



Overview of the Oil and Gas Basins of Colombia

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1. Introduction
2. Colombian General Geological Framework
3. Colombia Round 2012
 - 3.1. Block Types
 - 3.2. Technical Aspects of Basins
 - 3.3. Minimum Exploration Program (Conventional Blocks)
 - 3.4. Unconventional Resources
 - 3.5. Minimum Exploration Program (Unconventional Blocks)
 - 3.6. Database (EPIS)
4. Summary and Conclusions

Content

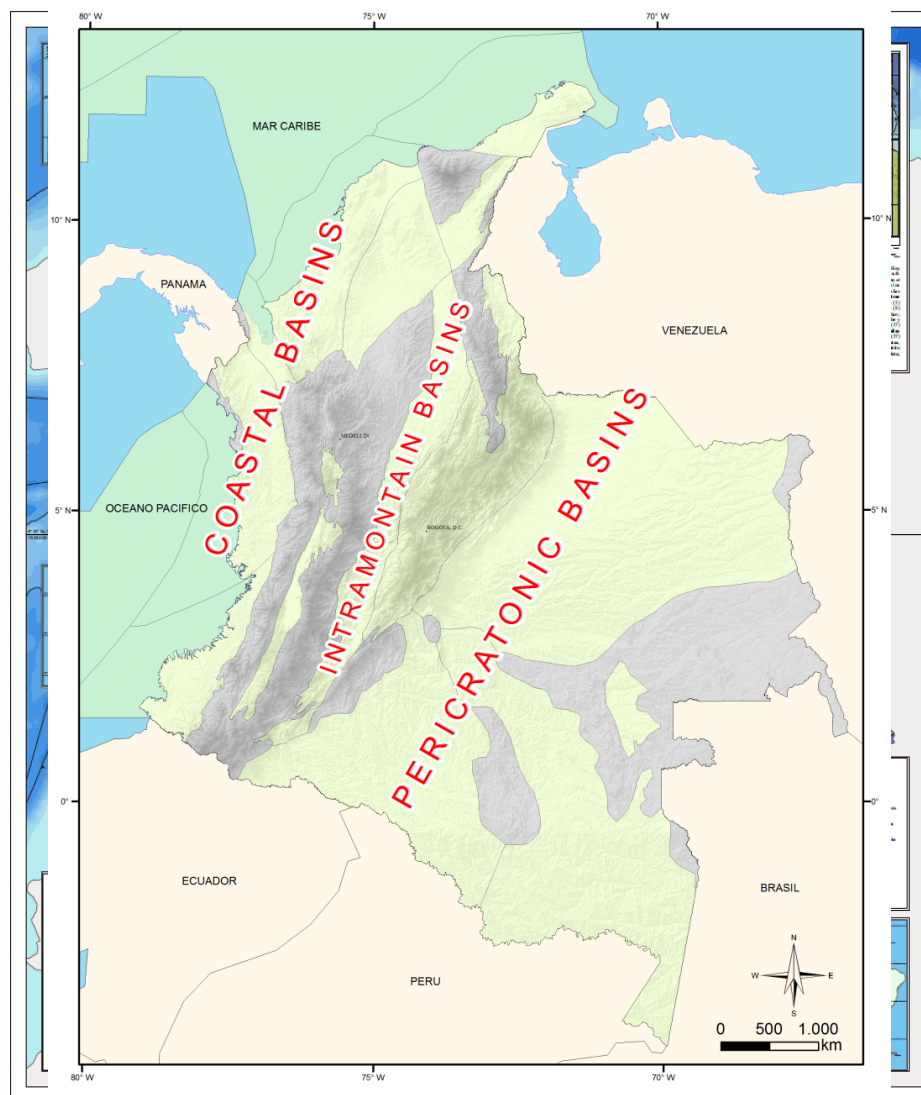


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Colombia

= *Diverse Geology*

= *Something For All Explorers!*



Area Comparison



Texas is about
60% of the size of
Colombia

Colombia
1,141,748 km²

Texas
696,241 km²

Area Comparison



Alberta is about
60% of the size of
Colombia

Colombia
1,141,748 km²

Alberta
661,848 km²

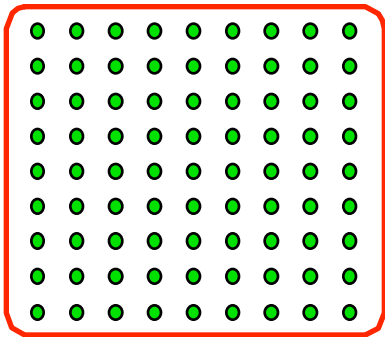
Colombia – An Underexplored Country



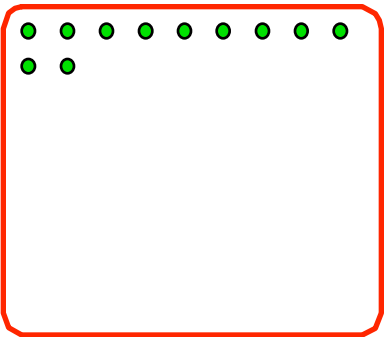
Wells per 1,000 km²

UNITED STATES	—————>	83
CANADA	—————>	11
COLOMBIA	—————>	2

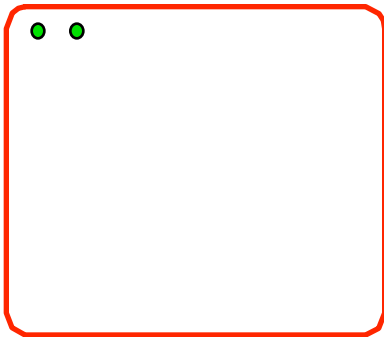
UNITED STATES



CANADA



COLOMBIA



Colombia – An Underexplored Country



Western Sedimentary Basin of Canada

Approx. 525,000 wells
1 well / 2.5 km²

Eastern Cordillera-Llanos-Putumayo
2,026 wells
1 well / 200 km²

Colombia has room to explore!

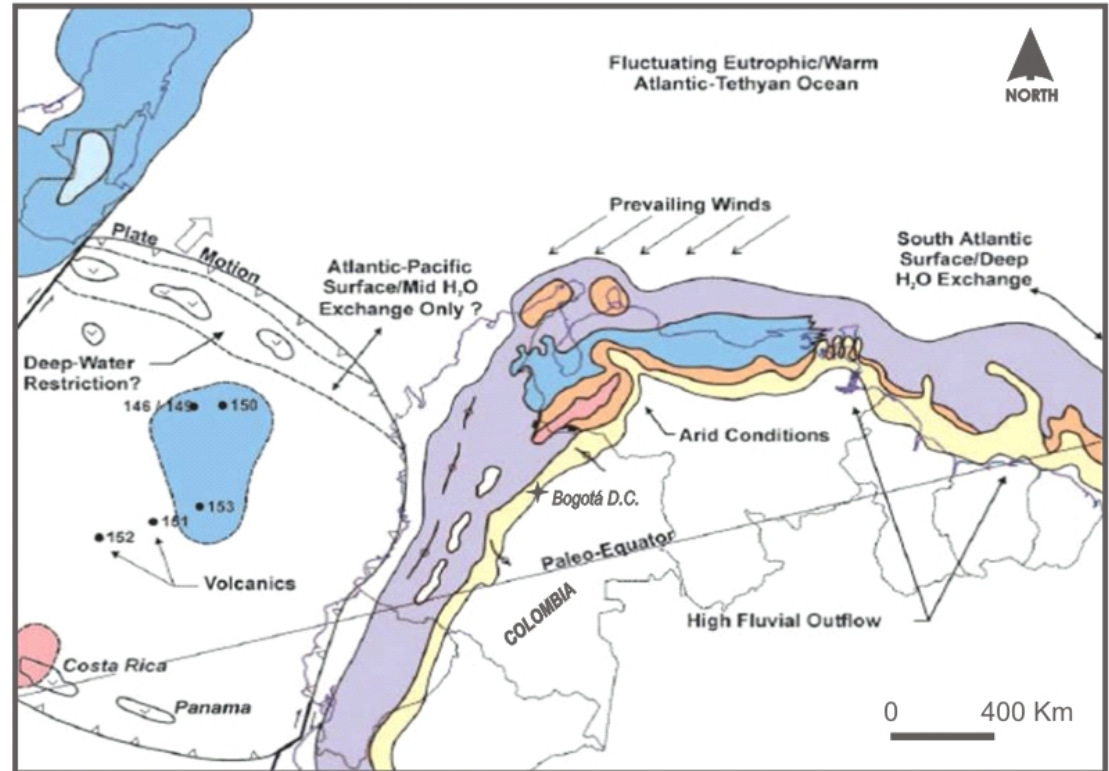
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Colombia Has World-Class Source Rock!

- ✓ Mid-Cretaceous La Luna / Gachetá, Villeta, Cansona – A rich, regional hydrocarbon source rock.
- ✓ Tertiary carbonaceous shales and coals.
- ✓ In the shallower basins, these rocks might have generated commercial quantities of biogenic methane.



From Villamil, 2003, AAPG

Late Cenomanian-Turonian paleogeography of NW South America. La Luna / Cansona deposition in purple and blue.

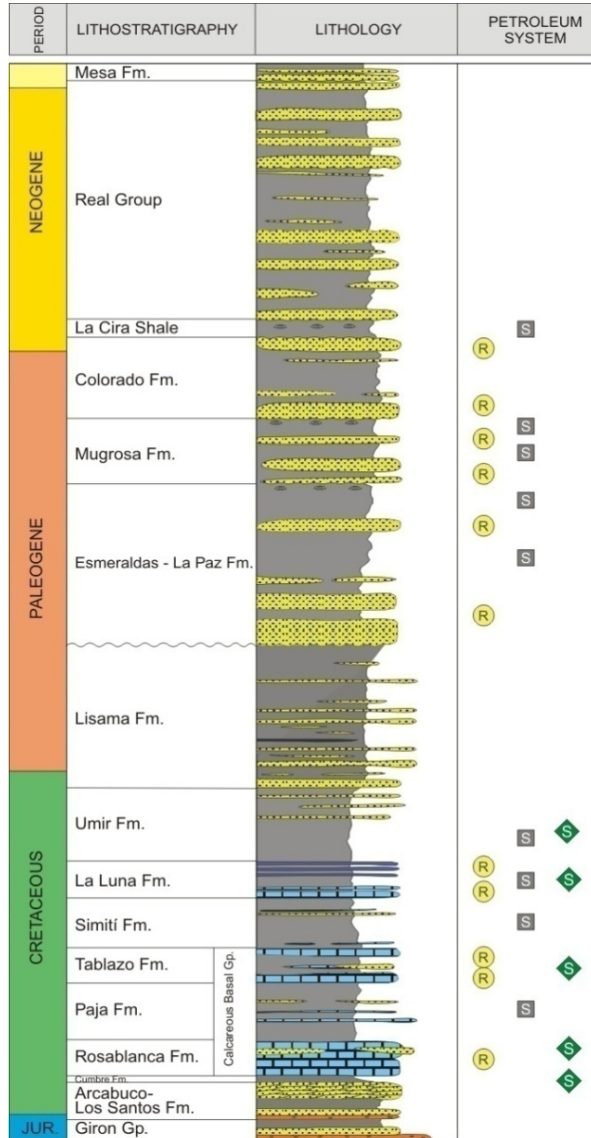
Colombia Has Reservoirs!



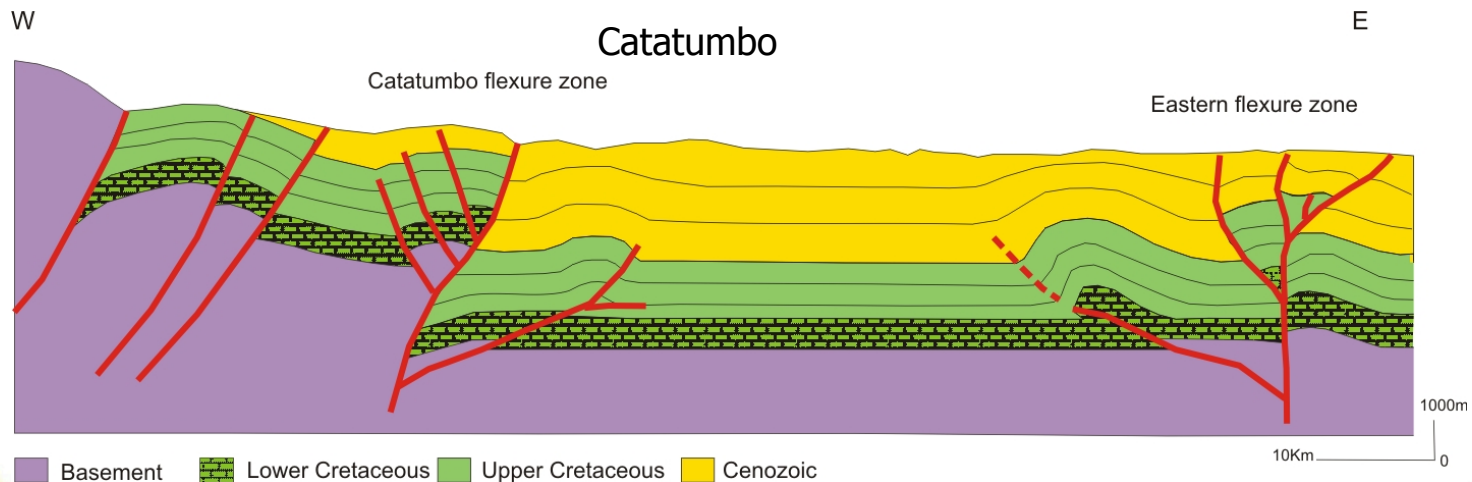
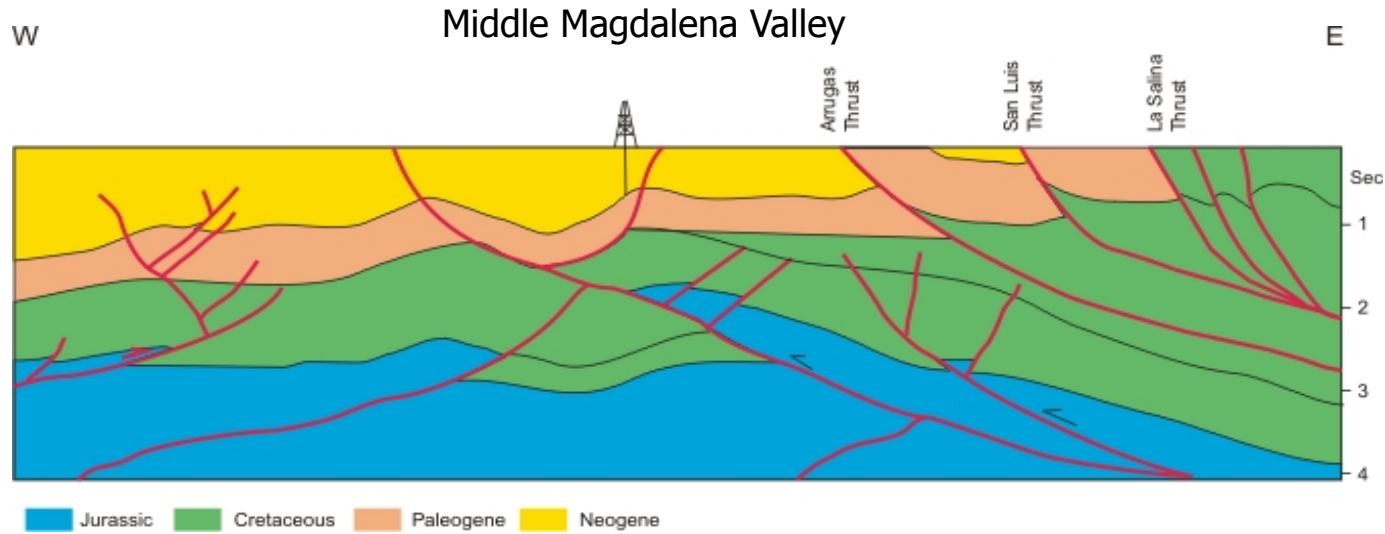
FOR CONVENTIONAL HC

Middle Magdalena Basin Reservoirs

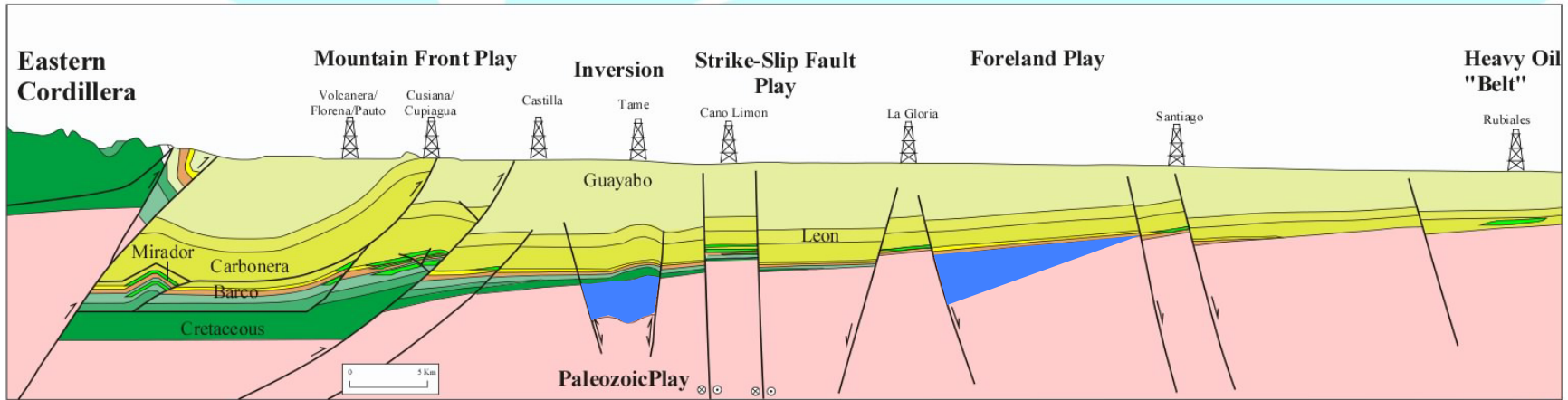
<p>Colorado Fm. Mugrosa Fm. Esmeralda Fm. La Paz Fm. Lisama Fm.</p>	<p>Sandstones Porosity: 15 – 20% Permeability: 20 – 600 md</p>
<p>La Luna Fm. Tablazo Fm. Rosablanca Fm.</p>	<p>Fractured Limestone</p>



Colombia Has a Wide Variety of Structural Styles



Colombia Has a Wide Variety of Structural Styles

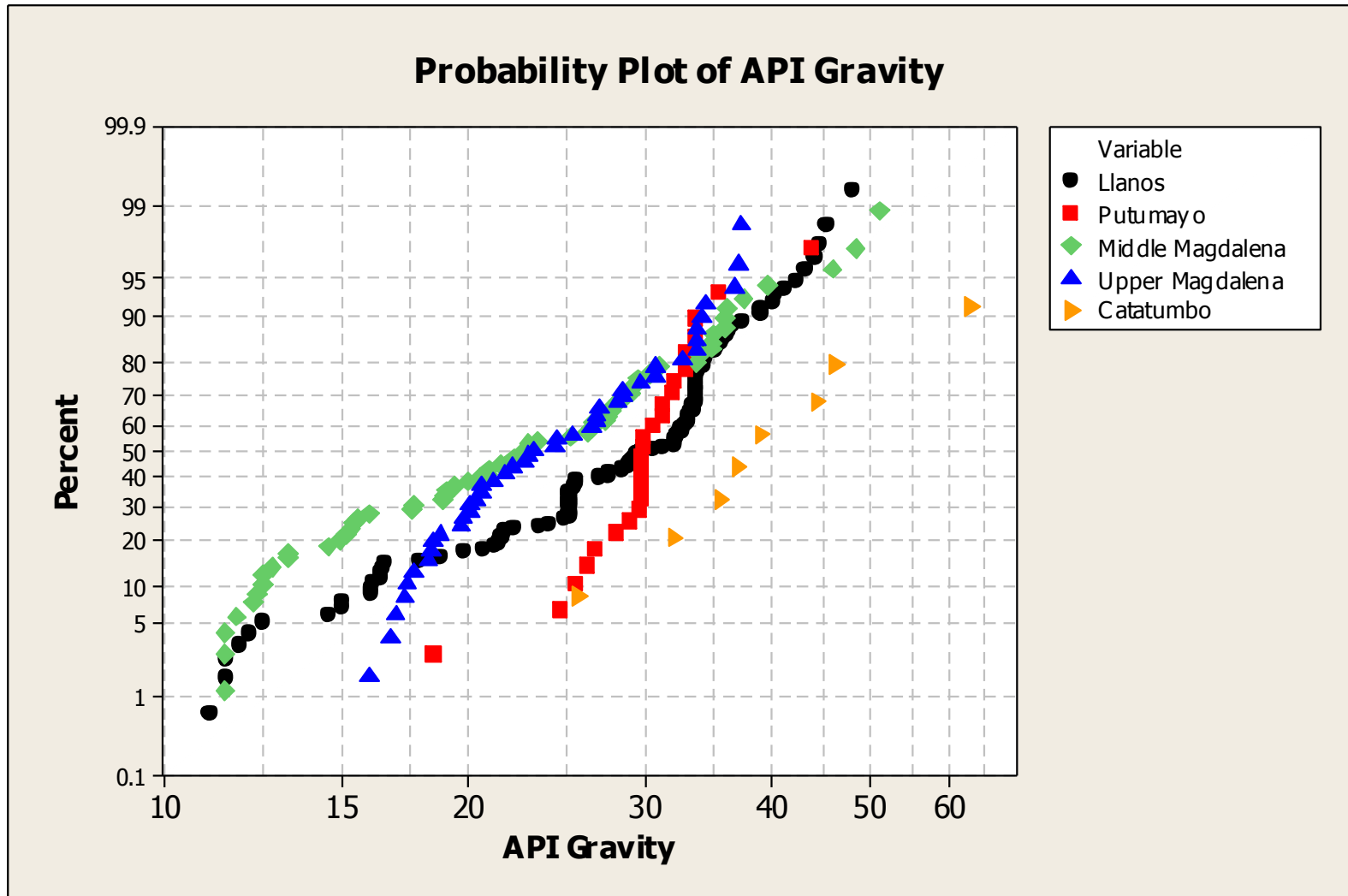


Generalized cross section for the Llanos Basin

Trap styles within Llanos Basin

- ▶ Antithetic normal faults
- ▶ Inversion structures
- ▶ Thrust – related anticlines
- ▶ Stratigraphic traps
- ▶ Fault-propagation folds
- ▶ Similar Paleozoic traps

Crude Oil Quality



Content

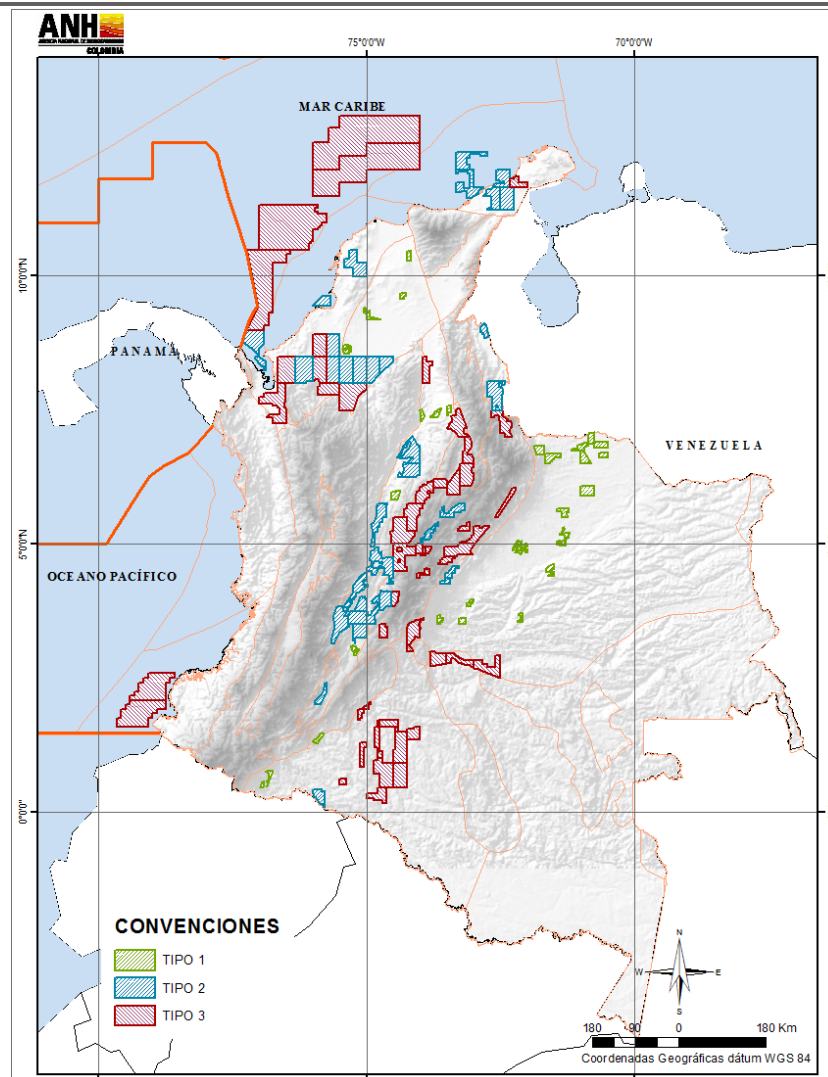


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Colombia Round 2012

	Onshore	Offshore
Type 1	29	
Type 2	29	5
Type 3	40	6
TOTAL	98	11

Type	2D Seismic (km)	Number of wells	Total (km ²)
Type 1	914	76	6,565
Type 2	1,644	186	35,913
Type 3	438	23	92,297
TOTAL	2,996	285	134,775



