

Ronda Colombia 2012





Overview of the Oil and Gas Basins of Colombia

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3.4. Minimum Exploration Program (Unconventional Blocks)

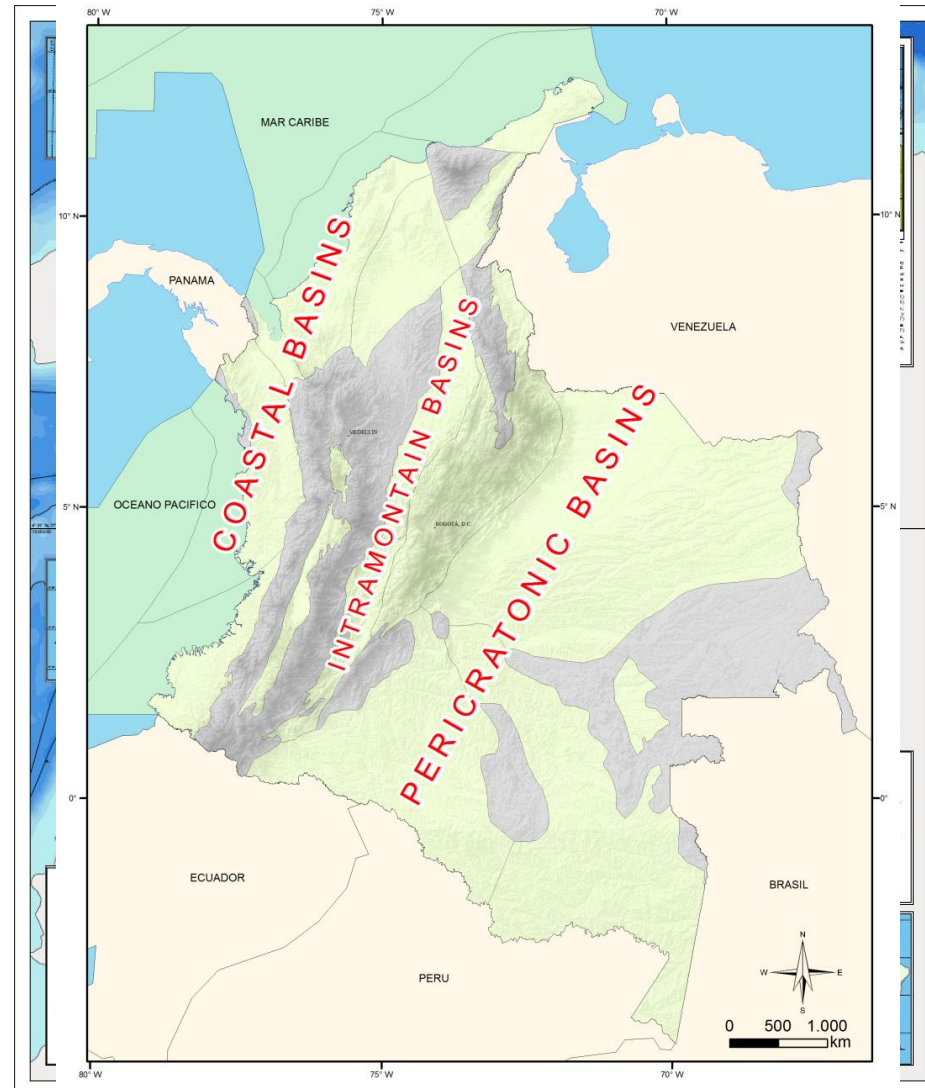
3.5. Database (EPIS)

4. Summary and Conclusions

Colombia

= *Diverse Geology*

= *Something For All Explorers!*



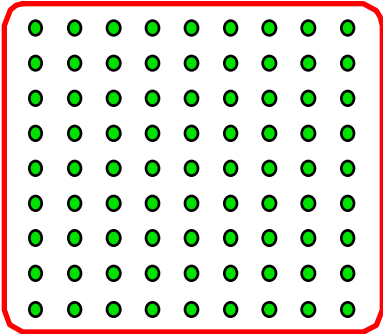
Colombia – An Underexplored Country



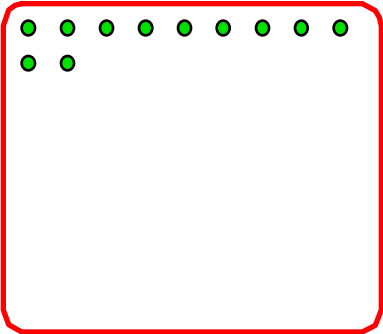
Wells per 1,000 km²

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

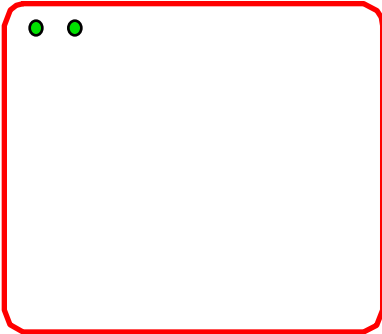
UNITED STATES



CANADA



COLOMBIA



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3.1. Technical Aspects of Basins

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3.4. Unconventional Resources

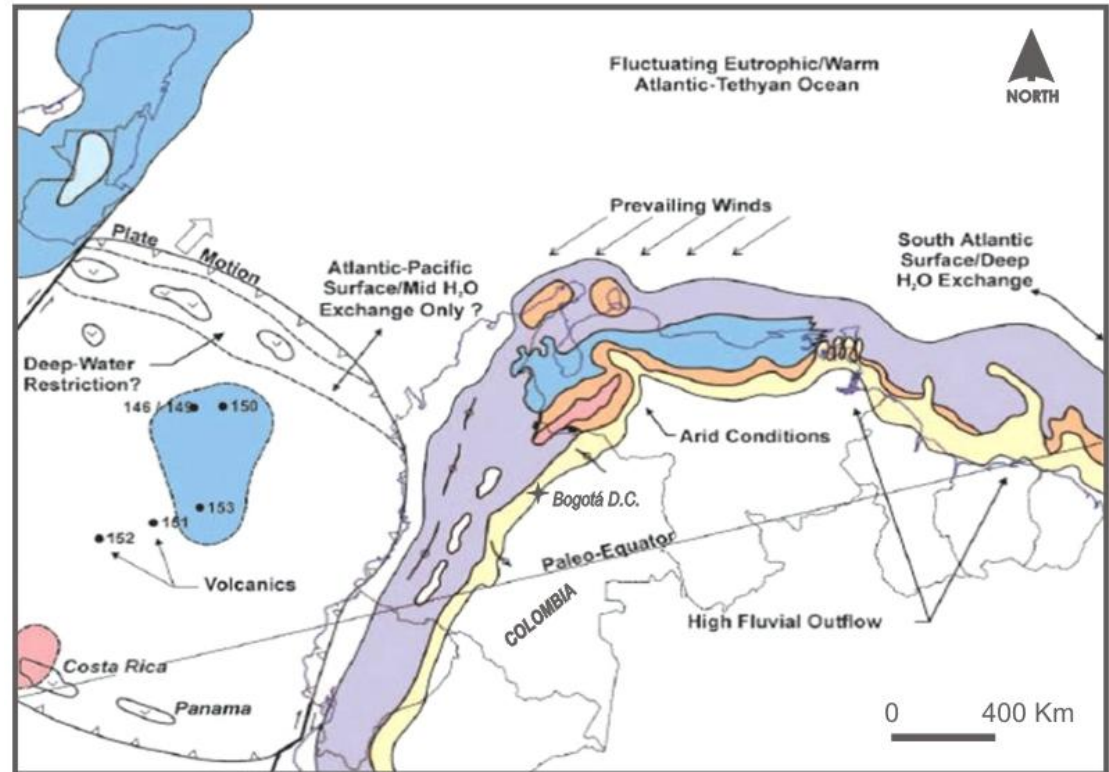
3.5. Minimum Exploration Program (Unconventional Blocks)

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.

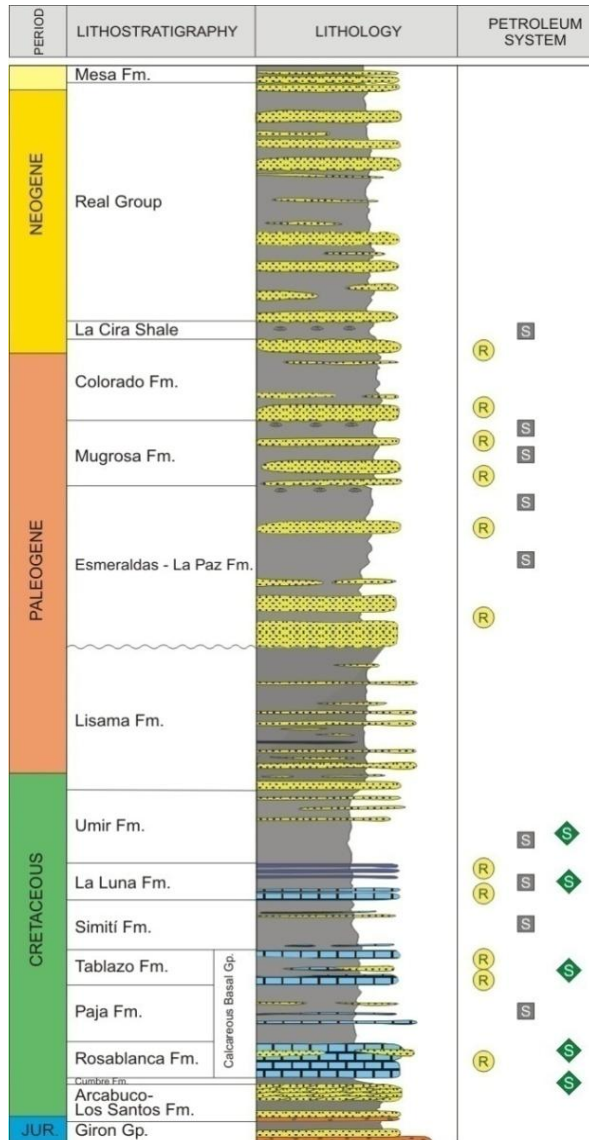
Colombia Has Reservoirs!



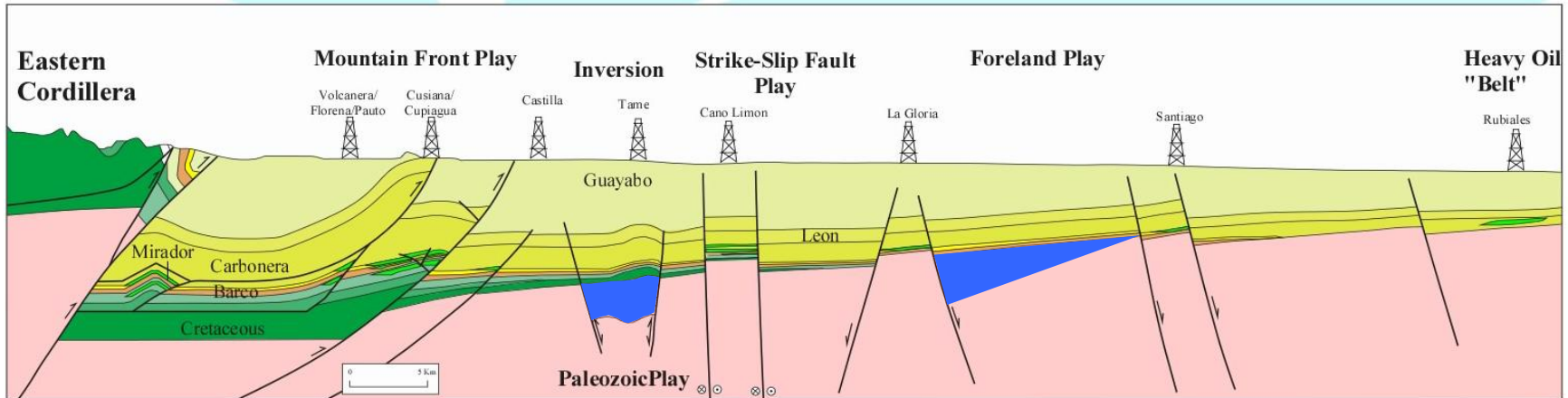
FOR CONVENTIONAL HC

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

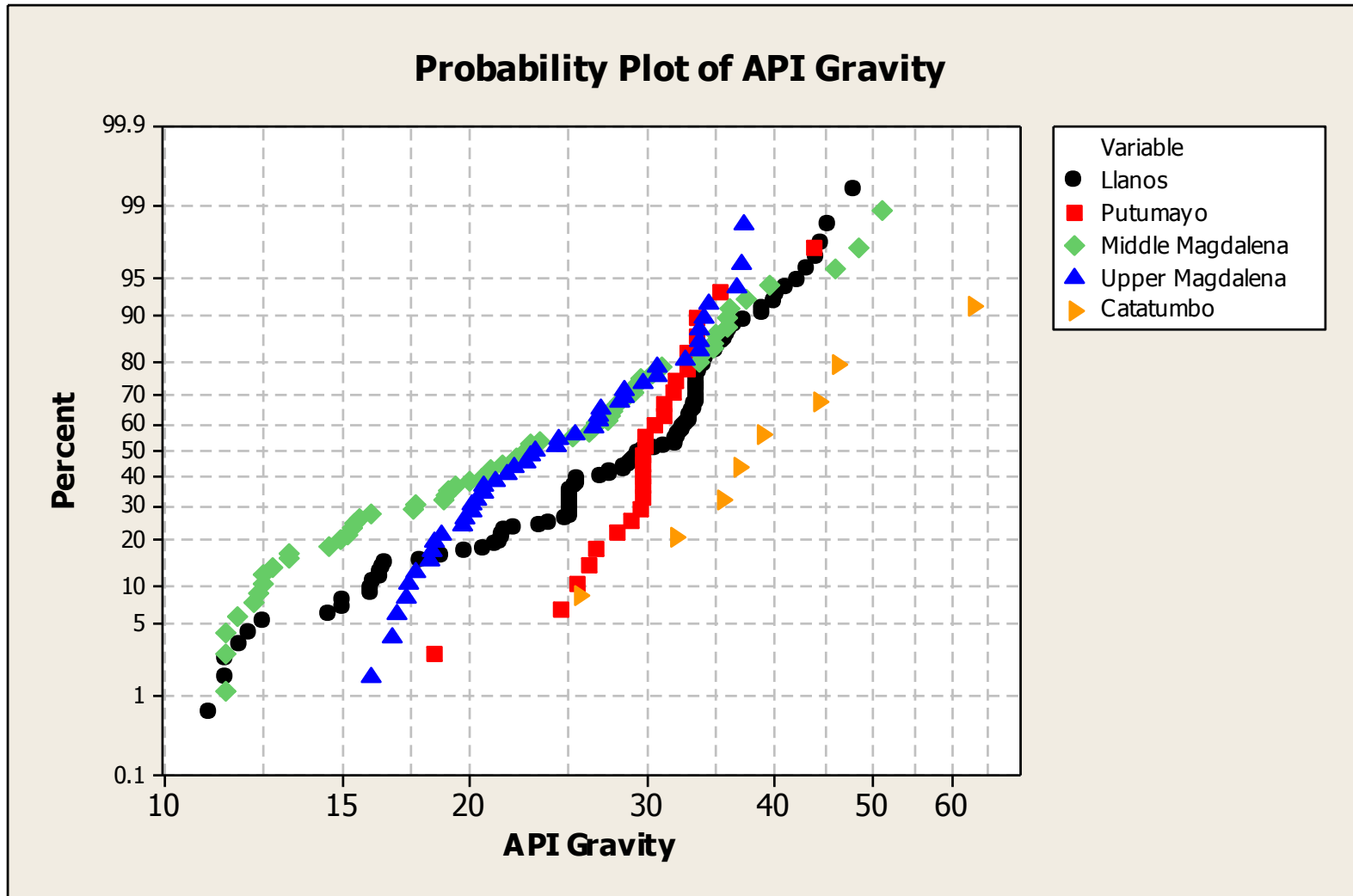


Generalized E-W Cross Section - Llanos Basin

Trap styles within Llanos Basin

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

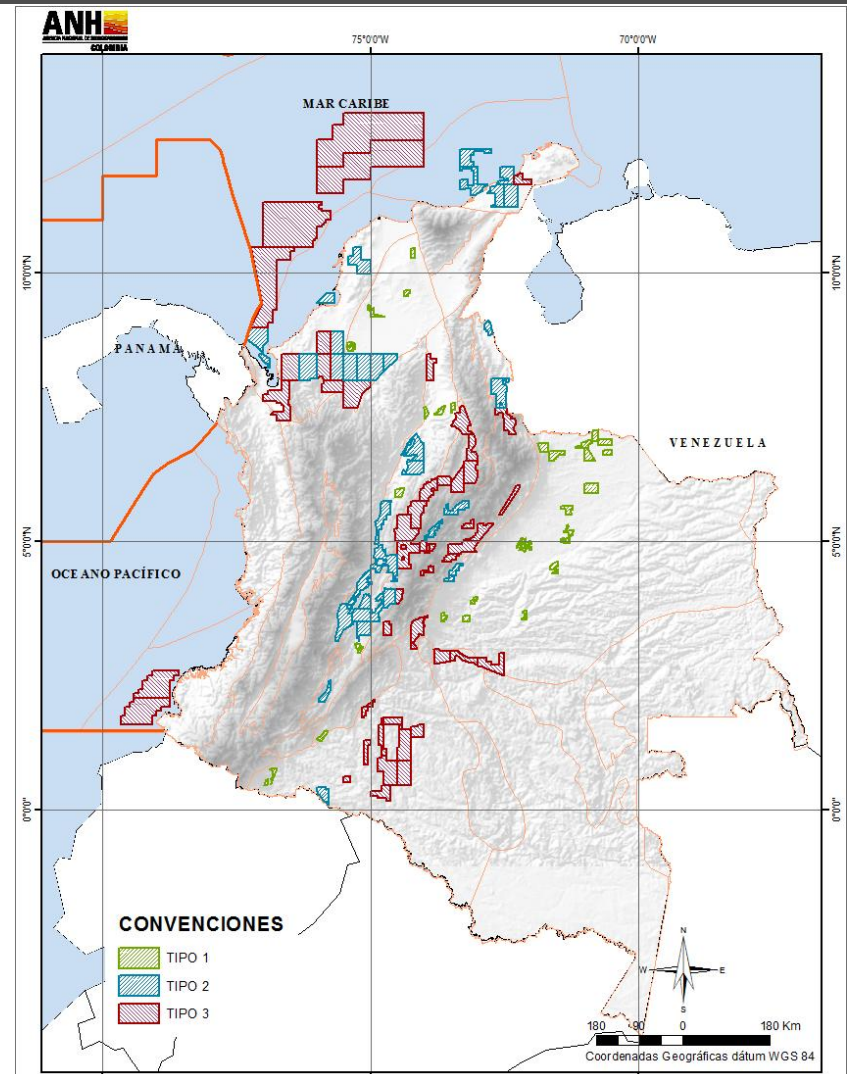
Crude Oil Quality



Colombia Round 2012

| | Onshore | Offshore |
|----------------------|-----------|-----------|
| Type 1 (Mature) | 29 | |
| Type 2 (Emerging) | 29 | 5 |
| Type 3 (Frontier) | 40 | 6 |
| 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 |

