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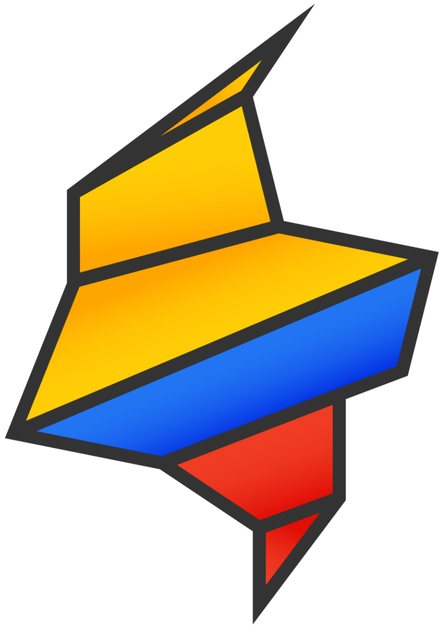
El futuro es de todos

Minenergía



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UNIVERSIDAD NACIONAL DE COLOMBIA

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Universidad Pedagógica y Tecnológica de Colombia

UNIVERSIDAD DE PAMPLONA

ACGGP
ASOCIACIÓN COLOMBIANA DE GEÓLOGOS Y GEOFÍSICOS DEL PETRÓLEO

AAPG

SEG

Acipet
Asociación Colombiana de Ingenieros de Petróleos

acp

EAGE

EASTERN CORDILLERA BASIN

Geological Integration, Evaluation of Oil Systems and Prospectivity

2021-07-02

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CONTENT

- Work Team – *Kurt Bayer*
- Regional Geological Framework / Chronostratigraphic Sections / Gross Depositional Environments – *Luis Vergara*
- Petrophysics, Reservoirs and Seals – Helman Bonilla, *Luis Vergara**
- Structural sections / Plays, prospects and leads – *Andres Mesa**
- Petroleum System / Yet to Find – *Cesar Mora*
- Final Comments – *Kurt Bayer*

*Speaker

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INTRODUCTION

Work Team

• Project Director	*Kurt Bayer*
• UPTC Coordinator	Carlos Julio Rodríguez
• Stratigraphy Advisor	*Luis Vergara*
• Structural Geology Advisor	*Andrés Mesa*
• Petroleum Systems Modeling	*Cesar Mora*
• Geologist support in Stratigraphy	Gatsby López
• Petrophysics Advisor	Helman Bonilla
• Seismic Interpretation	Mary Piragauta
	Nelly Piragauta
	Maria Murillo
	Gener Bautista
• Yet to Find	Juan Guarín
• Support Geologist at MSP	Leady Caro
• GIS Specialist	Aldemar Cardozo

14 Professionals

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Geological Framework
Chronostratigraphic Sections
Gross Depositional Environments

LUIS VERGARA

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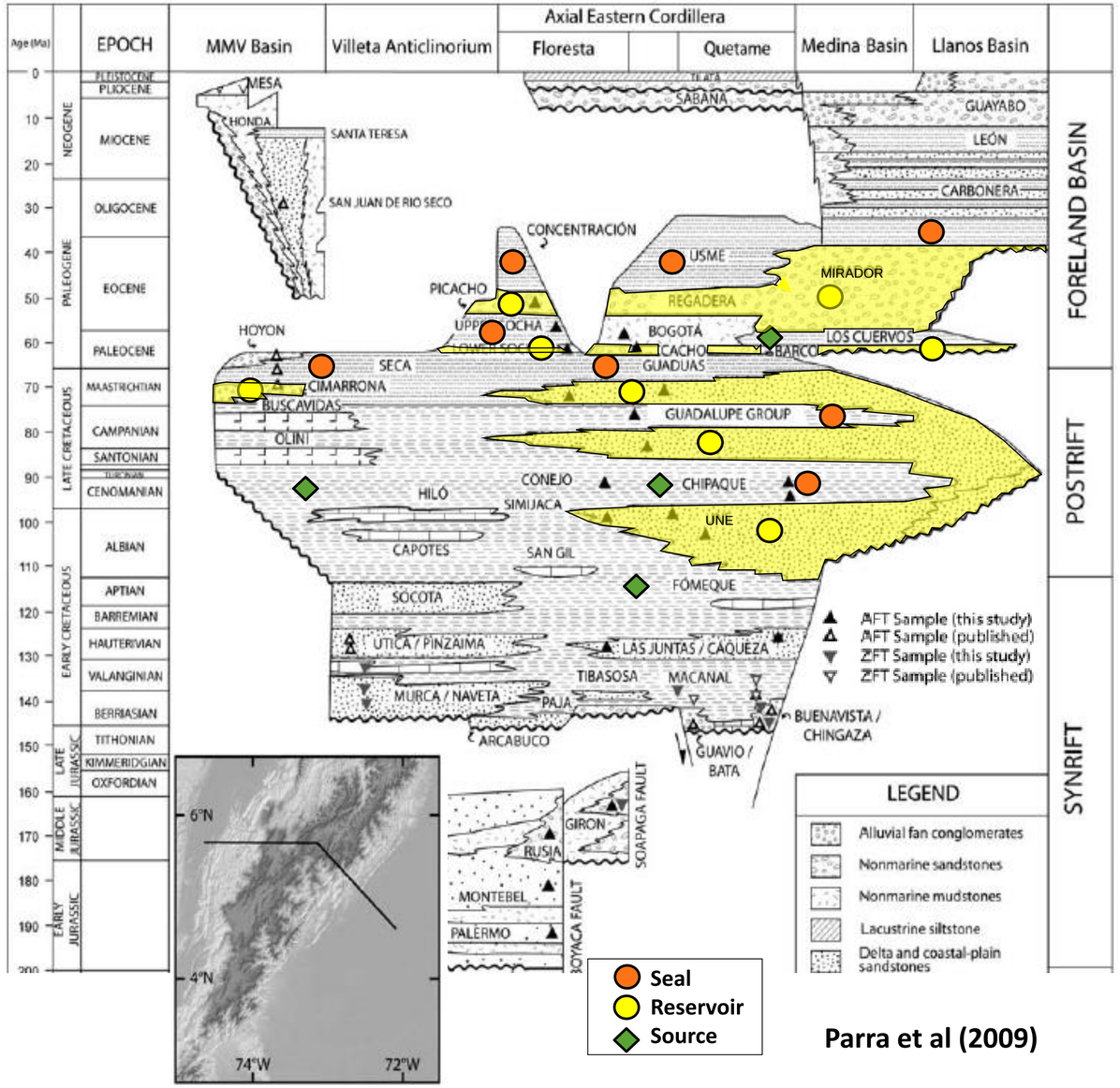
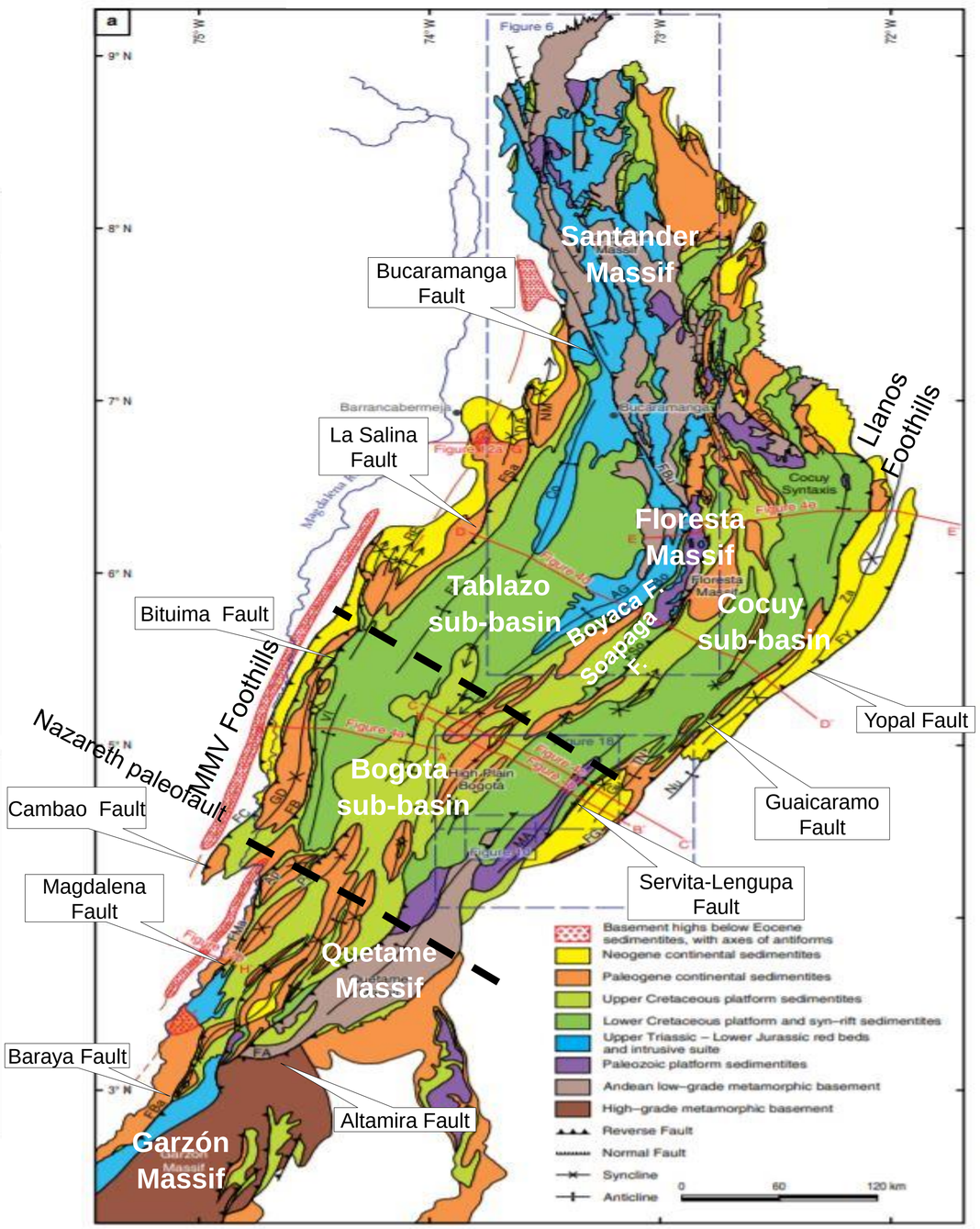
GEOLOGICAL FRAMEWORK

Chronostratigraphy



Parra et al (2009)

Main structural elements



Faults

- FB: Bituima Fault
- FBo: Boyacá Fault
- FBu: Bucaramanga Fault
- FC: Cambao Fault
- FCh: Labateca Fault
- FG: Guaicáramo Fault
- FMa: Magdalena Fault
- FSa: La Salina Fault
- FSo: Soapaga Fault
- FY: Yopal Fault
- FBa: Baraya Fault
- FA: Algeciras Fault
- FAl: Altamira Fault

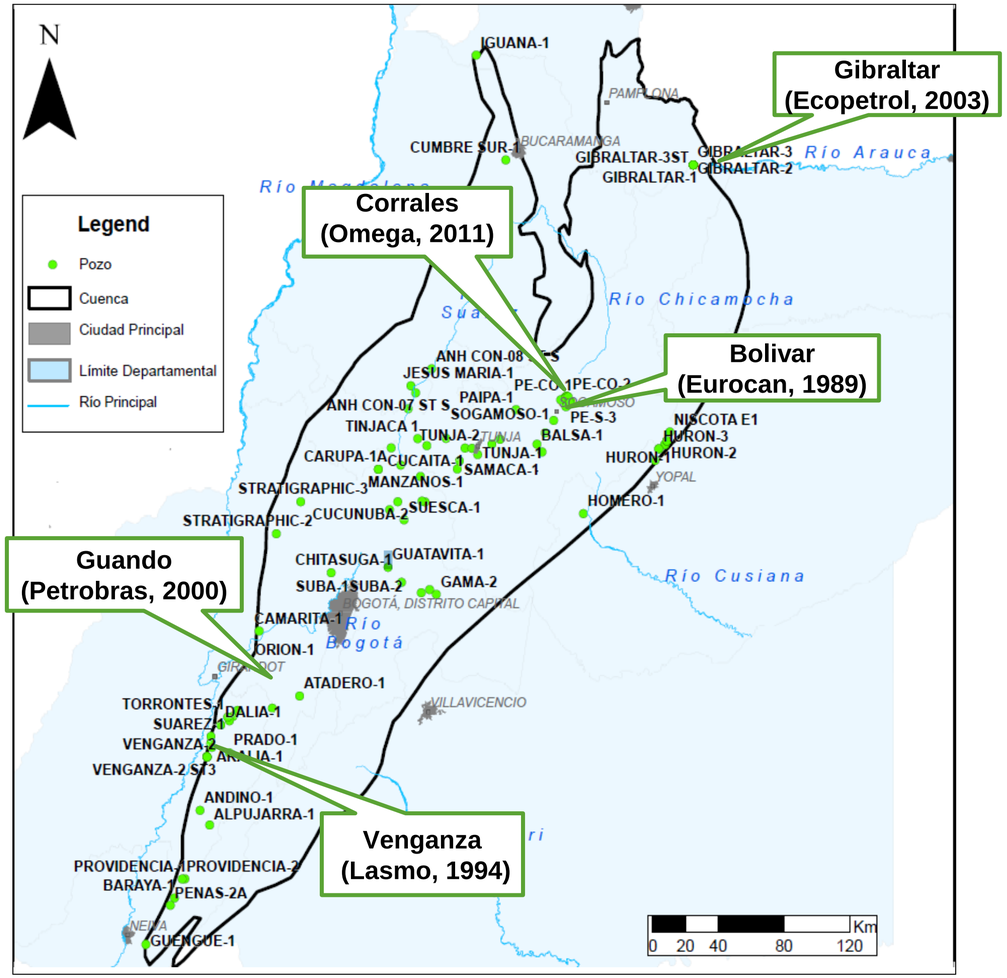
Folds

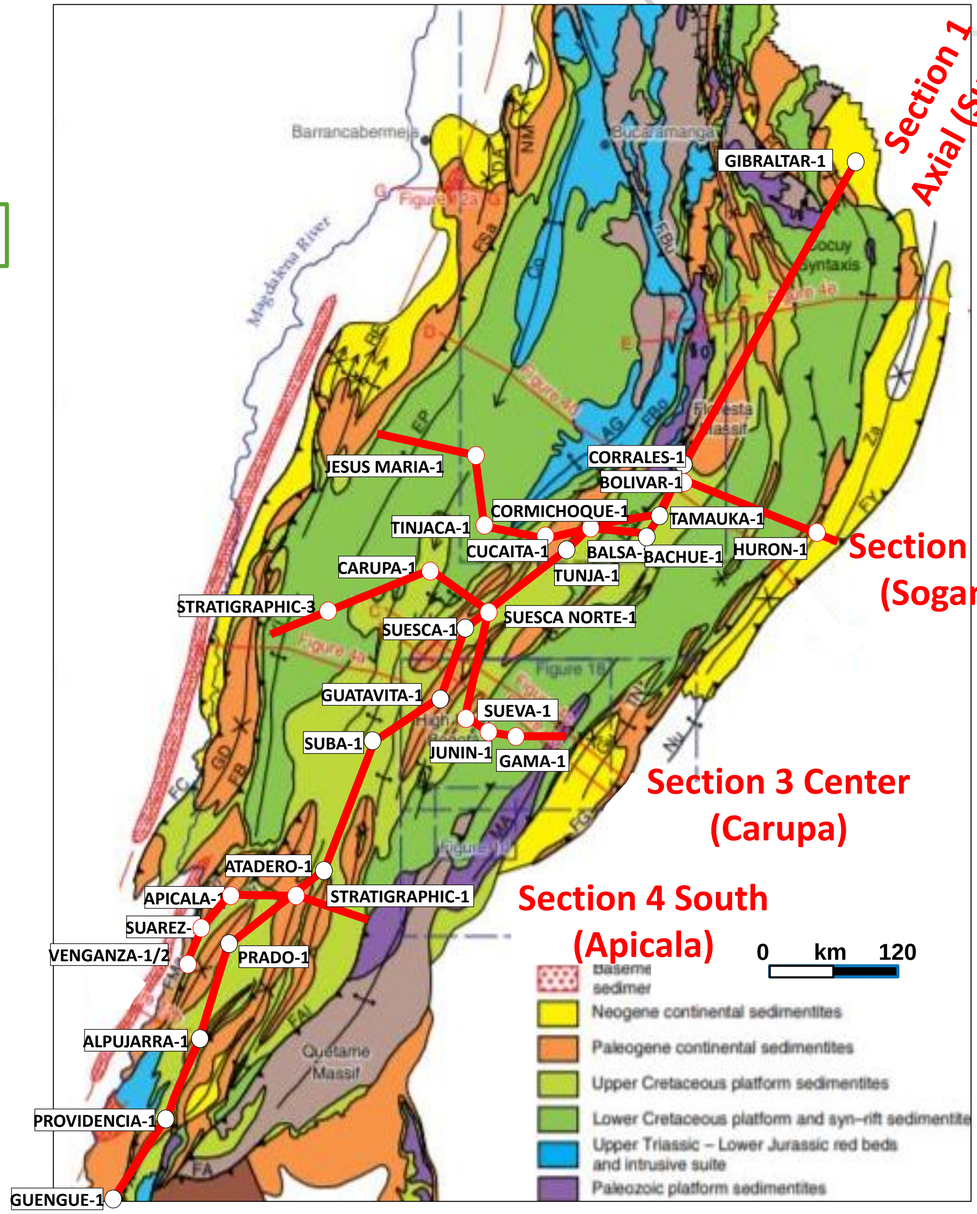
- AG: Arcabuco–Guantiva Anticline
- Ap: Carmen de Apicalá Syncline
- Vl: Villeta Anticlinorium
- RE: Rio Ermitaño Syncline
- Co: Los Cobardes Anticline
- EP: El Peñon Anticline
- Ma: Montecristo Anticline
- Gd: Guaduas Syncline
- Gu: Guavio Anticline
- NM: Nuevo Mundo Syncline
- DA: De Armas Syncline
- Pr: Prado Syncline
- TN: Tierranegra Anticline
- Za: Zamaricote Syncline
- Nu: Nunchía Syncline

(Kammer et al, 2020)

CHRONOSTRATIGRAHIC SECTIONS

Basin outline with wells and oil fields





- 1 axial and 3 cross sections
- incorporate key wells with available information
- preferably deep levels
- 30 wells used

Kammer et al (2020)

SECTION – 1 AXIAL (Suesca)

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SW — NE

I.C.S. (2020)

Guengue-1 | Providencia-1 | Alpujarra-1 | Prado-1 | Atadero-1 | Suba-1 | Guatavita-1 | Suesca-1 | Tunja-1 | Cormichoque-1 | Tamauka-1 | Corrales-1 | Gibraltar-1

Bogota (Cundinamarca) Sub-basin

Sub-cuenca del Cocuy

45413 m | 35235 m | 44027 m | 54248 m | 64062 m | 31688 m | 29669 m | 59046 m | 27632 m | 25403 m | 155504 m

Sabana Tilatá

Grupo Honda

Uplift in Oligocene

Uplift in early Miocene

Uplift in early Eocene

Pliocene Rhyolites intruded Une Fm.

Fusagasugá

Grupo Gualanday

Concentración

Picacho

Bogotá

Socha Sup.

Socha Inf.

Cacho

Carbonera C6-C7

Mirador

Los Cuervos

Barco

Guadalupe

Seca

(Guaduala)

La Tabla

Guaduas

Guadalupe

Los Cuervos

Colon

Chipaque

La Frontera

Chipaque

Hondita-Lomagorda

Tetuán

Caballos

Une

Yavi

Basal Cretaceous conglomerates on Paleozoic (Sumapaz area)

Nazareth Paleofault

Apón

Tibasosa

Las Juntas

Macanal

?

Saldaña

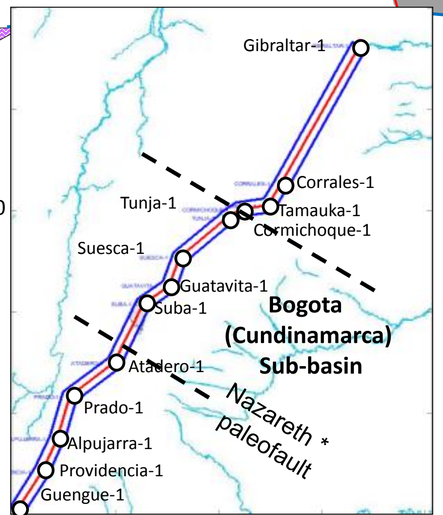
Salt deposits interbedded in Macanal shales; Zipaquirá and Nemocón salt mines

Grupo Girón

CENOZOIC: NEOGENE (PLIOCENE: PIACENZIAN, ZANCLEAN; MIOCENE: MESSINIAN, TORTONIAN, SERRAVALLIAN, LANGHIAN, BURDIGALIAN, AQUITANIAN); PALEOGENE (OLIGOCENE: CHATTIAN, RUPELIAN; EOCENE: PRIABONIAN, BARTONIAN, LUTETIAN, YPRESIAN; PALEOCENE: THANETIAN, SELANDIAN, DANIAN)

MESOZOIC: CRETACEOUS (LATE: MAASTRICHTIAN, CAMPANIAN, SANTONIAN, CONIACIAN, TURONIAN, CENOMANIAN; EARLY: ALBIAN, APTIAN, BARREMIAN, HAUTERIVIAN, VALANGINIAN, BERRIASIAN); JURASSIC (MALM: TITHONIAN, KIMMERIDGIAN, OXFORDIAN; DOGGER: CALLOVIAN, BATHONIAN, BAJOCIAN, AALENIAN; LIAS: TOARCIAN, PLIENSBACHIAN, SINEMURIAN, HETTANGIAN)

0 km 100



Well control

Uplift episode (Mora et al 2019)

Onlap surface

Erosion surface

Shales, outer shelf

Salt (evaporites)

Chert ("Lidita"), outer shelf

Limestone, outer shelf

Sandstone, deep water (turbidites)

Volcanics, continental

Clay, lacustrine; recent terraces

Sandstone, fluvial

Conglomerates, alluvial fans/continental molasse

Shales, paralic with coal measures

Sandstone, littoral or shoreface

Conglomerates and alluvial sands

Clays, continental

Surface Geology for all sections:

Gómez, J., Montes, N.E., Nivia, A. & Diederix, H., compiladores. 2015. Mapa Geológico de Colombia 2015. Escala 1:100 000. Servicio Geológico Colombiano, Bogota

* Sarmiento, L. et al (2006)

SECTION – 2 NORTH (Sogamoso)

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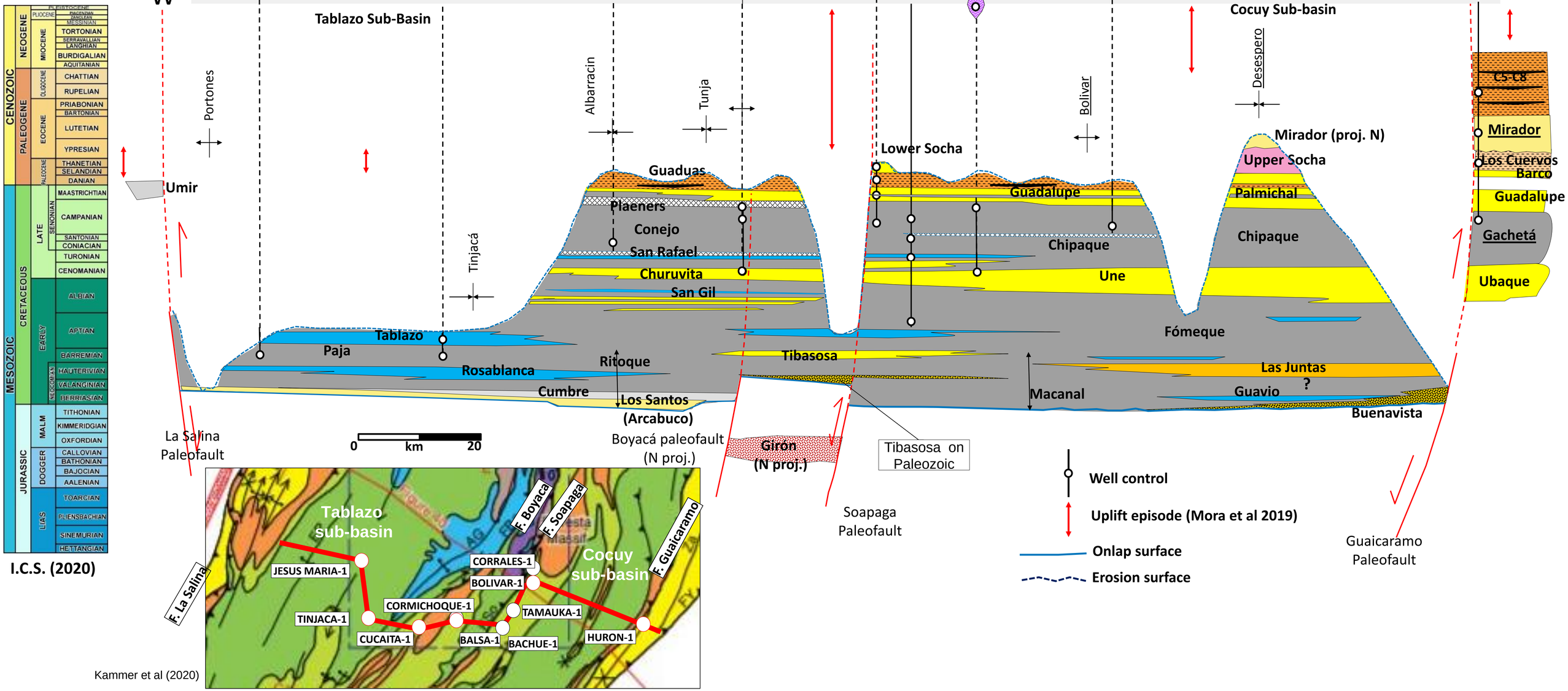

I.C.S. (2020)

Kammer et al (2020)

SECTION – 3 CENTER (Carupa)

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Uplift in Late Paleocene

Uplift in Oligocene

Uplift in Middle Miocene

Uplift in Oligocene

Uplift in Mid. Miocene

W

Stratigraphic-3

50811 m

Carupa-1A

Sabana

32635 m

Nemqueteba-1

Suesca Norte -1

49542 m

Sueva -1

13543 m

Junin -1

9134 m

Gama-2

E

Aposentos

Neusa

Bogota Sub-basin

Siecha-Sisga

Sueva

La Regadera (proj. N)

Upp. Socha

Low. Socha

Guaduas

Plaeners

Potential reservoirs (untested/undoc)

La Tabla

Gr. Olini

Guadalupe

Conejo

Frontera

Simijaca

Chiquinquirá

Chipaque

Une

Fómeque

Simití

Tablazo

Paja

Potential reservoirs (untested/undoc)

Alto del Caqueza (proj. S)

Las Juntas

Guavio

Macanal

Murca

Macanal

Buenavista

0 km 20

Well control

Uplift episode (Mora et al 2019)

Onlap surface

Erosion surface

Salt deposits interbedded with Macanal shales; Zipaquirá and Nemocón salt mines

Bituima Paleofault

Servitá-Lengupá Paleofault

CENOZOIC

NEOGENE

PLIOCENE: PLEISTOCENE, PIACENZIAN, ZANCLEAN

MIOCENE: MESSINIAN, TORTONIAN, SERRAVALLIAN, LANGHIAN, BURDIGALIAN, AQUITANIAN

PALEOGENE

OLIGOCENE: CHATTIAN, RUPELIAN

EOCENE: PRIABONIAN, BARTONIAN, LUTETIAN, YPRESIAN

PALEOCENE: THANETIAN, SELANDIAN, DANIAN

MESOZOIC

CRETACEOUS

LATE: MAASTRICHTIAN, CAMPANIAN, SANTONIAN, CONIACIAN, TURONIAN, CENOMANIAN

EARLY: ALBIAN, APTIAN, BARREMIAN, HAUTERIVIAN, VALANGINIAN, BERRIASIAN

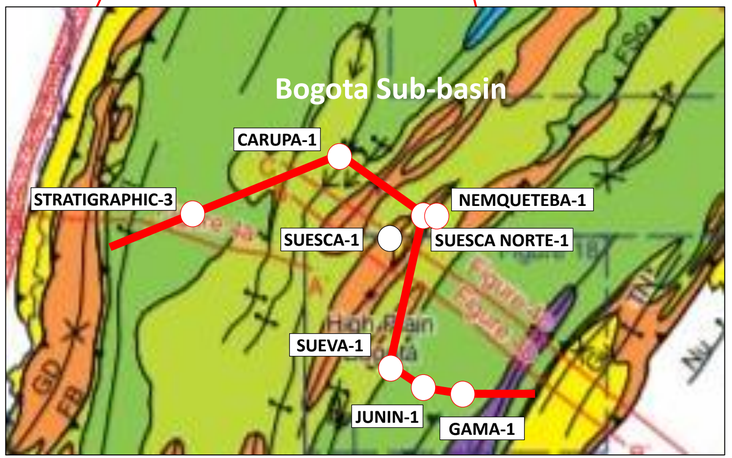
JURASSIC

MALM: TITHONIAN, KIMMERIDGIAN, OXFORDIAN

DOGGER: CALLOVIAN, BATHONIAN, BAJOCIAN, AALENIAN

LIAS: TOARCIAN, PLIENSBACHIAN, SINEMURIAN, HETTANGIAN

I.C.S. (2020)



Kammer et al (2020)

SECTION – 4 SOUTH (Apicalá)

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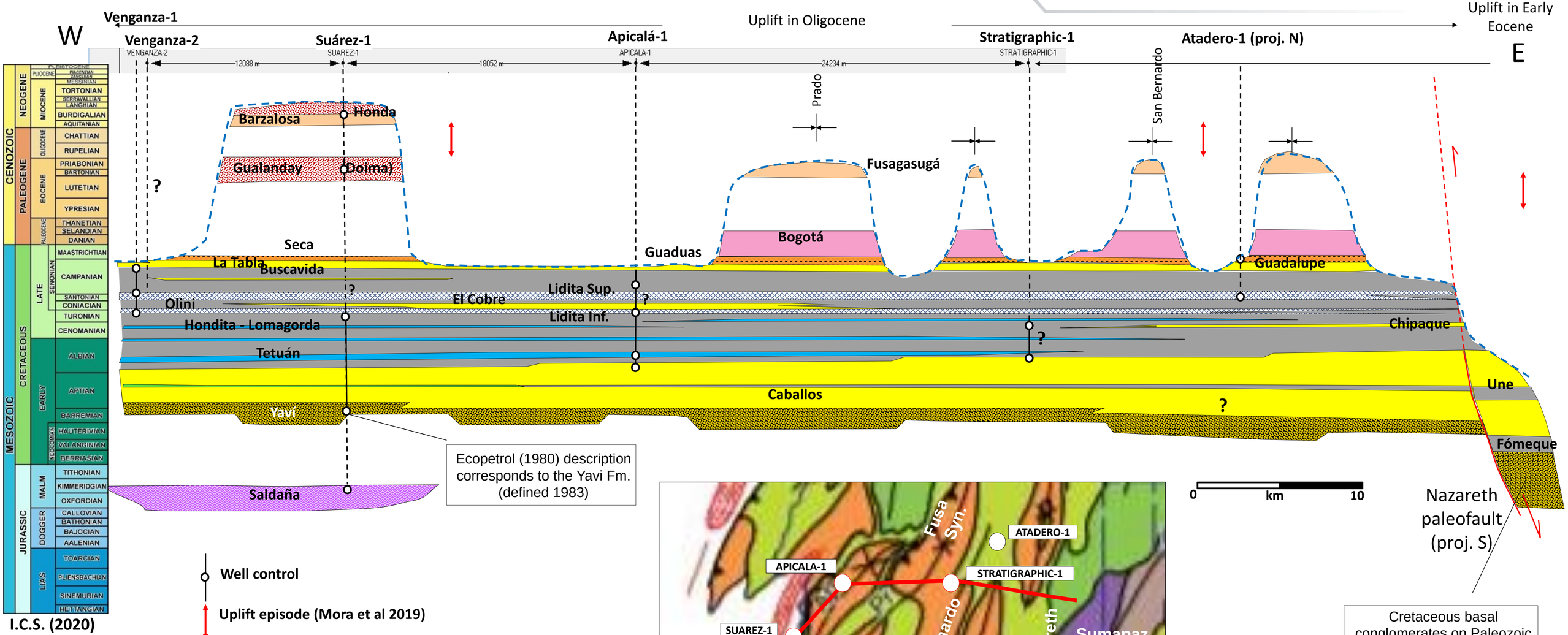