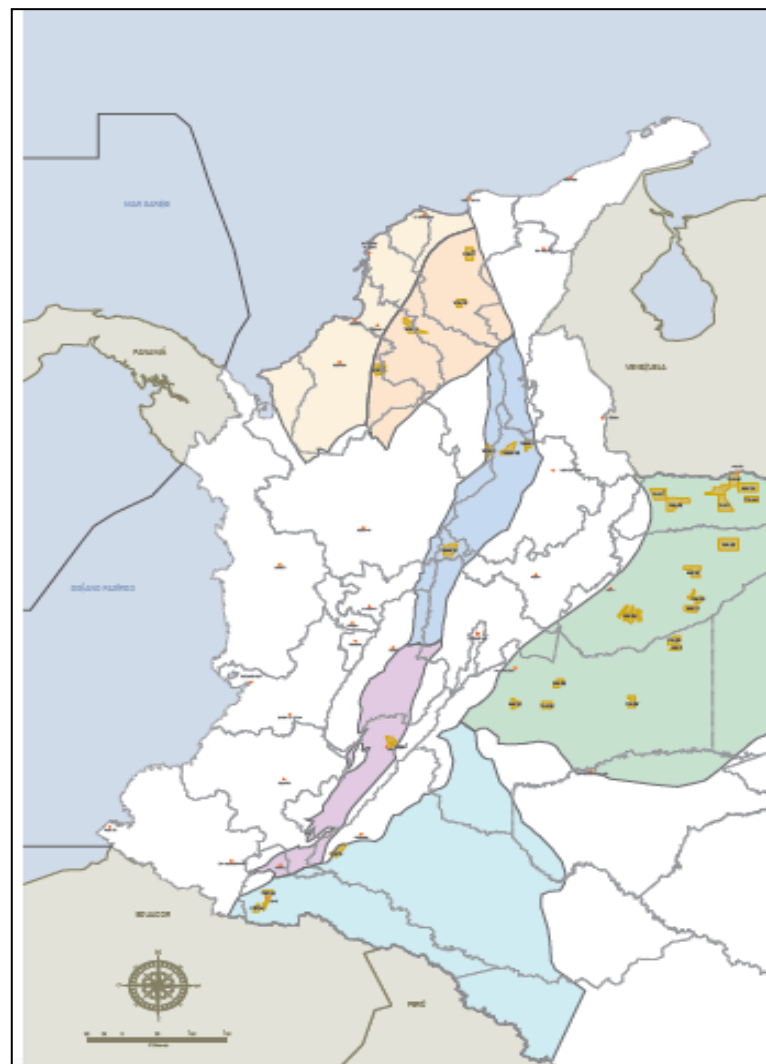
Type 1 Blocks

- ✓ Blocks in mature areas.
- ✓ E&P contracts

Type 1		
Blocks	Total Area (km ²)	Area Range (km ²)
29	6,565	76 – 573

Seismic lines	Wells
Seismic 2D (km)	Number of wells
914	76

Basins (5)
<ul style="list-style-type: none"> • Lower Magdalena Valley • Middle Magdalena Valley • Upper Magdalena Valley • Caguán-Putumayo • Llanos



Type 2 Blocks

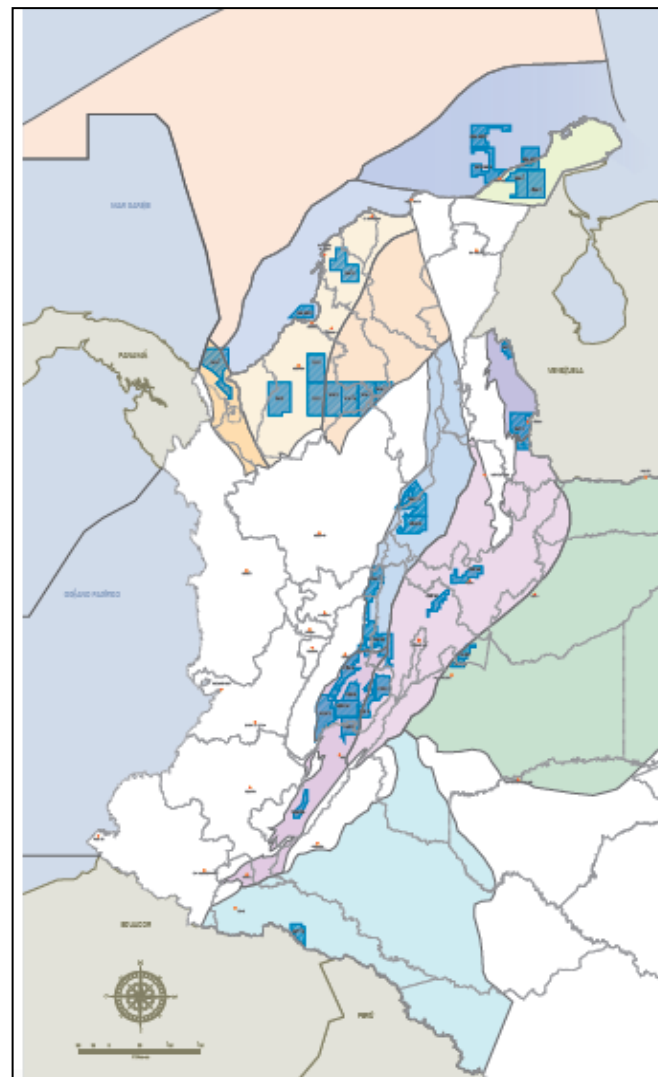
- ✓ Blocks with emerging prospectivity.
- ✓ E&P contracts.

Type 2		
Blocks	Total Area (km ²)	Area Range (km ²)
34	35,913	227 – 1,954

Seismic Lines	Wells
Seismic 2D (km)	Number of wells
1,644	186

Basins (12)

- | | |
|---|---|
| <ul style="list-style-type: none"> • Guajira • Guajira Offshore • Sinú Offshore • Urabá • Sinú-San Jacinto • Lower Magdalena Valley | <ul style="list-style-type: none"> • Middle Magdalena Valley • Upper Magdalena Valley • Caguán-Putumayo • Llanos • Eastern Cordillera • Catatumbo |
|---|---|



Type 3 Blocks

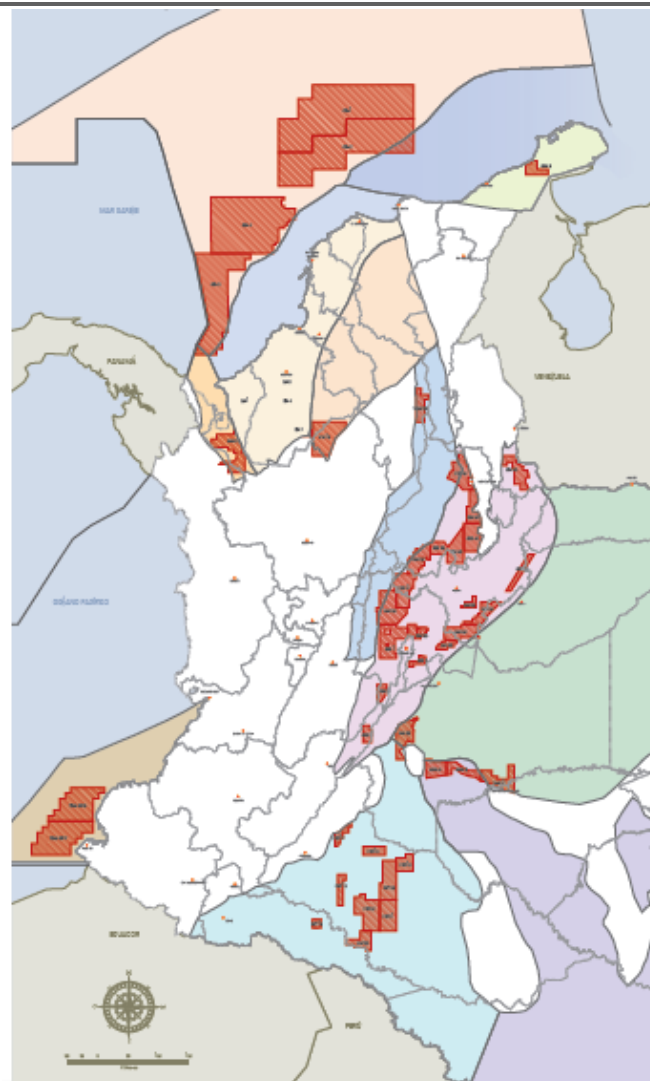
✓ Exploration Blocks in frontier areas for Technical Evaluation Agreements (TEA)

Type 3		
Blocks	Total Area (km ²)	Area Range (km ²)
46	92,297	186 – 14,275

Seismic Lines	Wells
Seismic 2D (km)	Number of wells
438	23

Basins (10)

- | | |
|---|---|
| <ul style="list-style-type: none"> • Guajira • Colombia • Urabá • Lower Magdalena Valley • Tumaco Offshore | <ul style="list-style-type: none"> • Vaupés-Amazonas • Middle Magdalena Valley • Caguán-Putumayo • Llanos • Eastern Cordillera |
|---|---|



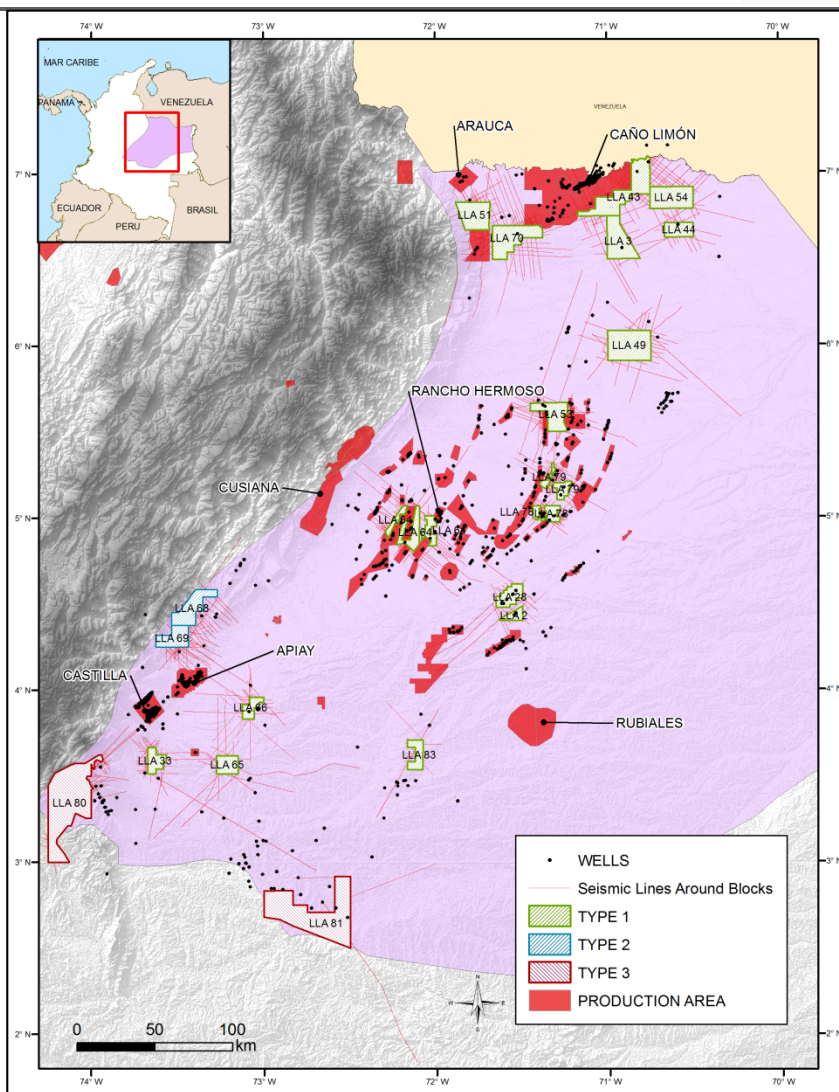
Content



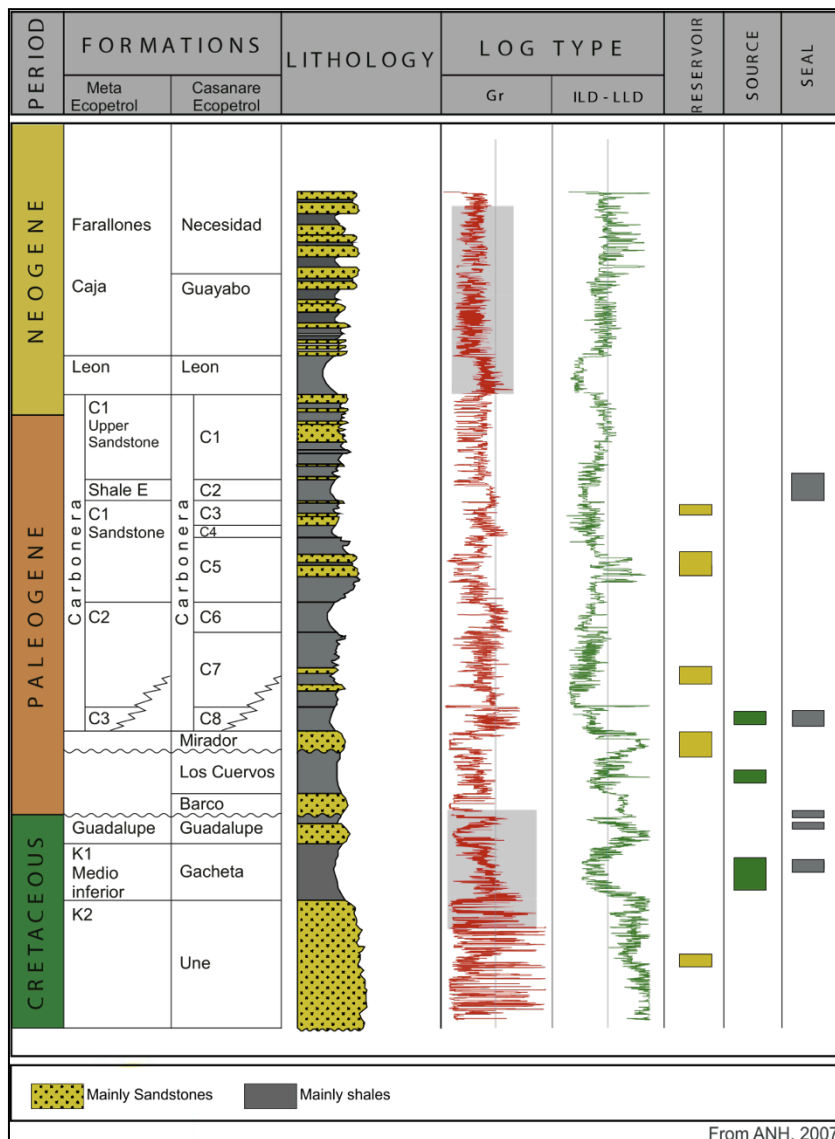
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Llanos Basin

- Mature in terms of exploration
- It is the country's most prolific basin.
- A preliminary assessment suggests that the basin is also prospective for *Shale Oil* and *Shale Gas*.



Llanos Basin

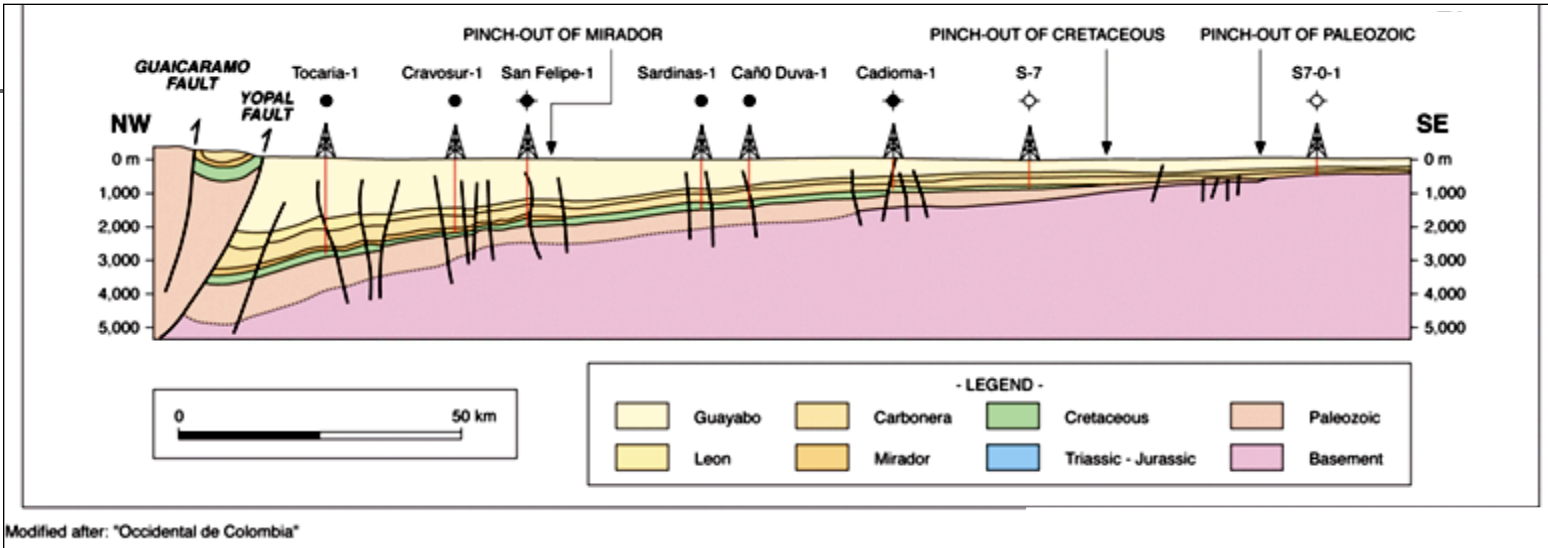


PETROLEUM SYSTEM

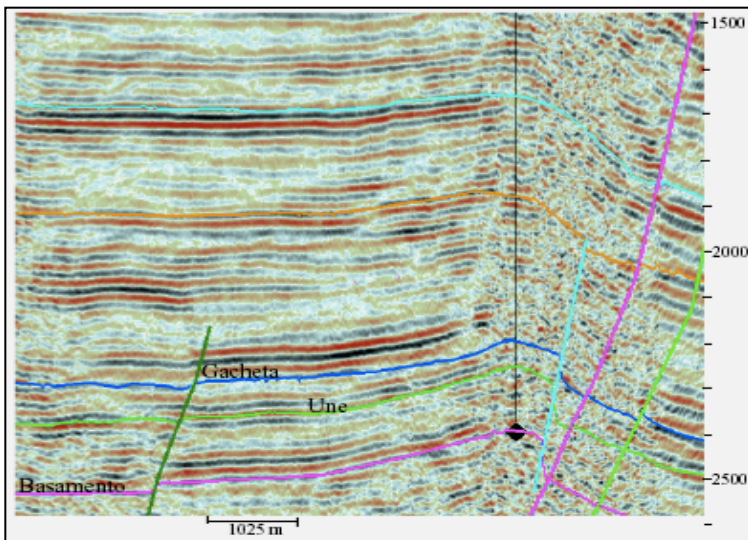
K (Gacheta) – **K** (Une)

K (Gacheta) – **P** (Mirador - Carbonera)

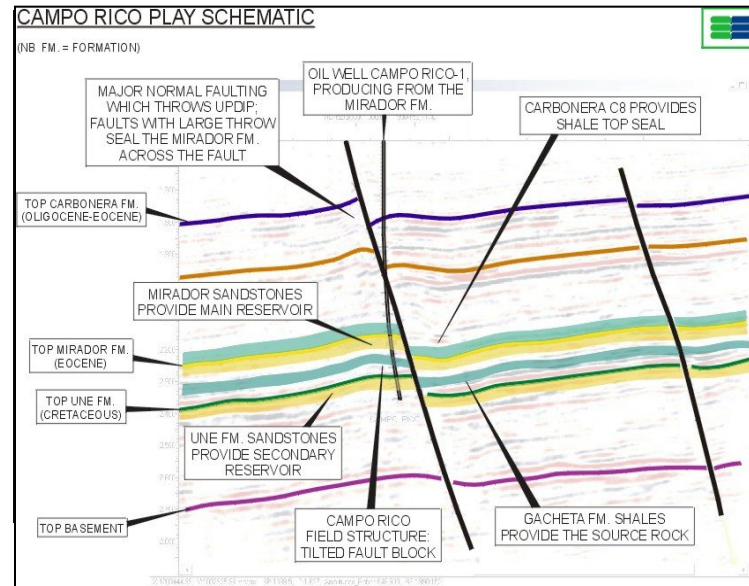
Structural Styles



Inversion structure

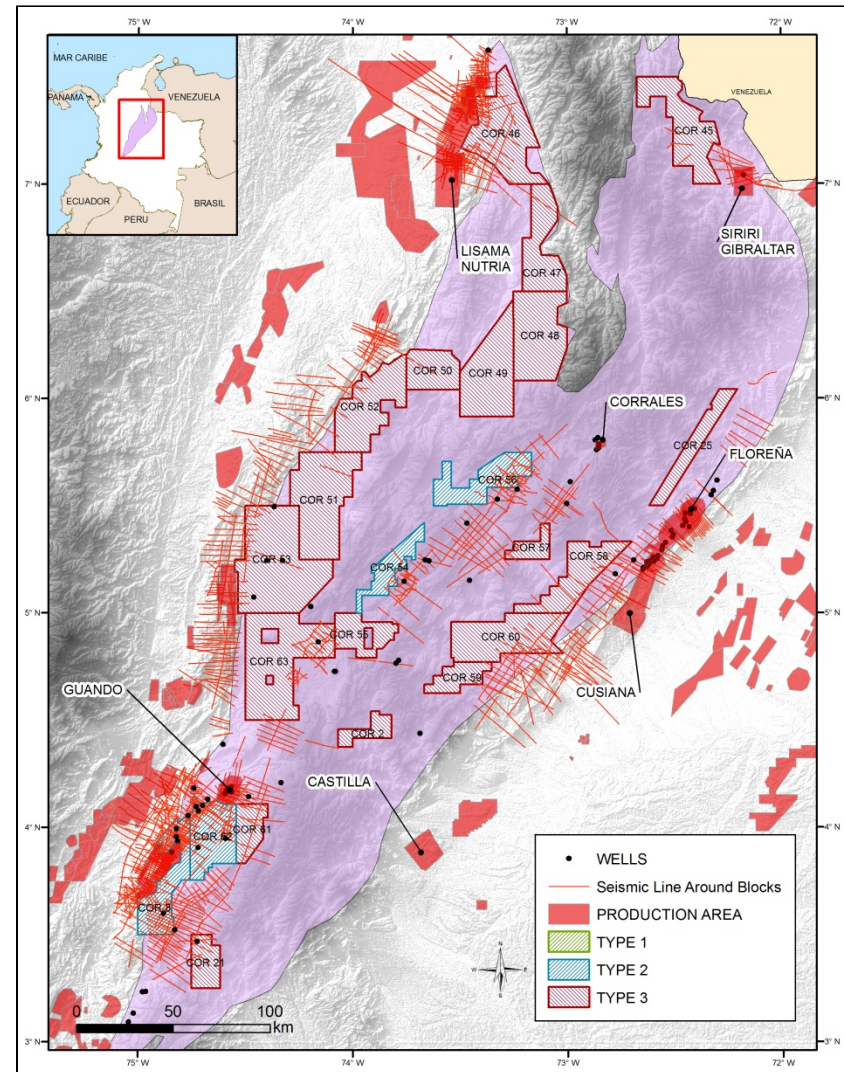


Antithetic normal fault



Eastern Cordillera Basin

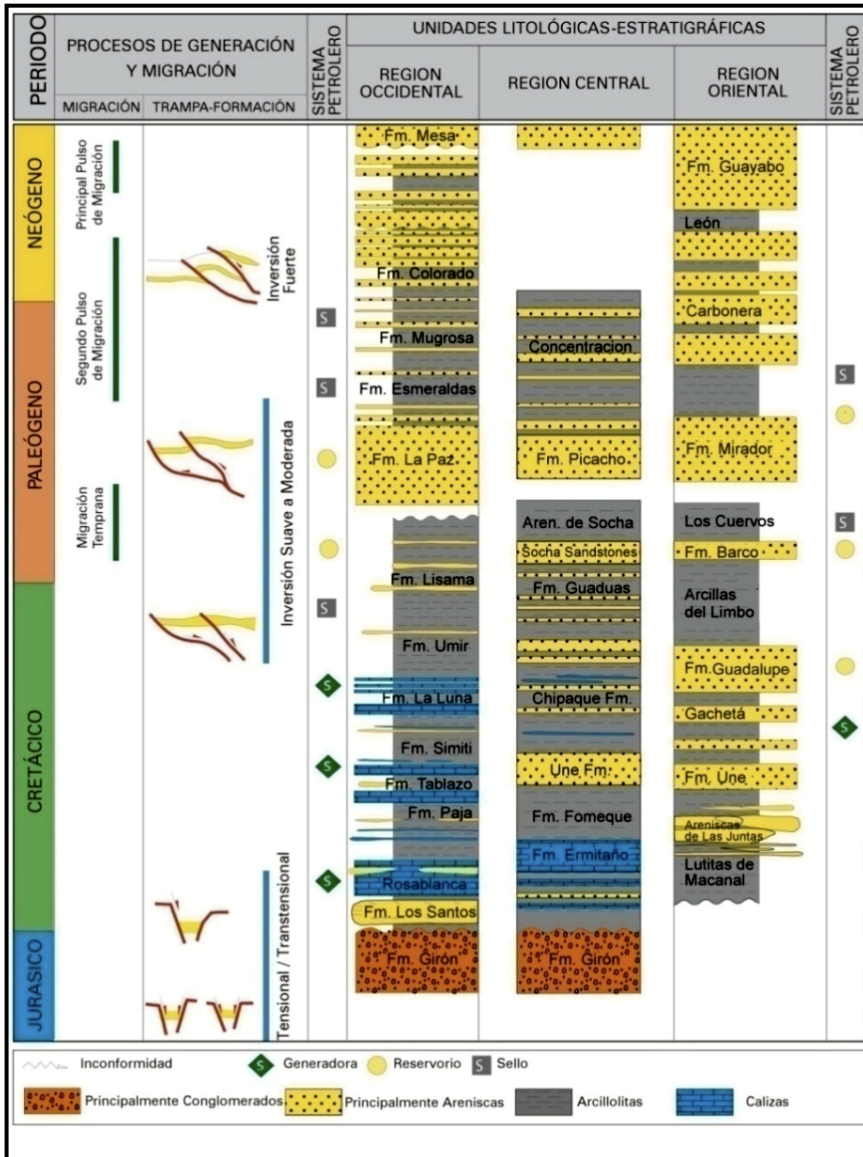
- Active petroleum system (Multiple seepage of liquid hydrocarbons)
- Excellent quality source rocks (Chipaque Fm= La Luna Fm)
- A preliminary assessment suggests that the basin is also prospective for *Shale Oil* and *Shale Gas*.



