUM SYSTEMS EVALUATION AND PROSPECTIVITY OF COLOMBIAN FRONTIER BASINS: NORTHERN MIDDLE MAGDALENA VALLEY AND CESAR - RANCHERÍA BASINS

PETROLEUM SYSTEMS MODELING PLAY FAIRWAY MAPS AND YET TO FIND EVALUATION NORTHERN MIDDLE MAGDALENA VALLEY - CESAR RANCHERÍA BASINS

César Mora

Claudia Posada

María Catalina Niño

Cristian Peñafort

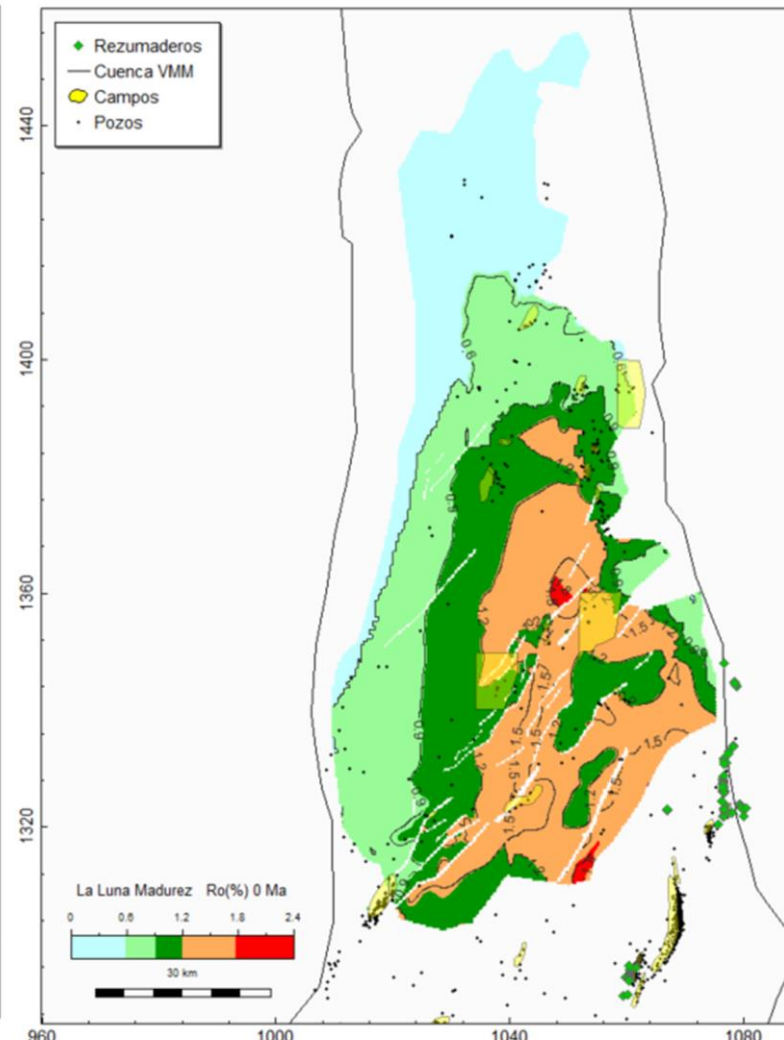
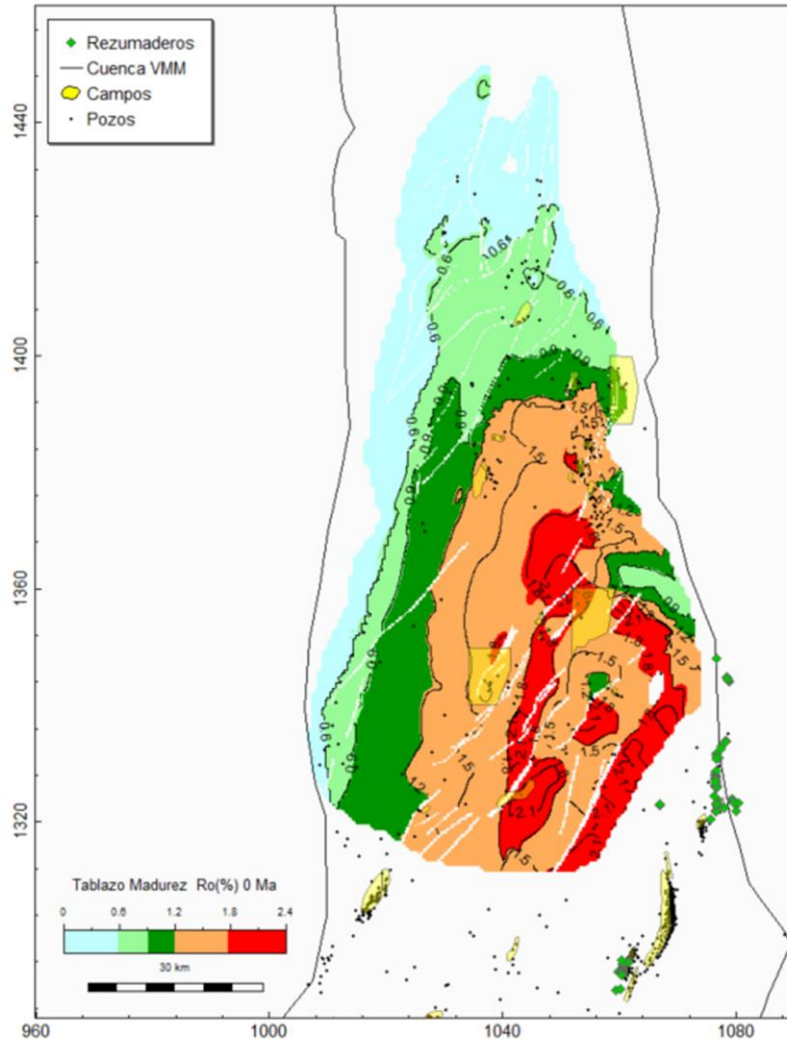
Patricia Chajín

Thermal Maturity Tablazo and La Luna Formations

Northern Middle Magdalena Valley Basin

Tablazo Fm.

La Luna Fm.



Pod of active source rock

% Ro shows unmaturing and mature areas from early oil to late gas window.

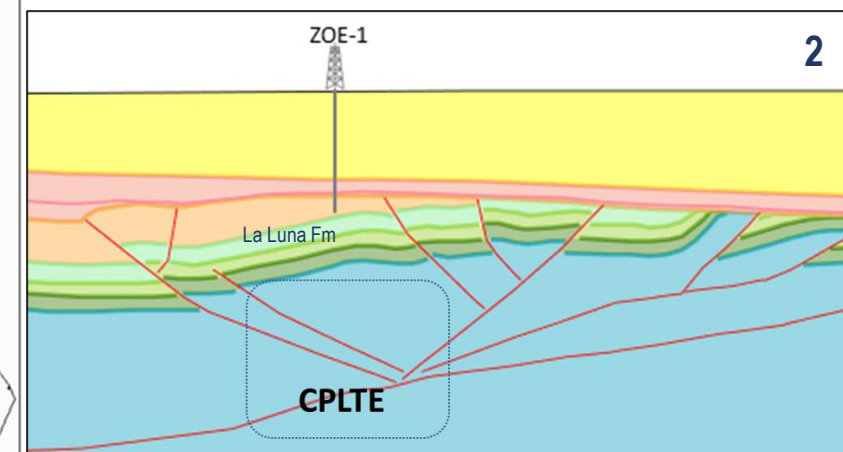
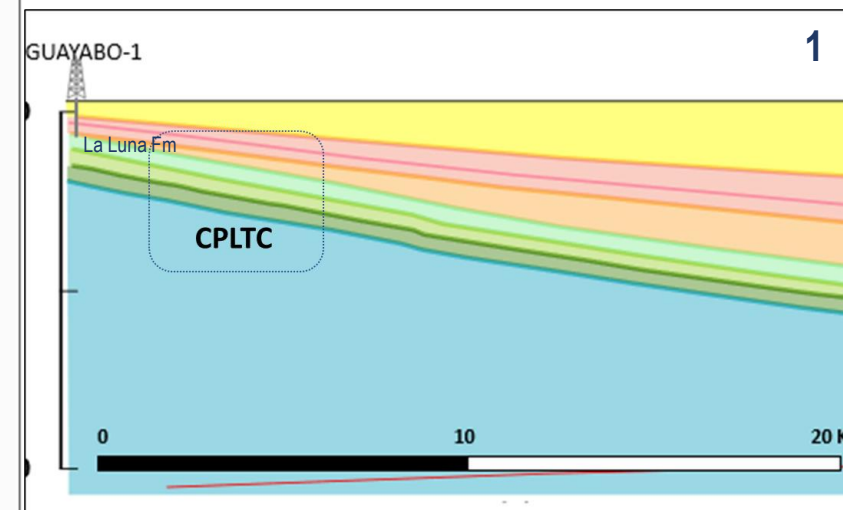
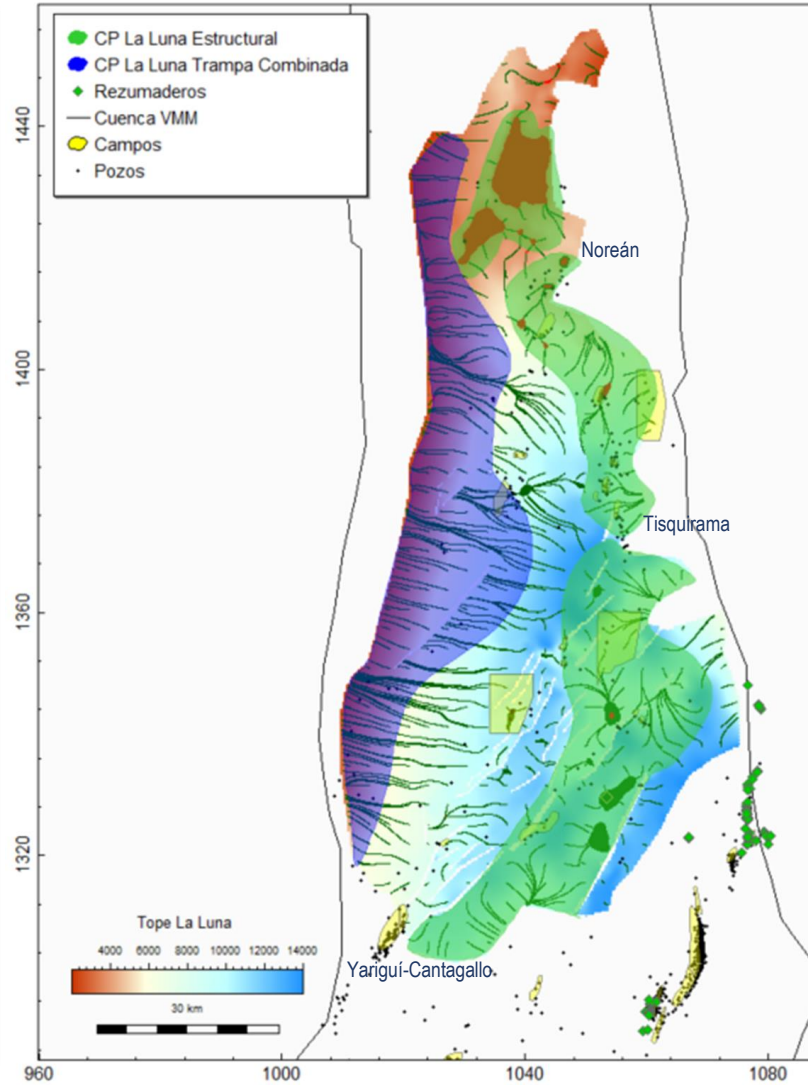
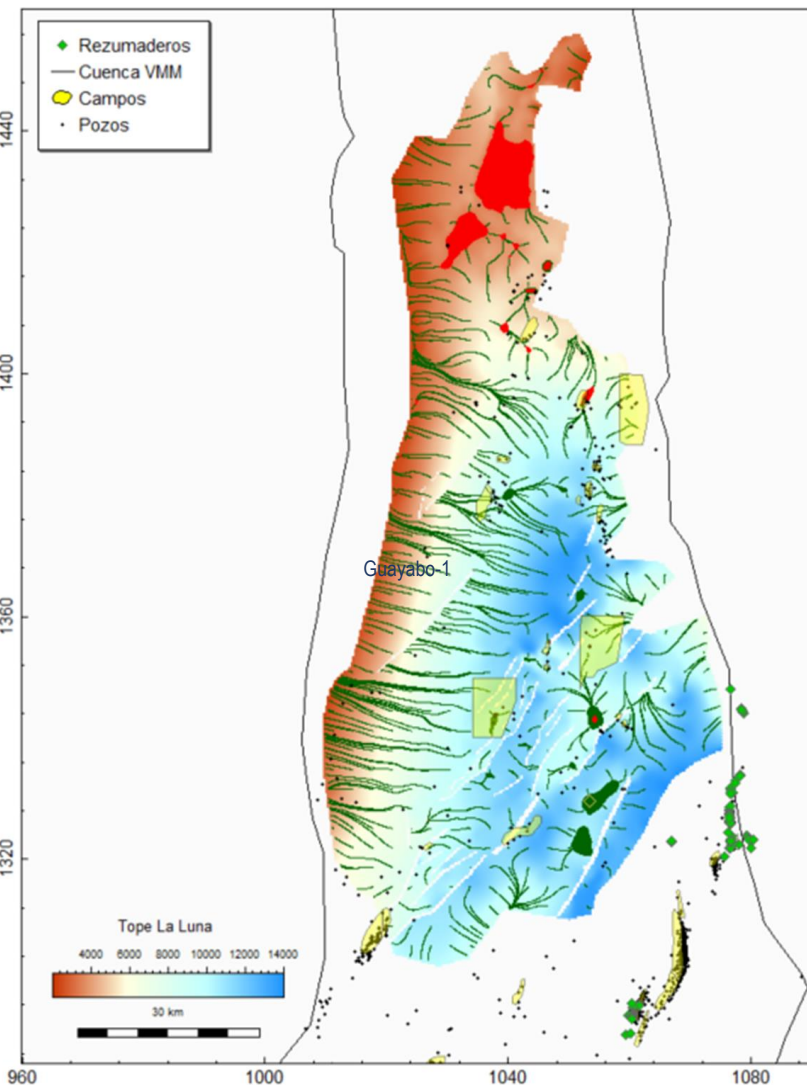
Tablazo Fm: shows the higher thermal maturity (over 2% Ro).

