



# **Overview of the Oil and Gas Basins of Colombia**

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2. Colombian General Geological Framework and Basins technical Aspects
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## **1. Introduction**

## 2. Colombian General Geological Framework and Basins Technical Aspects

## 3. Colombia Round 2012

### 3.1. Block Types

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### 3.3. Unconventional Resources

### 3.4. Minimum Exploration Program (Unconventional Blocks)

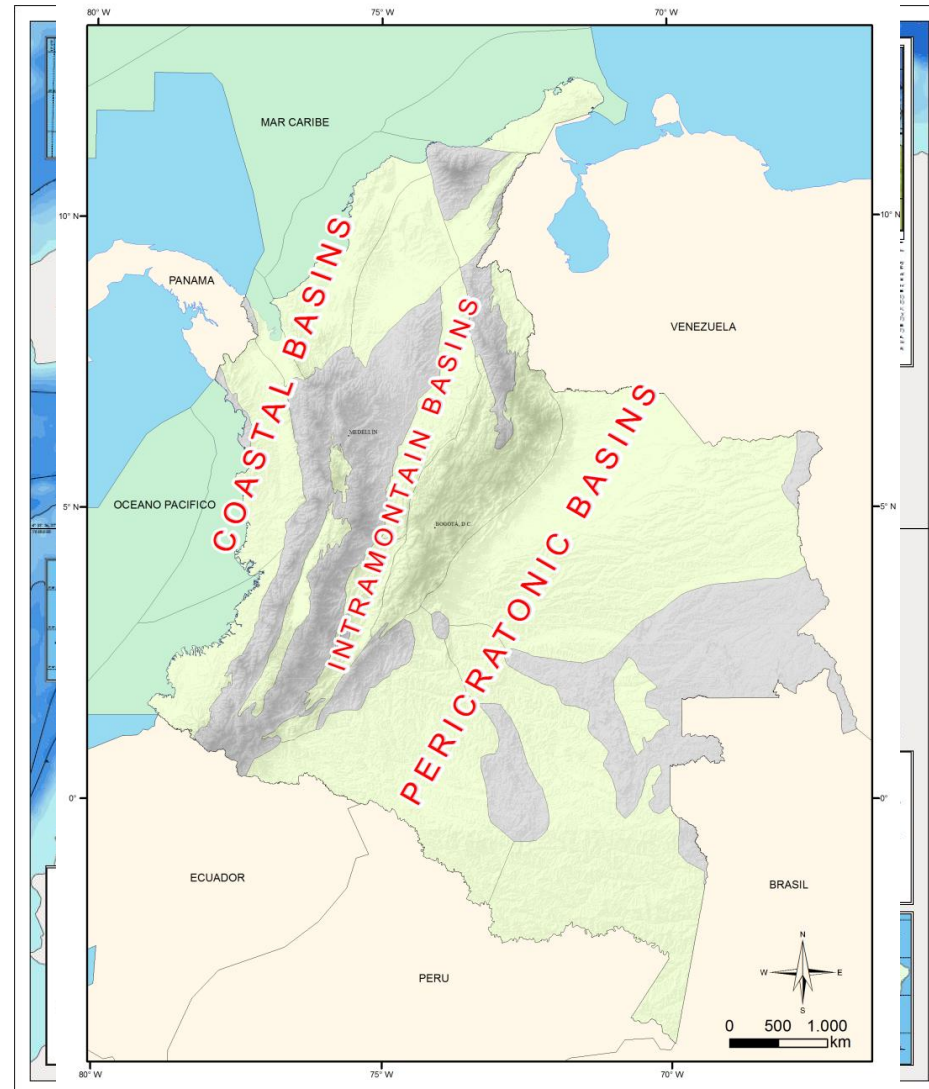
### 3.5. Database (EPIS)

## 4. Summary and Conclusions

# Colombia

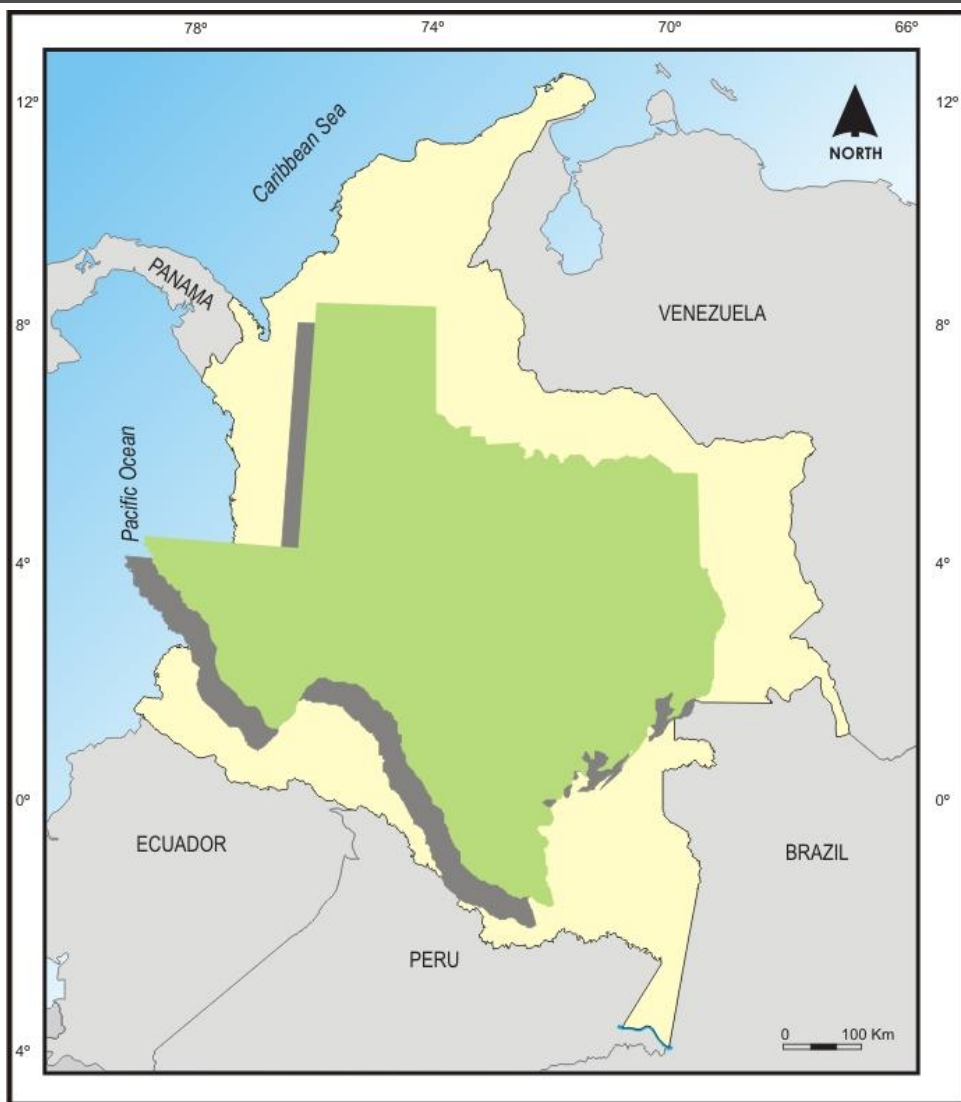
= *Diverse Geology*

= *Something For All Explorers!*





# Area Comparison



Texas is about  
60% of the size of  
Colombia

Colombia  
1,141,748 km<sup>2</sup>

Texas  
696,241 km<sup>2</sup>

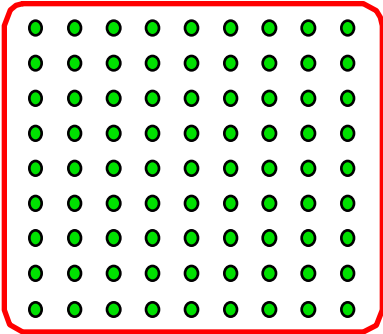
# Colombia – An Underexplored Country



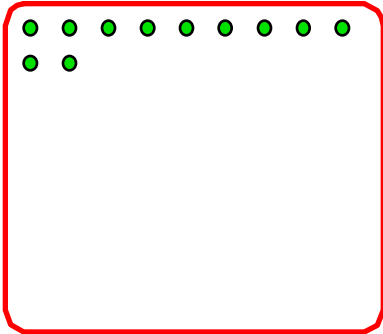
## Wells per 1,000 km<sup>2</sup>

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

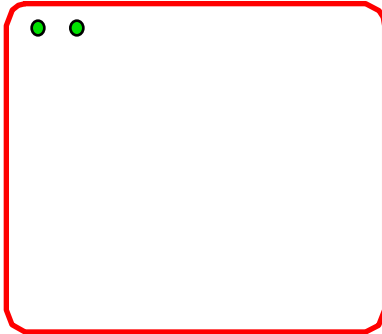
UNITED STATES



CANADA



COLOMBIA



# Colombia – An Underexplored Country



Western Sedimentary Basin of Canada

Approx. 525,000 wells  
1 well / 2.5 km<sup>2</sup>

Eastern Cordillera-Llanos-Putumayo  
2,026 wells  
1 well / 200 km<sup>2</sup>

*Colombia has room to explore!*

# Contents



## 1. Introduction

## **2. Colombian General Geological Framework and Basins Technical Aspects**

### 3. Colombia Round 2012

3.1. Technical Aspects of Basins

3.2. Block Types

3.3. Minimum Exploration Program (Conventional Blocks)

3.4. Unconventional Resources

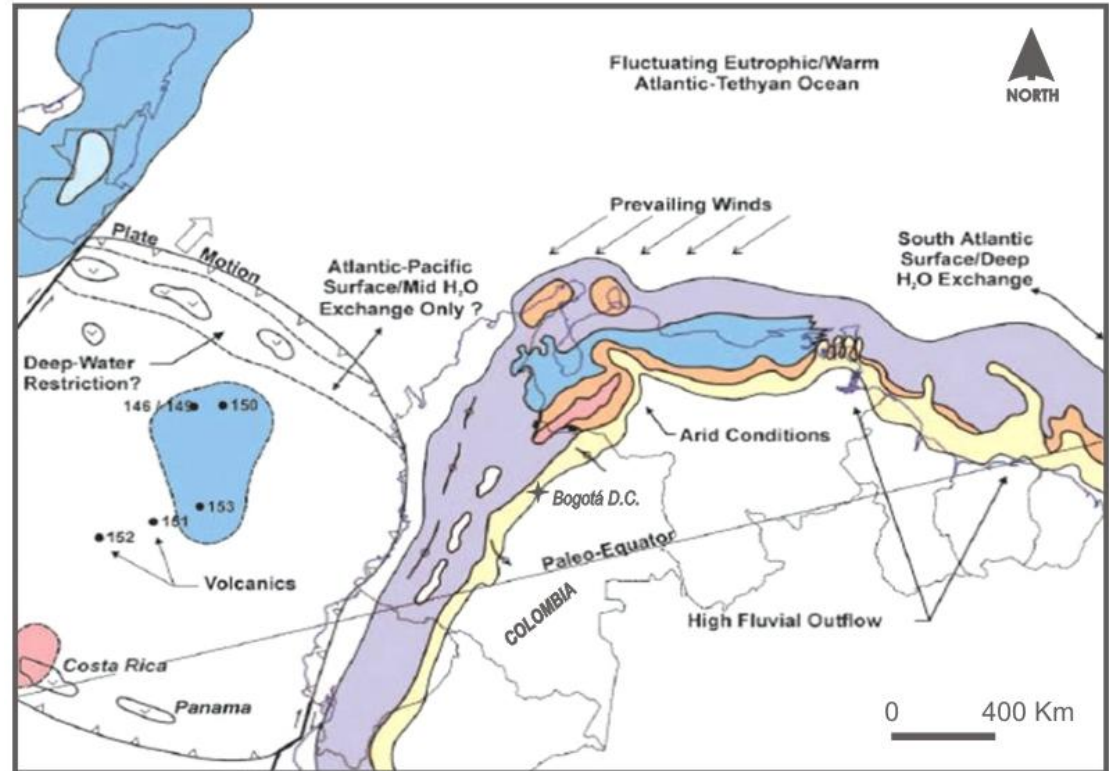
3.5. Minimum Exploration Program (Unconventional Blocks)

3.6. Database (EPIS)

## 4. Summary and Conclusions

# Colombia Has a World-Class Source Rock!

- ✓ Mid-Cretaceous La Luna / Gachetá, Villeta, Cansona – A rich, regional hydrocarbon source rock.
- ✓ Additionally, Tertiary carbonaceous shales and coals are also present.
- ✓ 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.

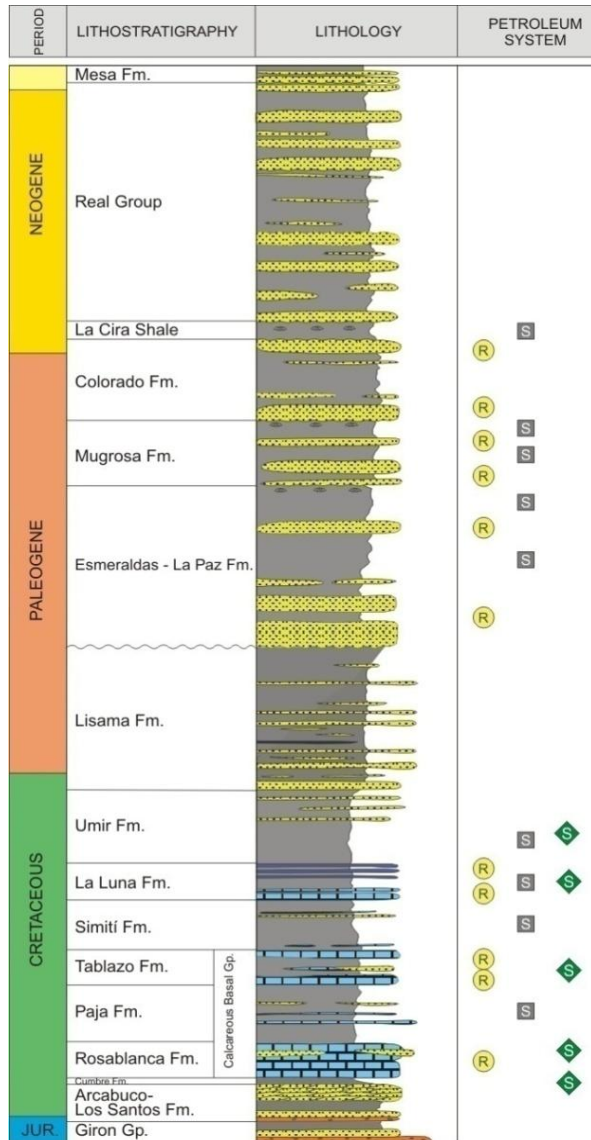
# Colombia Has Reservoirs!



FOR CONVENTIONAL HC

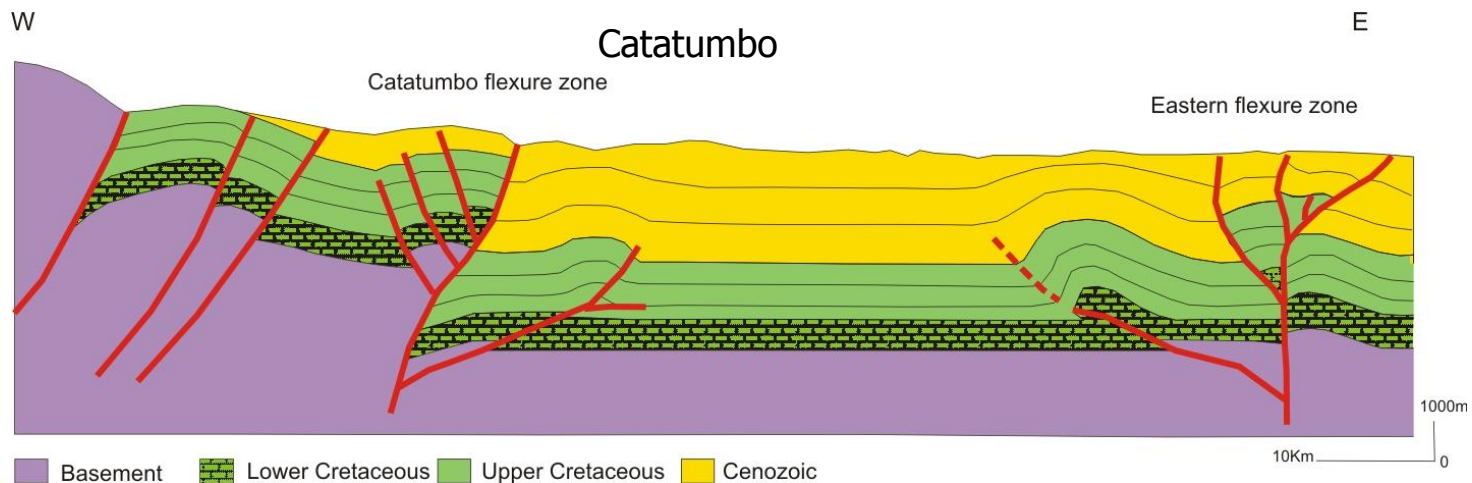
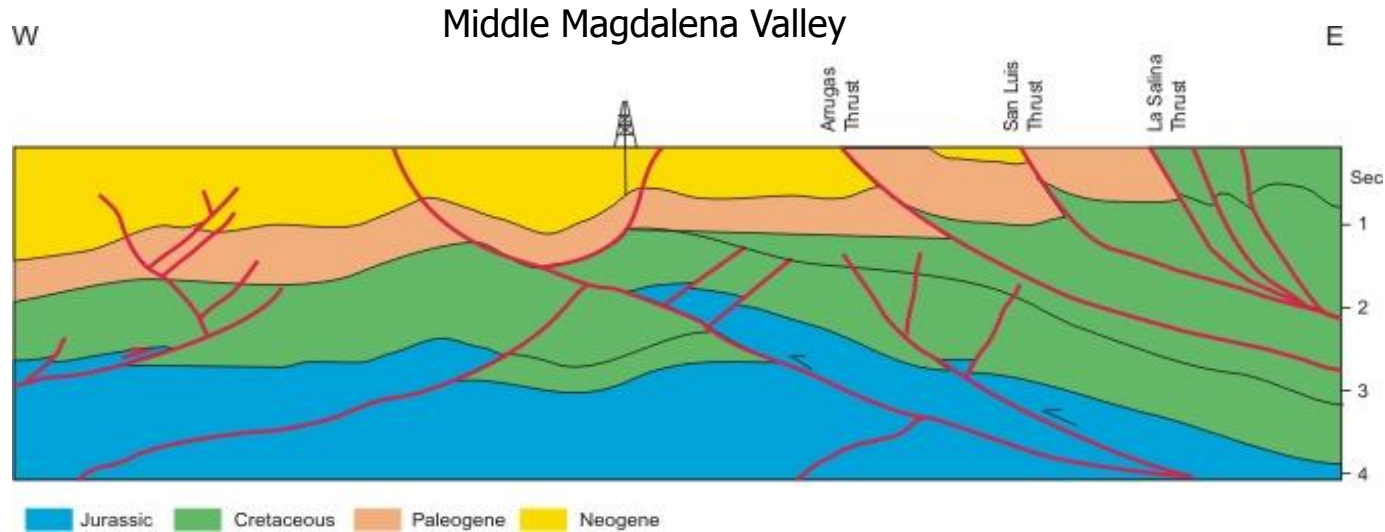
## Middle Magdalena Basin Reservoirs

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

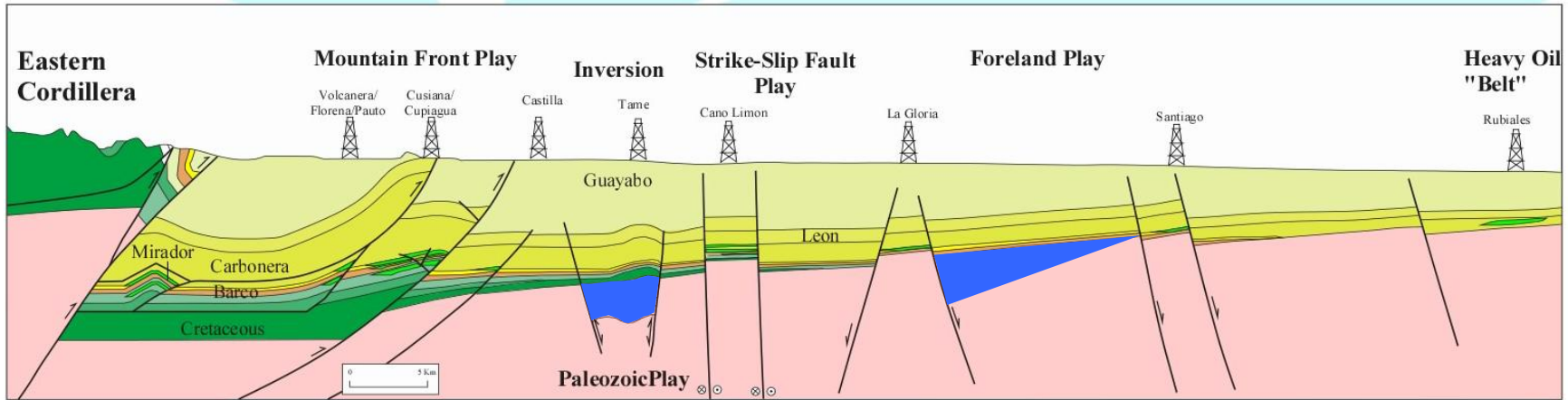




# Colombia Has a Wide Variety of Structural Styles



# Colombia Has a Wide Variety of Structural Styles



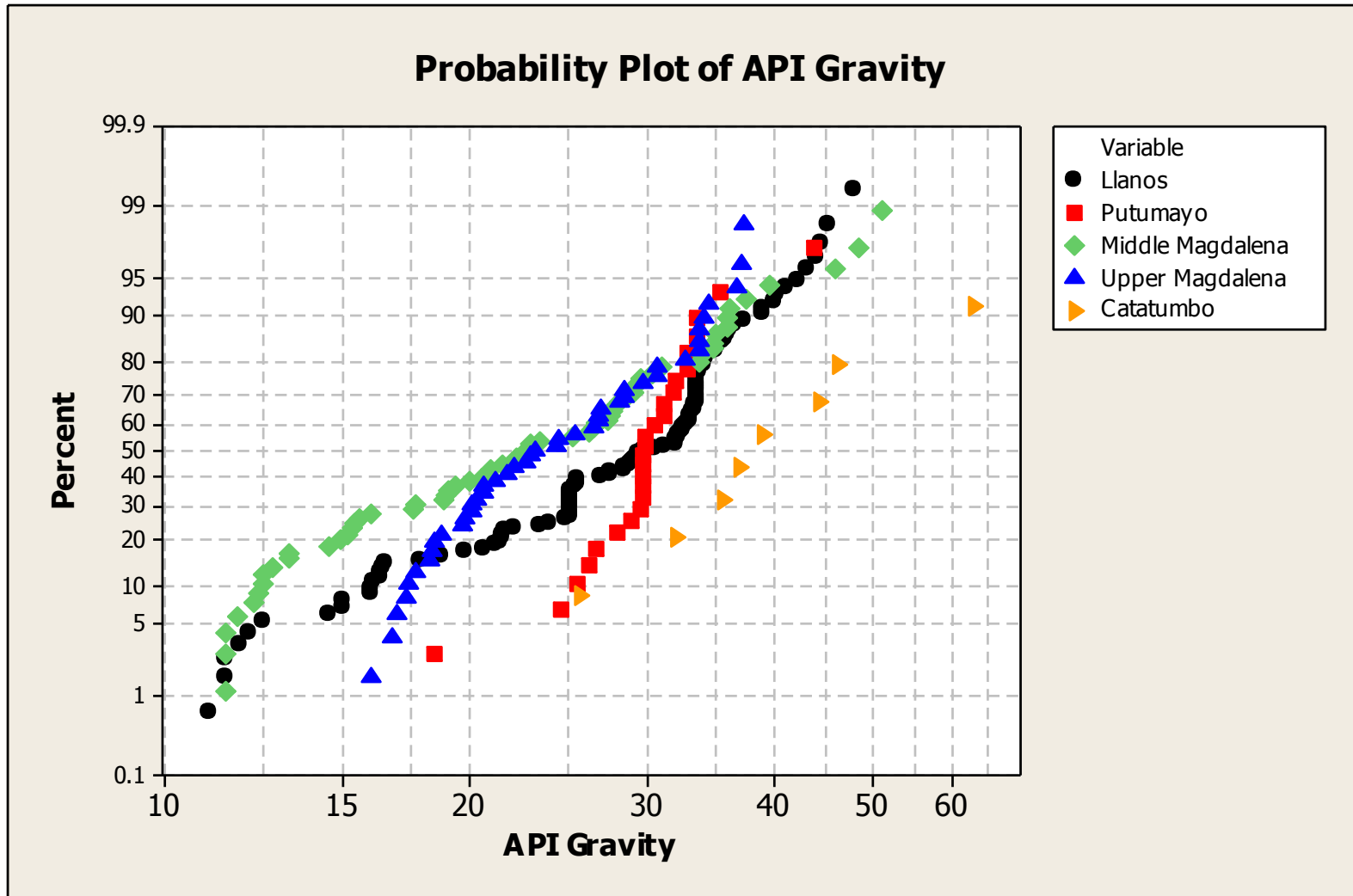
Generalized E-W Cross Section - Llanos Basin

## Trap styles within Llanos Basin

- ▶ Antithetic normal faults
- ▶ Inversion structures
- ▶ Thrust – related anticlines
- ▶ Stratigraphic traps
- ▶ Fault-propagation folds
- ▶ Similar traps anticipated in Pz rocks