Eastern Cordillera Basin

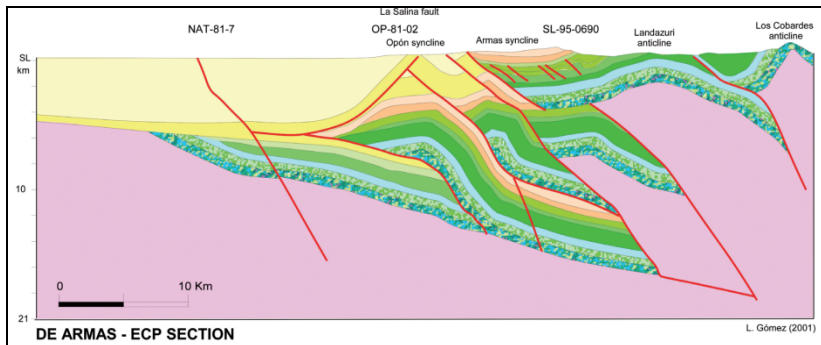
PETROLEUM SYSTEM

K (Gacheta- La Luna) – **K** (Guadalupe)
K (Gacheta- La Luna) – **P** (Barco-Mirador)

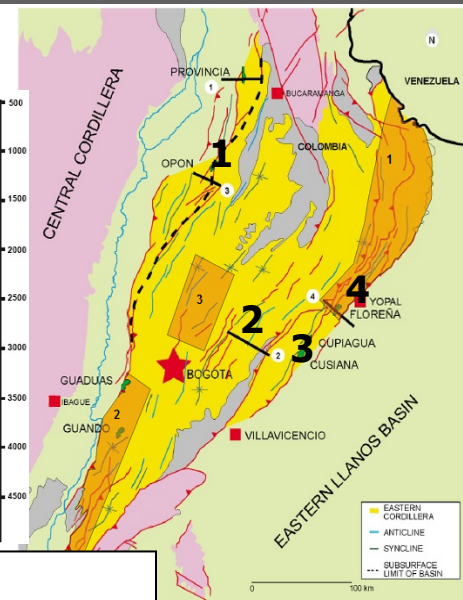
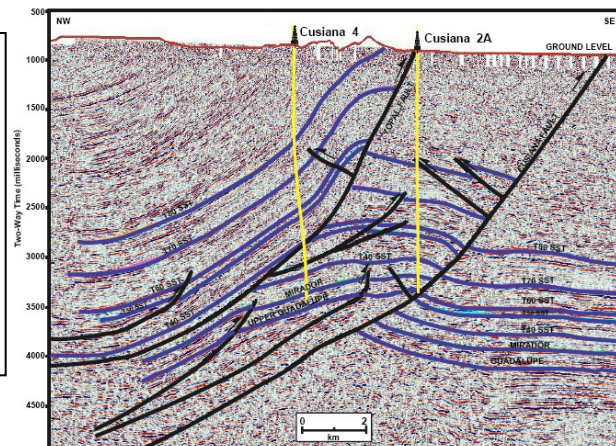


Structural Styles

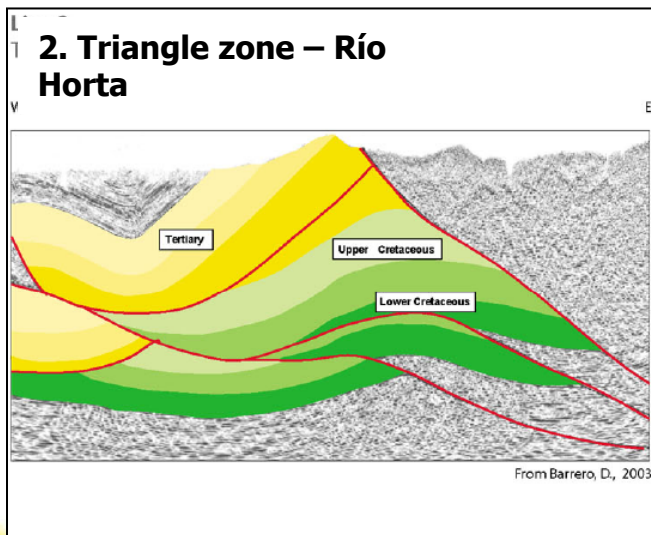
1. Sub thrust anticline



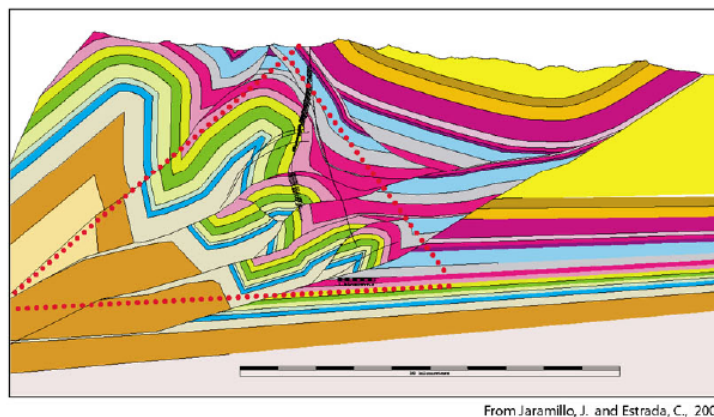
3. Cusiana field



2. Triangle zone – Río Horta

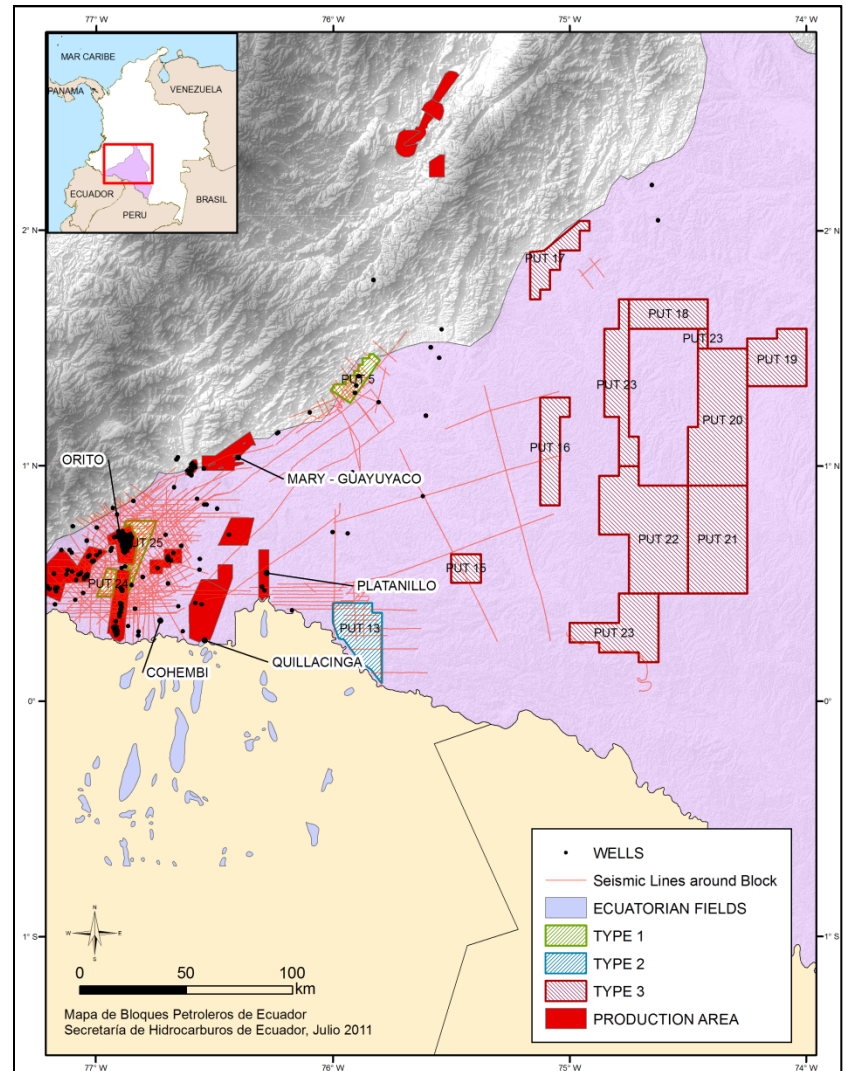


4. Duplex structure – Floreña area

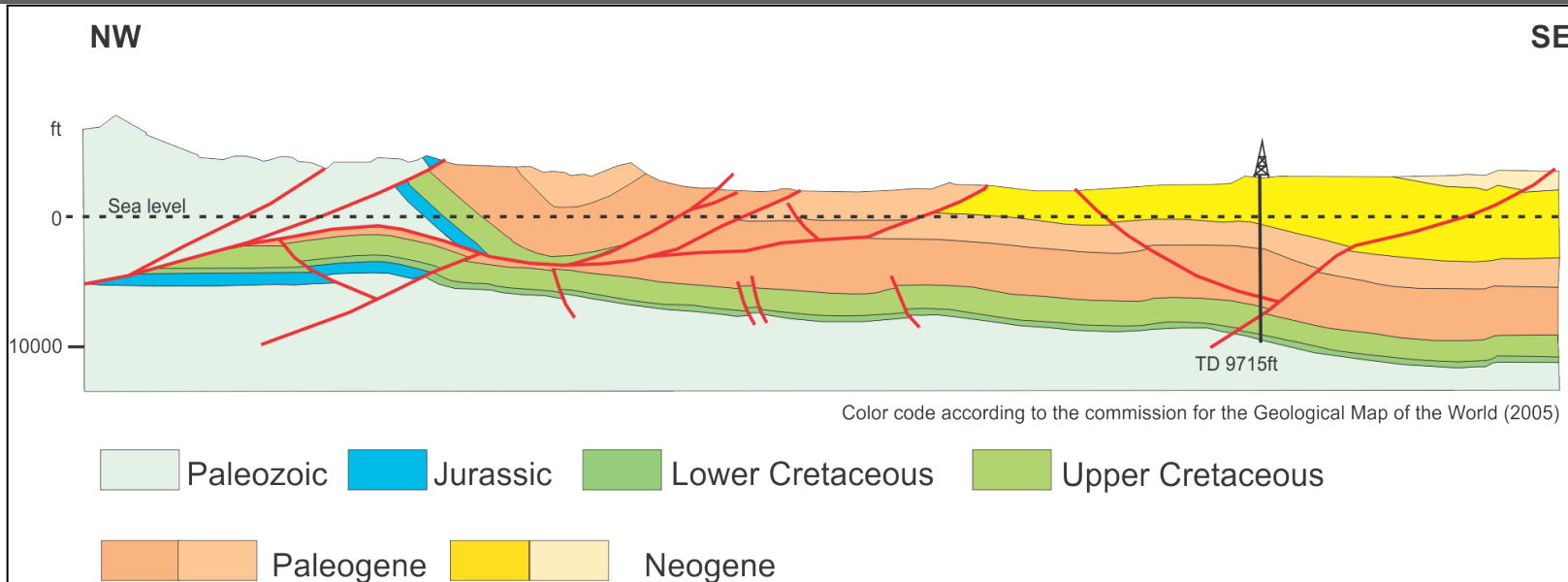


Caguán–Putumayo Basin

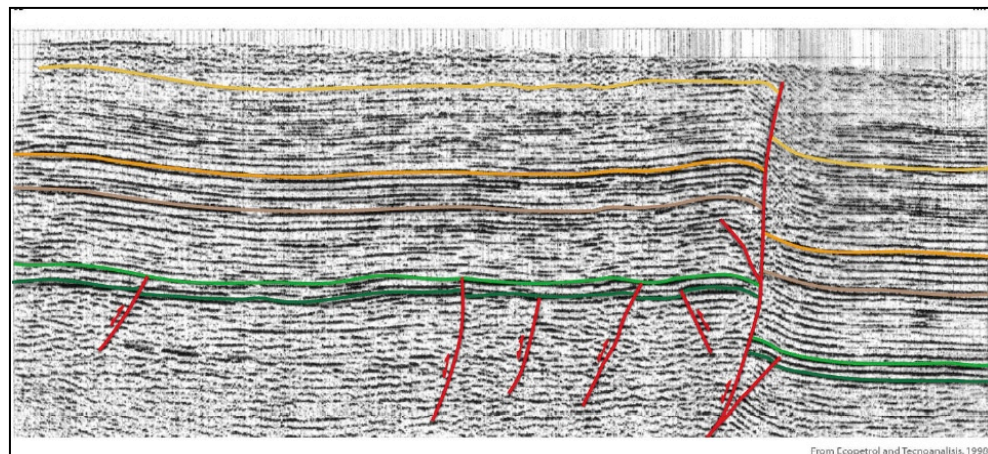
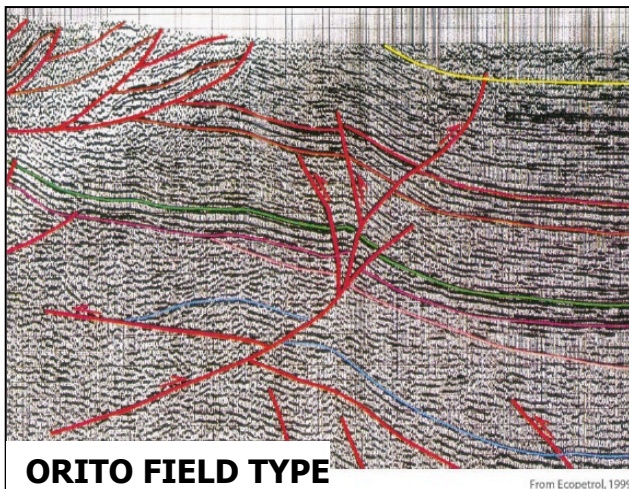
- Possible extension of the Llanos basin heavy oil belt.
- Possible petroleum system associated with Paleozoic rocks (Caguán Sub-basin)
- Excellent quality source rocks (Villeta Fm. and Caballos Fm.).



Structural Styles

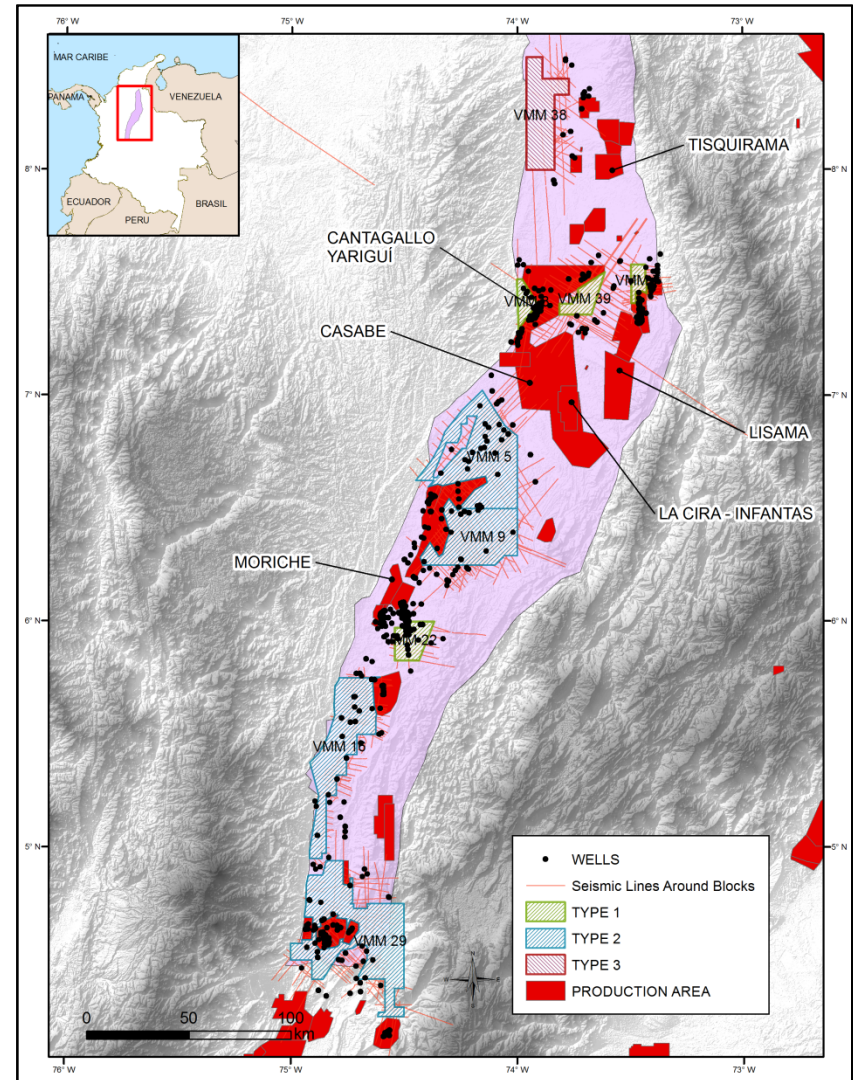


Inversion structure

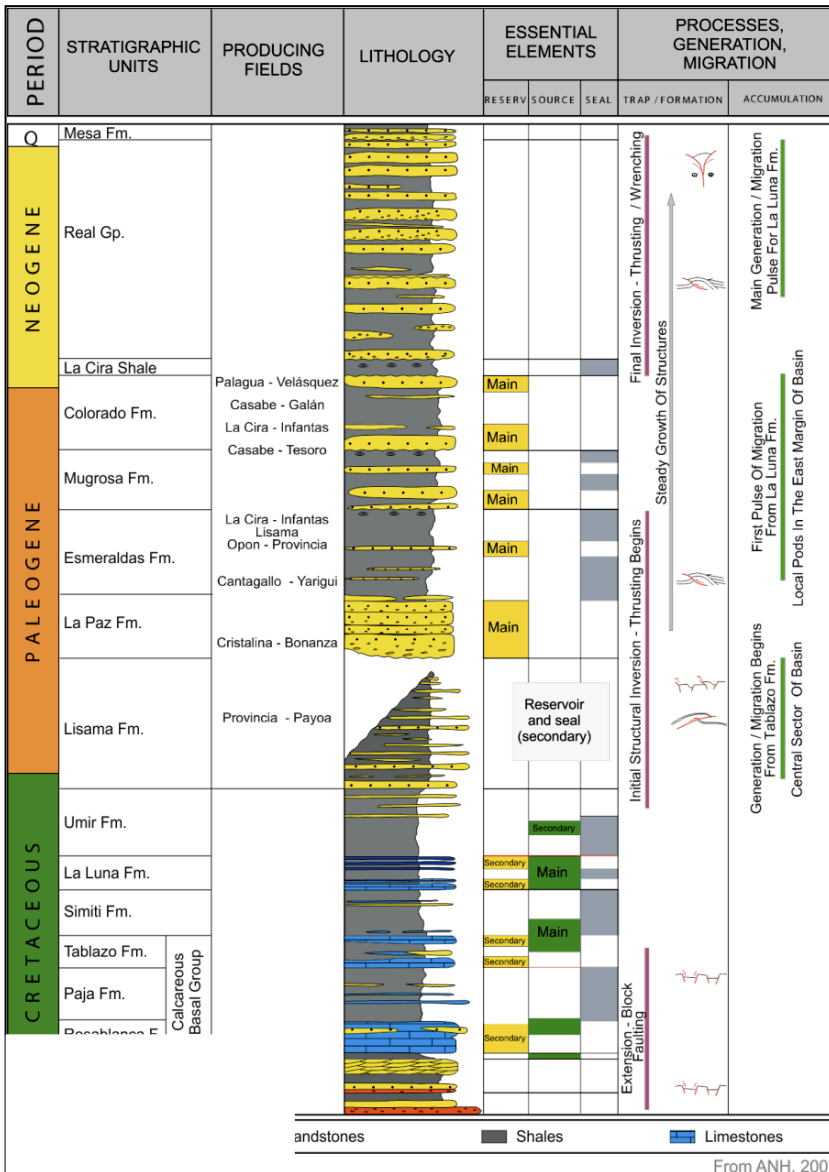


Middle Magdalena Valley Basin (VMM)

- It is a basin with further exploration in Colombia and one of the most prolific.
- Unexplored Cretaceous carbonates.
- A preliminary assessment suggests that the basin is also prospective for *Shale Oil* and *Shale Gas*.



Middle Magdalena Valley Basin (VMM)

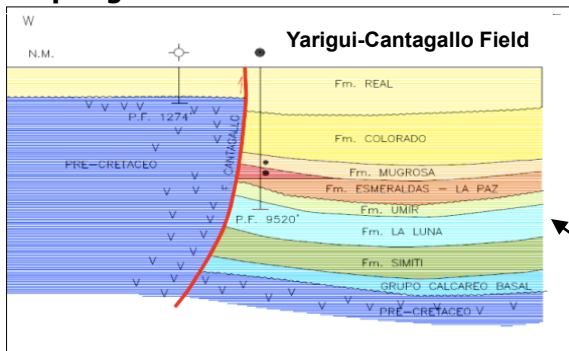


PETROLEUM SYSTEM

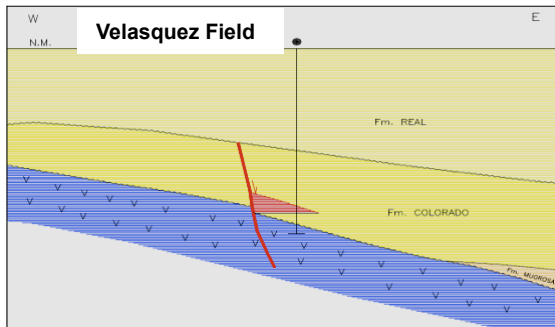
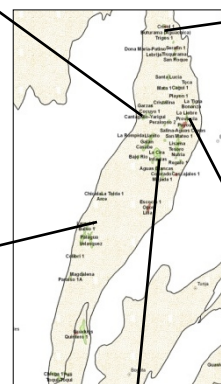
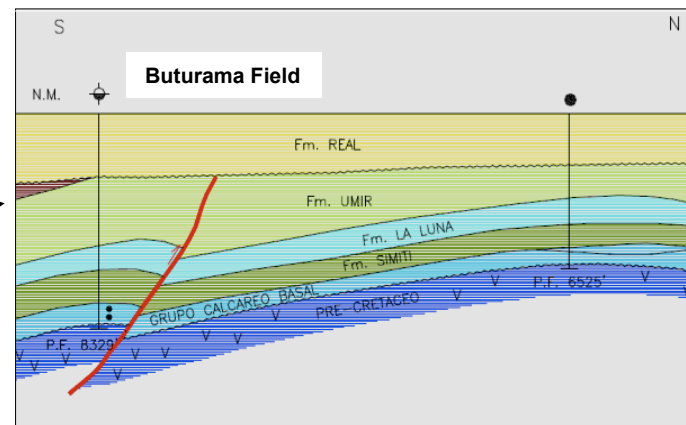
K (La Luna) – **P** (La Paz, Mugrosa, Colorado)

Structural Styles

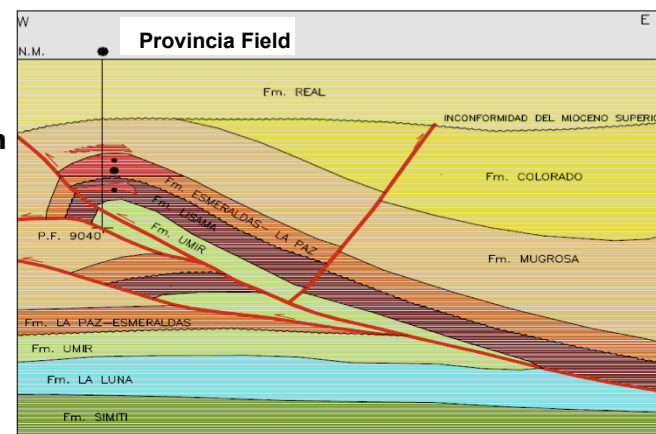
Faulted traps against basement of the Central Cordillera