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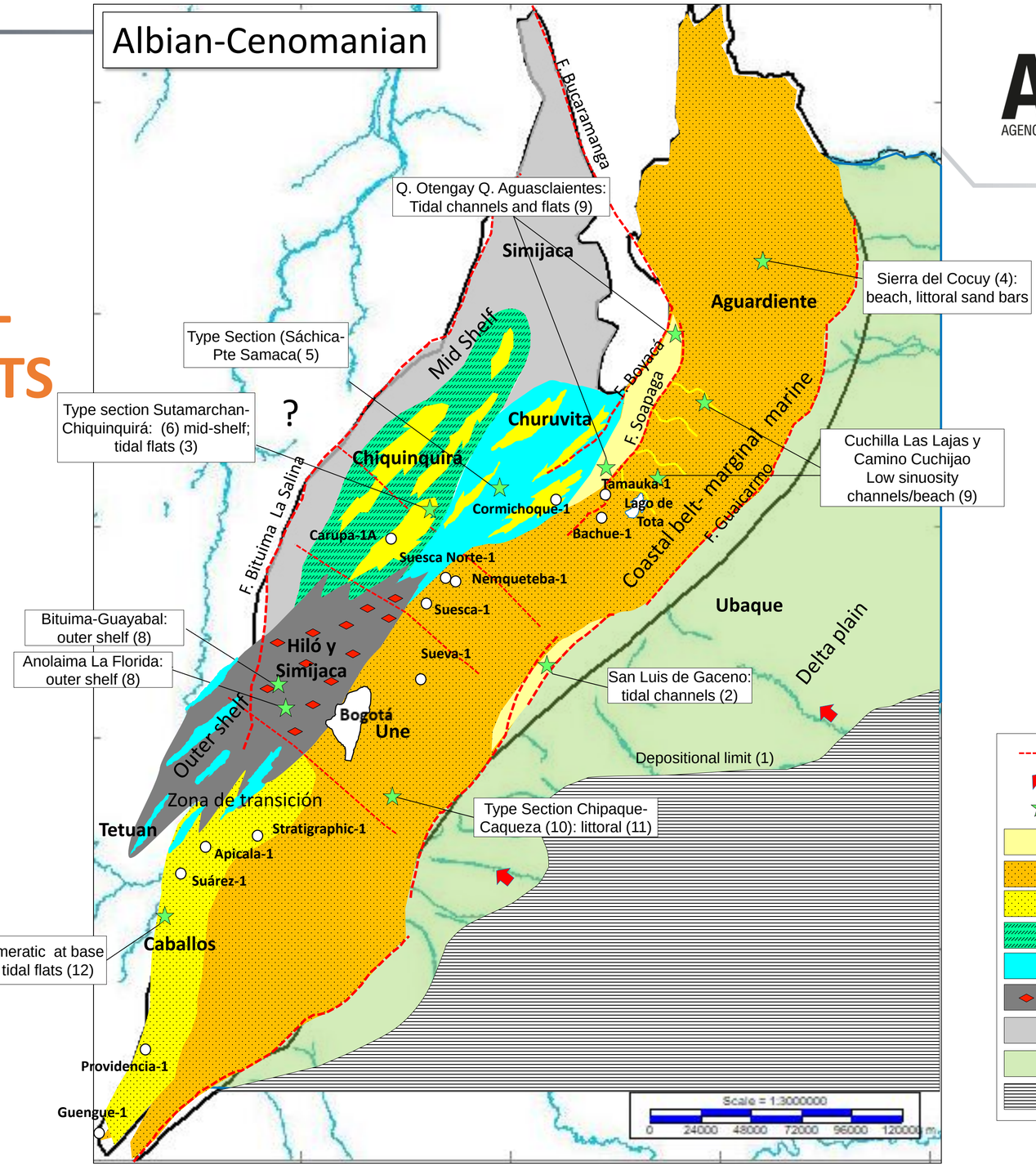
GROSS DEPOSITIONAL ENVIRONMENTS



Sources:

1) Cediel et al. (2003)
2) Guerrero & Sarmiento (1996)
3) Terraza & Tchegliakova (2005)
4) Fabre (1985)
5) Etayo (1968)
6) Ulloa & Rodriguez (1991)
7) Mojica & Macia (1983)
8) Martínez & Vergara (1999)
9) Fonseca & Mesa (1995)
10) Julivert (1968)
11) Renzoni (1962)
12) Renzoni (1994)

- Initial post-rift phase, marine
- Basin confined to border syn-rift faults
- Linear source from East (Guyana craton)
- Western provenance uncertain
- Reservoirs: Une, Aguardiente, Churuvita, Chiquinquirá, Caballos

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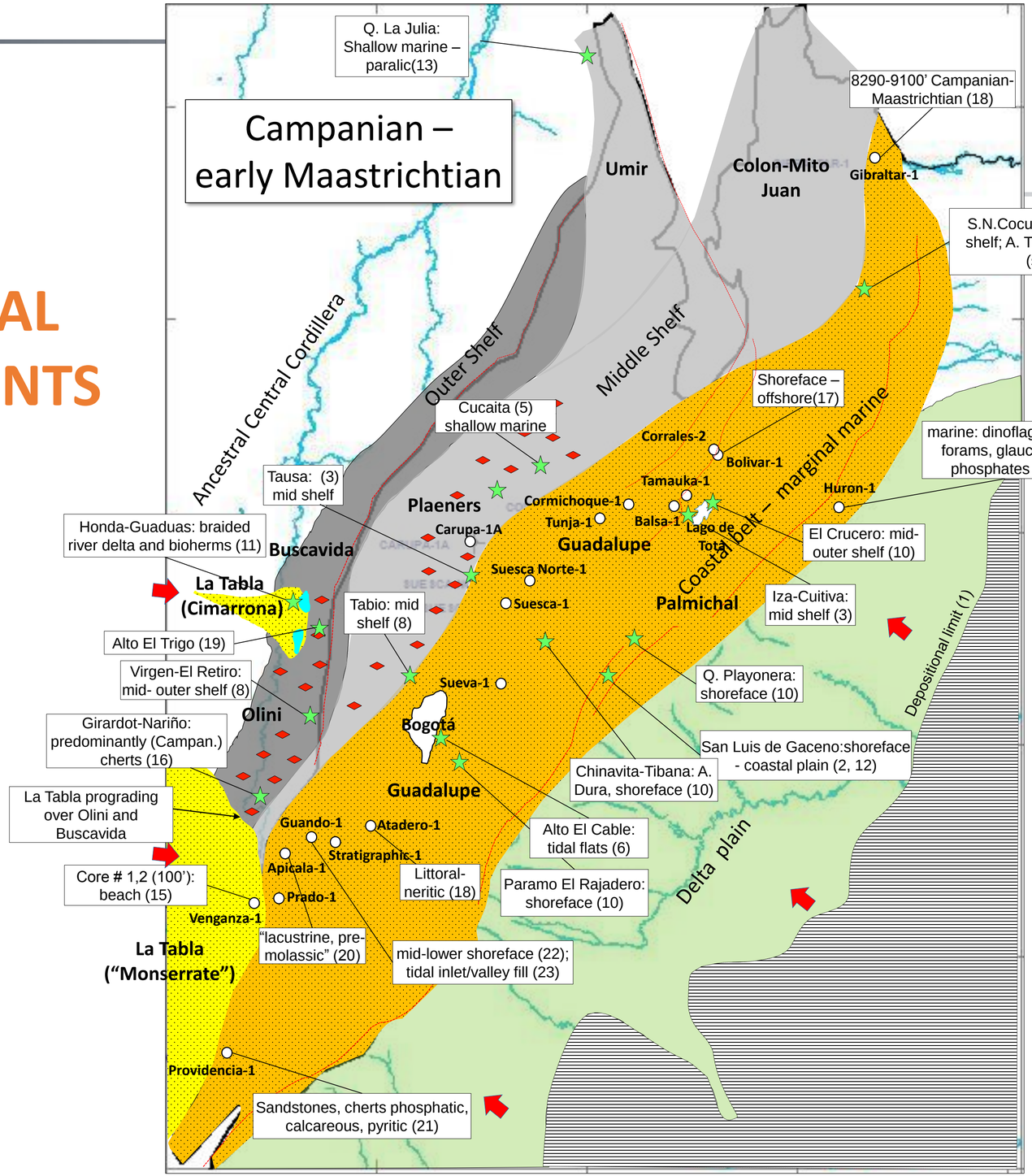
GROSS DEPOSITIONAL ENVIRONMENTS



- Final post-rift phase, marine
- Dual provenance after Central Cordillera emerged
- Sedimentation from East (linear-source) and West (point-source)
- Reservoirs: Guadalupe, Palmichal, La Tabla

Sources:

1) Cediel et al (2003)
2) Guerrero & Sarmiento (1996)
3) Föllmi et al (1991)
4) Fabre (1985)
5) Etayo (1968)
6) Perez & Salazar (1978)
7) Mojica & Macia (1983)
8) Martinez & Vergara (1999)
9) Julivert (1974)
10) Vergara & Rodriguez (1997)
11) Gómez & Pedraza (1994)
12) Tchegliakova et al (1997)
13) Tchegliakova (1995)
14) Hocol (2009)
15) Lasmo (1992)
16) Buergl & Tobon (1954)
17) U. Nal – ANH (2008)
18) Garzon (2002)
19) Ulloa(1986)
20) Rojas et al (1980)
21) Petrobras (1994)
22) Reyes et al (2003)
23) Leckie et al. (2003)

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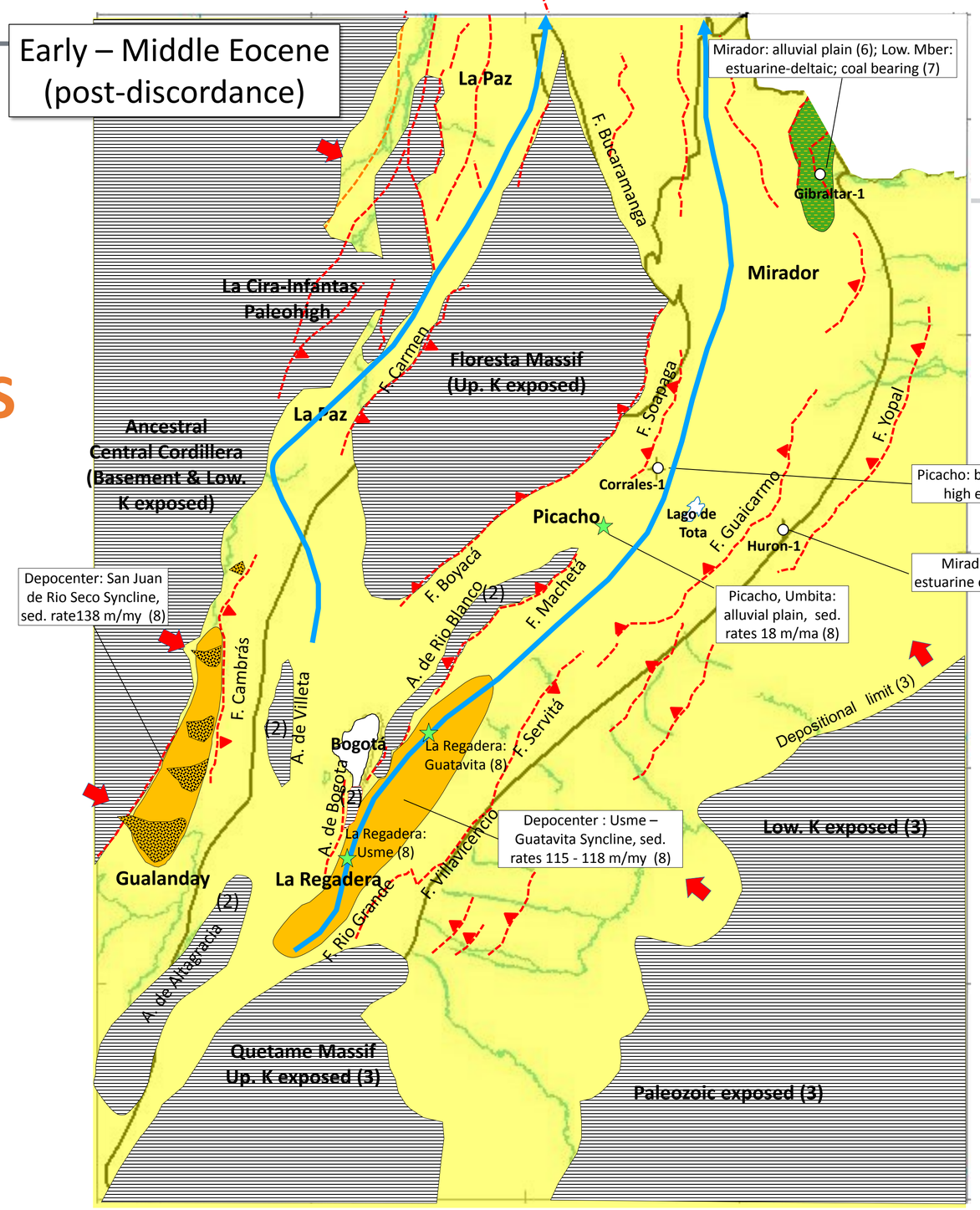
GROSS DEPOSITIONAL ENVIRONMENTS

Sources:

1) Caballero et al (2020)
2) Mora et al (2013)
3) Reyes-Harker et al (2015)
4) U.Nal.- ANH (2008)
5) Salazar & Numpaque (2009)
6) Garzón (2001)
7) Occidental (2002)
8) Bayona et al (2013)

- Redrawn from Caballero et al (2020)
- Inverted faults and provenance axes from Mora et al (2013)
- Depocenters after Bayona et al. (2013)



- Foreland basin, continental
- Basin confined by several exhumed intrabasinal blocks
- Multiple area sources
- 2 Main fairways: MMV and axial zone, northwards sediment dispersion
- 2 Depocenters with high sedimentation rates: Usme-Guatavita and San Juan de Rio Seco
- Reservoirs: (Lower) Mirador, Picacho, La Regadera, La Paz

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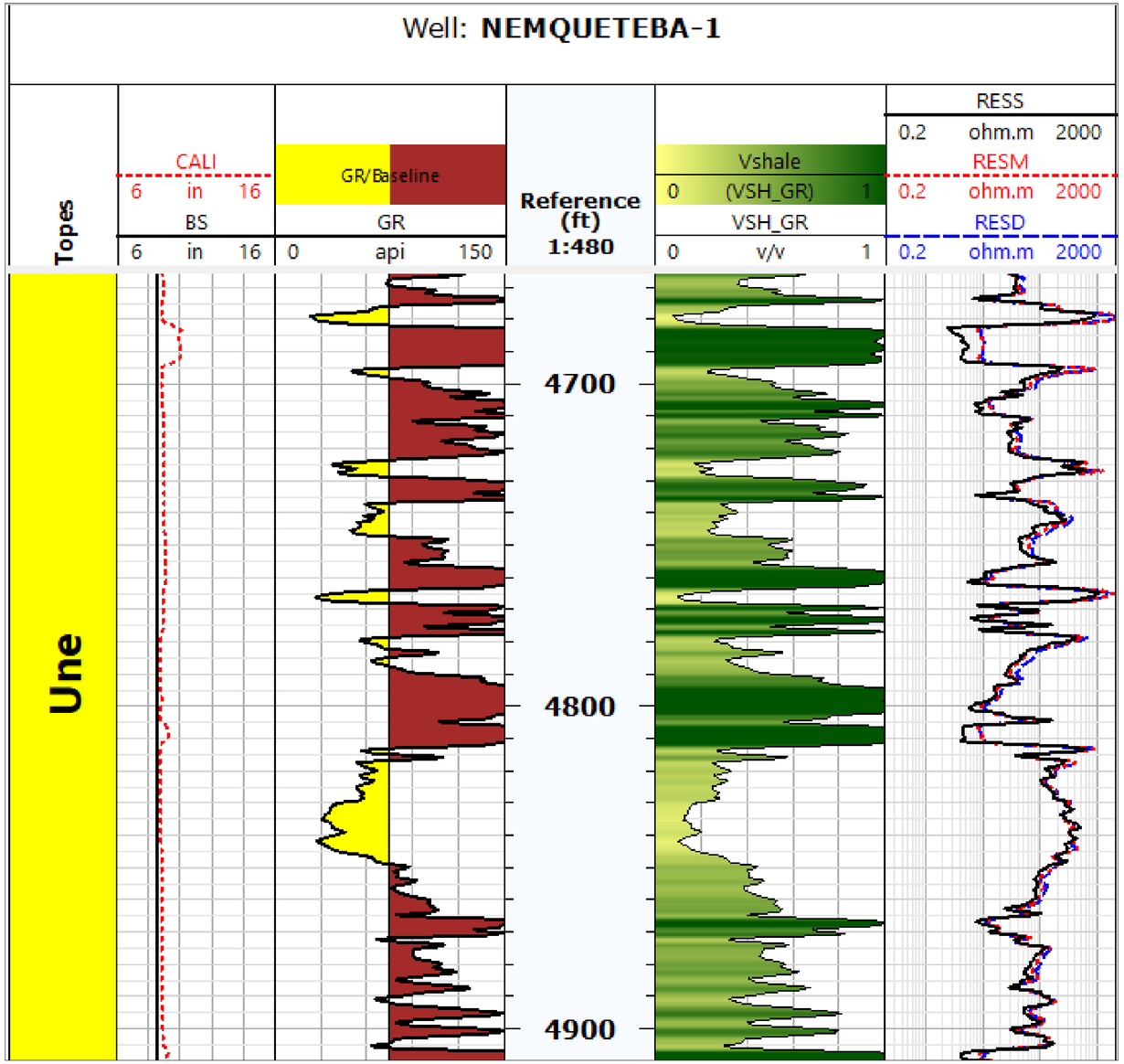
Petrophysics, Reservoirs and Seals

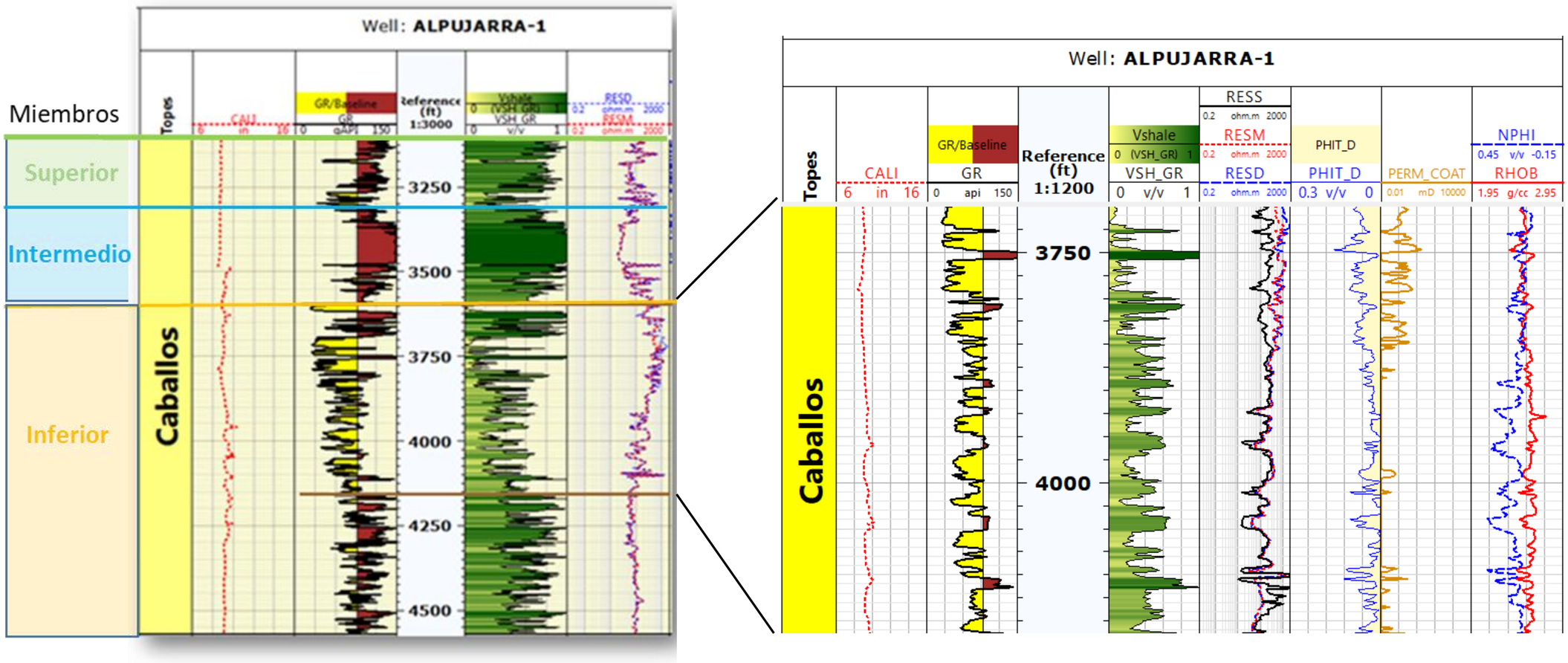
HELMAN BONILLA / LUIS VERGARA

RESERVOIR EVALUATION
Une Formation



- Main target in Nemqueteba-1 (Maurel & Prom, 2011)
- Thickness of 1379 ft (1200-4200 ft in outcrops, Fabre, 1981)
- GR 30 - 45 API
  Vsh 50% average, min 15%
  PhiE 4 - 7%
  k 800 - 1000 mD

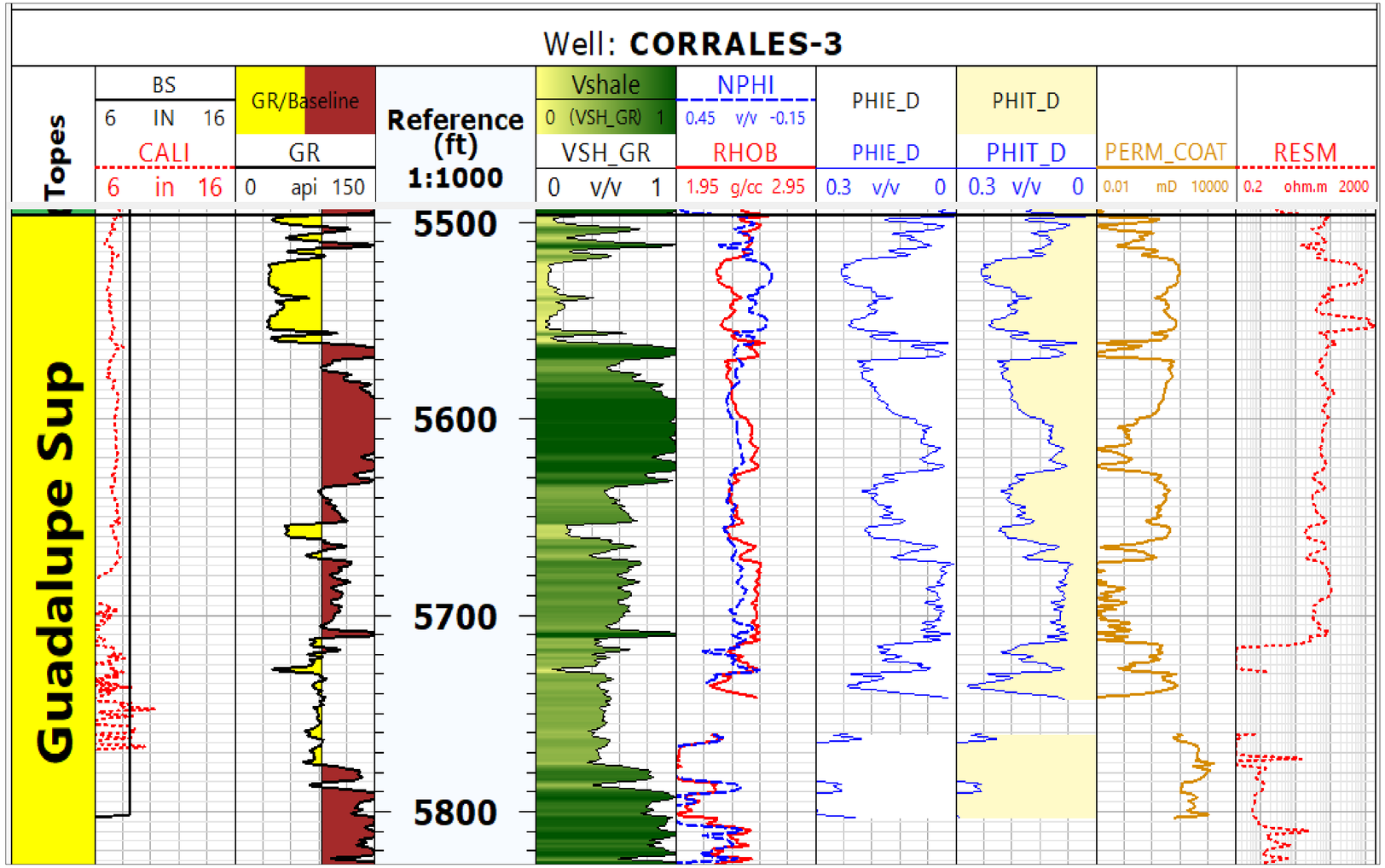
RESERVOIR EVALUATION
Caballos Formation



- Thickness 1525 ft (Hocol, 1992)
- Upper and Lower Caballos have reservoir quality
- Porosity 10% average, but 20 -25% in clean zones
- K average 800 - 1000 mD.

RESERVOIR EVALUATION

Guadalupe Formation

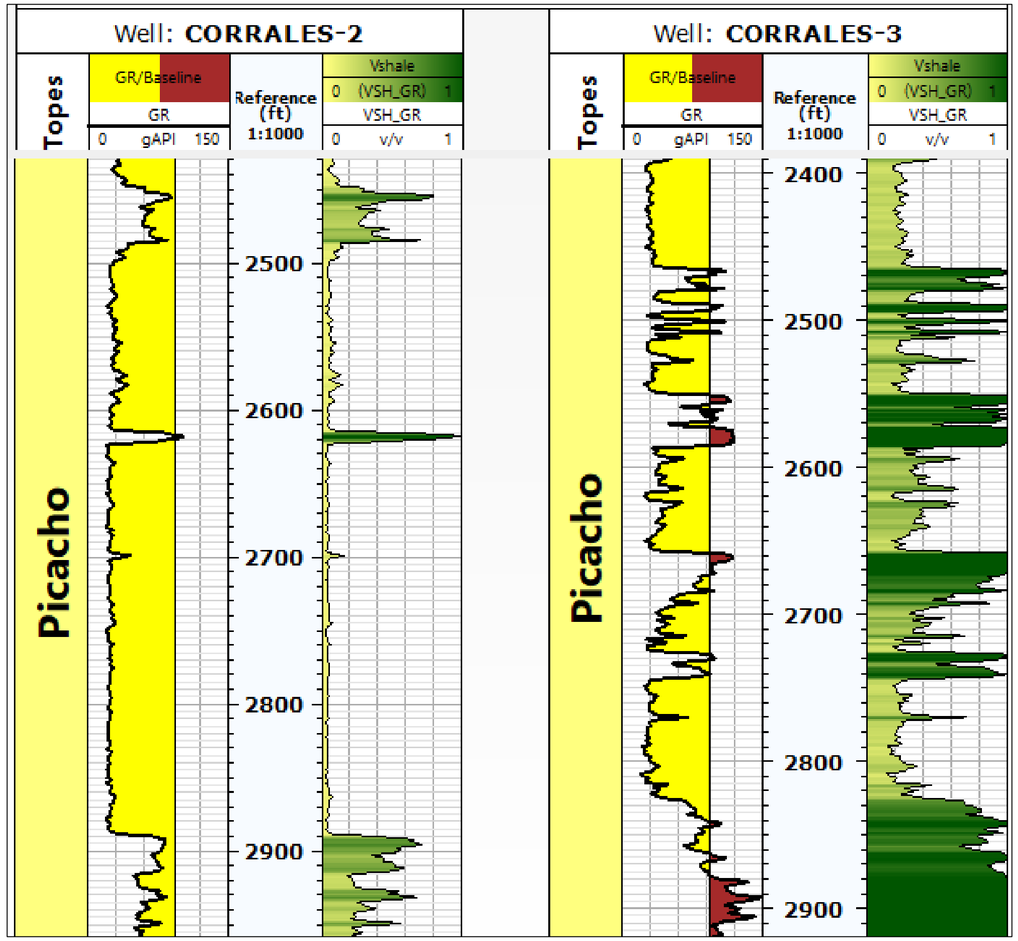


- Main Reservoir in Bolivar and Corrales Fields (Omega Energy)
- Thickness ~ 300 ft
- PhiE 25-30%
- Vsh < 8 %
- k ~ 1000 mD

RESERVOIR EVALUATION

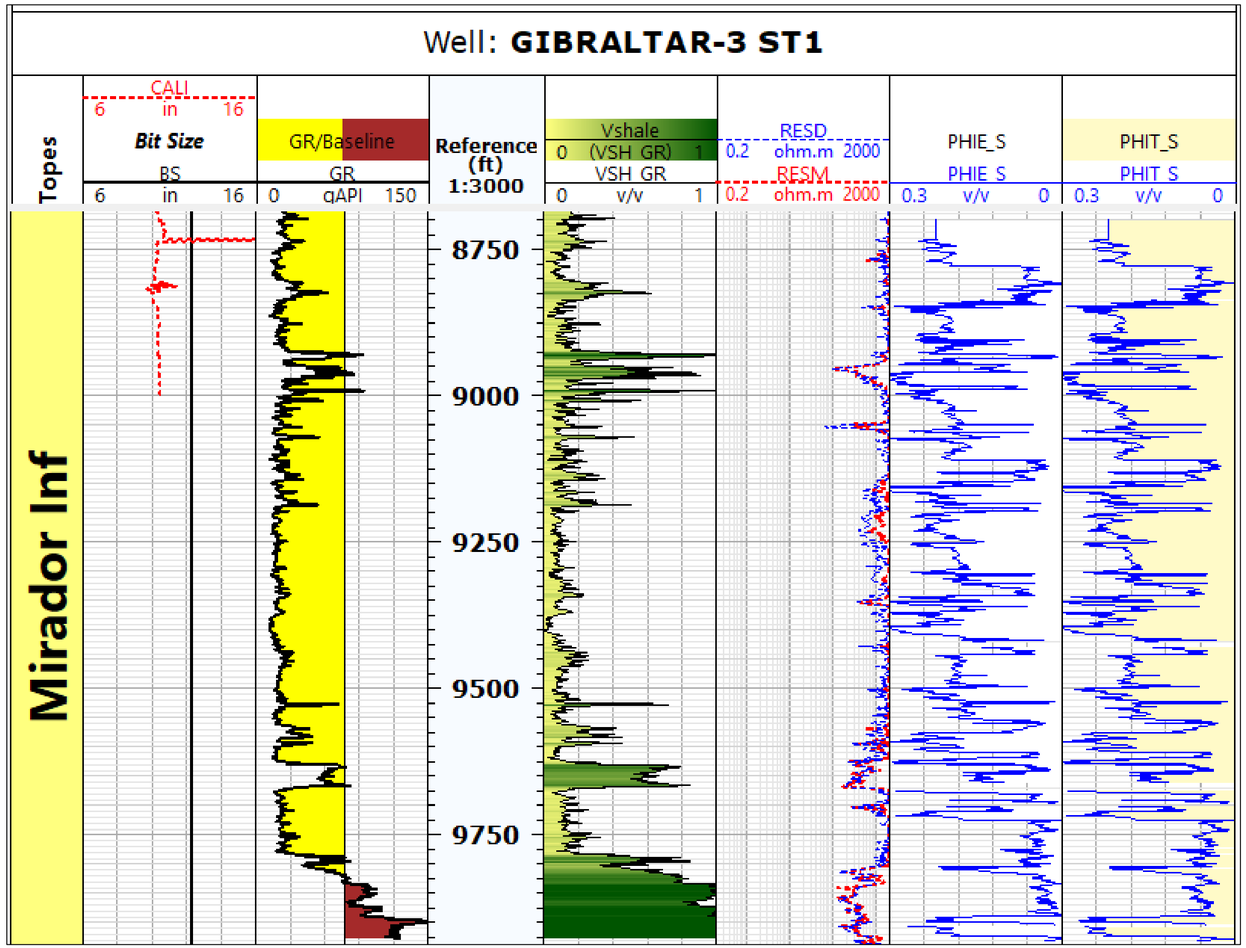
Eocene Reservoirs

Picacho Formation



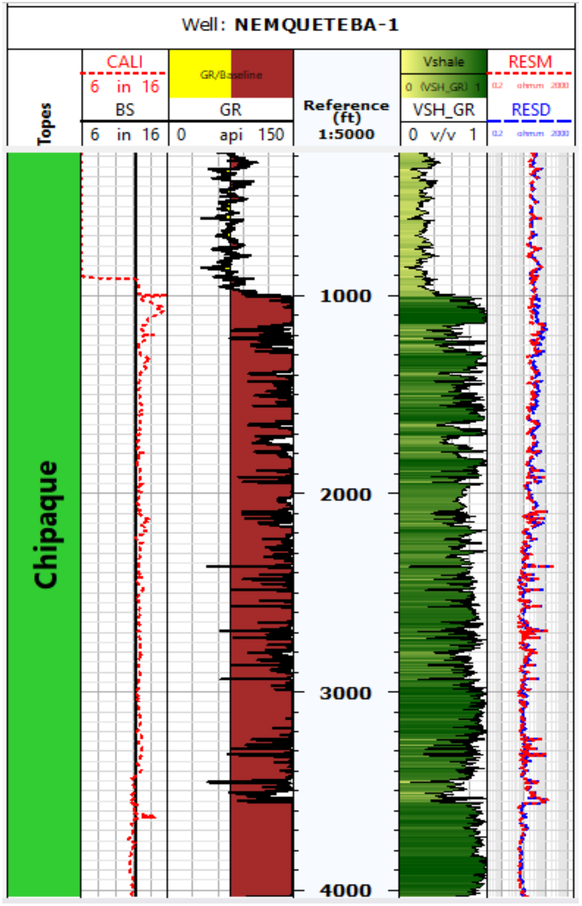
- Oil bearing reservoir in Corrales
- Massive to high NTG sandstones, clean
- GR 20 - 25 API; Vsh < 15% (down to 10%)

Mirador Formation

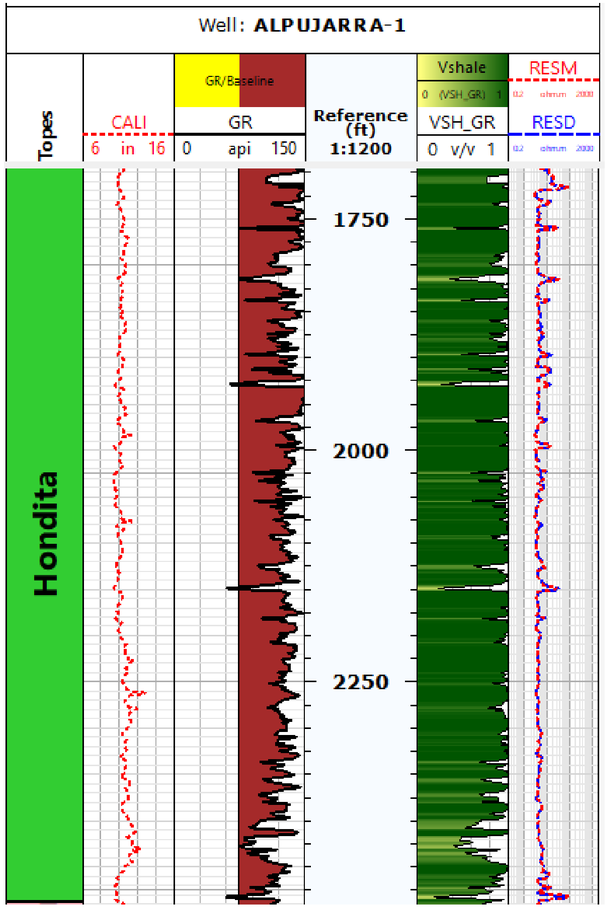


- Main reservoir in Gibraltar-1 (Oxy, 2002)
- GR < 15 API; Vsh < 10%
- PhiE 25 - 30%, K around 800 mD