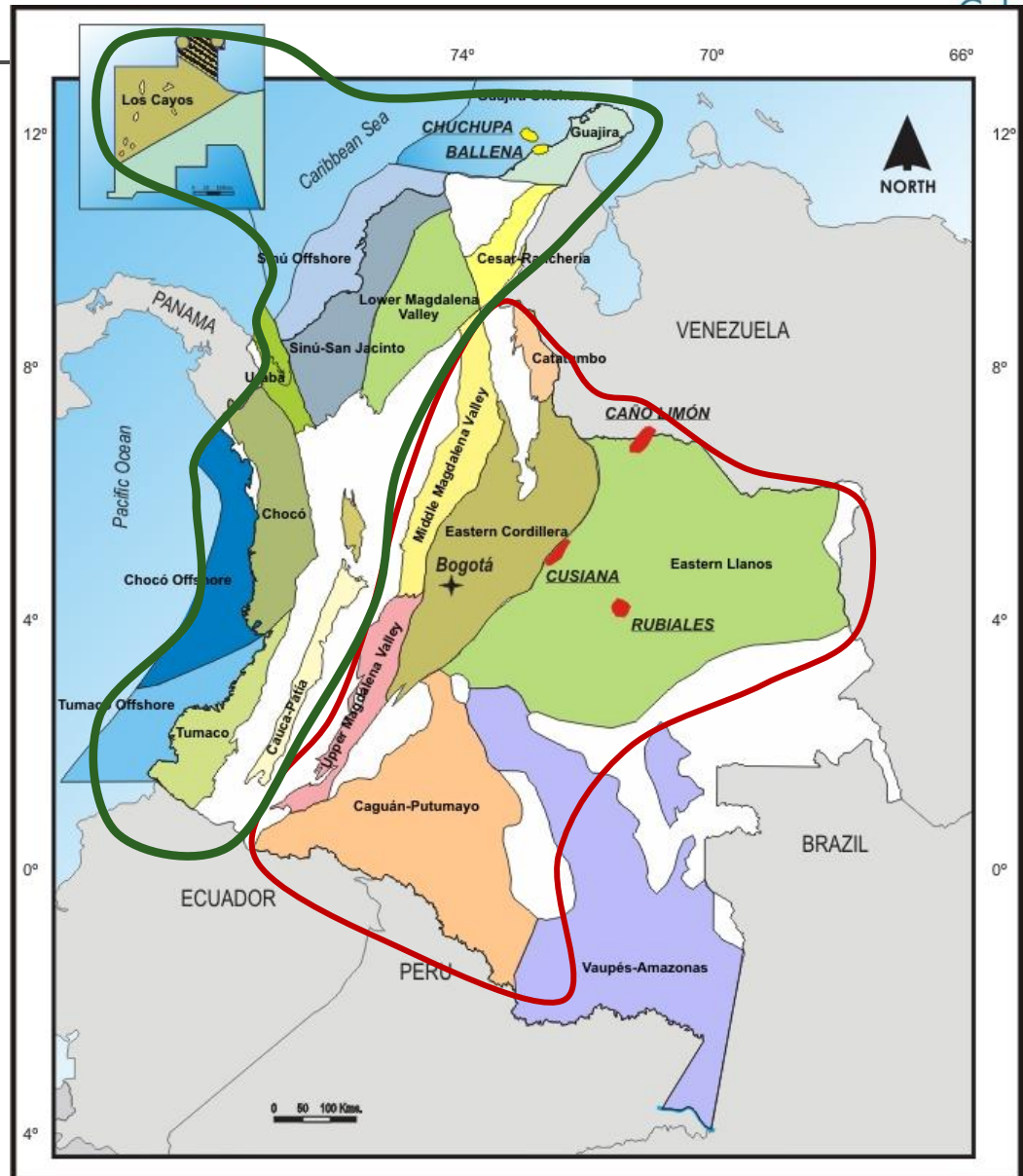


Colombian Basins

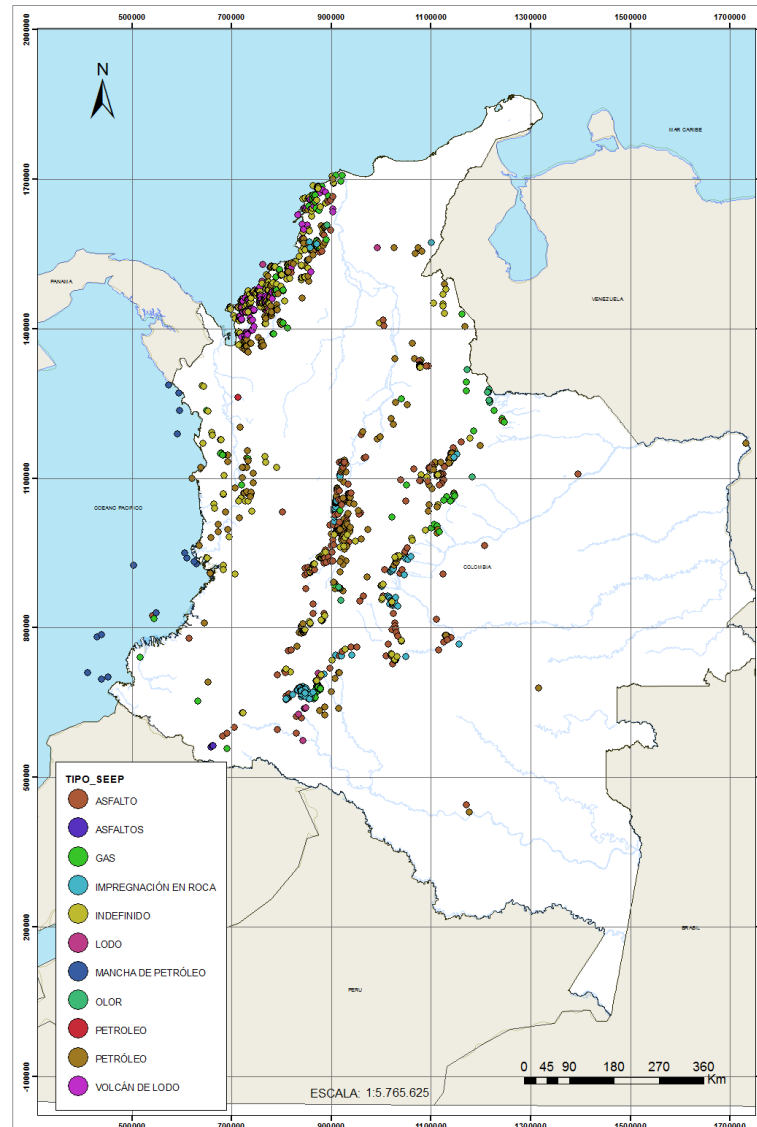
Colombia is blessed with a large number of proven and high potential oil and gas basins:

Mature and emerging pericratonic and intermountain basins in the east and center of Colombia.

Emerging and frontier coastal and offshore basins in the west and north of Colombia.



Oil and Gas Seeps



Why is Colombia an attractive place to explore ?



Let's consider the following points:

- Underexplored basins with proven petroleum systems
- When were the major discoveries made?
- Exploration tools used in the past
- Geologic concepts applied in the past

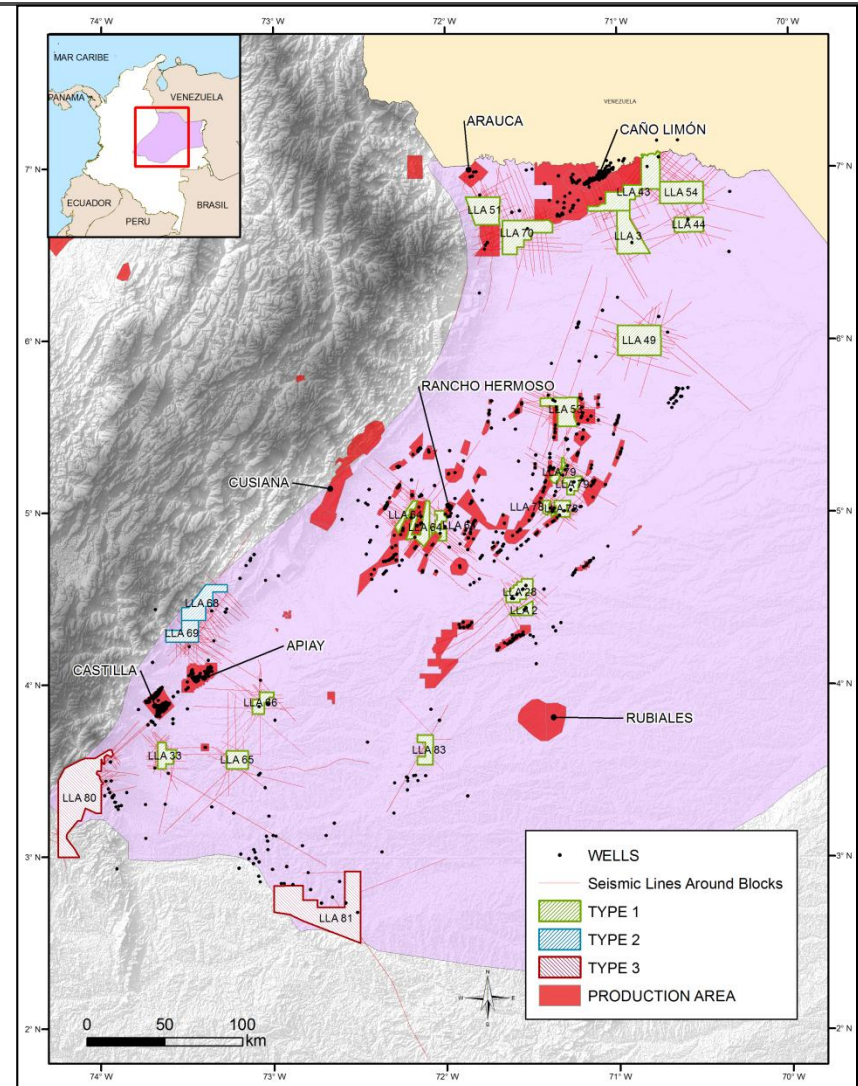
Consequently,

1. There are large areas which remain unexplored/underexplored, in both producing and frontier basins
2. We need to generate new ideas
3. We have to apply the new concepts
4. We have to use new technologies available

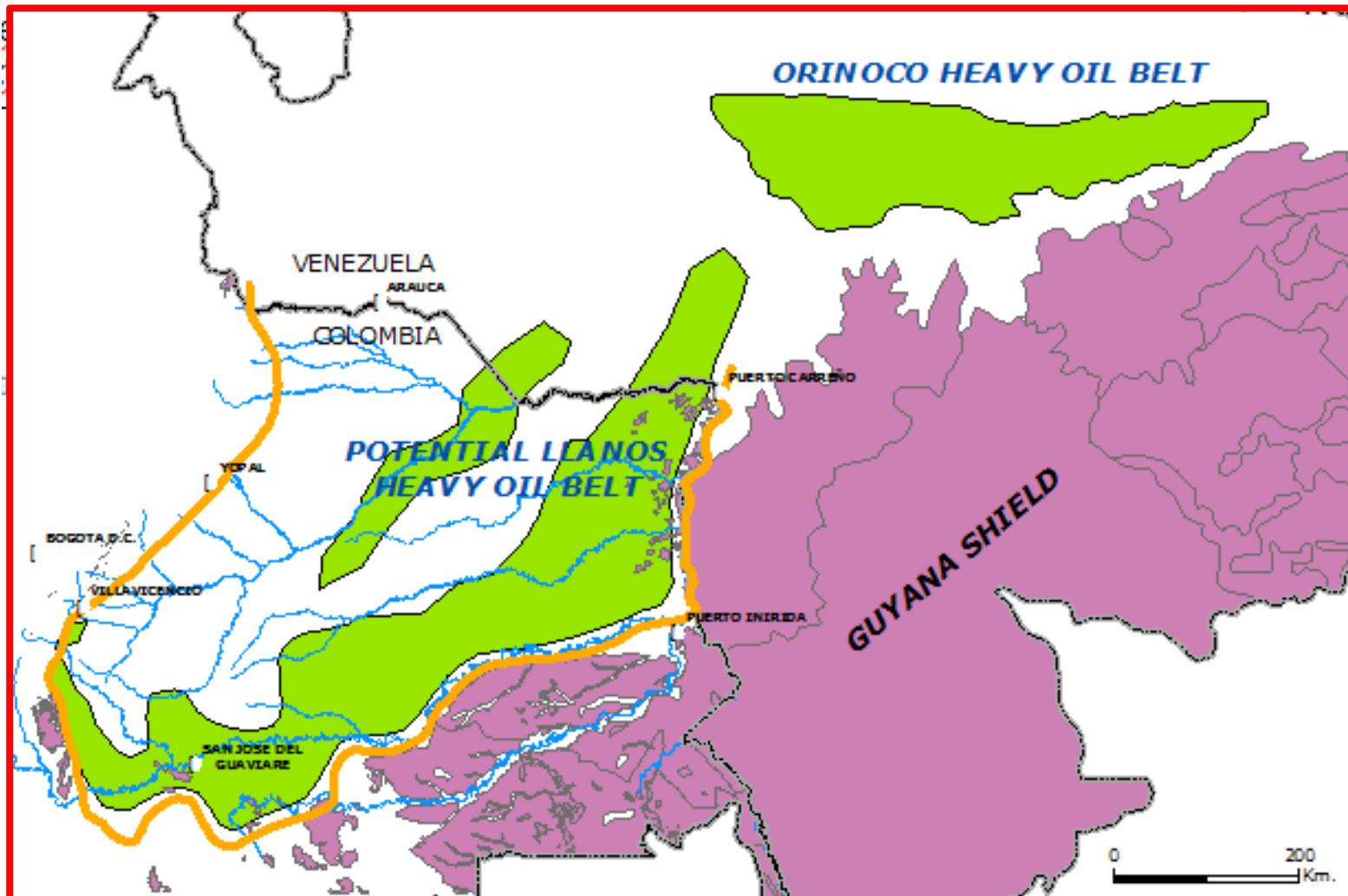
It's time for conducting 3D seismic exploration

Llanos Basin

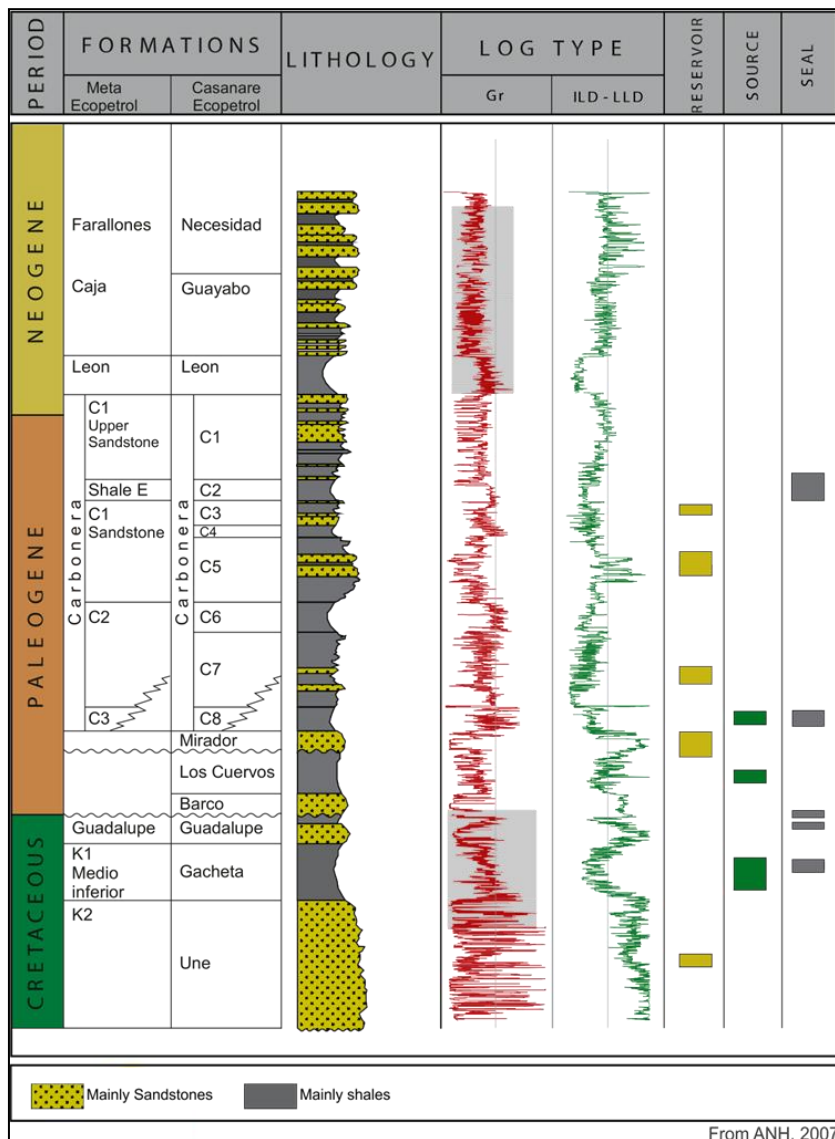
- Mature in terms of exploration
- It is the country's most prolific basin.
- A preliminary assessment of hydrocarbon resources suggests that the basin is also prospective for *Shale Oil* and *Shale Gas*.