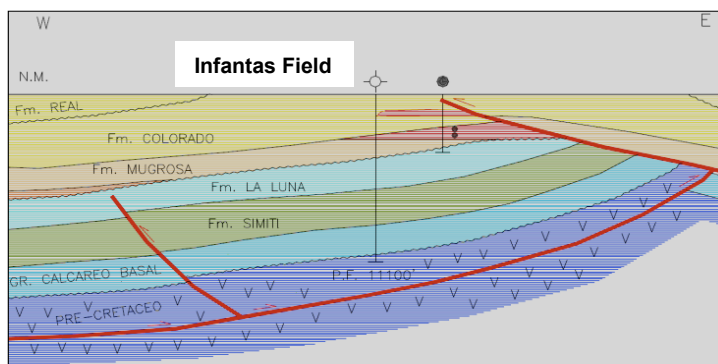
Lower Cretaceous fractured limestones



Fold Propagation Fault



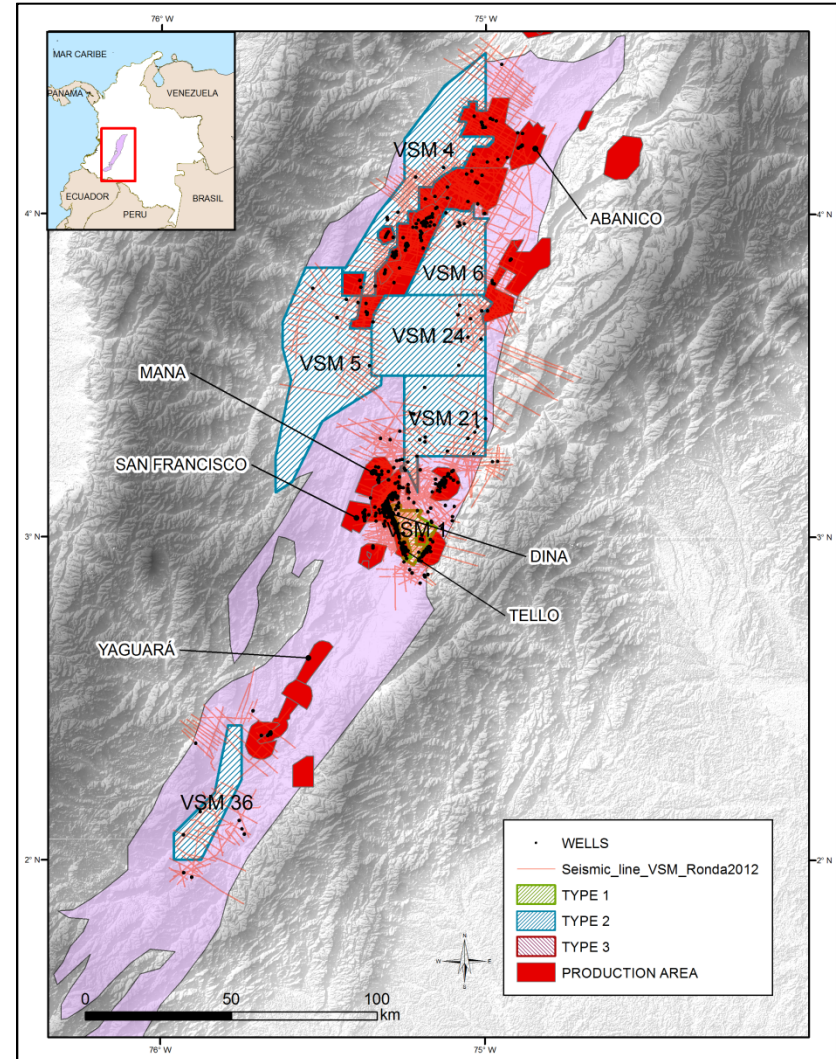
Subthrusts structures associated to Andean deformation



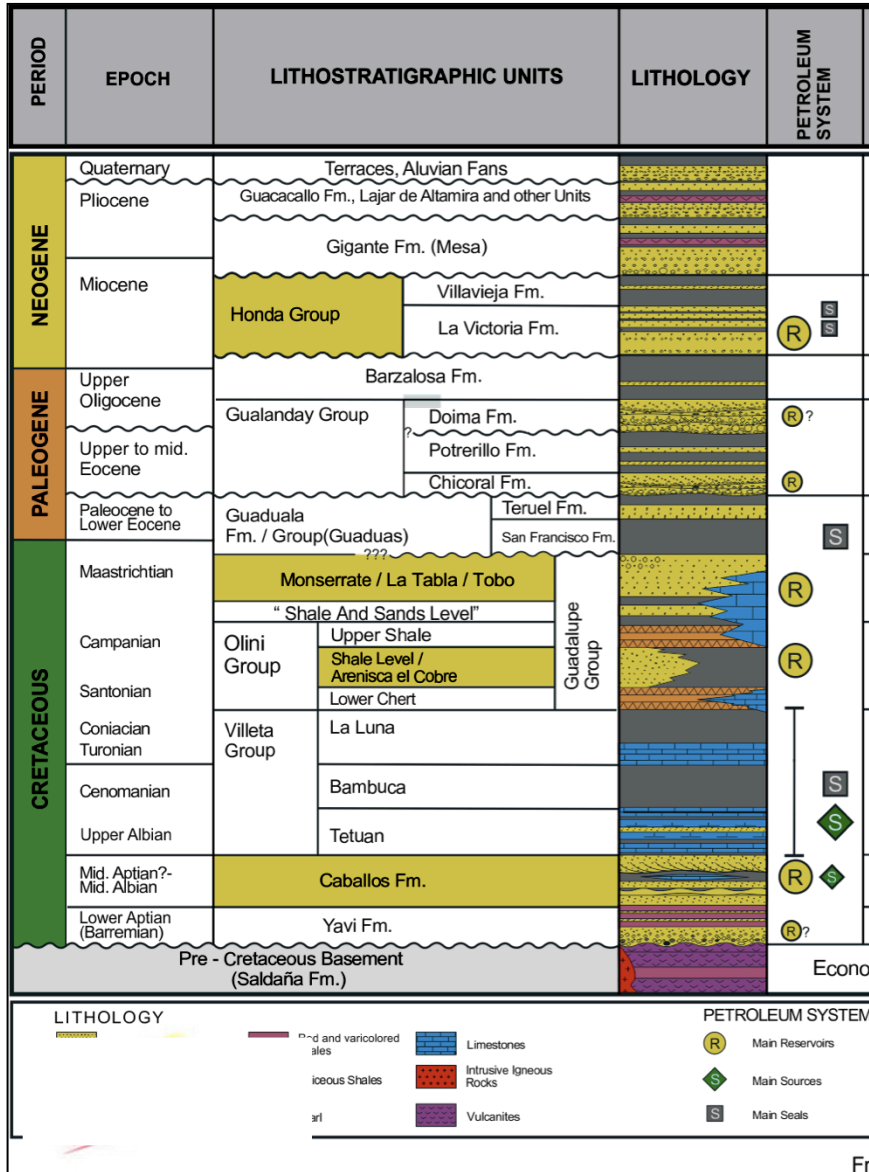
Normal fault traps - eastward dipping monocline

Upper Magdalena Valley Basin (VSM)

➤ A preliminary assessment suggests that the basin is also prospective for *Shale Oil* and *Shale Gas*.



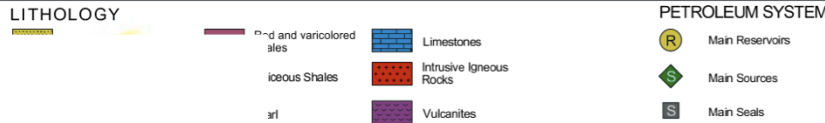
Upper Magdalena Valley Basin (VSM)



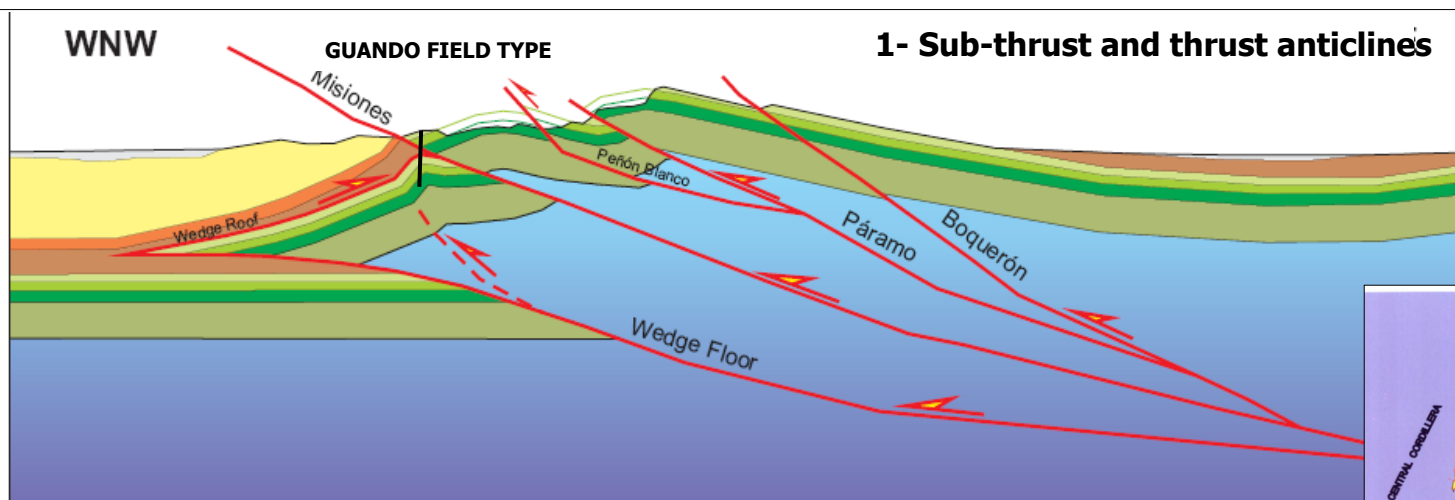
PETROLEUM SYSTEM

K (Caballos-Tetuan) – **K** (Caballos-Guadalupe)

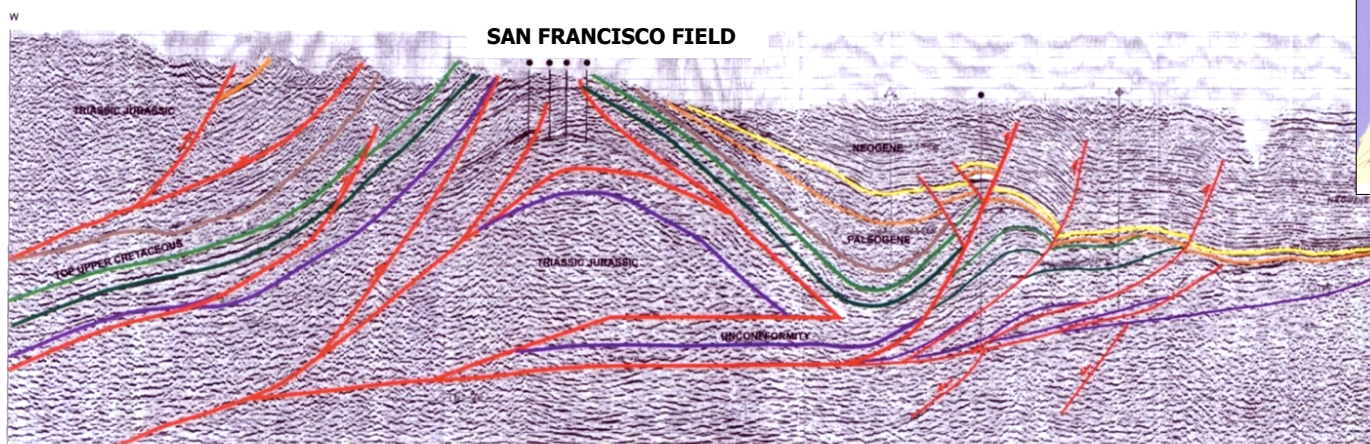
K (Caballos-Tetuan) – **P-N** (Gaulanday, Honda)



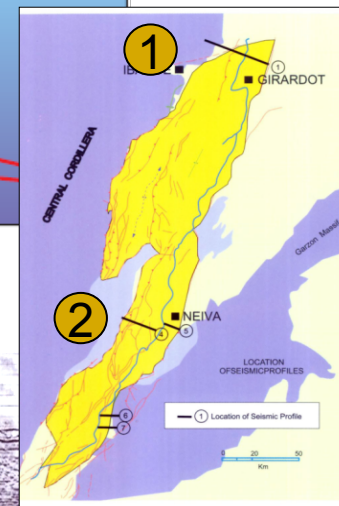
Structural Styles



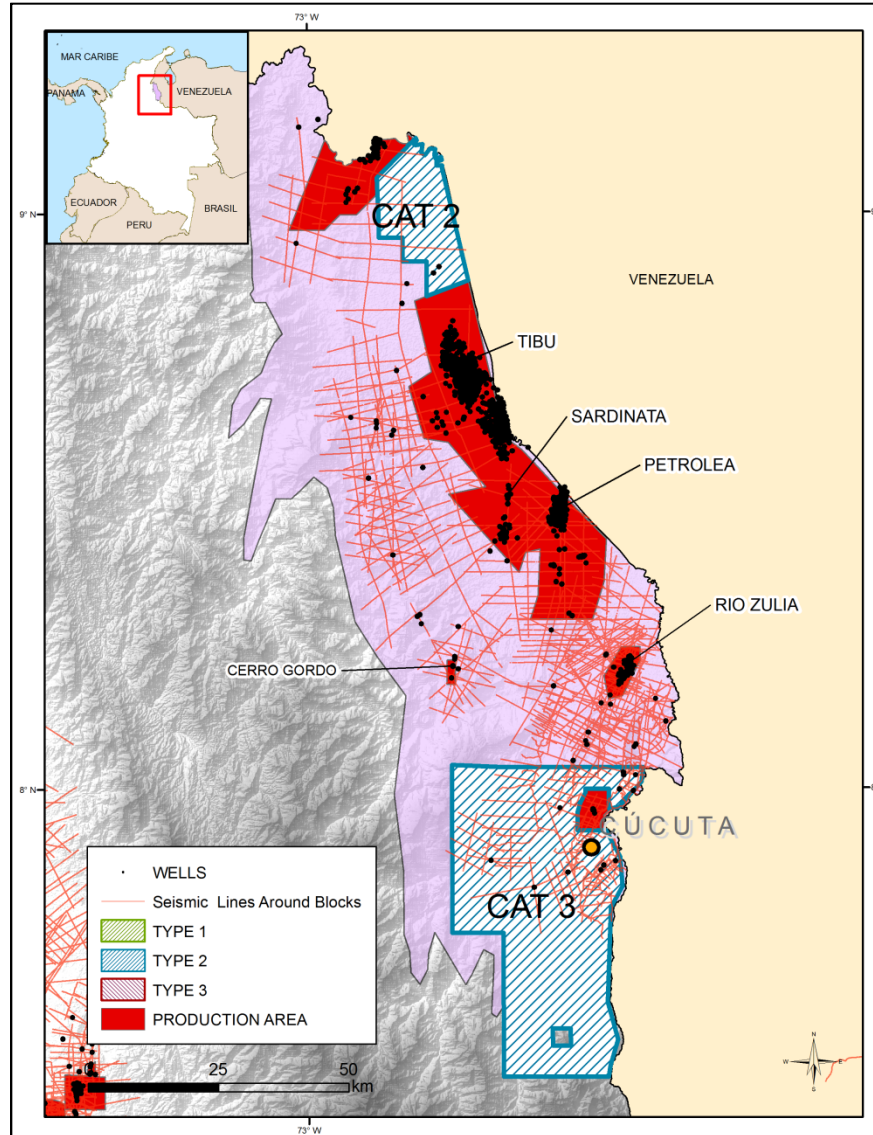
2- Fault Bend Fold and imbricate thrust fans



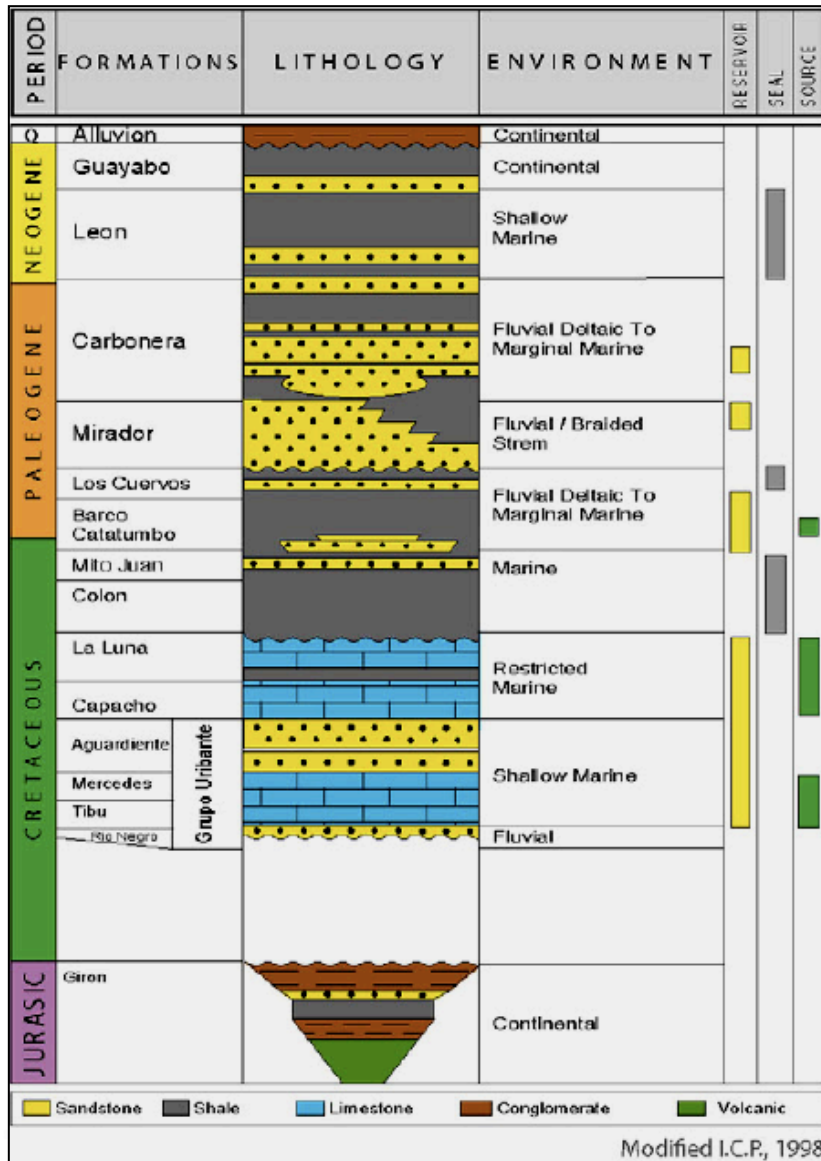
From Seismic Atlas, 1998



Catatumbo Basin (CAT)



Catatumbo Basin (CAT)



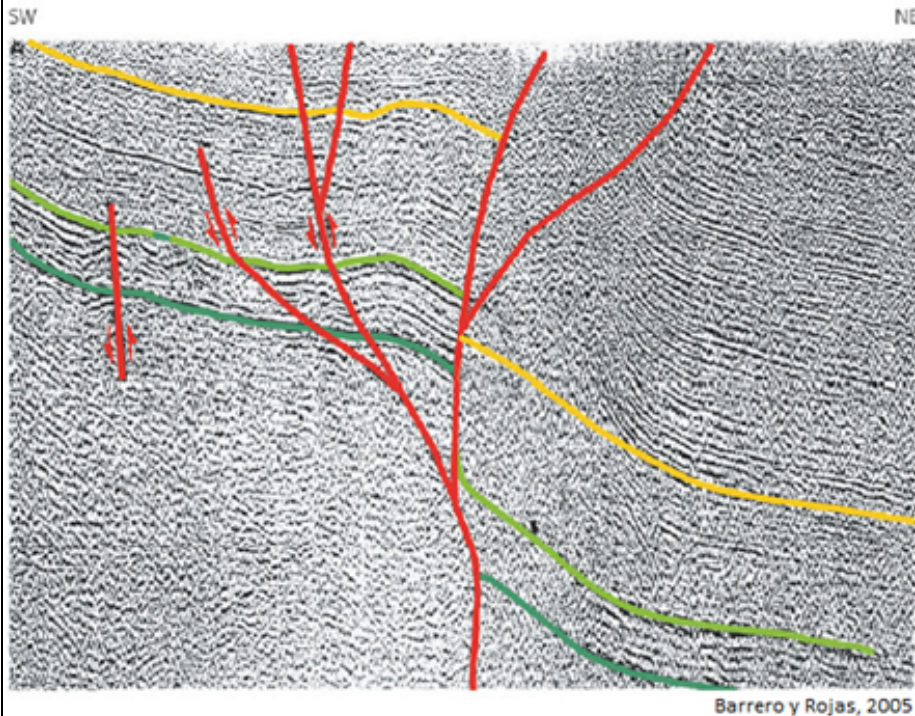
PETROLEUM SYSTEM

K (Uribante, La Luna) – **K** (Uribante, La Luna)

K (Uribante, La Luna) – **P** (Barco, Mirador, Carbonera)

Structural Styles

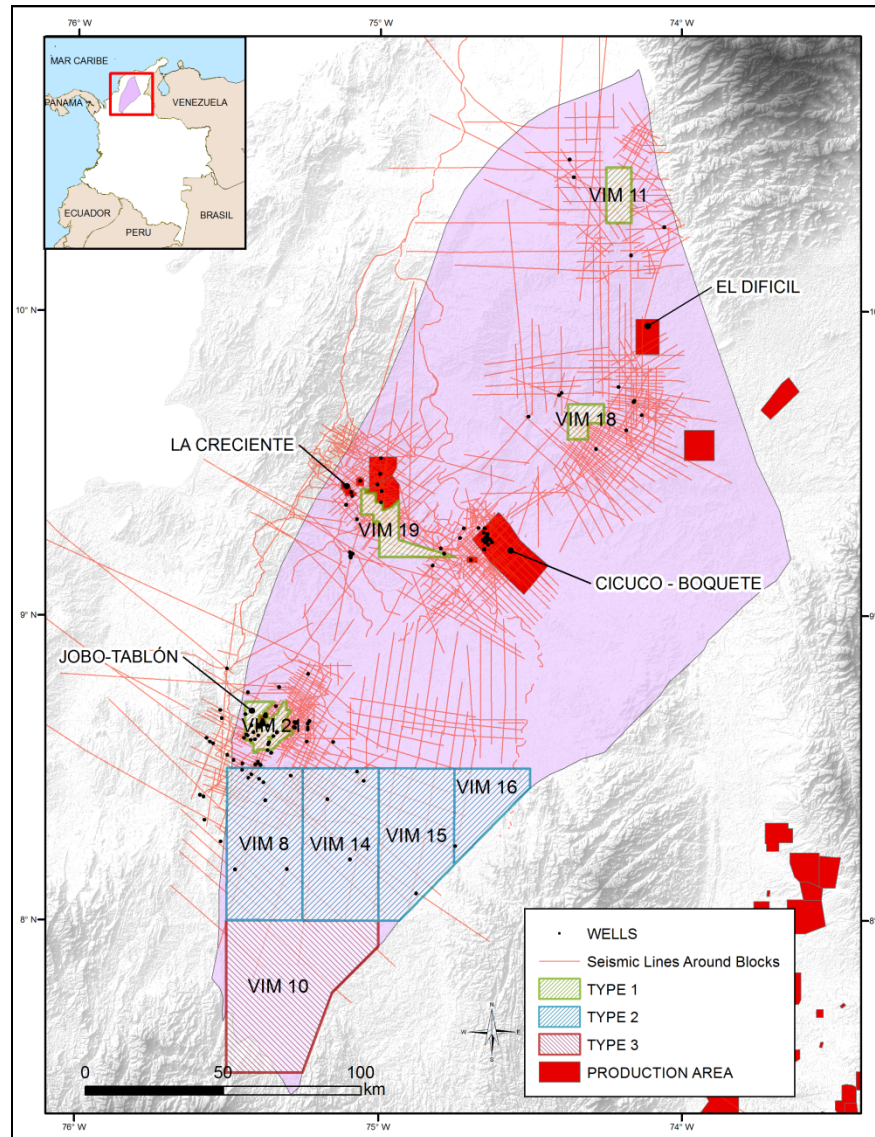
1- High and slow side closure against faults branch of inversion structure



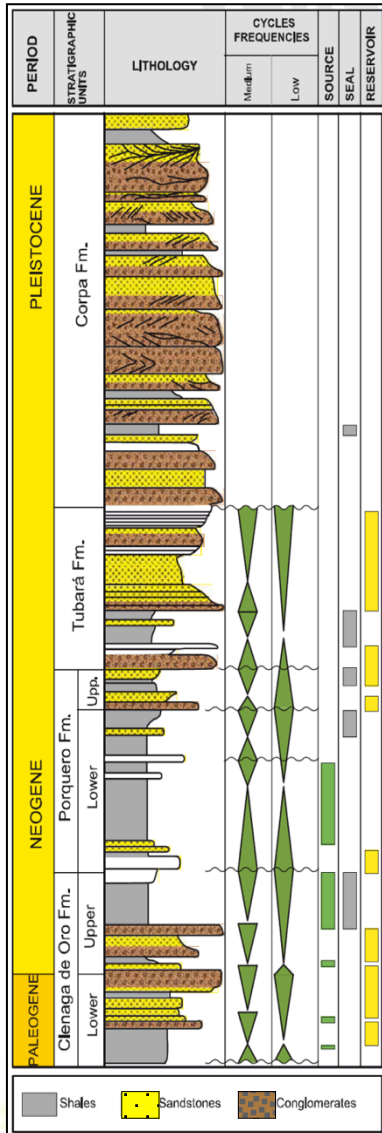
2- Wrench anticline trap



Lower Magdalena Valley (VIM)



Lower Magdalena Valley (VIM)