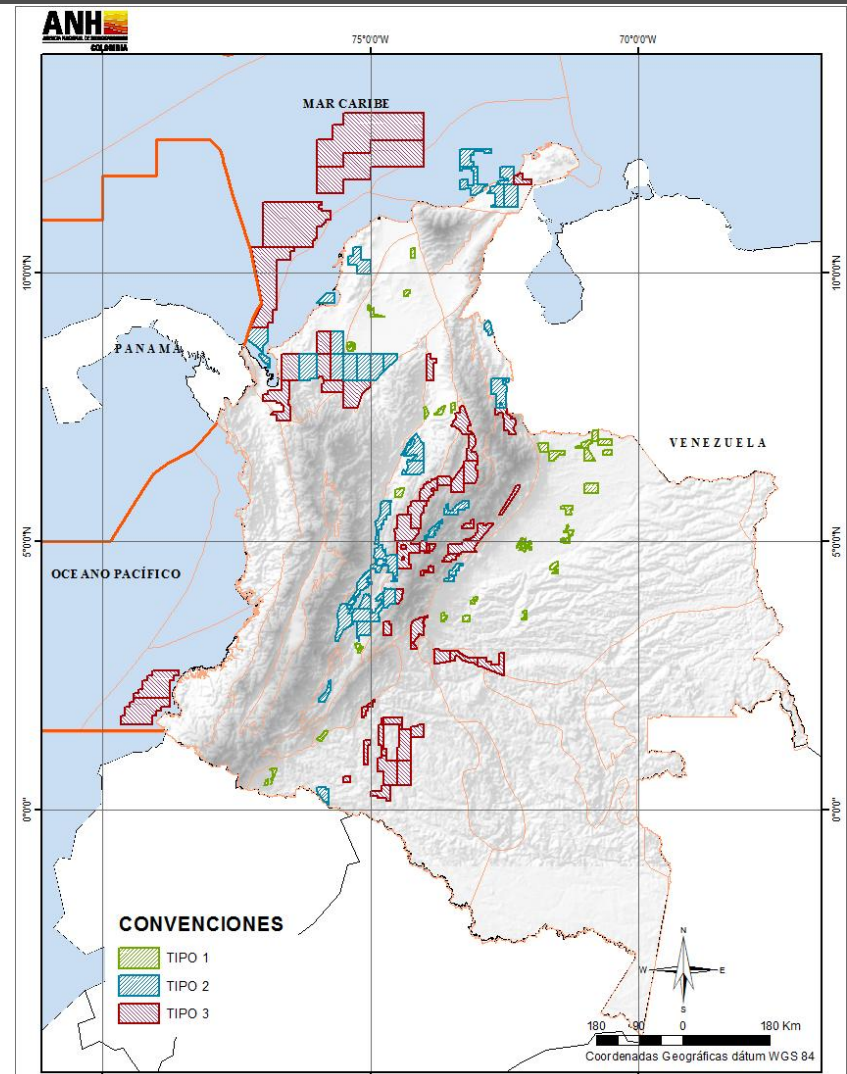
# Crude Oil Quality



# Colombia Round 2012

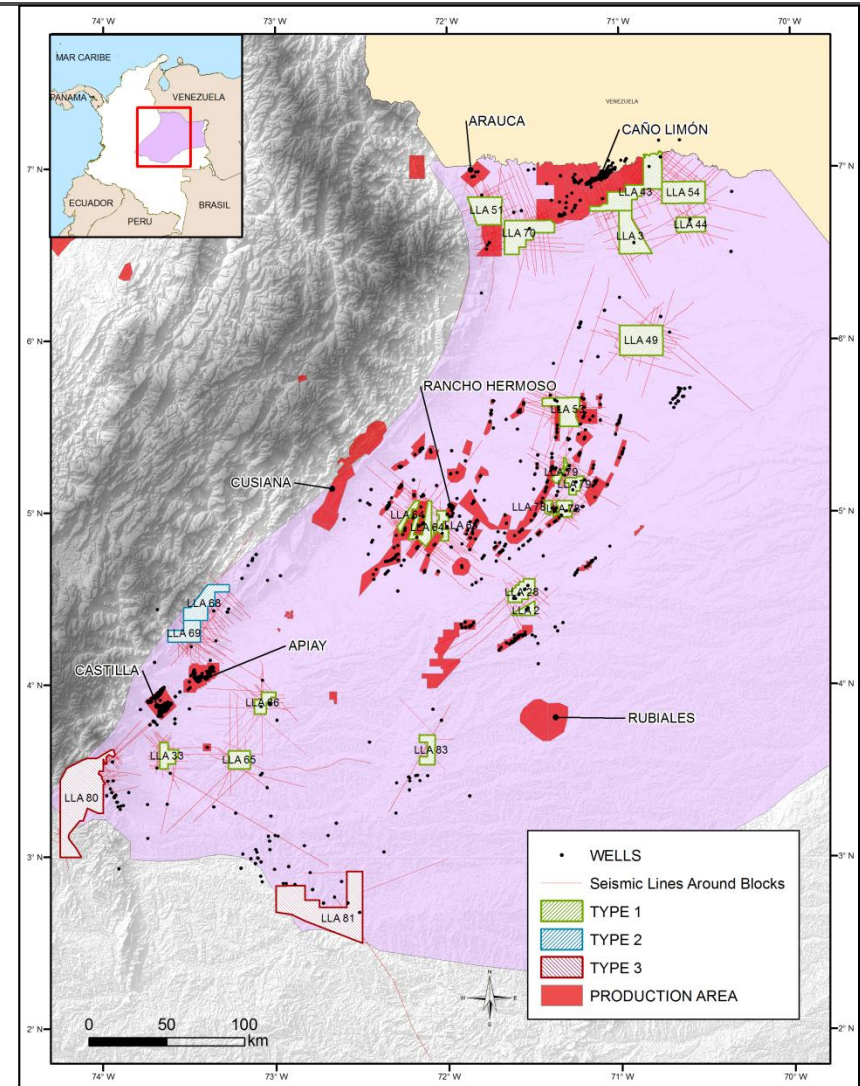
	Onshore	Offshore
Type 1 (Mature)	29	
Type 2 (Emerging)	29	5
Type 3 (Frontier)	40	6
<b>TOTAL</b>	<b>98</b>	<b>11</b>

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

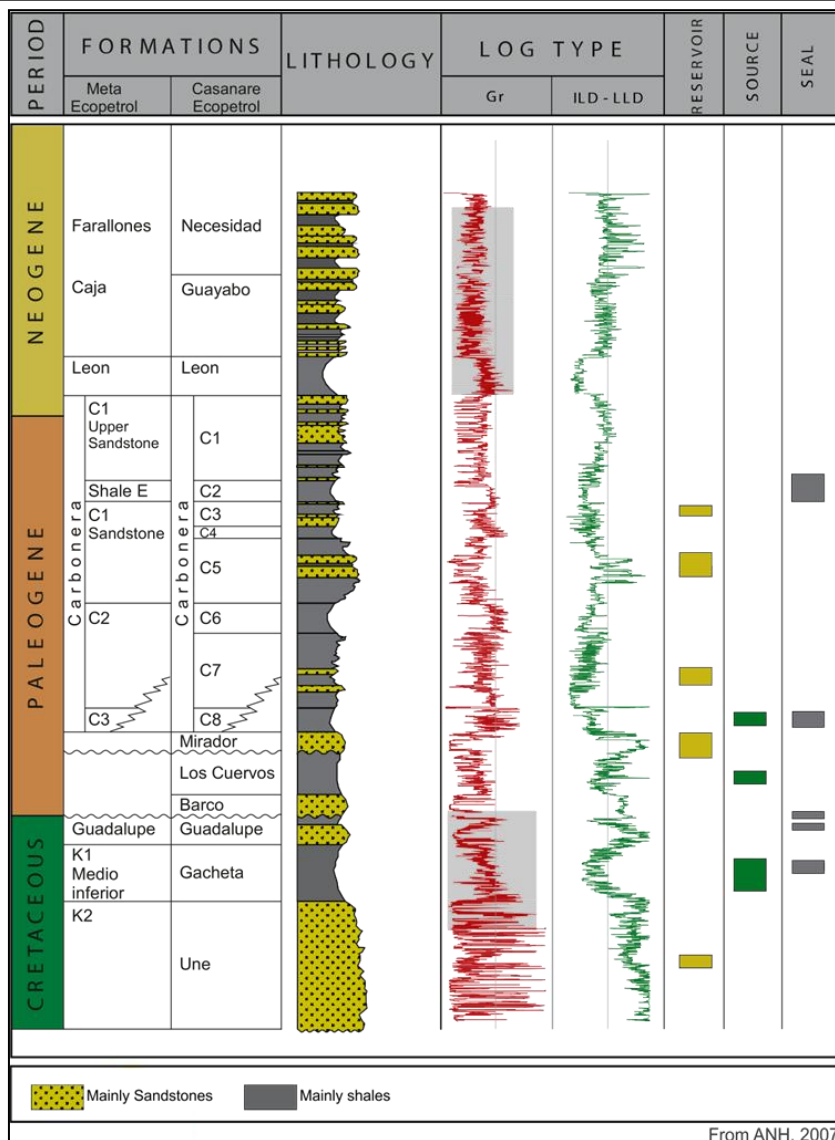


# Llanos Basin

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



# Llanos Basin



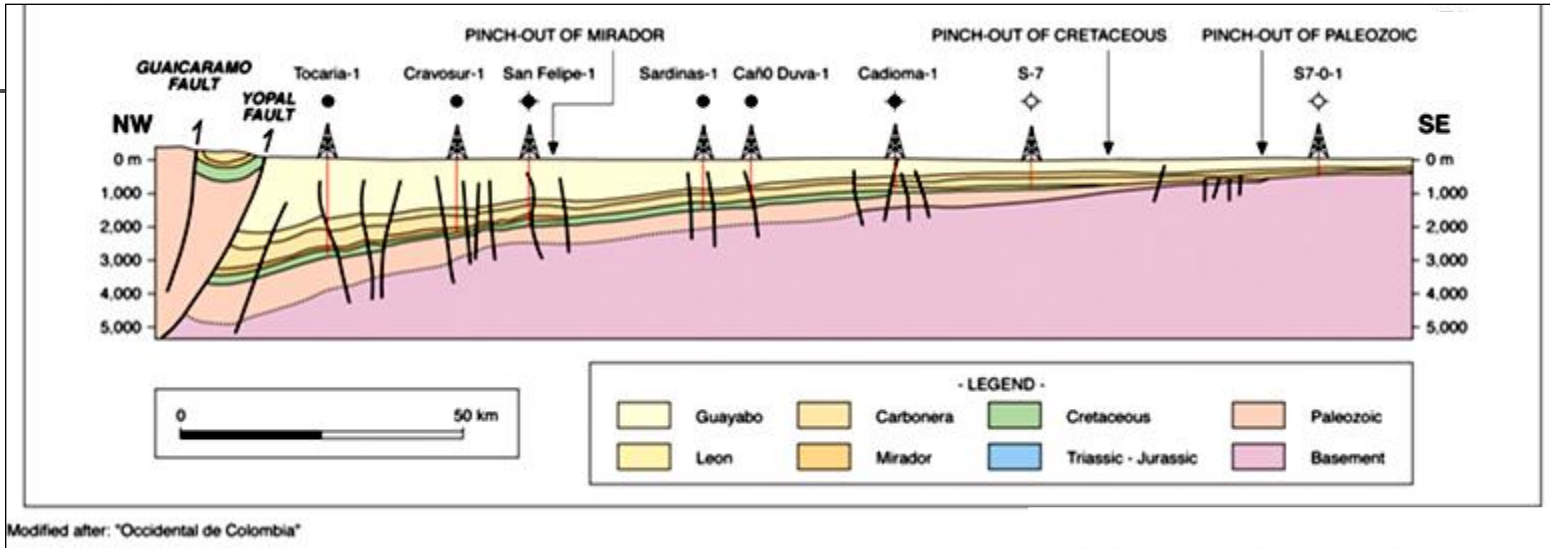
## PETROLEUM SYSTEM

**K** (Gacheta) – **K** (Une)

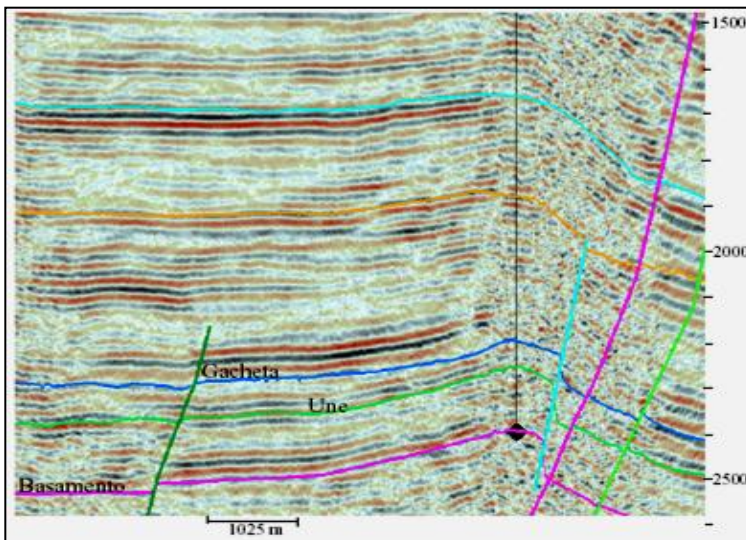
**K** (Gacheta) – **P** (Mirador - Carbonera)



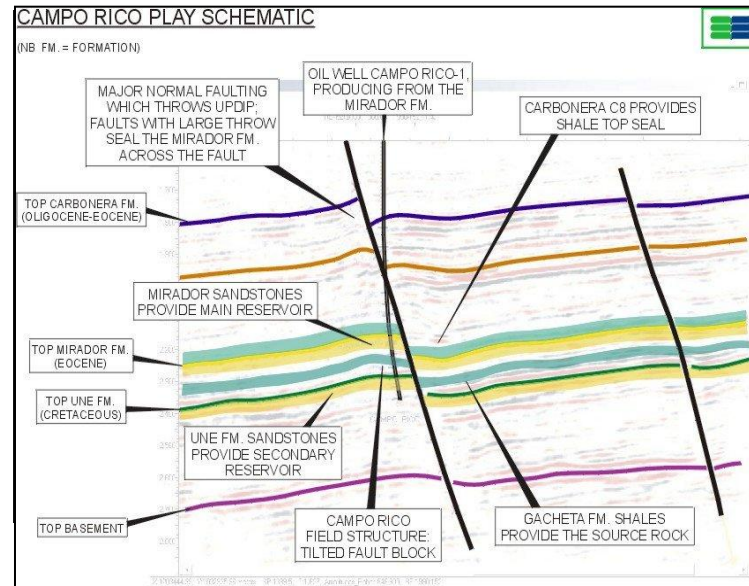
# Structural Styles



**Inversion structure**

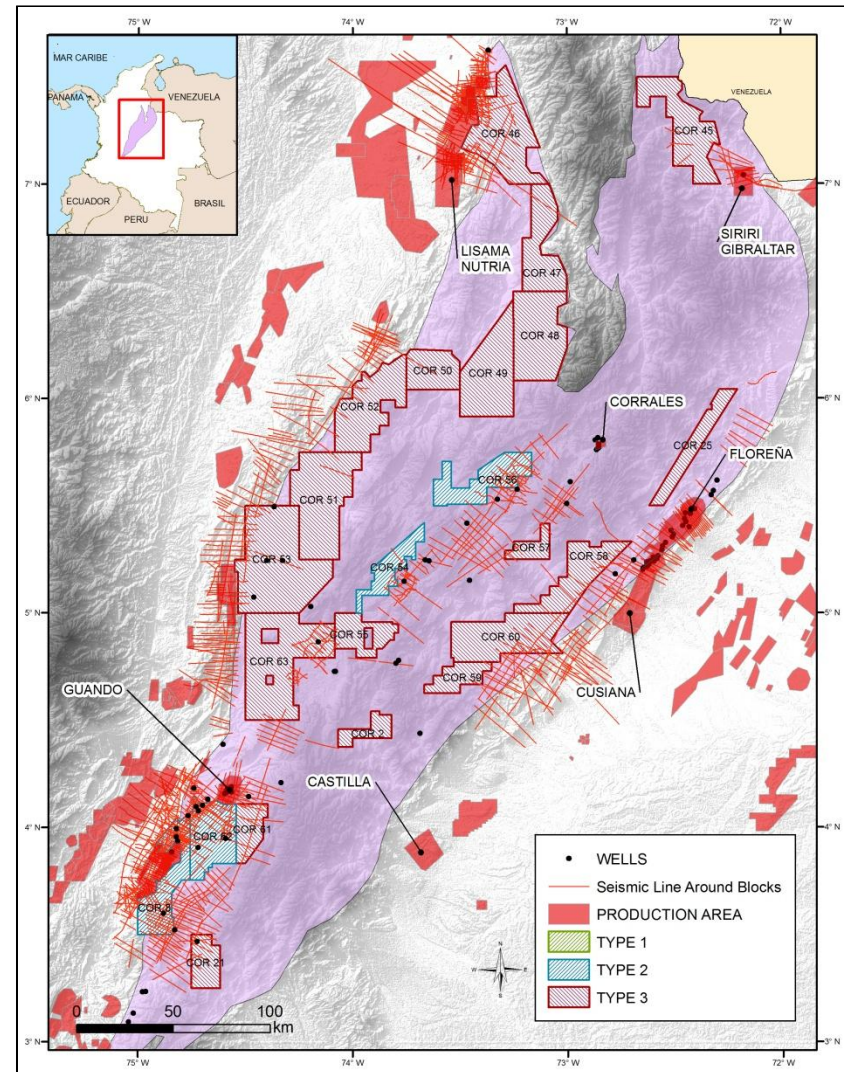


**Antithetic normal fault**



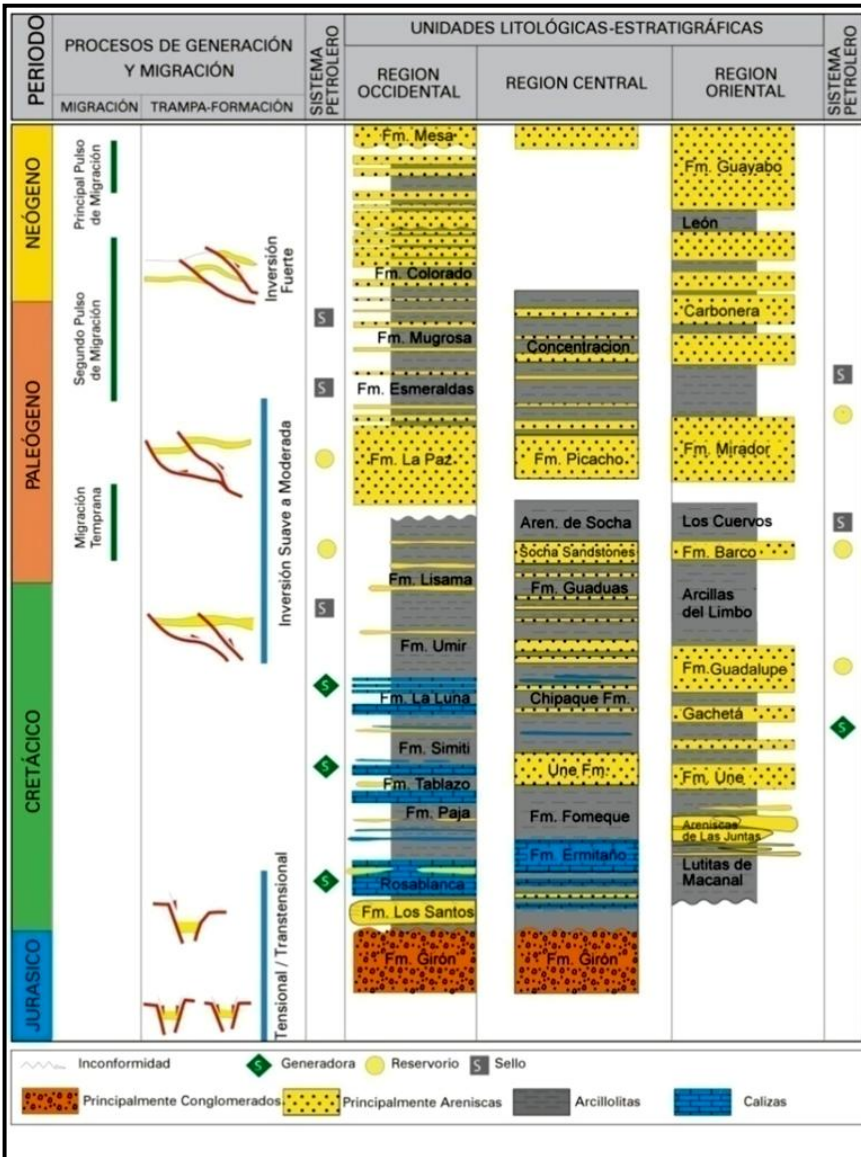
# Eastern Cordillera Basin

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





# Eastern Cordillera Basin



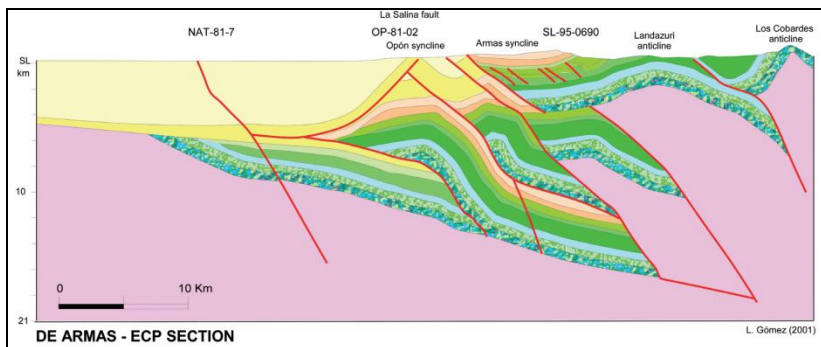
## PETROLEUM SYSTEM

**K** (Gacheta- La Luna) – **K** (Guadalupe)

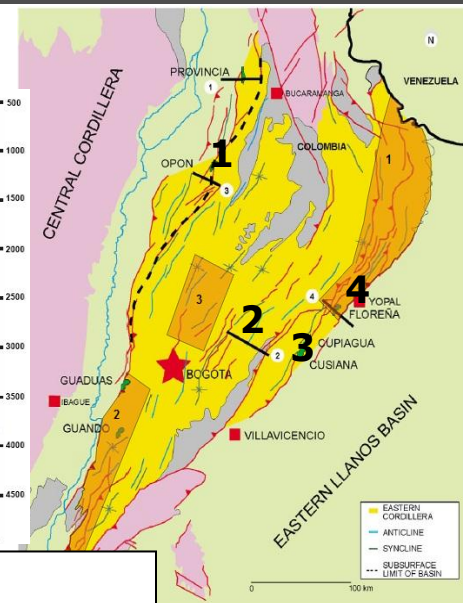
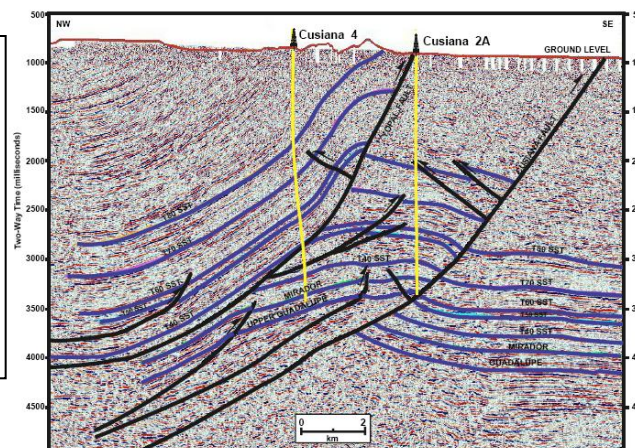
**K** (Gacheta- La Luna) – **P** (Barco-Mirador)