La Luna Fm: shows lower thermal maturity with large generating areas and more prospective zones.

Migration / Charge and Play Fairway Maps

Northern Middle Magdalena Valley Basin

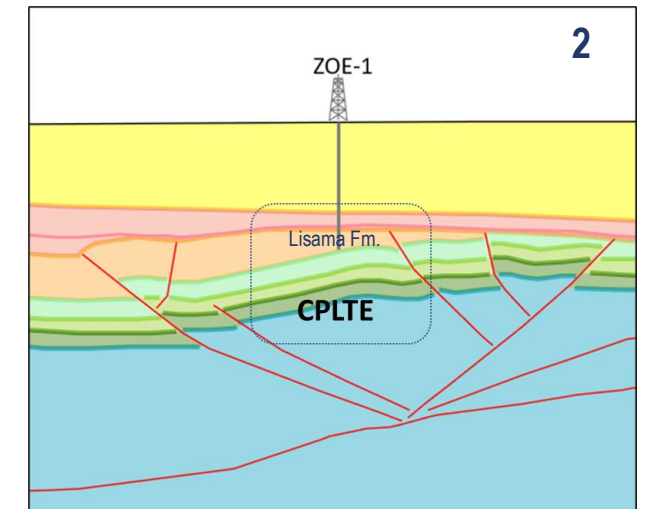
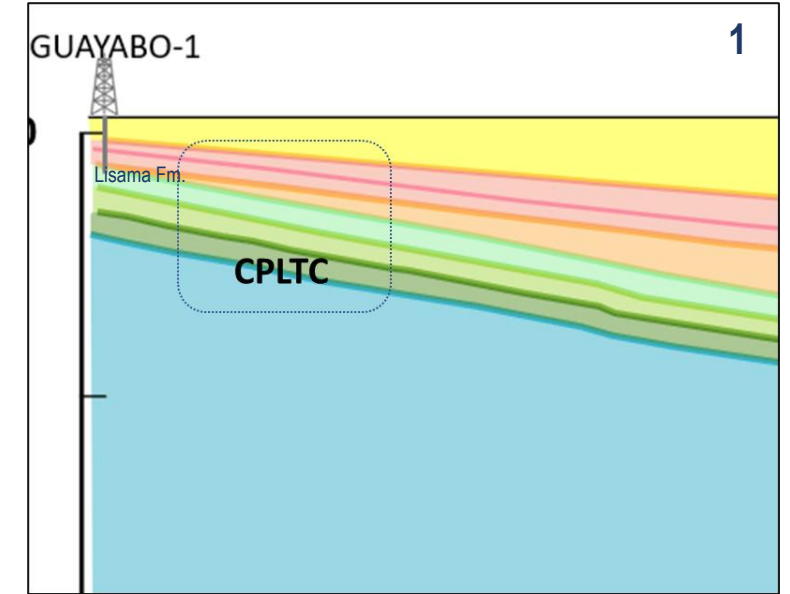
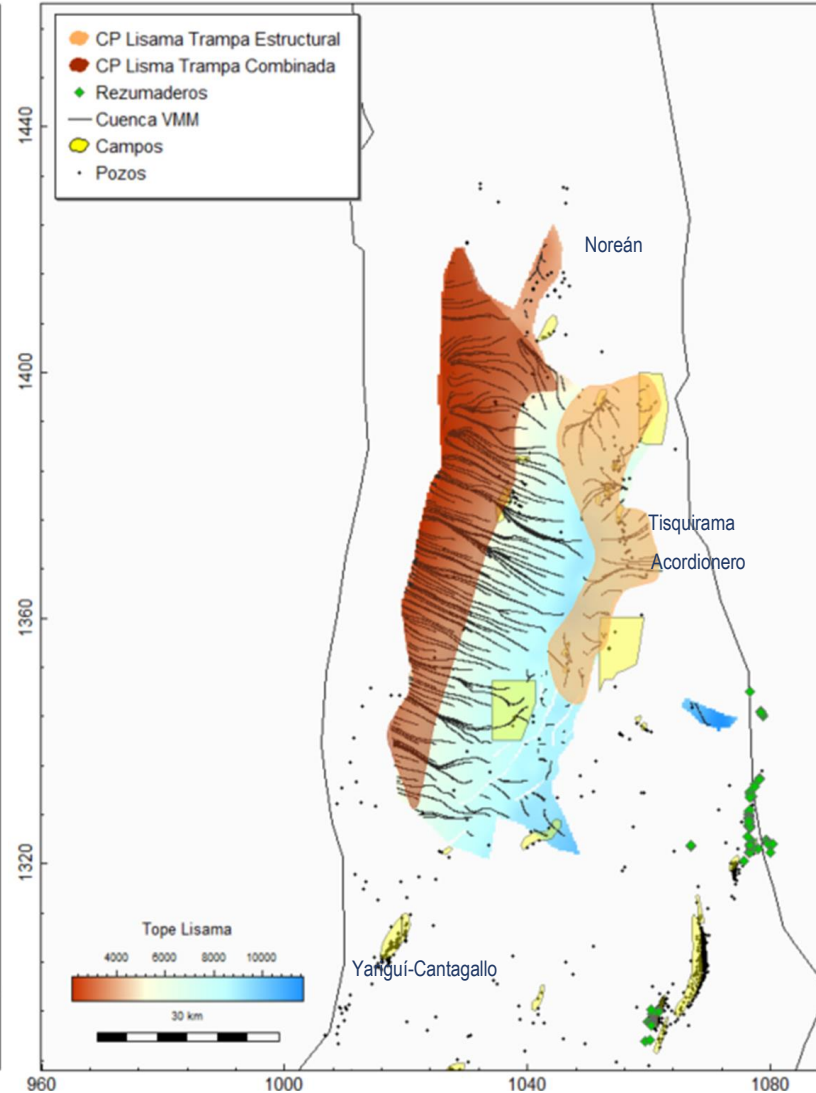
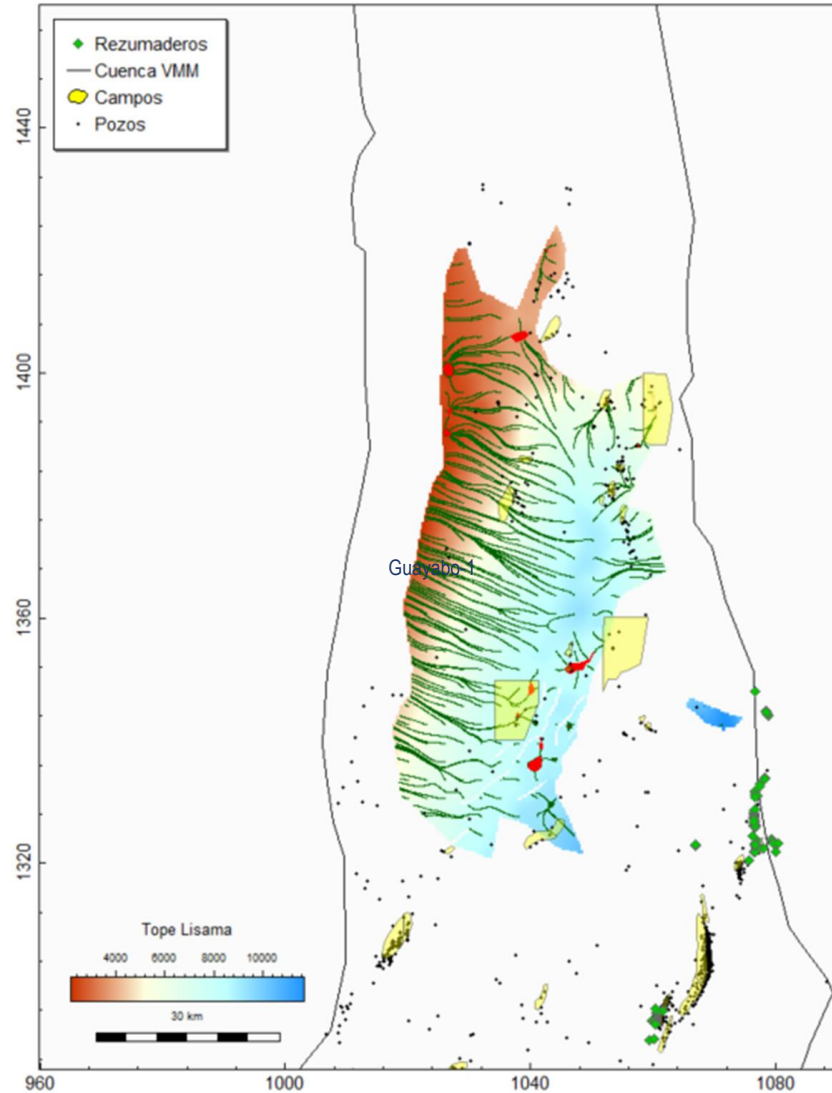
La Luna Formation