PETROLEUM SYSTEM

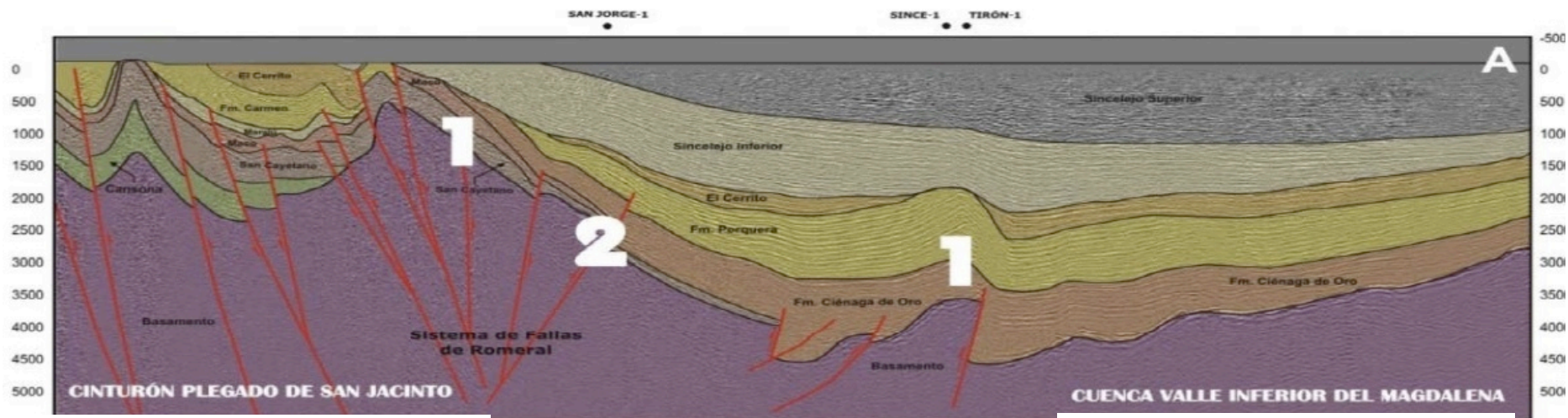
P (Ciénaga de Oro) – **N** (Ciénaga de Oro, Tubará)

N (Porquero) – **N** (Porquero, Tubará)

Barrero et al, 2008

Structural Styles

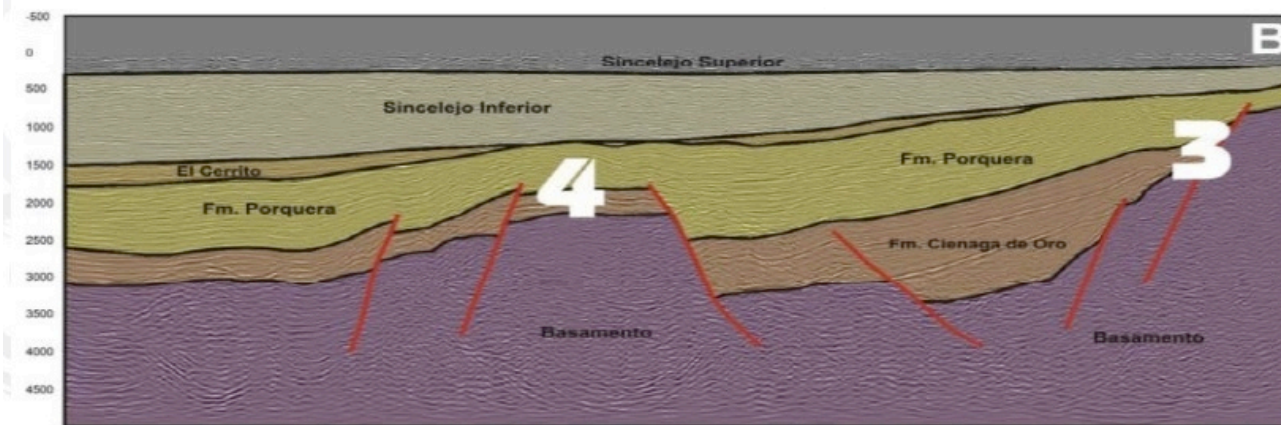
- 1- Inversion anticlines 2- Fault juxtaposition traps 3- Pinch-outs against basement 4- Basement High



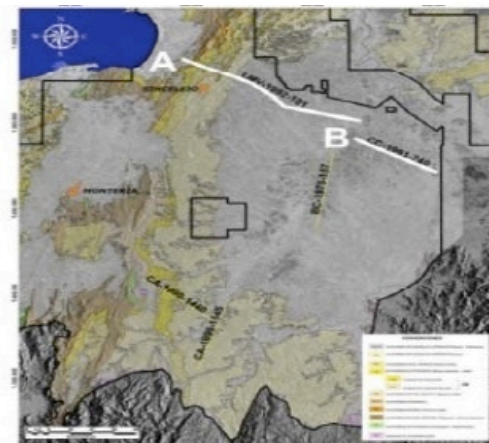
SAN JACINTO FOLD BELT

LMV-1992-101

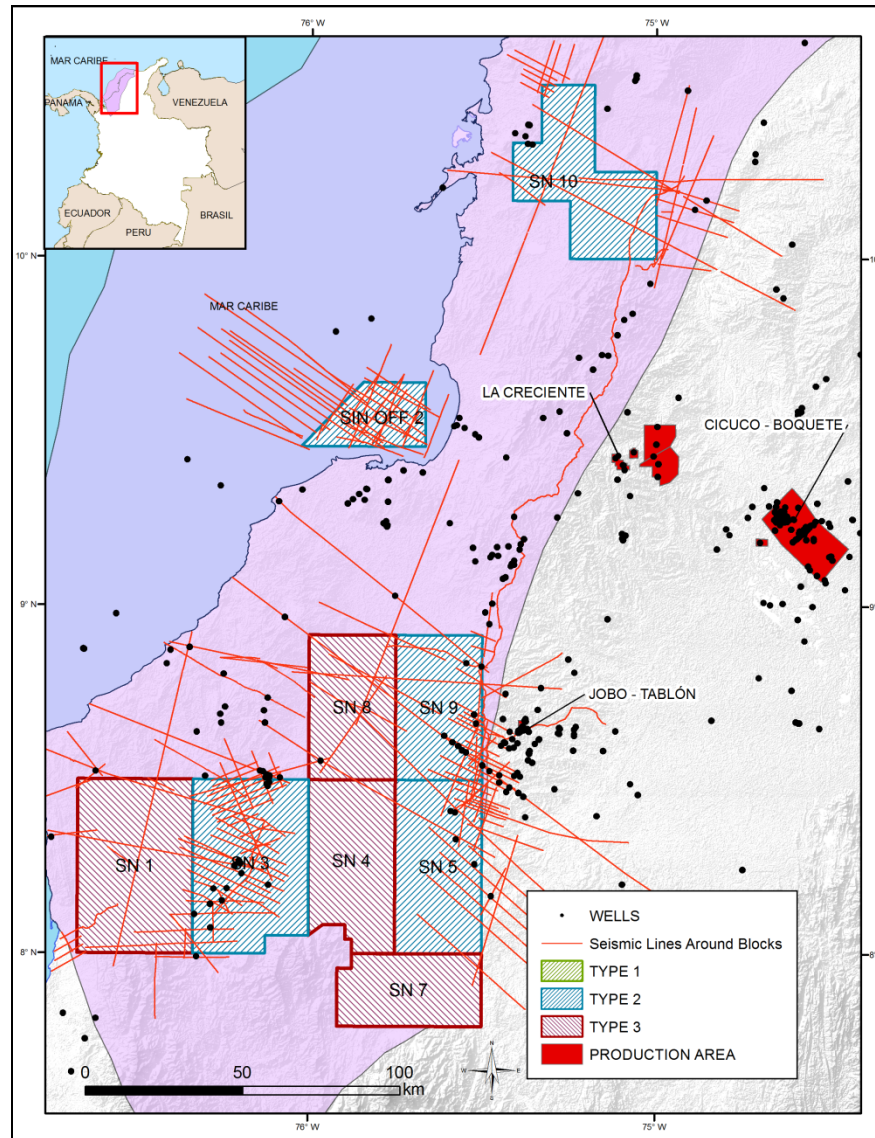
VIM BASIN



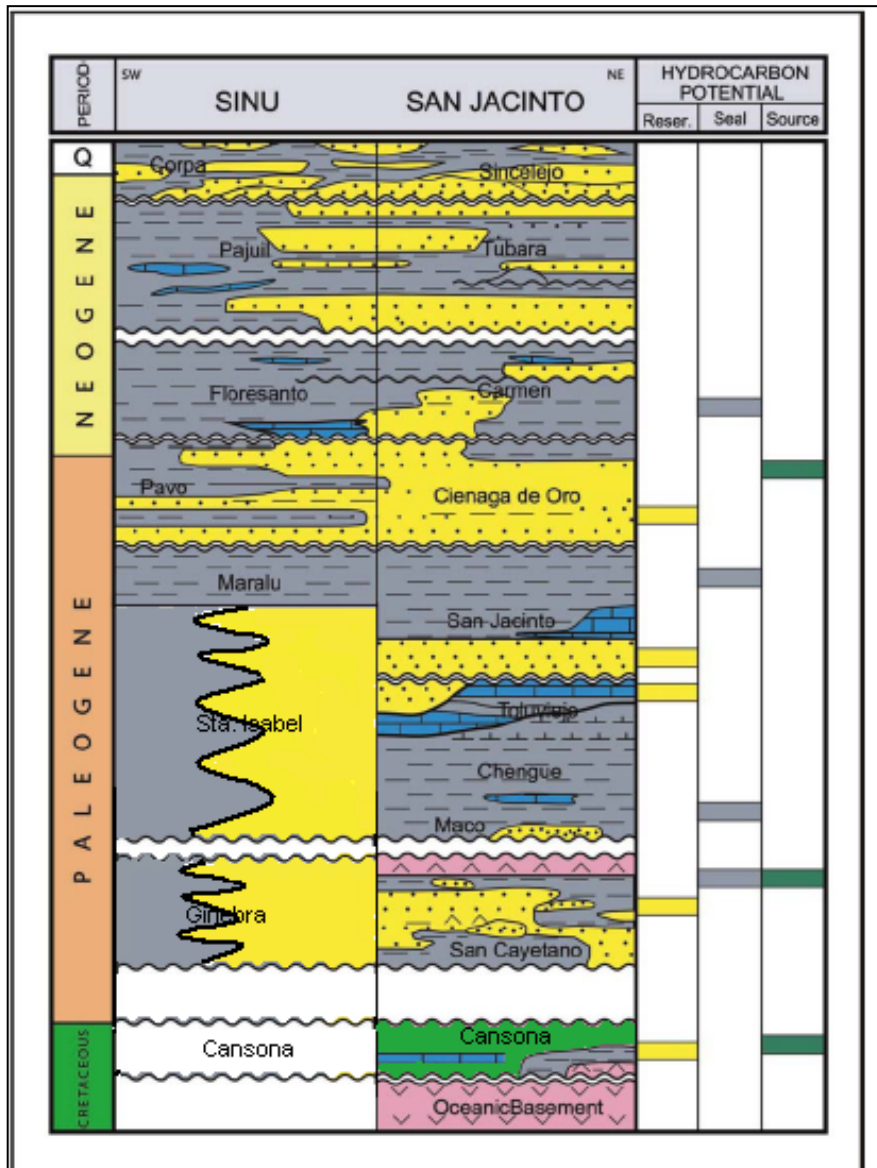
CC-1991-740



Sinú–San Jacinto Onshore and Sinú–San Jacinto Offshore Basins



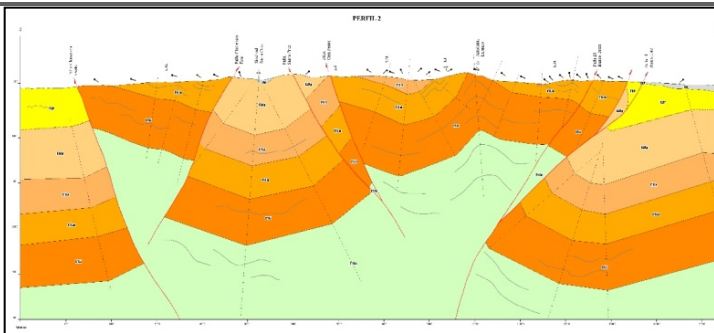
Sinú– San Jacinto Onshore and Sinú-San Jacinto Offshore Basins



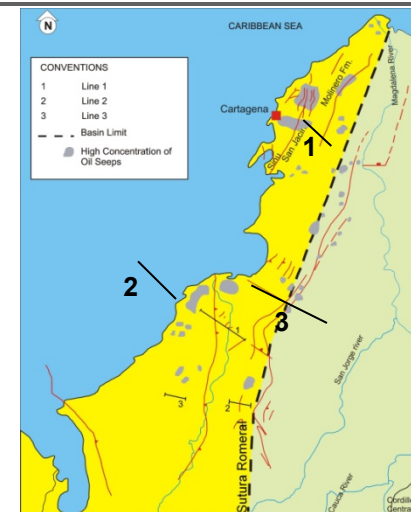
PETROLEUM SYSTEM

K? (?Cansona) – **P** (San Cayetano, Ciénaga de Oro)

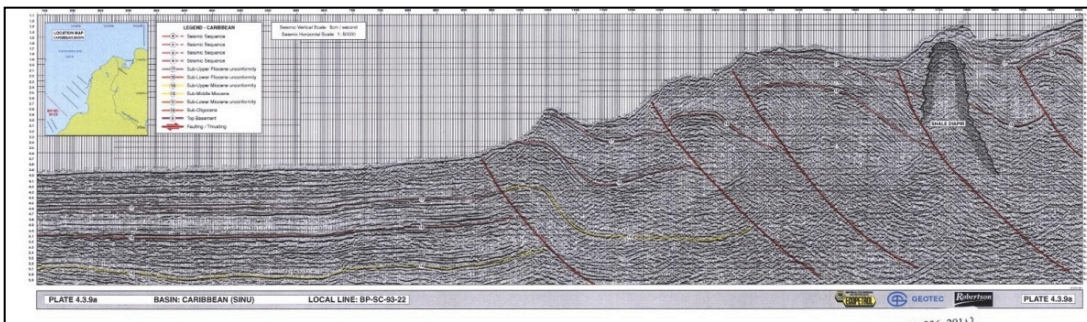
Structural Styles



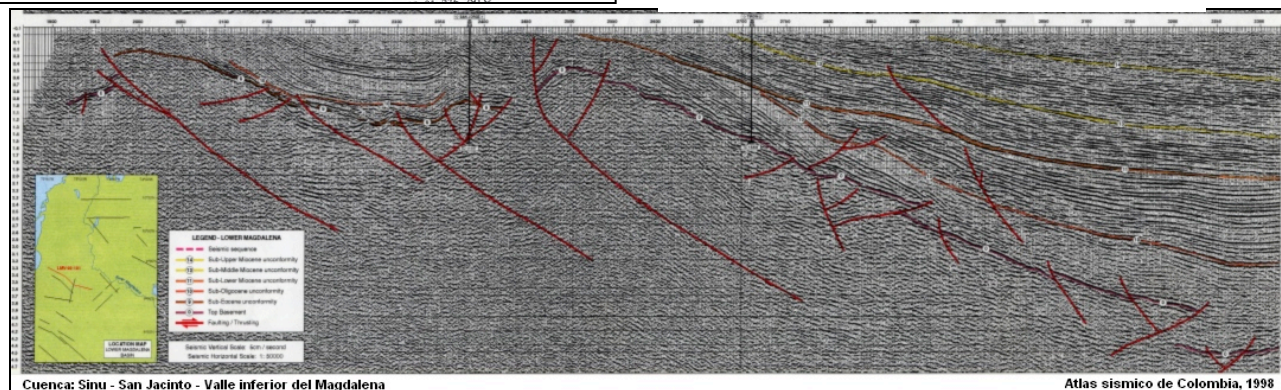
1- Wrench structure – San Jacinto Fold Belt



2- Fold propagation fault and diapiric structures - Sinu Fold Belt - offshore



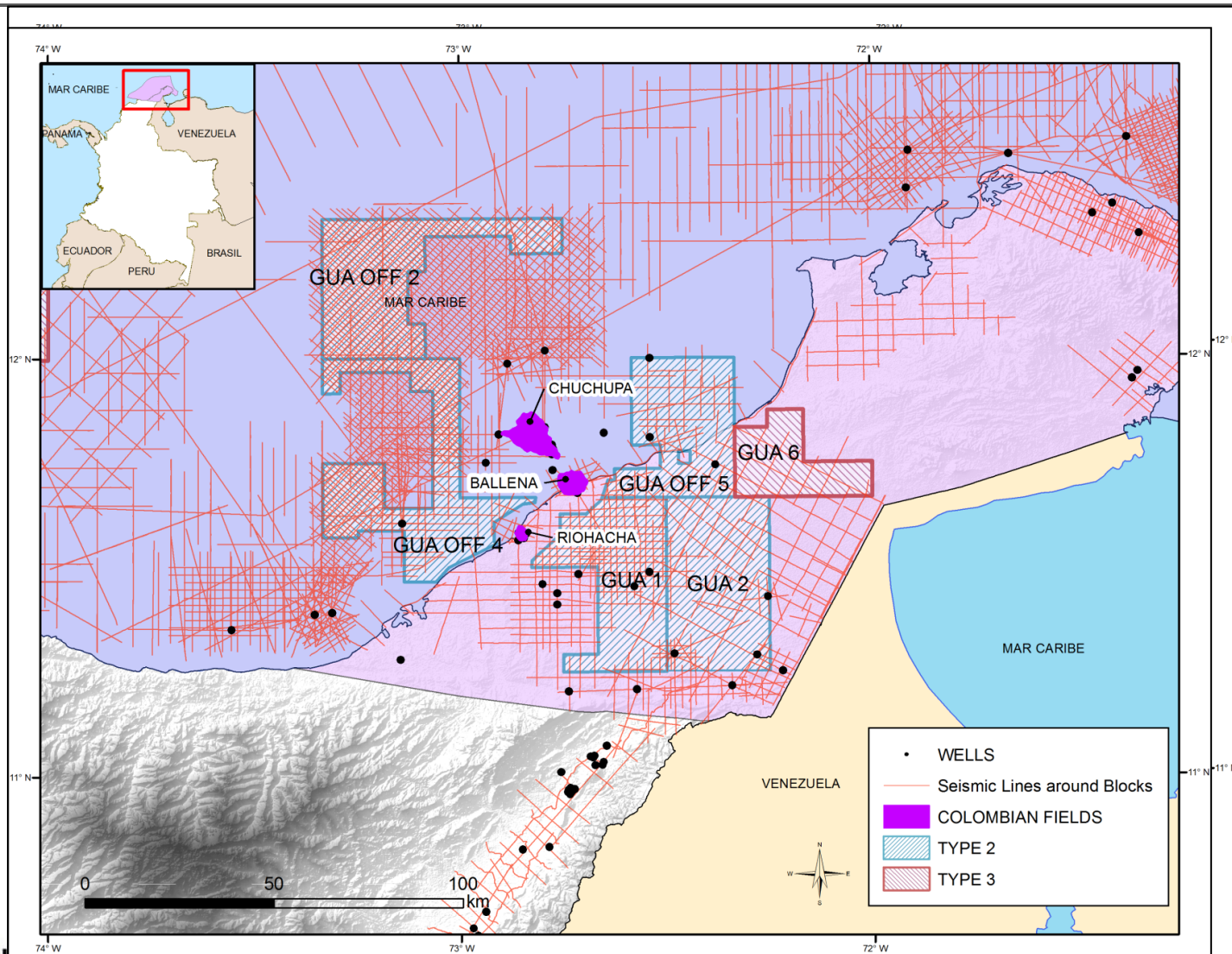
3- Inversion structure - Romeral Fault System



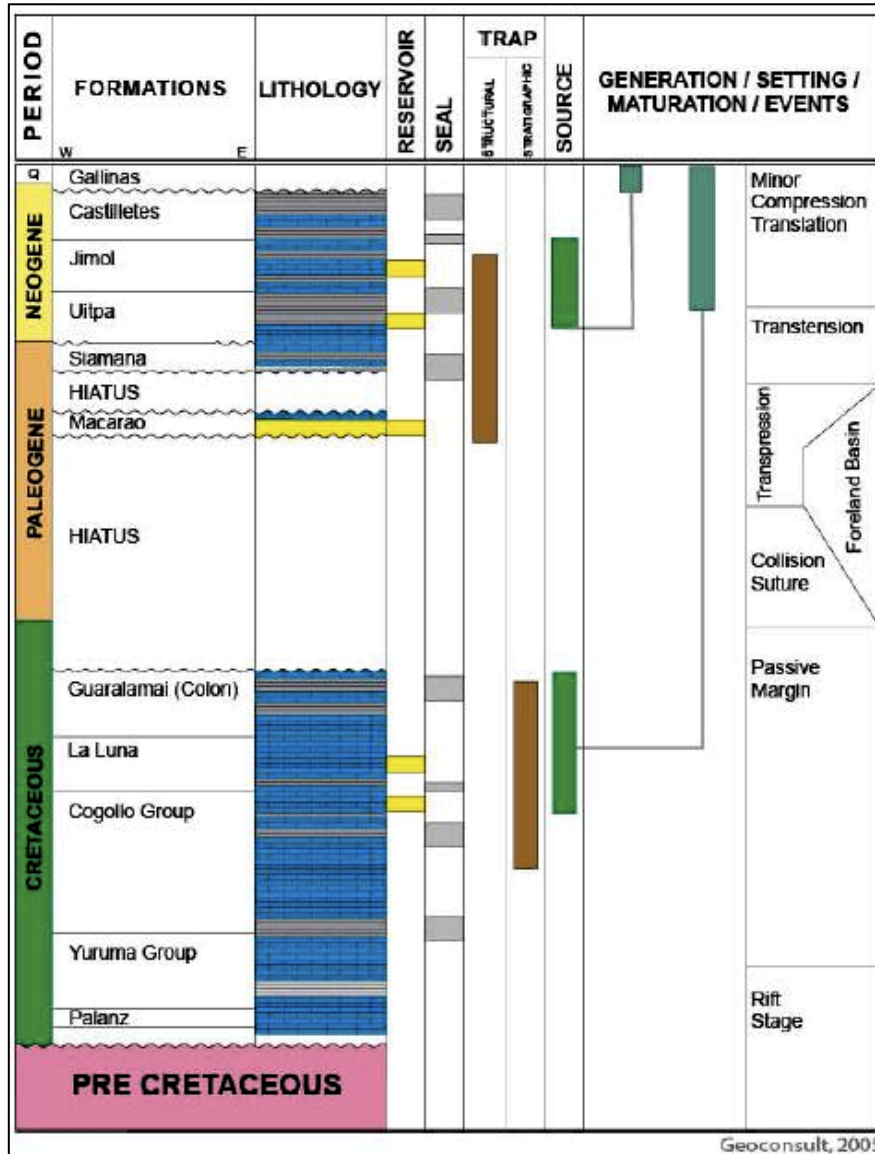
Cuenca: Sinu - San Jacinto - Valle inferior del Magdalena

Atlas sísmico de Colombia, 1998

Guajira Onshore and Guajira Offshore Basins



Guajira Onshore and Guajira Offshore Basins



Geoconsult, 2005

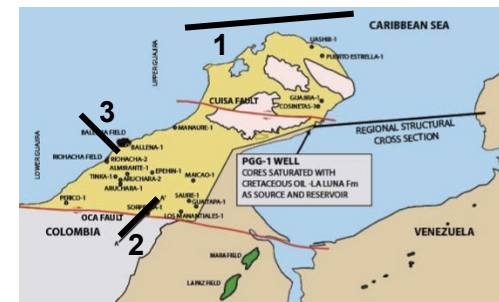
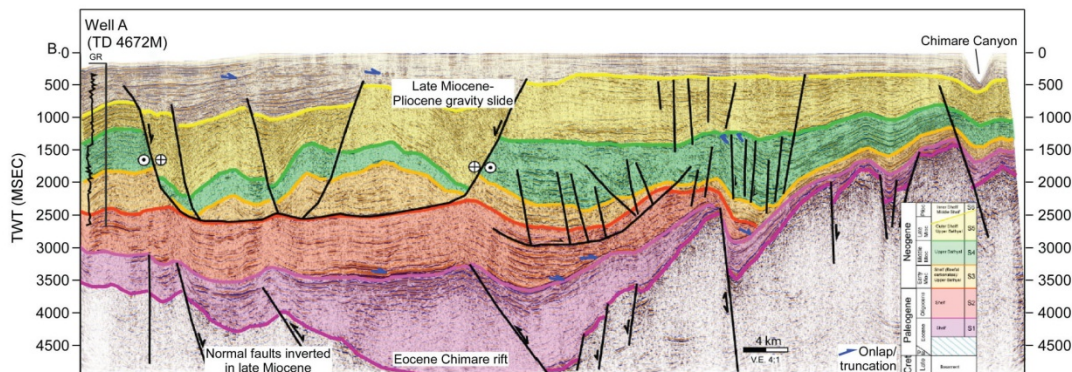
PETROLEUM SYSTEM

K (La Luna) – **K** (La Luna)

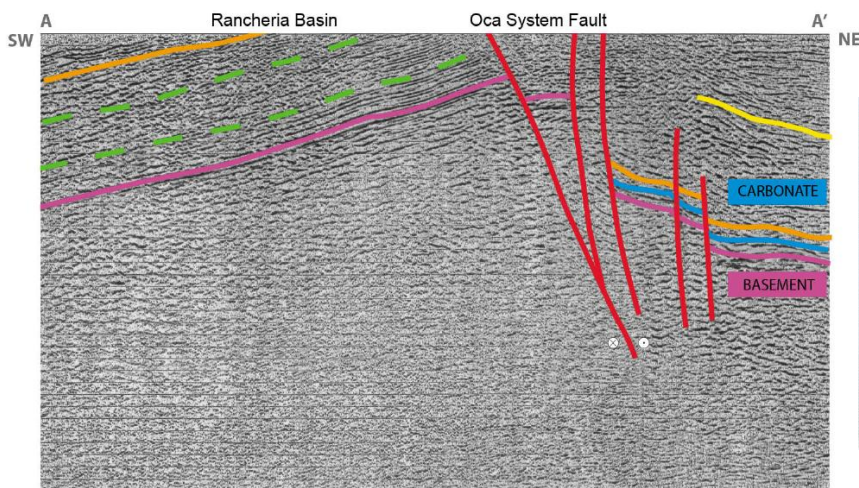
K (Uribante, La Luna) – **P-N** (Macarao, Uitpa)