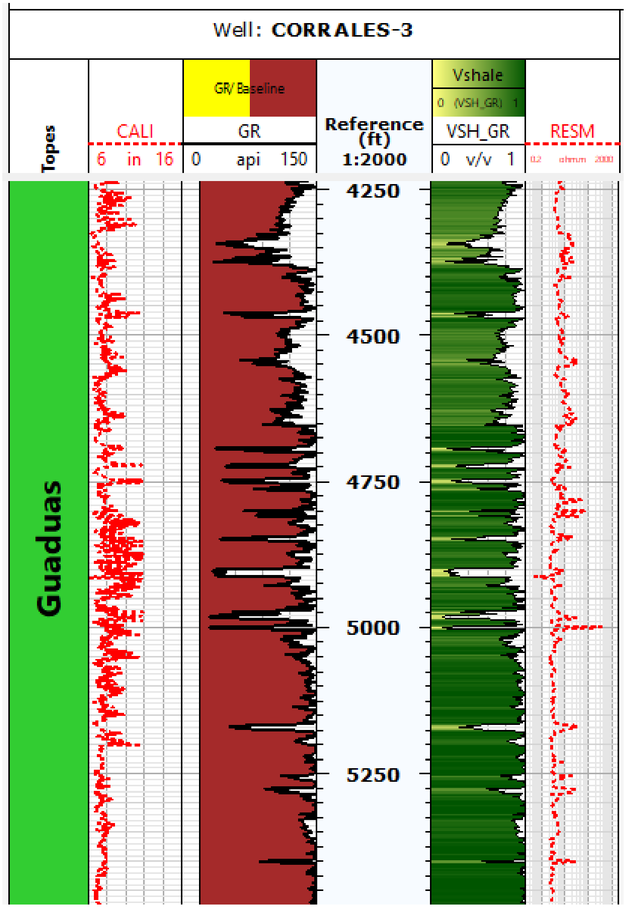
SEAL EVALUATION
Selection of Main Seals



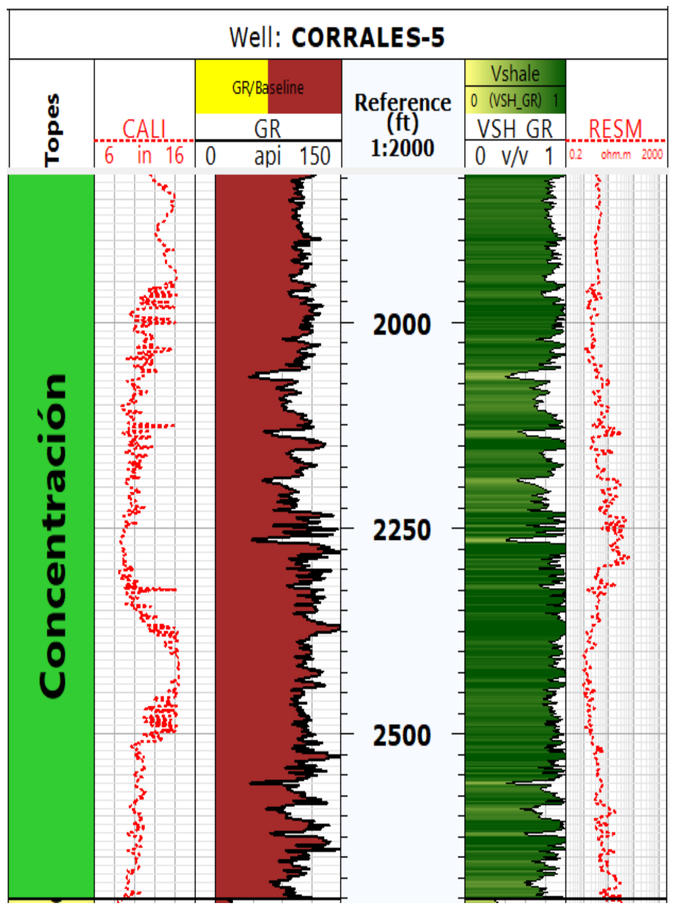
- Une – Chipaque
- Thickness ~ 4200 ft
- Vsh 80%, down to 5-40% in sandstone stringers



- Caballos - Hondita
- Thickness ~ 1570 ft
- Vsh > 90 %



- Guadalupe-Guaduas
- Thickness ~ 1640 ft (Corrales 2)
- Vsh 80 - 90%, up to > 90%



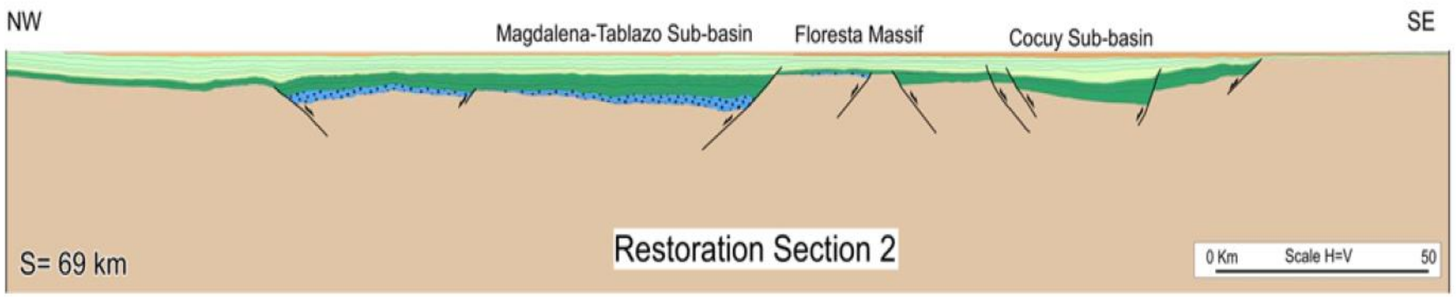
- Picacho-Concentración
- Vsh 80 - 90%

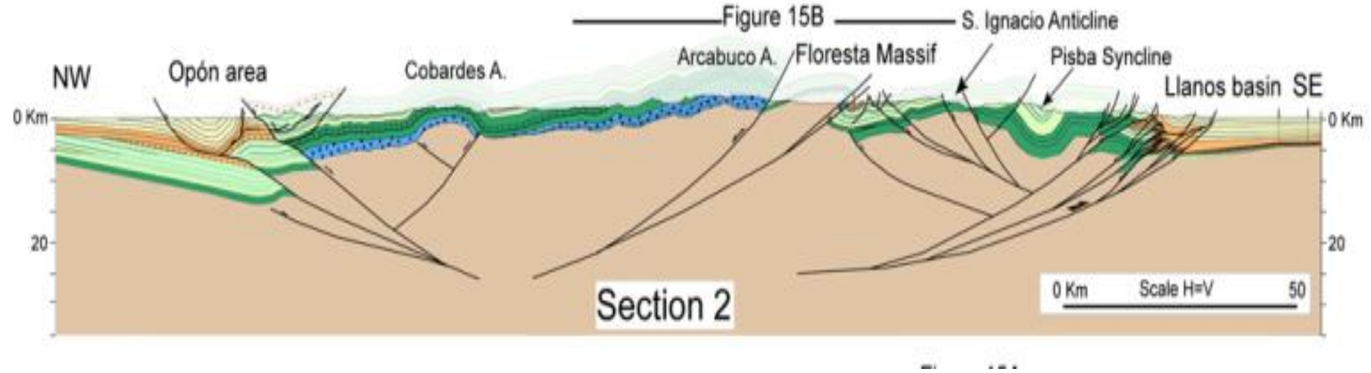
Structural sections / Exploratory Plays

ANDRES MESA

- Interpreters
  - ✓ Mary Piragauta
  - ✓ Nelly Piragauta
  - ✓ Maria Murillo
  - ✓ Gener Bautista

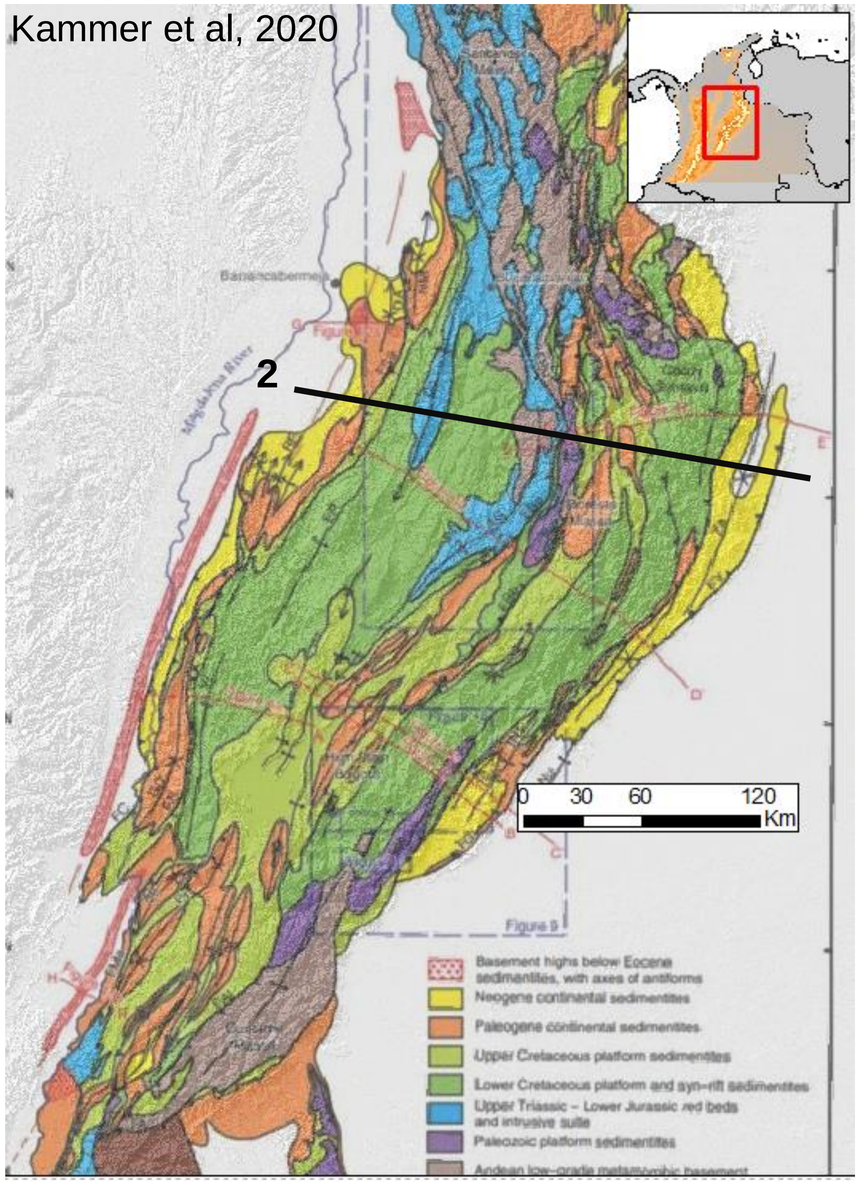
STRUCTURAL FRAMEWORK



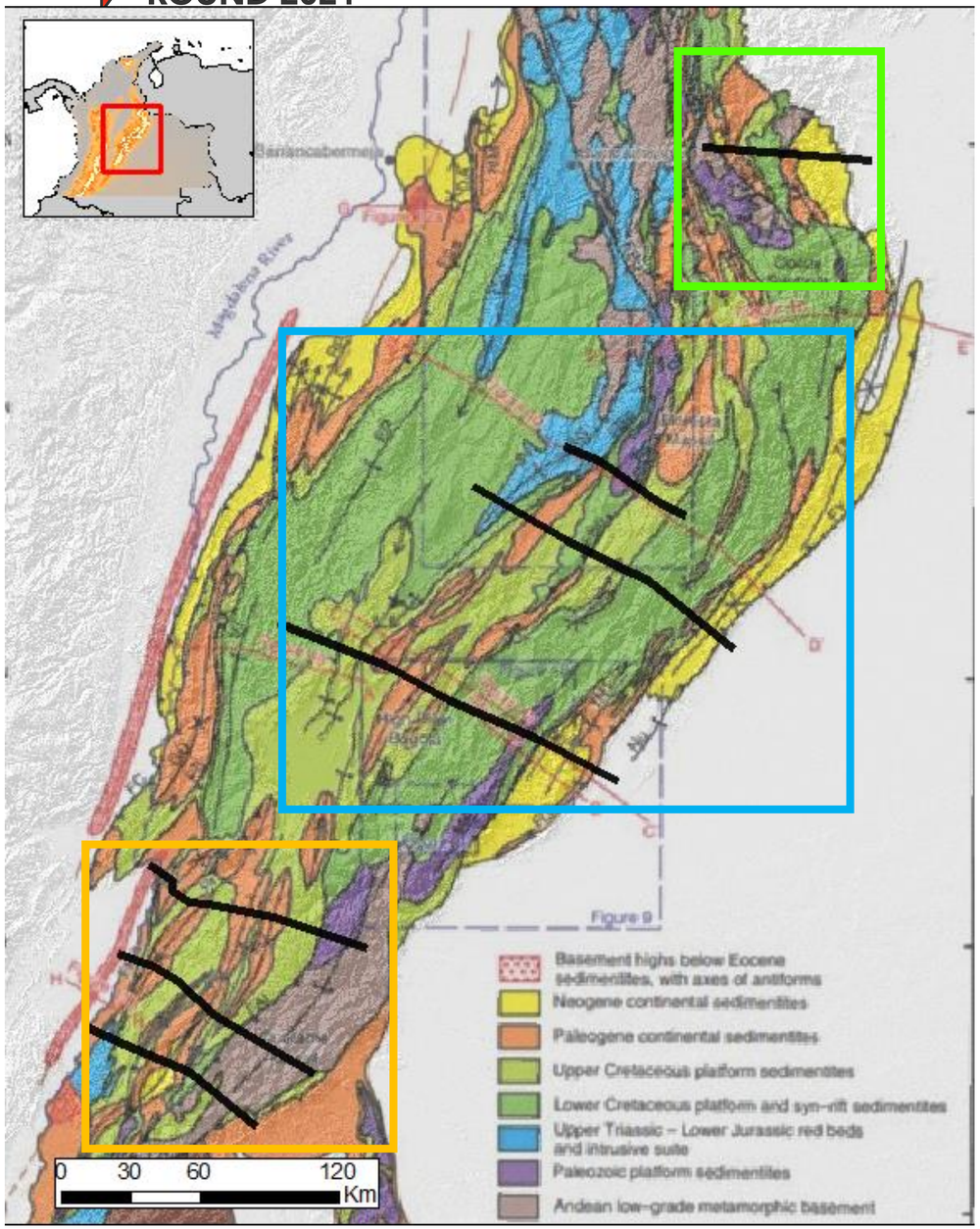


Teson, et al 2013

Kammer et al, 2020



AREAS OF STUDY



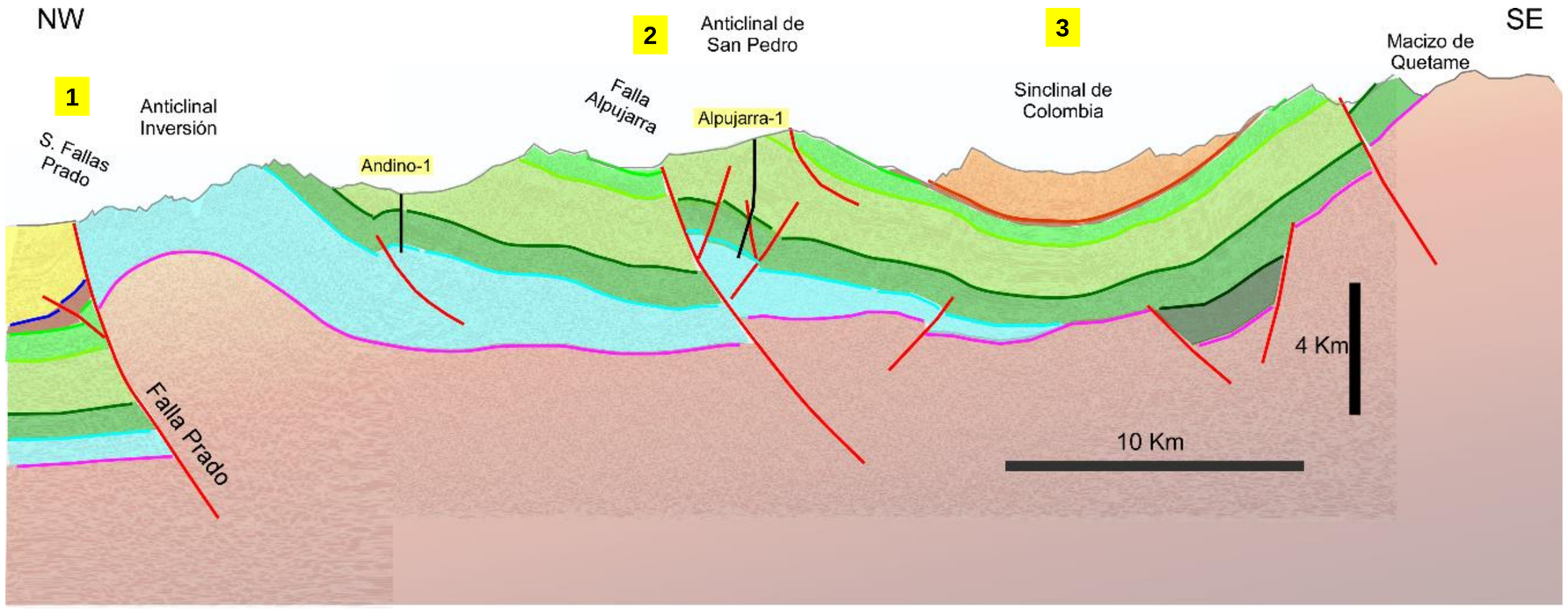
Based on TWT seismic data and Surface geology, seven structural sections were built during the Project

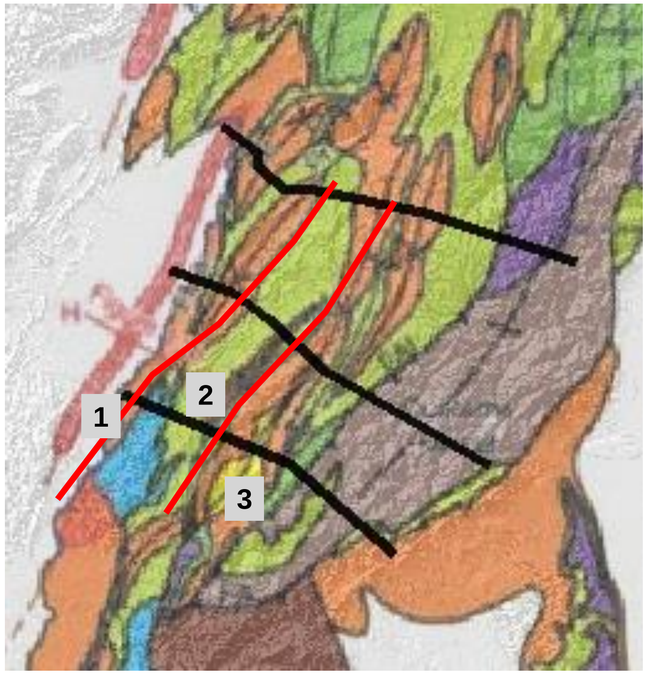
The area was subdivided in:

- Gibraltar
- Axial – Eastern Foothills
- Southwest

Kammer et al, 2020

Transect 1. Andino – Alpujarra





Fms Honda y Barzalosa

Fm Gualanday / Bogotá

Fm Seca

Fms Guadalupe y Olini

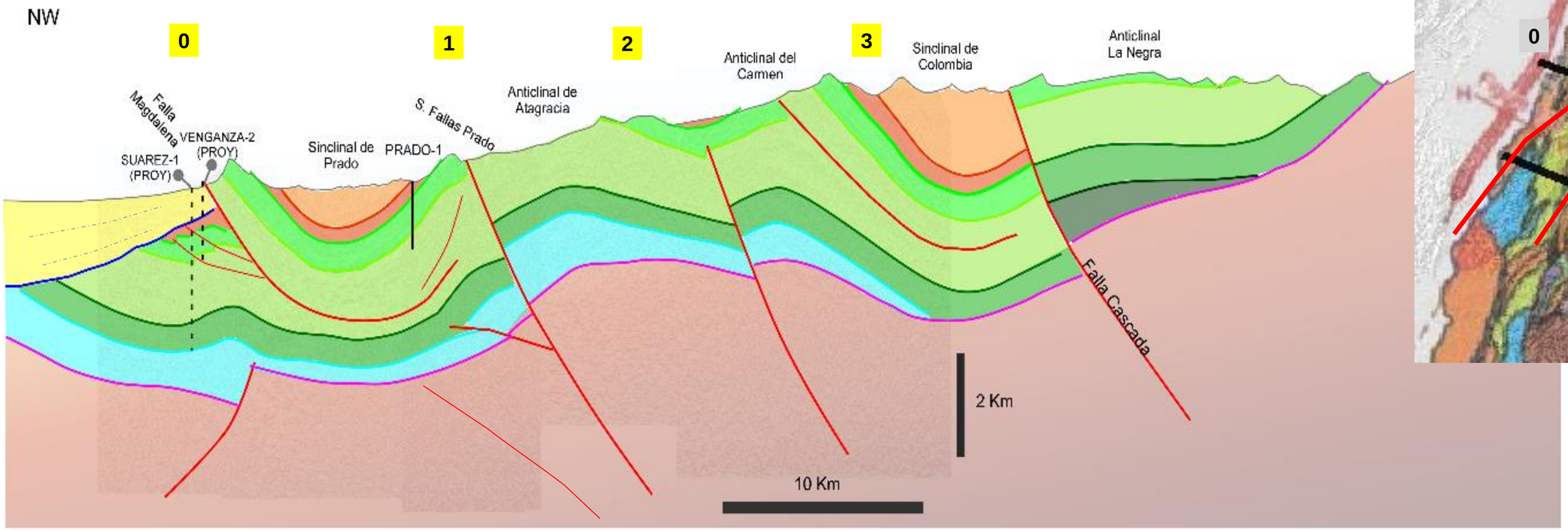
Fms Hondita y Tetuan

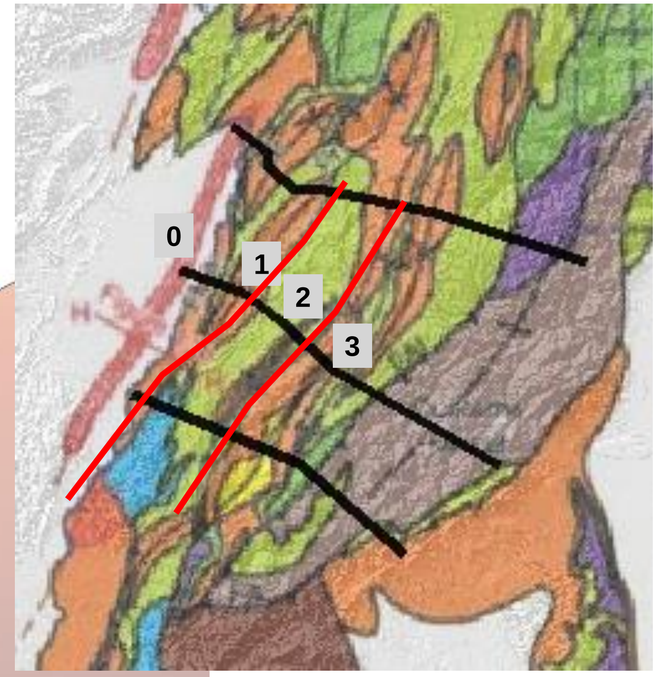
Fms Caballos y Yavi

Fm Saldaña

Paleozoico Sedimentario y Pre-Cámbrico

Transect 2. Venganza – Prado

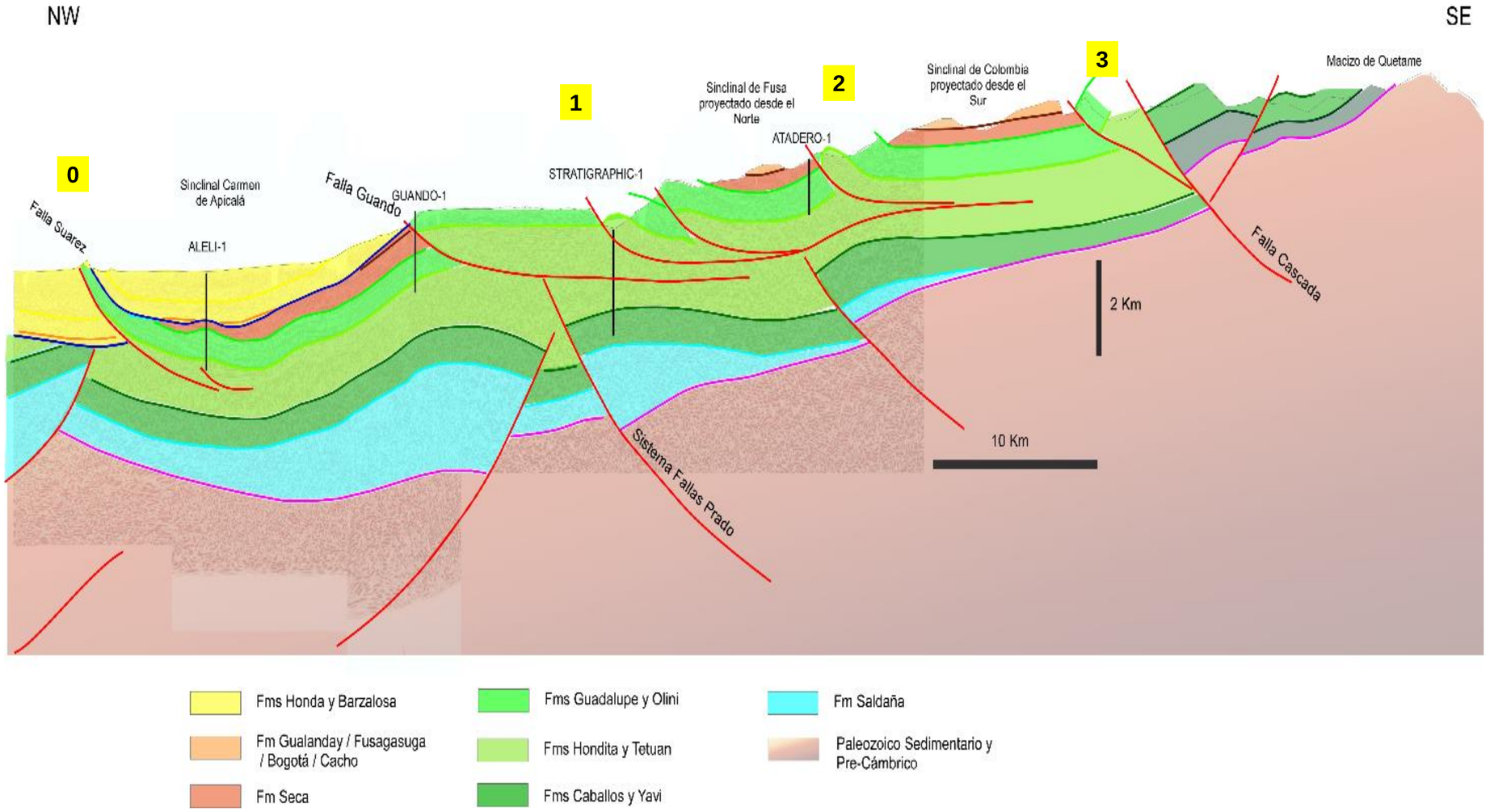


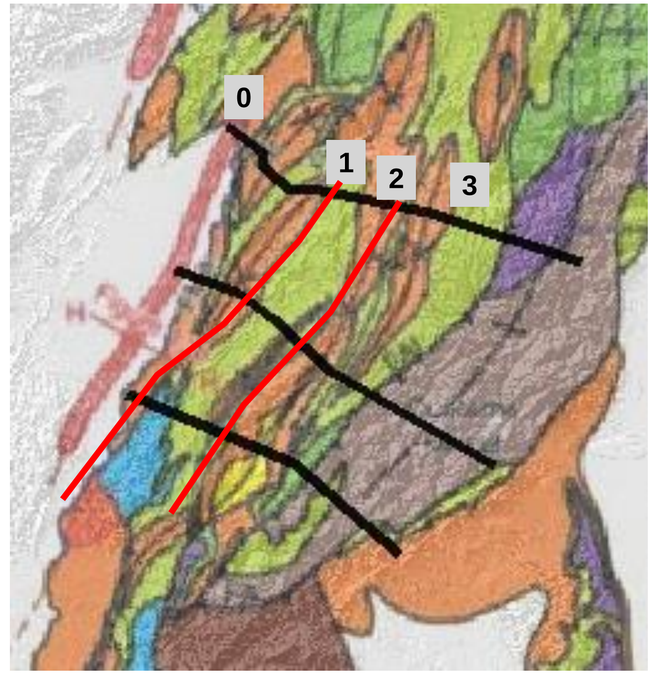


Fms Honda y Barzalosa
Fm Gualanday / Fusagasuga / Bogotá / Cacho
Fm Seca
Fms Guadalupe y Olini
Fms Hondita y Tetuan
Fms Caballos y Yavi
Fm Saldaña
Paleozoico Sedimentario y Pre-Cámbrico