# Structural Styles

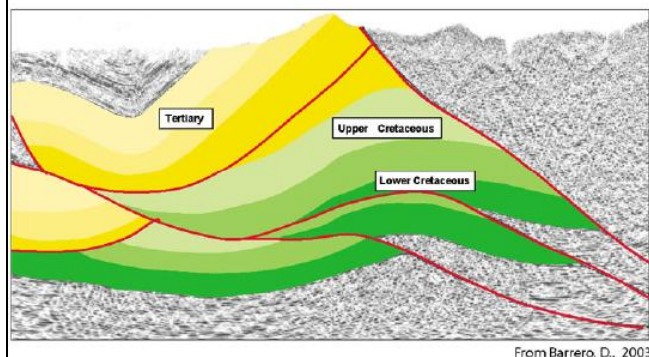
## 1. Sub thrust anticline



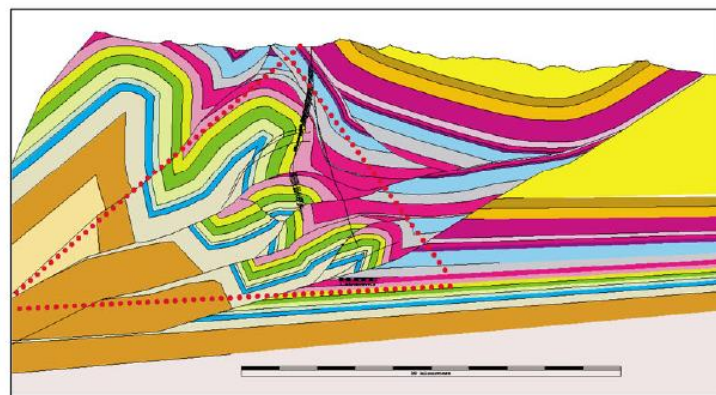
## 3. Cusiana field



## 2. Triangle zone – Río Horta



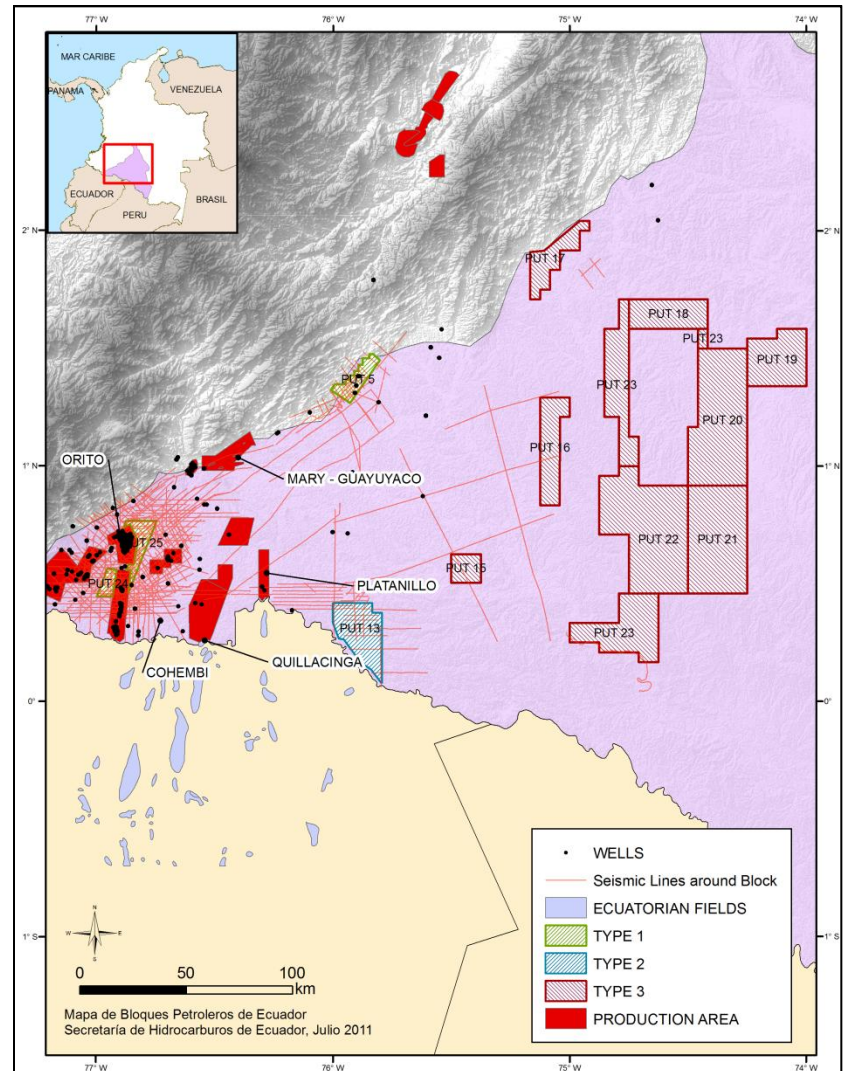
## 4. Duplex structure – Floreña area



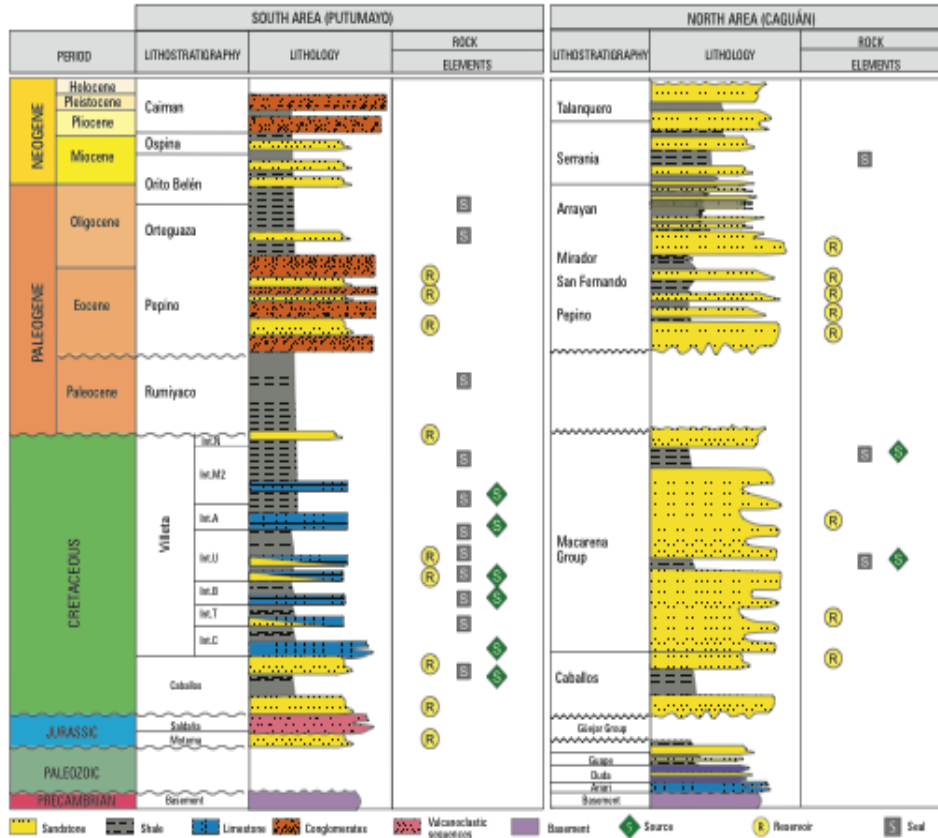


# Caguán–Putumayo Basin

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



# Caguán–Putumayo Basin

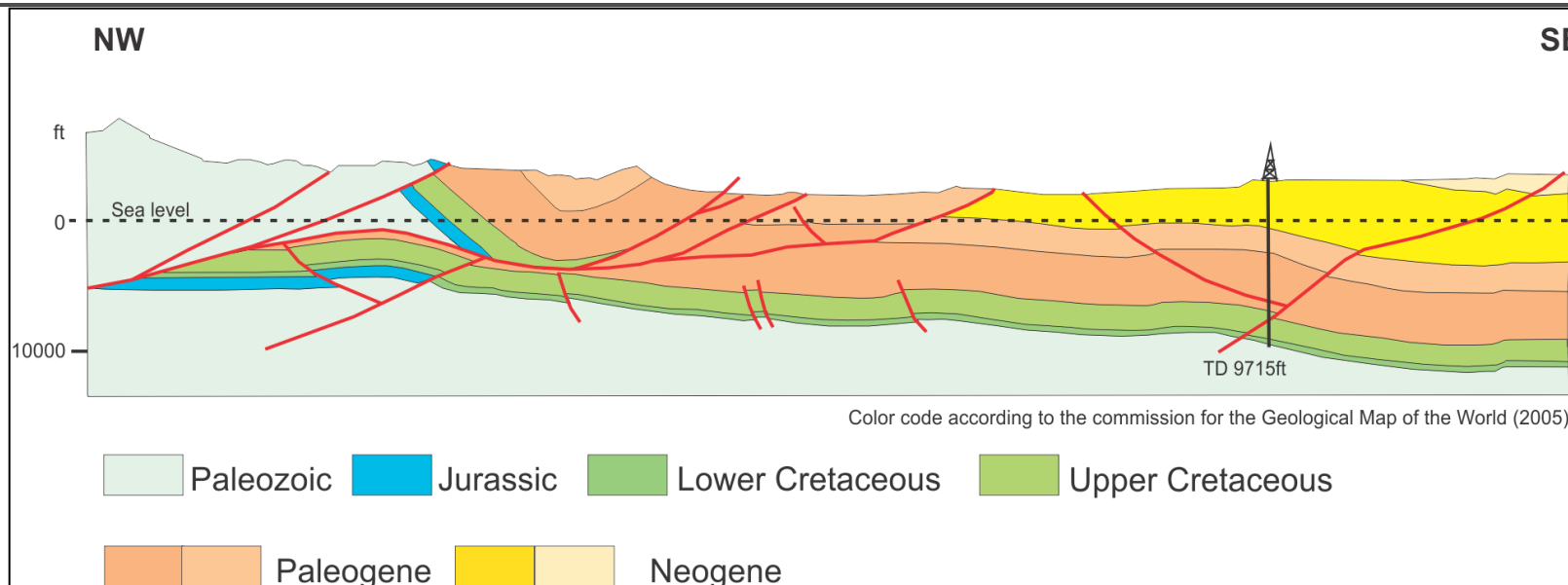


## PETROLEUM SYSTEM

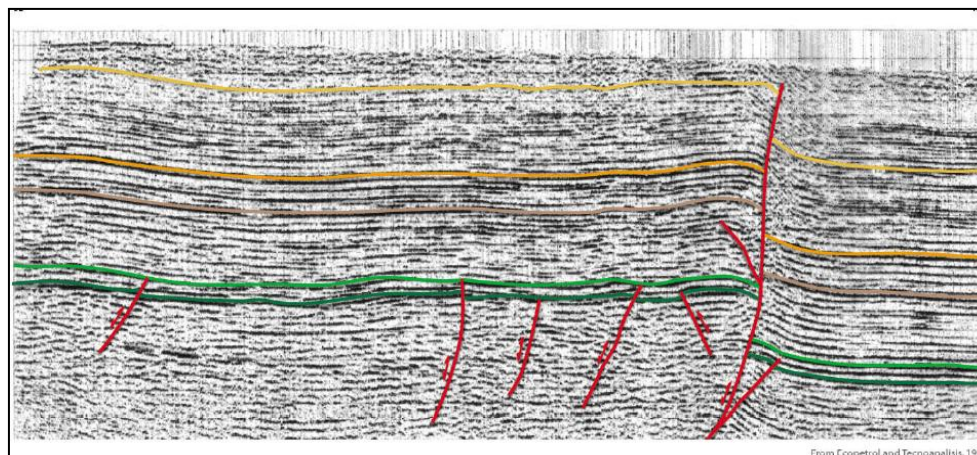
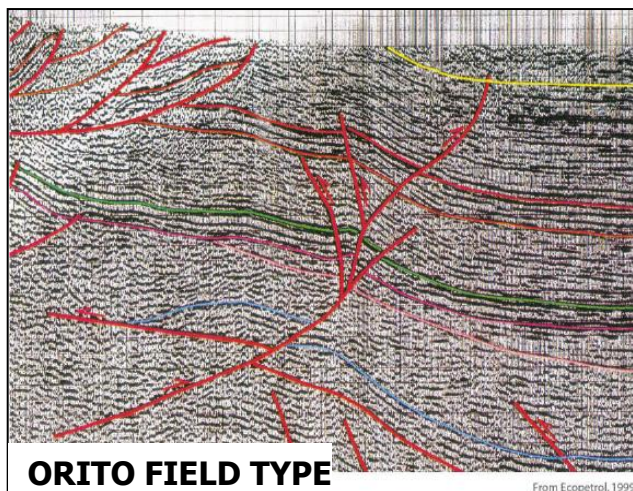
**K** (Caballos-Villeta) – **K** (Caballos-Villeta)

**K** (Caballos-Villeta) – **P** (Papino)

# Structural Styles



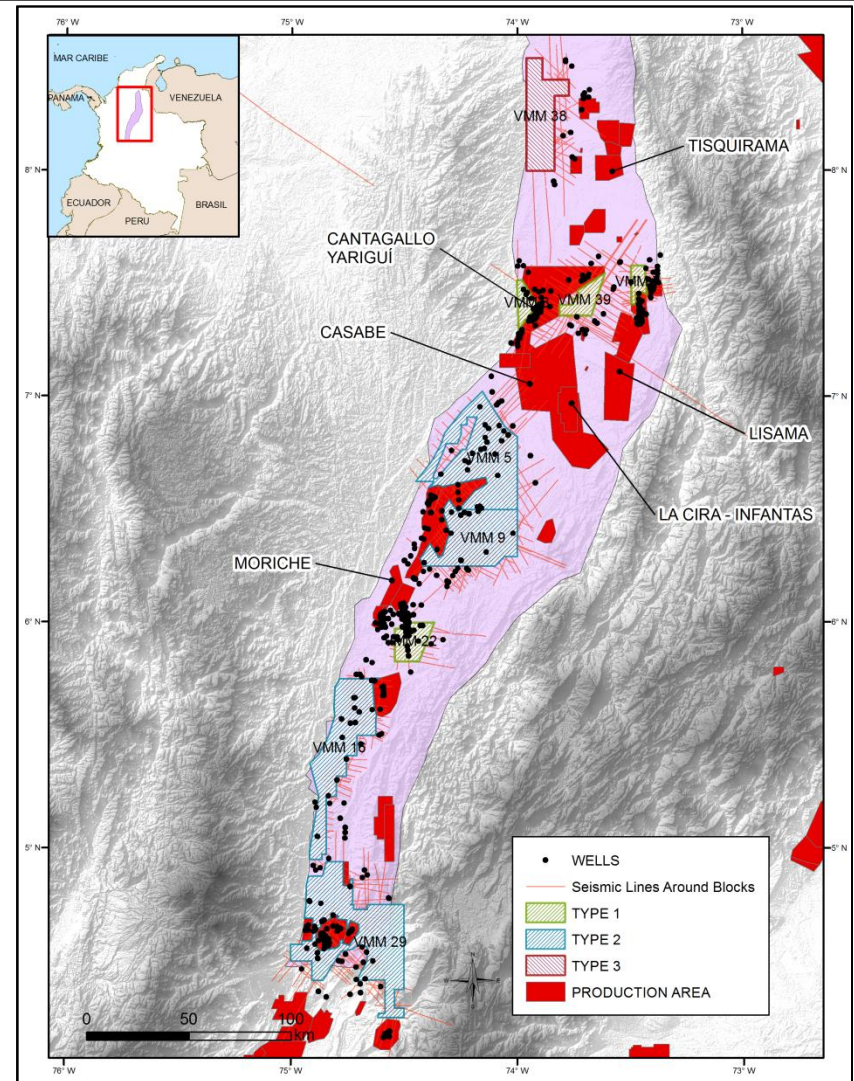
## Inversion structure



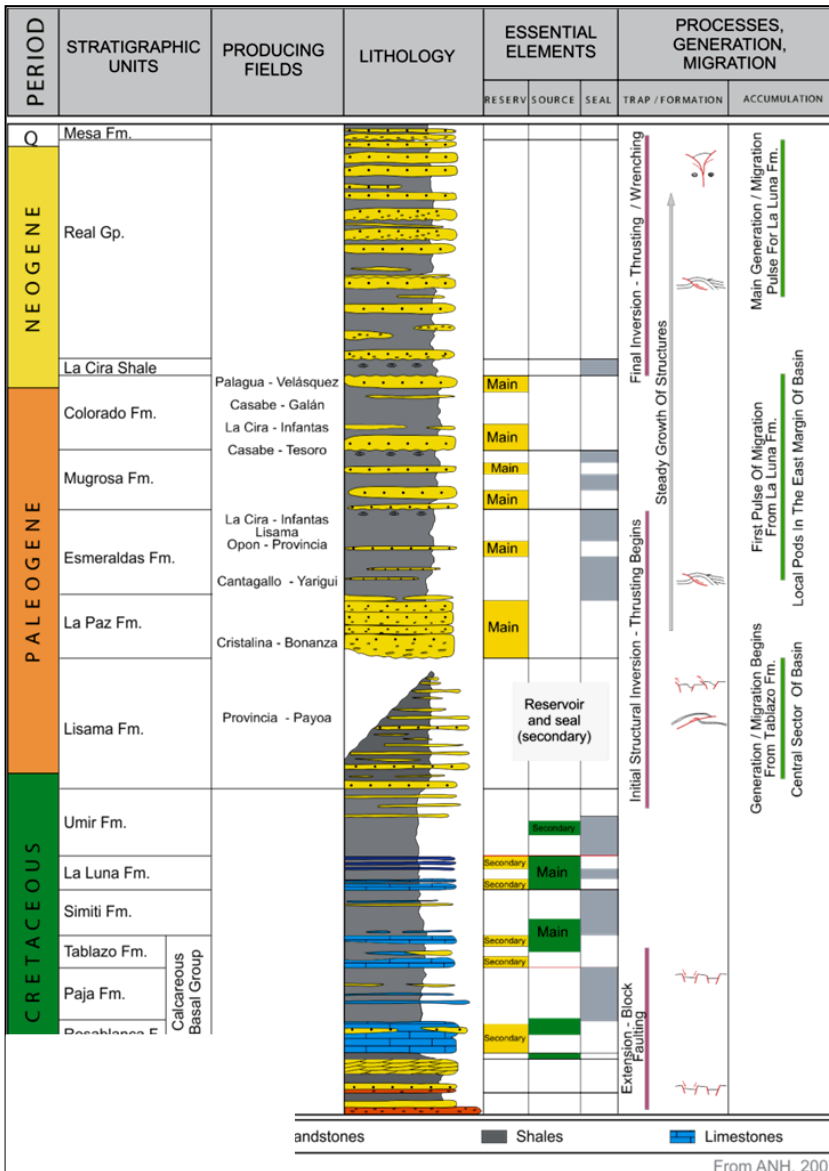


# Middle Magdalena Basin (VMM)

- It has additional exploration potential and is one of the most prolific basins in the country.
- Unexplored Cretaceous carbonates.
- A preliminary assessment of the hydrocarbon resources suggests that the basin is also prospective for *Oil Shale* and *Shale Gas*.



# Middle Magdalena Basin (VMM)

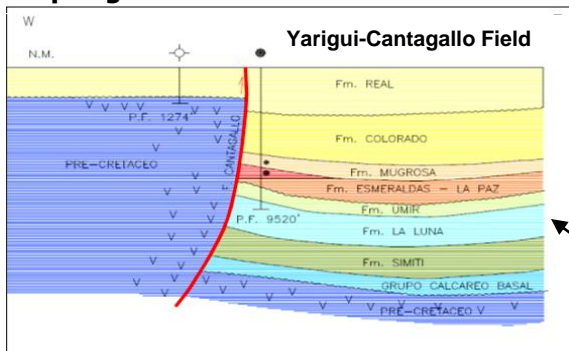


## PETROLEUM SYSTEM

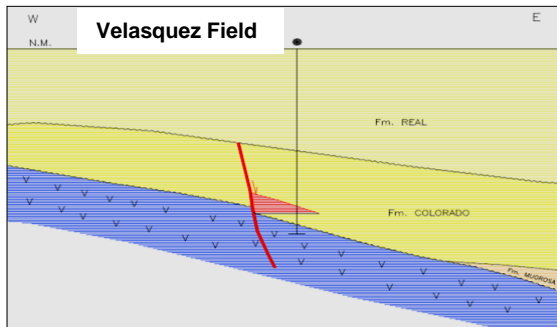
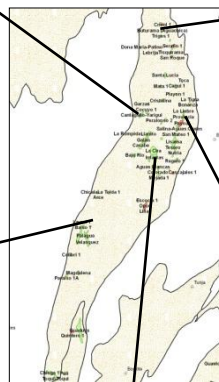
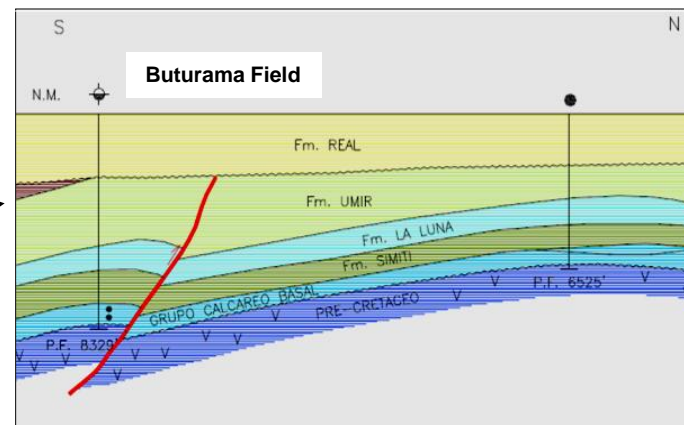
**K** (La Luna) – **P** (La Paz, Mugrosa, Colorado)

# Structural Styles

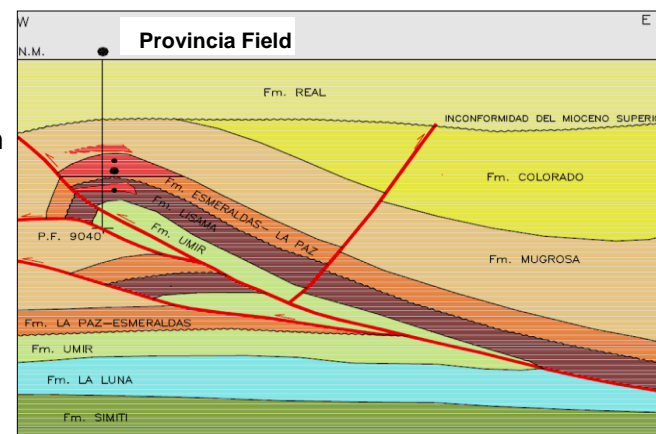
**Faulted traps against basement of the Central Cordillera**



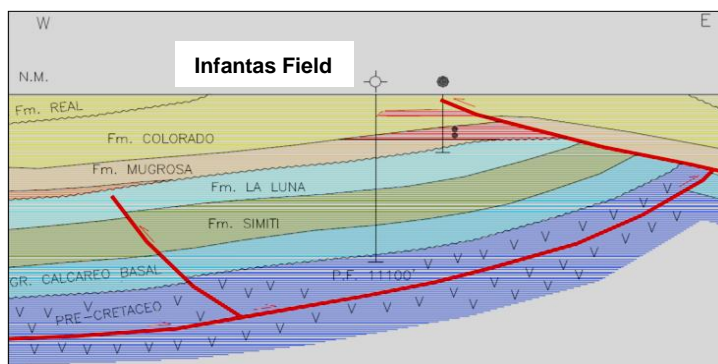
**Lower Cretaceous fractured limestones**



**Fold Propagation Fault**



**Subthrusts structures associated to Andean deformation**

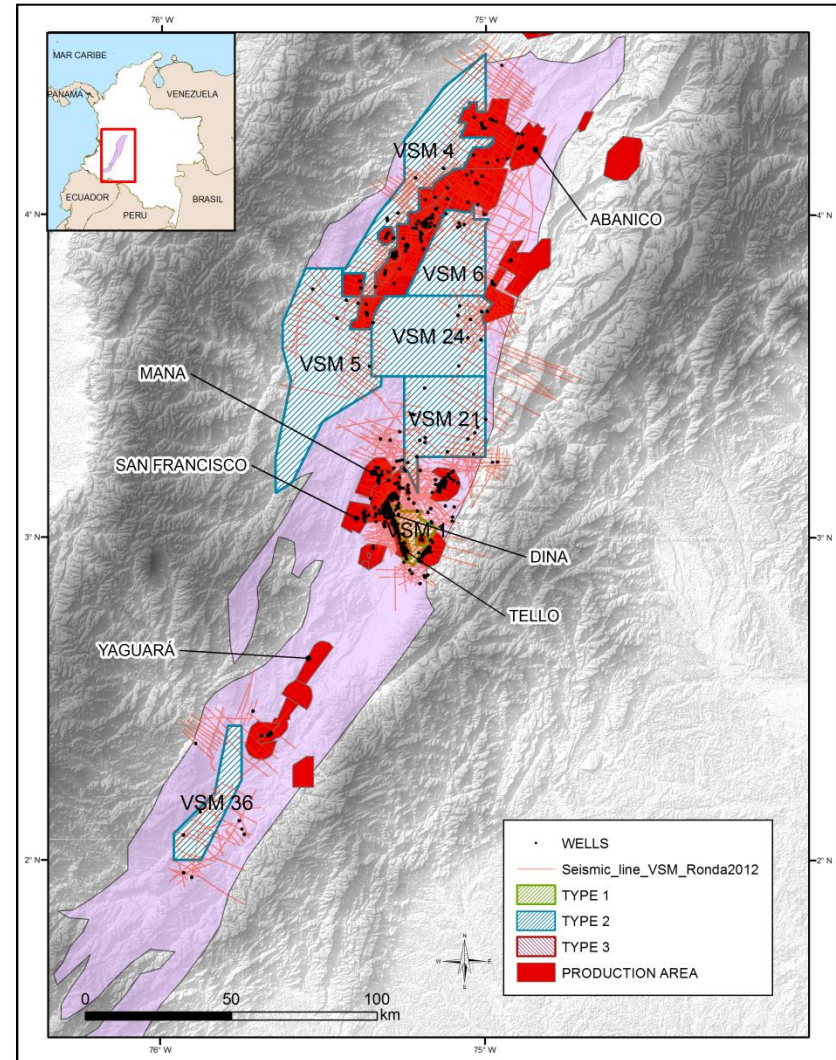


**Normal fault traps - eastward dipping monocline**

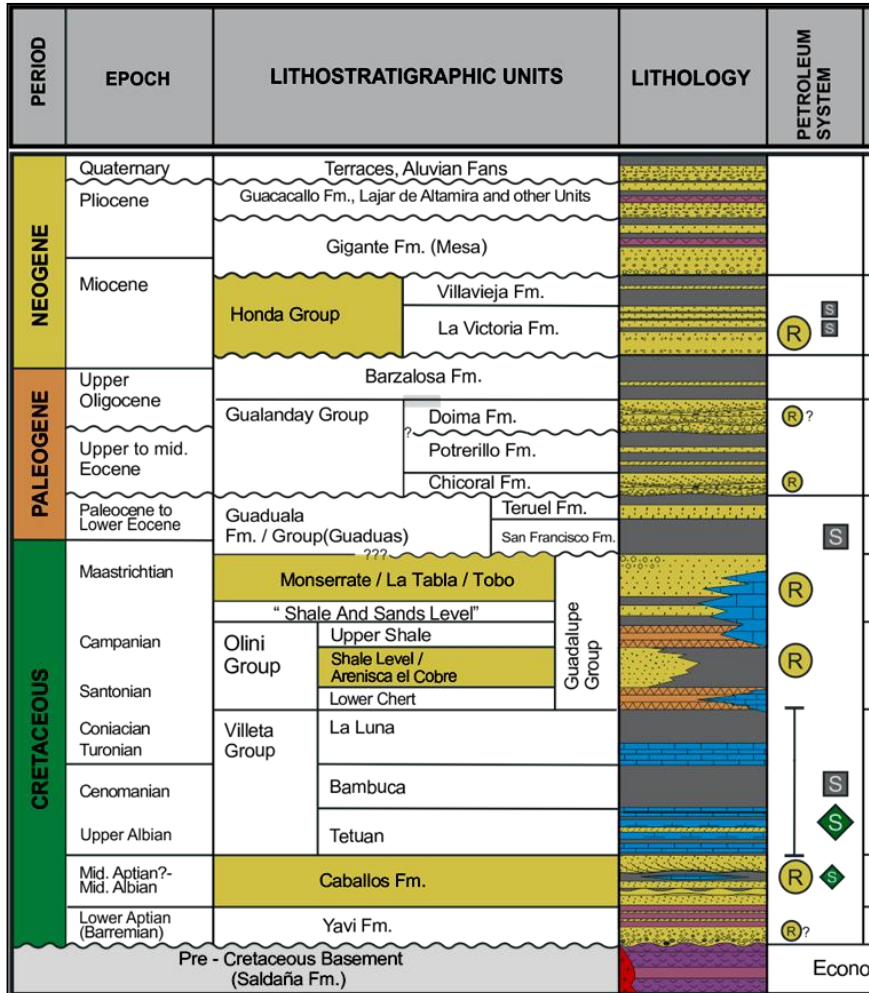


# Upper Magdalena Basin (VSM)

➤ A preliminary assessment on the hydrocarbon resources of the country suggests that the basin is also prospective for *Oil Shale* and *Shale Gas*.