Llanos Basin



Llanos Basin

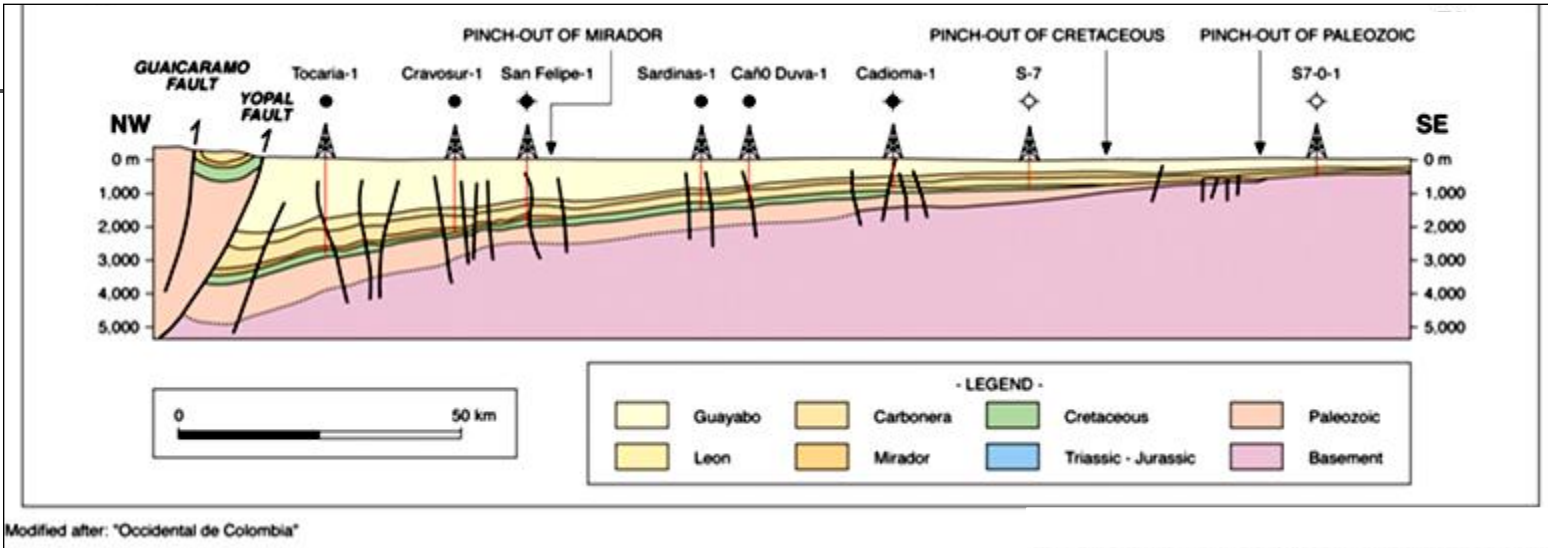


PETROLEUM SYSTEM

K (Gacheta) – **K** (Une)

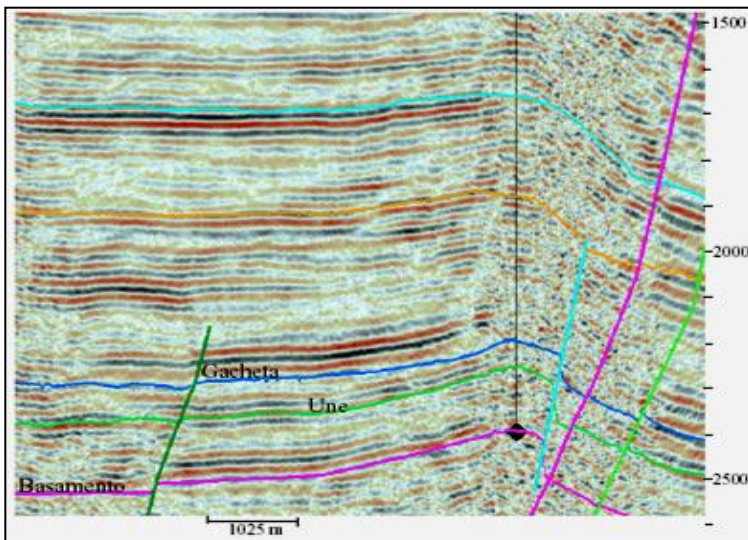
K (Gacheta) – **P** (Mirador - Carbonera)

Structural Styles

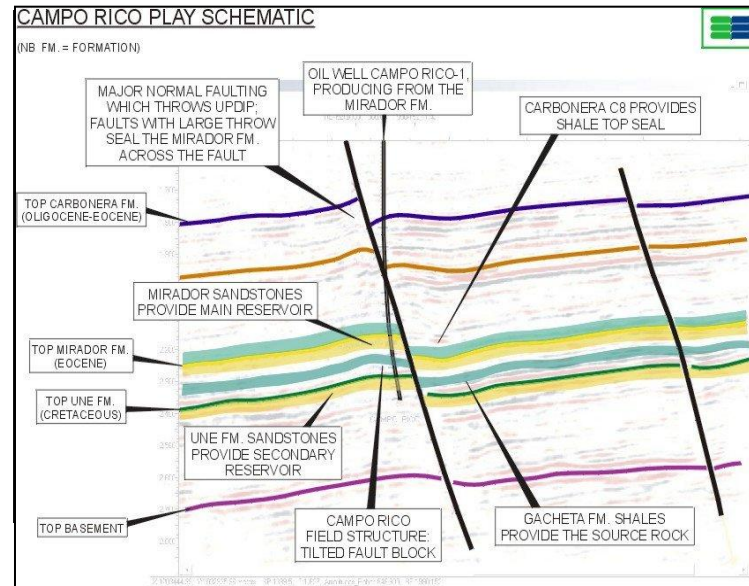


Modified after: "Occidental de Colombia"

Inversion structure

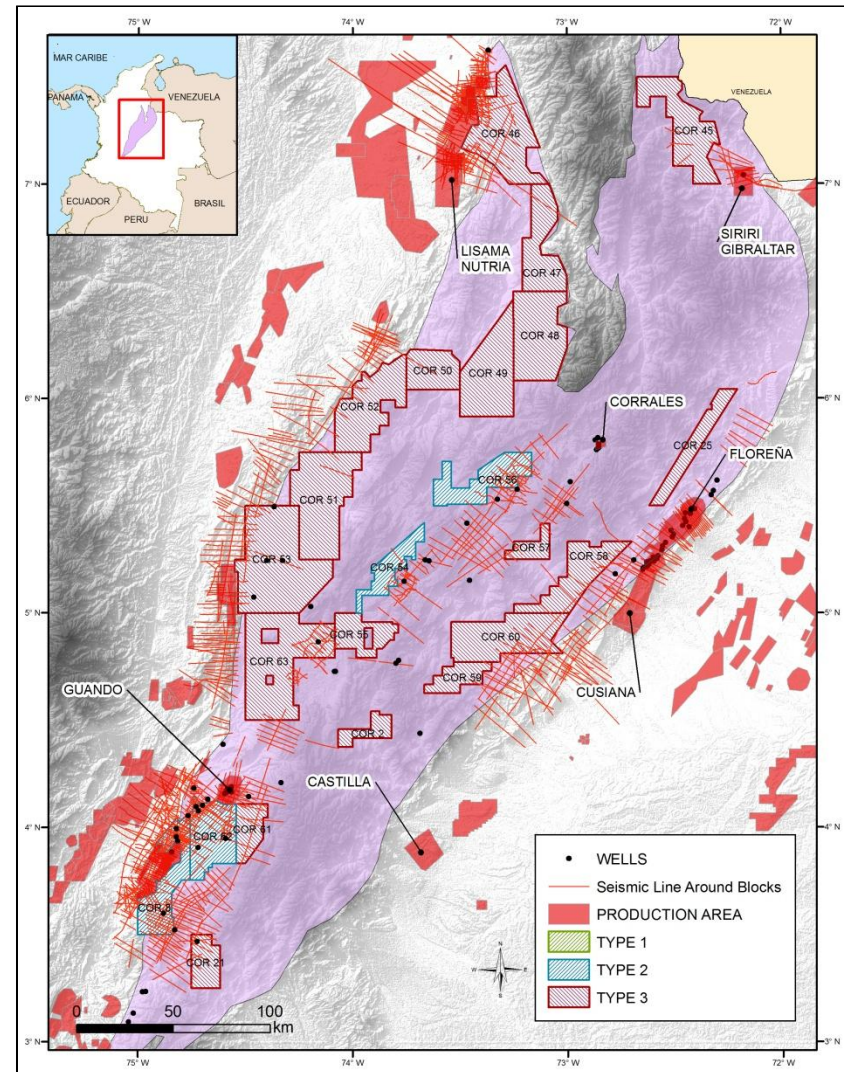


Antithetic normal fault

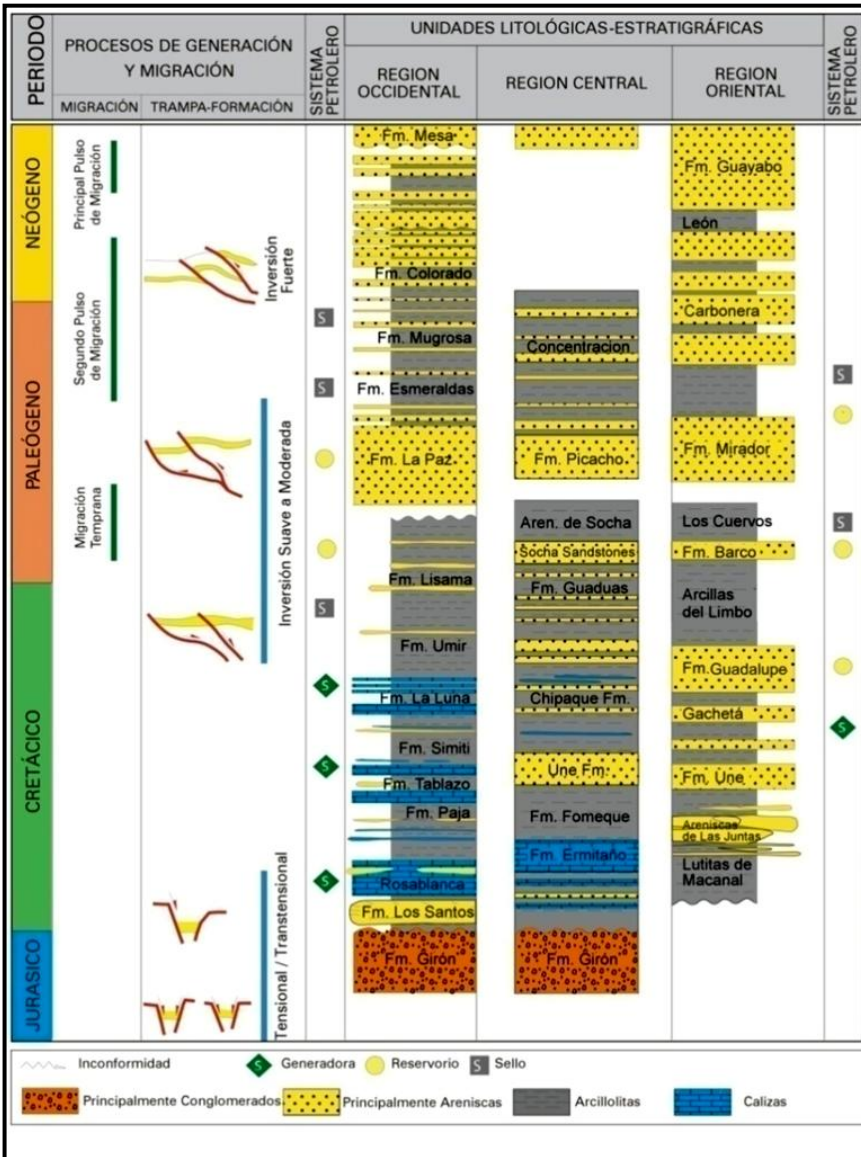


Eastern Cordillera Basin

- 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



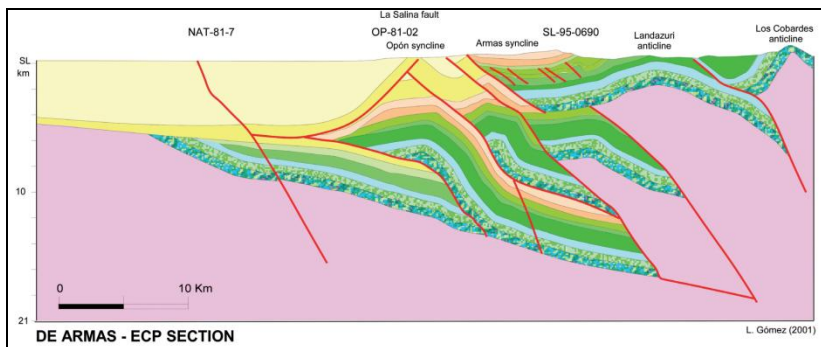
PETROLEUM SYSTEM

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

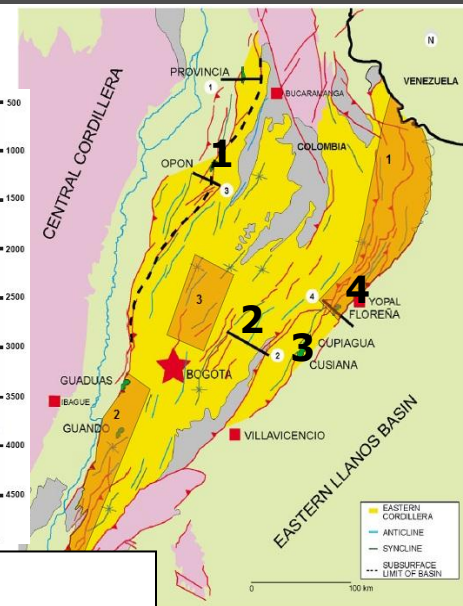
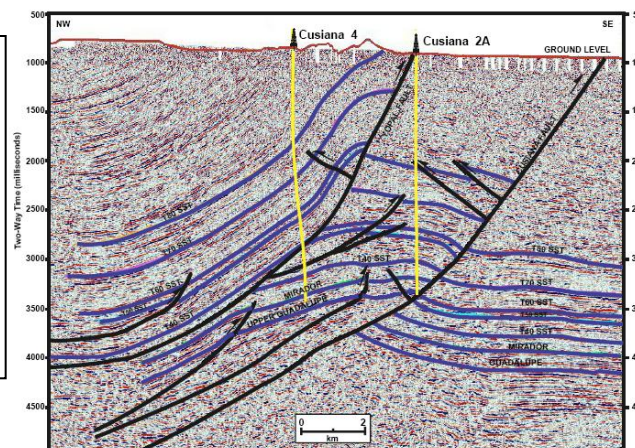
K (Gacheta- La Luna) – **P** (Barco-Mirador)