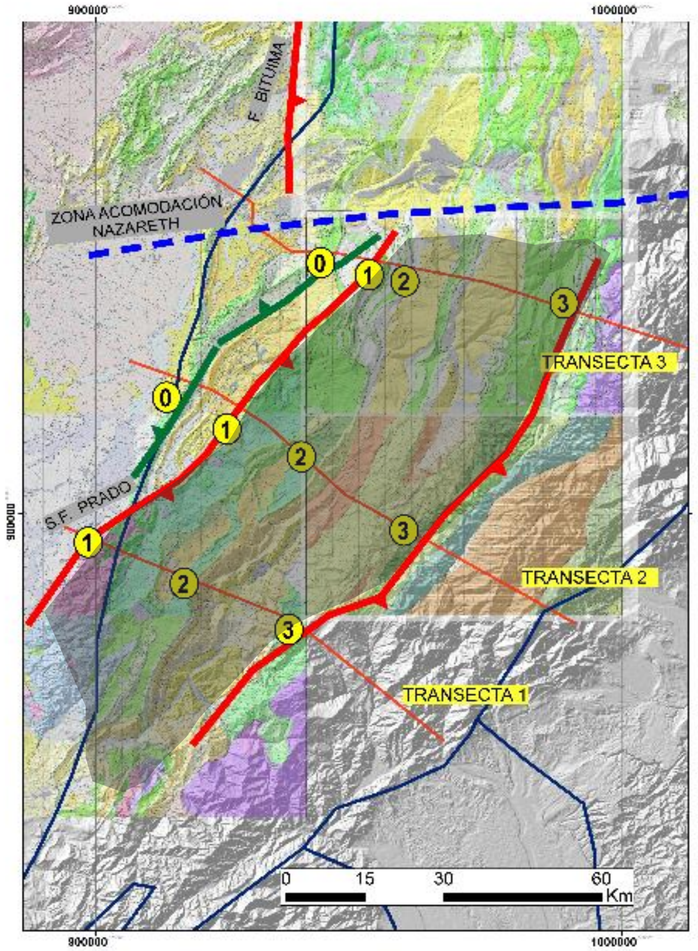
SOUTH WEST AREA

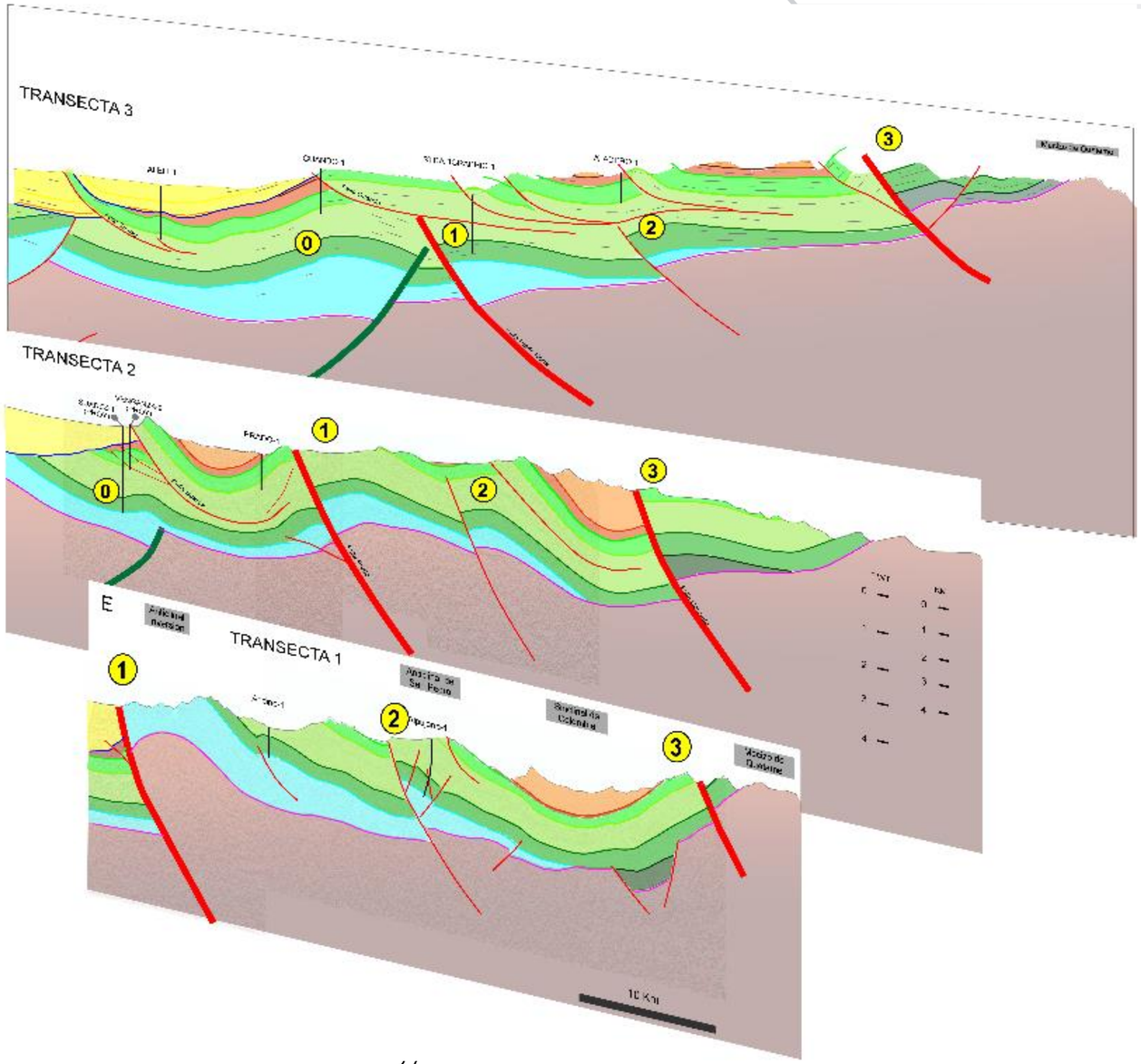
Transect 3. Guando – Atadero

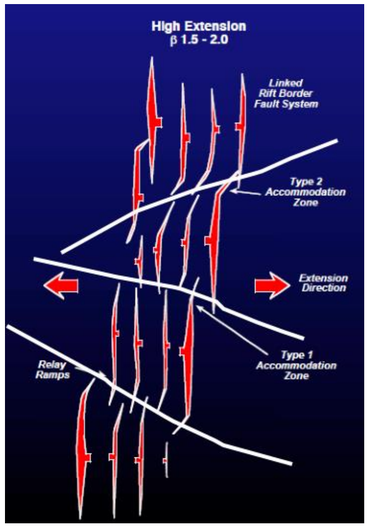




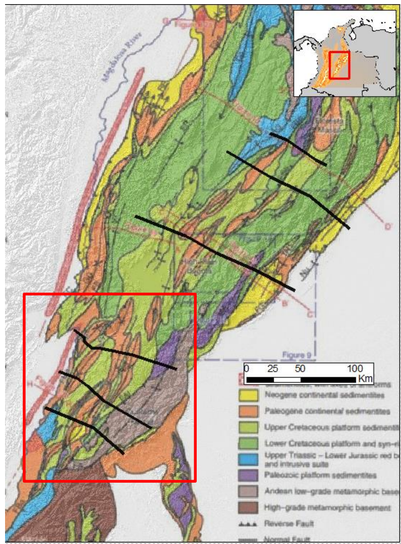
SOUTH WEST AREA



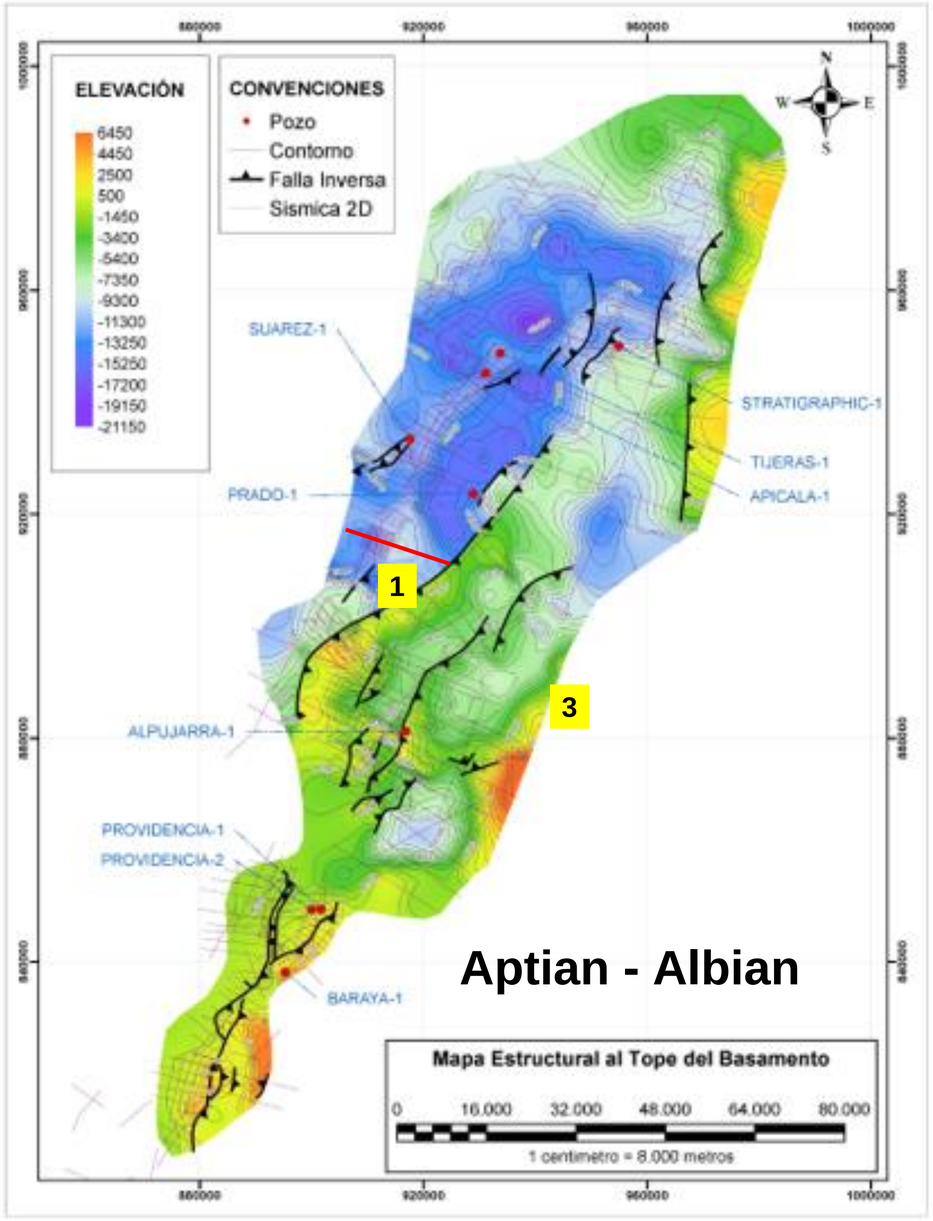


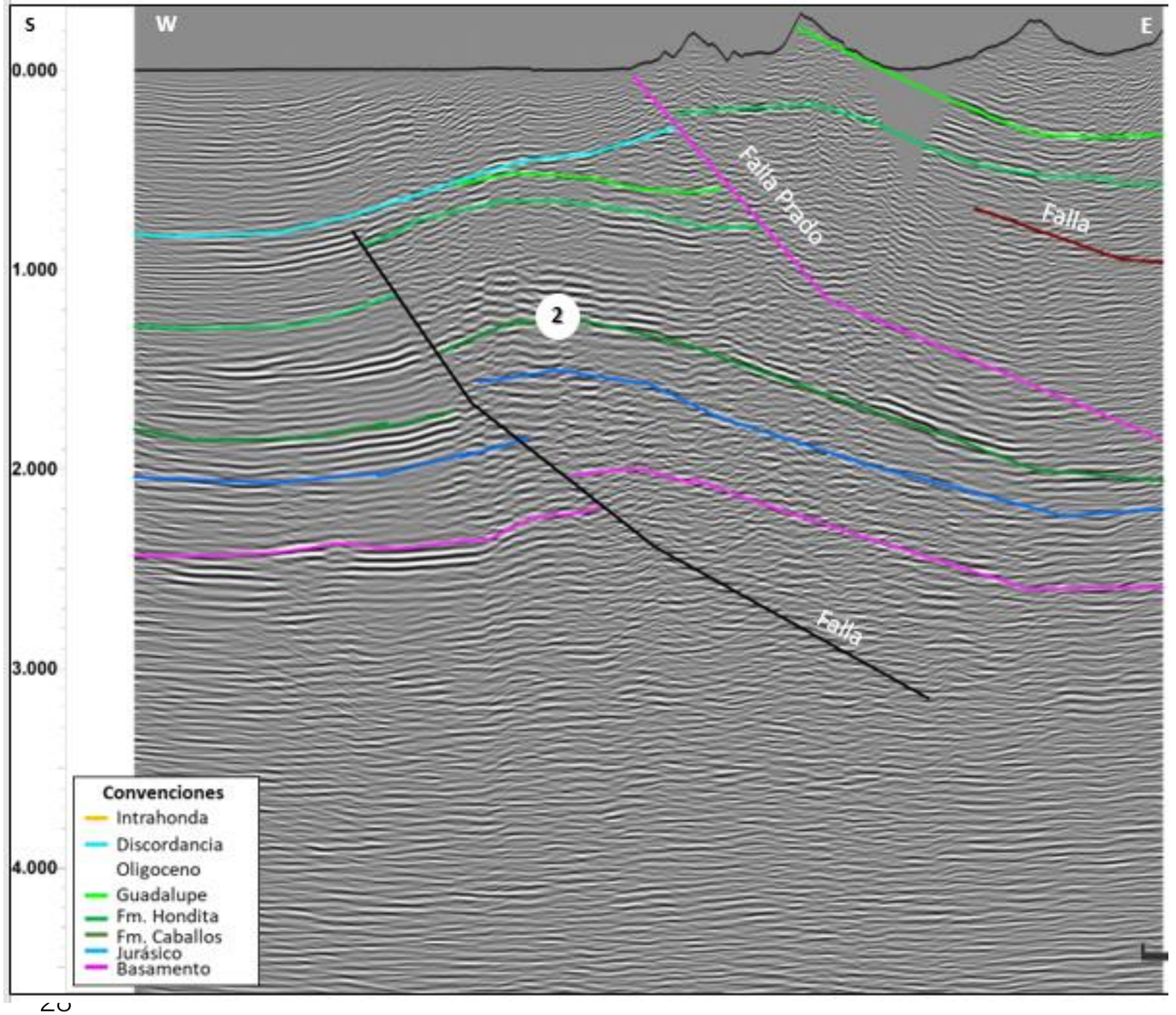


From McClay 2010

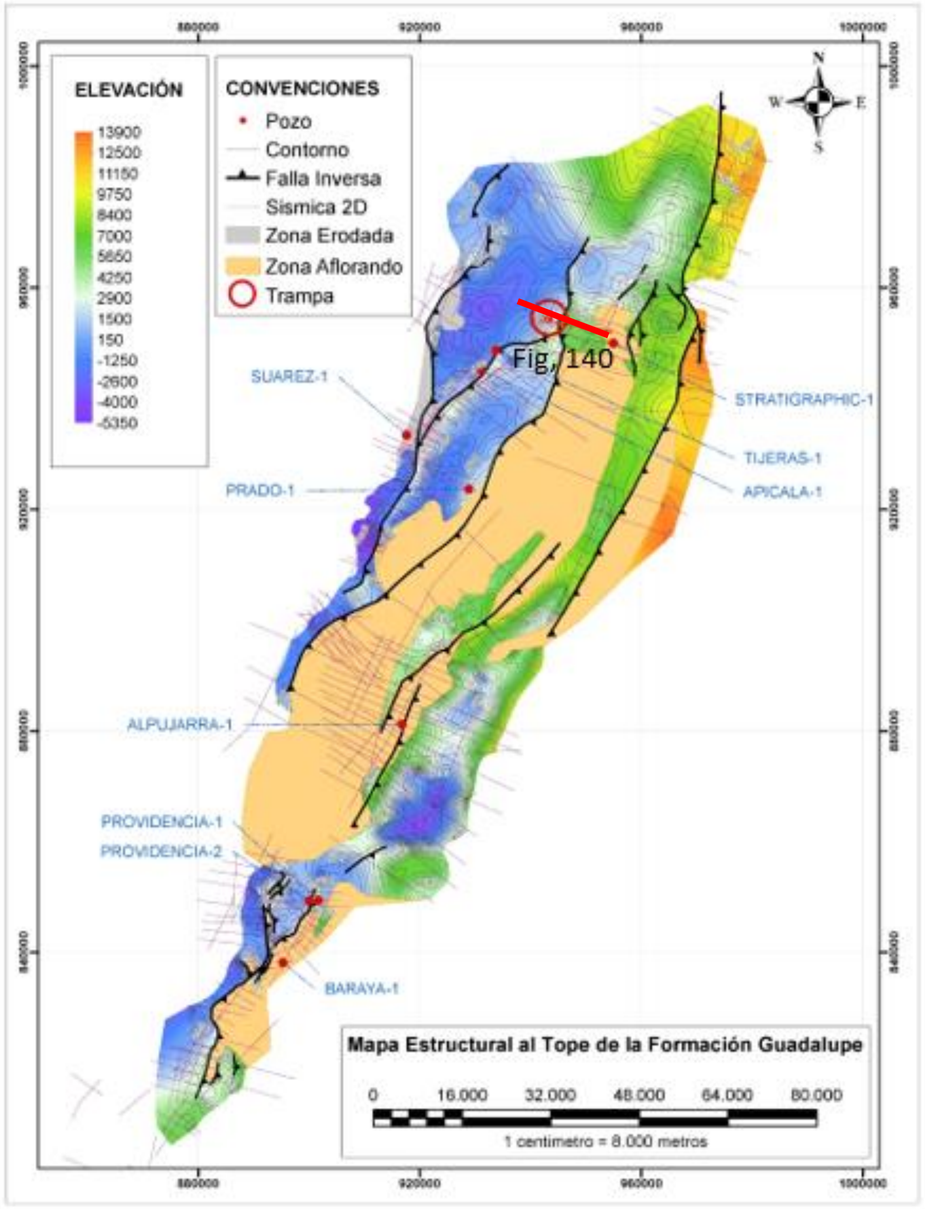


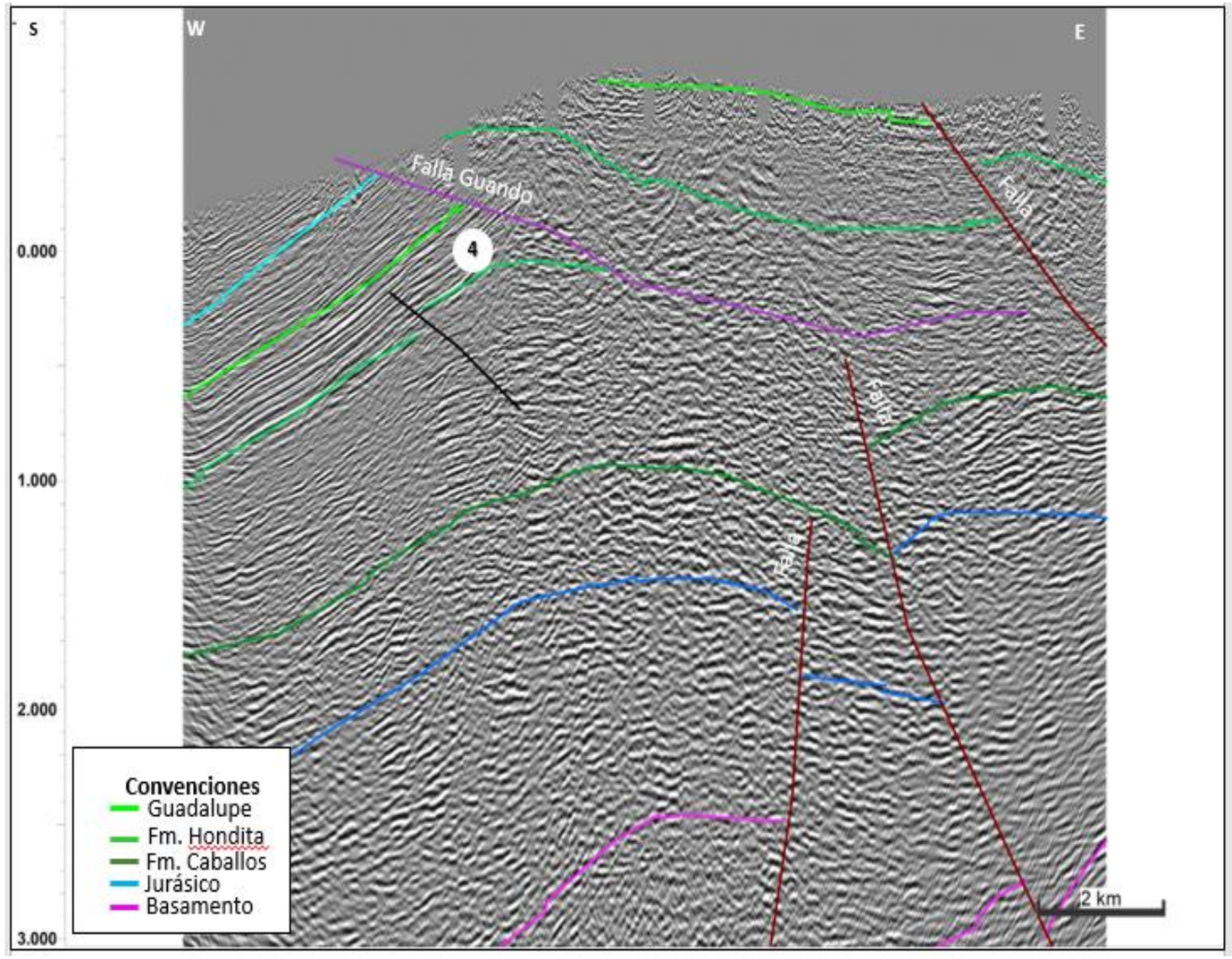
TOP CABALLOS STRUCTURAL MAP



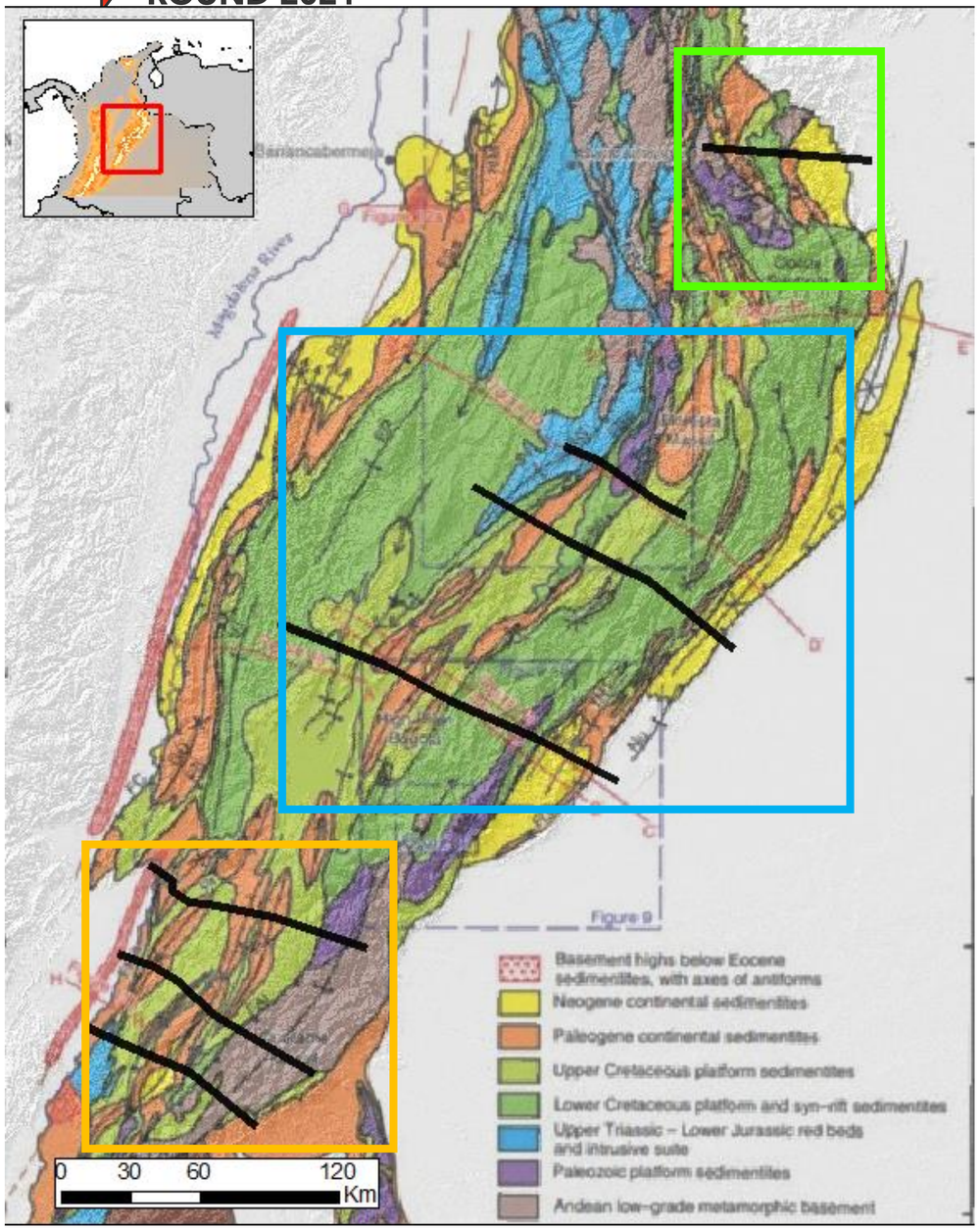


TOP GUADALUPE STRUCTURAL MAP





AXIAL – EASTERN FOORHILLS

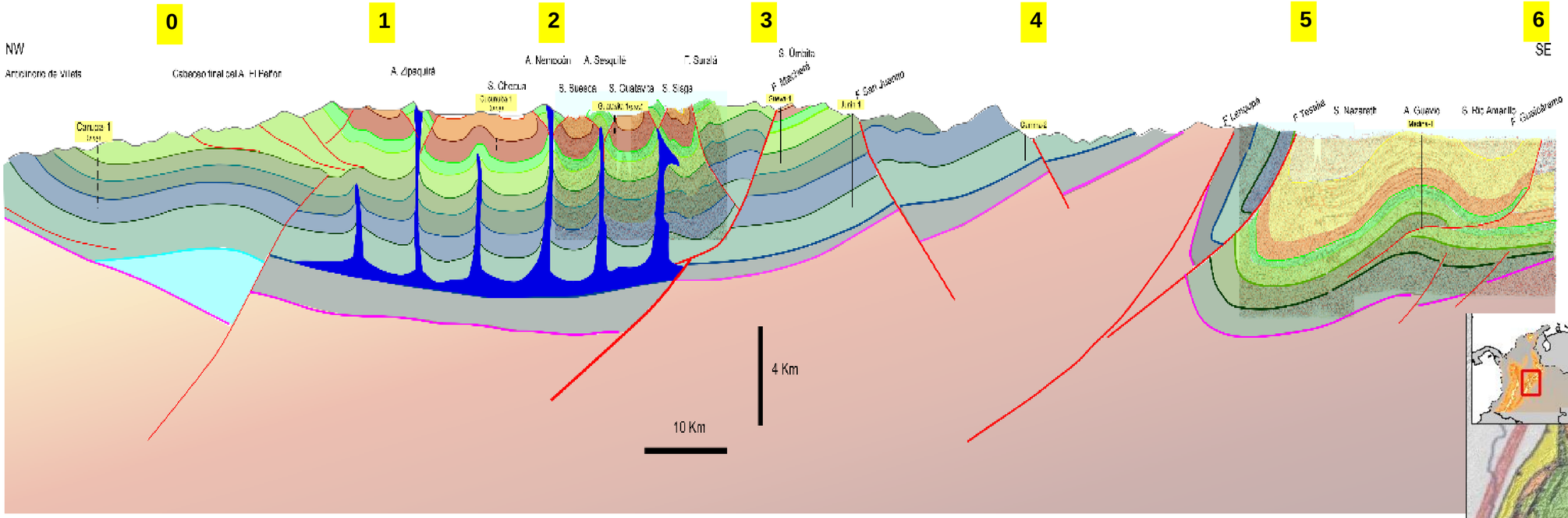


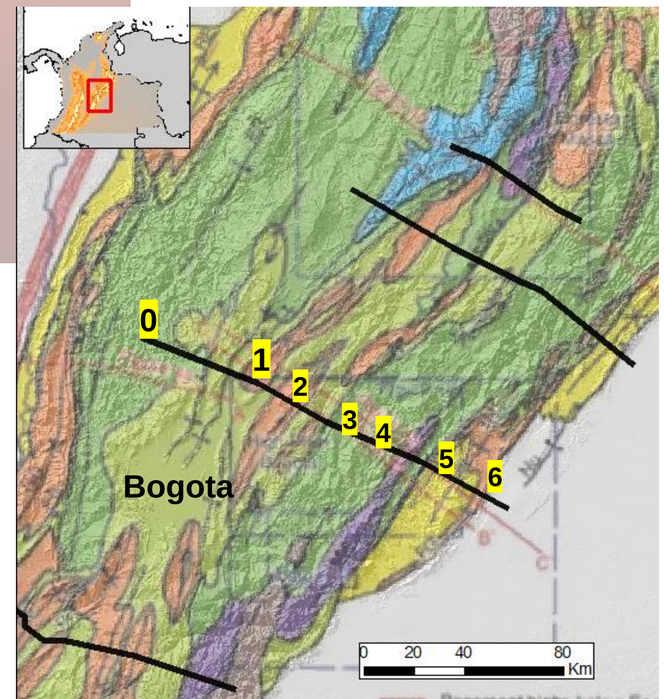
The area was subdivided in:

- Gibraltar
- Axial – Eastern Foothills
- Southwest

Kammer et al, 2020

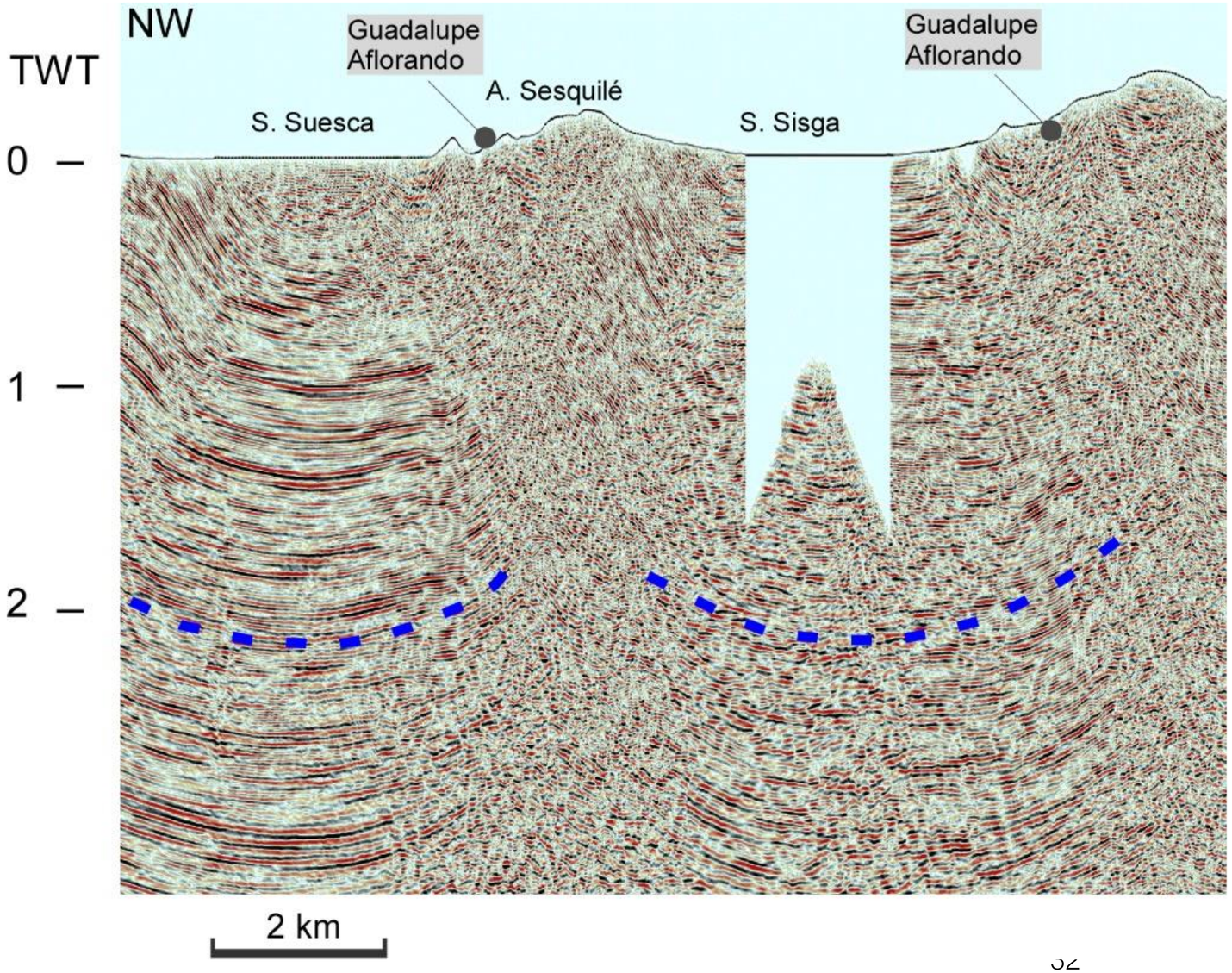
Transect 4. Zipaquirá – Medina



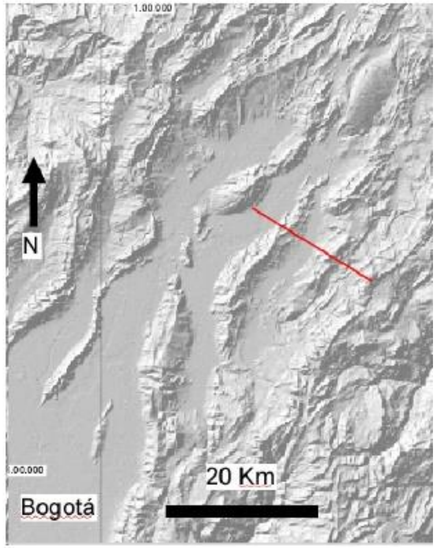


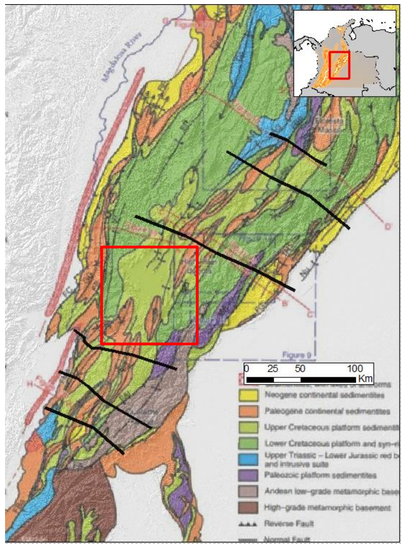
- Fm Bogotá y Cacho
- Fm Une / Churuvita / Simijaca
- Depósitos de Sal
- Fm Guaduas
- Fm Fómeque / Tibasosa / Simiti
- Fm Guavio / Buenavista
- Fm Guadalupe
- Fm Juntas / Paja / Ritoque
- Fm Arcabuco / Rusia / Girón
- Fm Chipaque / Conejo / Frontera
- Fm Macanal / Rosablanca / Cumbre
- Paleozoico / Pre-Cámbrico

AXIAL AND EASTERN FOOTHILLS

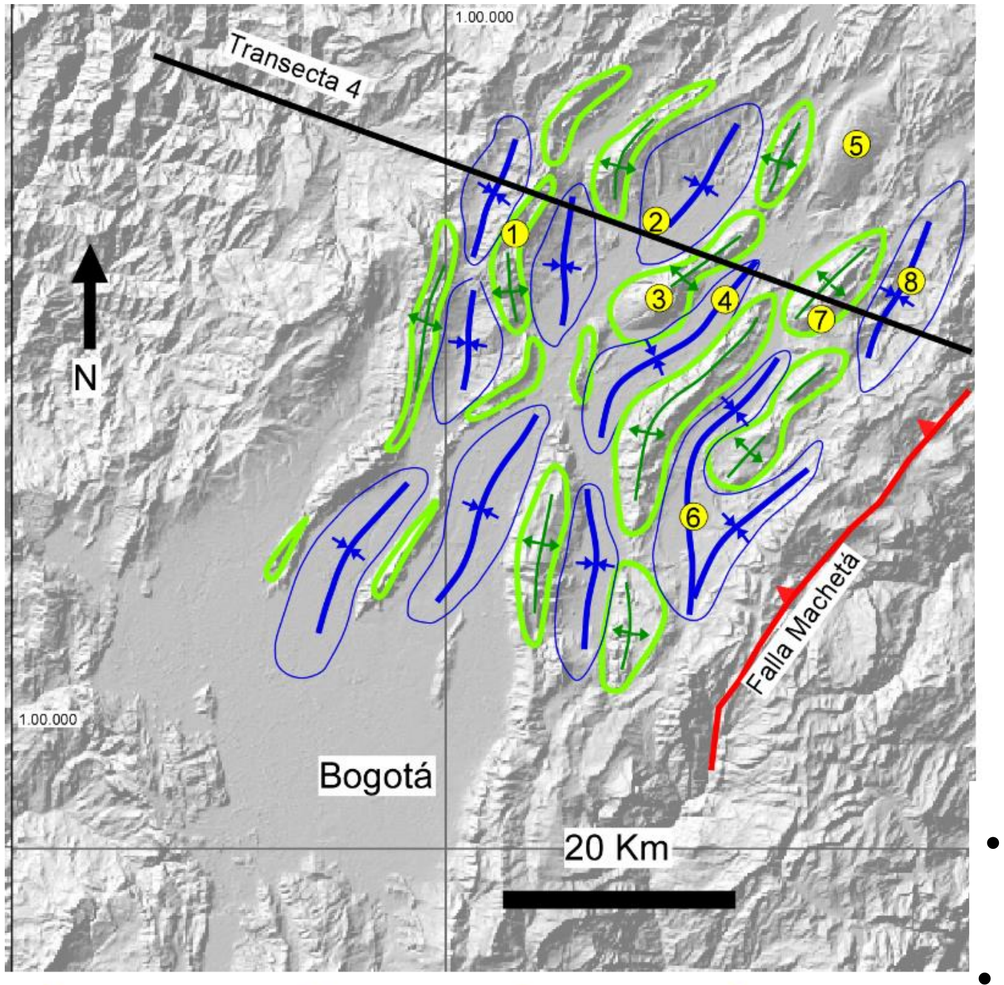


- Salt mines
- Symmetric synclines,
- High noise around the center of the structure,
- Anticlines with faulted flanks, inverted beds