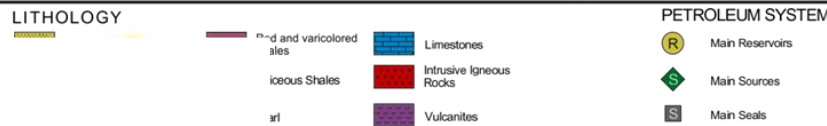
# Upper Magdalena Basin (VSM)



## PETROLEUM SYSTEM

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

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



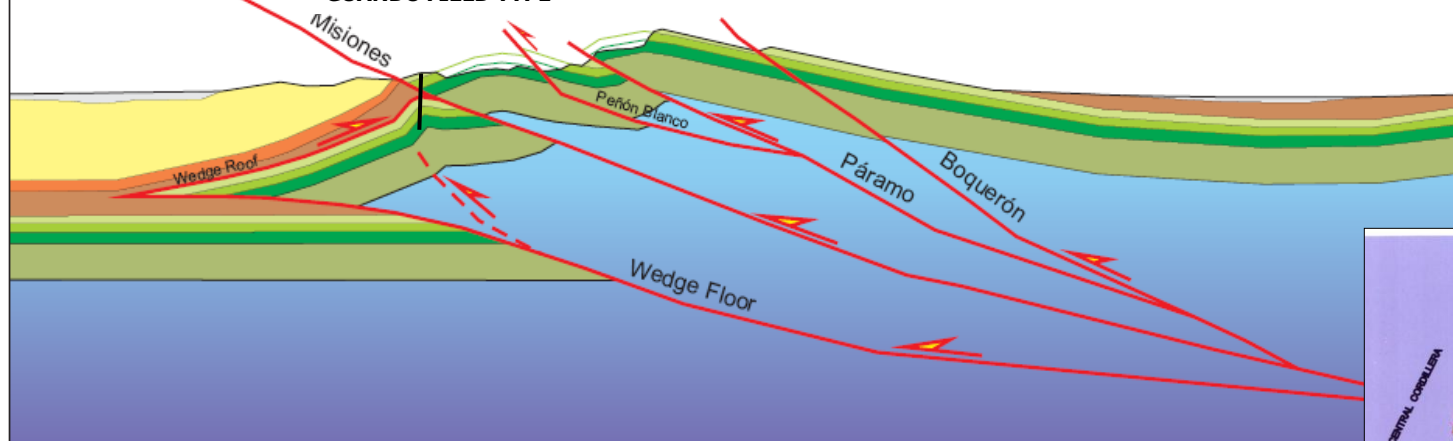


# Structural Styles

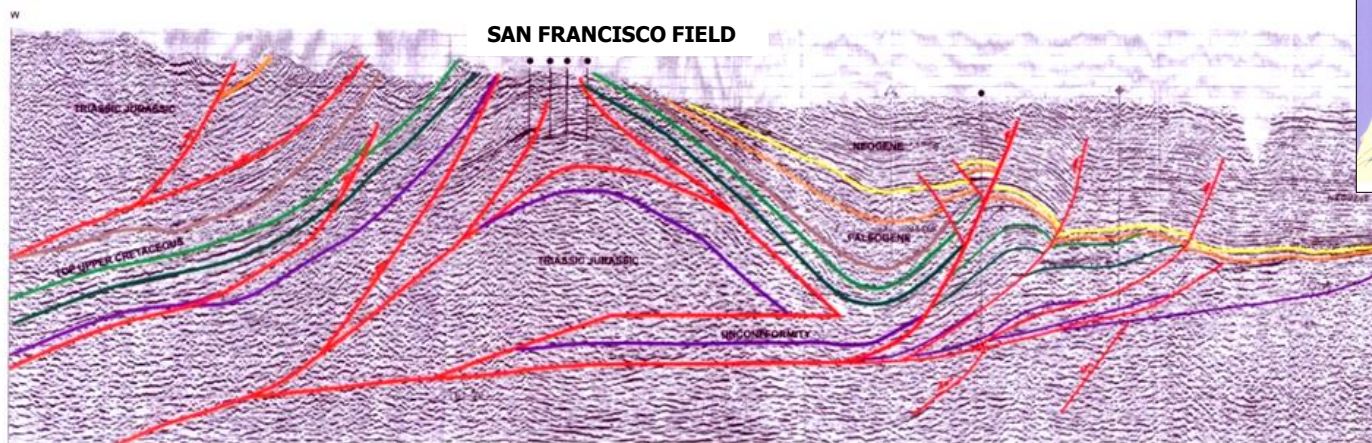
WNW

GUANDO FIELD TYPE

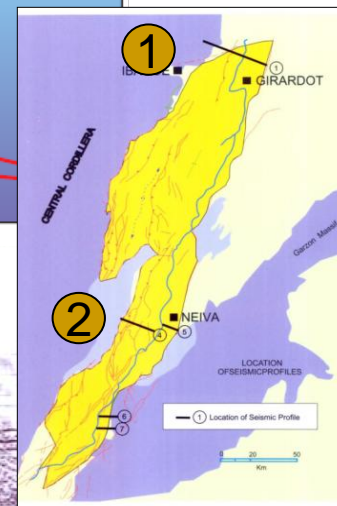
1- Sub-thrust and thrust anticlines



2- Fault Bend Fold and imbricate thrust fans

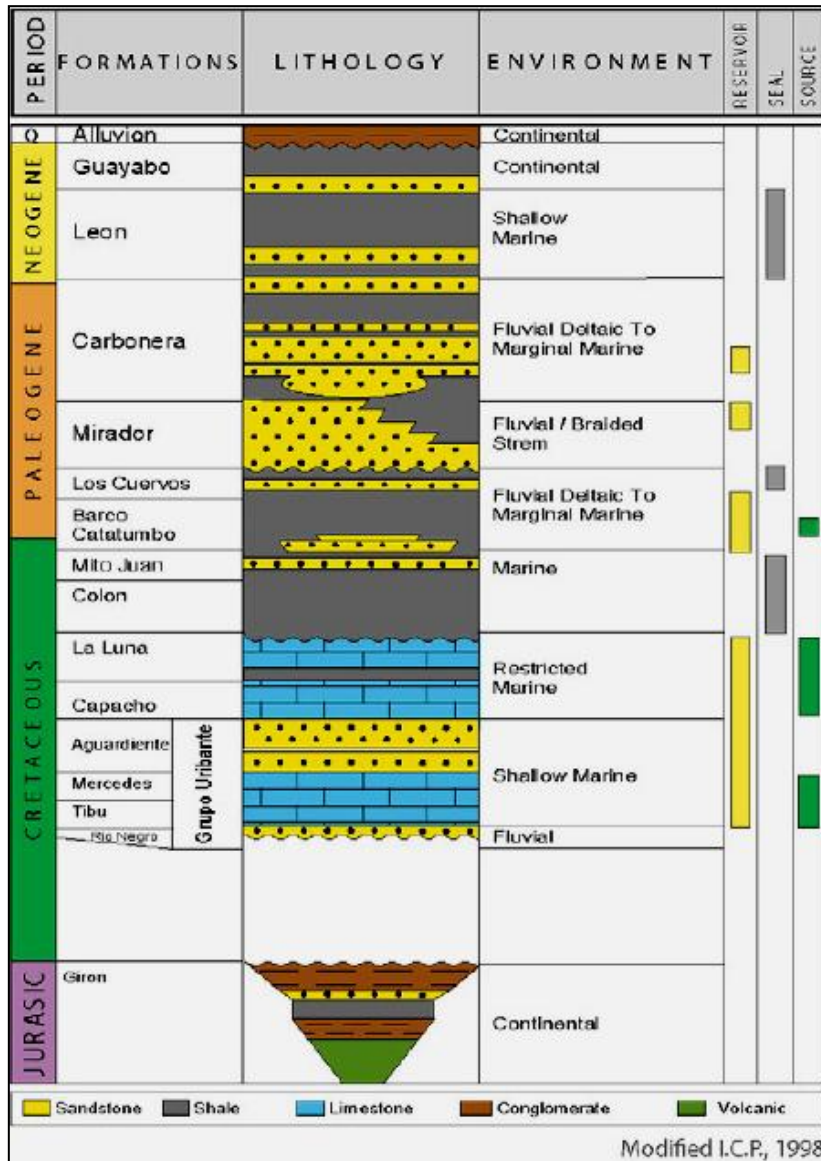


From Seismic Atlas, 1998





# Catatumbo Basin (CAT)



Modified I.C.P., 1998

## PETROLEUM SYSTEM

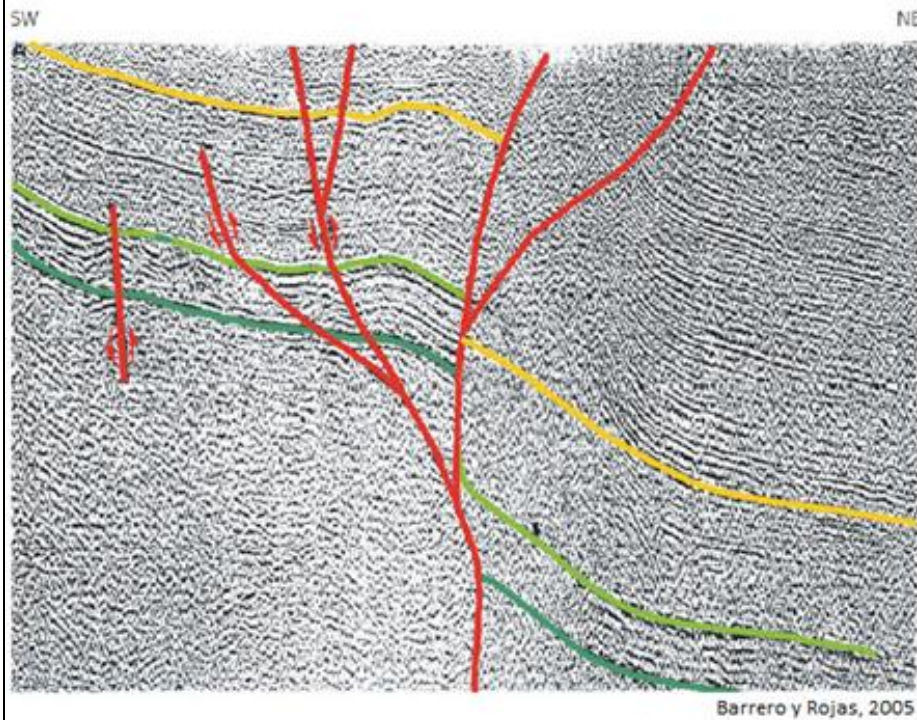
**K** (Uribante, La Luna) – **K** (Uribante, La Luna)

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

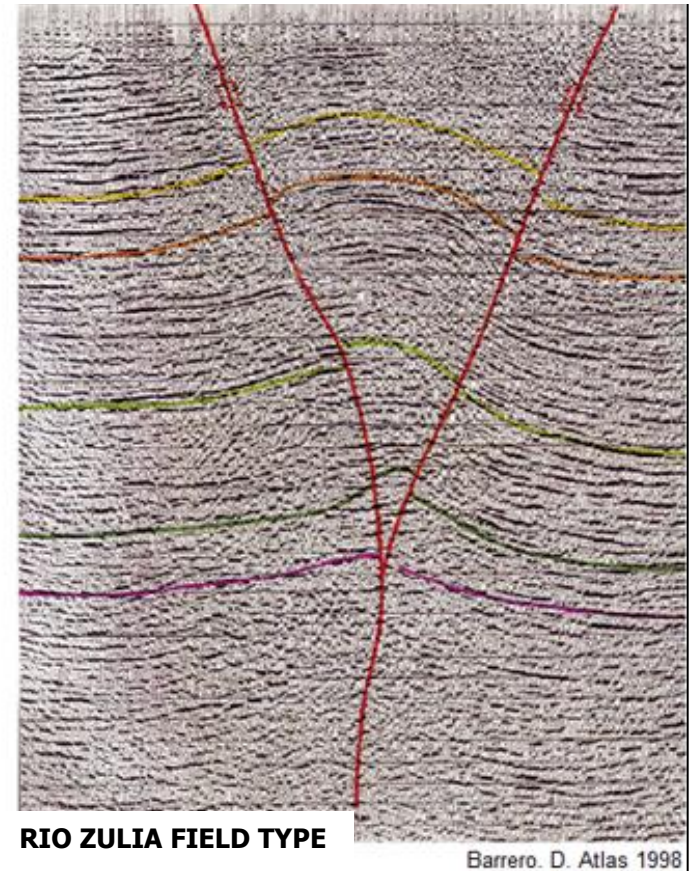


# Structural Styles

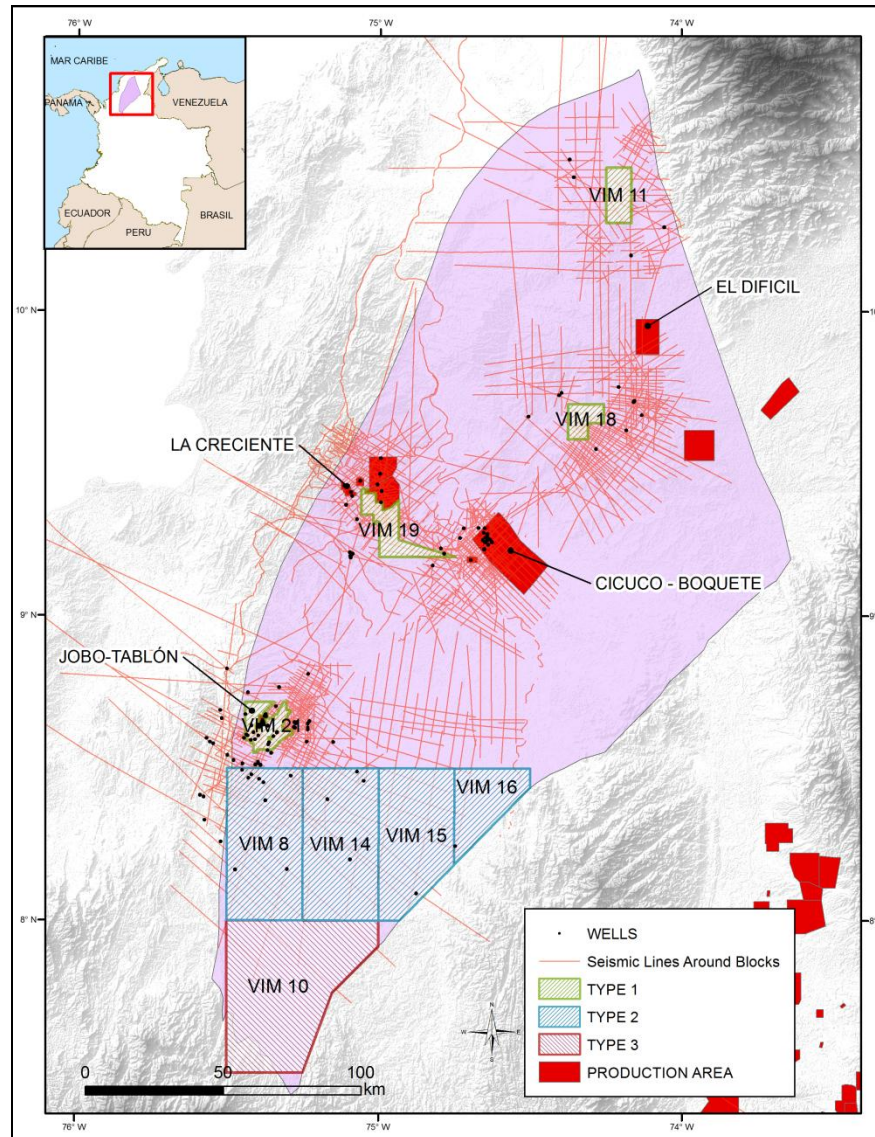
1- Closures on both hanging-wall and foot-wall of faults developed under transpression



2- Anticline traps (Flower Structures) developed under wrenching conditions

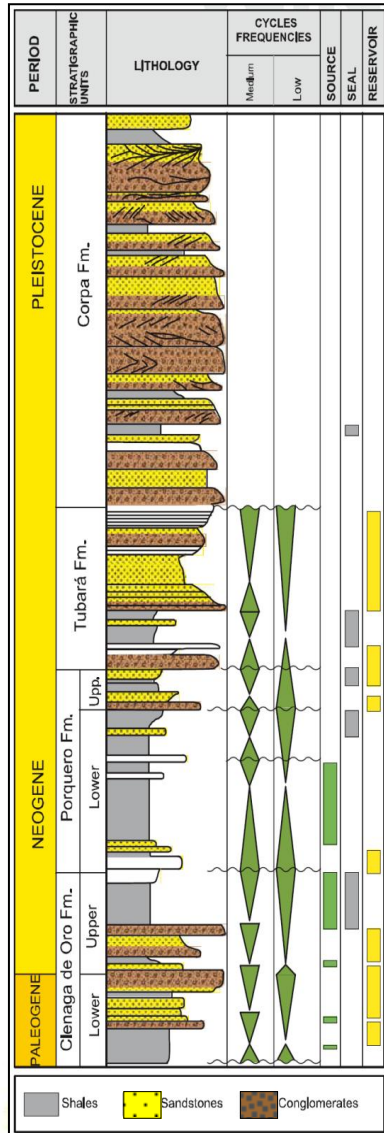


# Lower Magdalena Basin (VIM)





# Lower Magdalena Basin (VIM)



## PETROLEUM SYSTEM

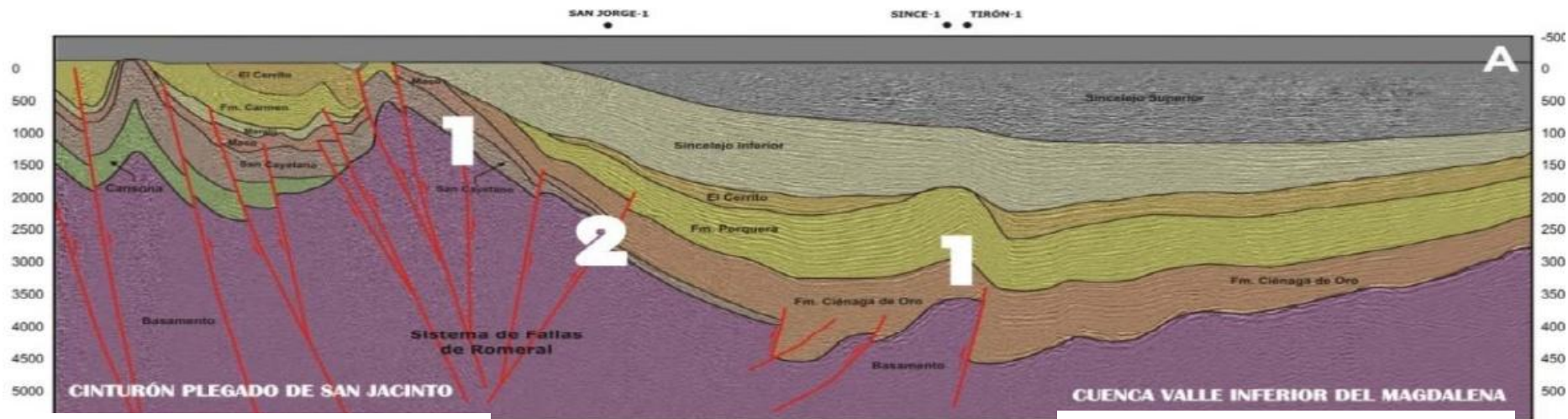
**P** (Ciénaga de Oro) – **N** (Ciénaga de Oro, Tubará)

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

Barrero et al, 2008

# Structural Styles

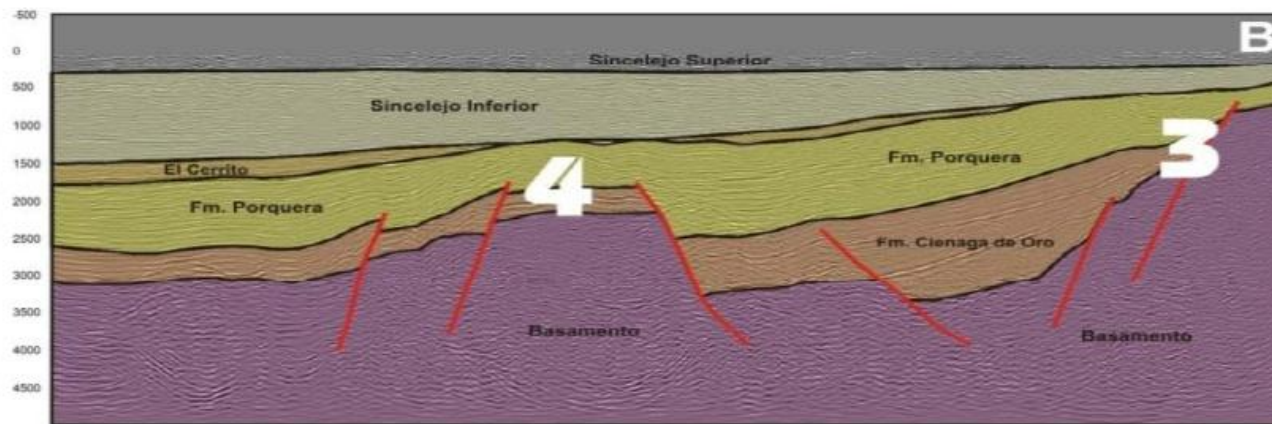
1- Inversion anticlines    2- Fault juxtaposition traps    3- Pinch-outs against basement    4- Basement High