Structural Styles

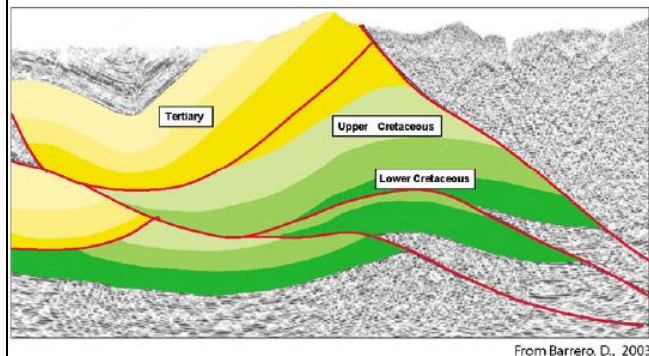
1. Sub thrust anticline



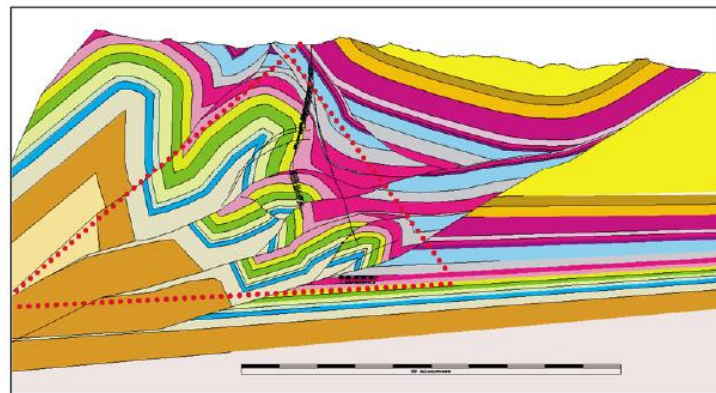
3. Cusiana field



2. Triangle zone – Río Horta

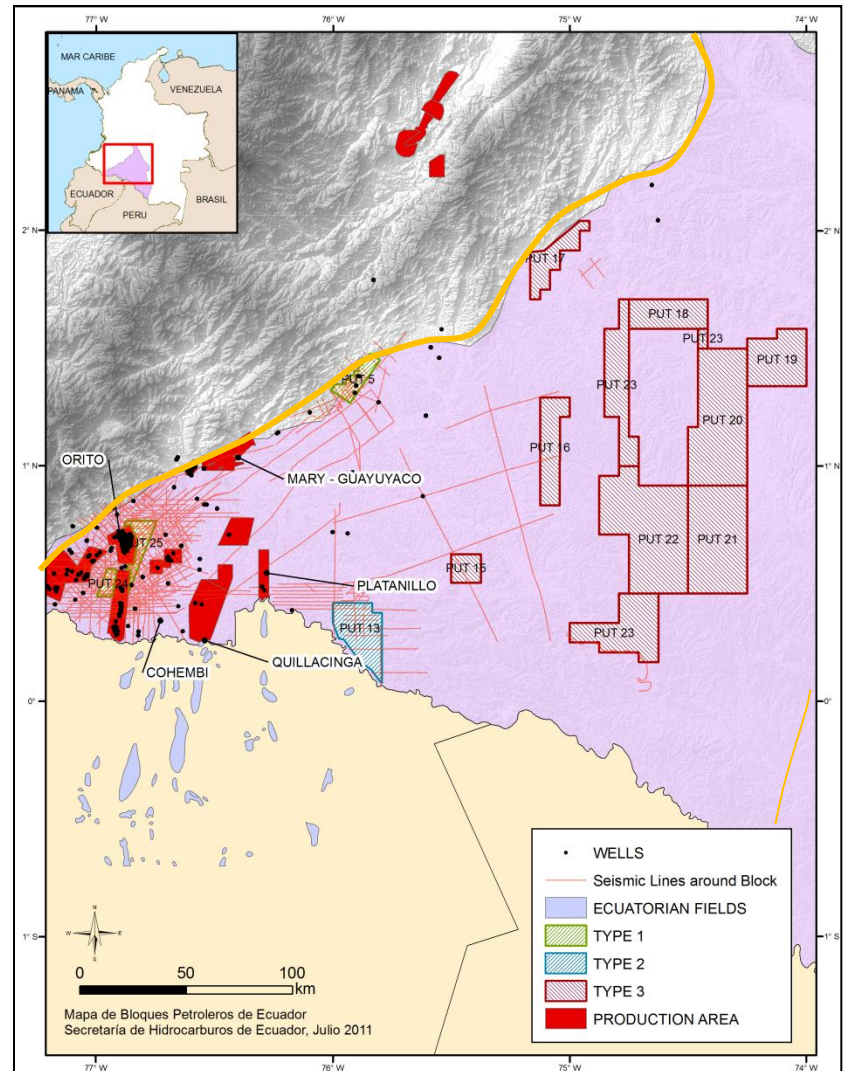


4. Duplex structure – Floreña area

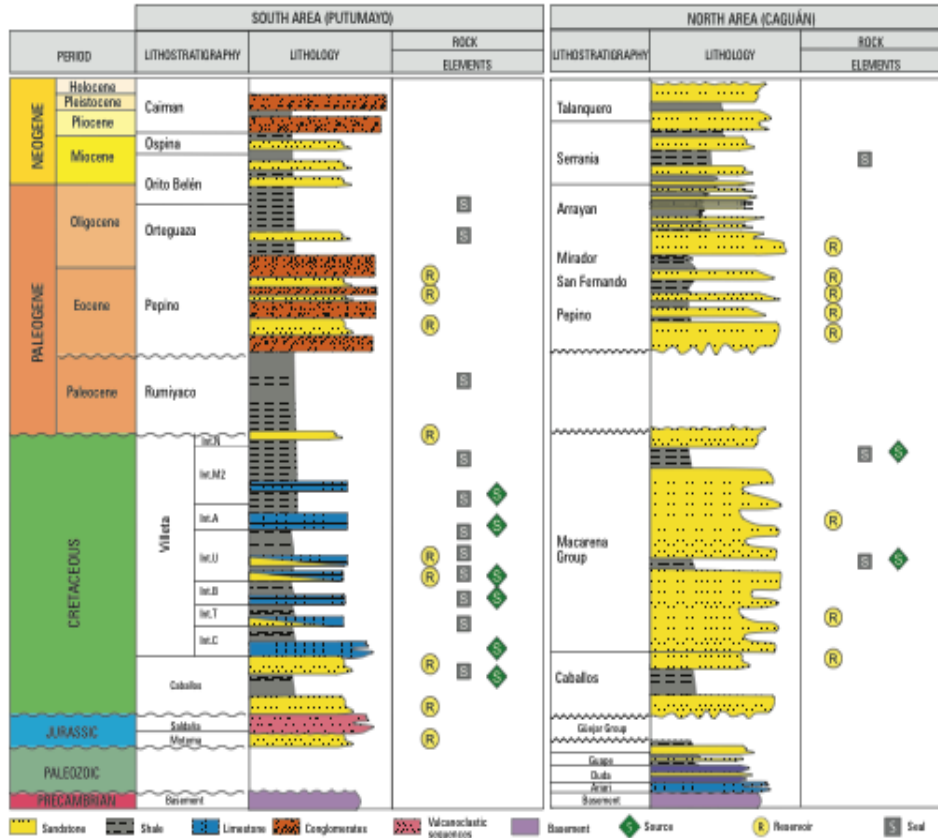


Caguán–Putumayo Basin

- 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

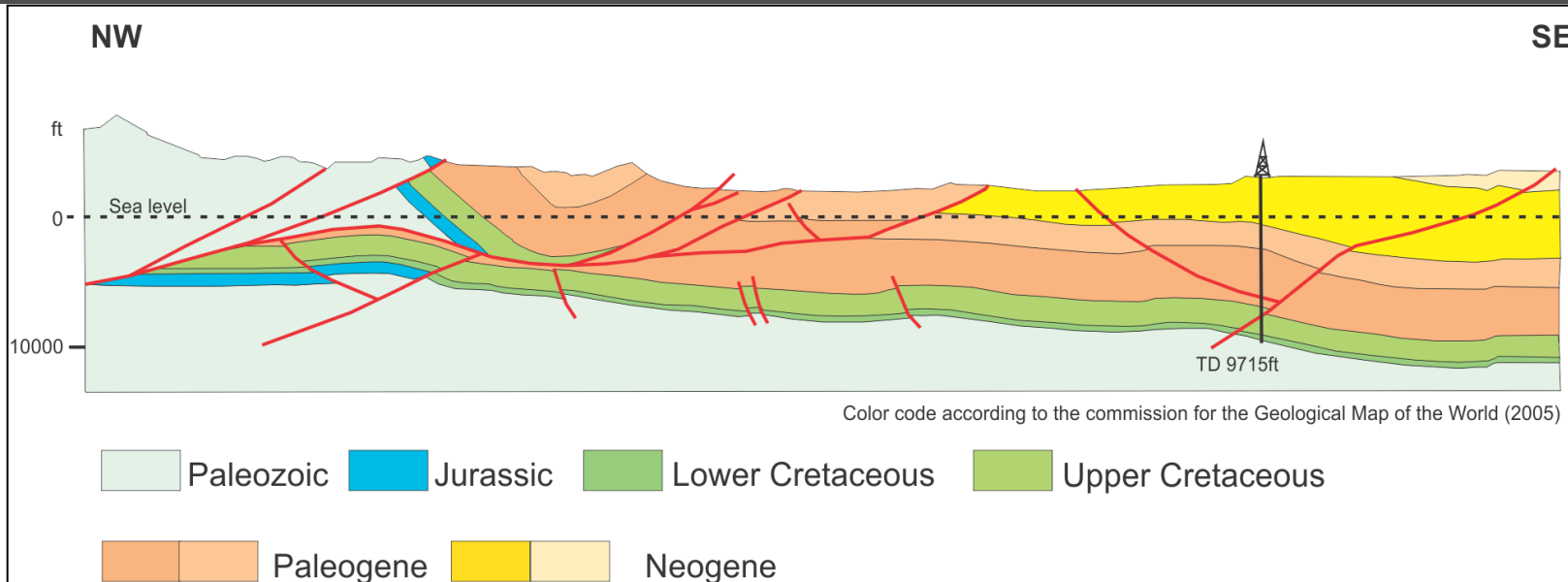


PETROLEUM SYSTEM

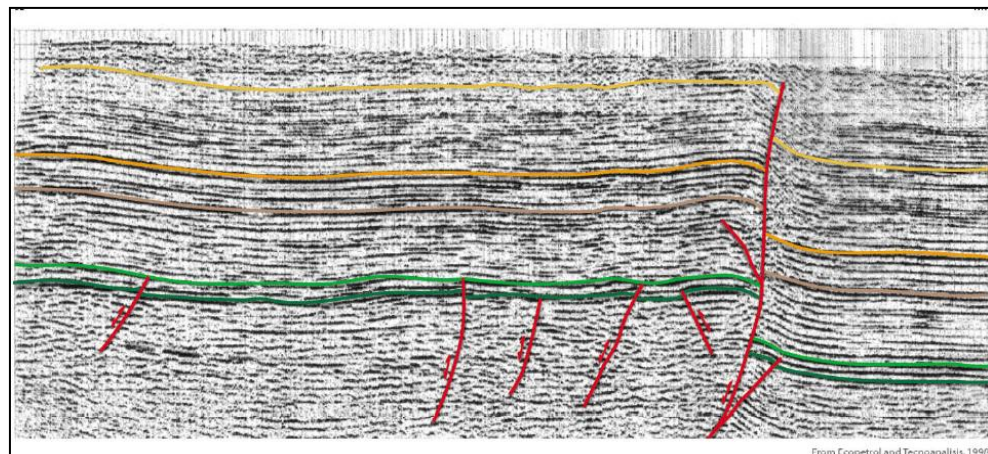
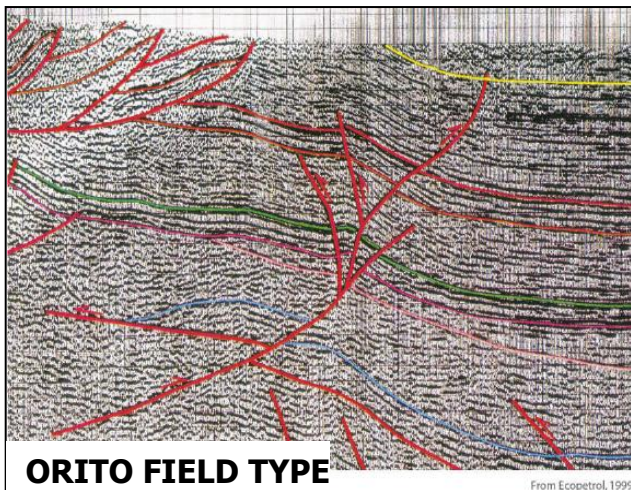
K (Caballos-Villeta) – **K** (Caballos-Villeta)

K (Caballos-Villeta) – **P** (Pepino)

Structural Styles

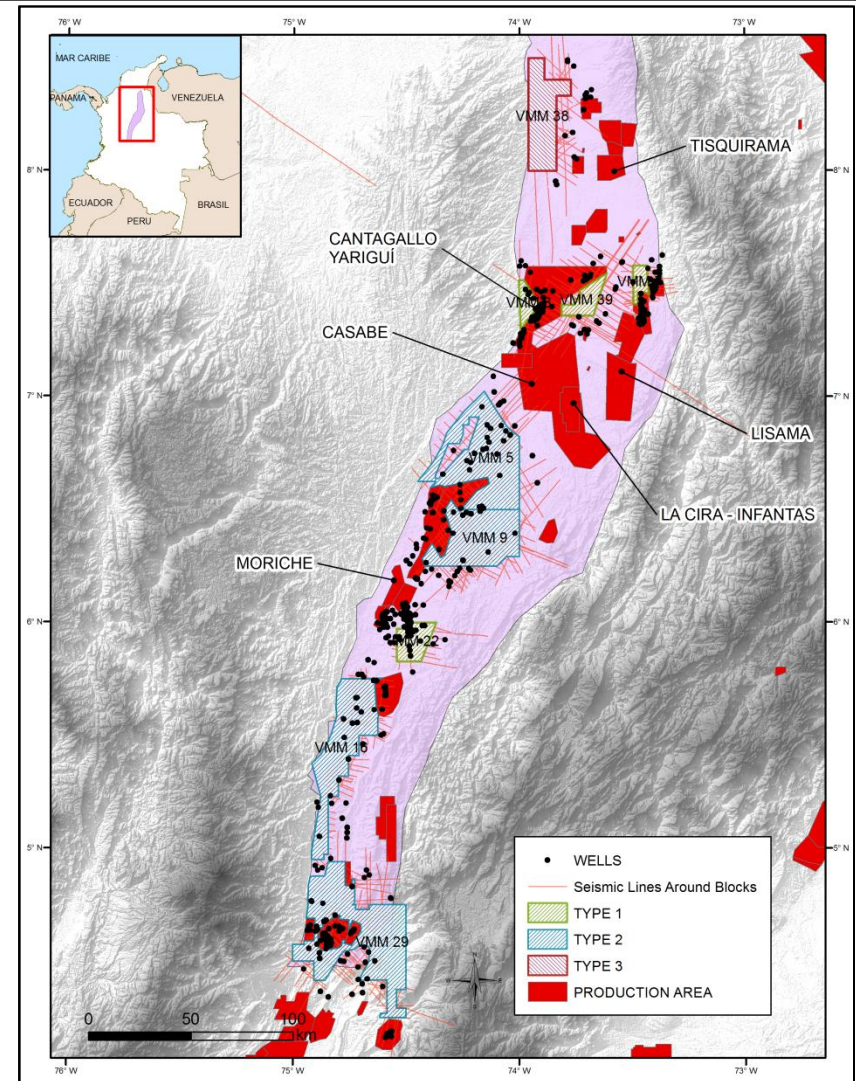


Inversion structure

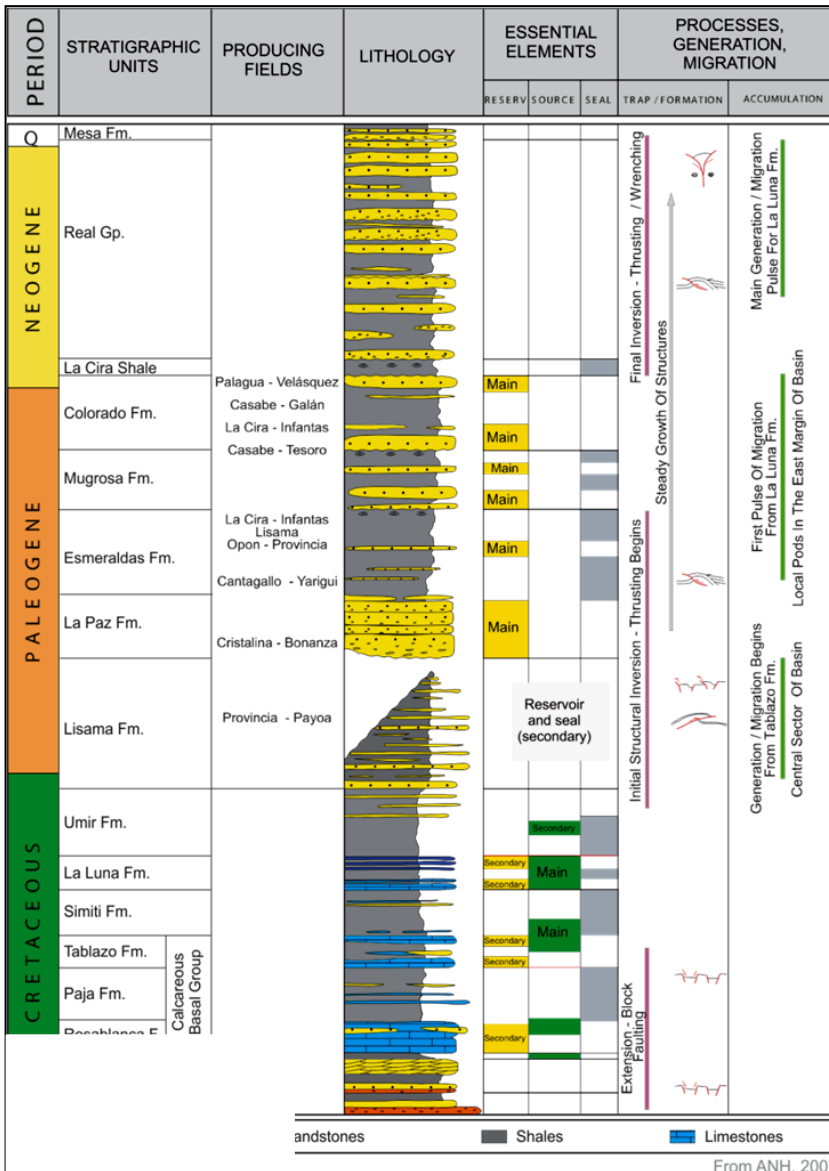


Middle Magdalena Basin (VMM)