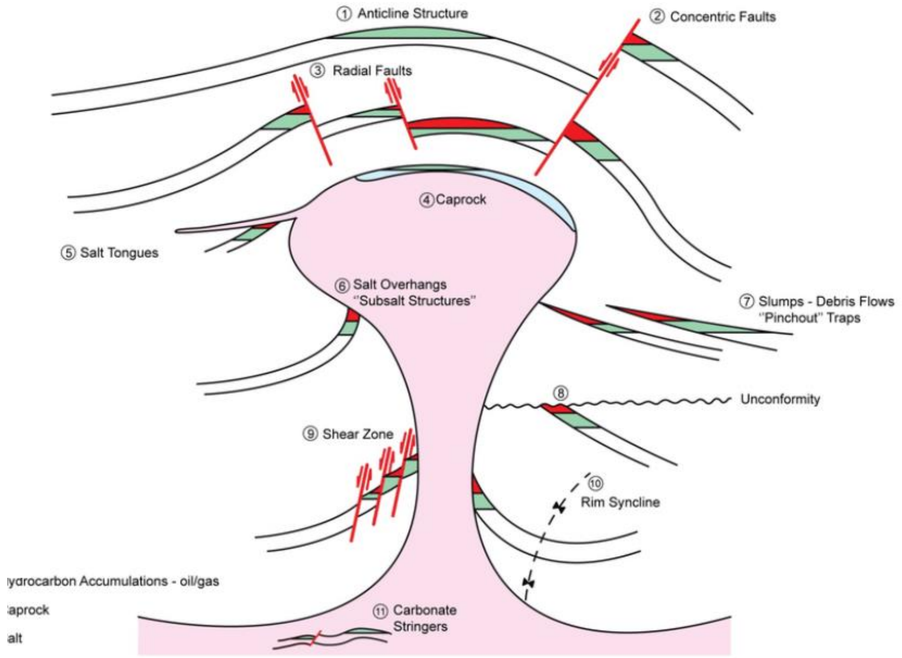




AXIAL SALT RELATED STRUCTURES POTENTIAL

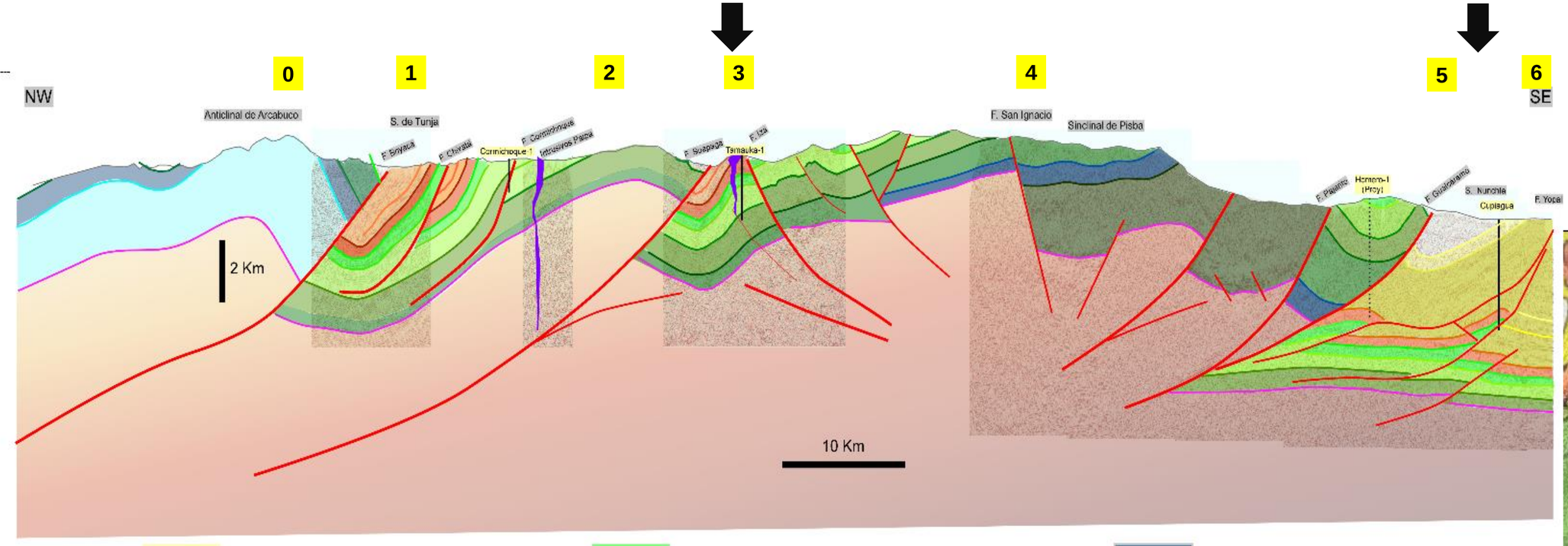


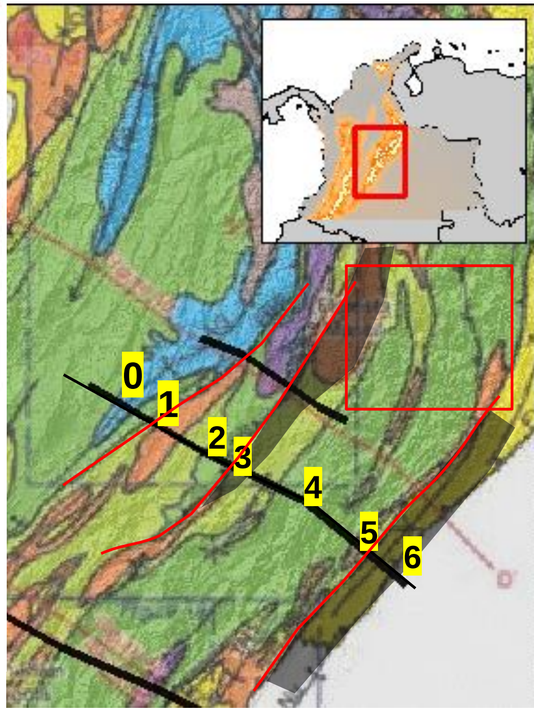
1 A. Zipaquirá
2 S. Chechua
3 A. Nemocón
4 S. Suesca
5 A. Suesca
6 S. Guatavita
7 A. Sesquilé
8 S. Sisga
Anticlinal
Sinclinal



- Possible configuration of the Sabana de Bogotá
- Plays associated with diapirs as in other basins in the world.

Transect 5. Cormichoque – Tamauka – Cuapiagua





Fm Leon

Fm Carbonera

Fms Picacho / Mirador Socha Sup / Barco/ Socha Inf / Cuervos

Fm Guaduas

Fms Guadalupe / Palmichal

Fm Chipaque / Conejo

Fms Une / Churuvita

Fms Tibasosa / Fomeque

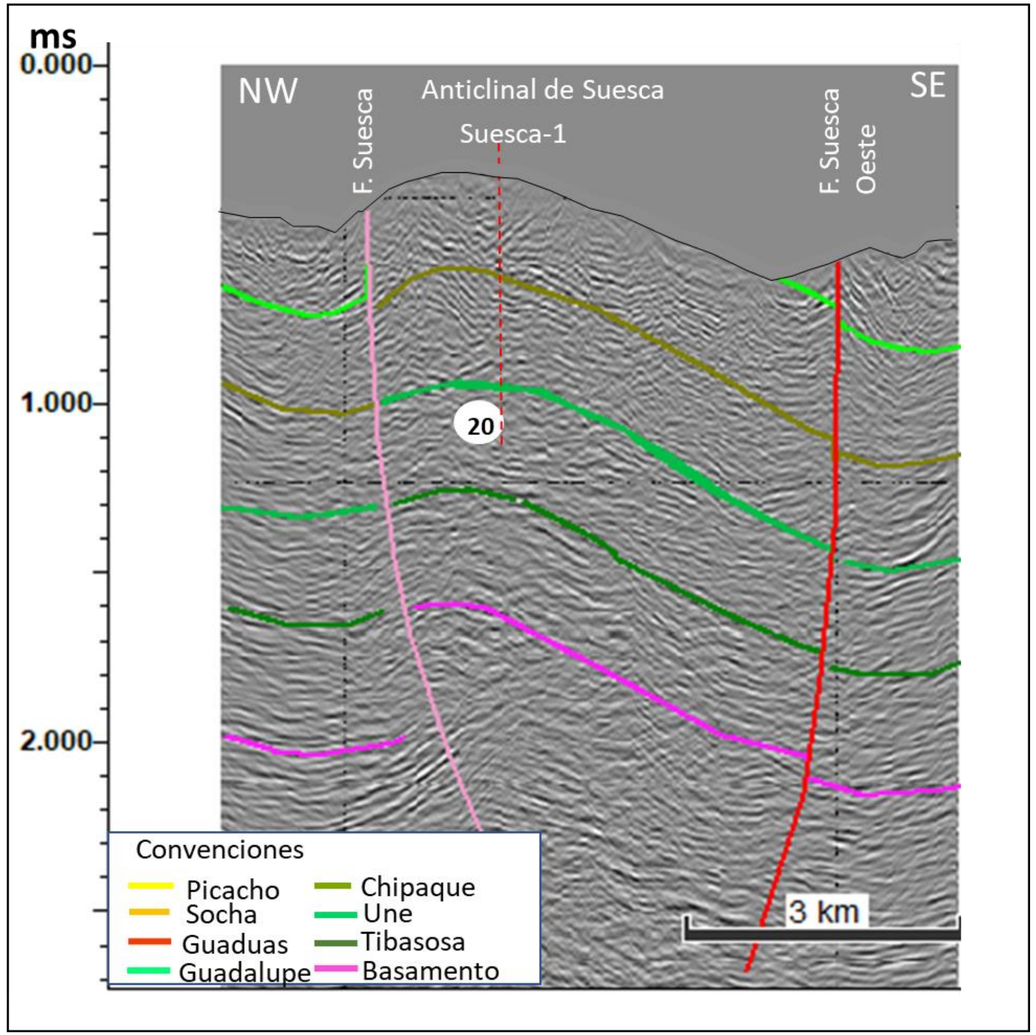
Fm Juntas / Paja / Ritoque

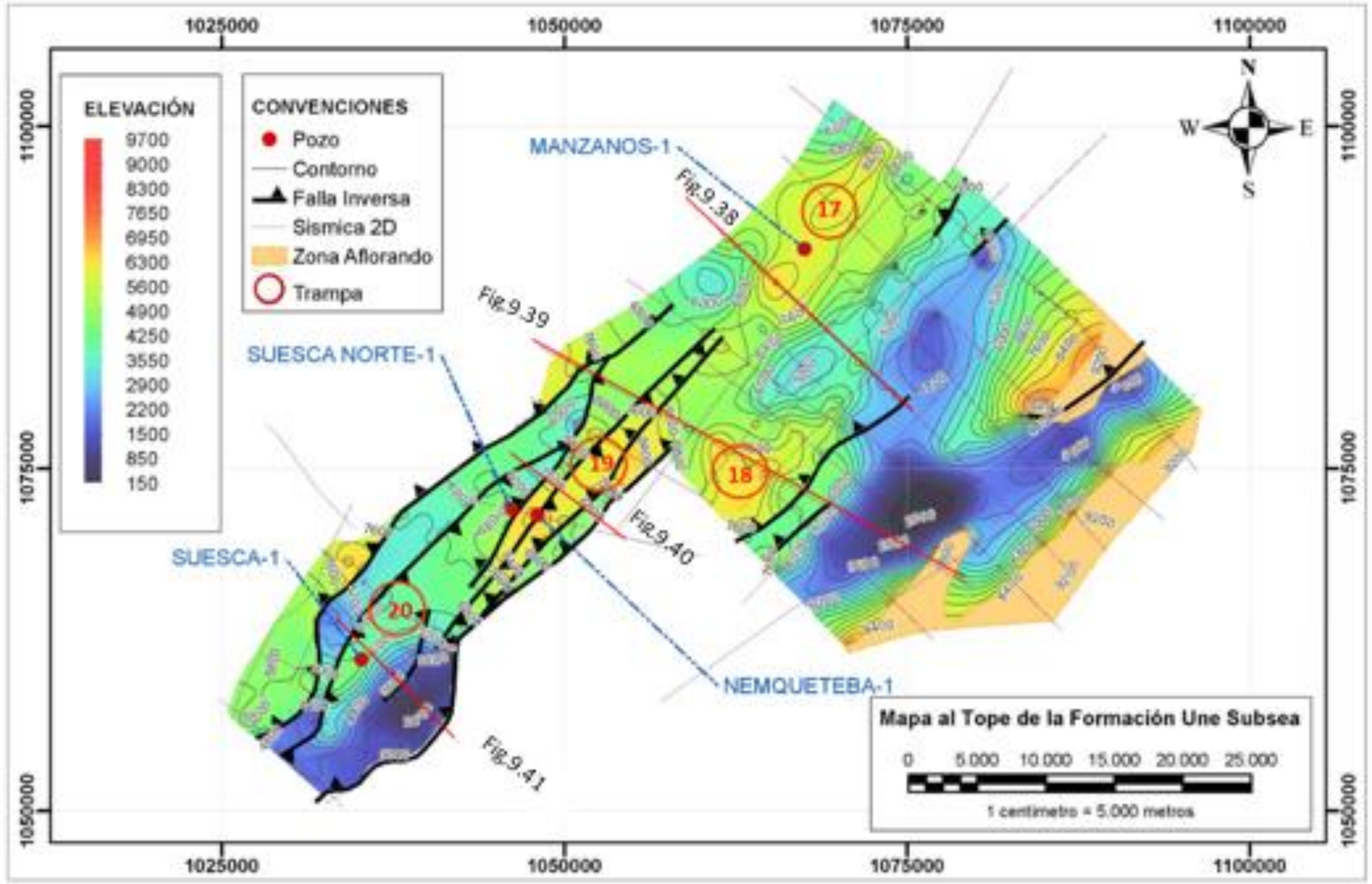
Fm Macanal / Rosablanca / Cumbre

Fm Arcabuco / Rusia / Girón

Paleozoico / Pre-Cámbrico

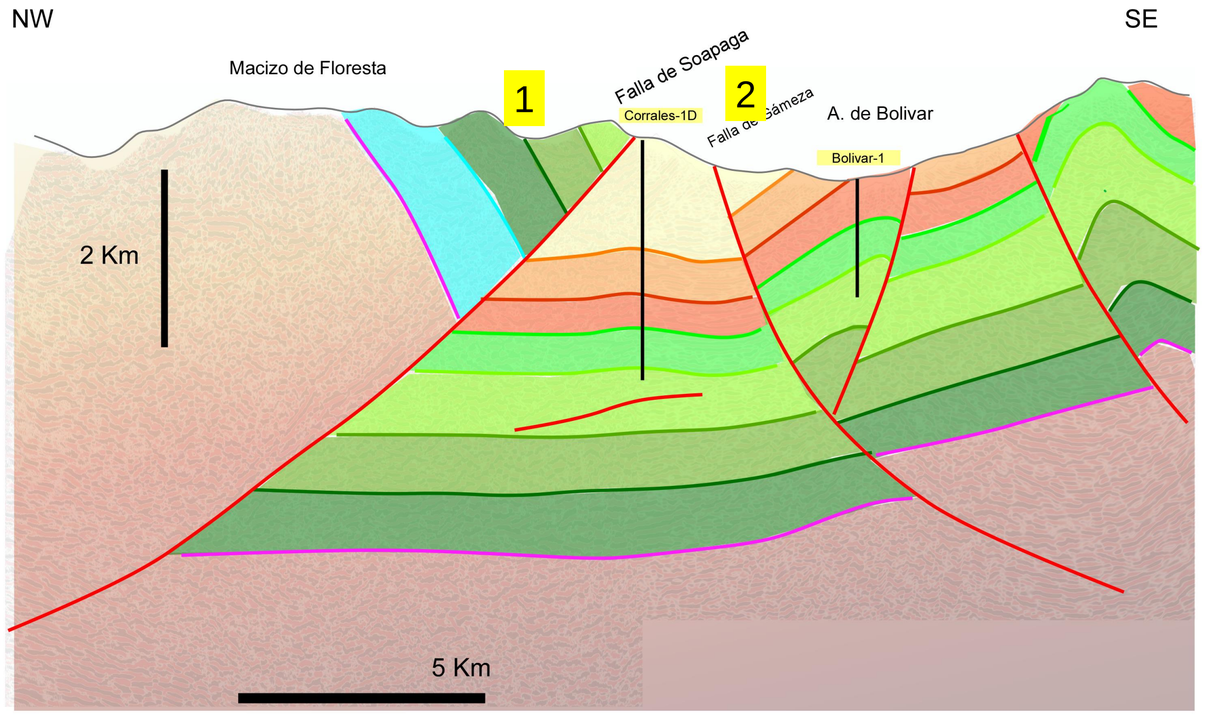
AXIAL THICK SKIN RELATED STRUCTURES POTENTIAL



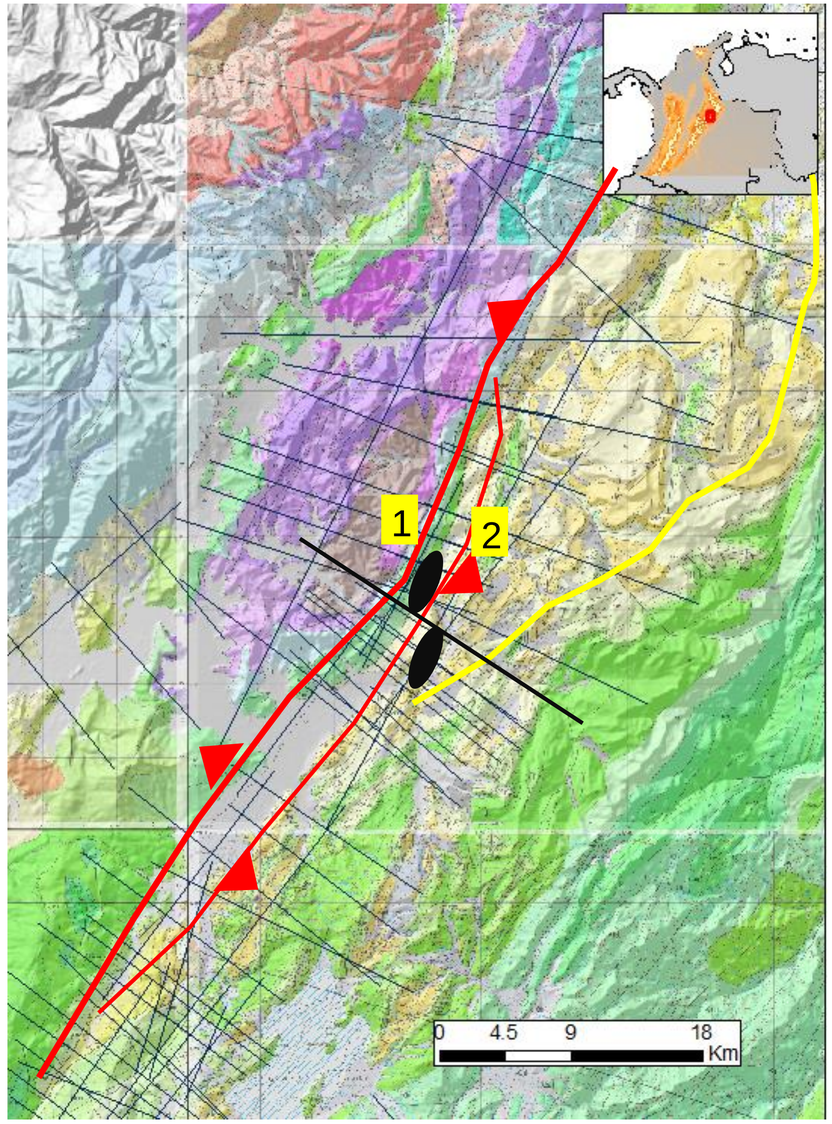


Top Une Fm Map

NORTH EASTERN HC PROVEN AREA

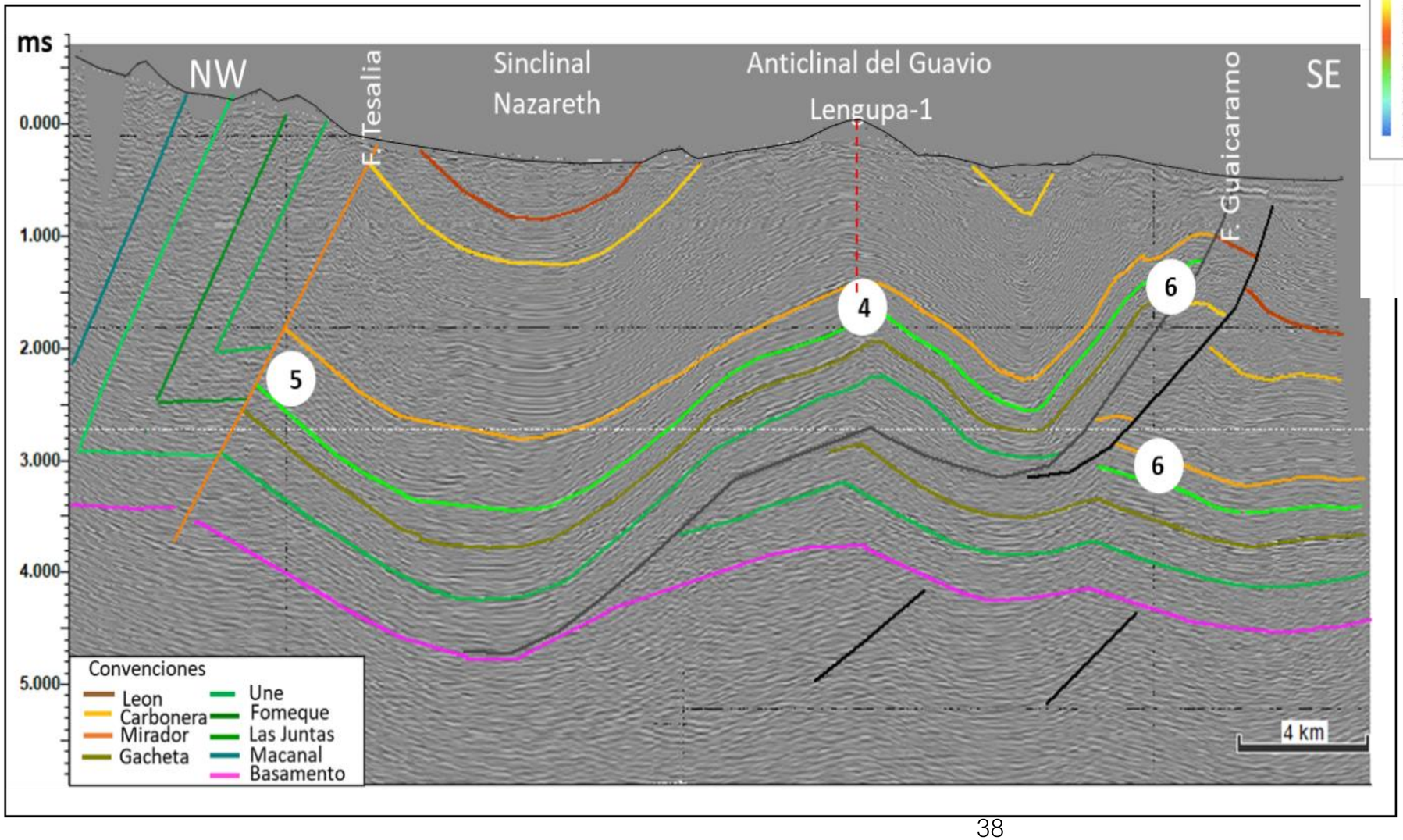


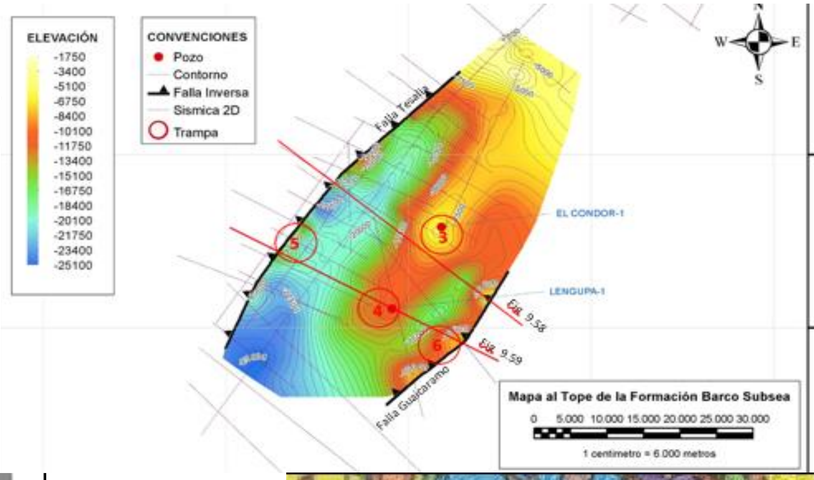
Fm Concentración
Fm Guadalupe
Fm Fómeque / Tibasosa
Fm Socha Inf / Socha Sup Picacho
Fm Chipaque
Fm Girón
Fm Guaduas
Fm Une
Paleozoico / Pre-Cámbrico

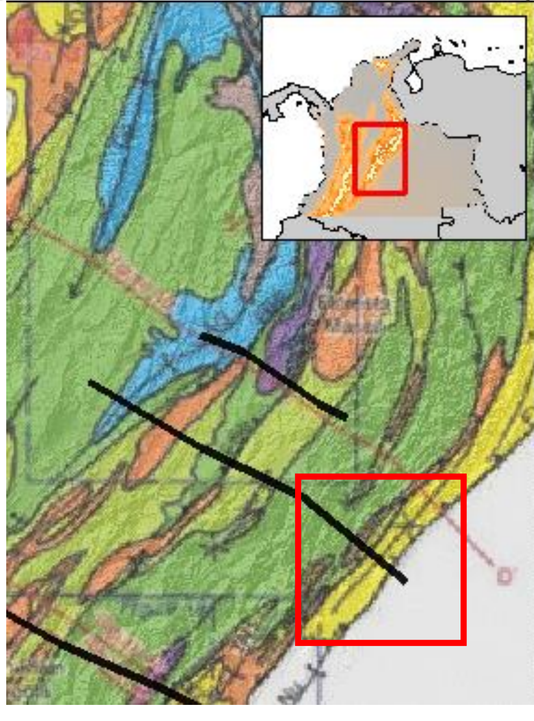


NORTH EASTERN HC PROVEN AREA

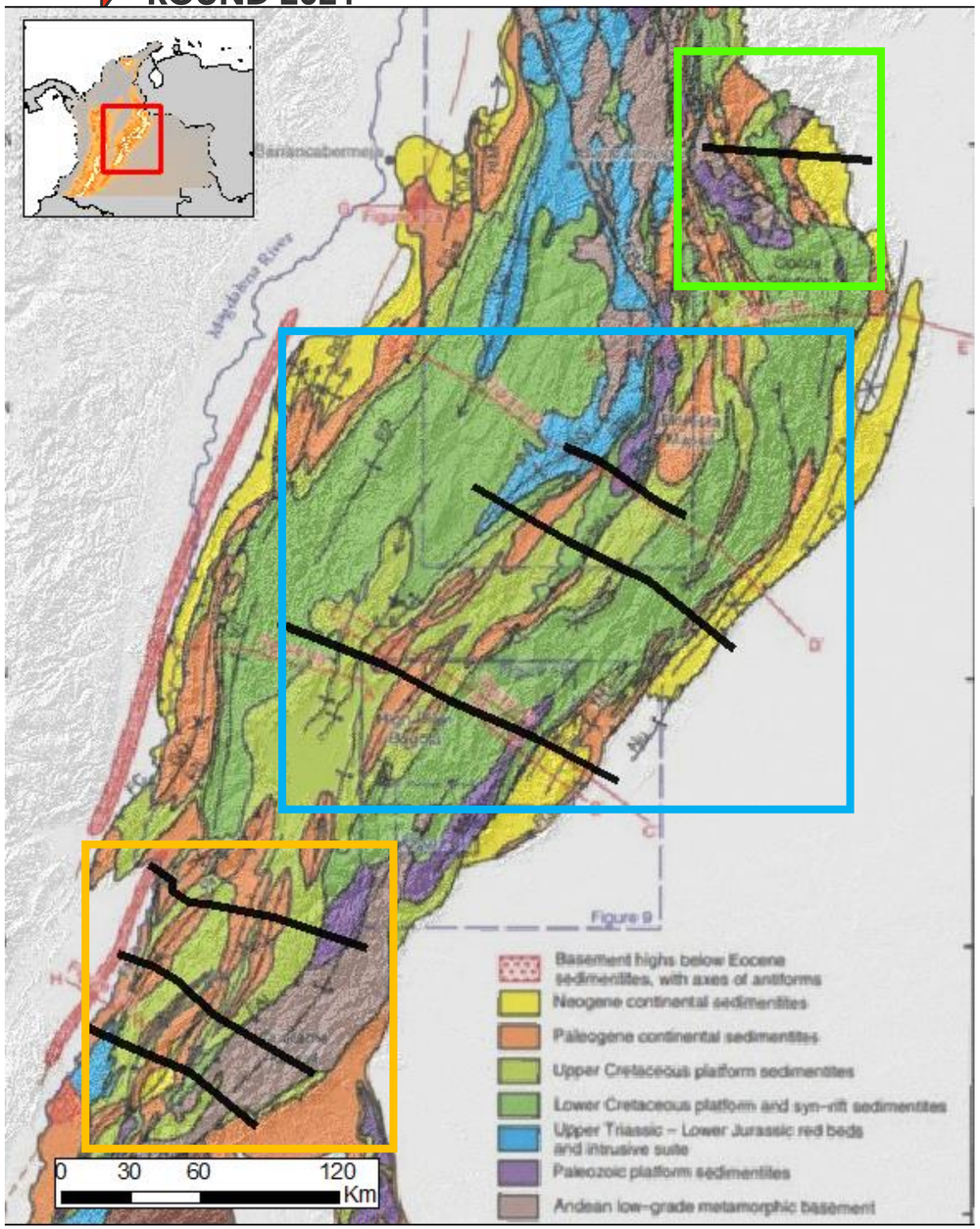
Sección sísmica : MVI-1997-1655







AREAS OF STUDY



Based con TWT seismic data and Surface geology, seven structural sections were build during the Project

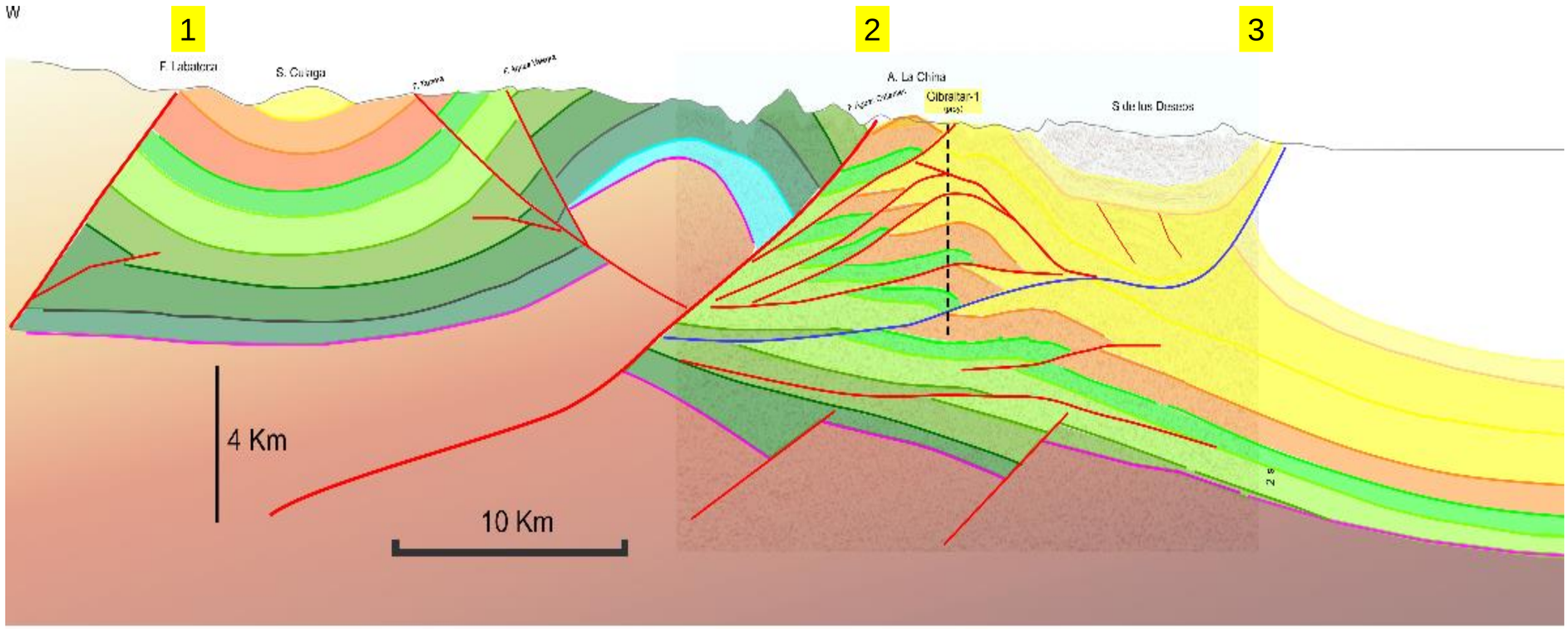
The area was subdivided in:

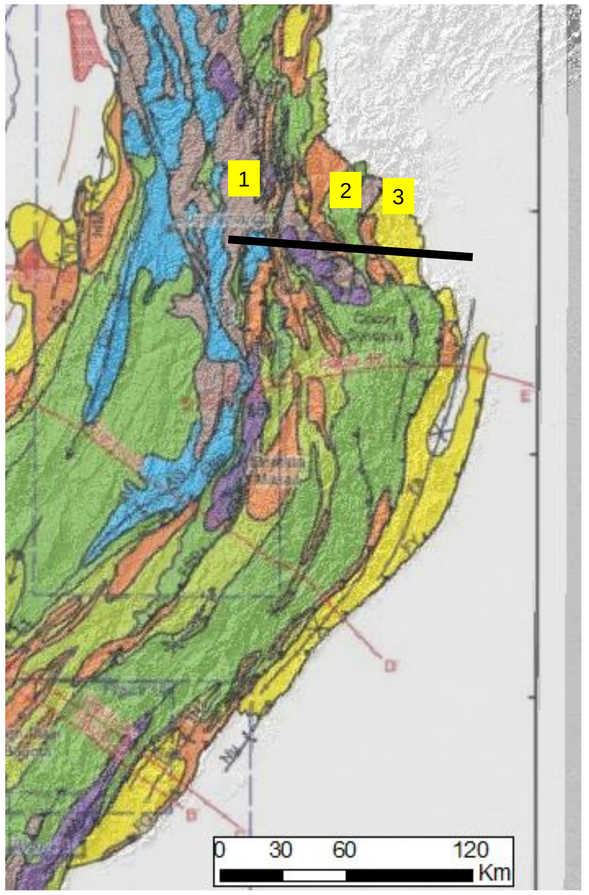
- Gibraltar
- Axial – Eastern Foothills
- Southwest