Migration / Charge and Play Fairway Maps

Northern Middle Magdalena Valley Basin

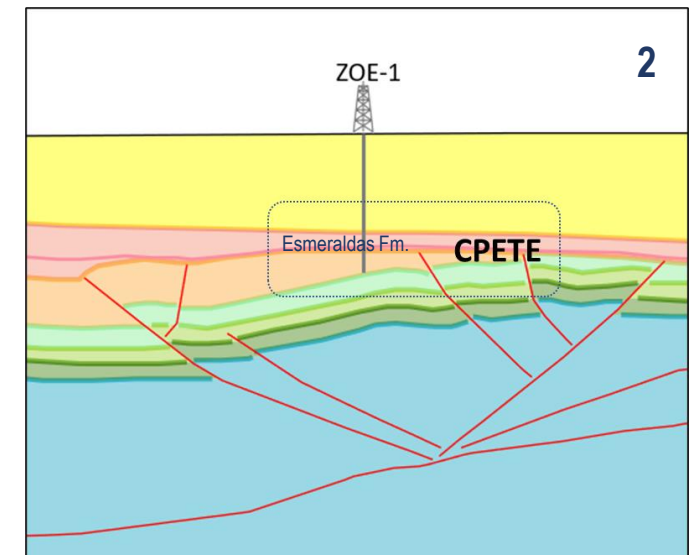
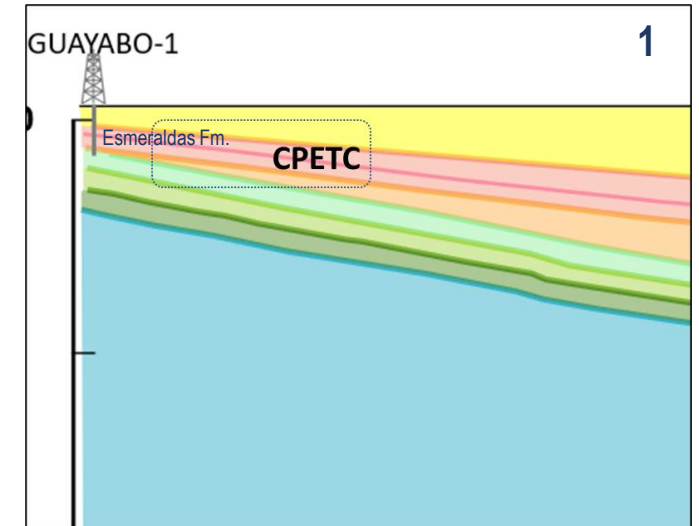
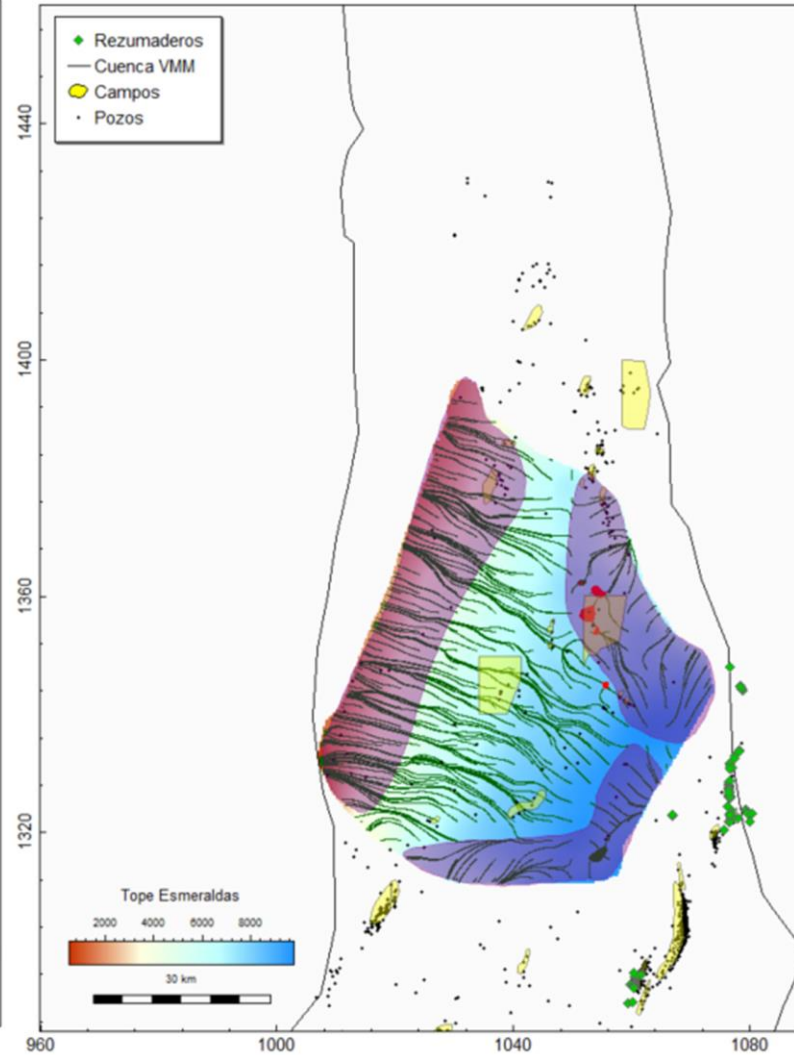
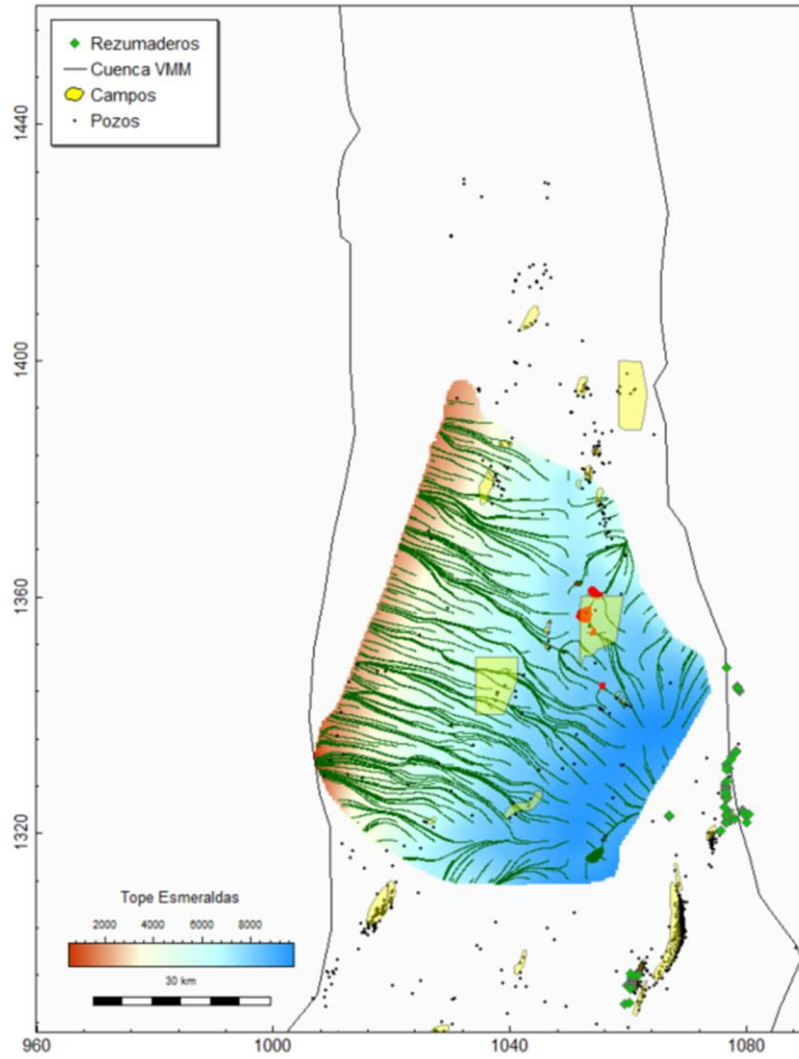
Lisama Formation



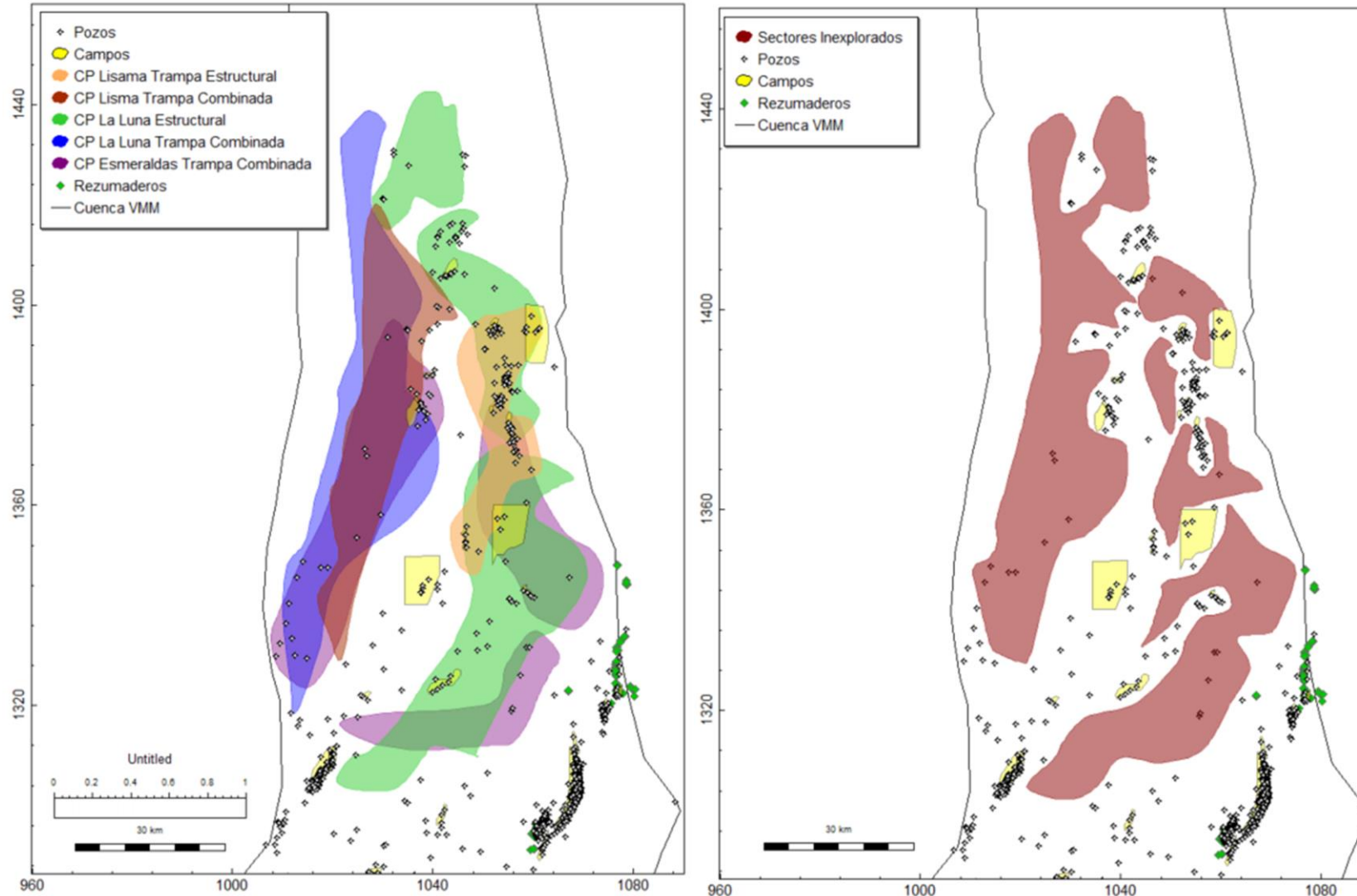
Migration / Charge and Play Fairway Maps