- 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)

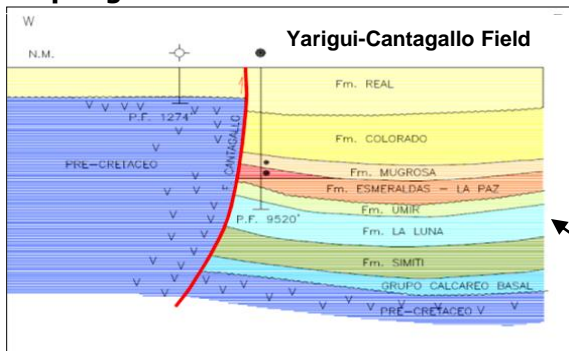


PETROLEUM SYSTEM

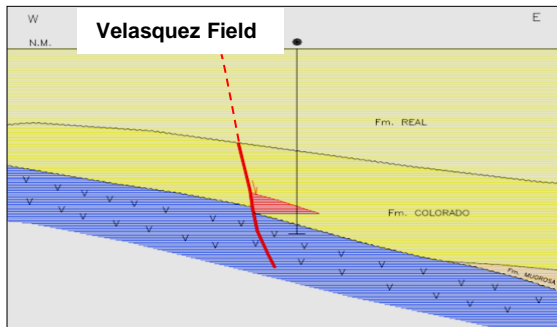
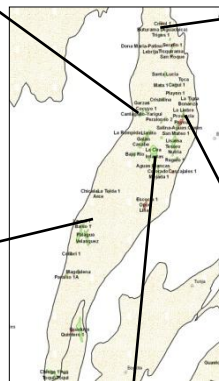
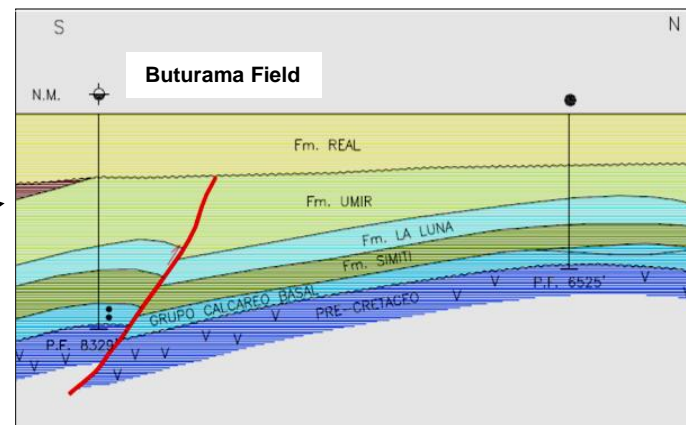
K (La Luna) – **P** (La Paz, Mugrosa, Colorado)

Structural Styles

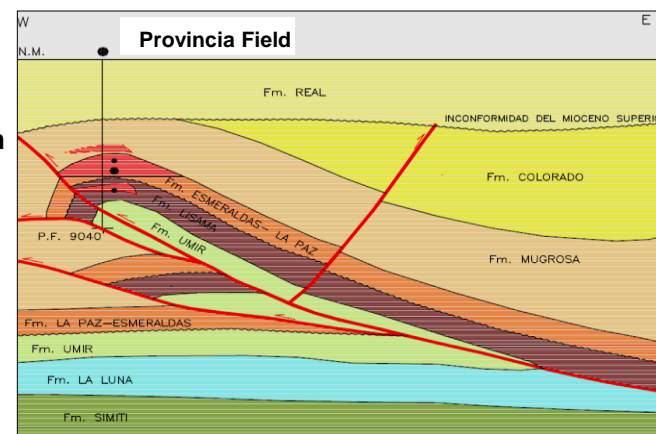
Faulted traps against basement of the Central Cordillera



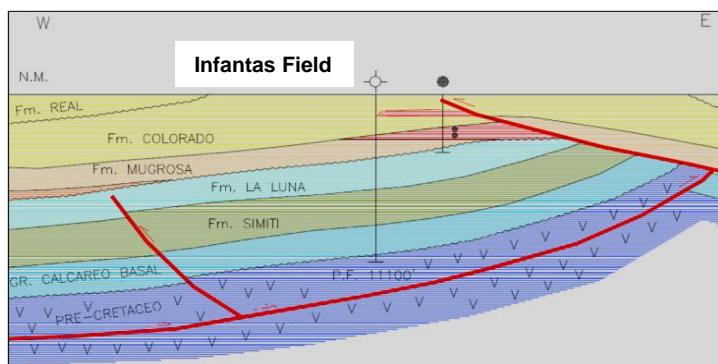
Lower Cretaceous fractured limestones



Fold Propagation Fault



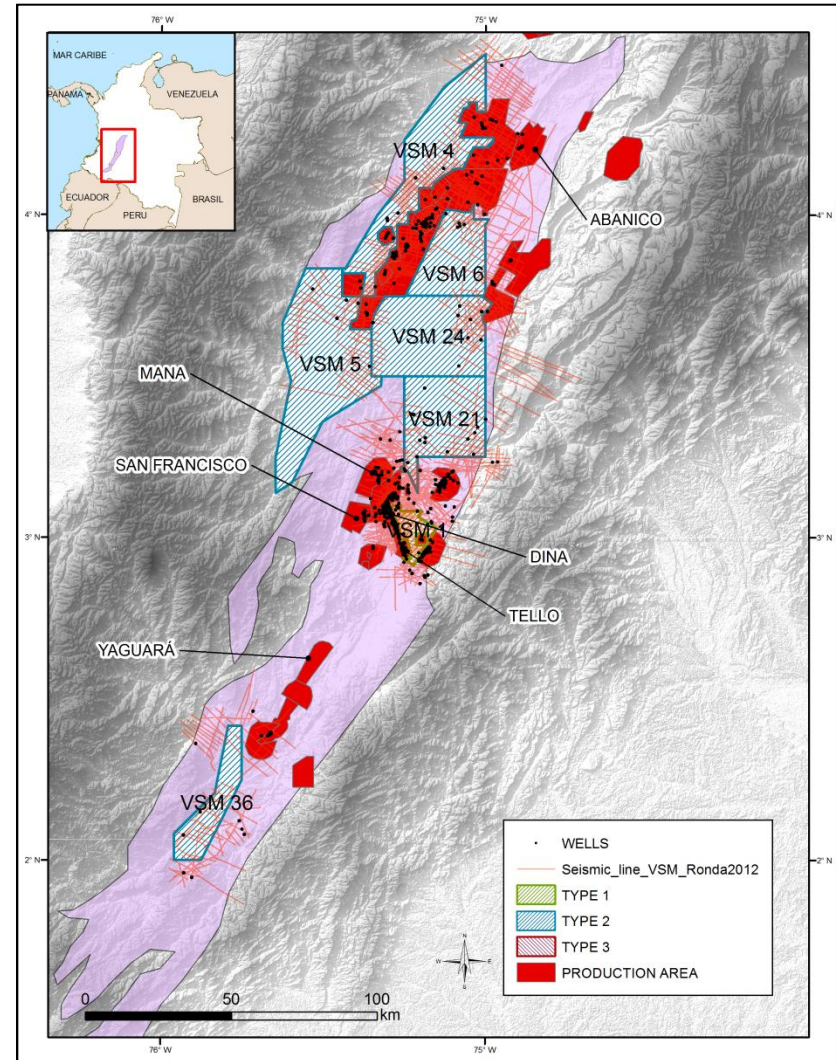
Subthrusts structures associated to Andean deformation



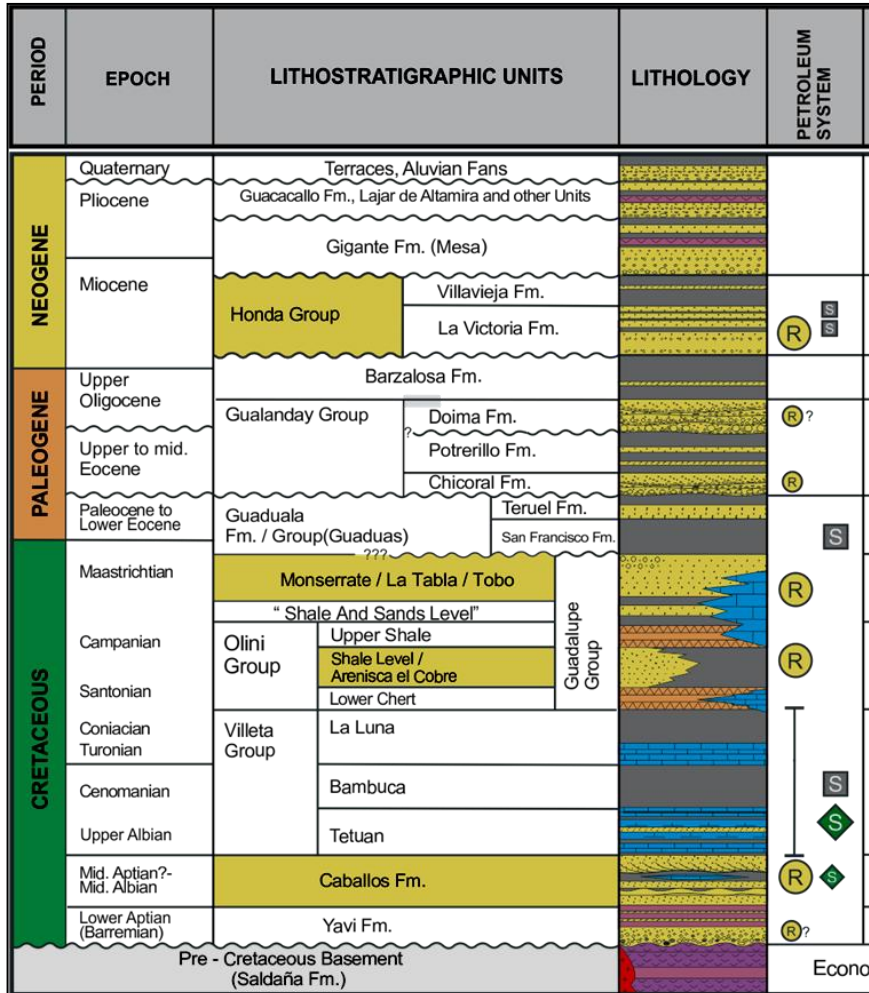
Normal fault traps - eastward dipping monocline

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*.
- Cretaceous carbonates though found productive at the Ortega Field, remain underexplored.



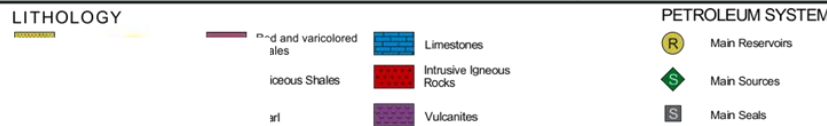
Upper Magdalena Basin (VSM)