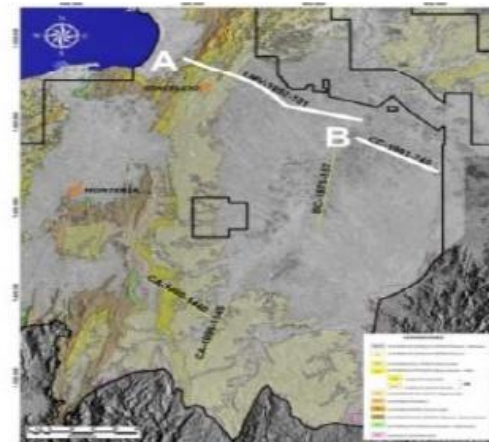
SAN JACINTO FOLD BELT

LMV-1992-101

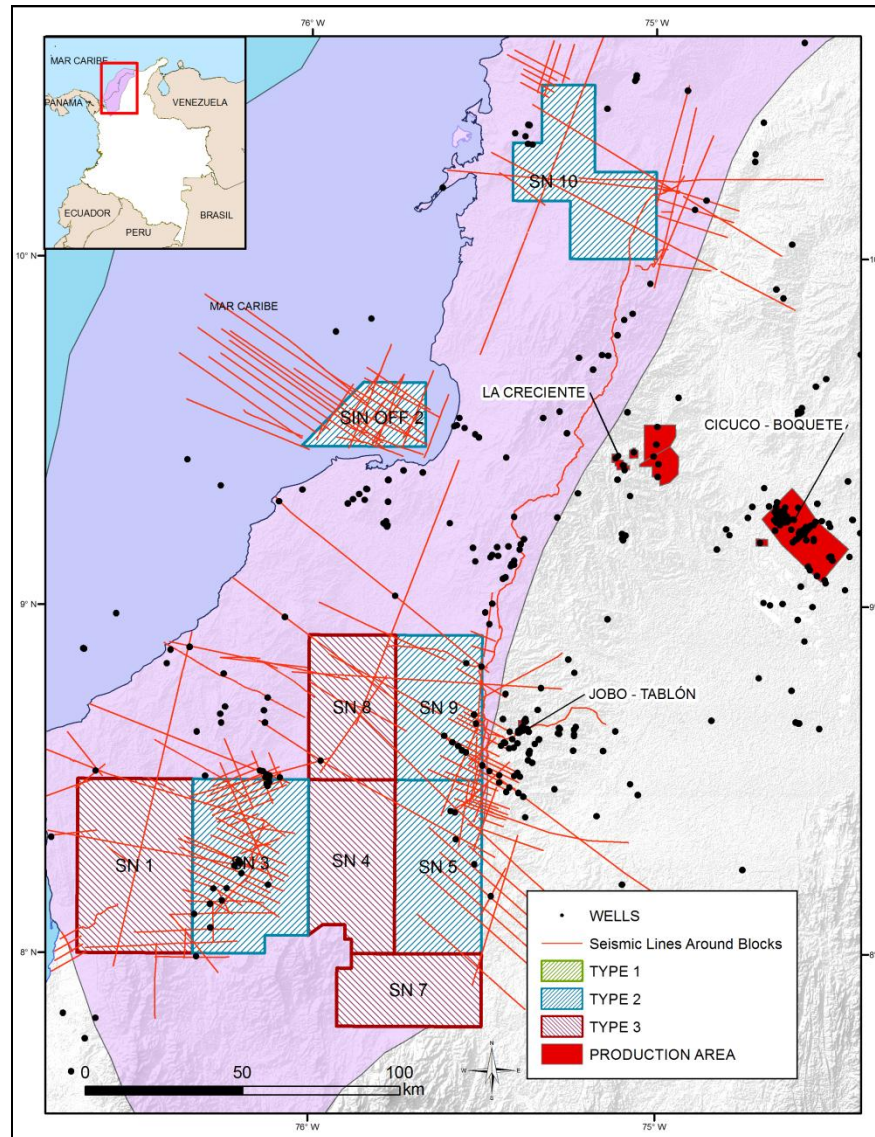
VIM BASIN



CC-1991-740

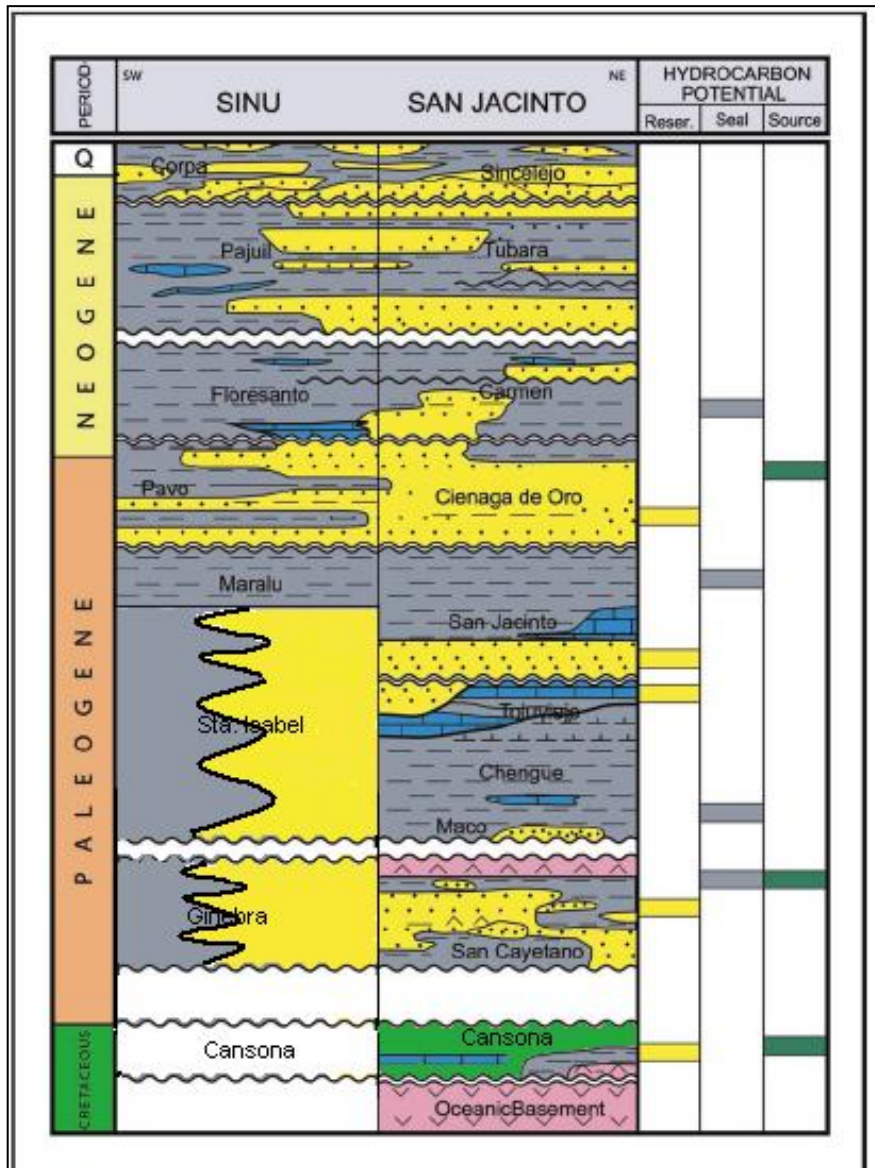


# Sinú–San Jacinto Onshore and Offshore Basins





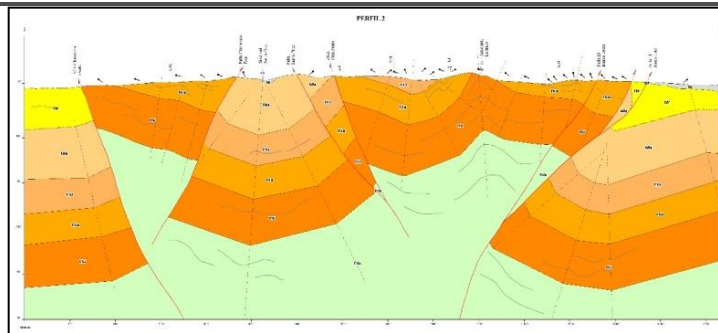
# Sinú– San Jacinto Onshore and Offshore Basins



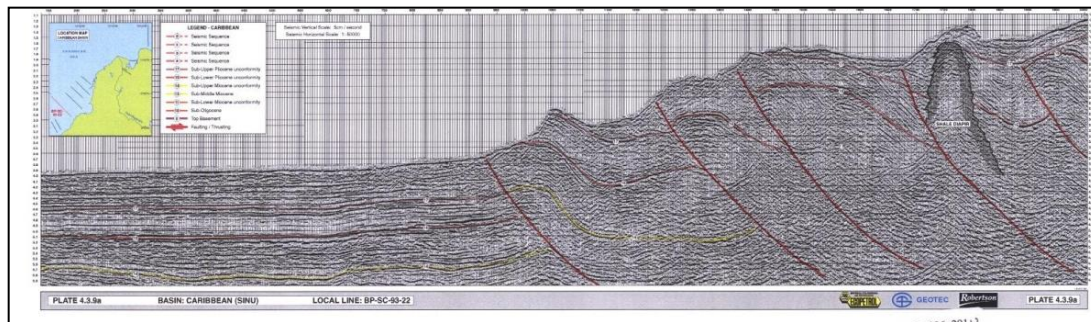
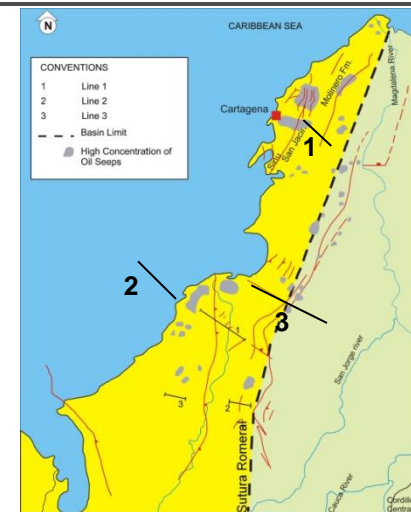
## PETROLEUM SYSTEM

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

# Structural Styles

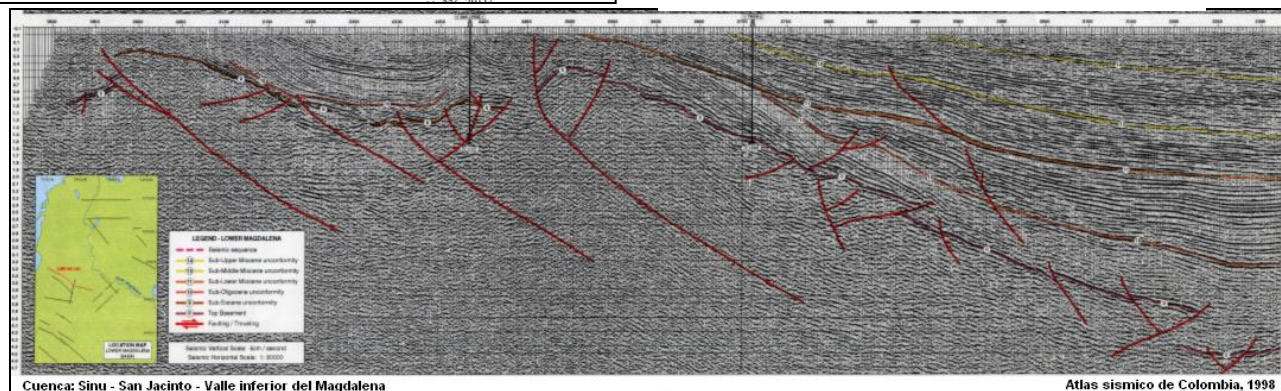


**1- Wrench structure – San Jacinto Fold Belt**



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

**3- Inversion structure - Romeral Fault System**

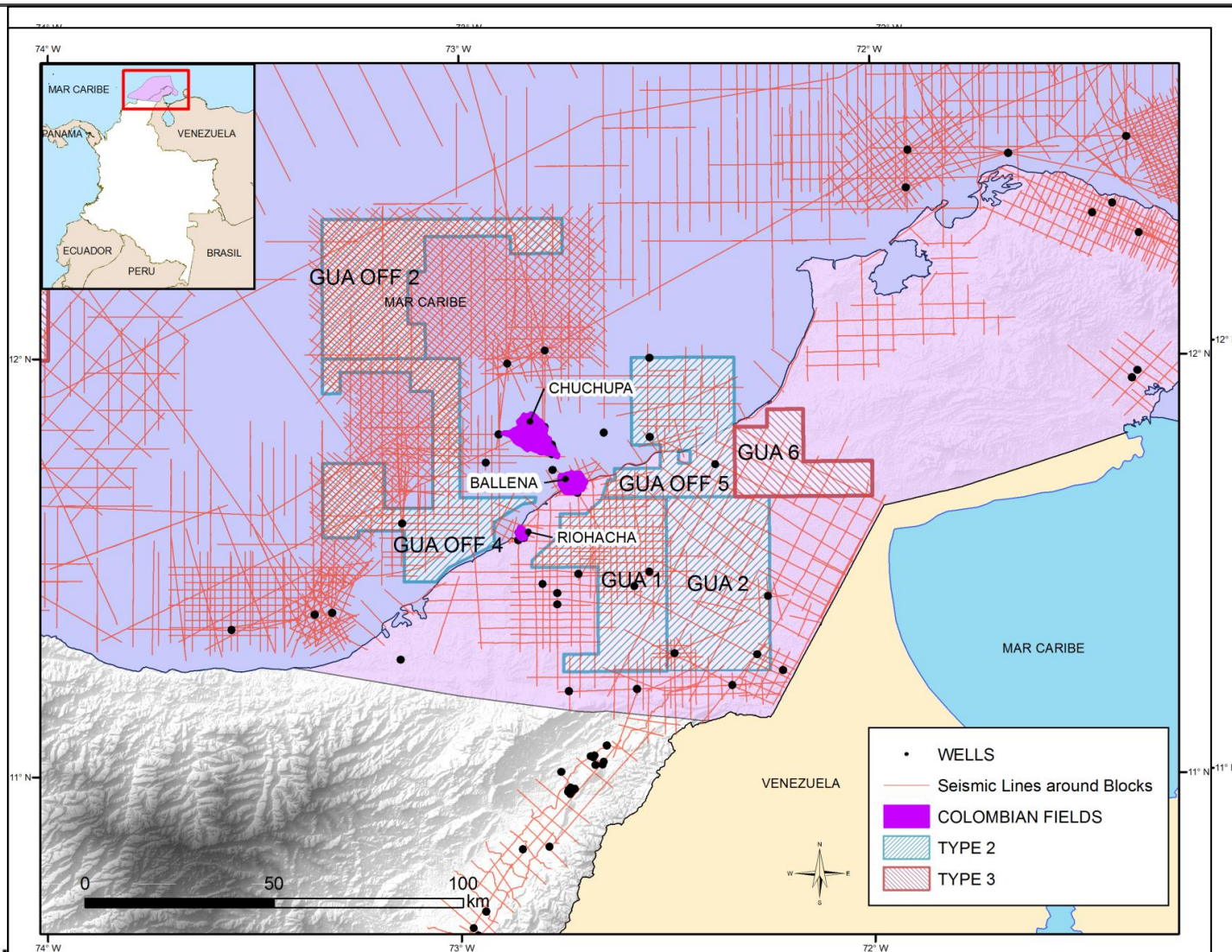


Cuenca Sinu - San Jacinto - Valle inferior del Magdalena

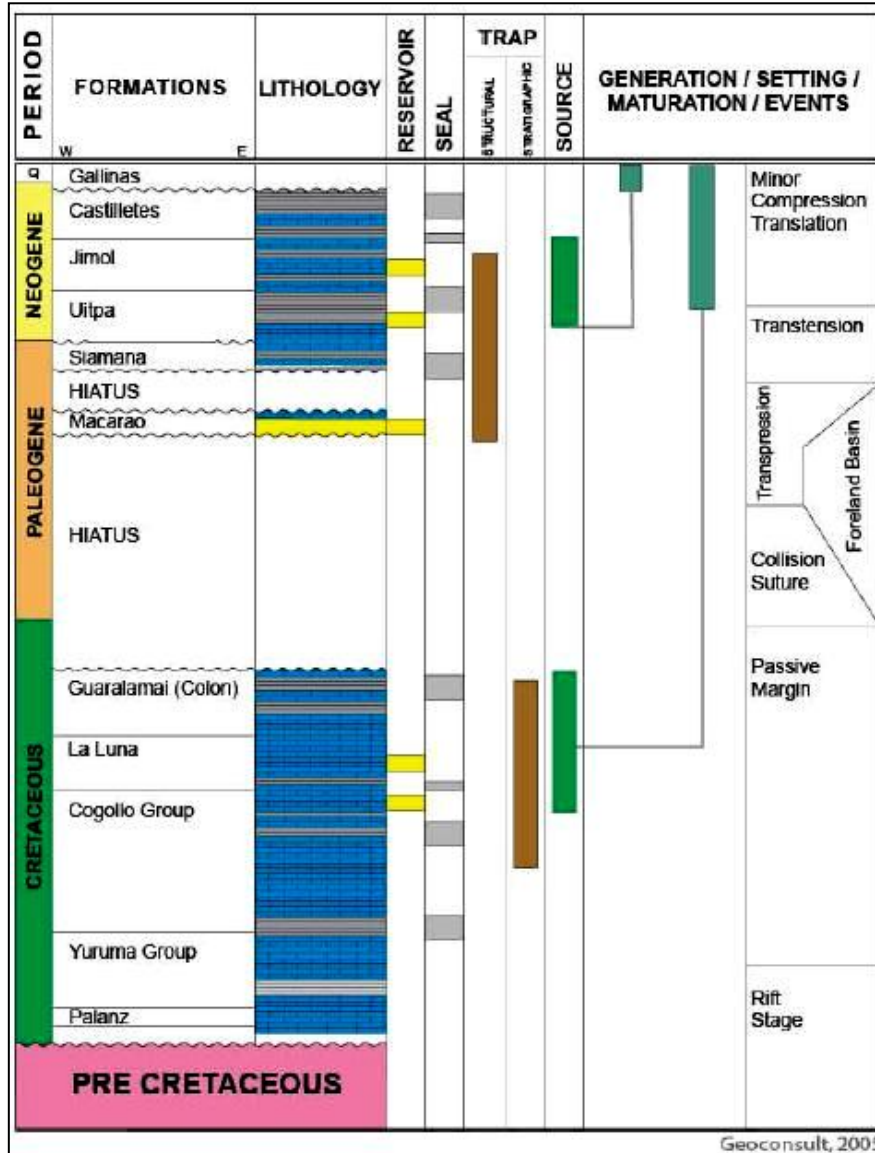
Atlas sísmico de Colombia, 1998



# Guajira Onshore and Offshore Basins



# Guajira Onshore and Offshore Basins



Geoconsult, 2005

## PETROLEUM SYSTEM

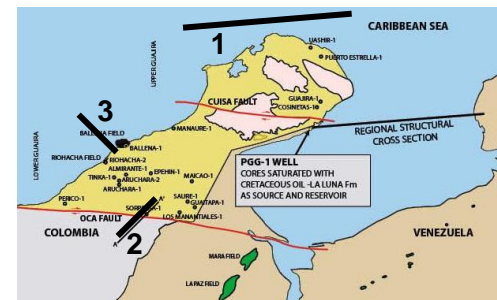
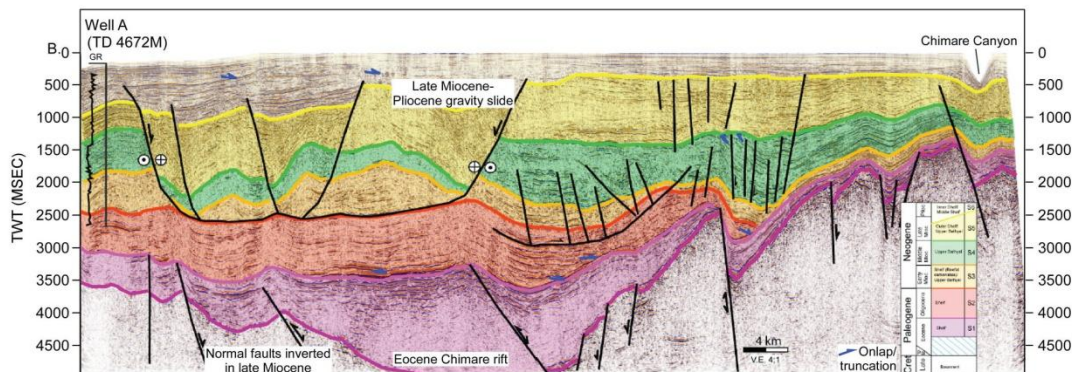
**K** (La Luna) – **K** (La Luna)

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

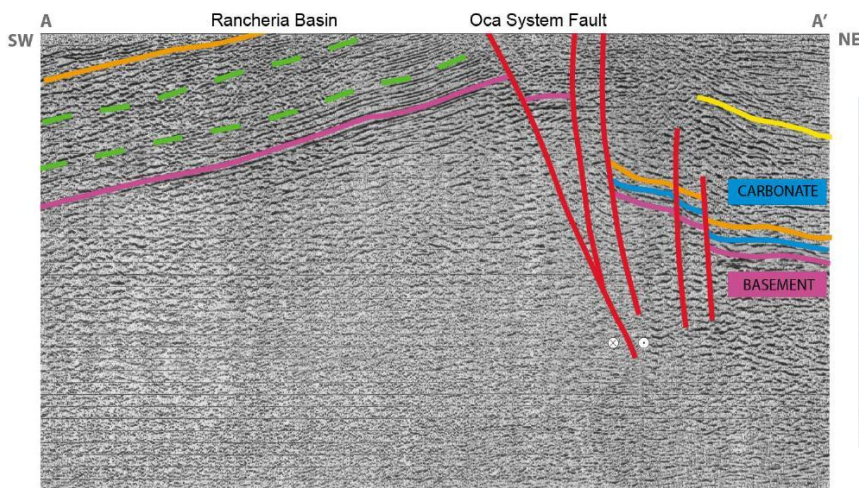


# Structural Styles

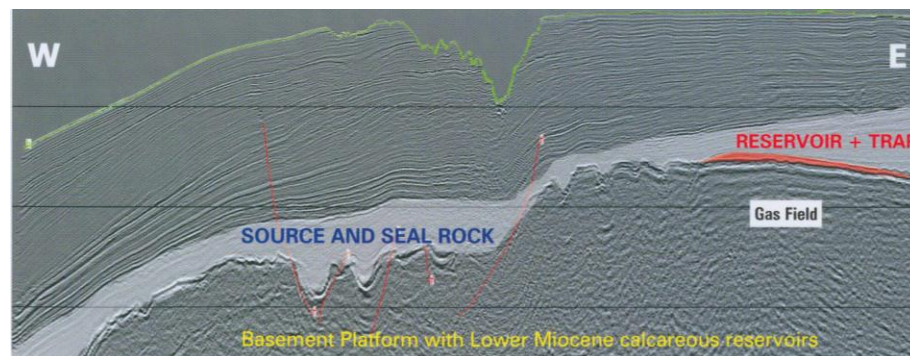
## 1- Normal Fault traps



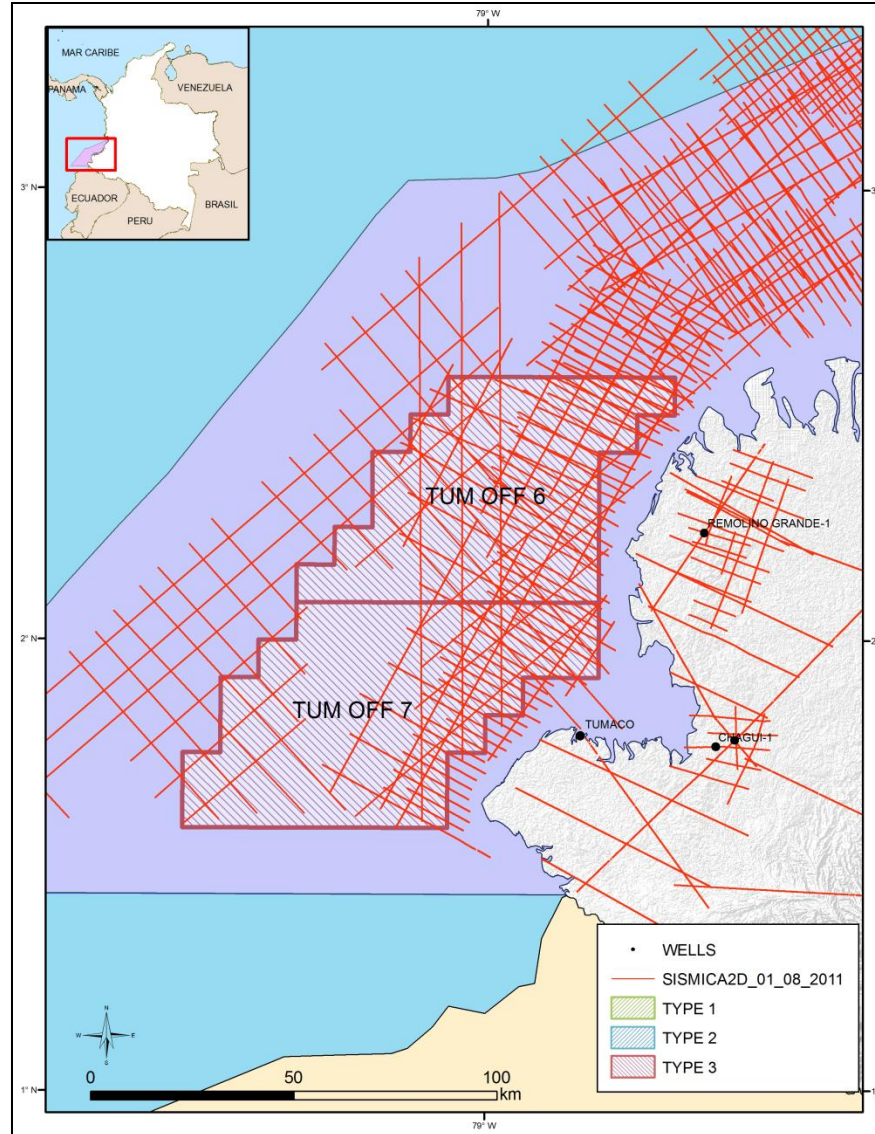
## 2- Oligocene carbonates strongly Fractured by the Oca Wrench System



## 3- Combined (structural and stratigraphic) traps



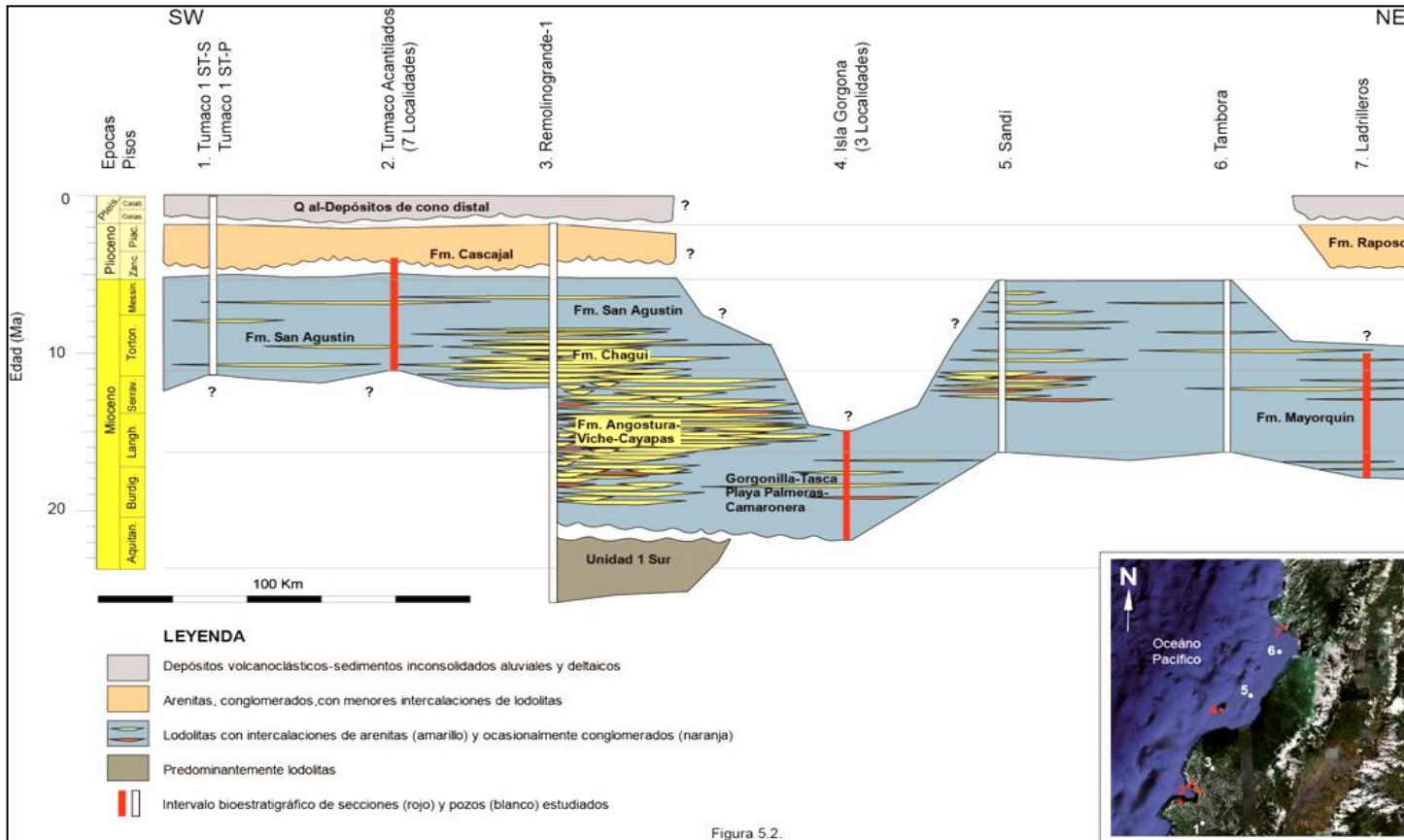
# Tumaco Basin Offshore (Tum)