Northern Middle Magdalena Valley Basin

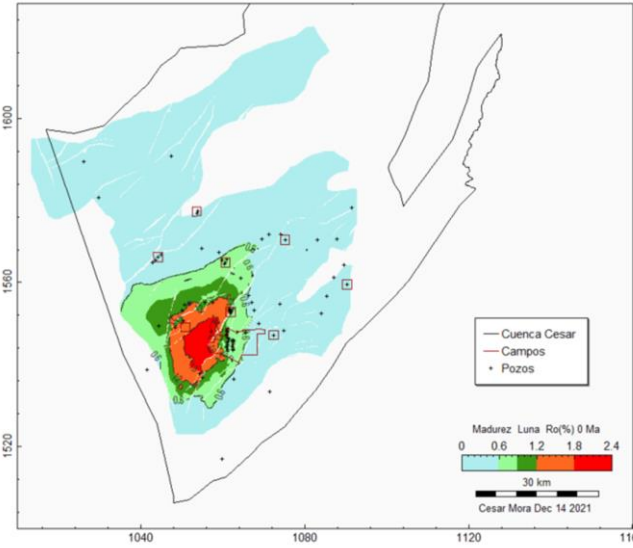
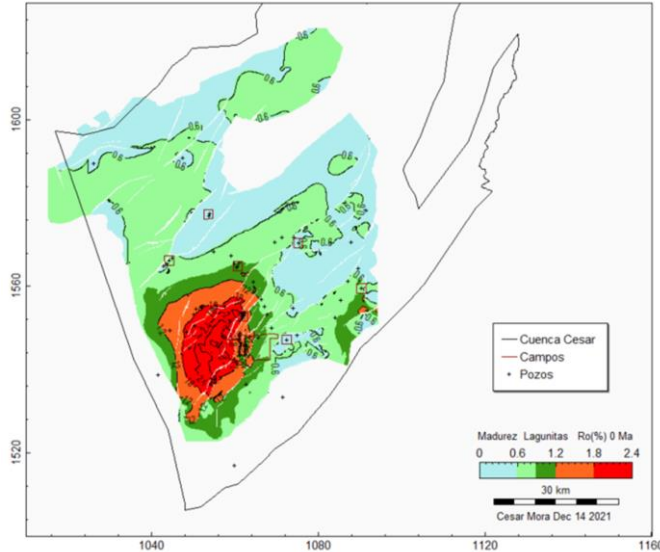
Esmeraldas Formation



Northern Middle Magdalena Valley Basin

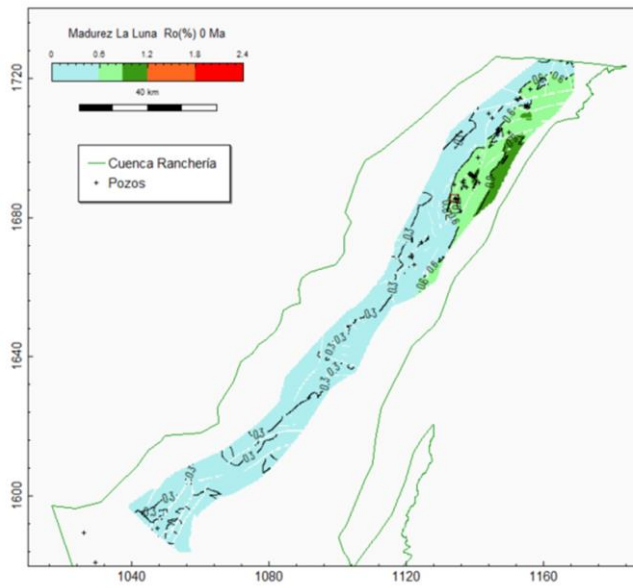
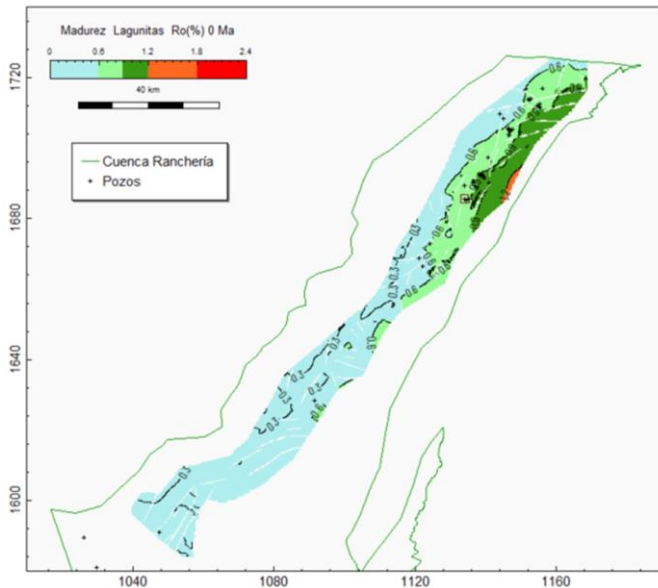


Thermal Maturity Lagunitas and La Luna Formations



Cesar

Lagunitas and La Luna Formations from early oil window to late gas window.

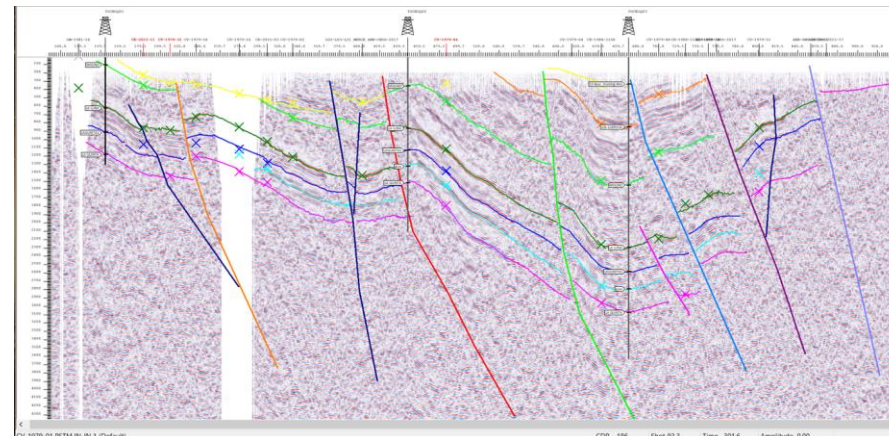
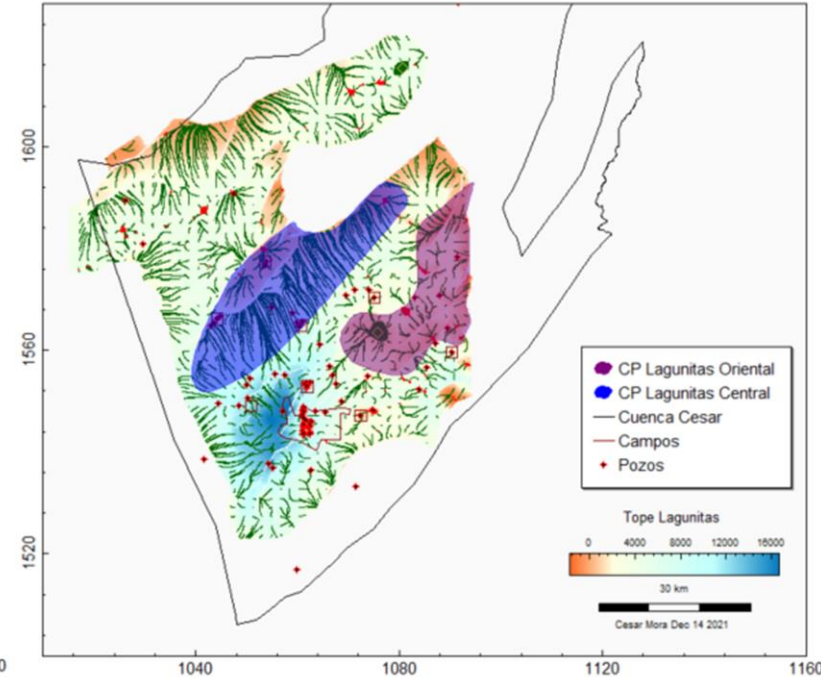
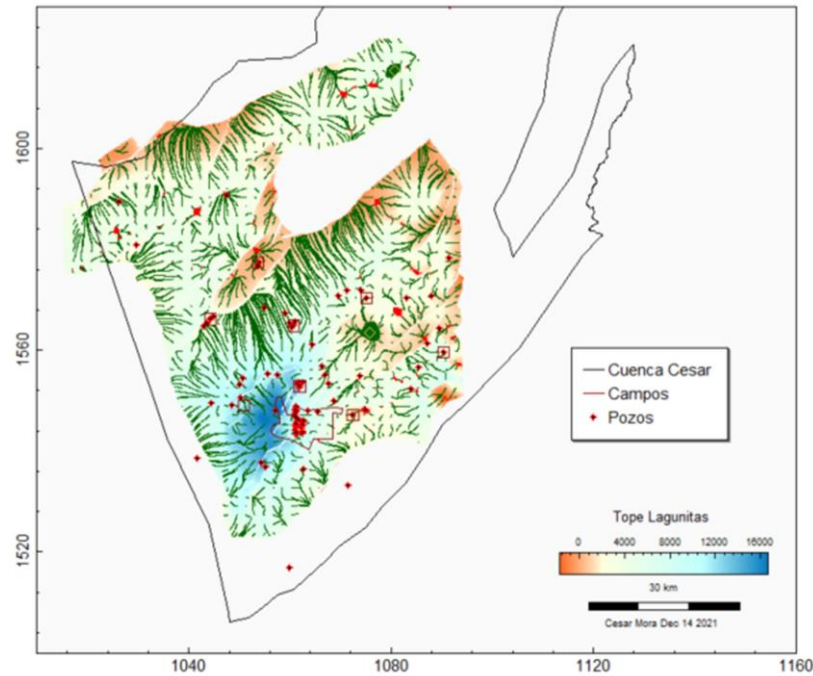


Ranchería

Lagunitas Formation has a higher maturity level that La Luna Formation which shows early to late oil window.