PETROLEUM SYSTEM

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

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

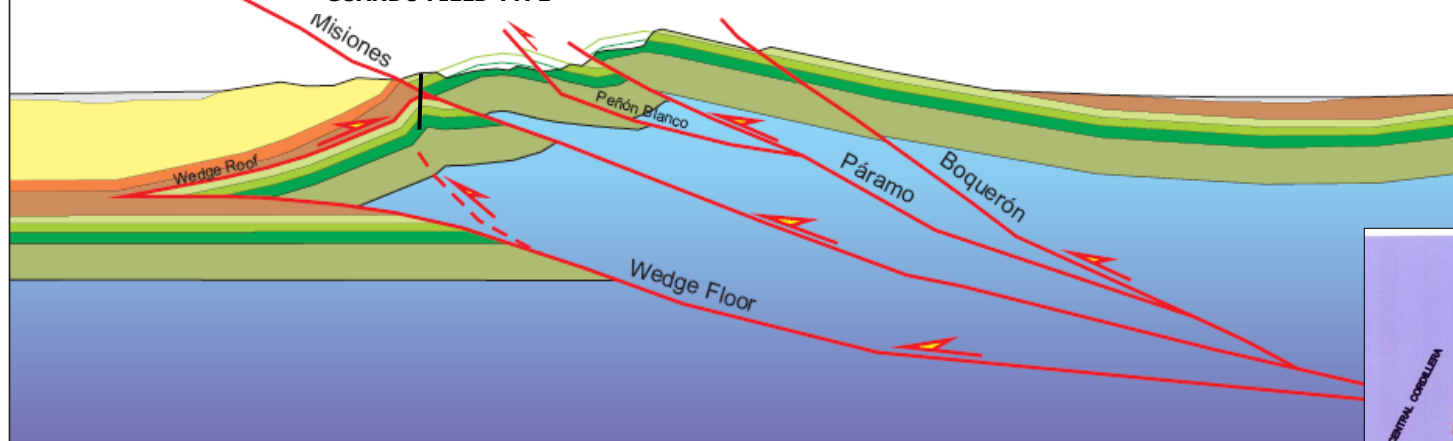


Structural Styles

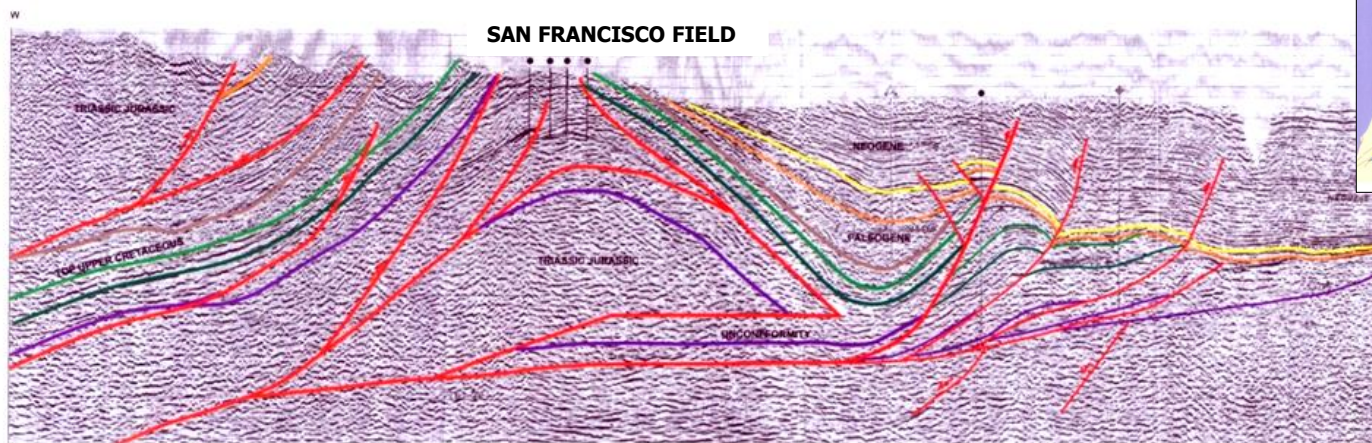
WNW

GUANDO FIELD TYPE

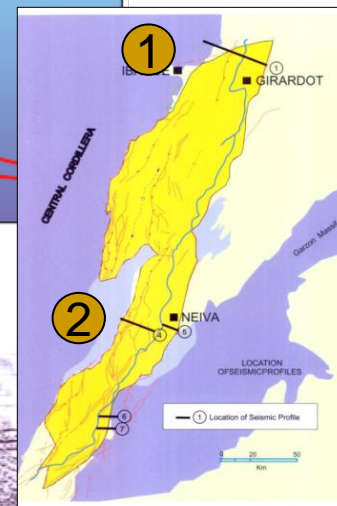
1- Sub-thrust and thrust anticlines



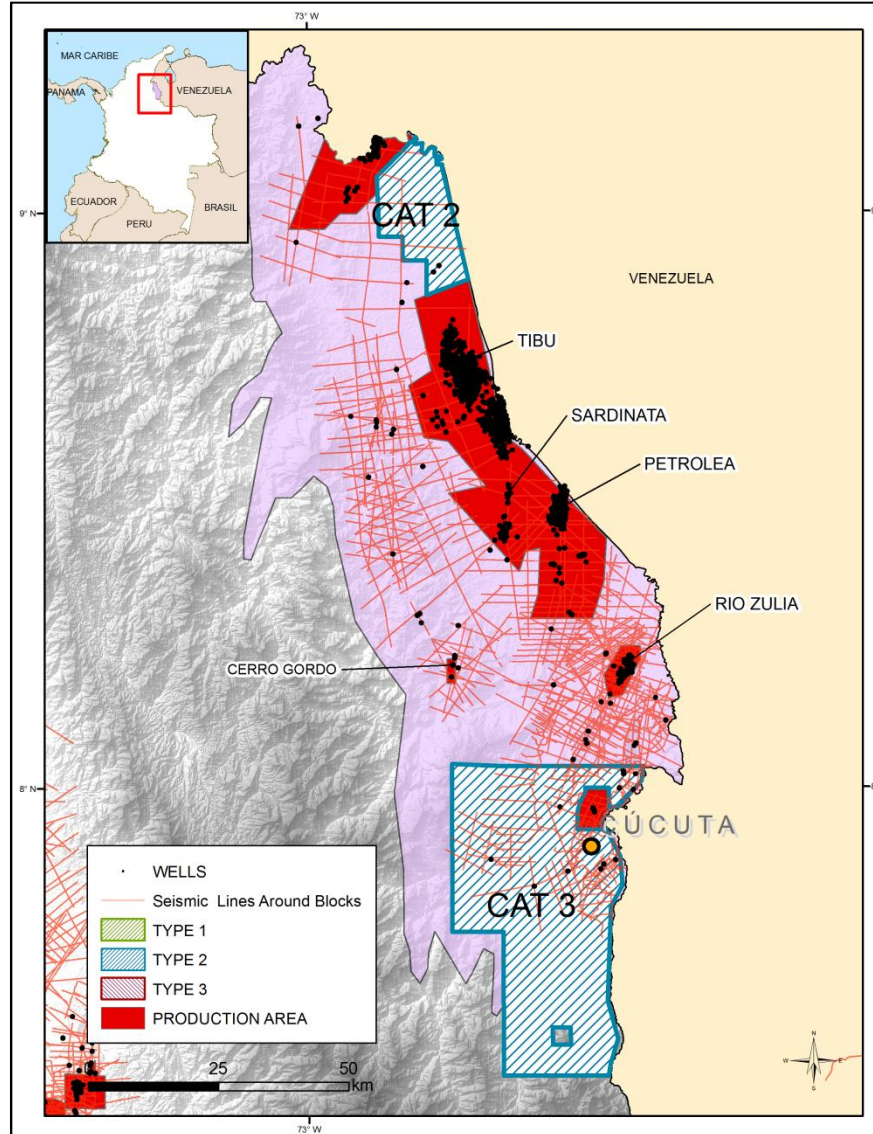
2- Fault Bend Fold and imbricate thrust fans



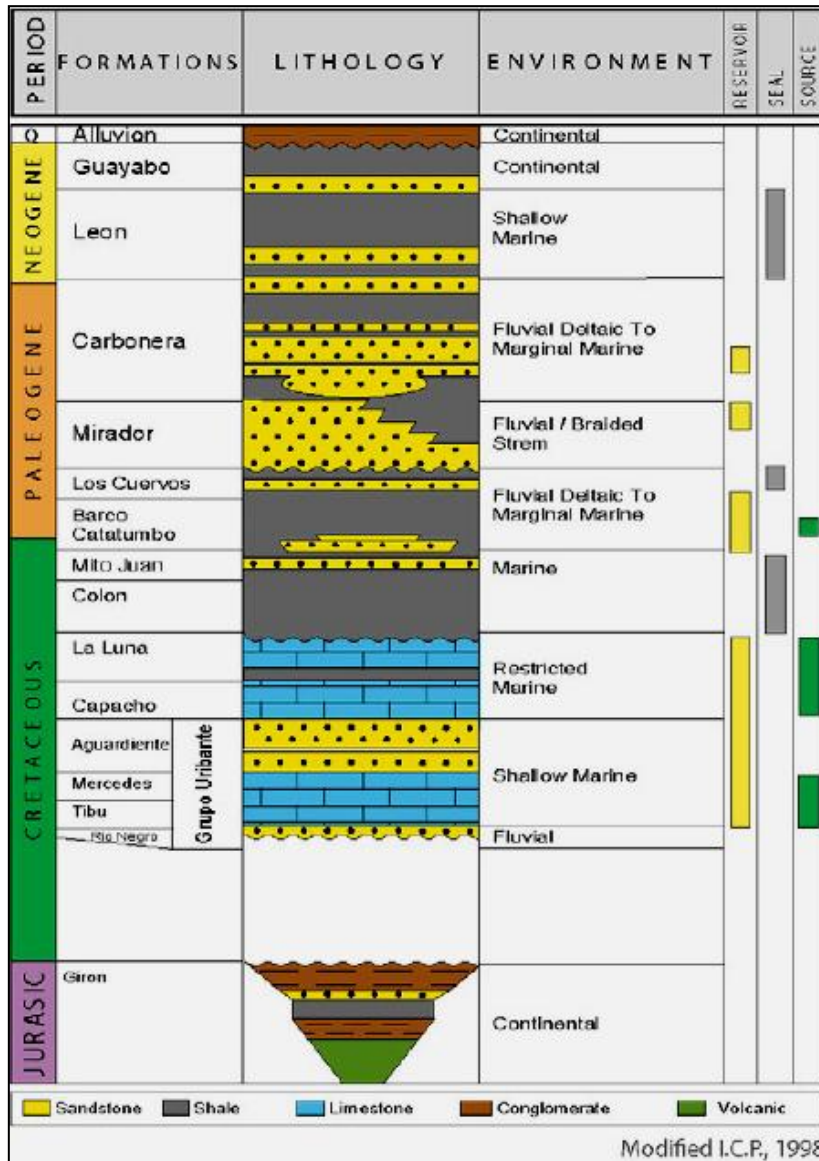
From Seismic Atlas, 1998



Catatumbo Basin (CAT)



Catatumbo Basin (CAT)



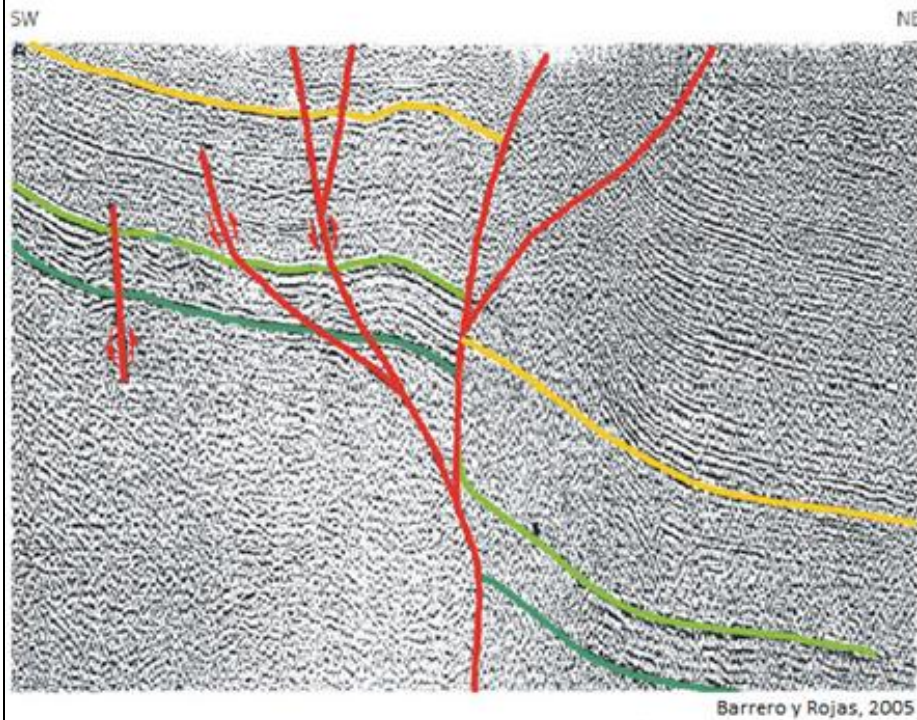
PETROLEUM SYSTEM

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

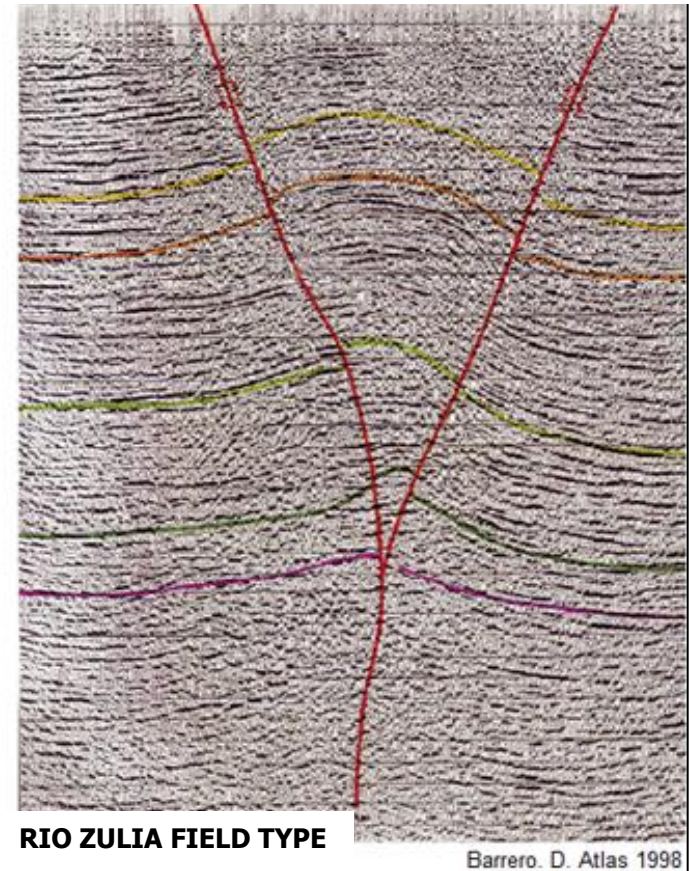
K (Uribante, La Luna) – **P** (Barco, Mirador , Carbonera)

Structural Styles

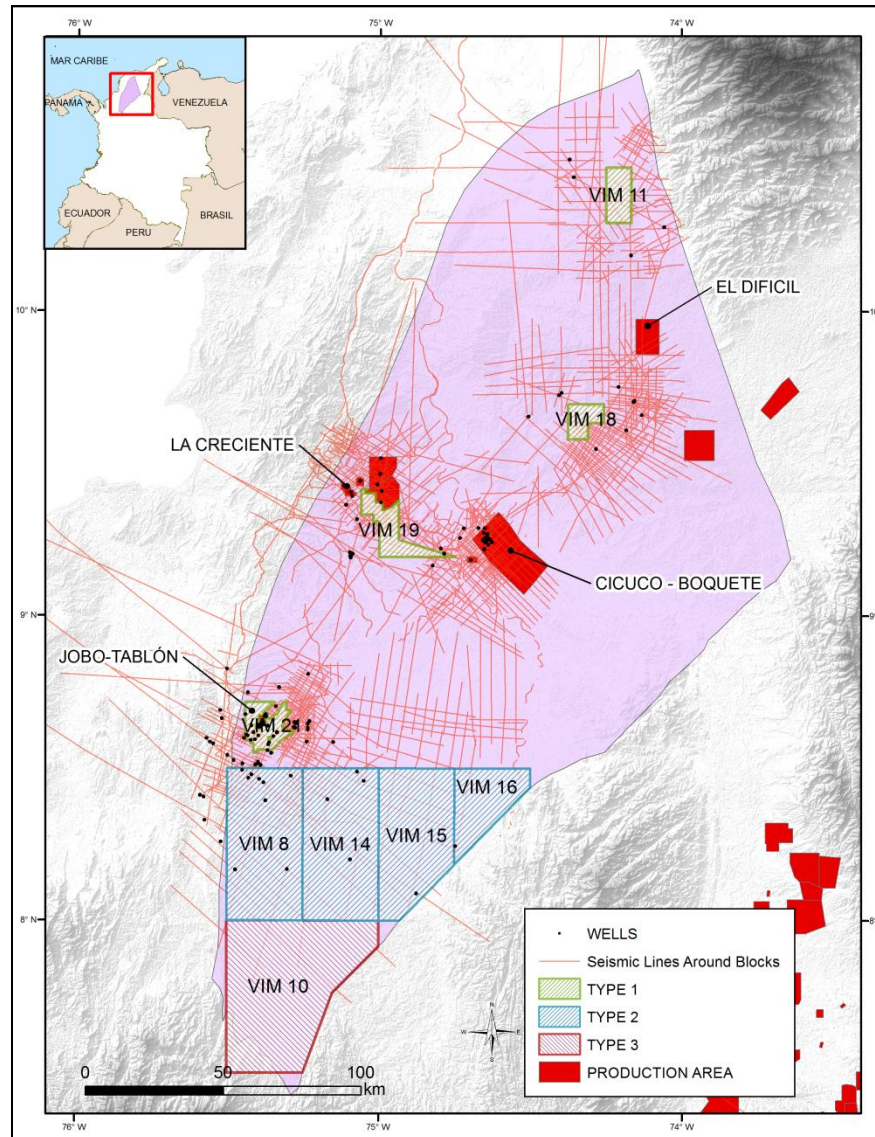
1- Closures on both hanging-wall and foot-wall of faults developed under transpression



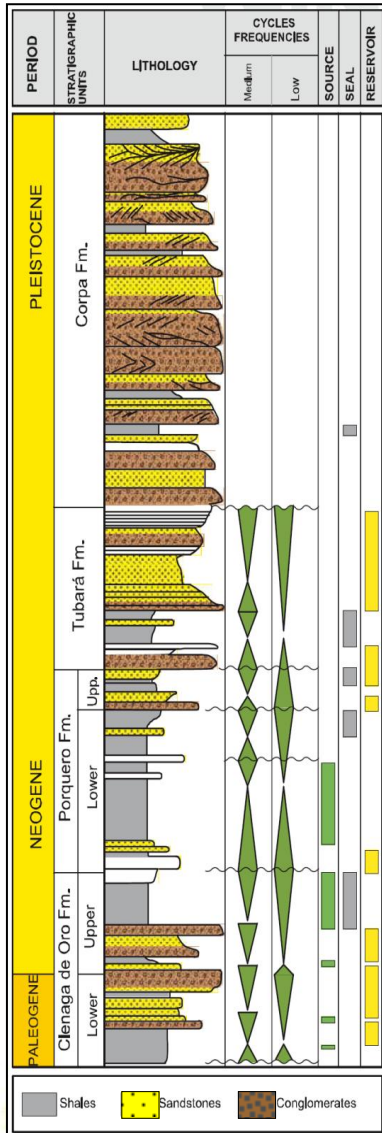
2- Anticline traps (Flower Structures) developed under wrenching conditions



Lower Magdalena Basin (VIM)



Lower Magdalena Basin (VIM)



PETROLEUM SYSTEM

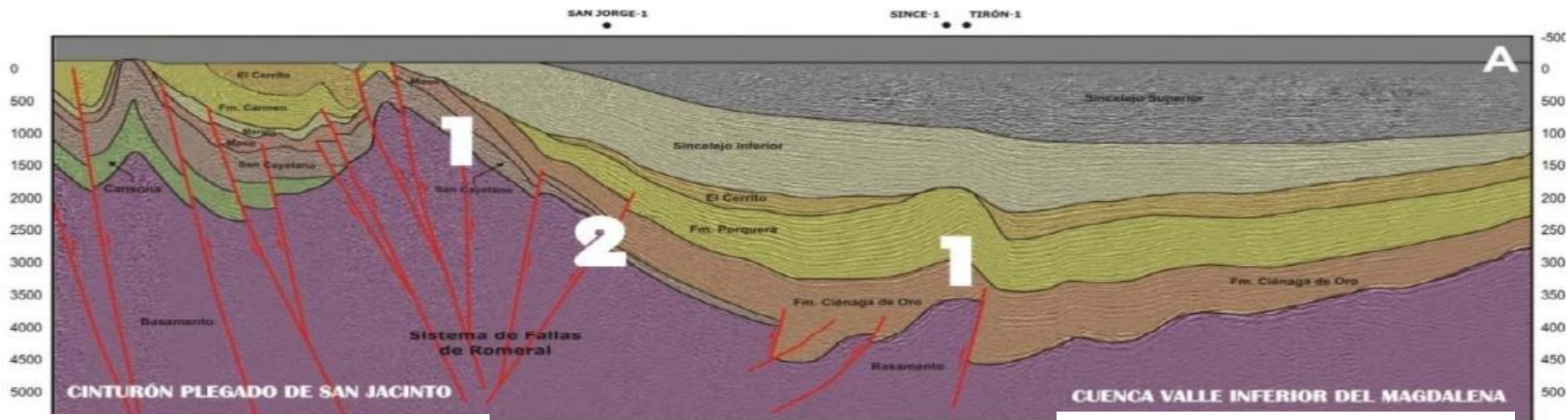
P (Ciénaga de Oro) – **N** (Ciénaga de Oro, Tubará)