# Tumaco Basin Offshore (Tum)

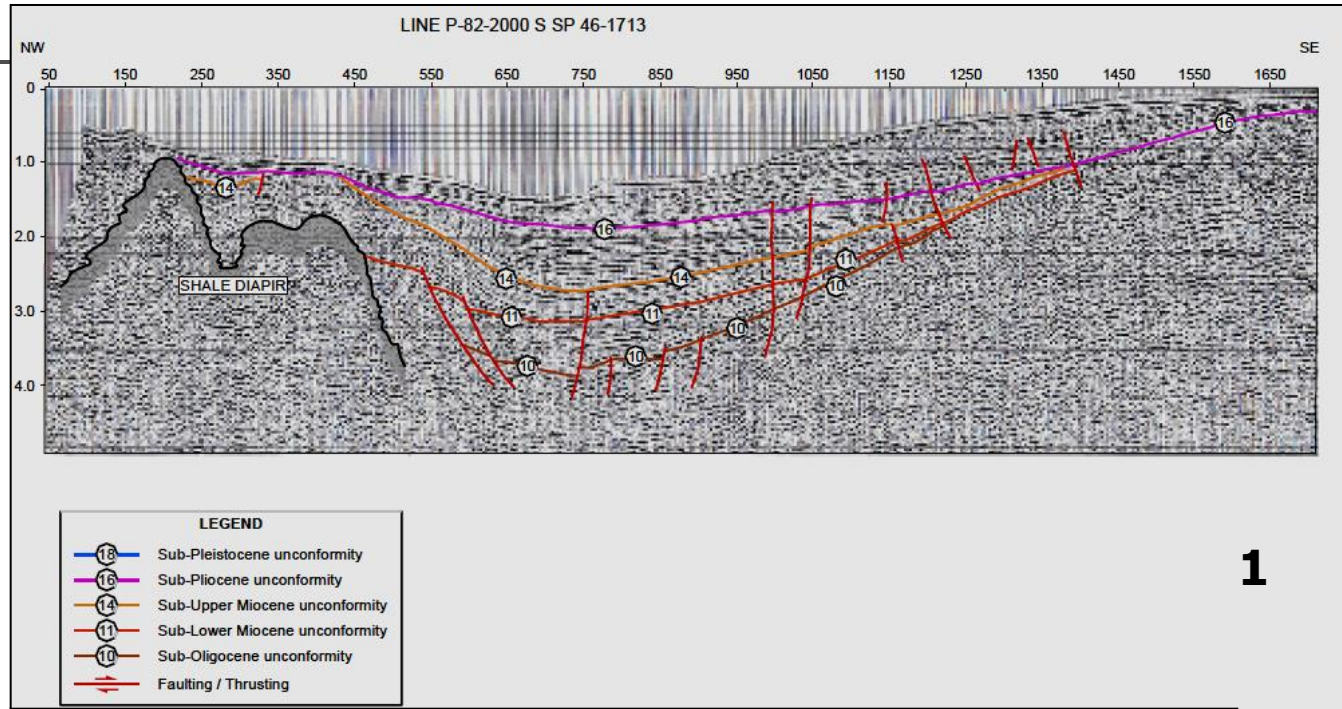
## Stratigraphic chart



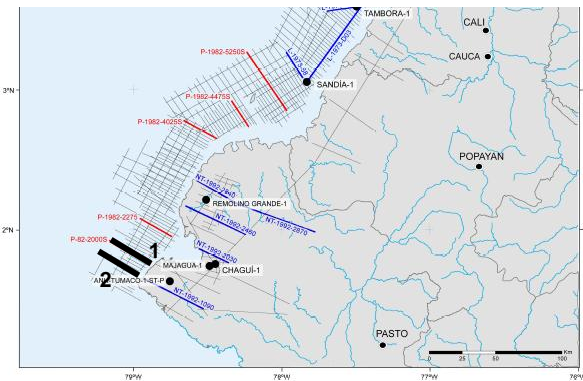
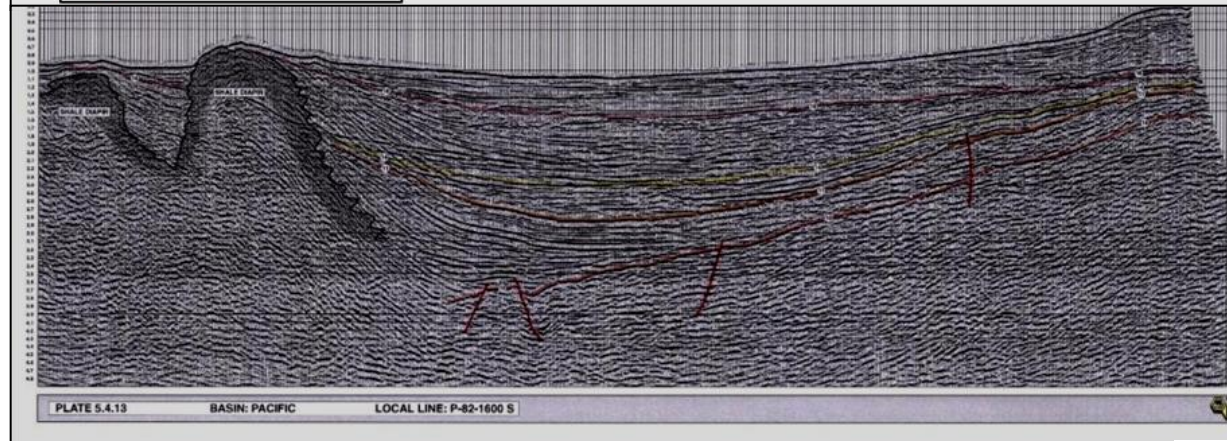
**PETROLEUM SYSTEM**  
P? ( ) – N (Angostura -Cayapas)



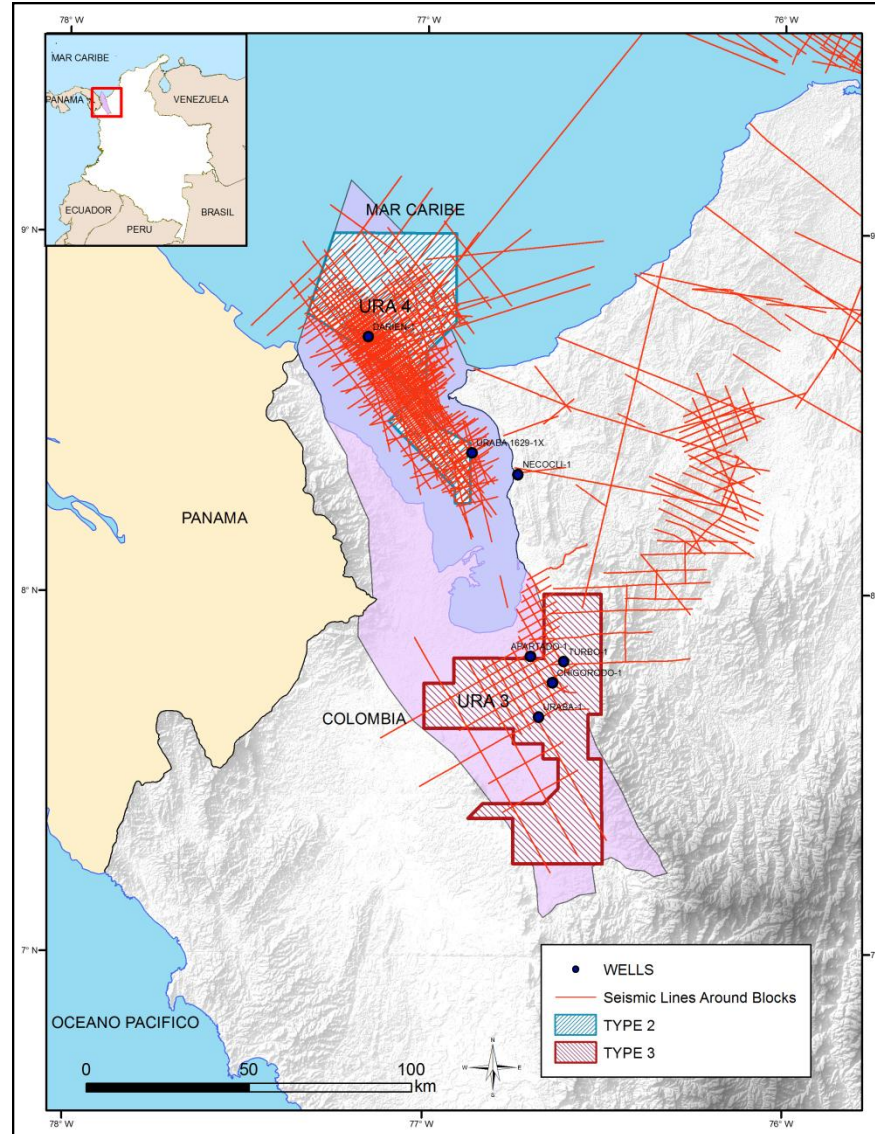
# Structural Styles



**1- 2 Normal faults and stratigraphic traps , diapiric structures**



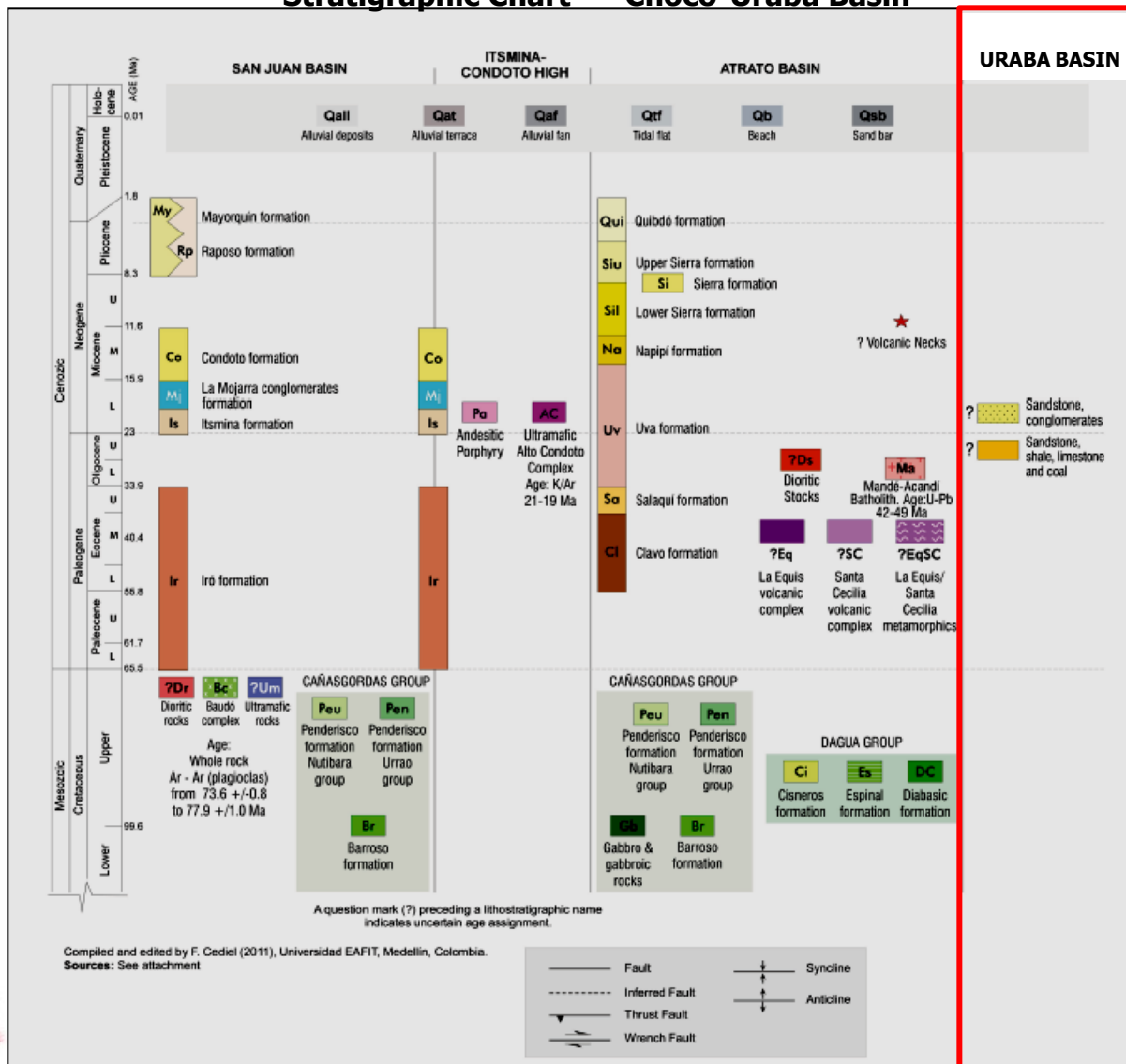
# Urabá Basin (Ura)



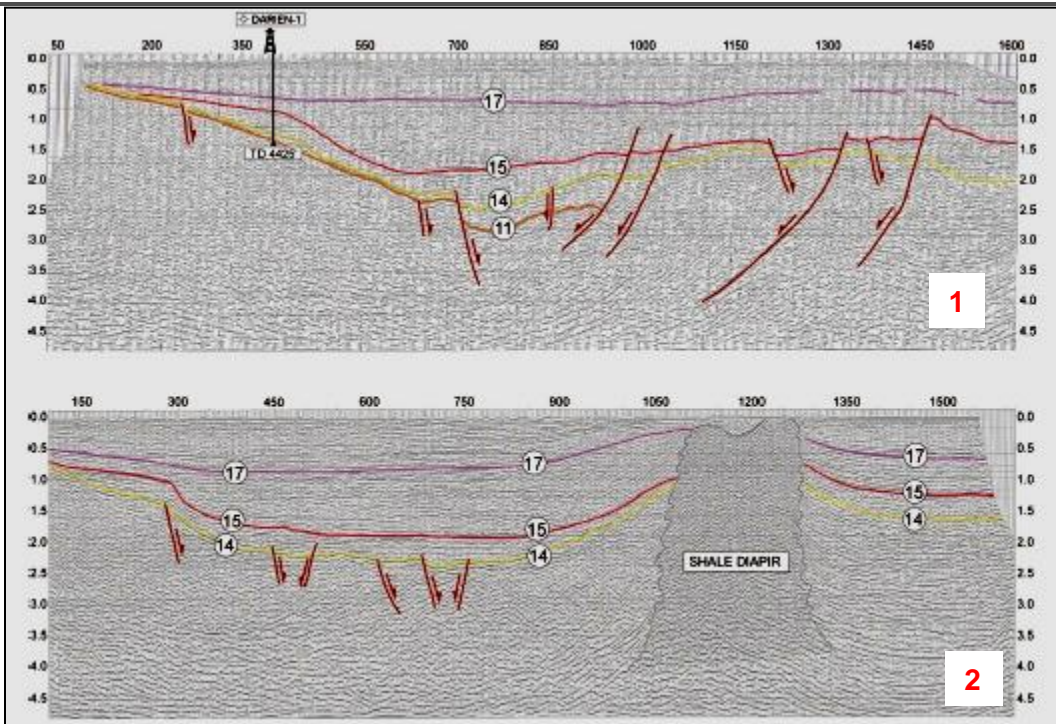


# Urabá Basin (Ura)

## Stratigraphic Chart – Chocó-Urabá Basin



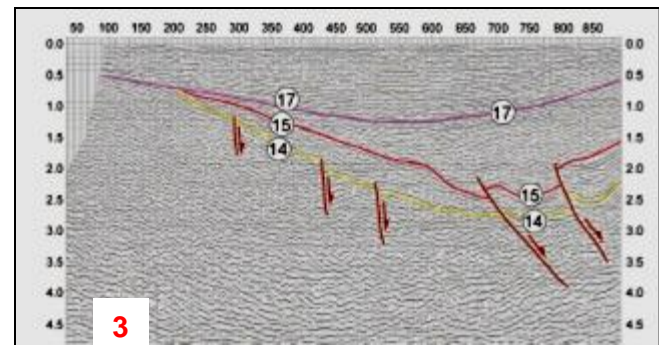
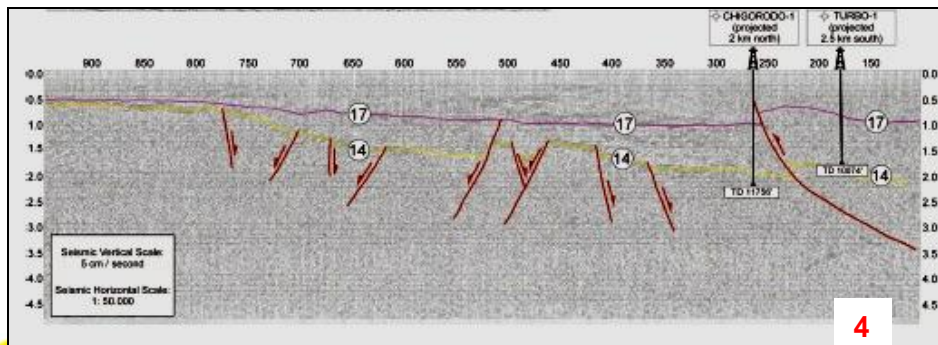
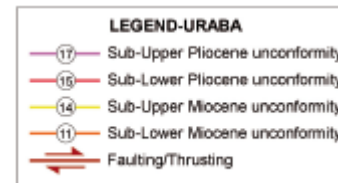
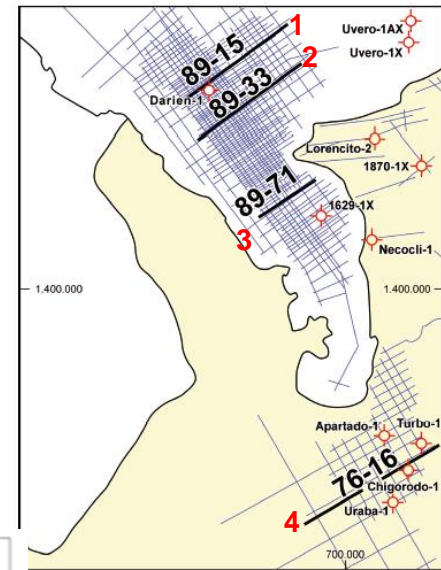
# Structural Styles



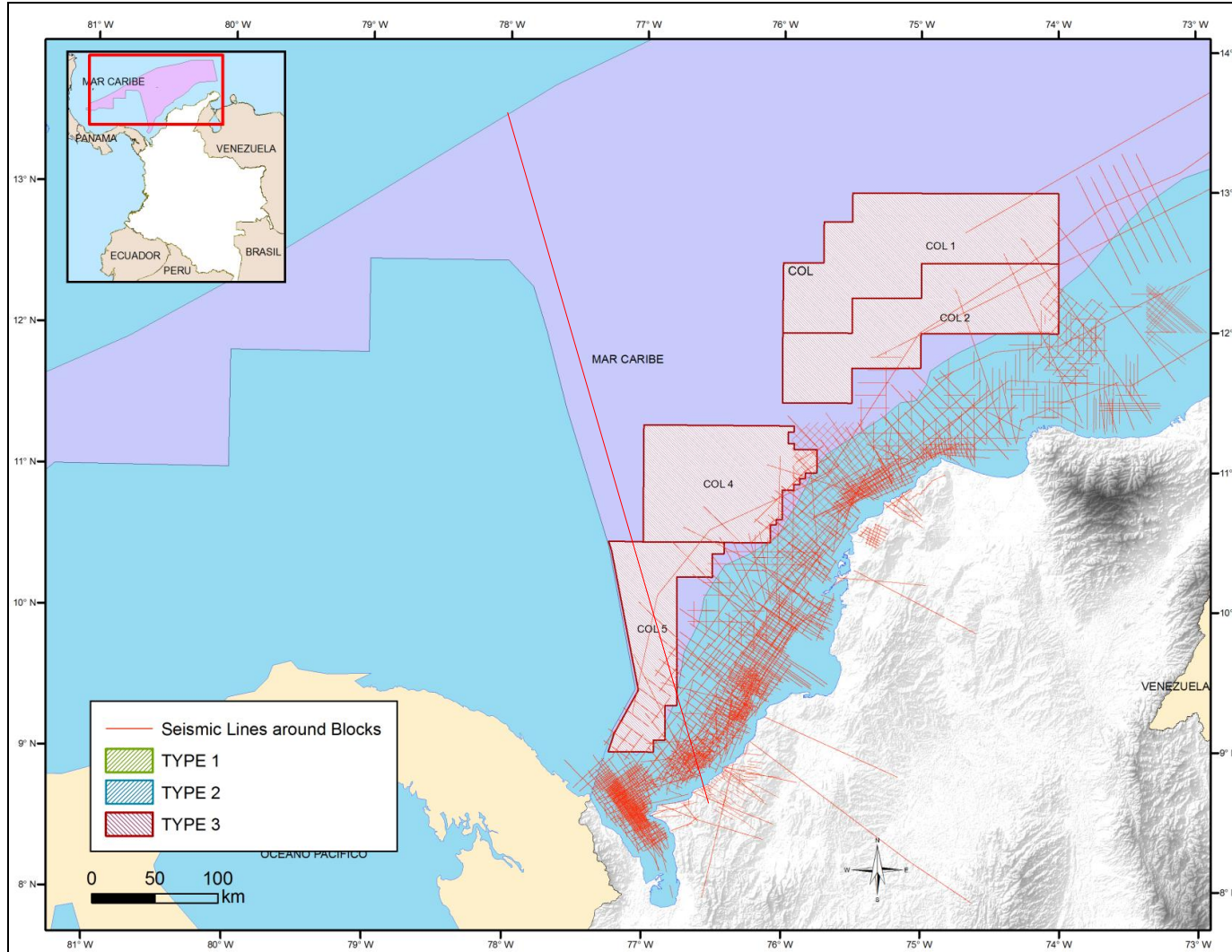
**1-3 Normal fault and stratigraphic traps**