Migration / Charge and Play Fairway Maps

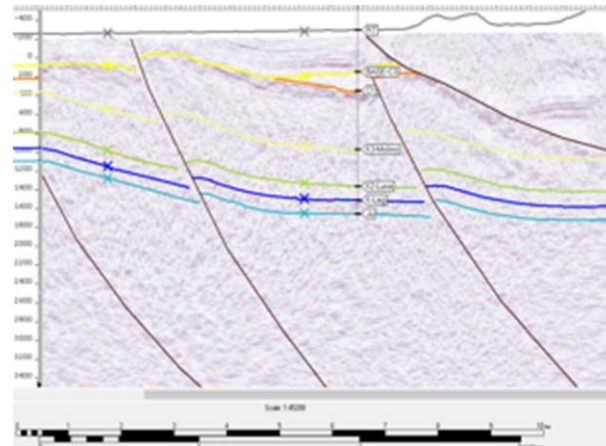
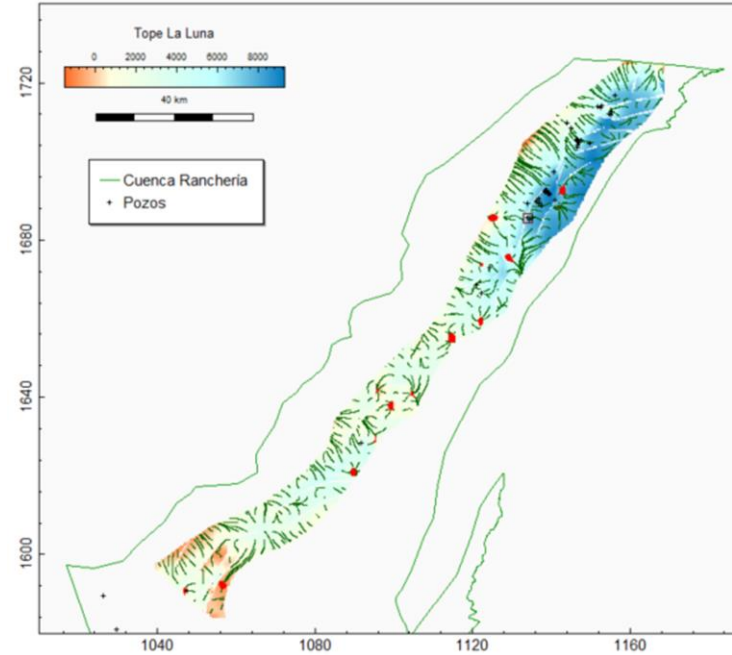
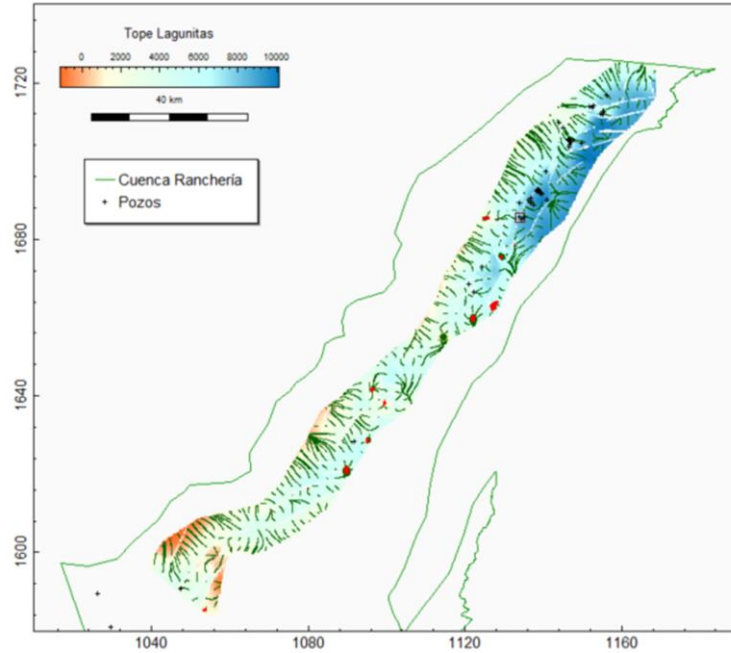
Cesar Basin – Lagunitas Formation



Lagunitas Formation is the most important level because is linked to Cesar fault system where migration flowpaths are located.

Migration / Charge and Play Fairway Maps

Ranchería Basin – Lagunitas and La Luna Formations

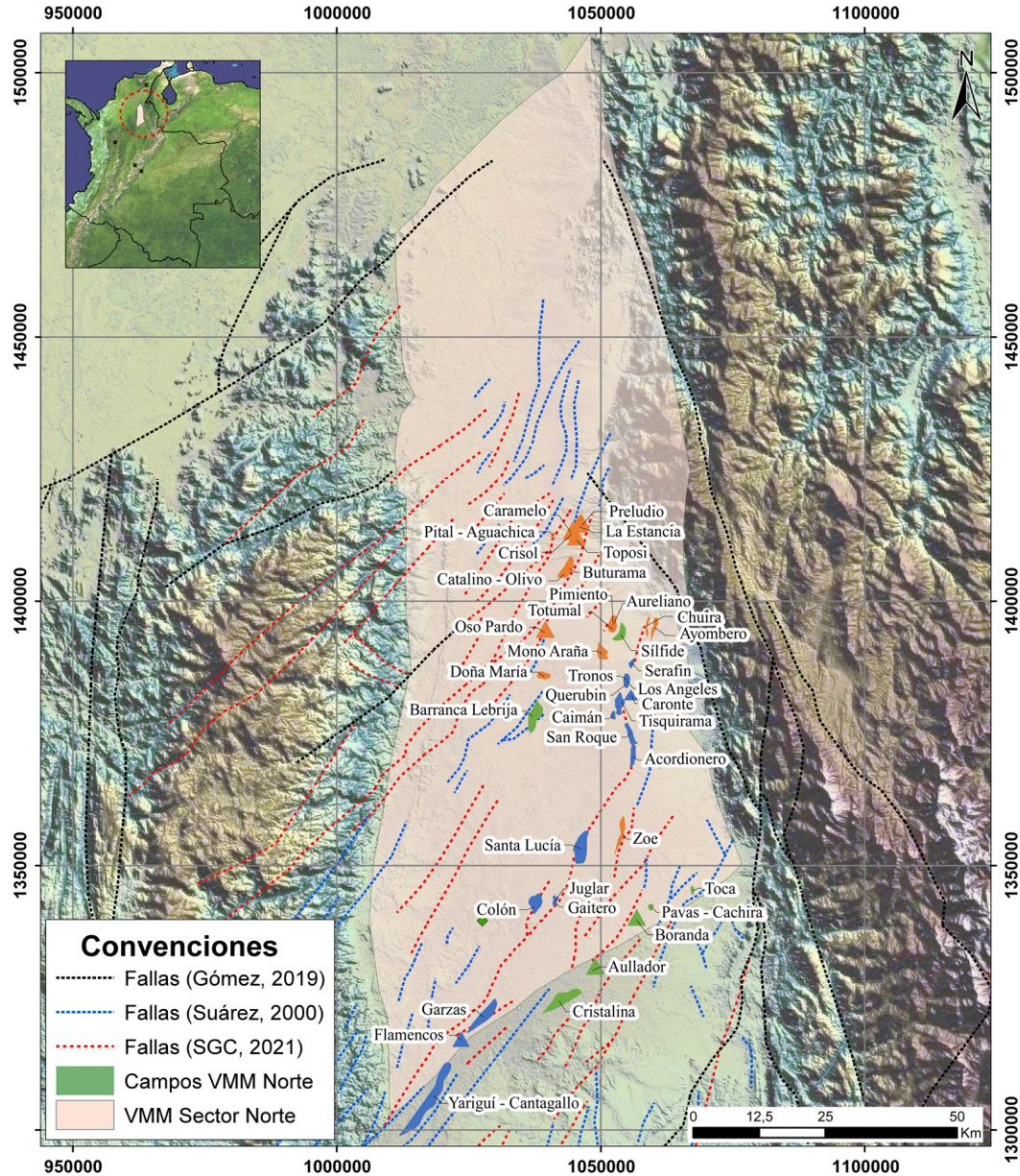


Ranchería

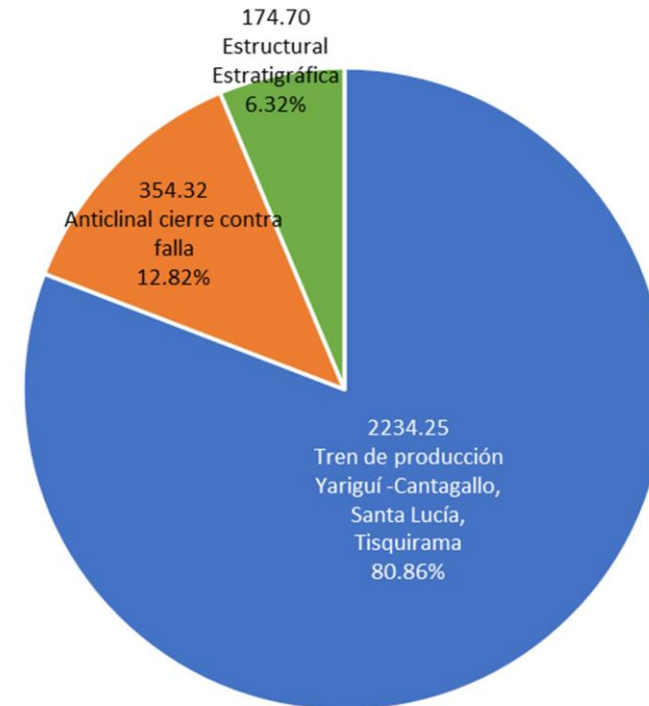
For Lagunitas and La Luna Formations the oil shows are small (<5 Mmboe).