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

Barrero et al, 2008

Structural Styles

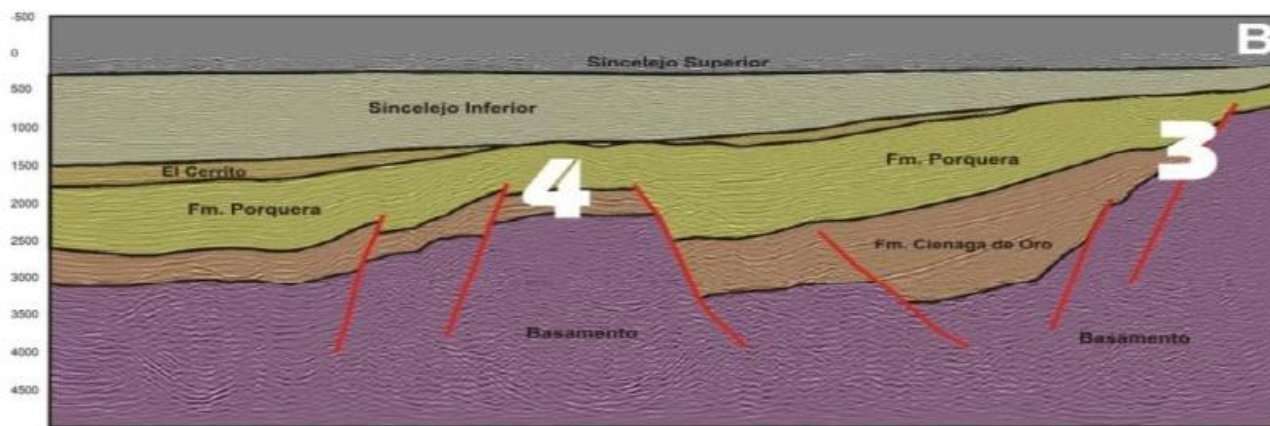
- 1- Inversion anticlines 2- Fault juxtaposition traps 3- Pinch-outs against basement 4- Basement High



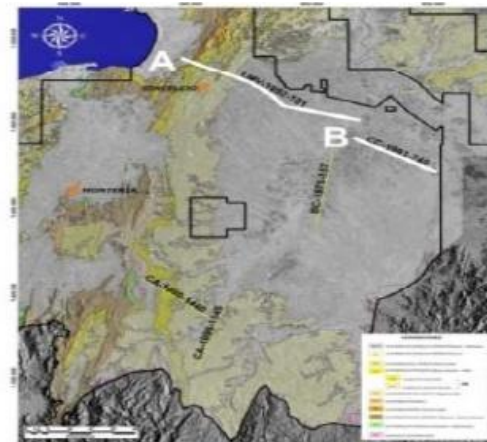
SAN JACINTO FOLD BELT

LMV-1992-101

VIM BASIN



CC-1991-740



Exploration History

- Only 31 exploratory wells drilled
- Numerous hydrocarbon occurrences
- Exploration has been punctual in the past
- Gas discoveries may have penalized exploration in the region
- Last exploration efforts conducted in the 1970's

Why this area?

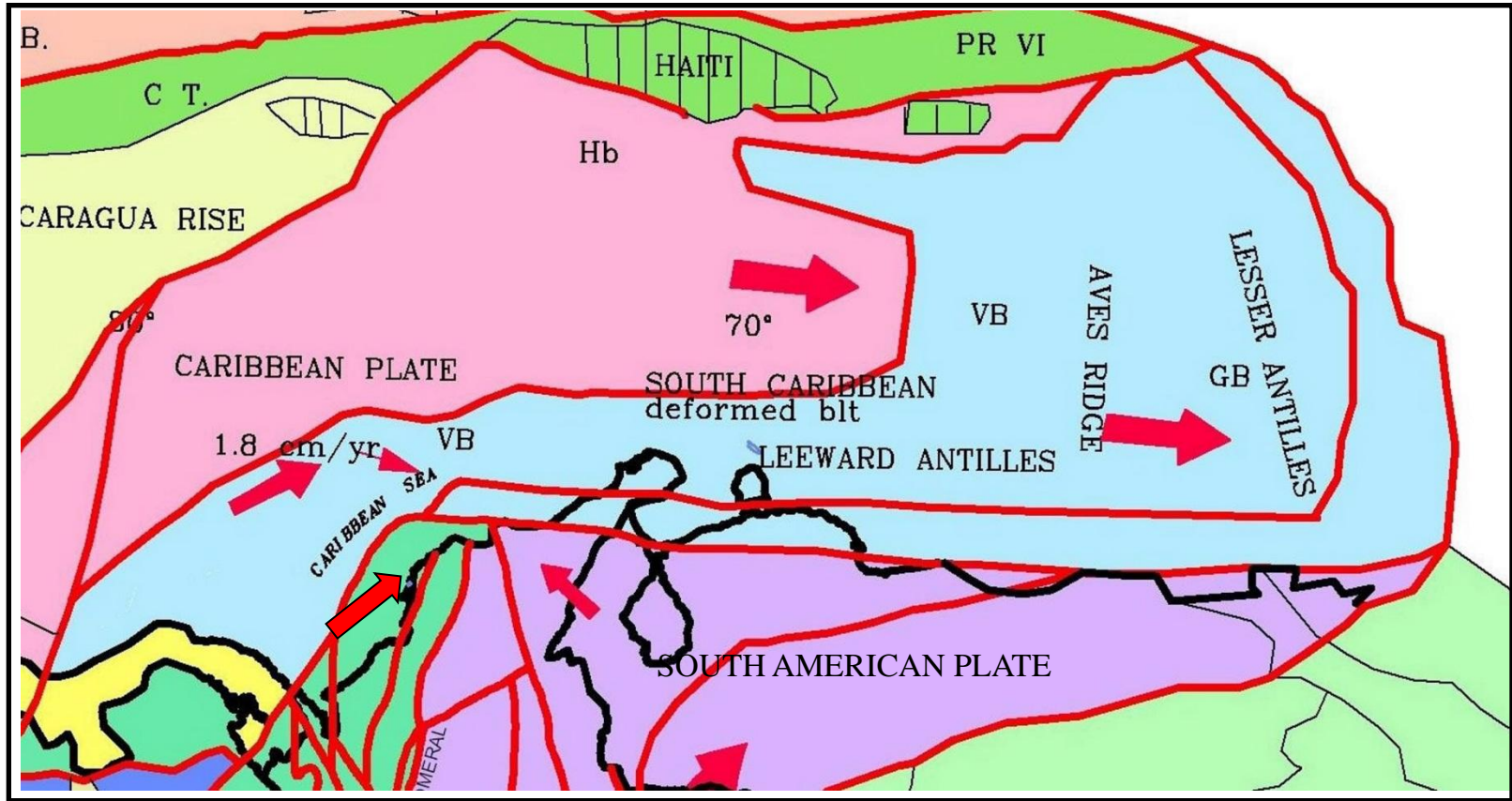
1. New geochemical information from piston core suggests thermogenic origin of hydrocarbons
2. Large areas remain unexplored/underexplored
3. Apply new ideas, new concepts and new technologies

Hydrocarbon Occurrences



Tectonic Setting

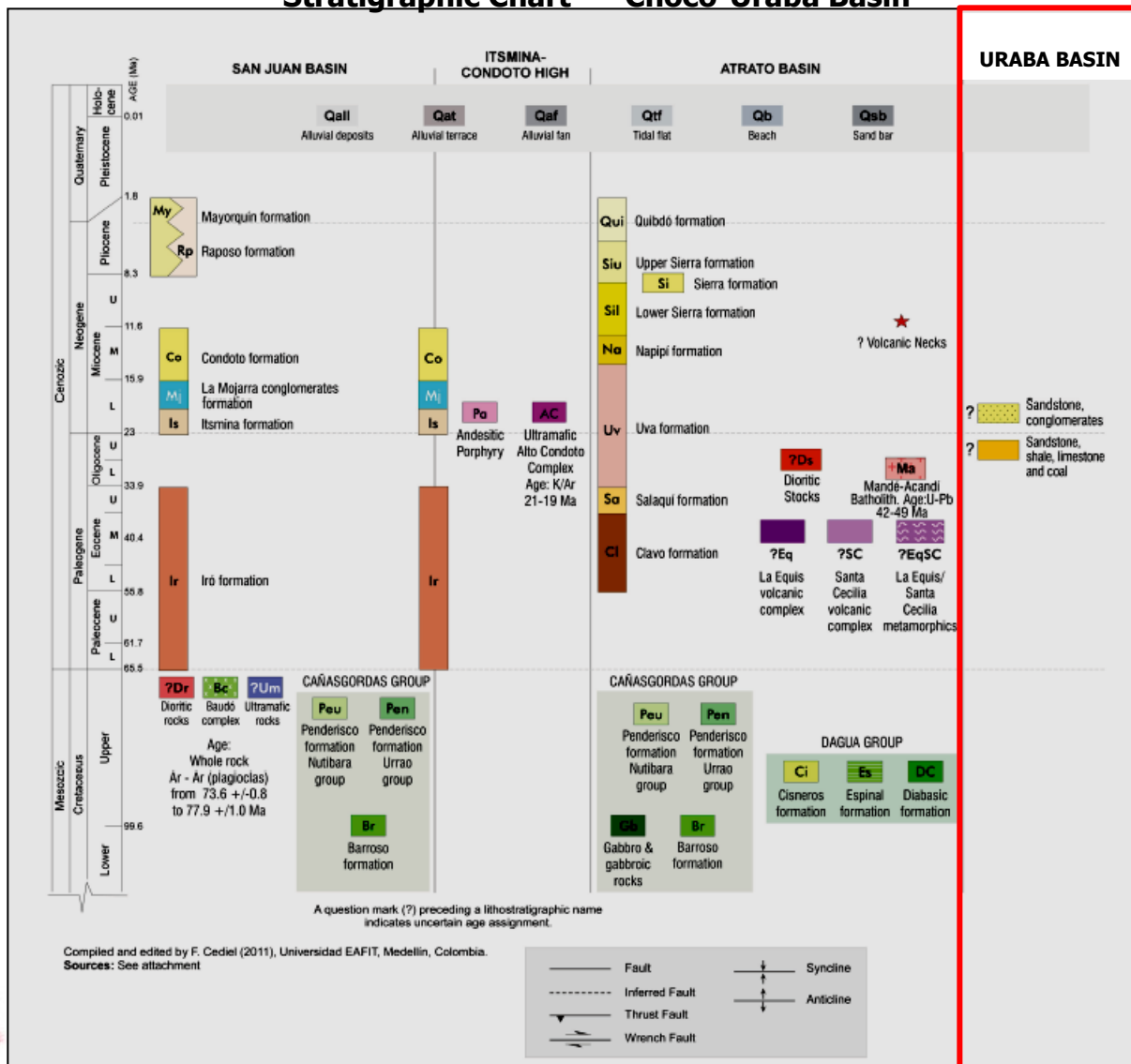
Tectonic Plates



After Diaz, L (2004)

Urabá Basin (Ura)

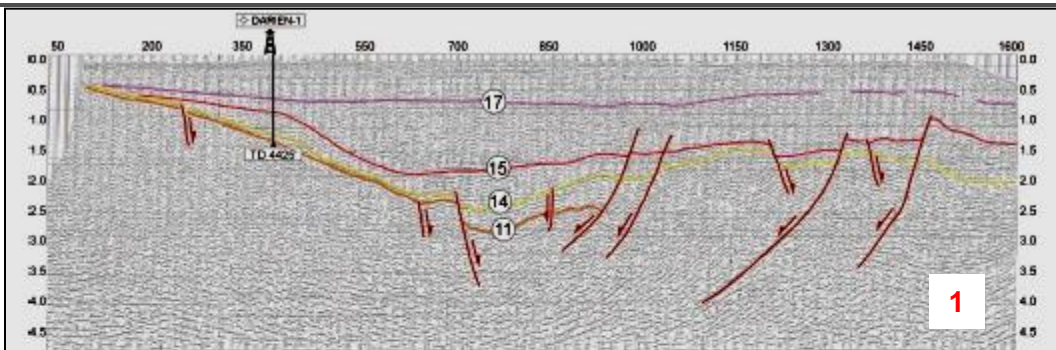
Stratigraphic Chart – Chocó-Urabá Basin



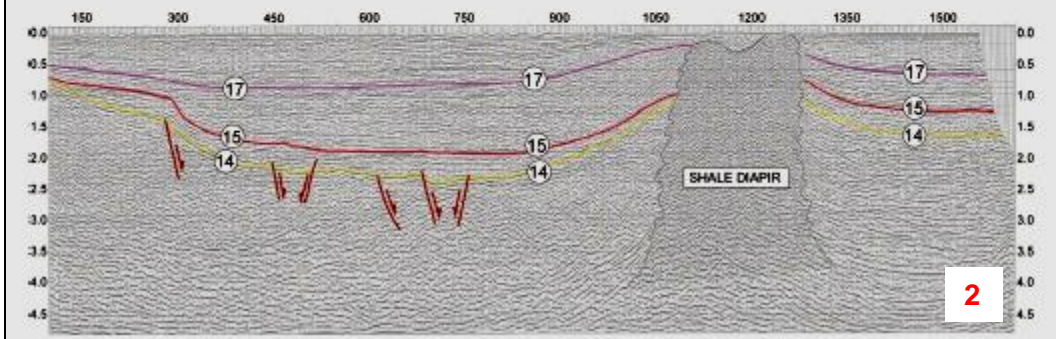
PETROLEUM SYSTEM

? UNPROVEN

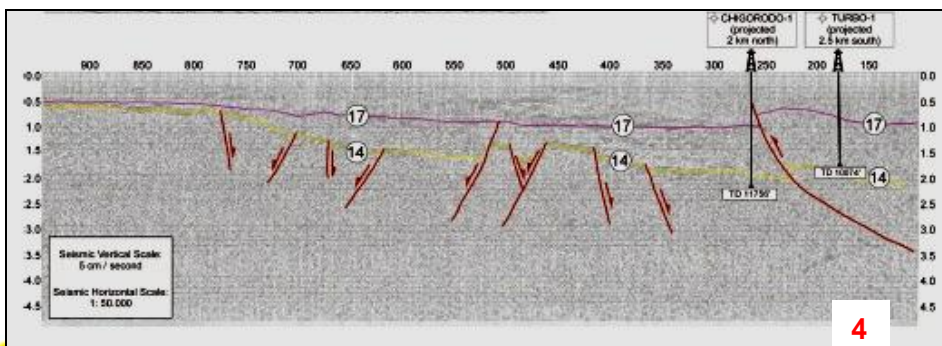
Structural Styles



1

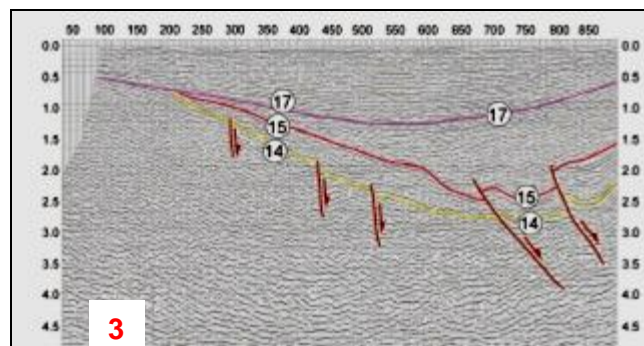
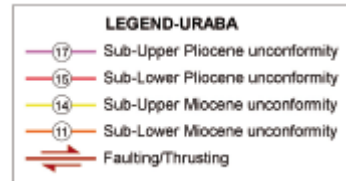
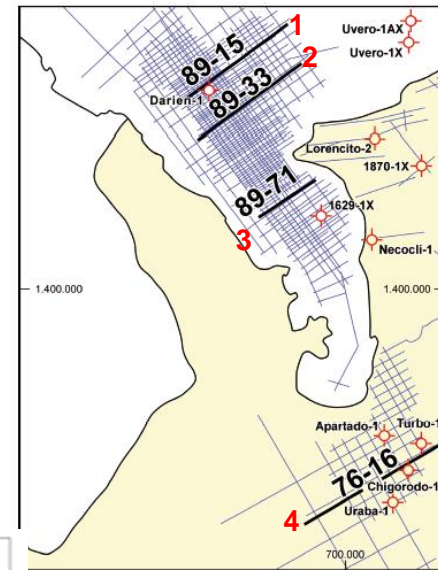