Structural Styles

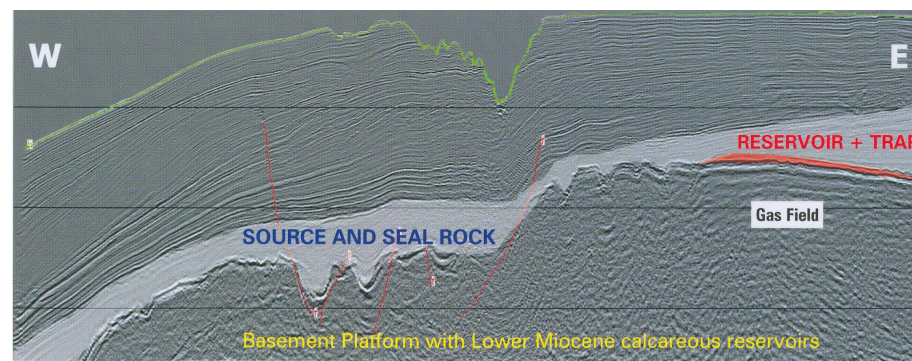
1- Normal Fault traps



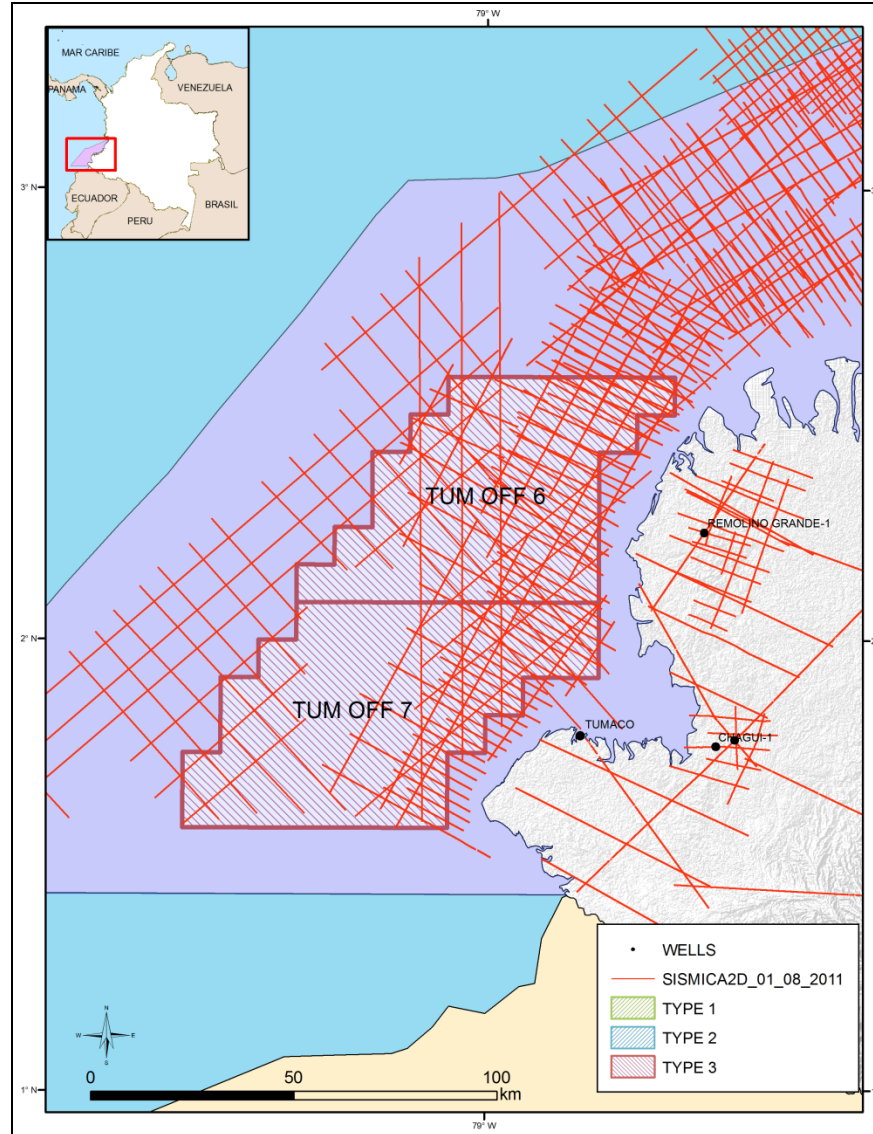
2- Oligocene carbonates strongly Fractured by the Oca Wrench System



3- Combined (structural and stratigraphic) traps



Tumaco Basin Offshore (Tum)



Tumaco Basin Offshore (Tum)

Stratigraphic chart

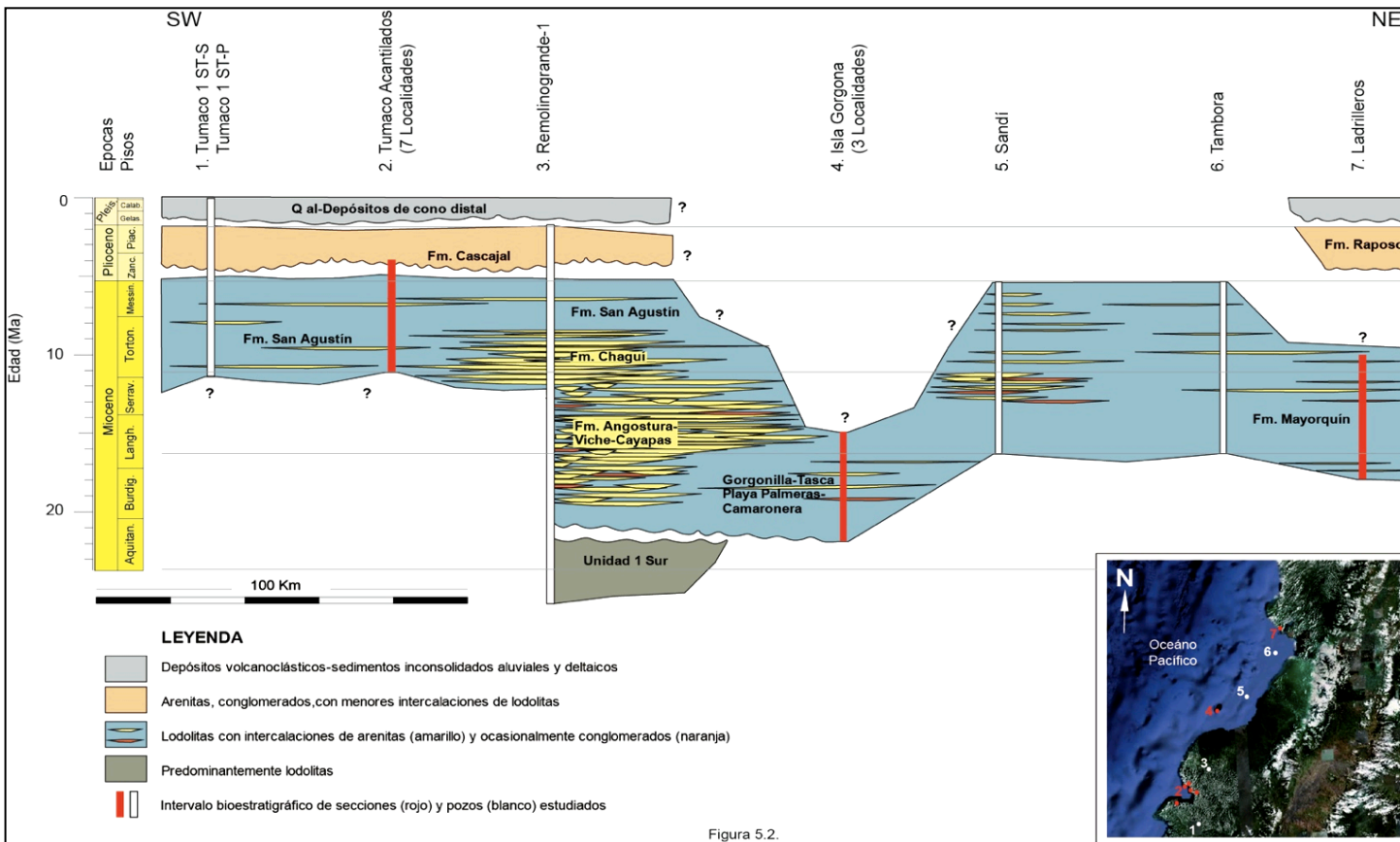
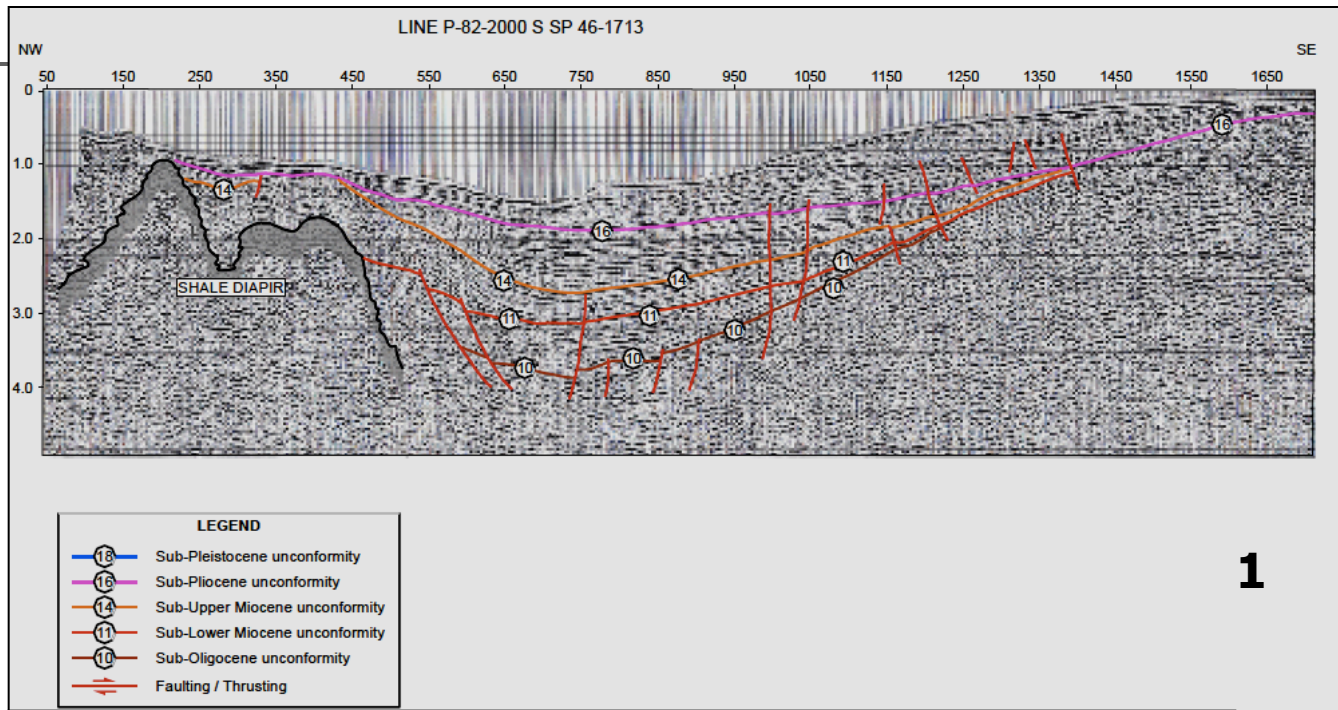


Figura 5.2.

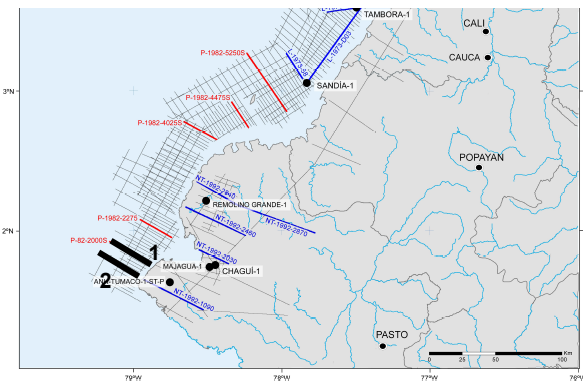
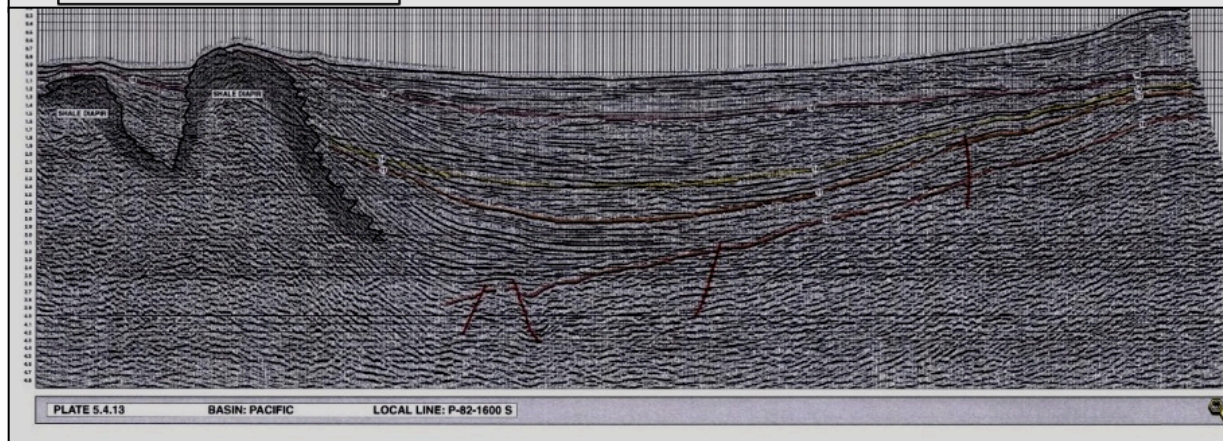
PETROLEUM SYSTEM

P? () – N (Angostura -Cayapas)

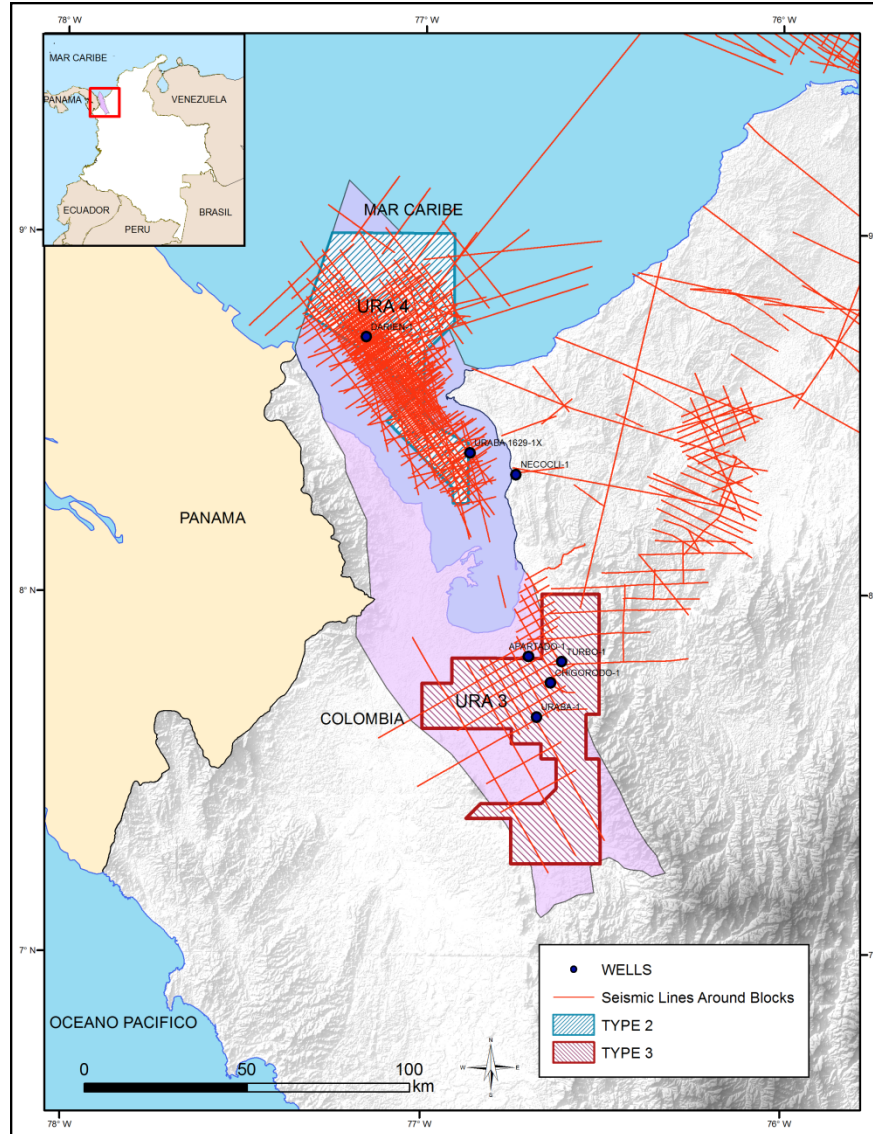
Structural Styles



1- 2 Normal faults and stratigraphic traps , diapiric structures

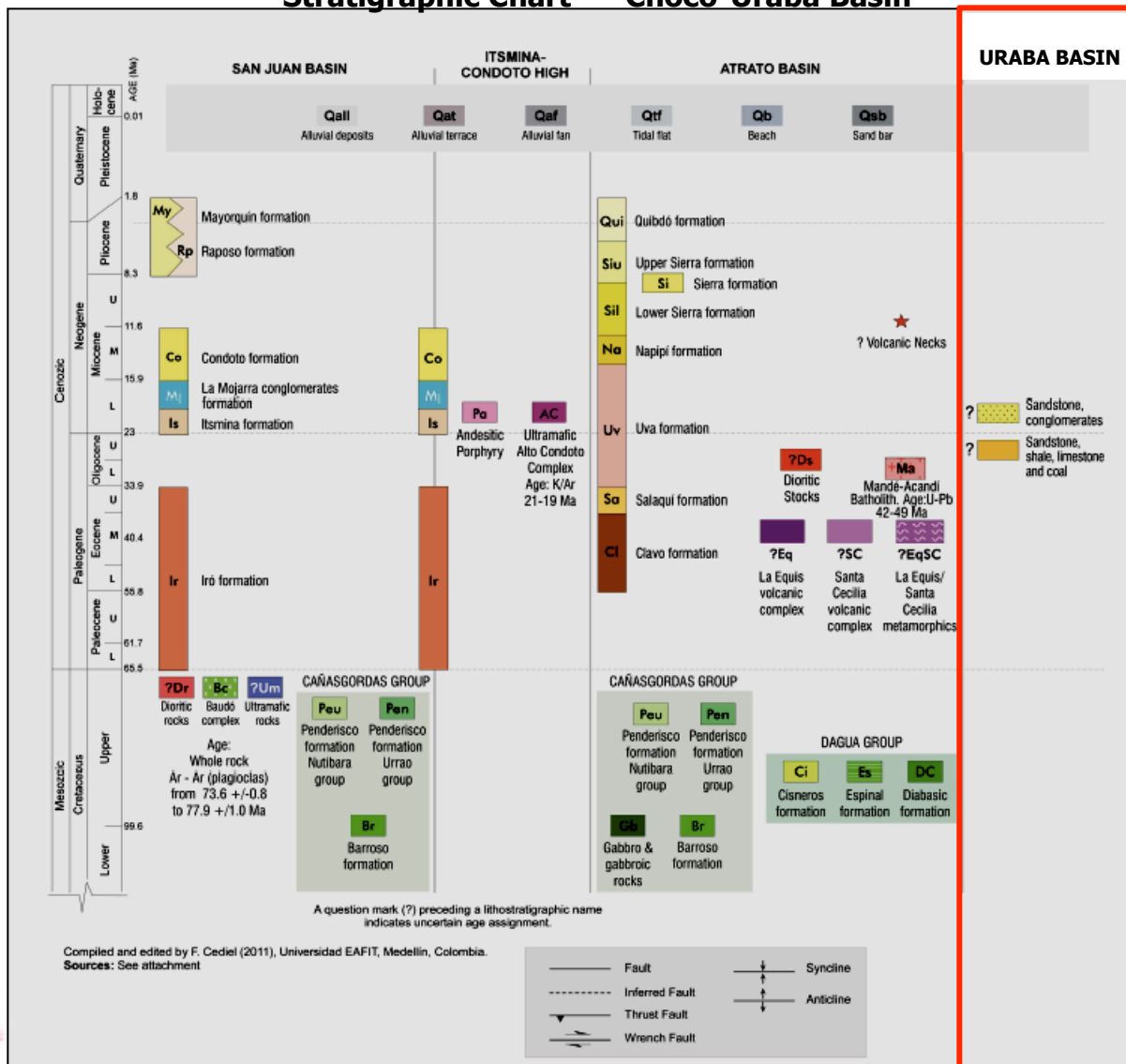


Urabá Basin (Ura)

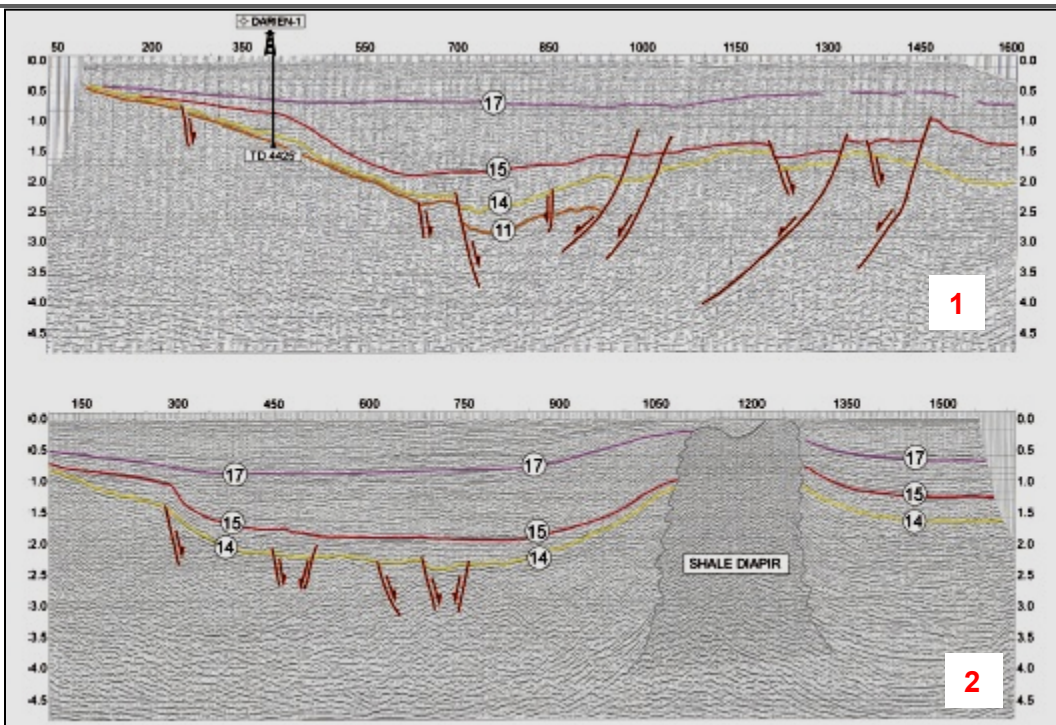


Urabá Basin (Ura)

Stratigraphic Chart – Chocó-Urabá Basin



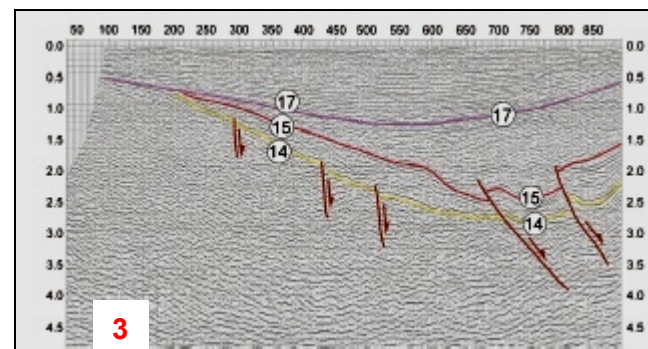
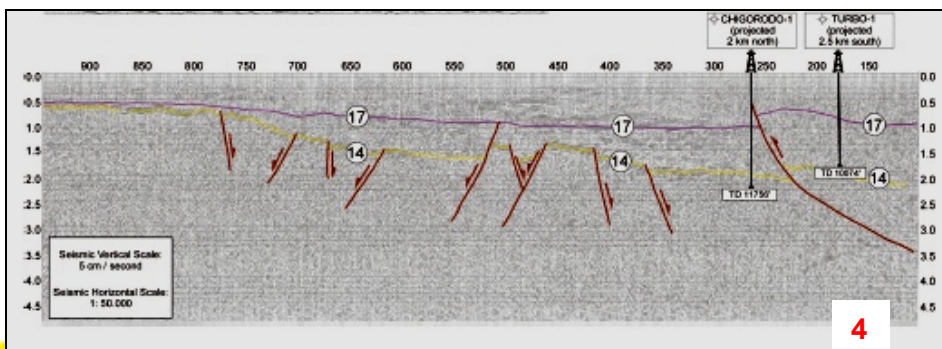
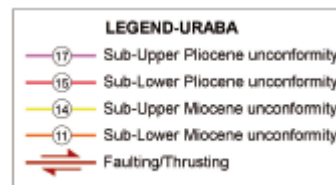
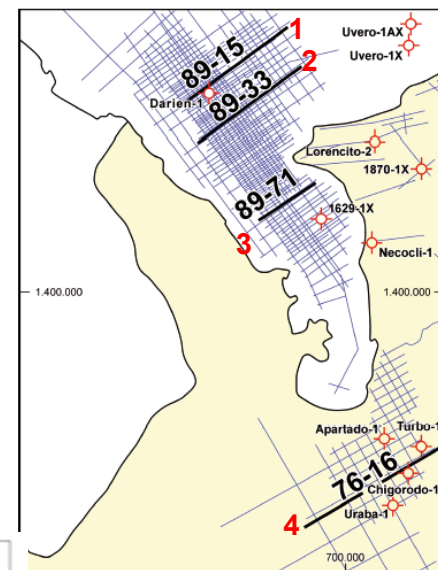
Structural Styles