**2 Diapiric structures**

**4 inversion structures**

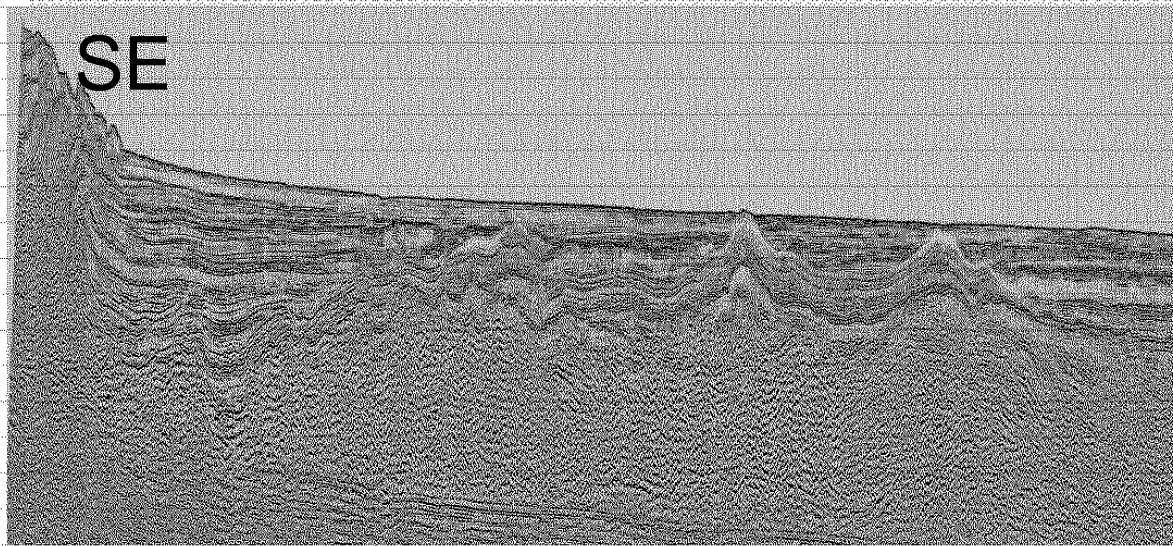


# Colombia Basin (Col)

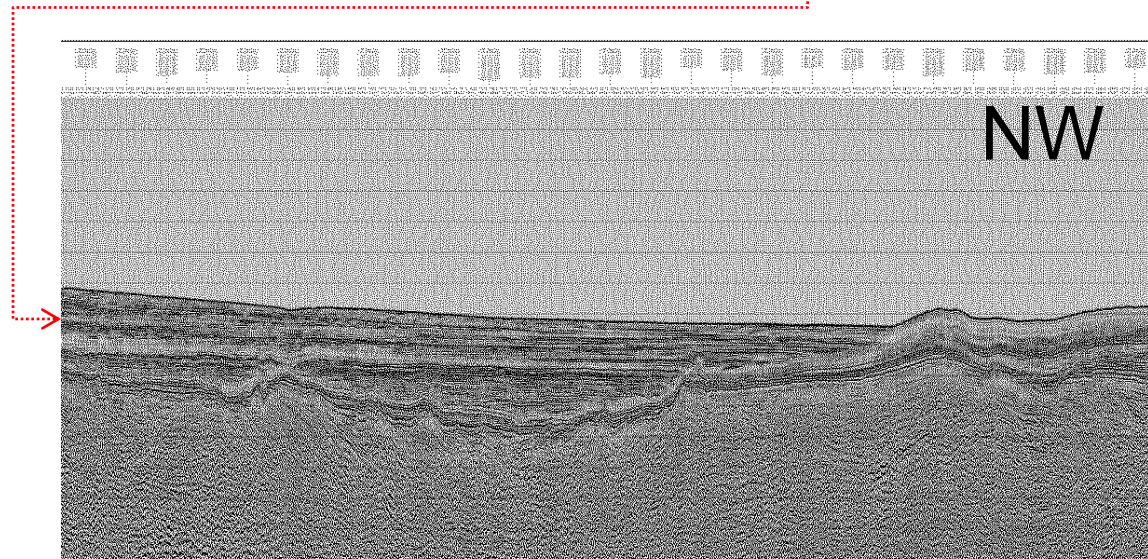




# Colombia Basin (Col)

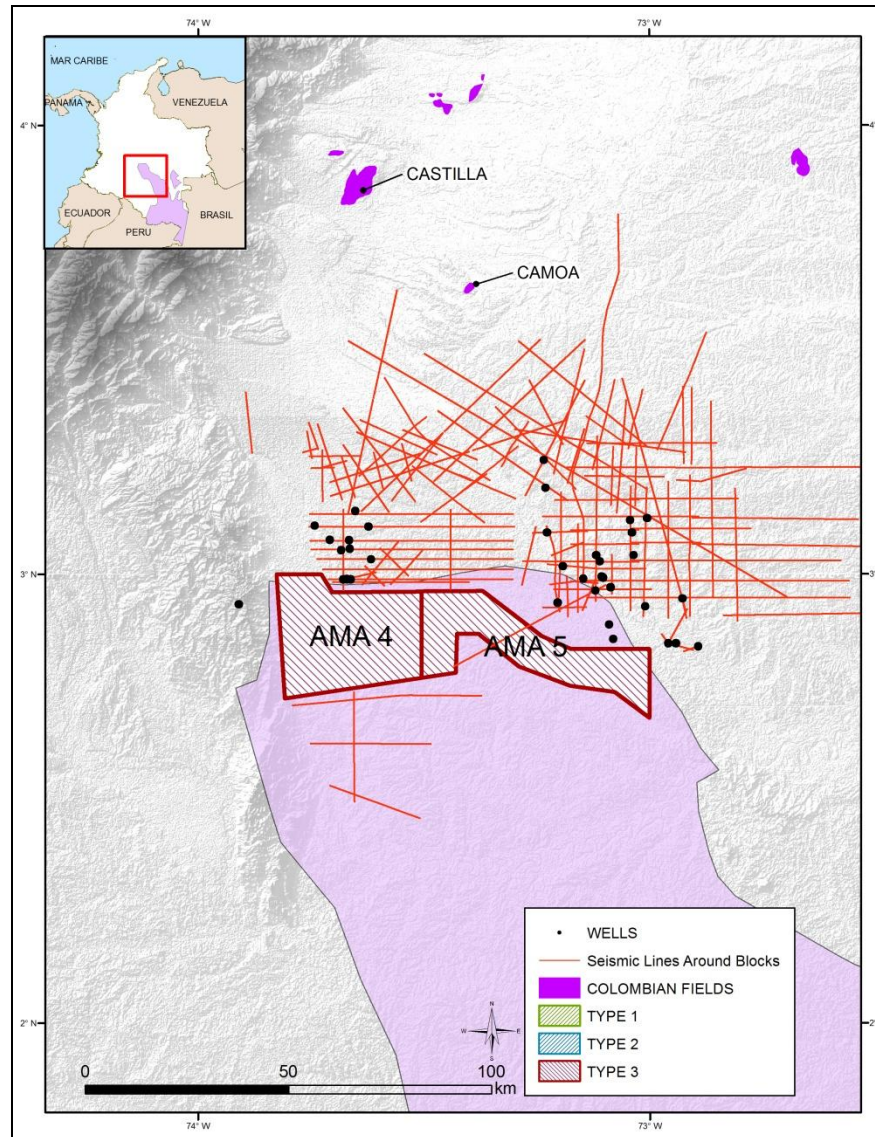


Seismic Line Colombia Basin





# Vaupés-Amazonas Basin (Vau)







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  - 3.2. Block Types
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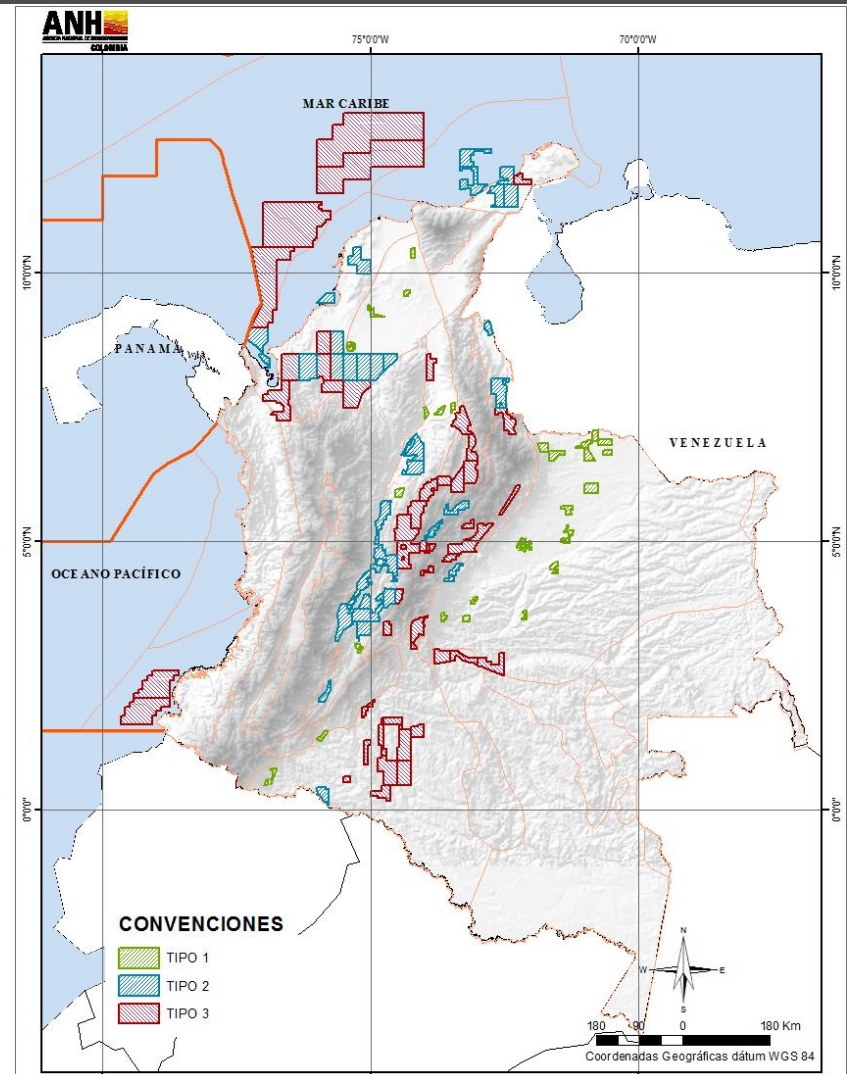


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# Colombia Round 2012

	Onshore	Offshore
Type 1	29	
Type 2	29	5
Type 3	40	6
<b>TOTAL</b>	<b>98</b>	<b>11</b>

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





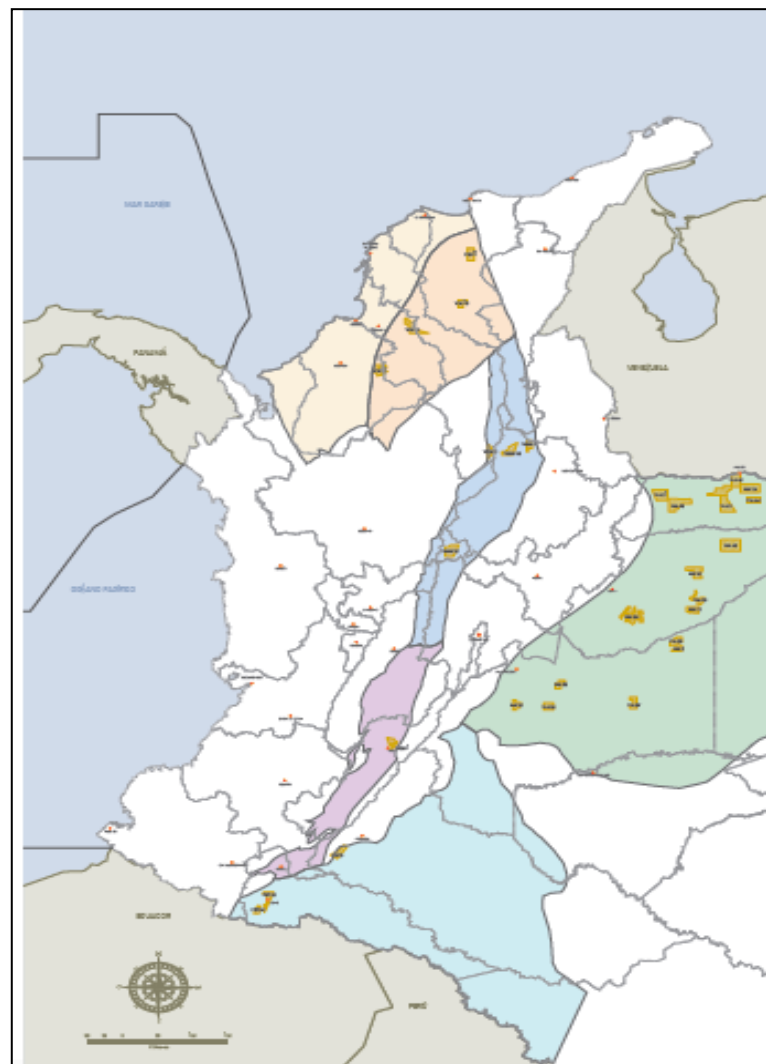
# Type 1 Blocks

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

Type 1		
Blocks	Total Area (km <sup>2</sup> )	Size Range (km <sup>2</sup> )
29	6,565	76 – 573

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

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



# Type 2 Blocks

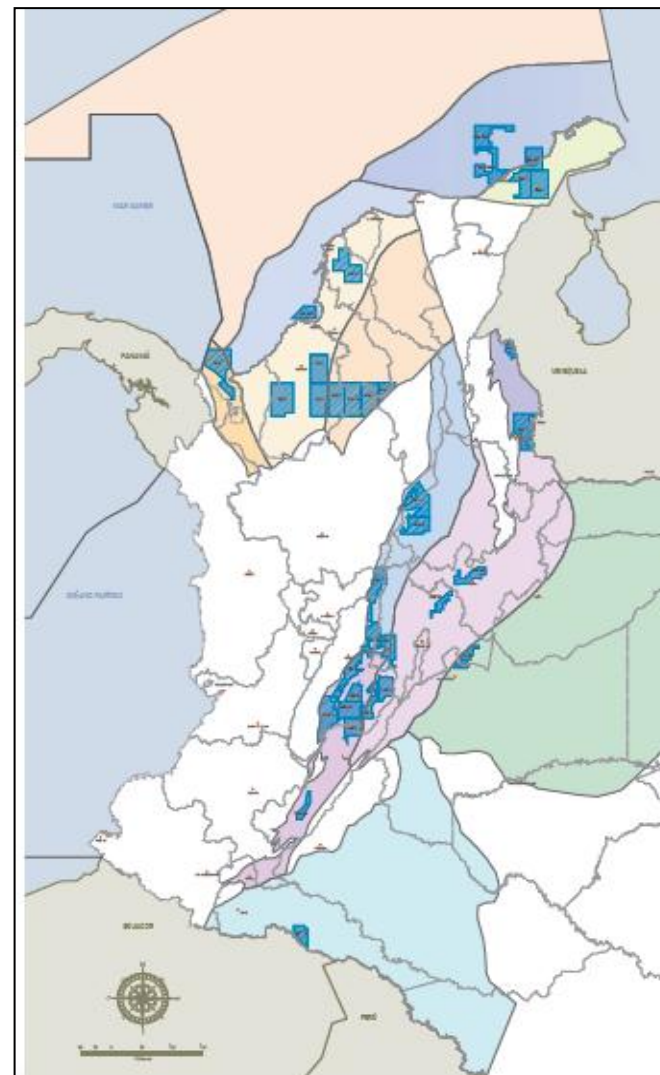
- ✓ Blocks in emerging areas.
- ✓ E&P contracts.

Type 2		
Blocks	Total Area (km <sup>2</sup> )	Size Range (km <sup>2</sup> )
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"> <li>• Guajira</li> <li>• Guajira Offshore</li> <li>• Sinú Offshore</li> <li>• Urabá</li> <li>• Sinú-San Jacinto</li> <li>• Lower Magdalena Valley</li> </ul> | <ul style="list-style-type: none"> <li>• Middle Magdalena</li> <li>• Upper Magdalena</li> <li>• Caguán-Putumayo</li> <li>• Llanos</li> <li>• Eastern Cordillera</li> <li>• Catatumbo</li> </ul> |
|---|---|



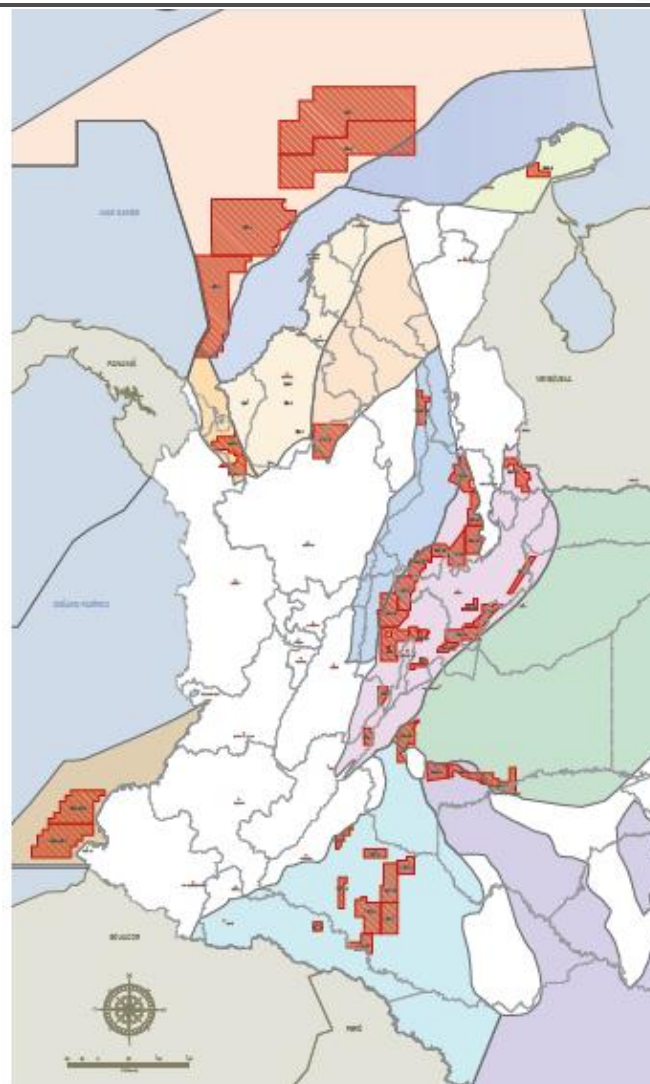
# Type 3 Blocks

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

Type 3		
Blocks	Total Area (km <sup>2</sup> )	Size Range (km <sup>2</sup> )
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"> <li>• Guajira</li> <li>• Colombia</li> <li>• Urabá</li> <li>• Lower Magdalena</li> <li>• Tumaco Offshore</li> </ul>	<ul style="list-style-type: none"> <li>• Vaupés-Amazonas</li> <li>• Middle Magdalena</li> <li>• Caguán-Putumayo</li> <li>• Llanos</li> <li>• Eastern Cordillera</li> </ul>



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# Minimum Exploration Program

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



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

# Minimum Exploration Program

## *Type 2 Conventional Offshore*



<b>Phase I (3 years)</b>	<b>Phase II (3 years)</b>
<ul style="list-style-type: none"><li>✓ 15 km<sup>2</sup> of 3D seismic / 200 km<sup>2</sup> of area.</li><li>✓ Collection of one (1) piston core / 200 km<sup>2</sup> of area.</li></ul>	<ul style="list-style-type: none"><li>✓ 1 (one) Exploratory well (the whole sedimentary sequence, or down to economic basement).</li></ul>

# Minimum Exploration Program

## **Type 3 Conventional Onshore and Offshore**



Onshore Unique Phase (3 years)	Offshore Unique Phase (3 years)
	✓ Piston Coring, 1 /10 km <sup>2</sup> .
✓ 2D Seismic, minimum 1km /10 km <sup>2</sup> .	✓ 2D Seismic, minimum 1km /10 km <sup>2</sup> .
✓ 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 bathymetric survey / 10 km <sup>2</sup> of area.



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# Area Comparison

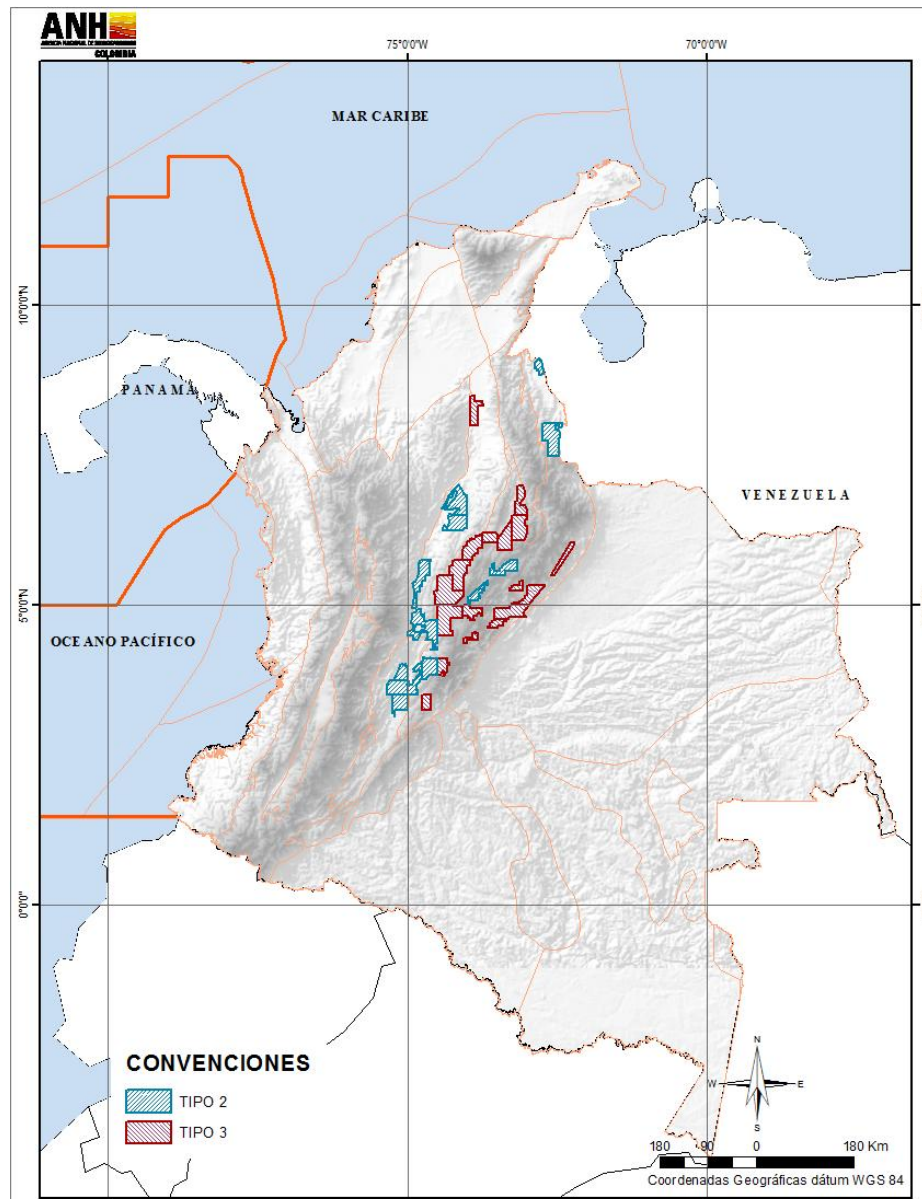


Texas is about  
60% of the size of  
Colombia

Colombia  
1,141,748 km<sup>2</sup>

Texas  
696,241 km<sup>2</sup>

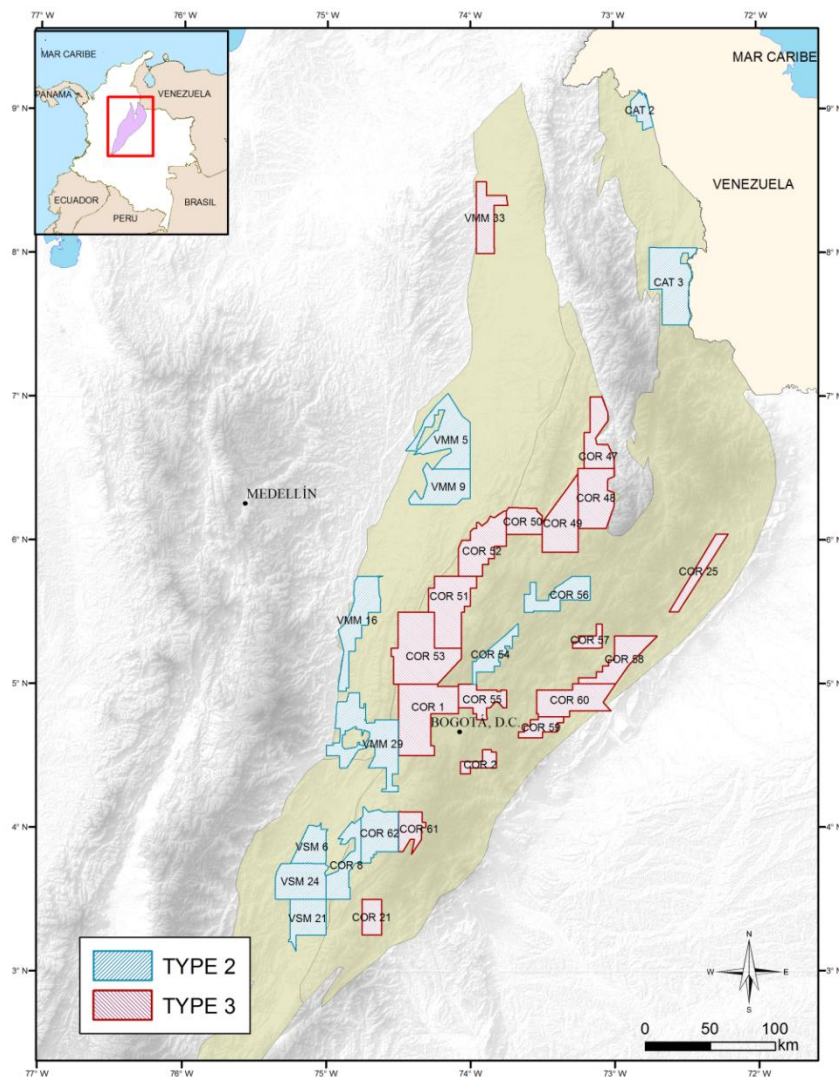
# Suggested Blocks for Unconventional Resources





# Prospective Areas for Unconventional Resources

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



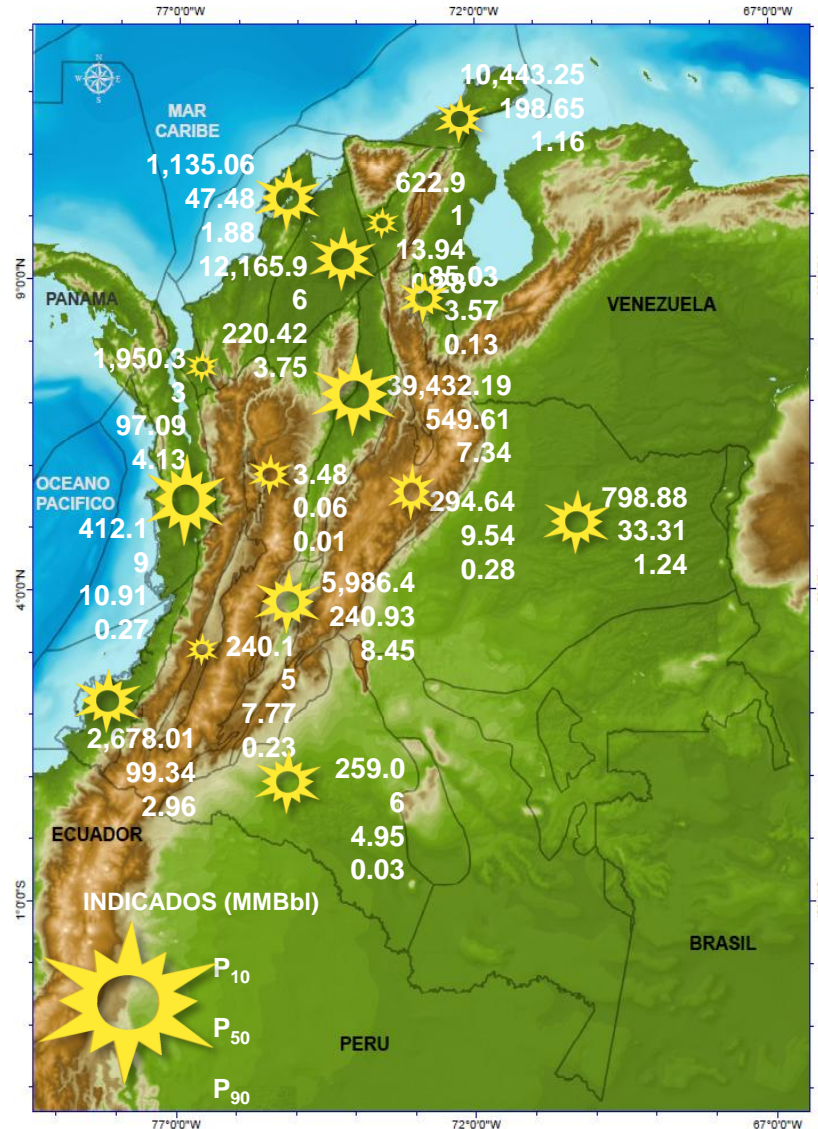
# Unconventional Resources (Preliminary Assesment, UNAL, 2011)