Kammer et al, 2020

GIBRALTAR AREA

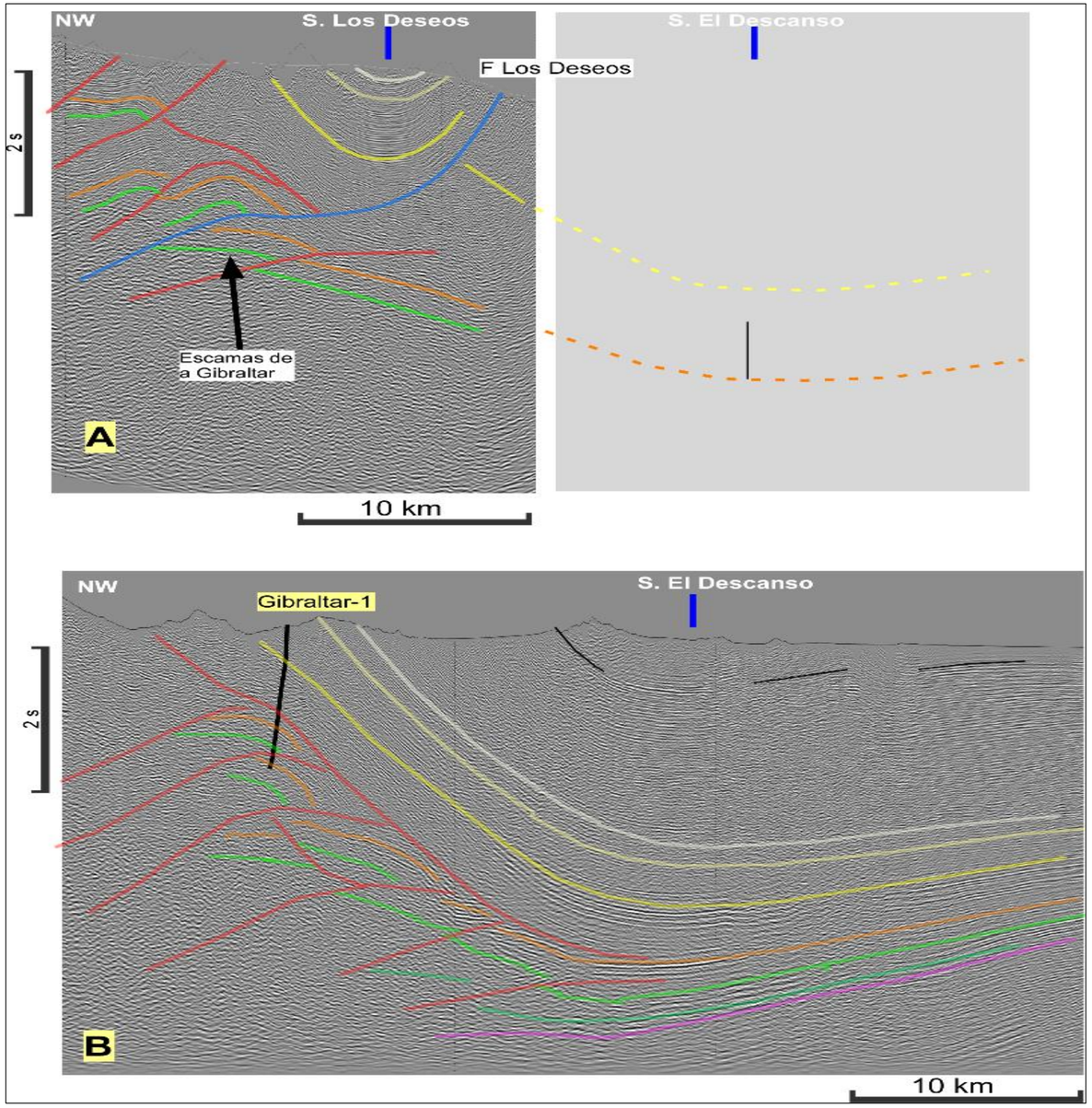
Transect 7. Gibraltar

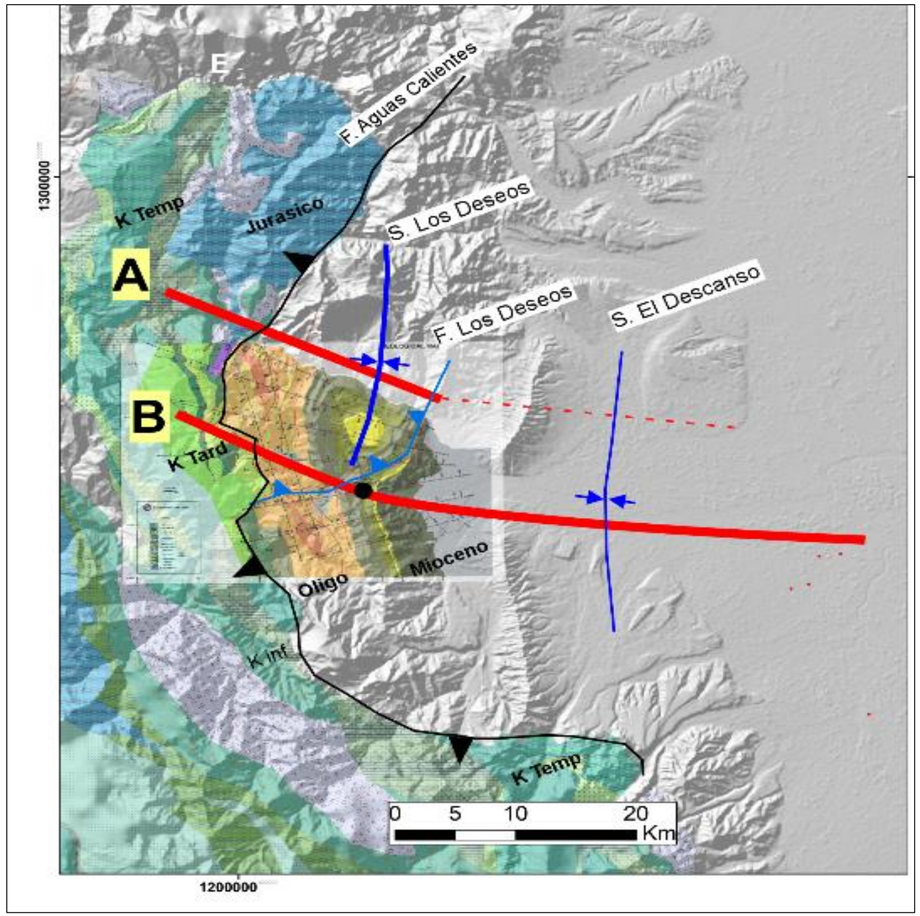


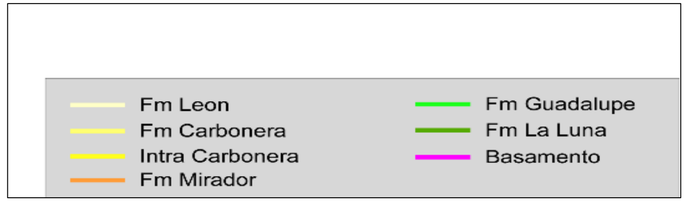


Fm Guayabo
Fm León
Fm Carbonera
Fms Mirador / Cuervos / Barco /
Fm Guadalupe
Fm La Luna
Fm Aguardiente
Fms Tibu / Mercedes
Fm Rio Negro
Fm Girón
Paleozoico / Pre-Cámbrico

GIBRALTAR AREA







CONCLUSIONS

- The Eastern Cordillera is an inverted basin where **different types of structures** were developed through its evolution.
- A **great variety of traps** can be found along the basin, including thick and thin skin structures, salt related traps in the central area and sub-thrusts traps.
- Guando Sub-thrust field in the Southwest, proves that this type of traps work and **need to be assessed** in the rest of the basin.
- **Salt domes** in the Bogotá nearby areas, are an interesting play to be explored as the gas market would be right there
- The triangular zone in the footwall of Soapaga fault, is a proven hydrocarbon province where Late Cretaceous and Tertiary reservoirs are preserved, giving more chances **of multi-target structures**.
- The Eastern foothills present the major discoveries, most of them targeting Tertiary reservoirs, but **Late Cretaceous reservoirs** in deeper structures must be considered.

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Petroleum System Yet to Find

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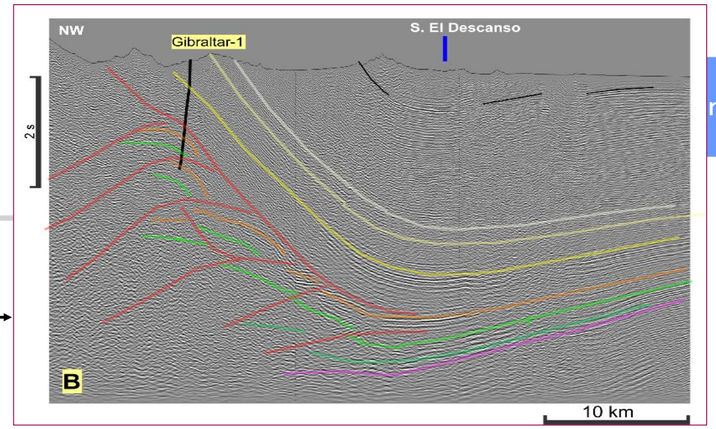
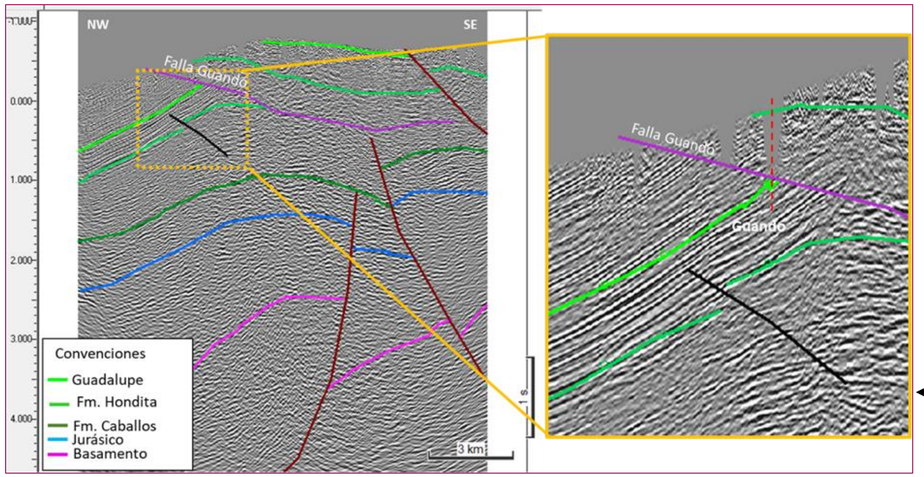
PETROLEUM SYSTEM MODELING

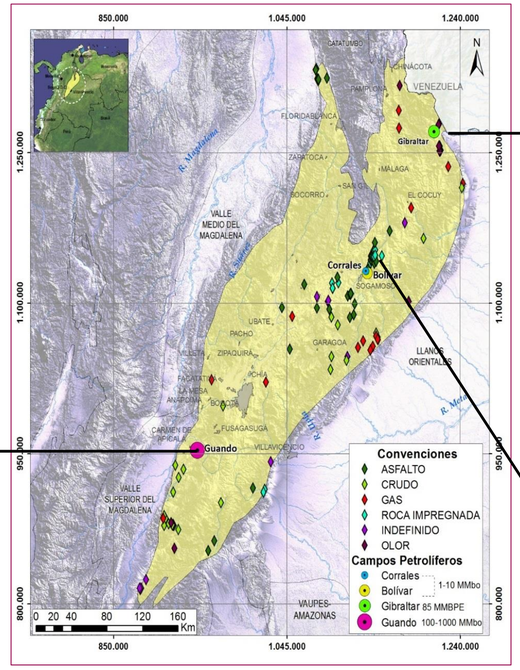
Hydrocarbons Occurrence And Proven Plays



Structural Play Middle Eocene
Field : Gibraltar
OOIP : 0.09 Bboe
Reservoir: Fm Mirador Gas & Condensate 53° API

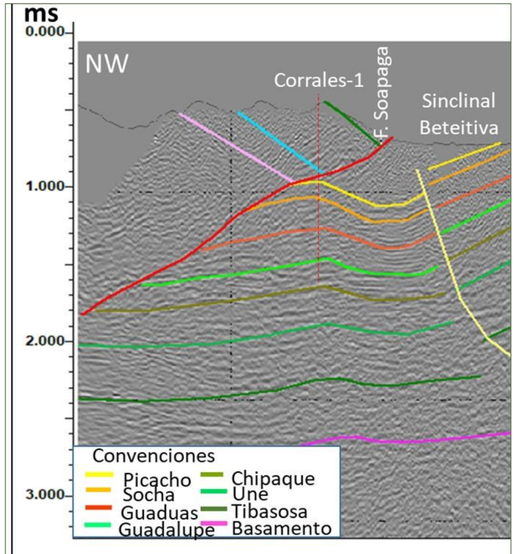


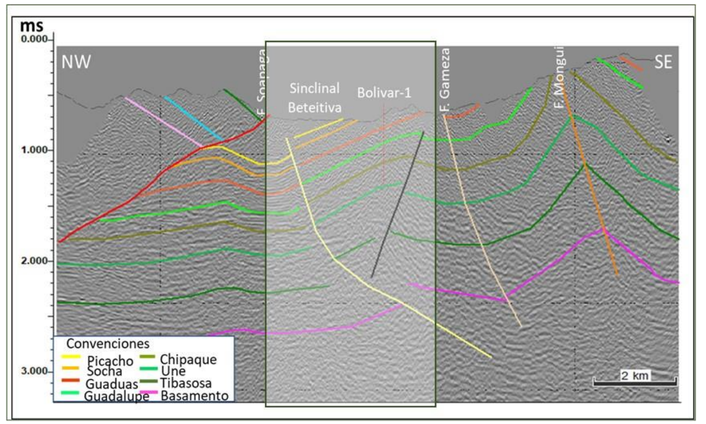
Structural Play Upper Cretaceous
Field : Guando & Guando SW
OOIP : 0.57 Bboe
Reservoir: Fm Monserrate 32° API



Campo	OOIP (mmboe)
BOLIVAR	3
CORRALES	75
GIBRALTAR	86
GUANDO	509
GUANDO SW	65
TOTAL	737

0.7 Bboe

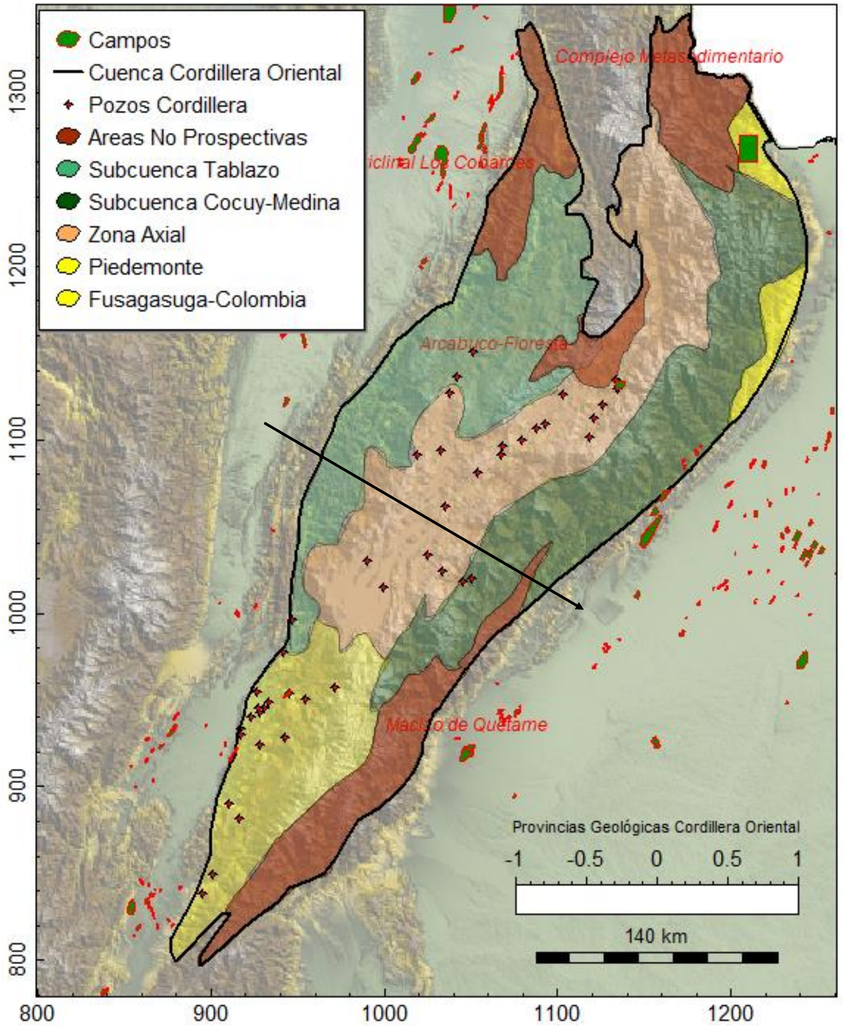


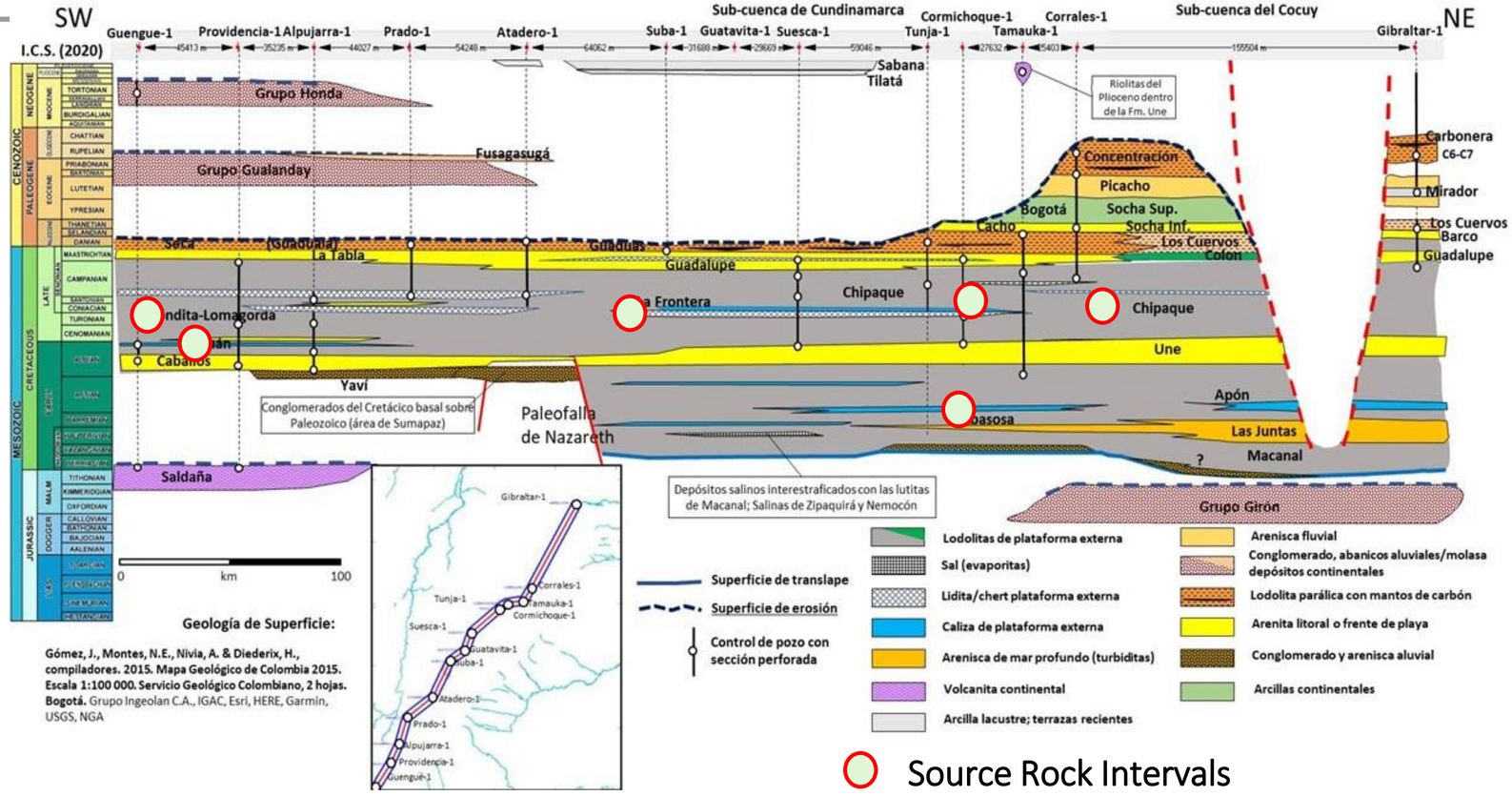


Structural Play Upper Cretaceous
Field : Corrales & Bolivar
OOIP : 0.078 Bboe
Reservoir: Fm Monserrate 25° API