YET TO FIND
Creaming Curve
Fractal Analysis
Mass Balance

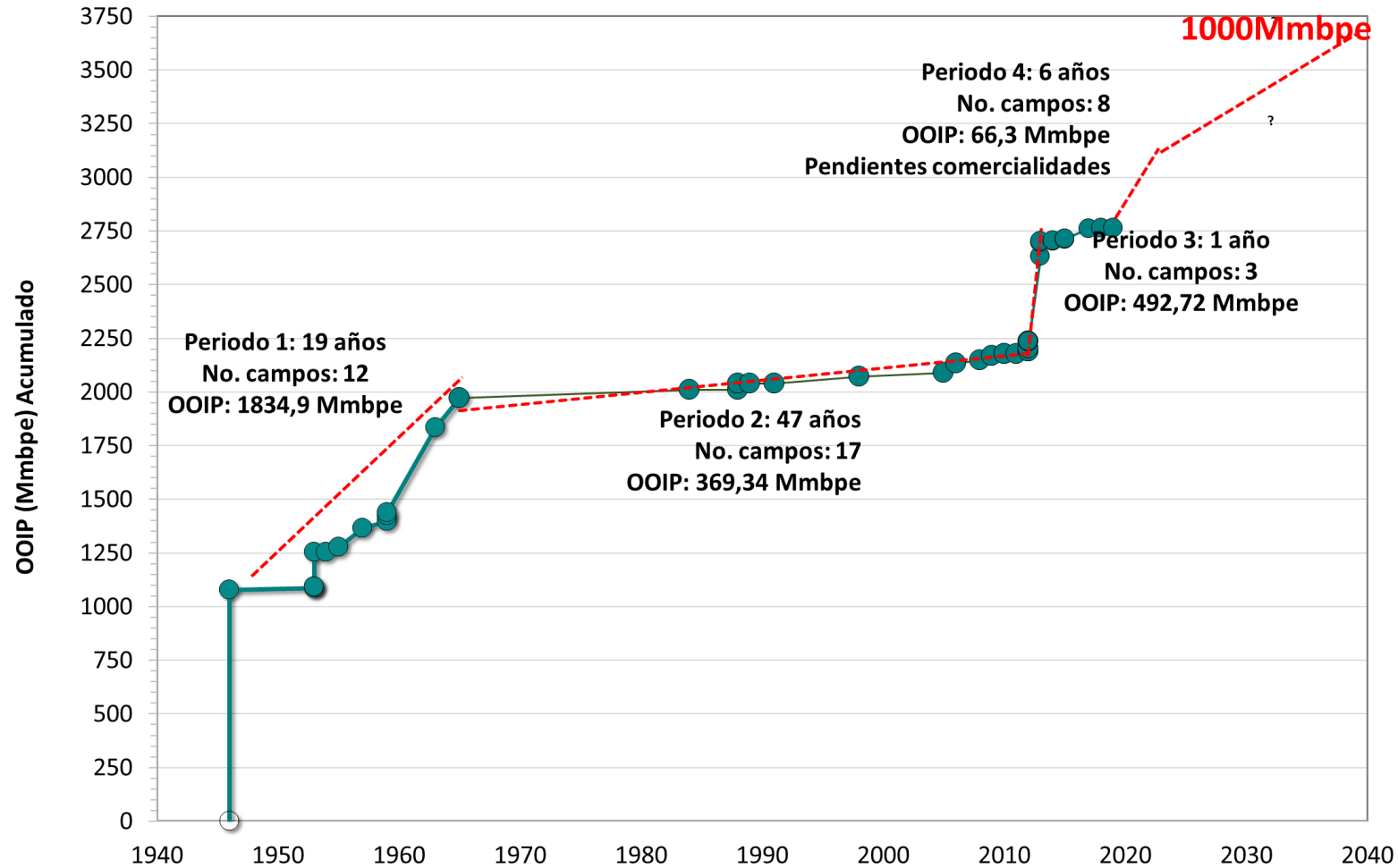
Proven Plays



Northern Middle Magdalena Valley Basin



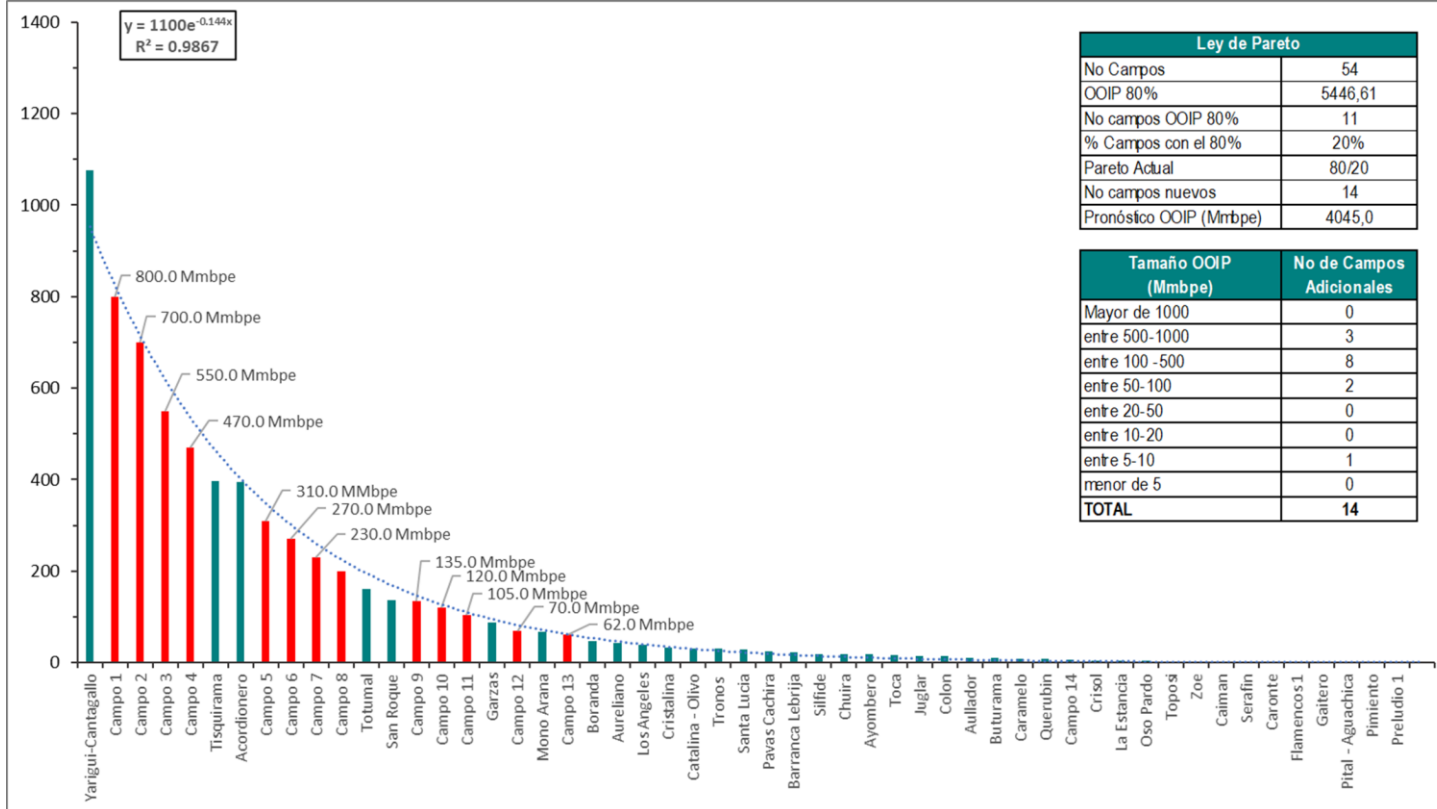
Yet to find / Creaming Curve



Creaming Curve Northern Middle Magdalena Valley Basin

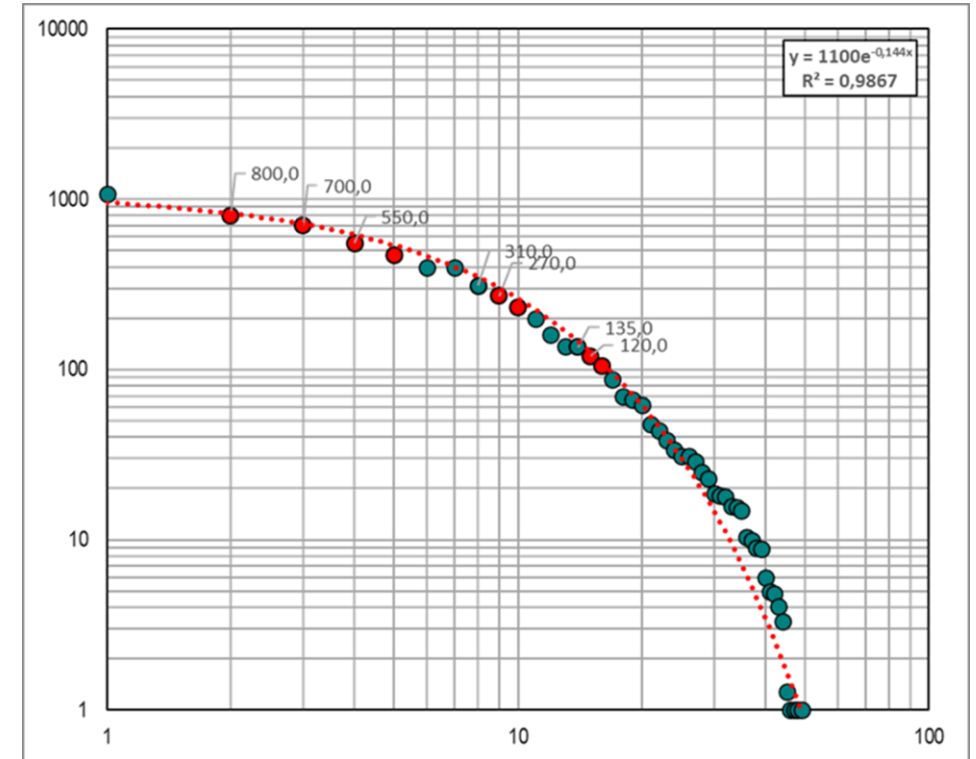
Yet to Find Fractal analysis prognosis

Northern Middle Magdalena Valley Basin



Ley de Pareto	
No Campos	54
OOIP 80%	5446,61
No campos OOIP 80%	11
% Campos con el 80%	20%
Pareto Actual	80/20
No campos nuevos	14
Pronóstico OOIP (Mmbpe)	4045,0

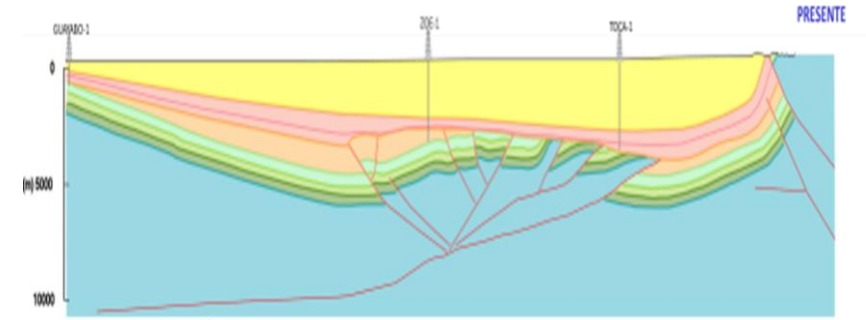
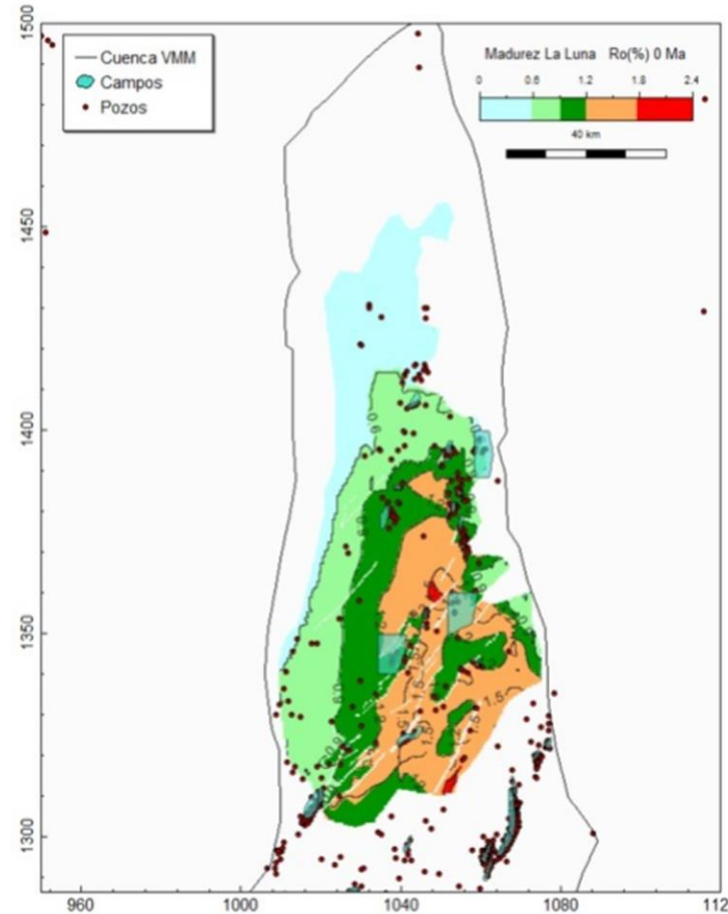
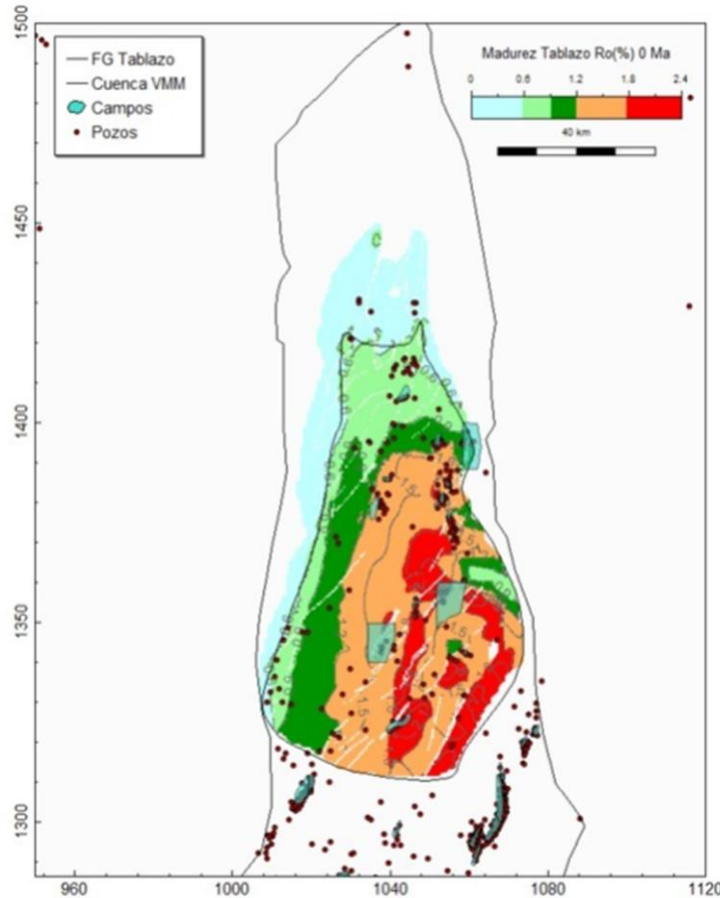
Tamaño OOIP (Mmbpe)	No de Campos Adicionales
Mayor de 1000	0
entre 500-1000	3
entre 100 -500	8
entre 50-100	2
entre 20-50	0
entre 10-20	0
entre 5-10	1
menor de 5	0
TOTAL	14



Fractal prognosis distribution of the northern sector of the MMV Basin as a function of the size of discovered and undiscovered fields.