Resources	Results P10 - P90	Prospective Basins
Tar Sands	151,153.8 – 3,455.1 MMbbl	Middle Magdalena Valley Eastern Cordillera Eastern Llanos
Oil Shale	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

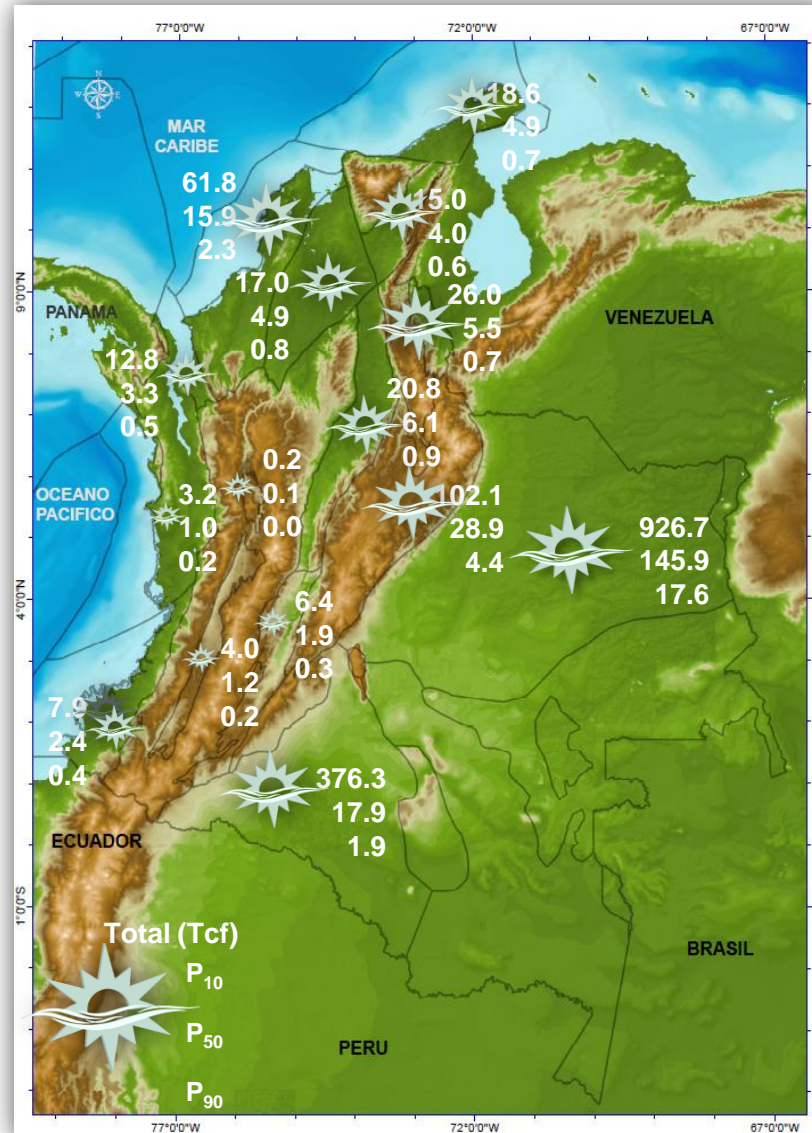
## Oil Shale in Colombia (Preliminary Assesment, UNAL, 2011)





# 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 <sup>2</sup> of the block area.		
✓ 2D Seismic, minimum 1km/5km <sup>2</sup> .		
✓ 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*

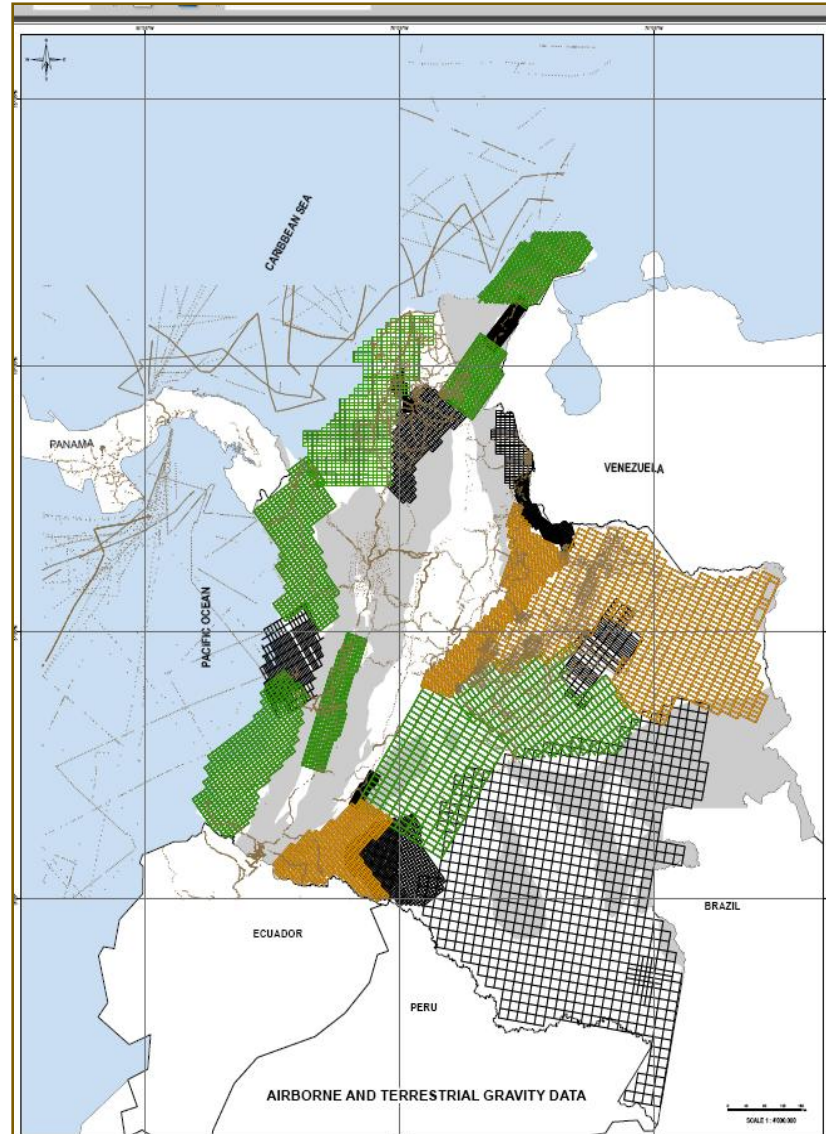


Onshore Unique Phase (3 years)
✓ Geological mapping, scale 1:25.000, or larger, minimum 50% of the block area.
✓ 2D Seismic, minimum 1km / 10 km <sup>2</sup> .
✓ Regional analysis (i.e. mapping with remote sensing or airborne geophysical methods).
✓ 2 (two) stratigraphic wells, with physical and geochemical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

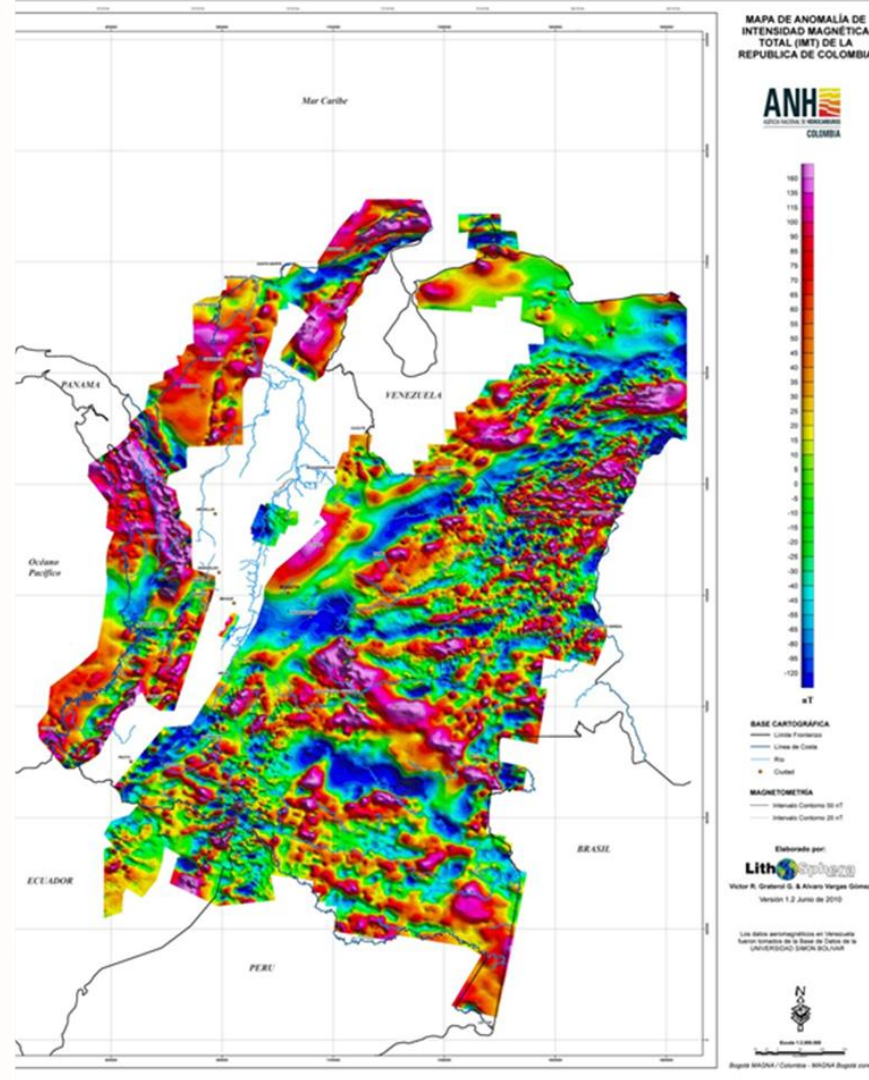
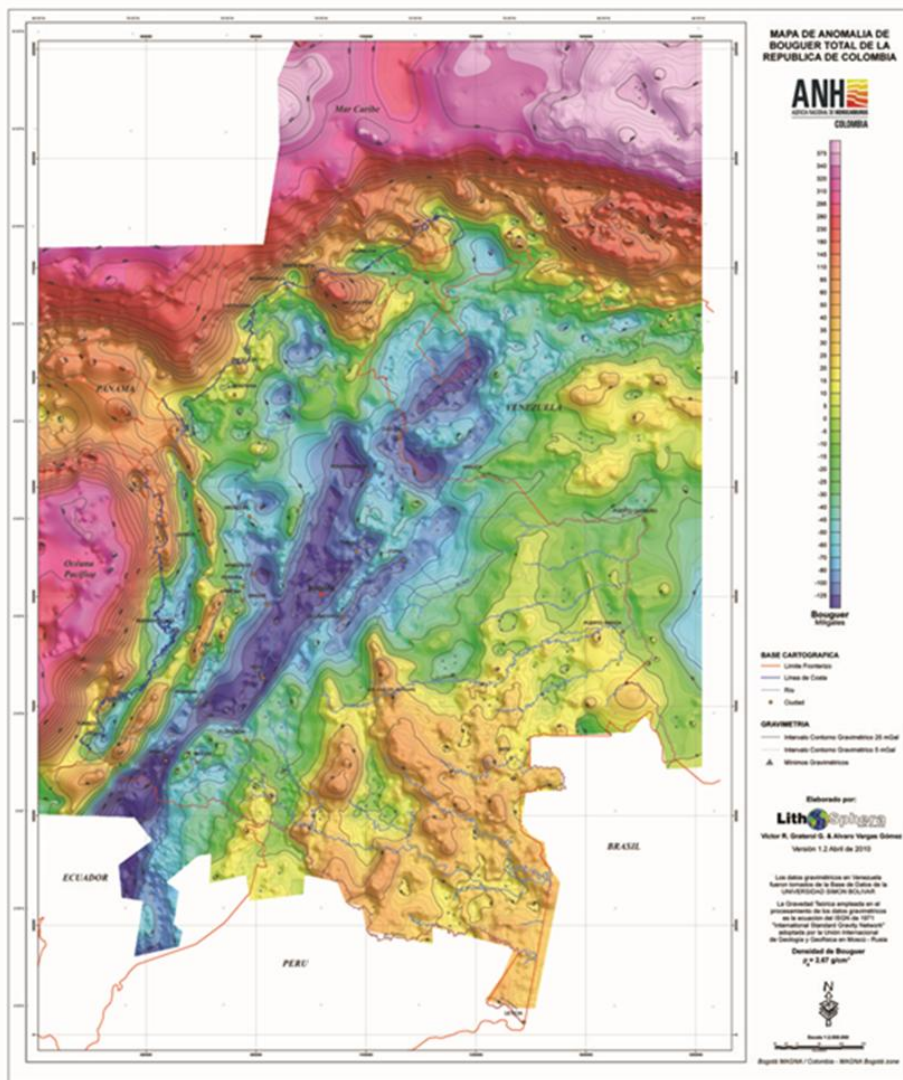
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# Airborne Geophysical Coverage

-  ANH 2005-2007
-  ANH 2008-2009

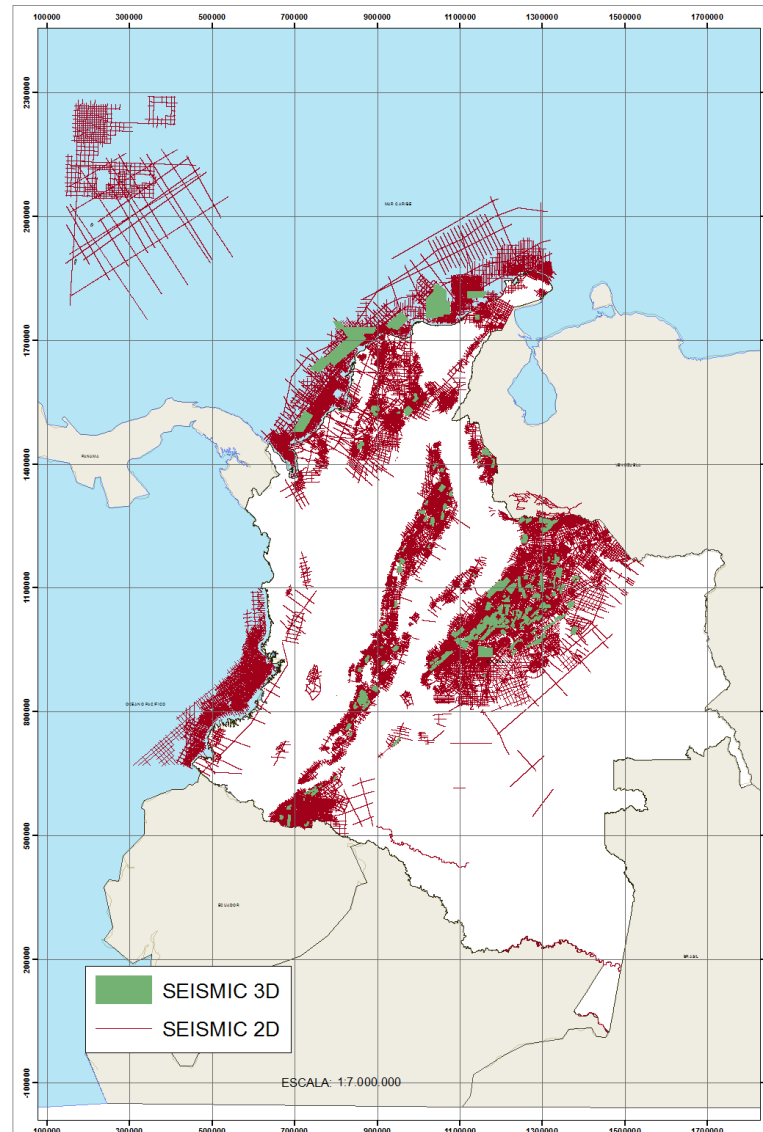


# Gravity and Magnetic Anomalies Maps

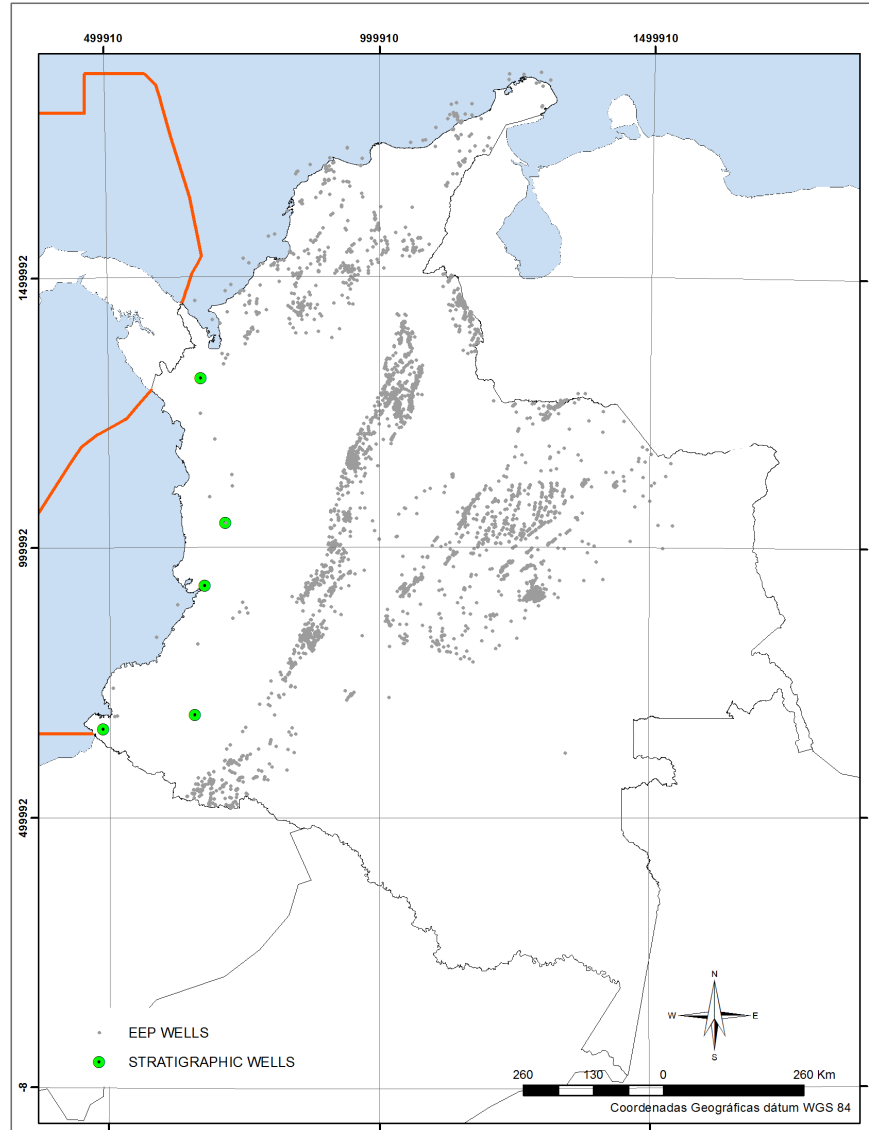




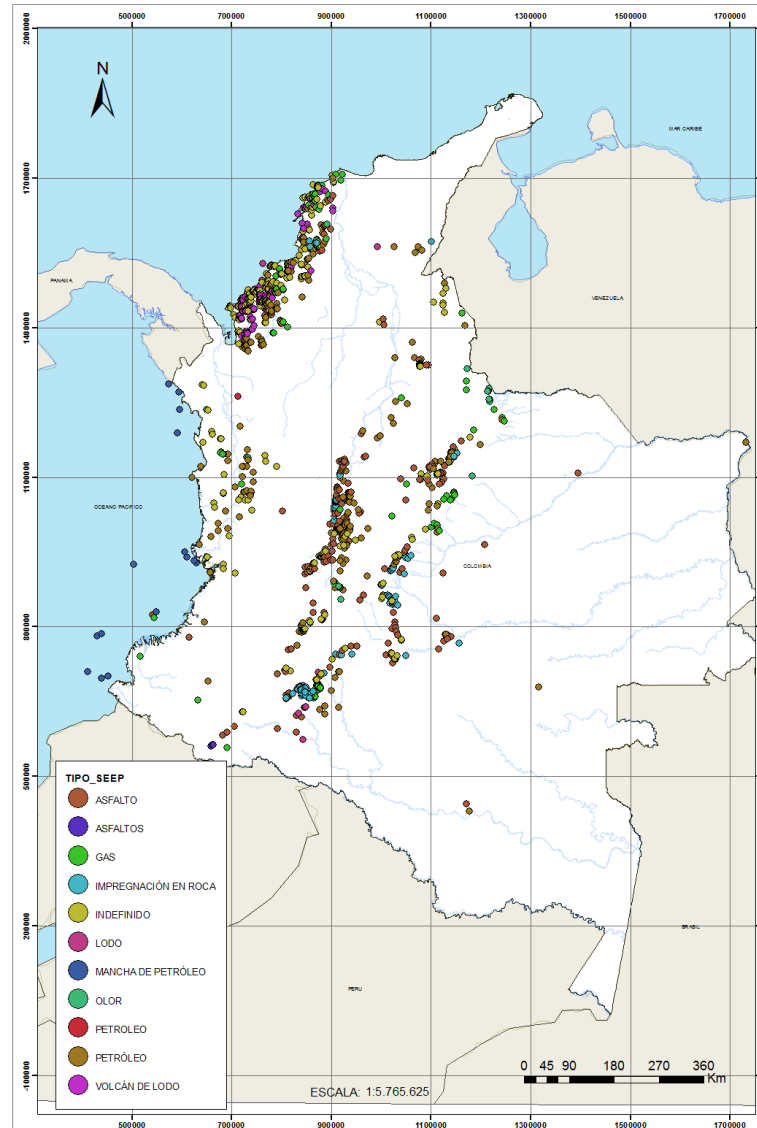
# 2D and 3D Seismic Coverage



# Exploration, Evaluation, Production and Stratigraphic Wells Map



# Oil and Gas Seeps



# Information Packages

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
<b>TOTAL</b>	<b>504</b>	<b>2,996</b>	<b>20</b>	<b>285</b>



# Information Packages



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

Regalías

Rendición de Cuentas

Reglamento de Reservas

**CLICK**

Todas las preguntas y respuestas del Proceso de la Ronda Colombia 2012, se publicarán a través del Sitio web [www.rondacolombia2012.com](http://www.rondacolombia2012.com)

**RONDA COLOMBIA 2012, INICIATIVA ESTRATÉGICA PARA DARLE SOSTENIBILIDAD AL DESARROLLO PETROLERO DEL PAÍS**

22-02-2012

**MME, Bogotá D.C.**, febrero 21 de 2012. La Ronda Colombia 2012 que presentó oficialmente la Agencia Nacional de Hidrocarburos (ANH) en Bogotá es un paso fundamental para darle sostenibilidad al desarrollo petrolero del país, dijo este martes el ministro de Minas y Energía, Mauricio Cárdenas.

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AGENCIA NACIONAL DE HIDROCARBUROS

ÁREAS DE REGLAMENTACIÓN ESPECIAL

Canal RSS

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# Summary and Conclusions



## Colombia has.....

- World class petroleum systems.
- Significant underexplored areas.
- Significant upside potential for unconventional hydrocarbon resources.

Therefore, there are excellent exploration opportunities, on a global scale, in **mature**, **emerging** and **frontier** basins





***New Ideas + New Technologies  
+ New Licenses***

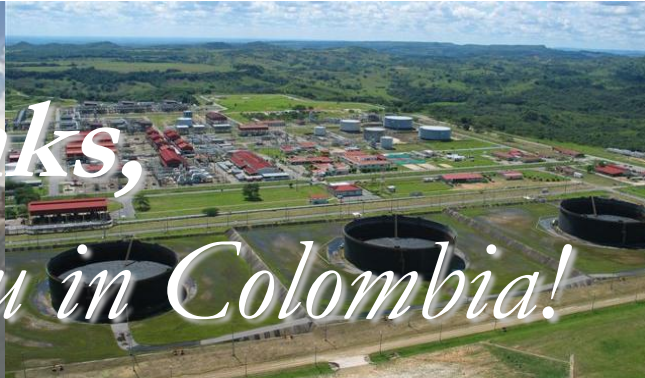
**=**



***Significant new discoveries***







*Thanks,  
See you in Colombia!*



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[www.epis.com.co/](http://www.epis.com.co/)  
[rondacolombia2012@anh.gov.co](mailto:rondacolombia2012@anh.gov.co)