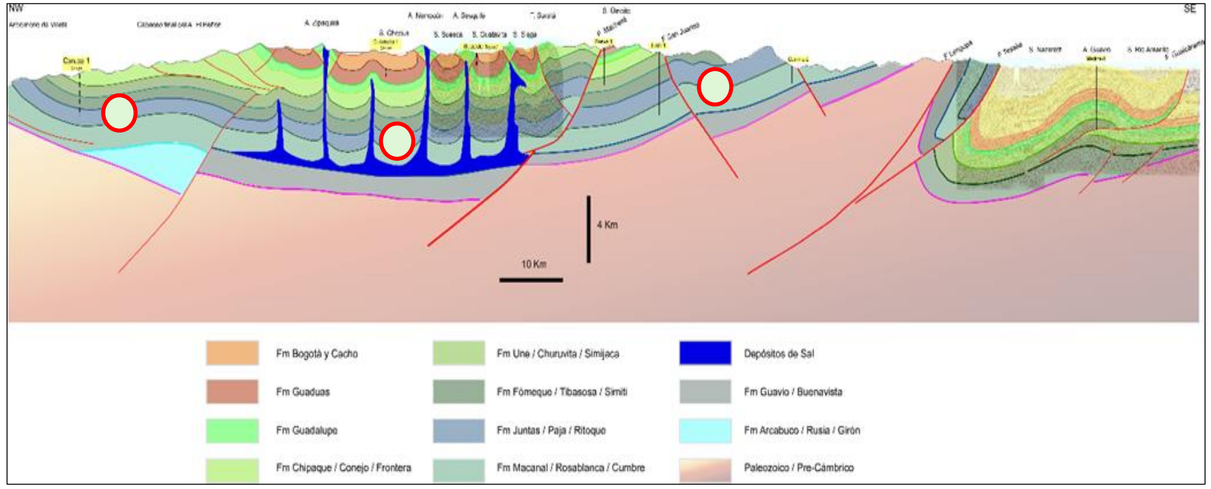
PETROLEUM SYSTEM MODELING

Hydrocarbon Potential



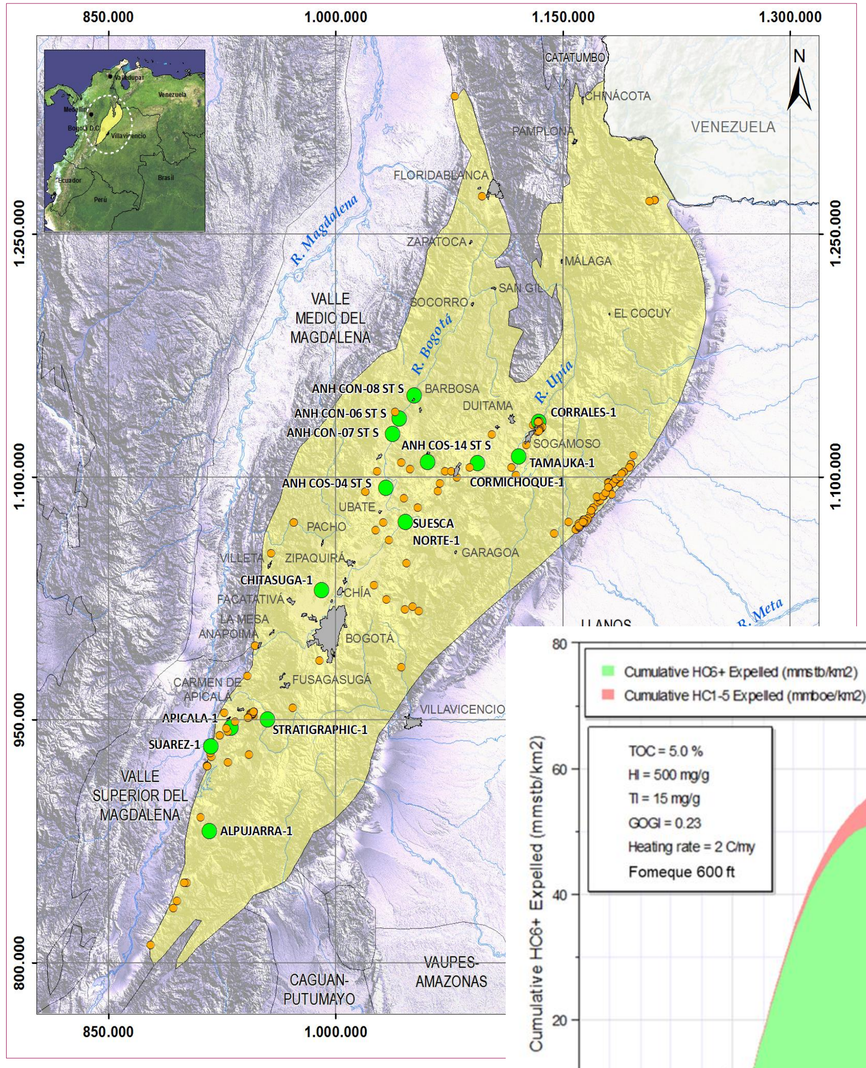


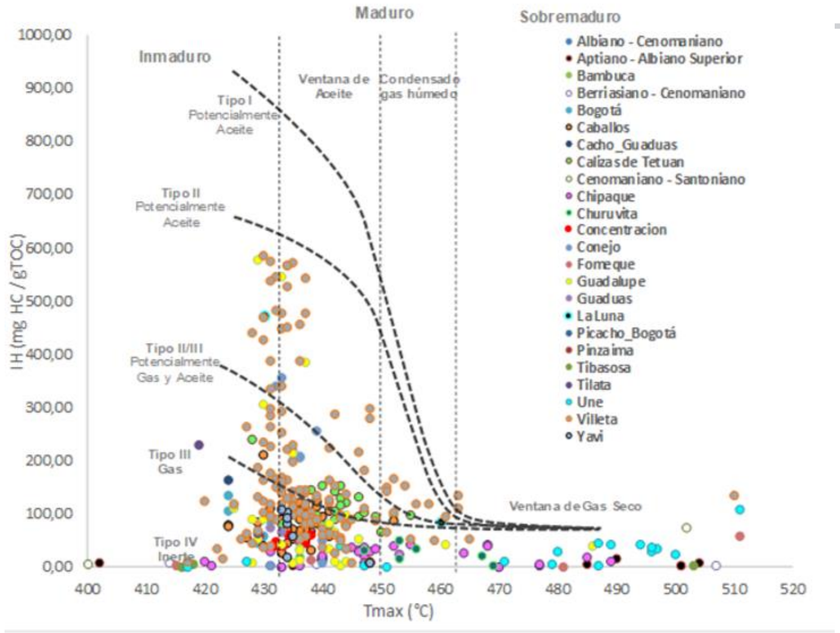
Source Rock Intervals

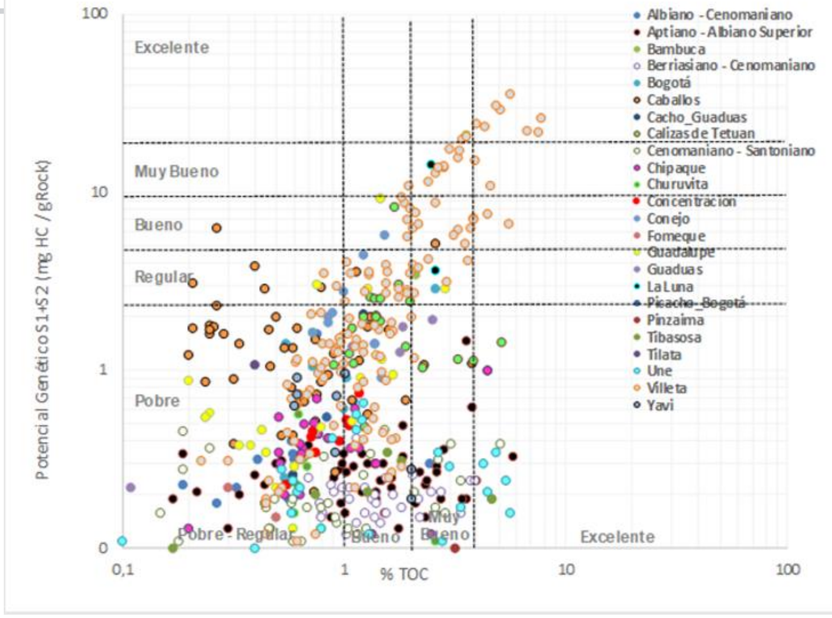


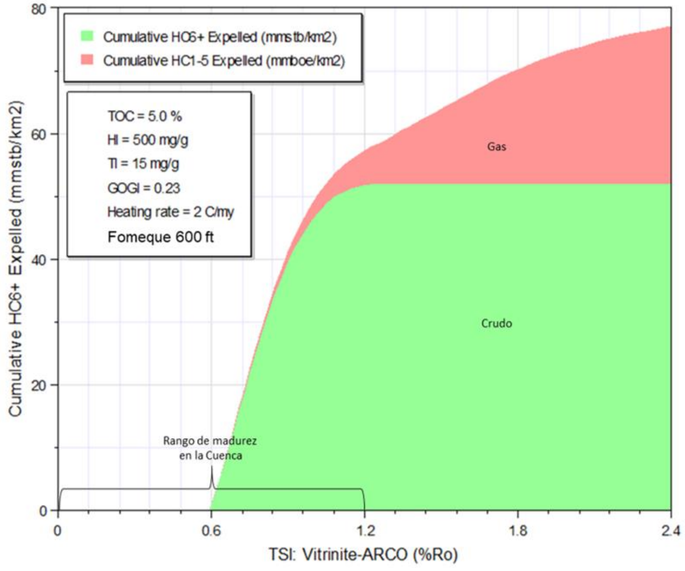
PETROLEUM SYSTEM MODELING

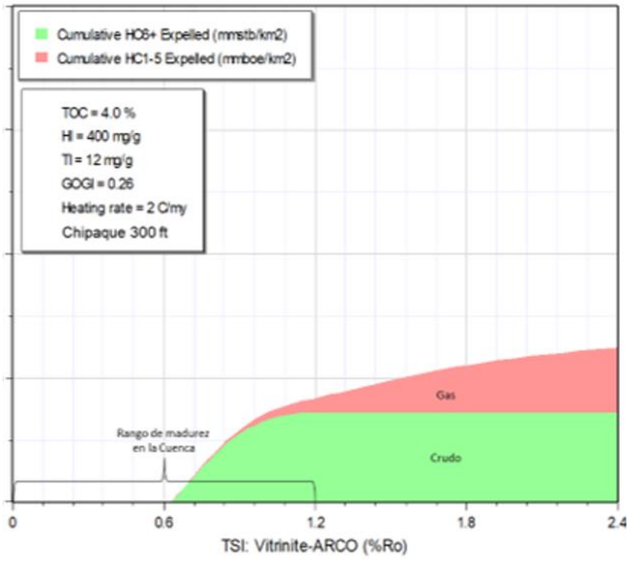
Hydrocarbon Potential

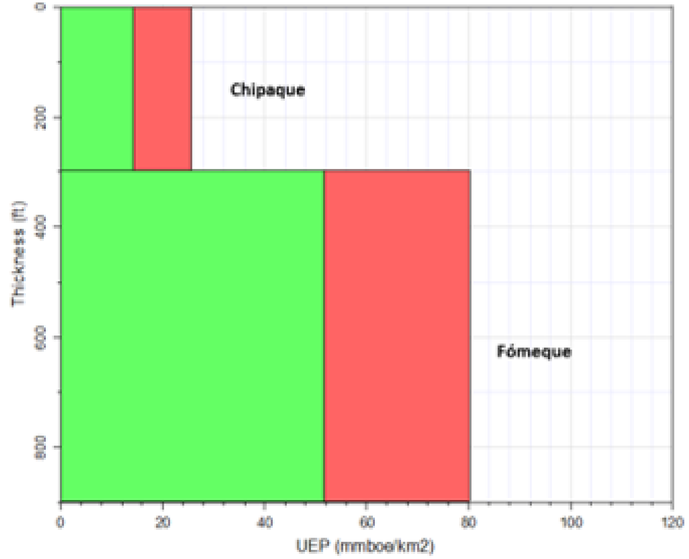






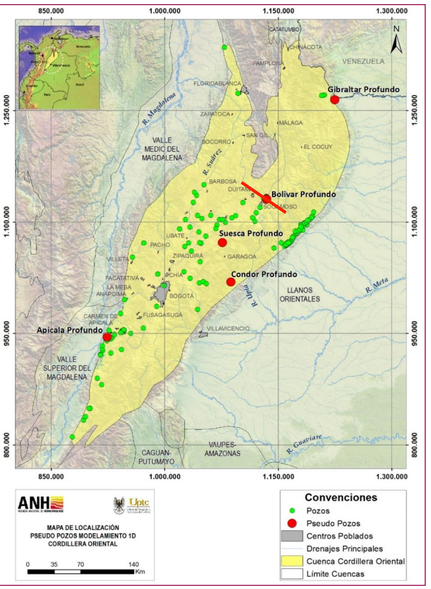


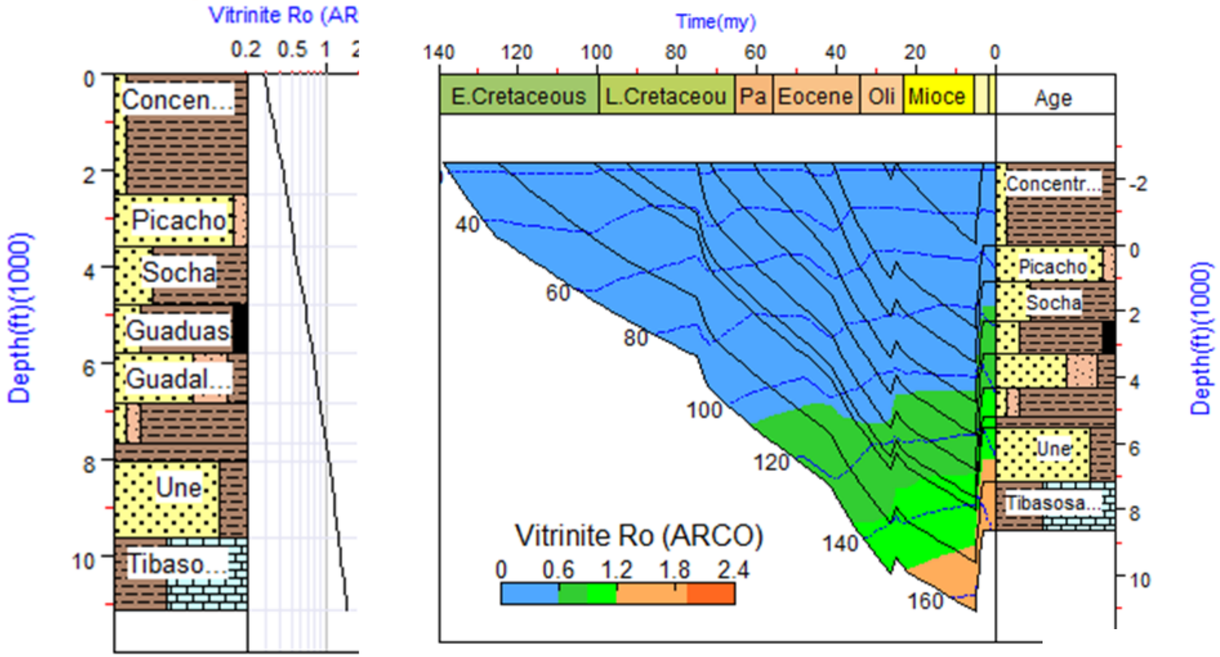


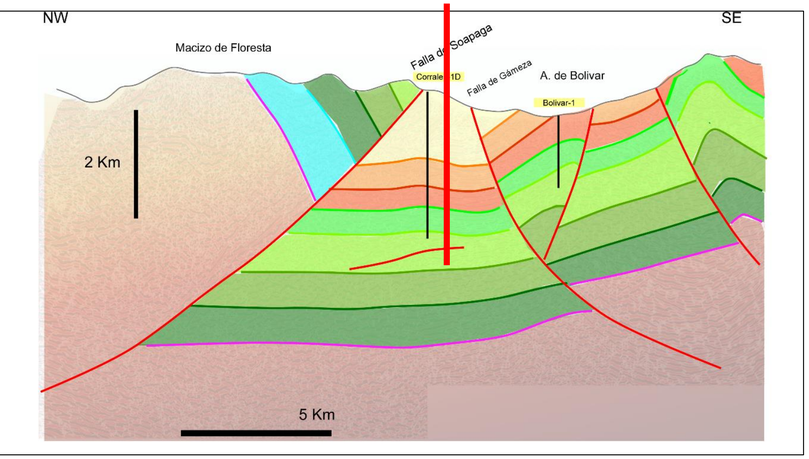


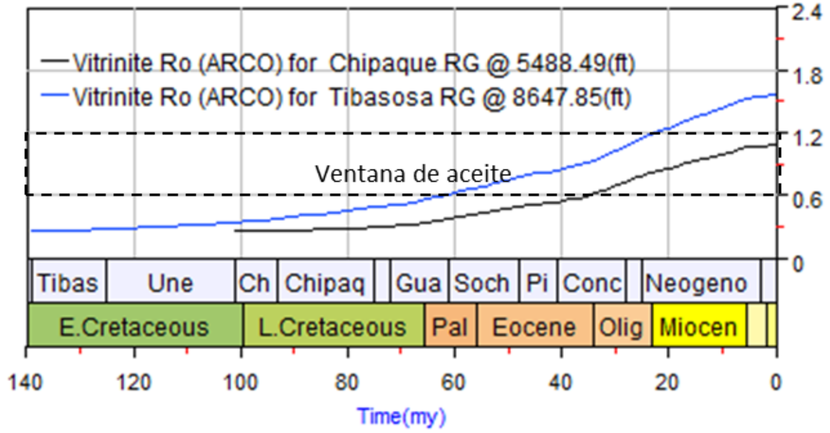
PETROLEUM SYSTEM MODELING

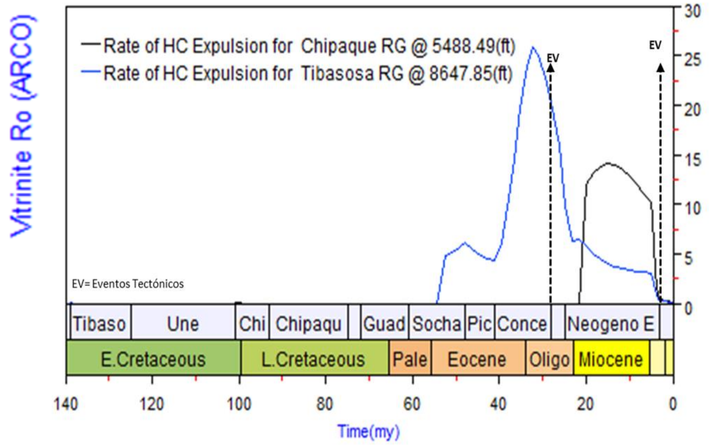
1D MODELING Bolivar Deep



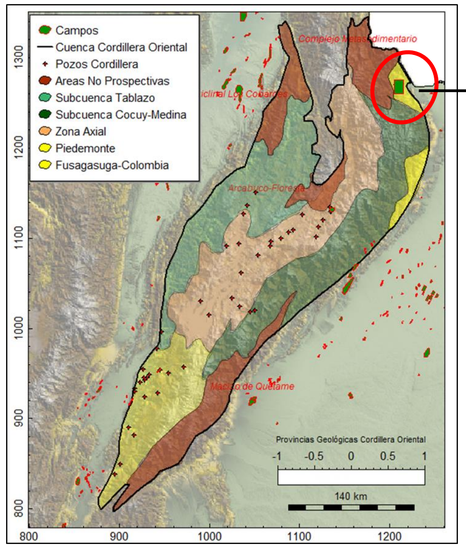


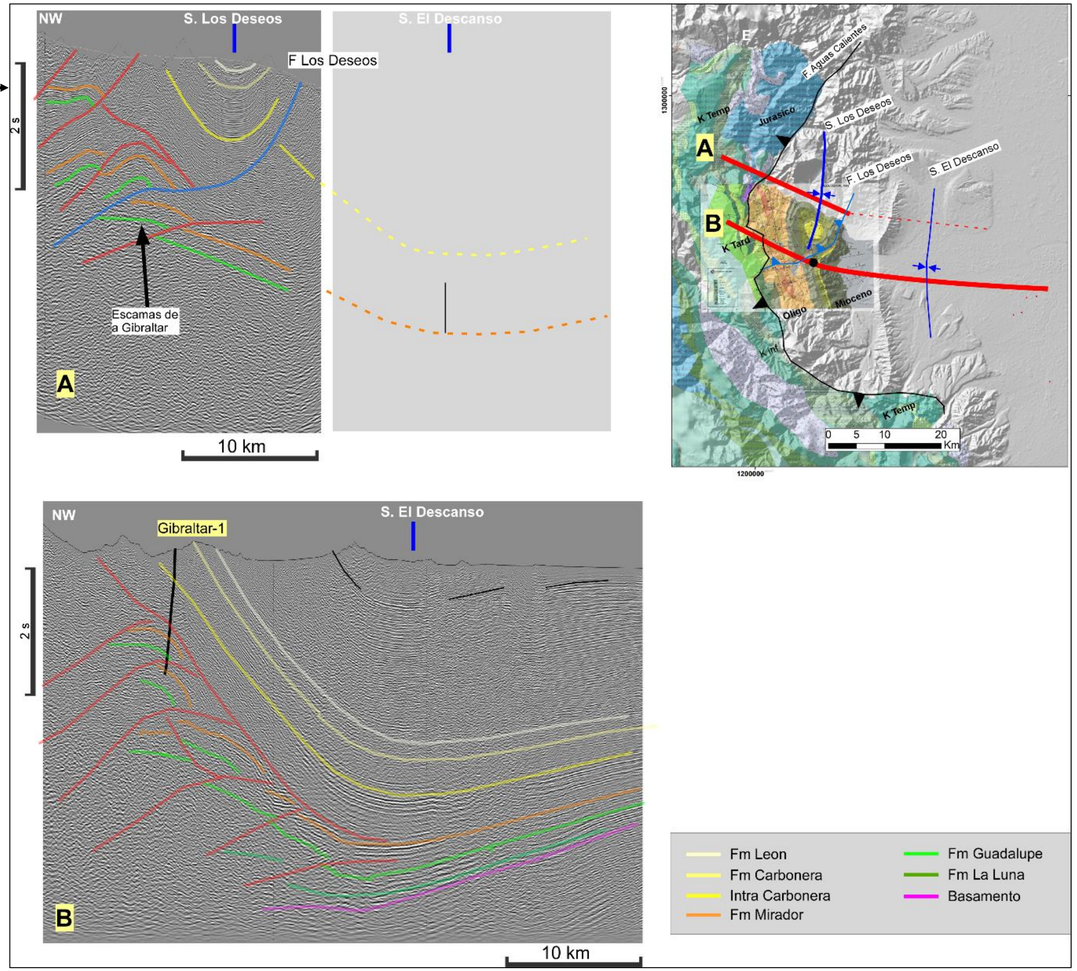


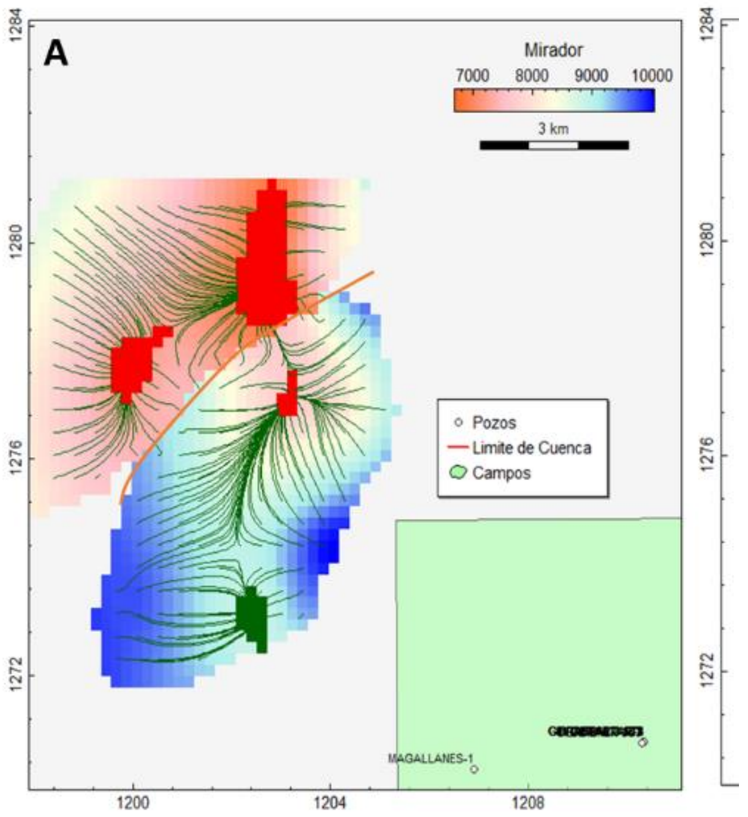




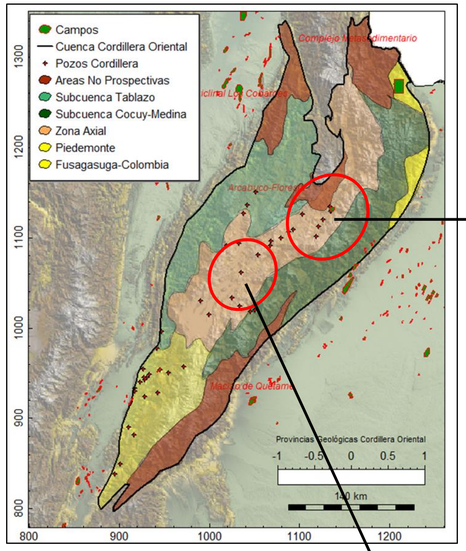
PLAY FAIRWAY MAPS Northern Area- Gibraltar

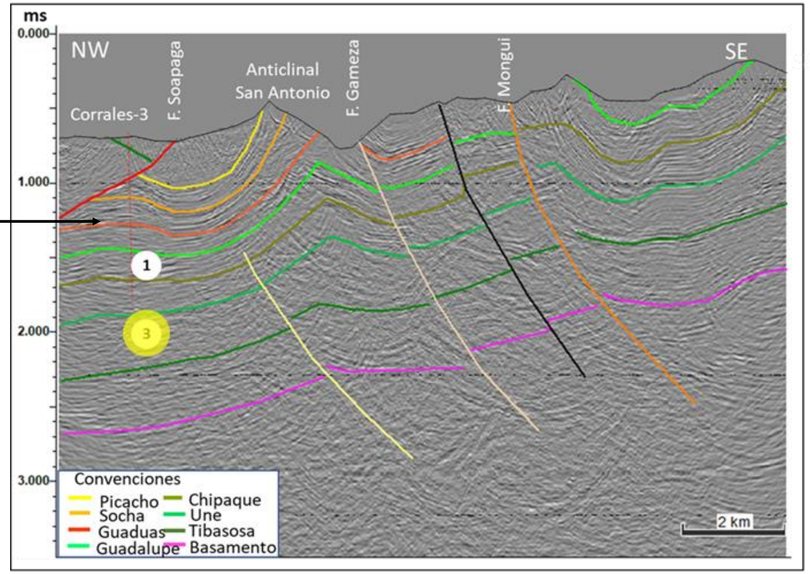


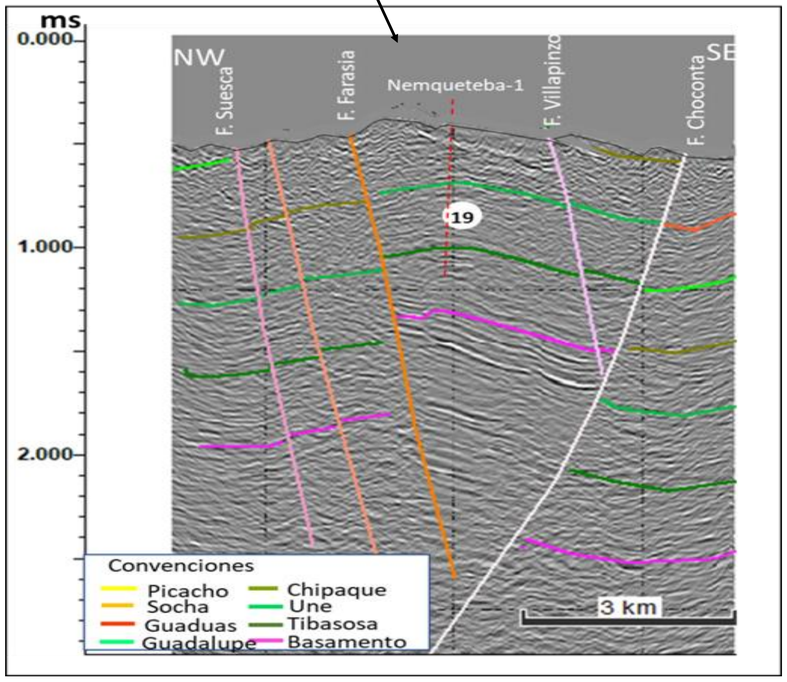


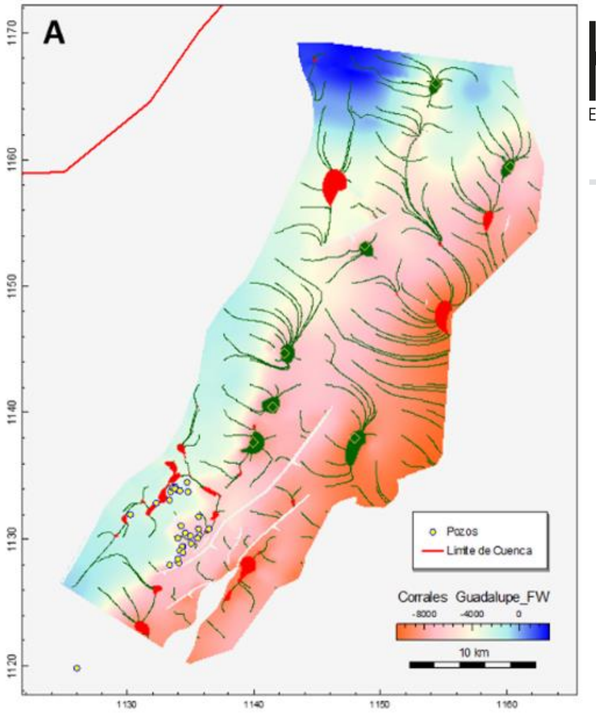


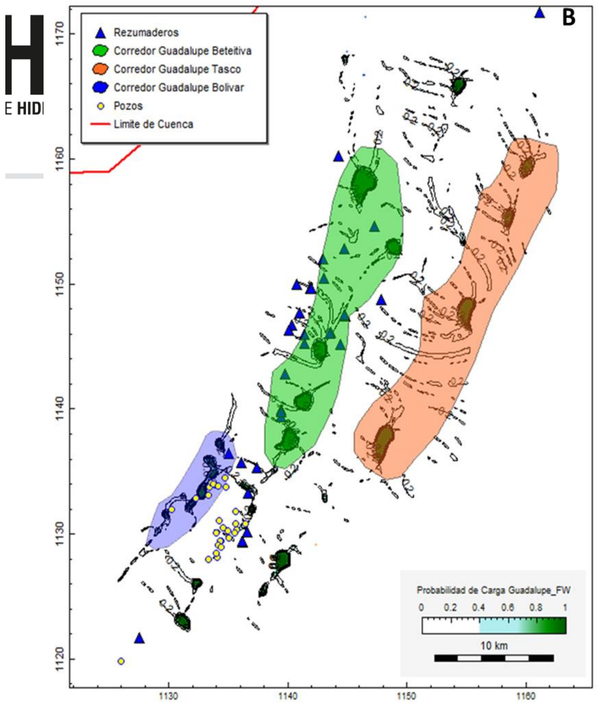
PLAY FAIRWAY MAPS Axial Zone

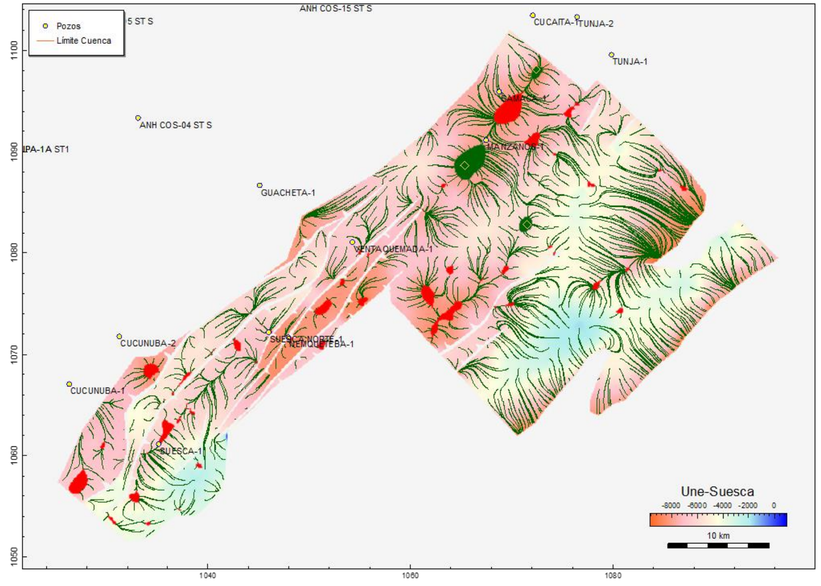


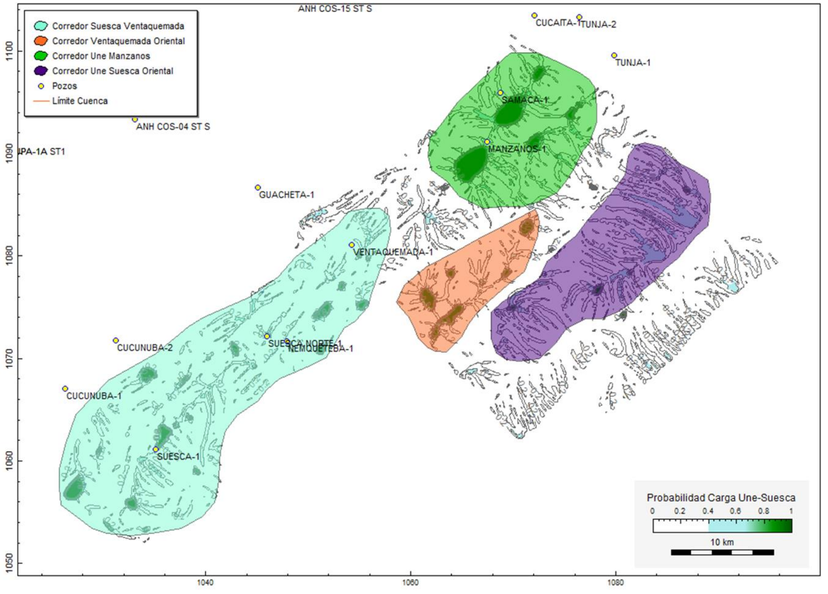




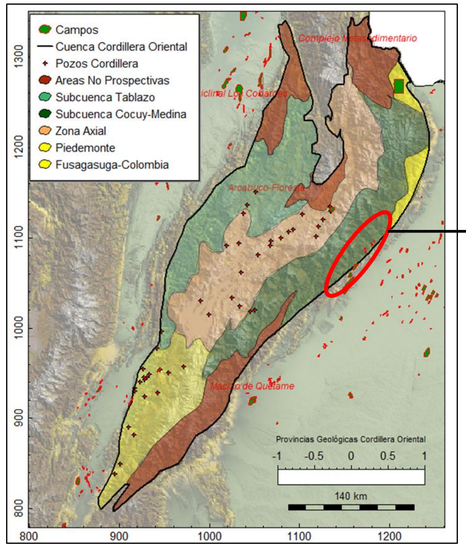


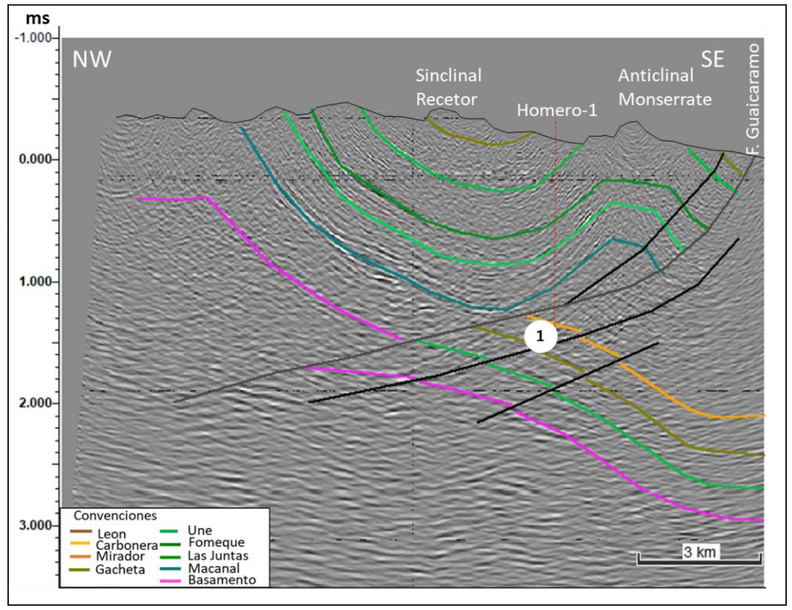


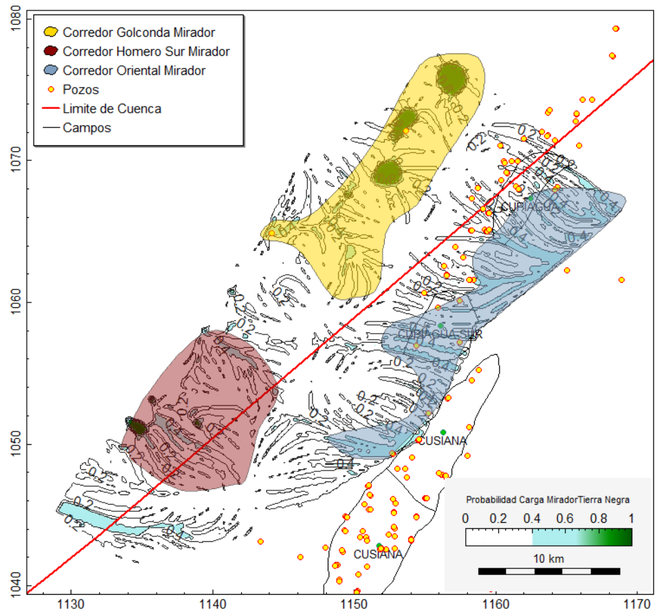


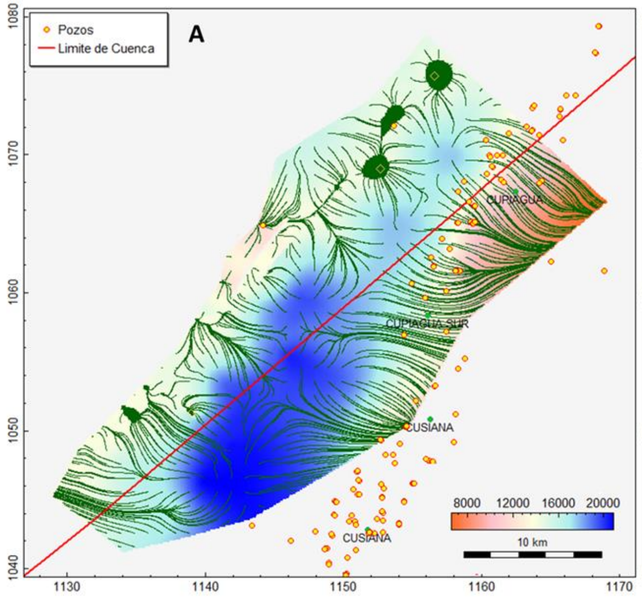


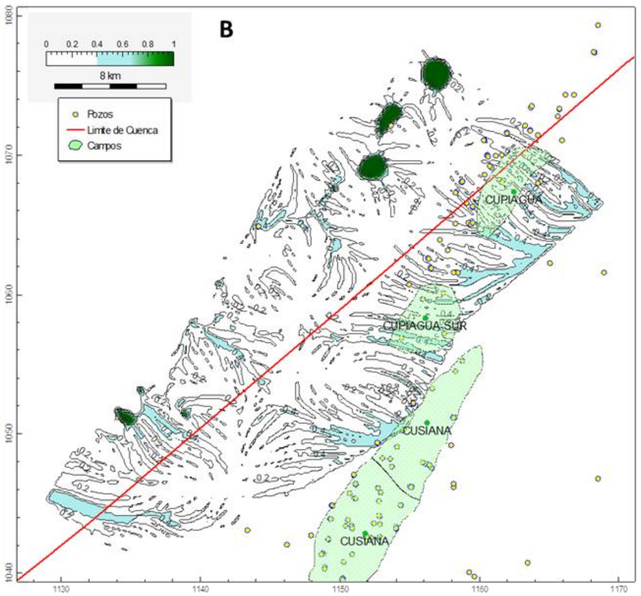
PLAY FAIRWAY MAPS Foothills – Tierra Negra

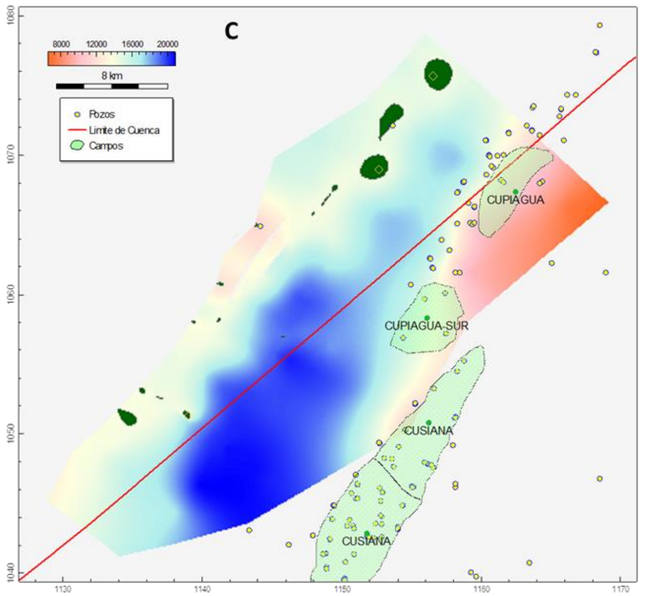




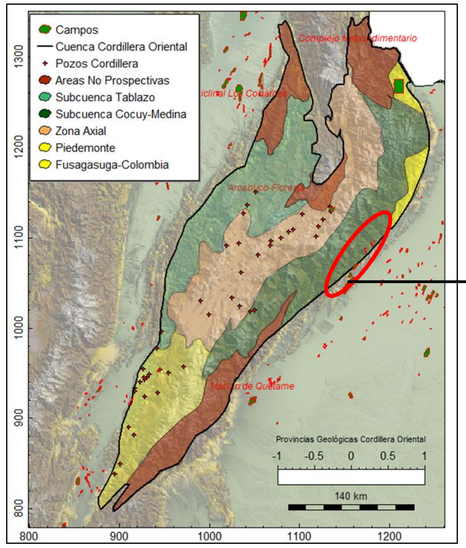


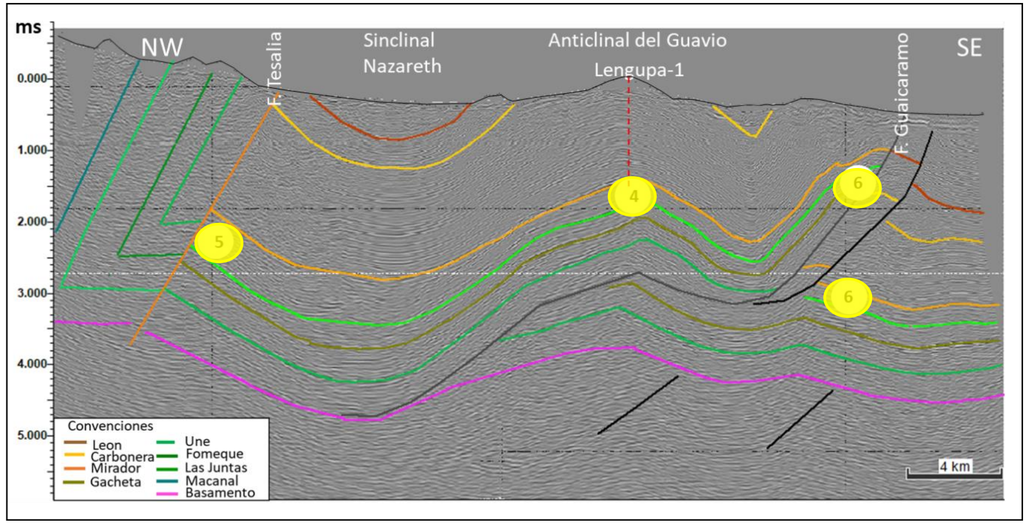


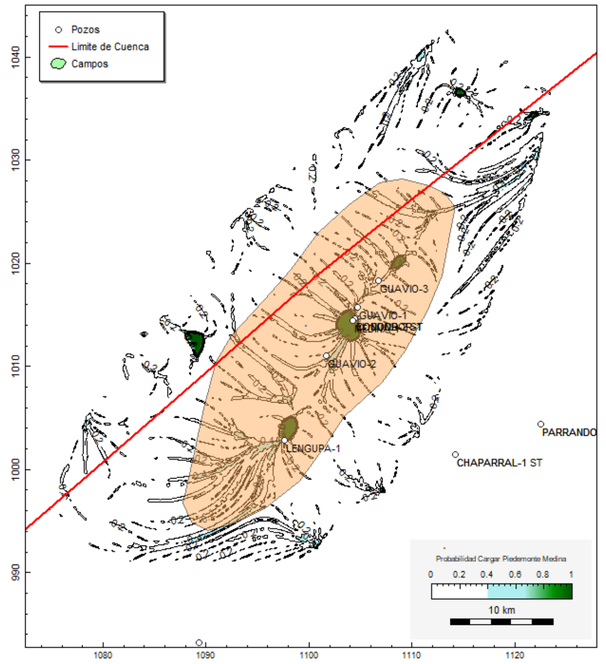


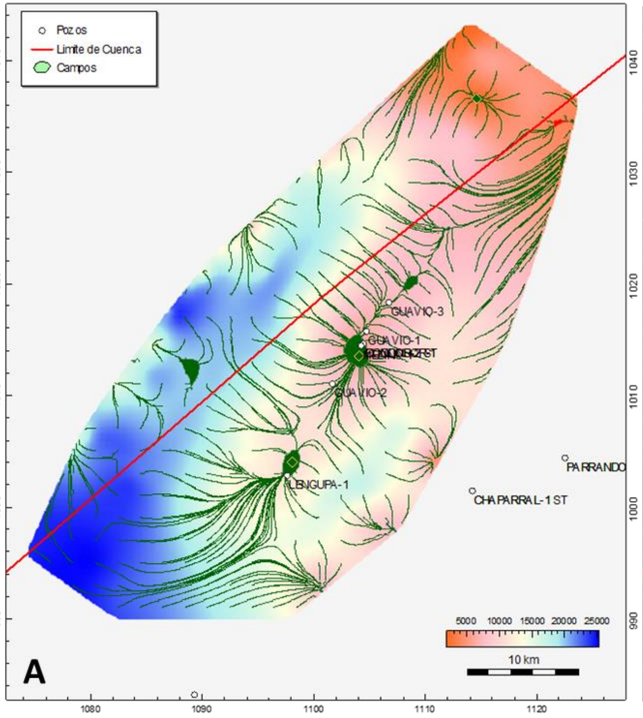


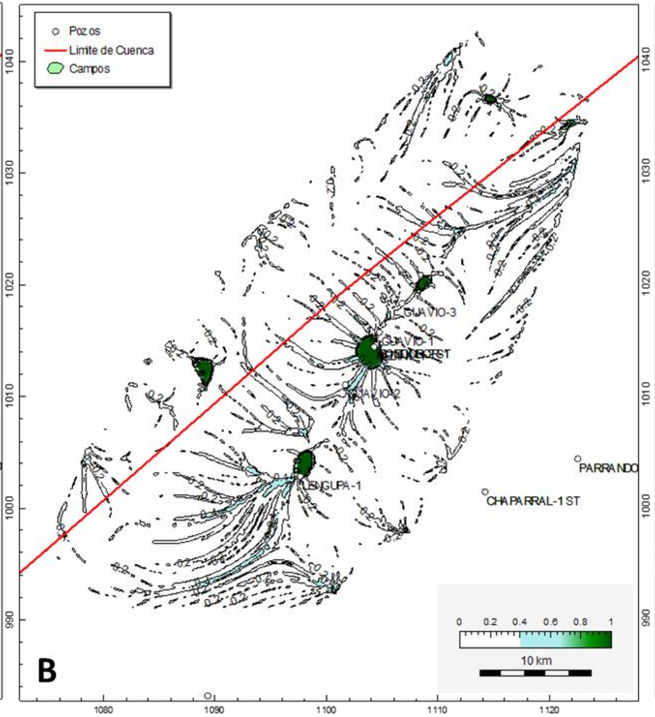
PLAY FAIRWAY MAPS Foothills – Medina

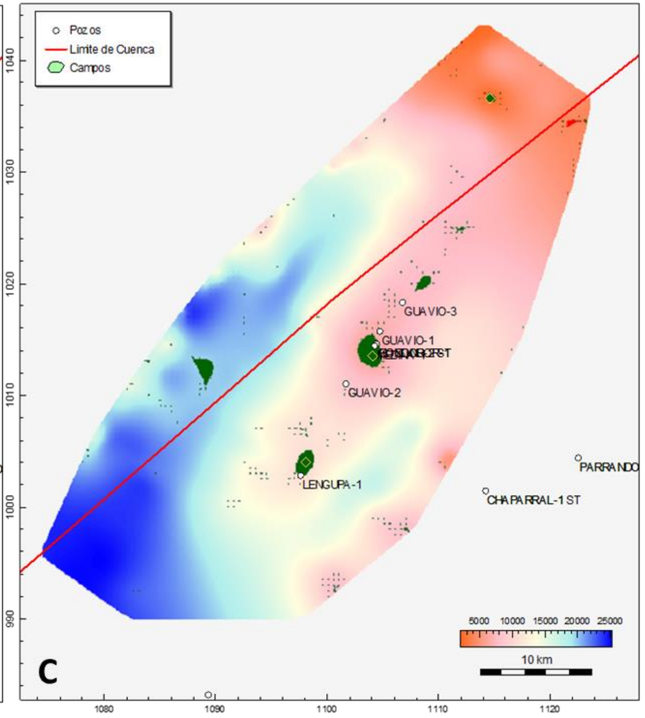












COLOMBIA ROUND 2021

PETROLEUM SYSTEM MODELING

3D MODELING

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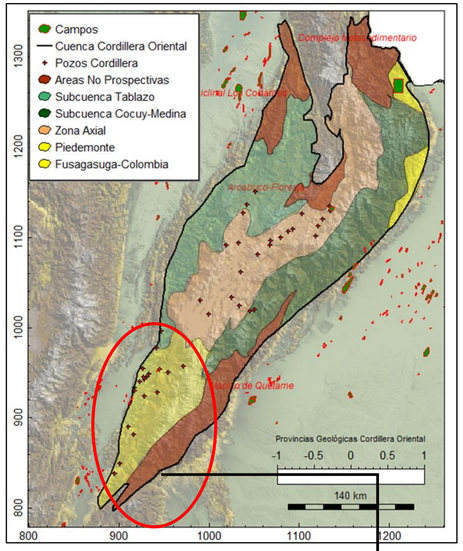