14 fields to discover OOIP = 4045 Mmboe

Yet to find / Mass Balance NMMV Basin



The areas of Santa Lucía pod of active source rock were calculated based on petroleum systems 3D modeling.

Tablazo Formation area is 4750 Km²
La Luna Formation area is 4400 Km²

FM. TABLAZO - K1 (Cretácico Inferior)	
Poligono	km ²
F.G. SantaLucia	4750

FM. LA LUNA - K2 (Cretácico Superior)	
Poligono	km ²
F.G. SantaLucia	4400

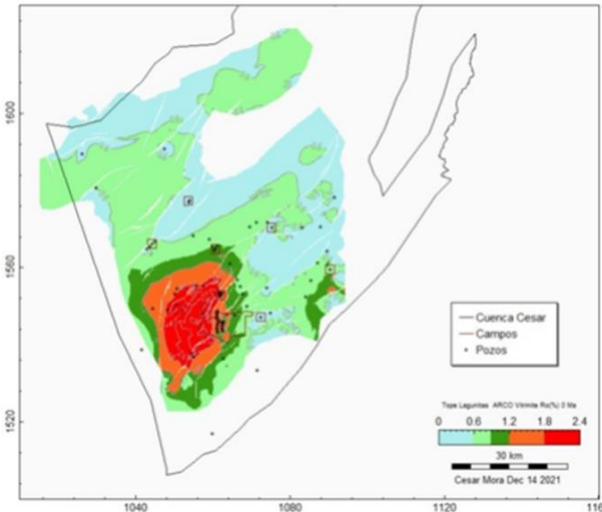
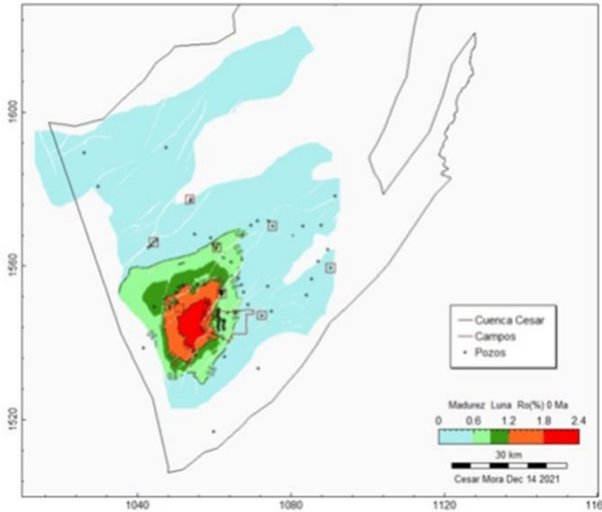
Santa Lucía pod of active source rock at the top of Tablazo and La Luna Formations

Northern Middle Madgalena Valley Basin

PARÁMETROS	UNIDADES	CUENCA VMM-Norte	TOTAL
		FG VMM Santa Lucia	
HC's Generados / Tablazo	Mmbpe	234.601	234.601
Hc's Disponibles / Tablazo	Mmbpe	33.431	33.431
HC's Generados / La Luna	Mmbpe	177.074	177.074
Hc's Disponibles /La Luna	Mmbpe	21.249	21.249
Total HC's Generados	Mmbpe	411.676	411.676
Recursos Disponibles	Mmbpe	54.680	54.680
Recursos Descubiertos (OOIP)	Mmbpe	2769	2.769
Recursos No Descubiertos	Mmbpe	51.911	51.911
Probabilidad de Hallazgo	%	15%	15%
Recursos Prospectivos (OOIP)	Mmbpe	7787	7787
Recursos Prospectivos Recuperables (FR = 25%)	Mmbpe	1947	1947

Yet to find / Mass Balance

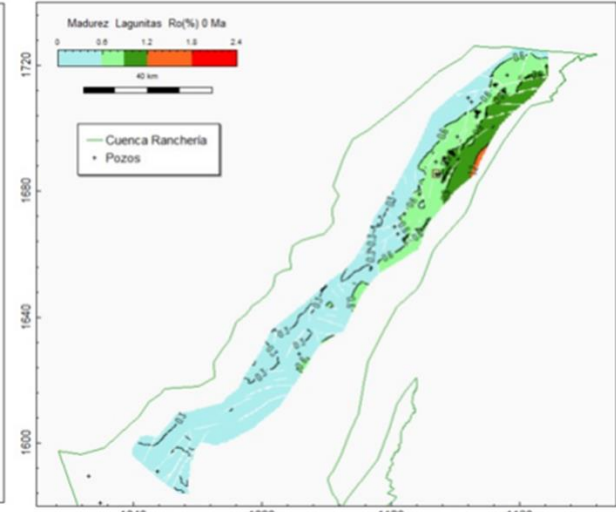
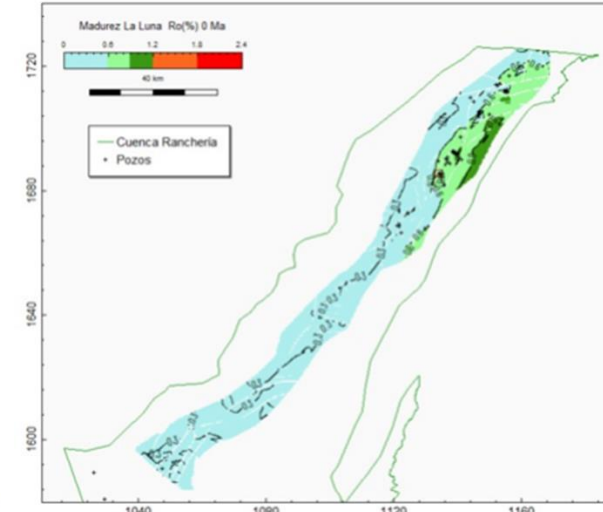
Cesar



FM. LA LUNA - K2 (Cretácico Superior)	
Poligono	km ²
Cesar	1280

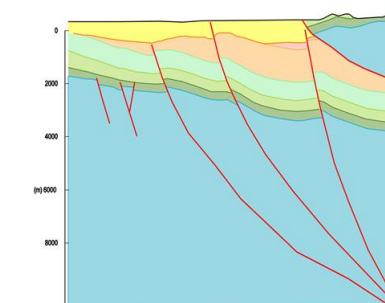
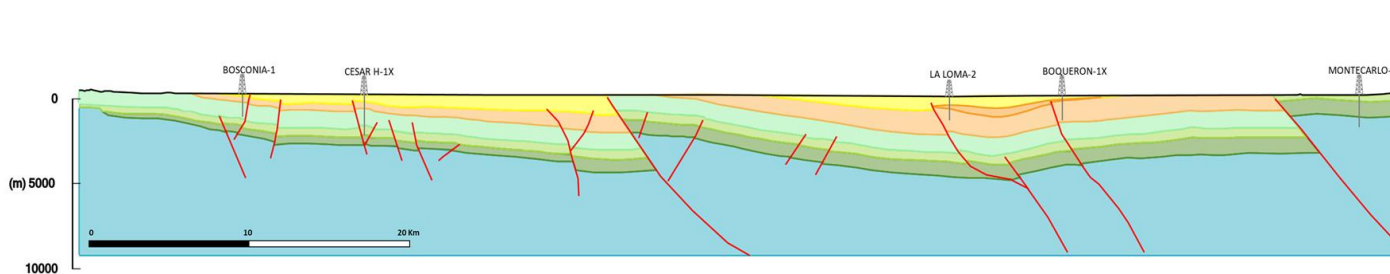
LAGUNITAS AGUAS BLANCAS - K1 (Cretácico)	
Poligono	km ²
Cesar	2600

Ranchería



FM. LA LUNA - K2 (Cretácico Superior)	
Poligono	km ²
Ranchería	450

LAGUNITAS AGUAS BLANCAS - K1 (Cretácico)	
Poligono	km ²
Ranchería	850



Ranchería and Cesar pods of active source rock Lagunitas-Aguas Blancas and La Luna Formations

Cesar Ranchería Basin

PARÁMETROS	UNIDADES	CUENCA CESAR RANCHERÍA		TOTAL
		CESAR	RANCHERIA	
HC's Generados / Lagunitas-Aguas Clara - K1	Mmbpe	17.513	5.399	22.911
Hc's Disponibles /Lagunitas-Aguas Clara - K1	Mmbpe	3.327	972	4.299
HC's Generados / La Luna - K2	Mmbpe	21.725	5.449	27.174
Hc's Disponibles /La Luna - K2	Mmbpe	3.476	654	4.130
Total HC's Generados	Mmbpe	39.238	10.848	50.085
Recursos Disponibles	Mmbpe	6.803	1.626	8.429
Recursos Descubiertos (OOIP)	Mmbpe	1,9	0	2
Recursos No Descubiertos	Mmbpe	6.802	1.626	8.427
Probabilidad de Hallazgo	%	13%	13%	13
Recursos Prospectivos (OOIP)	Mmbpe	884	211	1.096
Recursos Prospectivos Recuperables (FR = 25%)	Mmbpe	221	53	274

Yet to find – Prospective Resources OOIP

Northern Middle Magdalena Valley

- **Creaming curve method:** Projection for the next 20 years with average discovery trend of the last 10 years: Prospective resources 1000 Mmboe.
- **Fractal Method:** Prognosis performed in compliance with Pareto's Law and with an exponential correlation with a correlation coefficient of 98%. Prospective resources 4045 Mmboe.
- **Mass Balance Method:** Santa Lucía pod of active source rock for Tablazo and La Luna Formations --- Shows prospective resources about 7787 Mmboe.