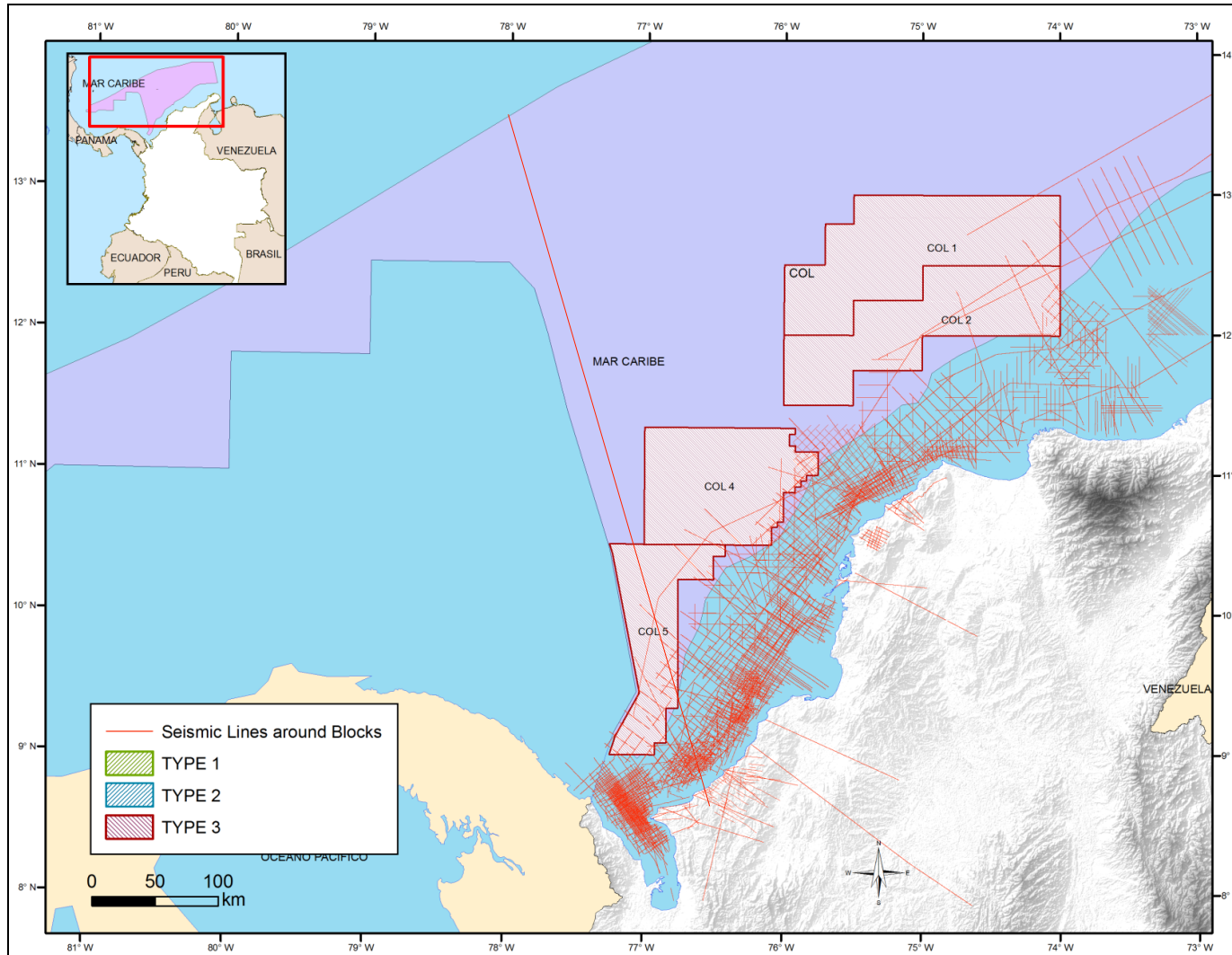
1-3 Normal fault and stratigraphic traps

2 Diapiric structures

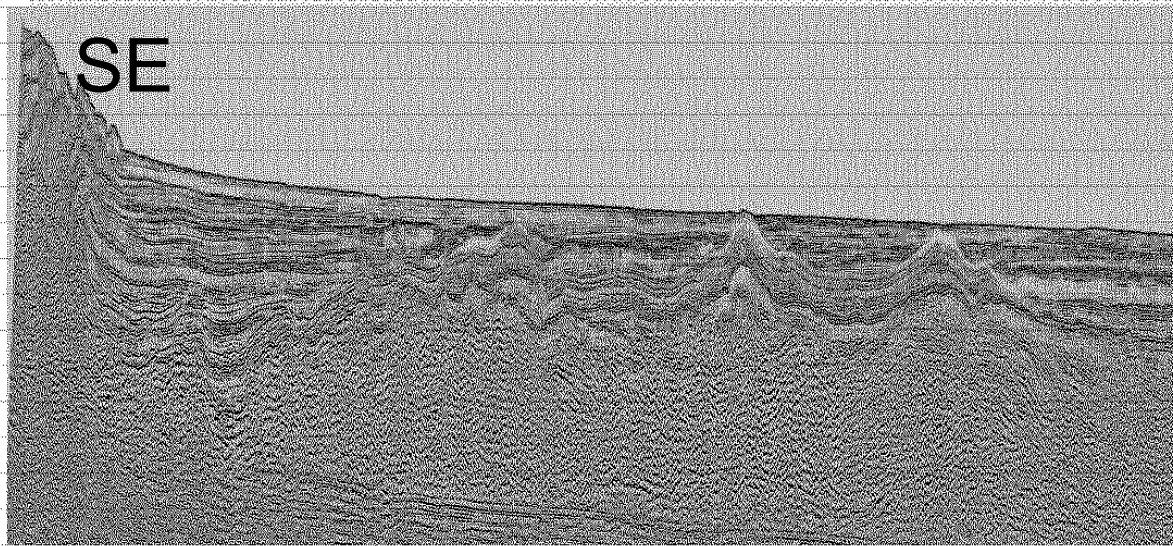
4 inversion structures



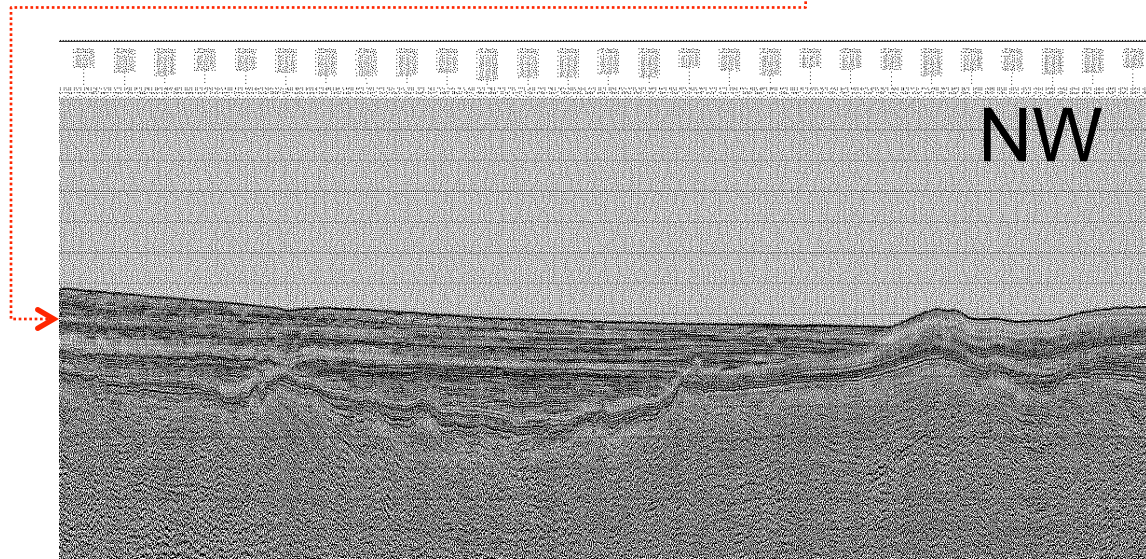
Colombia Basin (Col)



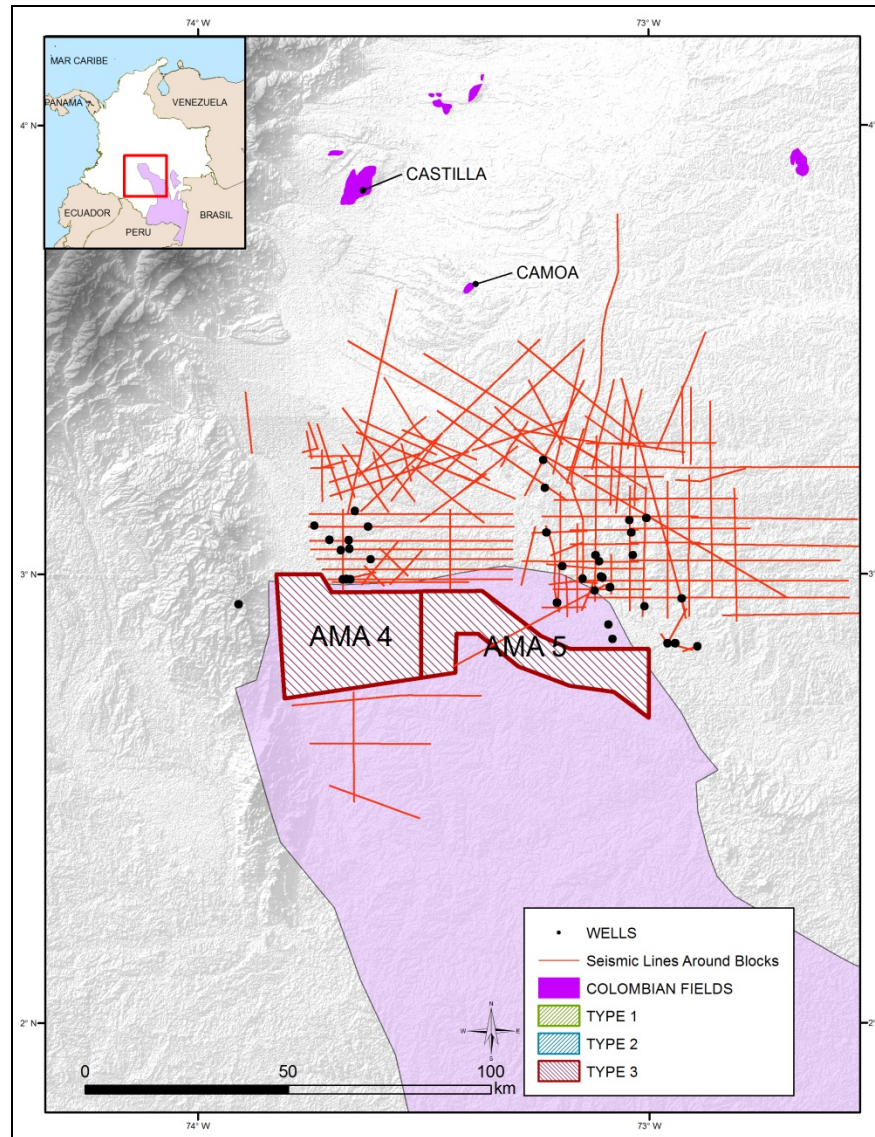
Colombia Basin (Col)



Seismic Line Colombia Basin



Vaupés-Amazonas Basin (Vau)



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Minimum Exploration Program

Blocks *Type 1* & *Type 2* Conventional Onshore



Phase I (3 years)	Phase II (3 years)
✓ 2D Seismic, minimum 1km/5km ² .	✓ 3D Seismic, minimum 1km ² /10km ² .
✓ 1 Exploratory well (the whole sedimentary sequence, or up to the economic basement).	✓ 2 Exploratory wells (the whole sedimentary sequence, or up to the economic basement).

Minimum Exploration Program

Type 2 Conventional Offshore



Phase I (3 years)	Phase II (3 years)
<ul style="list-style-type: none">✓ 15 km² of 3D seismic / 200 km² of area.✓ Collection of one (1) piston core / 200 km² of area.	<ul style="list-style-type: none">✓ 1 (one) Exploratory well (the whole sedimentary sequence, or up to the economic basement).

Minimum Exploration Program

Type 3 Conventional Onshore and Offshore



Onshore Unique Phase (3 years)	Offshore Unique Phase (3 years)
	✓ Piston Coring, 1 /10 km ² .
✓ 2D Seismic, minimum 1km /10 km ² .	✓ 2D Seismic, minimum 1km / 10 km ² .
✓ Regional analysis (i.e. mapping with remote sensing or airborne geophysical methods).	✓ Regional analysis (i.e. mapping with remote sensing or airborne geophysical methods).
✓ 1 (one) stratigraphic well, with physical and geochemical logs.	
	✓ 20 (twenty) km of bathymetry / 10 km ² of area.

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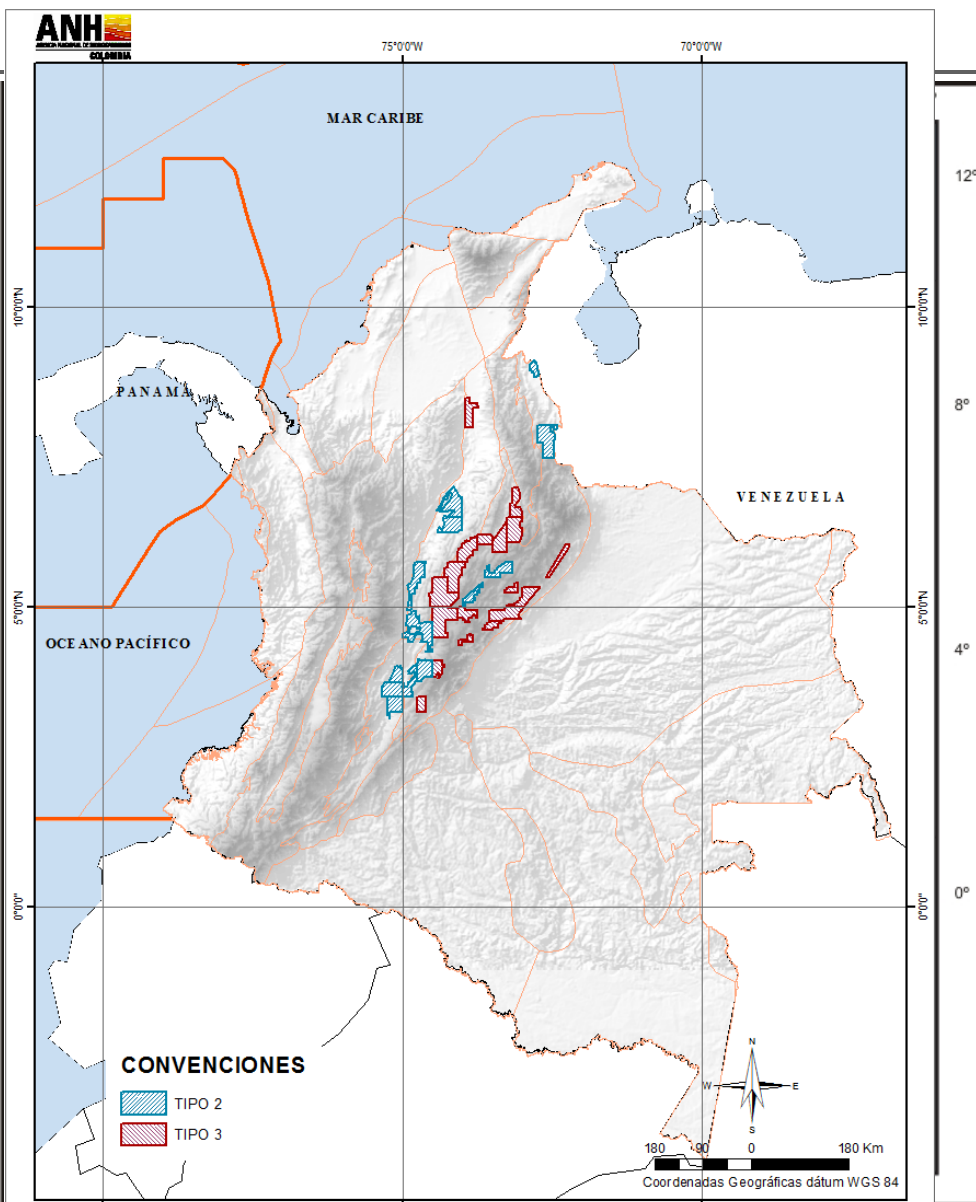
Area Comparison



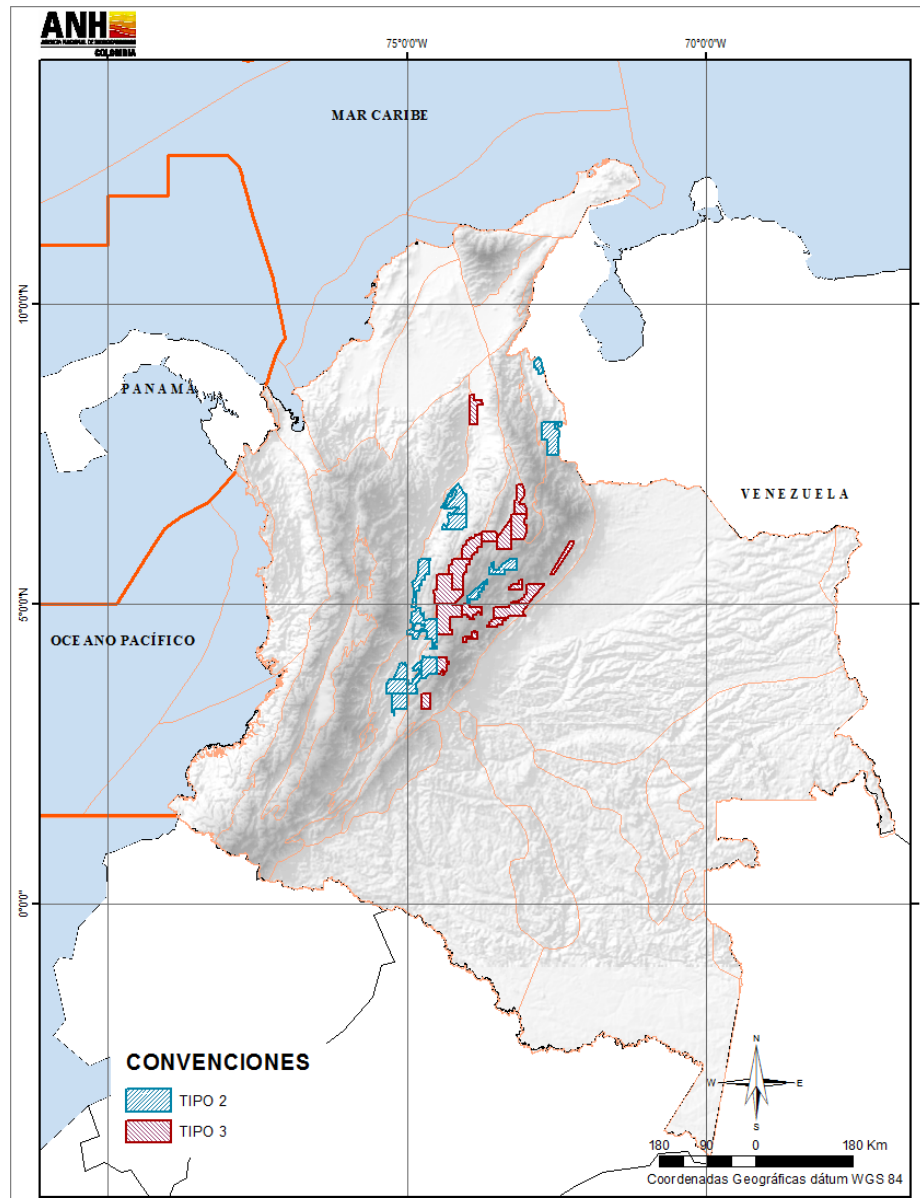
Texas is about
60% of the size of
Colombia

Colombia
1,141,748 km²

Texas
696,241 km²

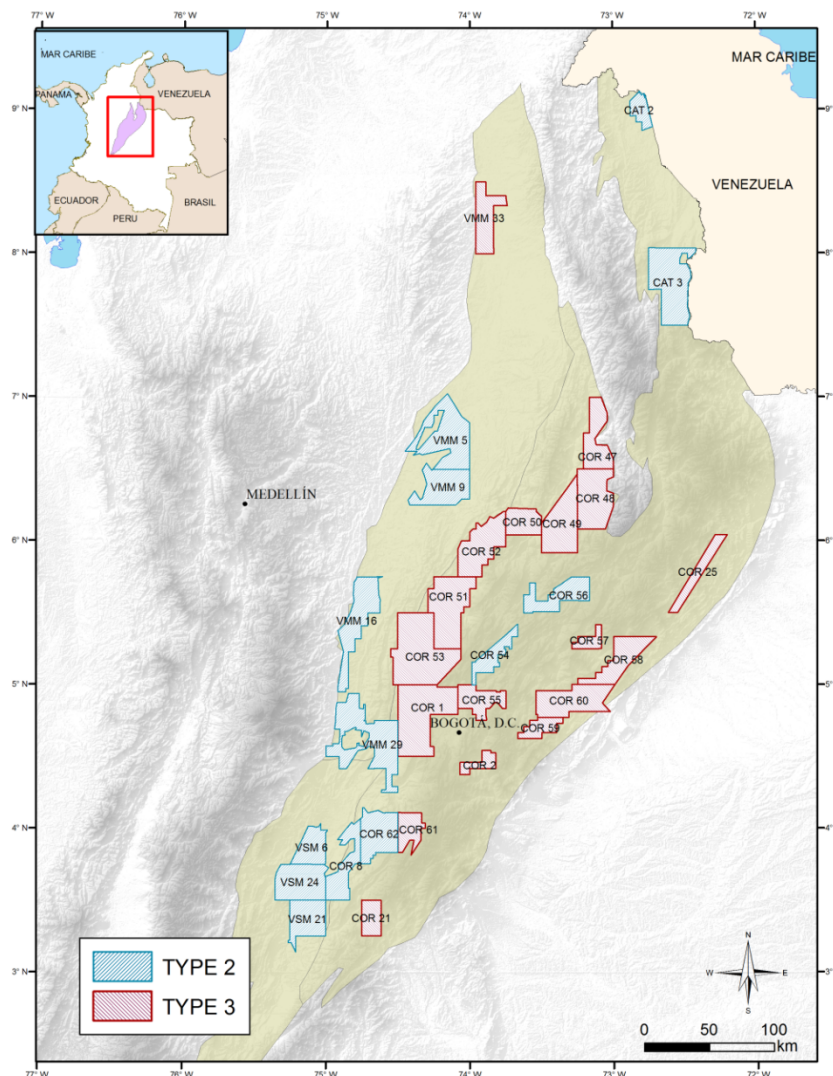


Suggested Blocks for Unconventional Resources



Prospectivity for Unconventional Resources

Unconventional HC. Colombia Round 2012			
Blocks (Total)	Type I	Type II	Type III
21	0	11	10
10	0	2	8

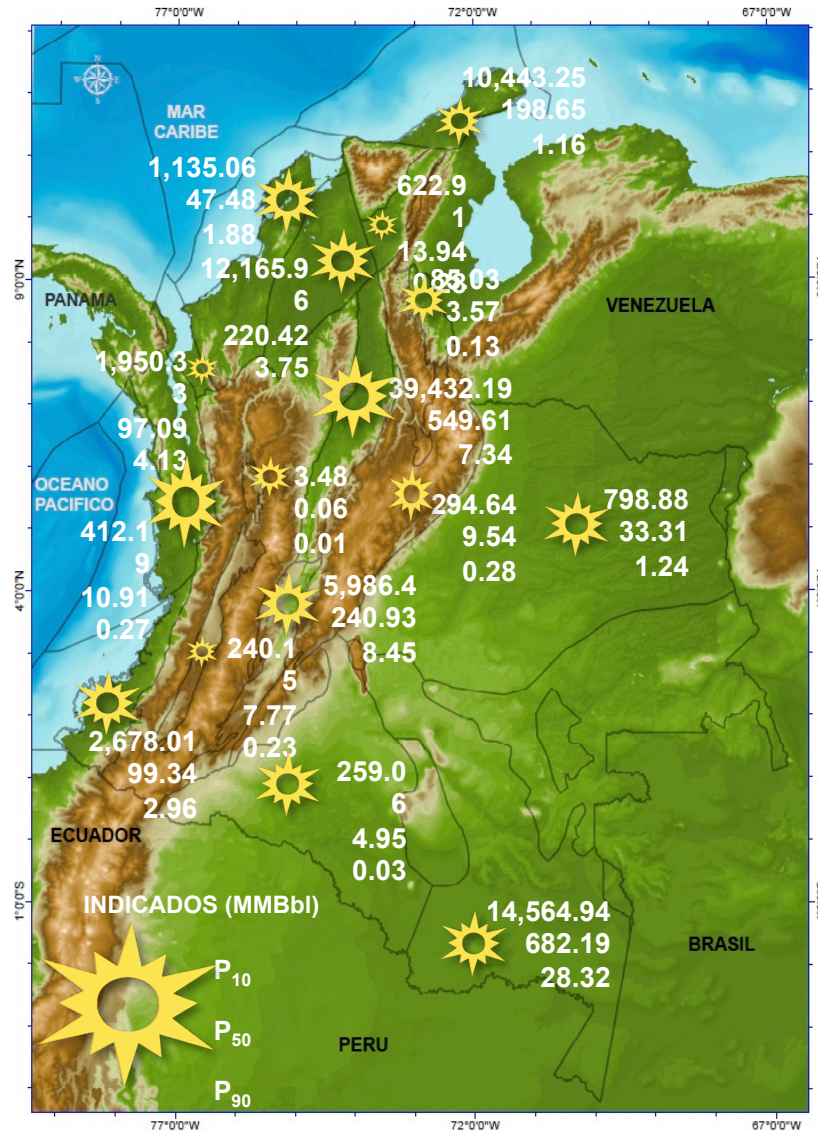


Unconventional Resources (Preliminary Assesment, UNAL, 2011)