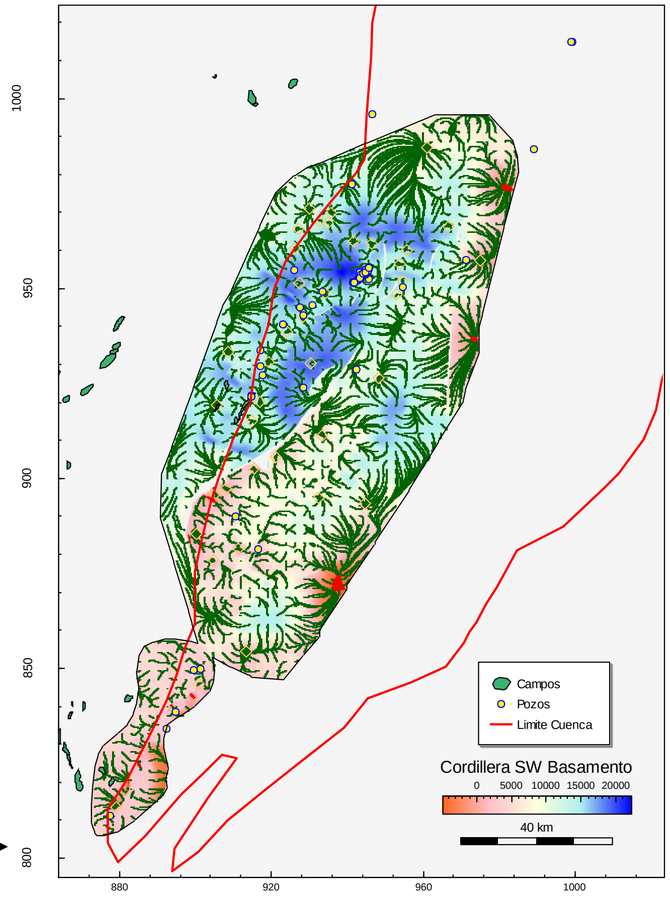

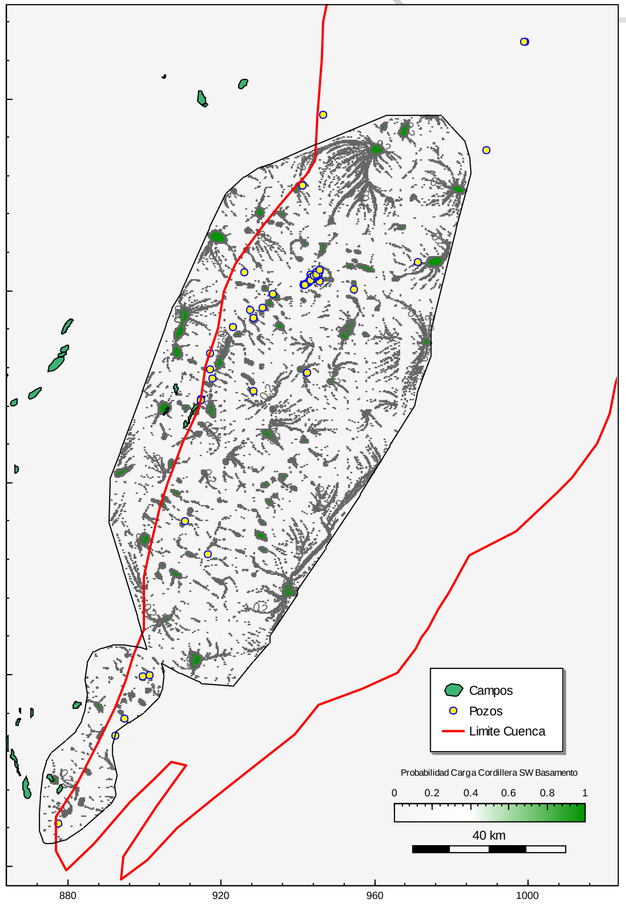

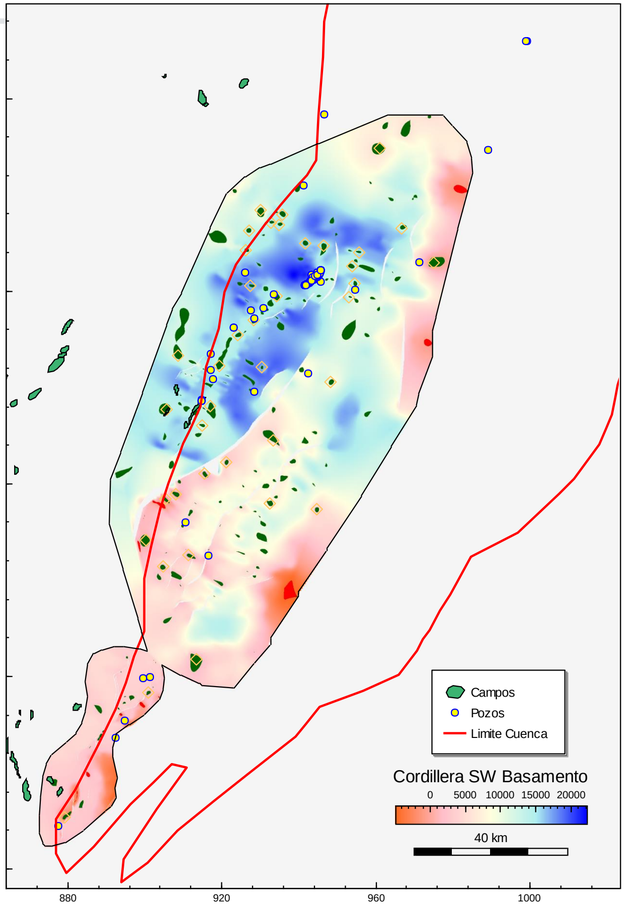

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PLAY FAIRWAY MAPS

Southern (Fusagasuga-Colombia)

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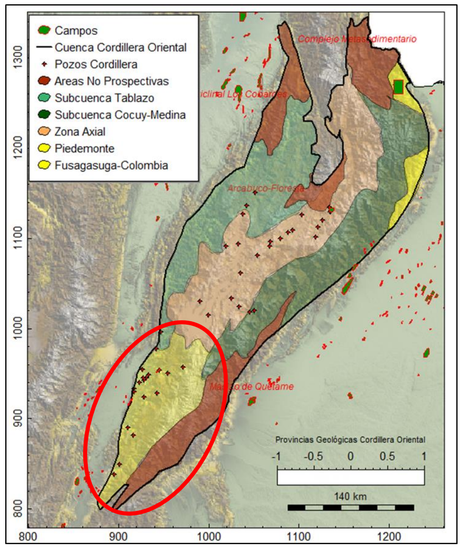

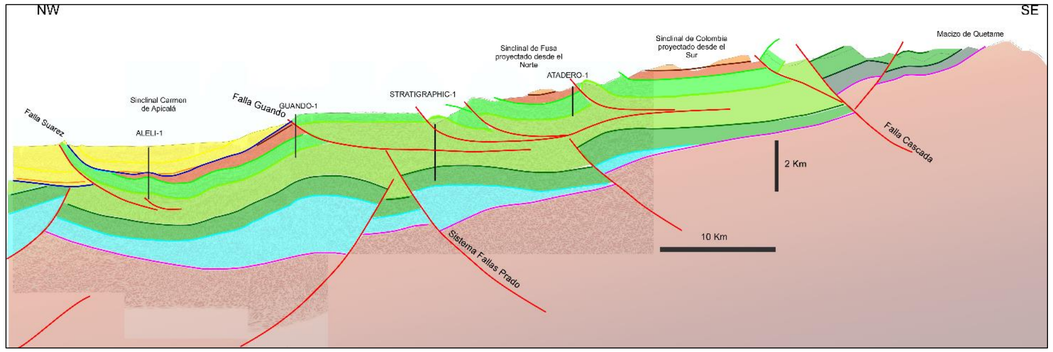

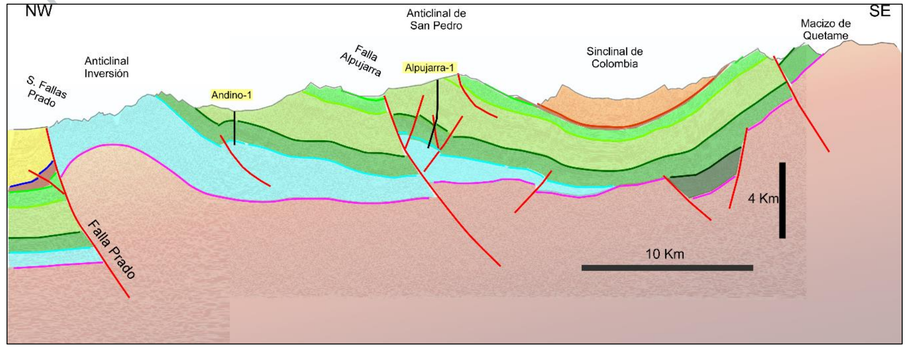

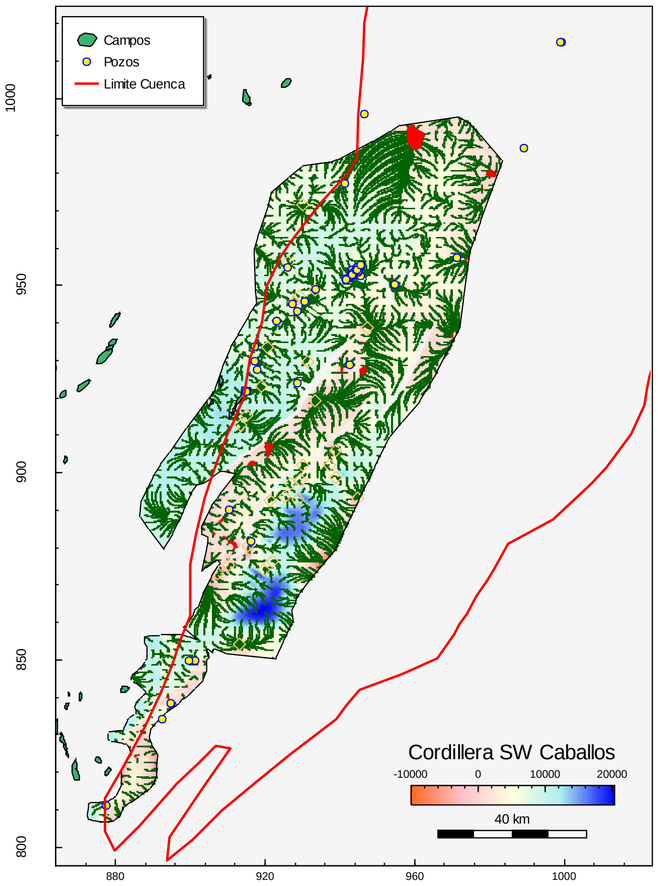

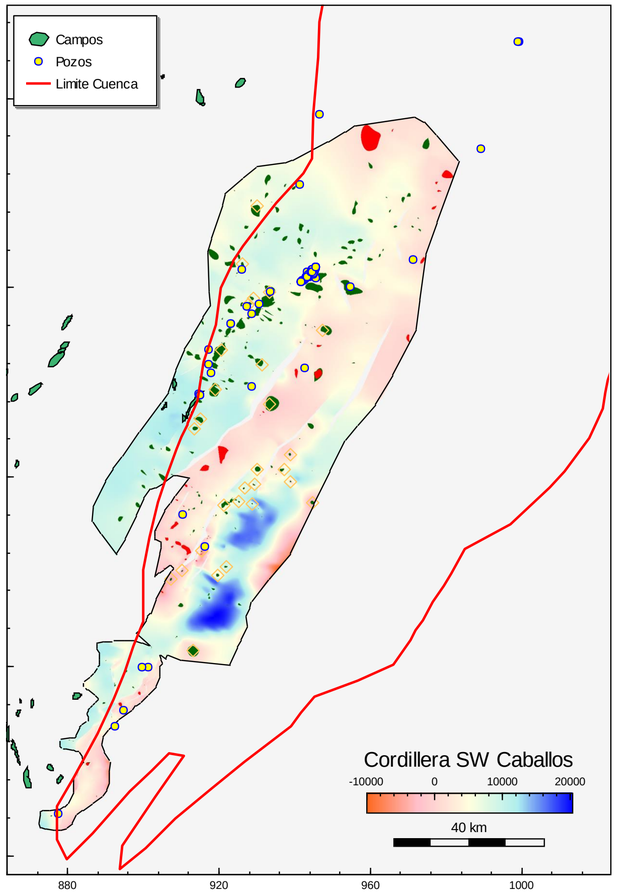

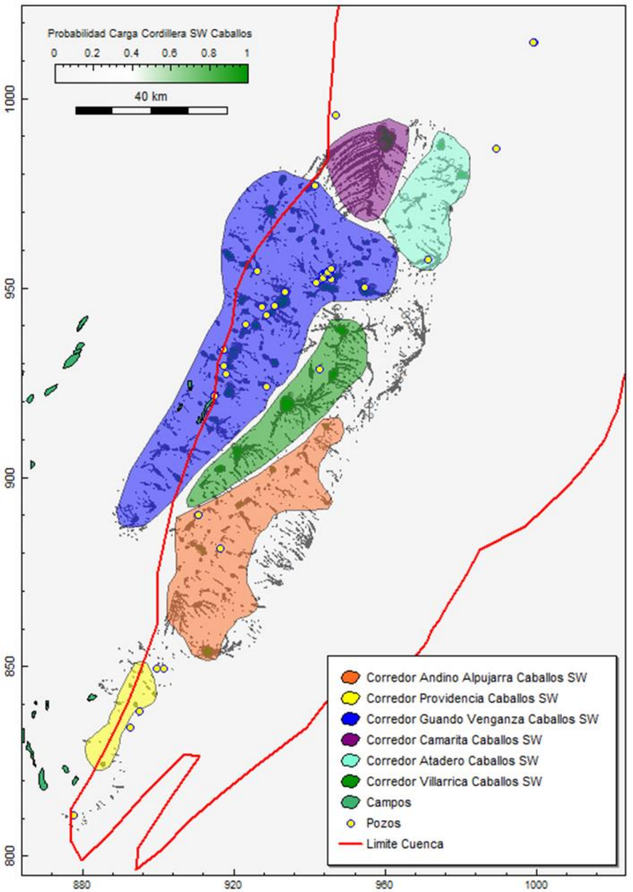

COLOMBIA ROUND 2021

PLAY FAIRWAY MAPS

Southern (Fusagasuga-Colombia)

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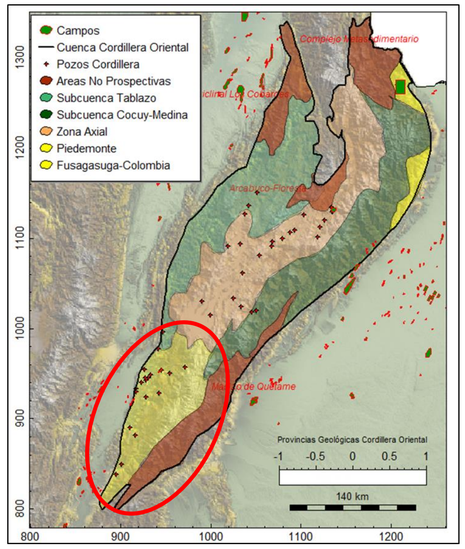
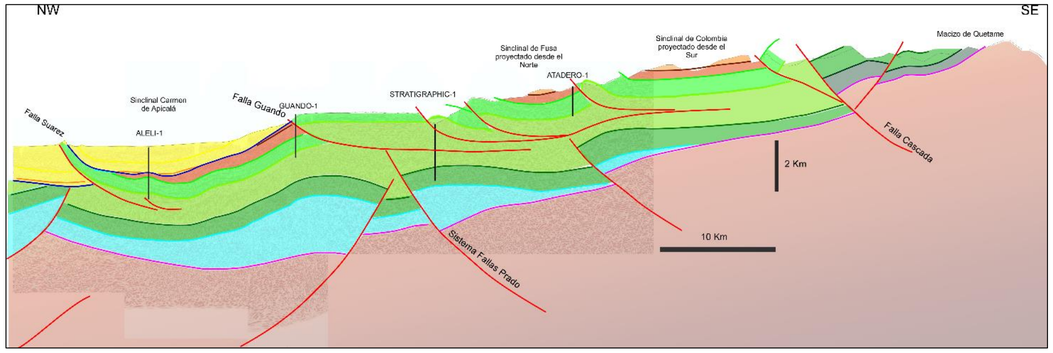
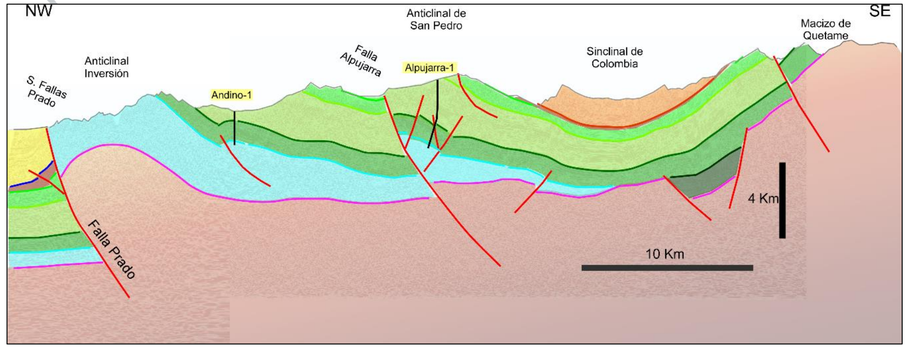
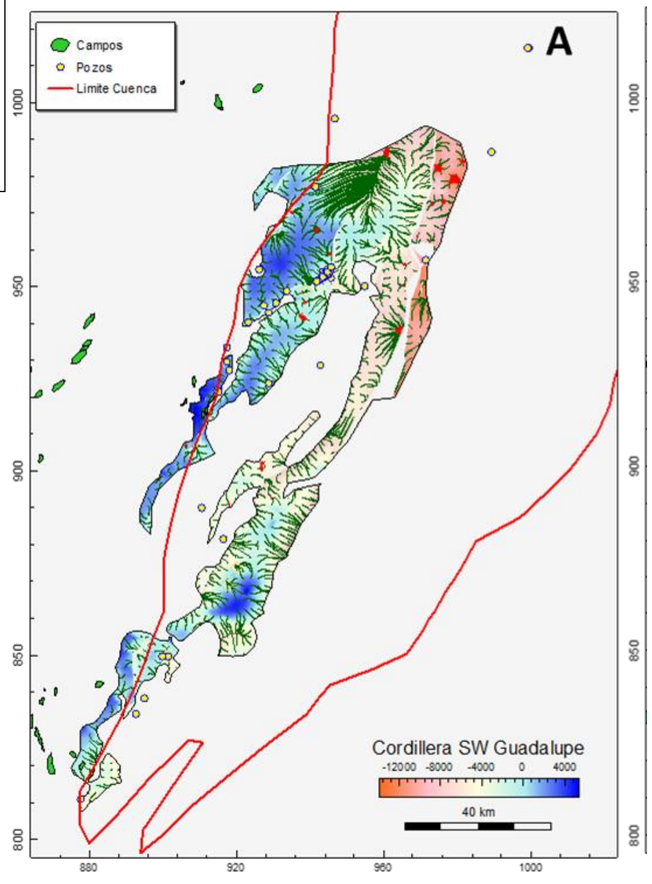
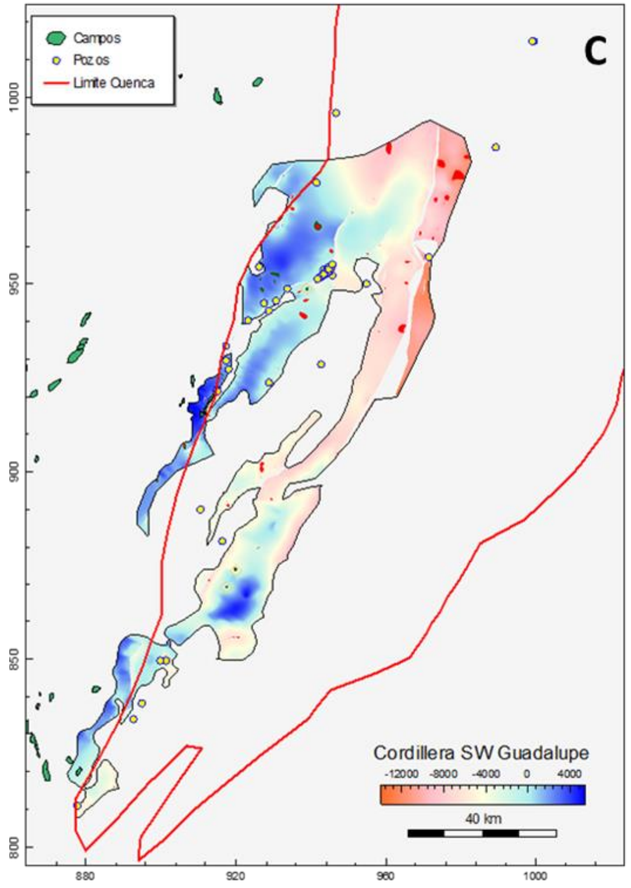
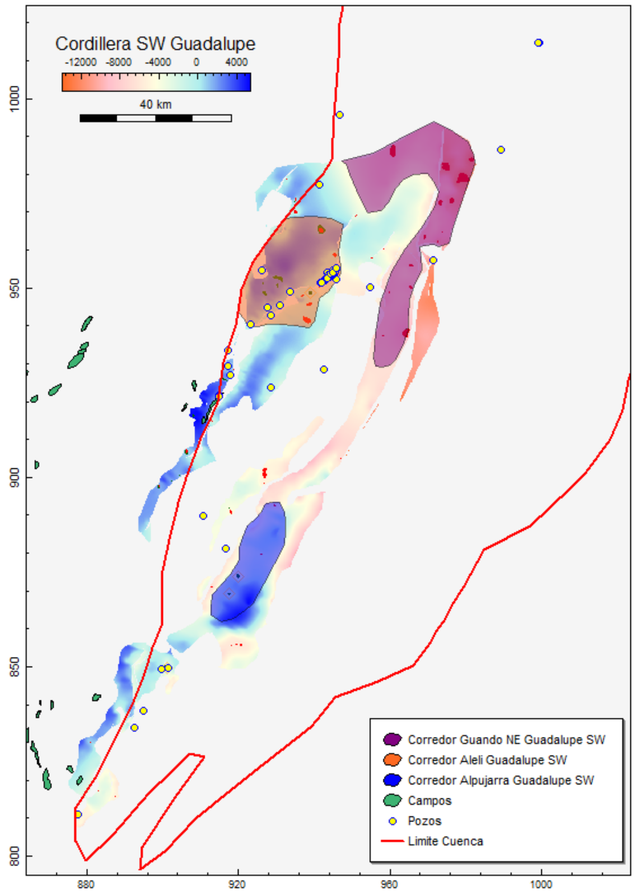










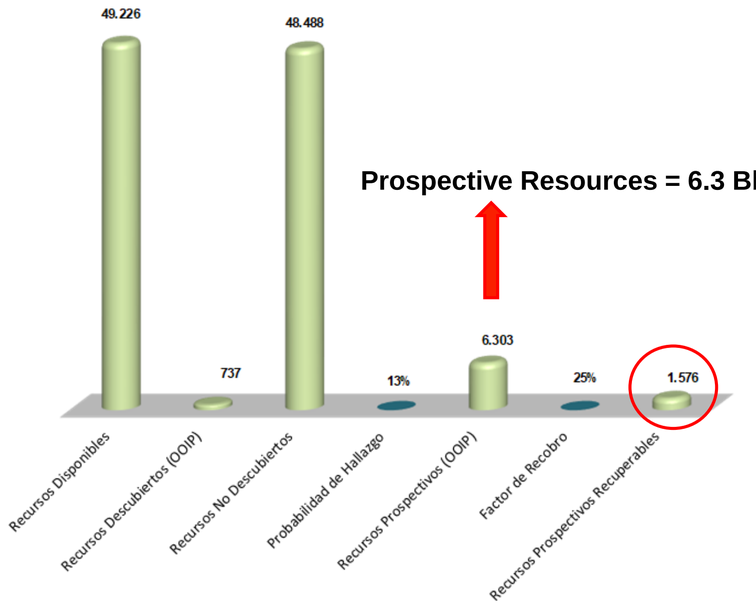


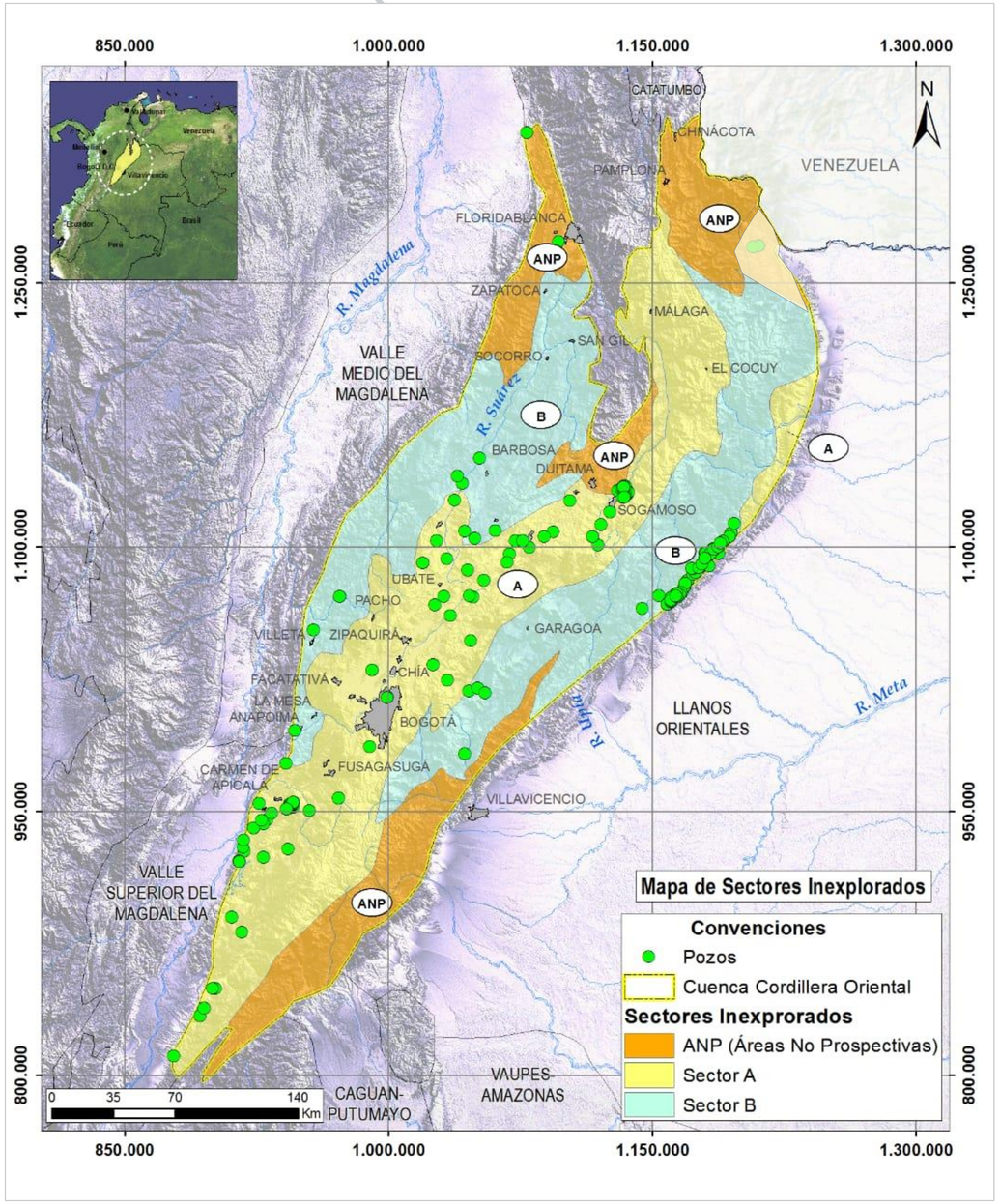
YET TO FIND
PROSPECTIVE RESOURCES / MASS BALANCE

PARÁMETROS	UNIDADES	Cordillera Oriental					TOTAL
		Fusagasugá / Colombia	Cocuy / Medina	Tablazo	Zona Axial	Pidemonte Norte	
HC´s Generados Paleoceno	MMbpe	0	0	0	0	8.637	8.637
HC´s Disponibles Paleoceno	MMbpe	0	0	0	0	344	344
HC´s Generados por la Fm Chipaque	MMbpe	146.198	236.065	162.096	303.294	33.152	880.805
HC´s Disponibles Fm Chipaque	MMbpe	2.977	4.807	3.301	6.176	675	17.935
HC´s Generados por la Fm Fomeque	MMbpe	316.439	510.950	350.847	656.462	71.756	1.906.454
HC´s Disponibles Fm Fomeque	MMbpe	5.137	8.294	5.695	10.656	1.165	30.947
Total HC´s Generados	MMbpe	462.637	747.015	512.943	959.756	113.545	2.795.895
Recursos Disponibles	MMbpe	8.114	13.101	8.996	16.832	2.183	49.226
Recursos Descubiertos (OOIP)	MMbpe	573,58	0	0	77,91	86	737
Recursos No Descubiertos	MMbpe	7.540	13.101	8.996	16.754	2.098	48.488
Probabilidad de Hallazgo	%	13%	13%	13%	13%	13%	13%
Recursos Prospectivos (OOIP)	MMbpe	980	1703	1169	2178	273	6.303
Factor de Recobro	%	25%	25%	25%	25%	25%	25%
Recursos Prospectivos Recuperables	MMbpe	245	426	292	545	68	1.576

*FG= Foco Generador

Balance de Masas Cuenca Cordillera Oriental (MMbpe)





Final Comments

- The Easter Cordillera Basin has Plays, Leads and Prospects **ready to evaluate and drill**.
- Update and review confidentiality of the information to **increase the volume of data available** for this type of study, making the results more attractive to the Industry.
- Similar to USA, Canada, England and recently in Brazil, the seismic information, wells, surface geology, etc., could be **made public one year after being obtained**. It would be very useful for operators, investors and strategies of the ANH and the SGC.
- More volume and availability of geological and geophysical information stimulates **additional studies related to groundwater, minerals, infrastructure, construction, etc**.

Thanks

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DATE