Cesar - Ranchería

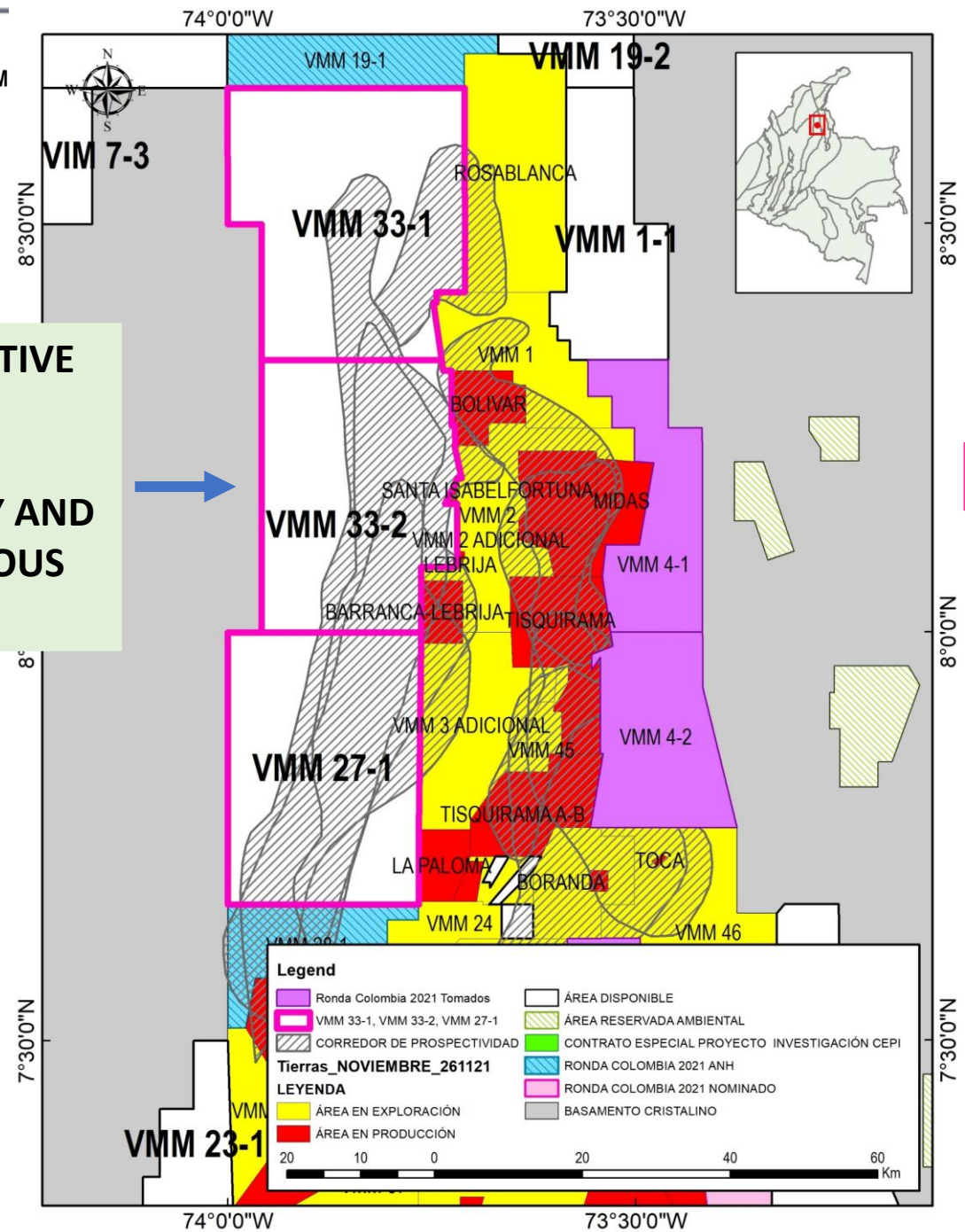
- **Mass Balance Method:** Cesar-Ranchería pod of active source rock Lagunitas- Aguas Blancas and La Luna Formations. Prospective resources 1096 Mmboe.

FAIRWAY MAPS AND ANH LAND MAP

WORKSHOP No 2
FEBRUARY 11th

**PROSPECTIVE AREA
BASAL
TERTIARY AND
CRETACEOUS
ROCKS**

**MIDDLE MAGDALENA BASIN
VMM 33-1, VMM 33-2 AND VMM 27-1**



Legend

Ronda Colombia 2021 Tomados	ÁREA DISPONIBLE
VMM 33-1, VMM 33-2, VMM 27-1	ÁREA RESERVADA AMBIENTAL
CORREDOR DE PROSPECTIVIDAD	CONTRATO ESPECIAL PROYECTO INVESTIGACIÓN CEPI
Tierras_NOVIEMBRE_261121	RONDA COLOMBIA 2021 ANH
ÁREA EN EXPLORACIÓN	RONDA COLOMBIA 2021 NOMINADO
ÁREA EN PRODUCCIÓN	BASAMENTO CRISTALINO

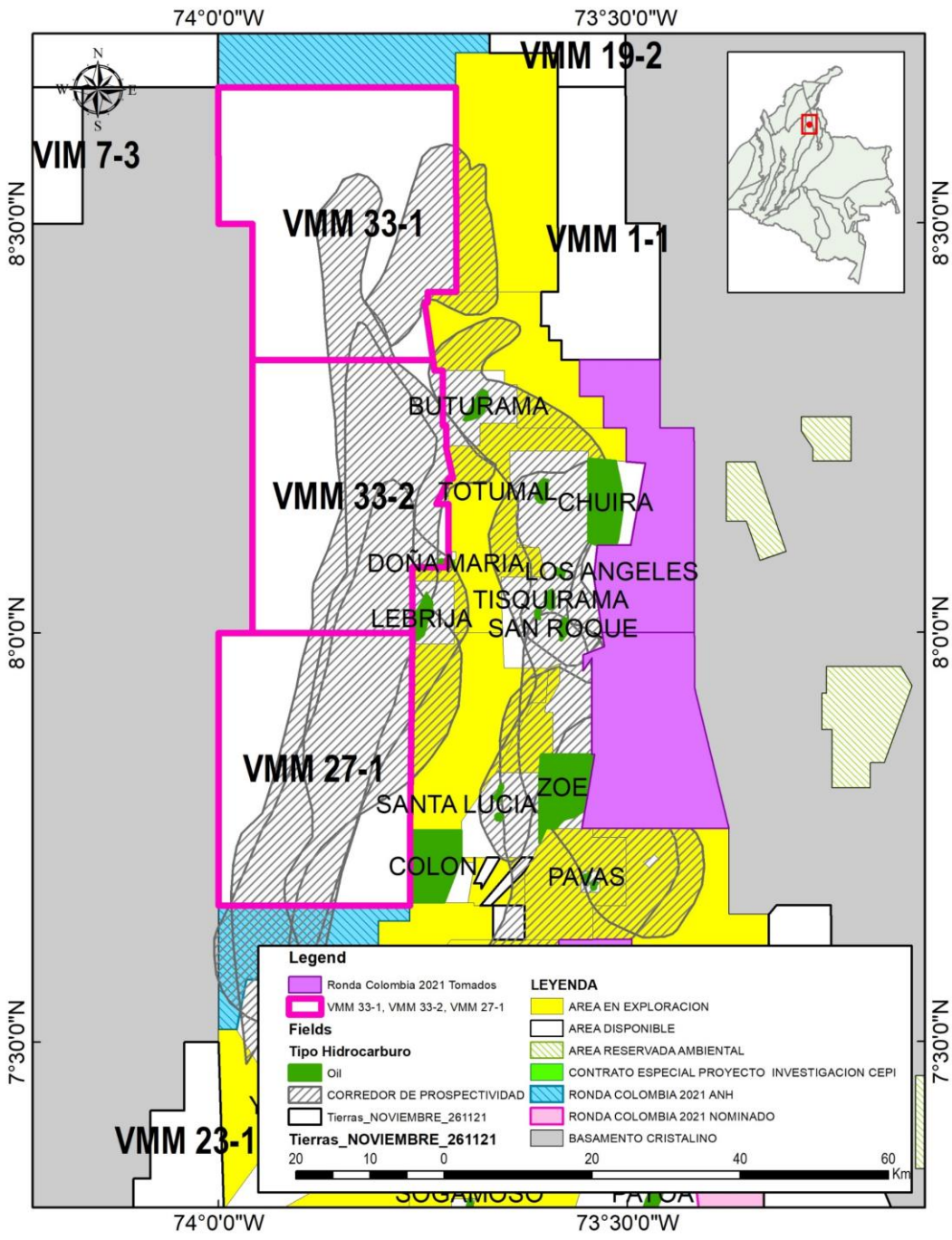
20 10 0 20 40 60 Km



WORKSHOP No 2
FEBRUARY 11th

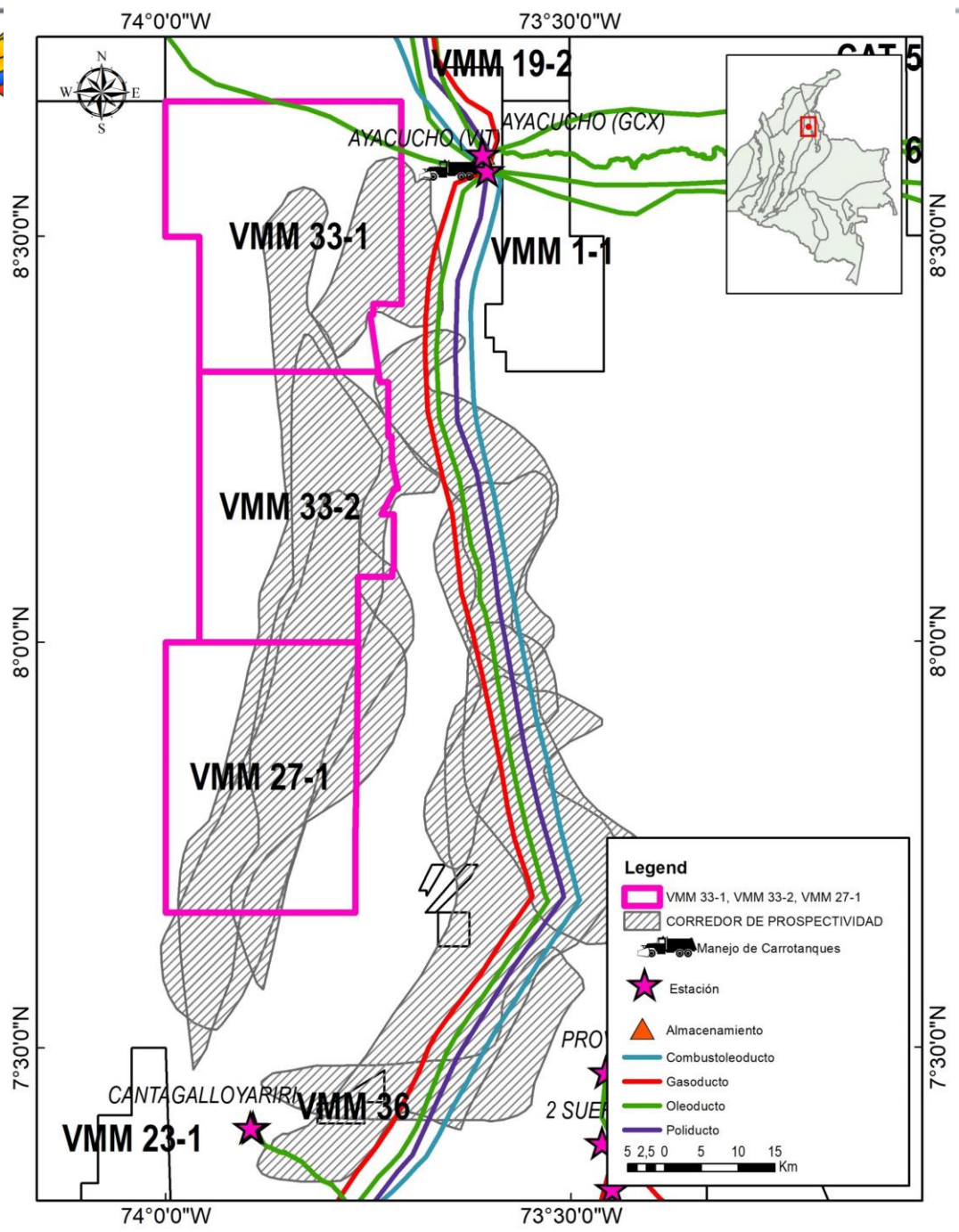


VMM 33-1, VMM 33-2 AND VMM 27-1 FIELDS





WORKSHOP No 2
FEBRUARY 11th



VMM 33-1, VMM 33-2 AND VMM 27-1
INFRASTRUCTURE