Resources	Results P10 - P90	Prospectivity Basins
Gas Hydrates	75.63 – 4.89 TCF	Chocó Offshore Sinú Offshore Guajira Offshore
Coalbed Methane	77.511 - 0.725 TCF	Sinú - San Jacinto Cesar - Ranchería Upper Magdalena Valley
Tar Sands	151,153.8 – 3,455.1 MMbbl	Middle Magdalena Valley Eastern Cordillera Eastern Llanos
Shale Oil	151,524 – 3,090.6 MMbbl	Eastern Cordillera Chocó Upper Magdalena Valley
Shale Gas	2,050.7 – 33.8 TCF	Eastern Cordillera Eastern Llanos Caguán - Putumayo
Tight Sands	43.7 – 1 TCF	Eastern Llanos Caguán - Putumayo Eastern Cordillera

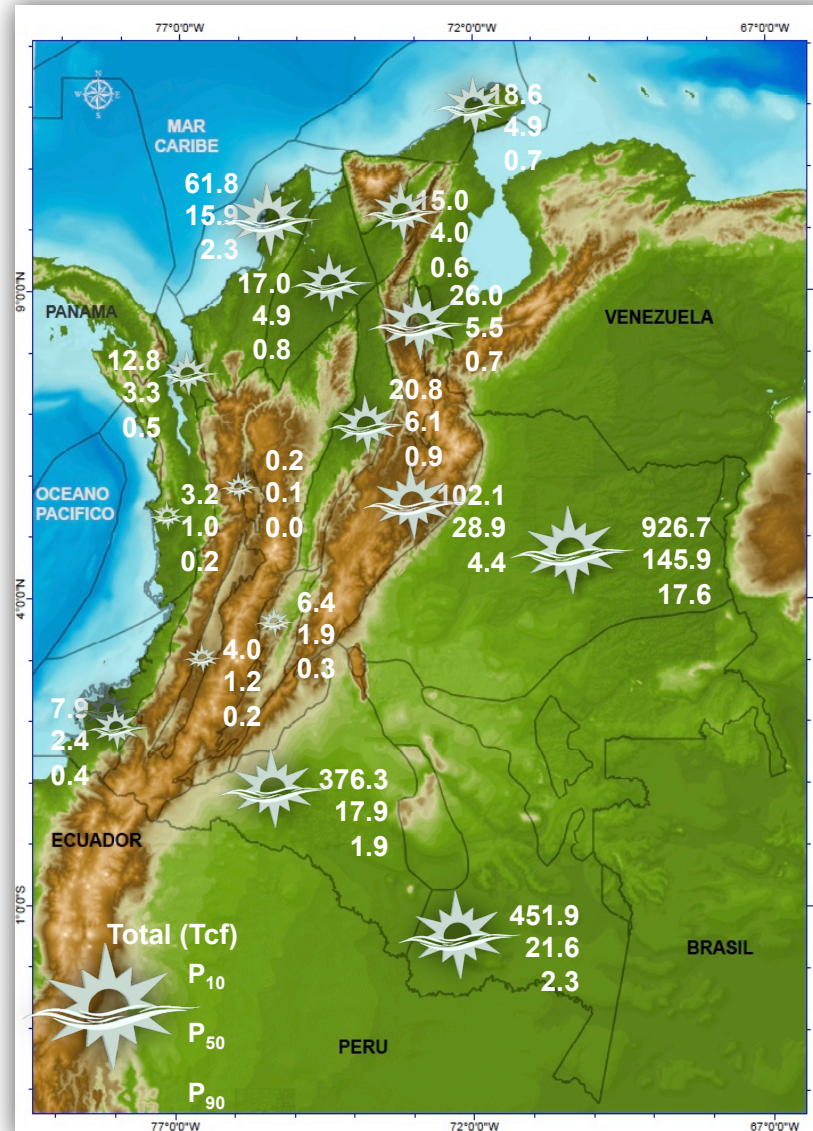
Unconventional Resources

Shale Oil in Colombia (Preliminary Assesment, UNAL, 2011)



Unconventional Resources

Shale Gas in Colombia (Preliminary Assesment, UNAL, 2011)



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Minimum Exploration Program

Type 2 Unconventional



Phase I (3 years)	Phase II (3 years)	Phase III (confirmation) (2 years)
✓ Geological mapping, scale 1:25.000 or higher, minimum 50% of the block area.		
✓ Surface geochemistry, minimum 1 km/5 km ² of the block area.		
✓ 2D Seismic, minimum 1km/5km ² .		
✓ 2 Stratigraphic wells, with physical and geochemical logs.	✓ 1 Stratigraphic well, with physical and geochemical logs.	
	✓ 2 Exploratory wells with physical and geochemical logs.	✓ 4 Exploratory wells with physical and geochemical logs.

Minimum Exploration Program



Type 3 Unconventional

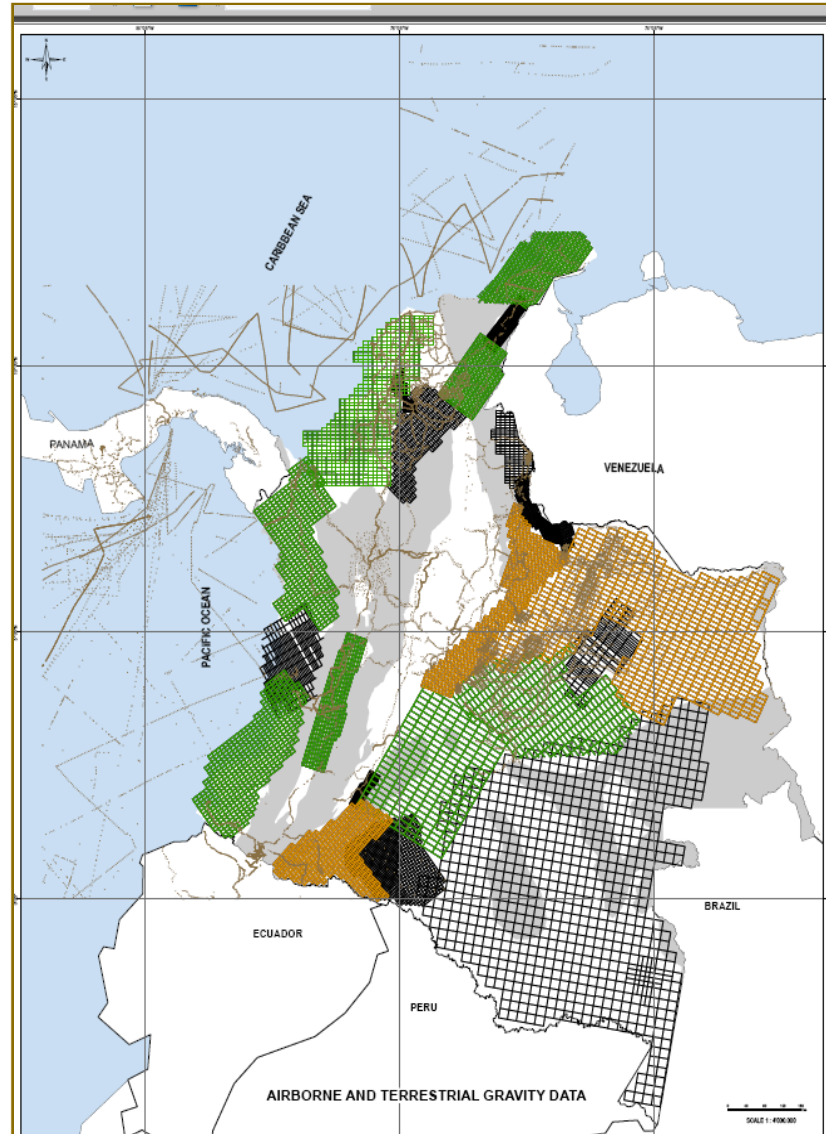


Onshore Unique Phase (3 years)
✓ Geological mapping, scale 1:25.000, or higher, minimum 50% of the block area.
✓ 2D Seismic, minimum 1km / 10 km ² .
✓ Regional analysis (i.e. mapping with remote sensing or airborne geophysical methods).
✓ 2 (two) stratigraphic wells, with physical and geochemical logs.
✓ Geochemical sampling, 2 km / 10 km ² .

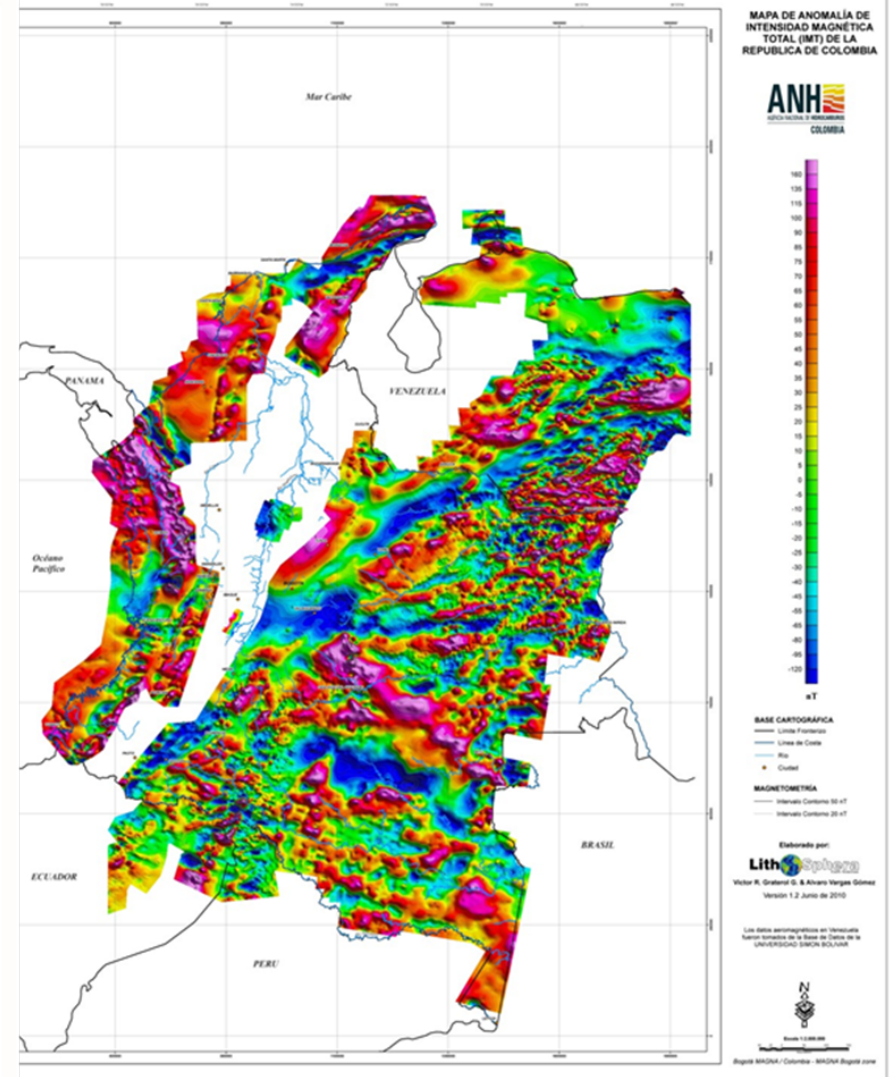
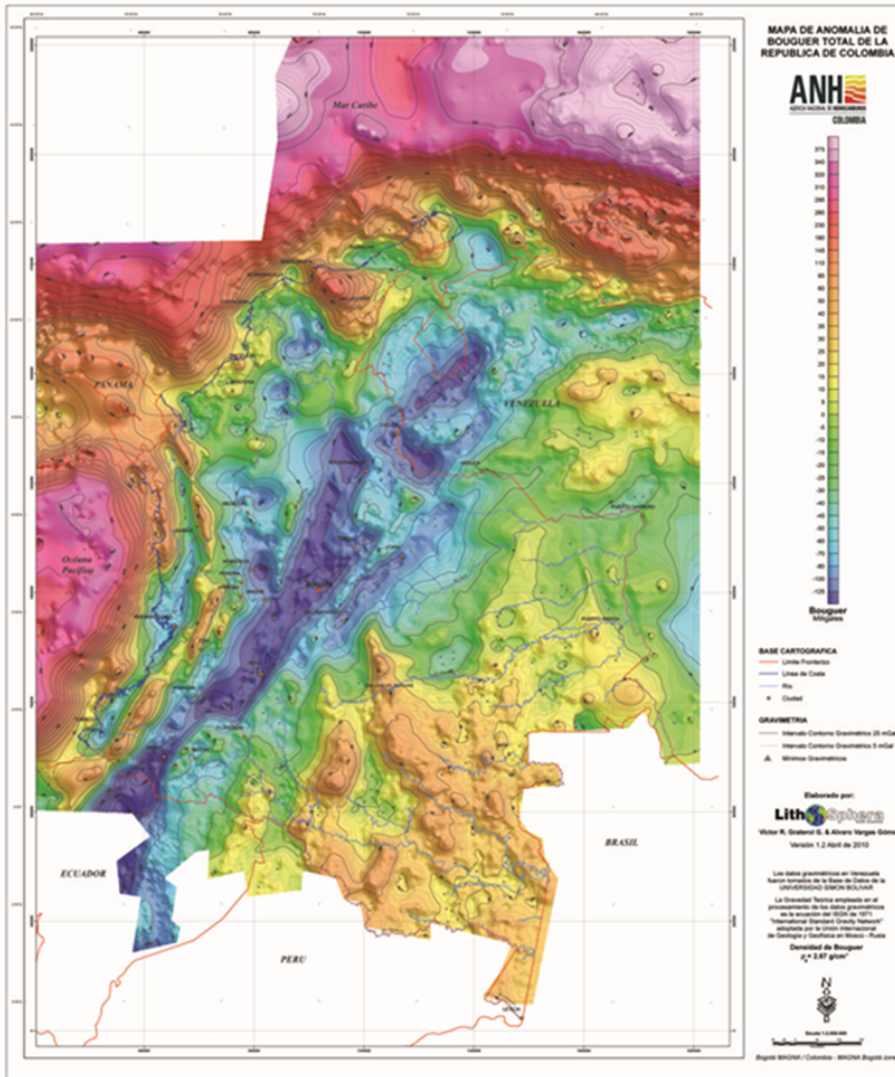
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Airborne Geophysical Coverage

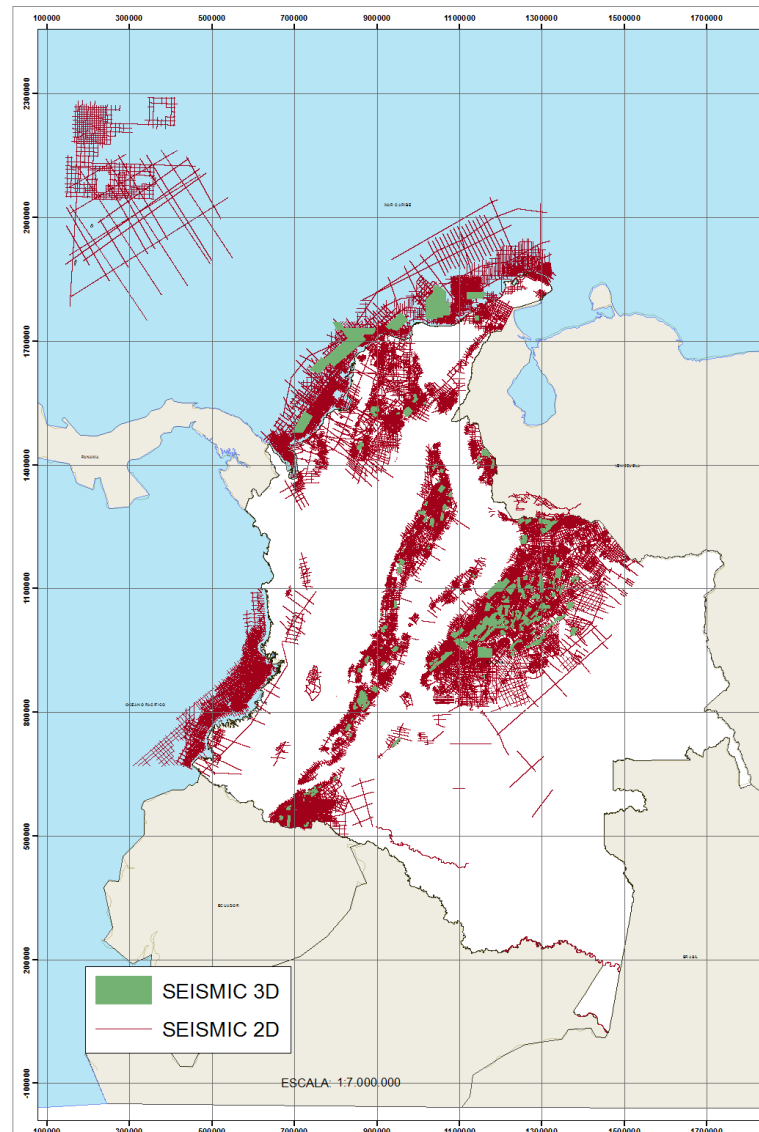
-  ANH 2005-2007
-  ANH 2008-2009



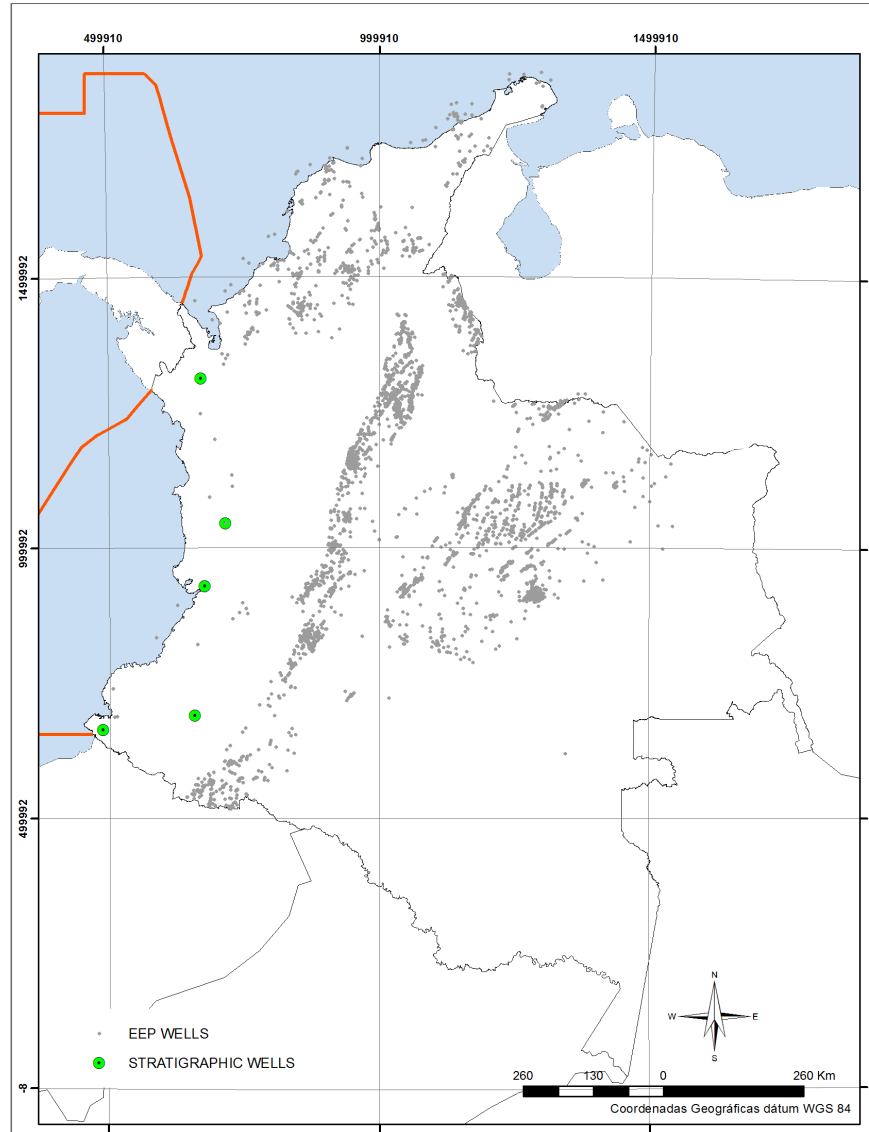
Gravity and Magnetic Anomalies Maps



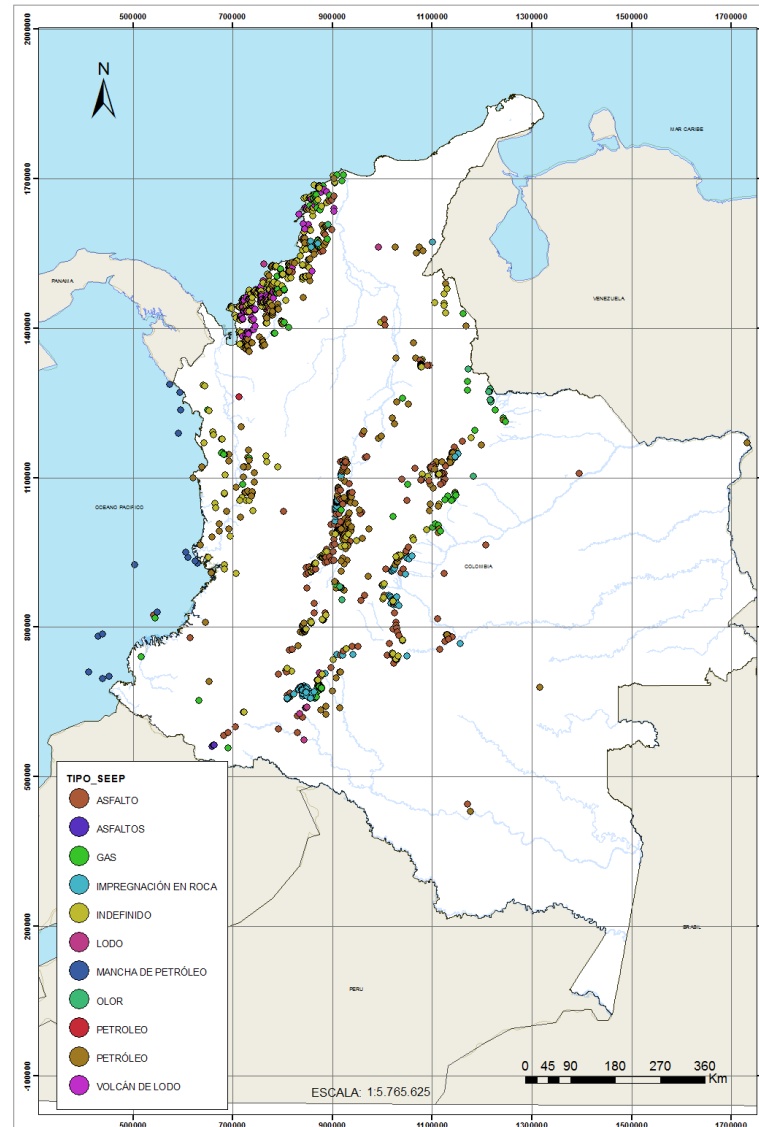
2D and 3D seismic coverage



Exploration, Evaluation, Production -EEP and Stratigraphic Wells Map



Oil and Gas Seeps



Package Information

BLOCKS	2D PROGRAMS	2D LINES	3D PROGRAMS 3D	WELLS
ANP	4	5	0	0
CAG-PUT	27	131	1	11
CAT	13	106	0	13
COL	1	10	0	0
COR	41	201	0	8
GUA	21	187	0	6
GUA OFF	3	5	0	2
LLA	136	648	10	31
PAC-OFF	2	72	0	4
SIN OFF	4	38	0	0
SIN SJ	23	135	0	25
URA	8	126	0	4
VIM	33	170	4	36
VMM	94	561	2	79
VSM	94	601	3	66
TOTAL	504	2,996	20	285

Package Information



<http://www.anh.gov.co/>

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Summary and Conclusions



- Colombia has world class petroleum systems.
- Colombia has significant underexplored areas.
- Large upside opportunities for unconventional hydrocarbon resources.

Colombia has excellent exploration opportunities on a global scale in **mature**, **emerging** and **frontier** basins.



*New Ideas + New Technologies
+ New Licenses*

=



Significant new discoveries





*Thanks,
See you in Colombia!*



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