2



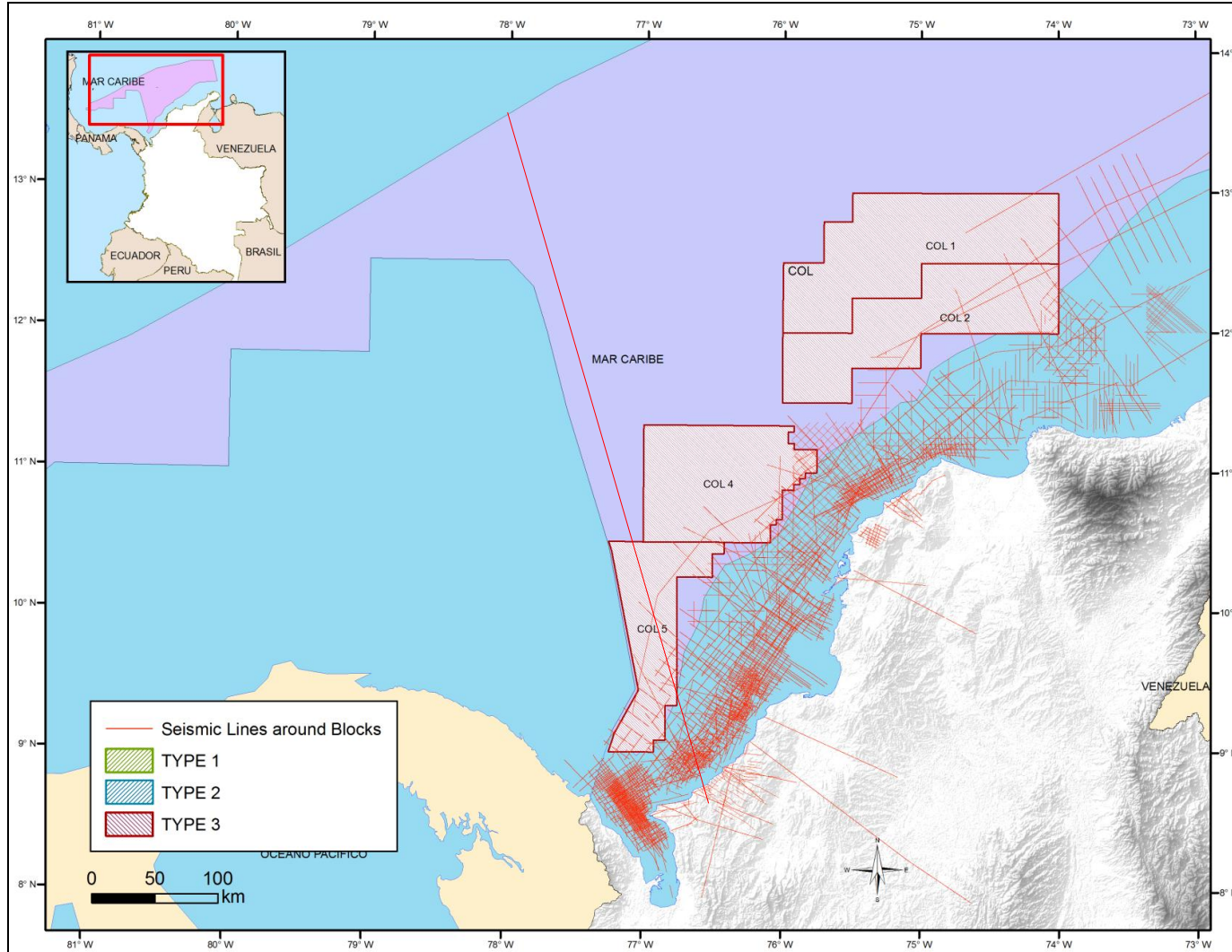
4

- 1-3 Normal fault and stratigraphic traps
- 2 Diapiric structures
- 4 inversion structures

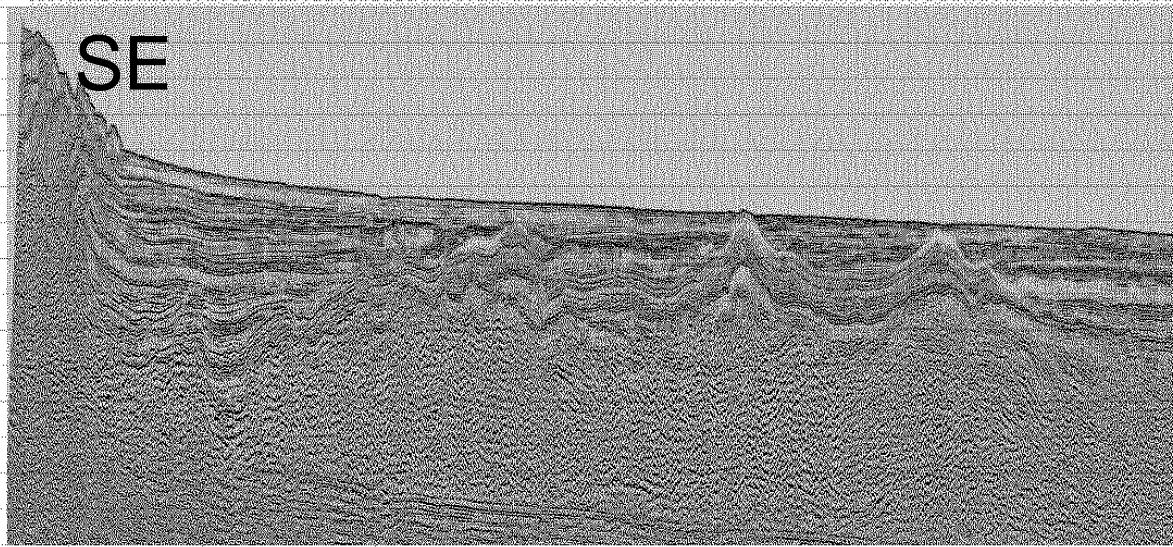


3

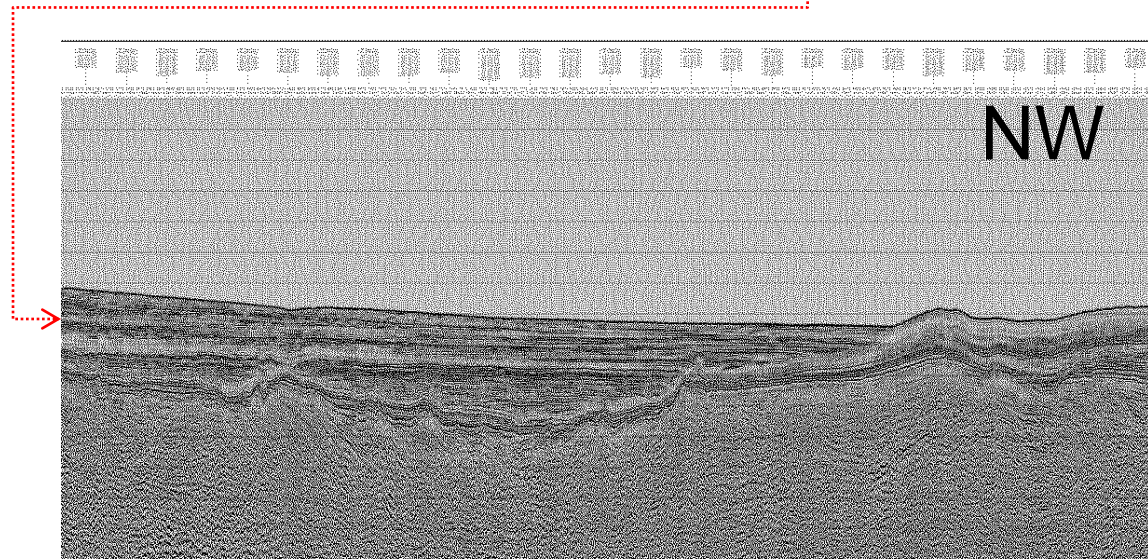
Colombia Basin (Col)



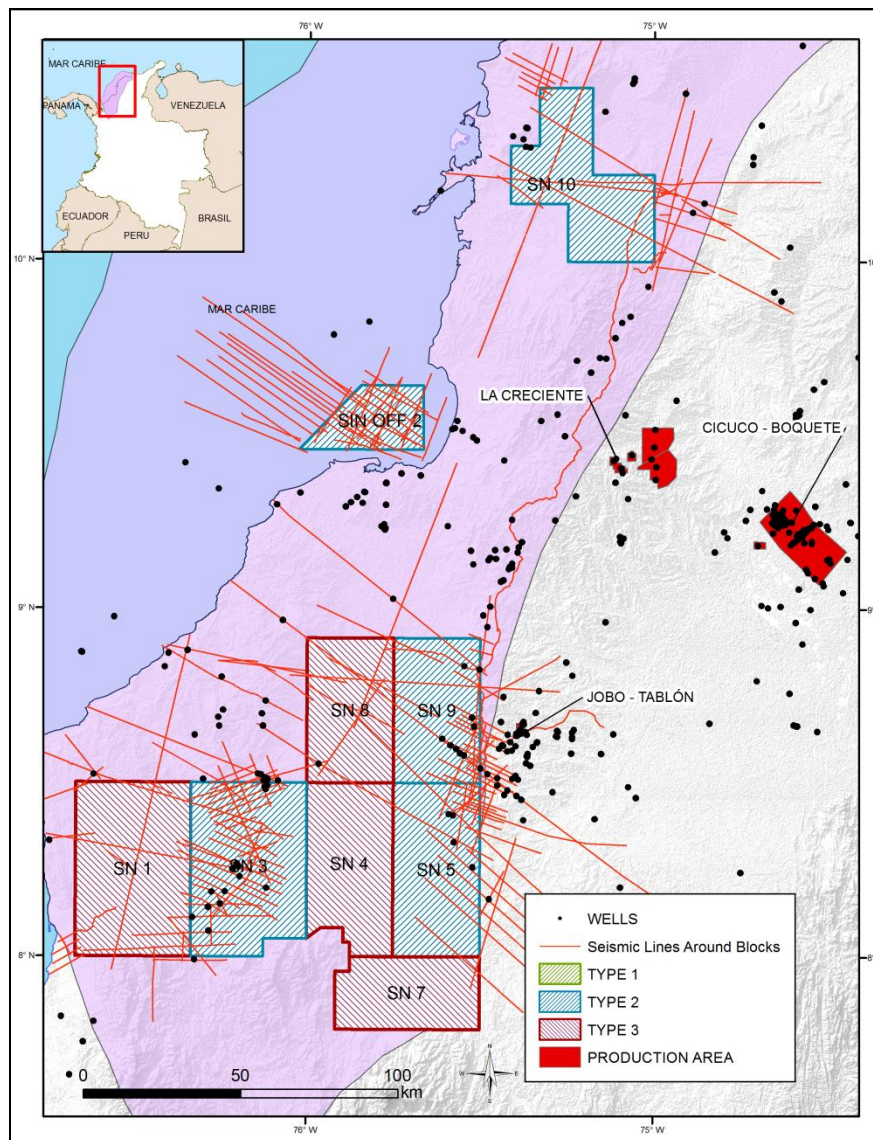
Colombia Basin (Col)



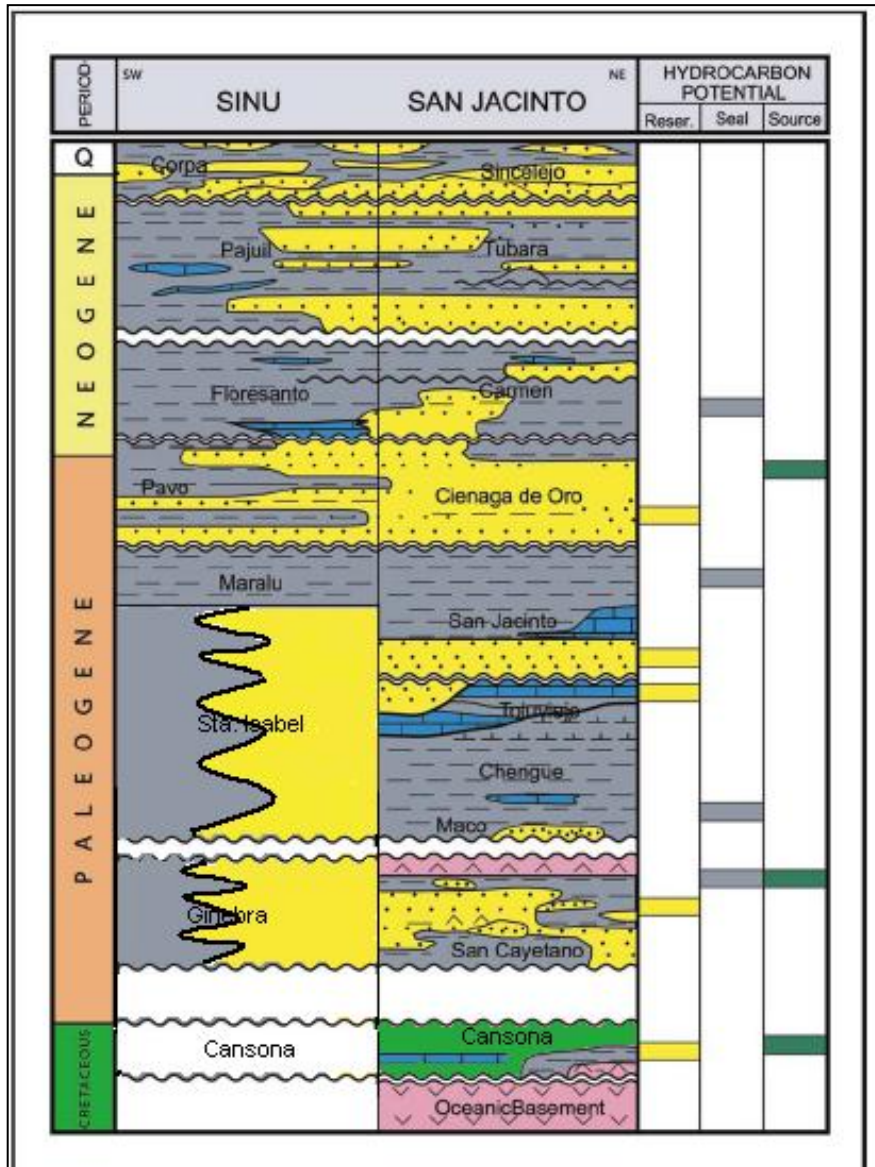
Seismic Line Colombia Basin



Sinú–San Jacinto Onshore and Offshore Basins

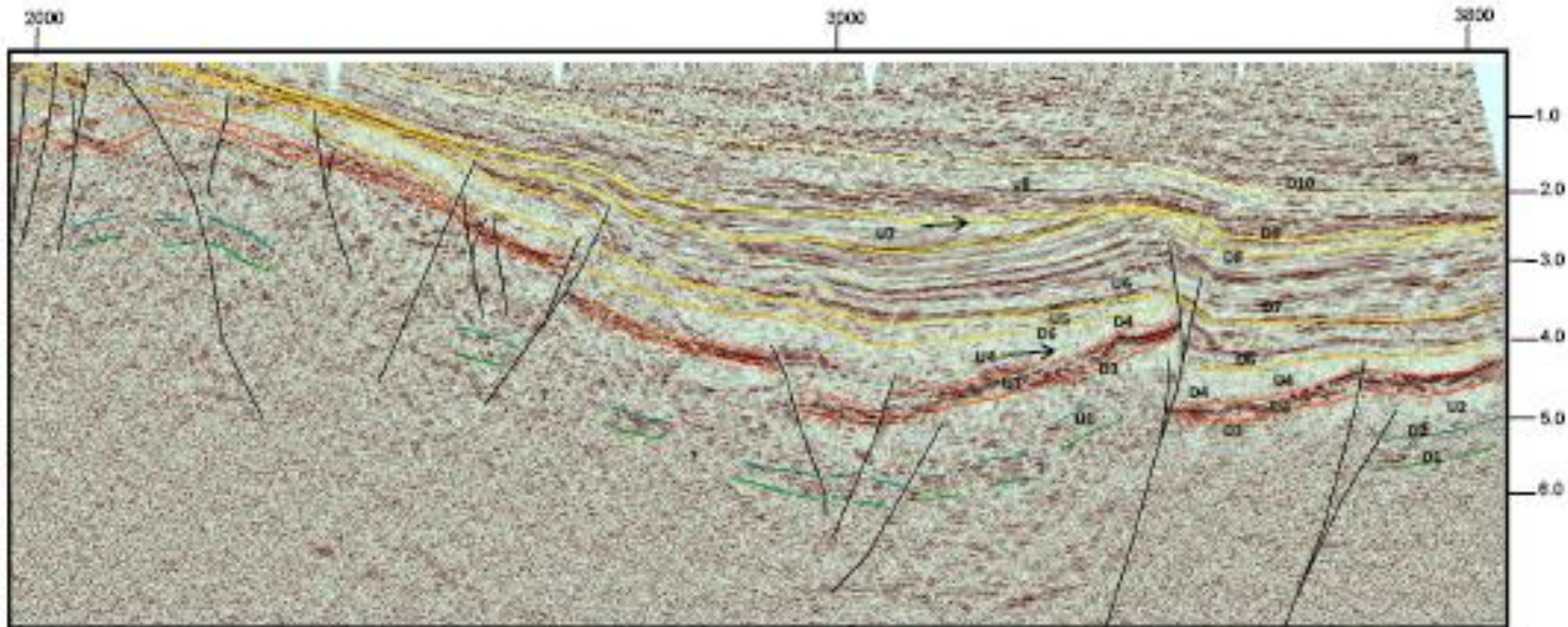


Sinú– San Jacinto Onshore and Offshore Basins



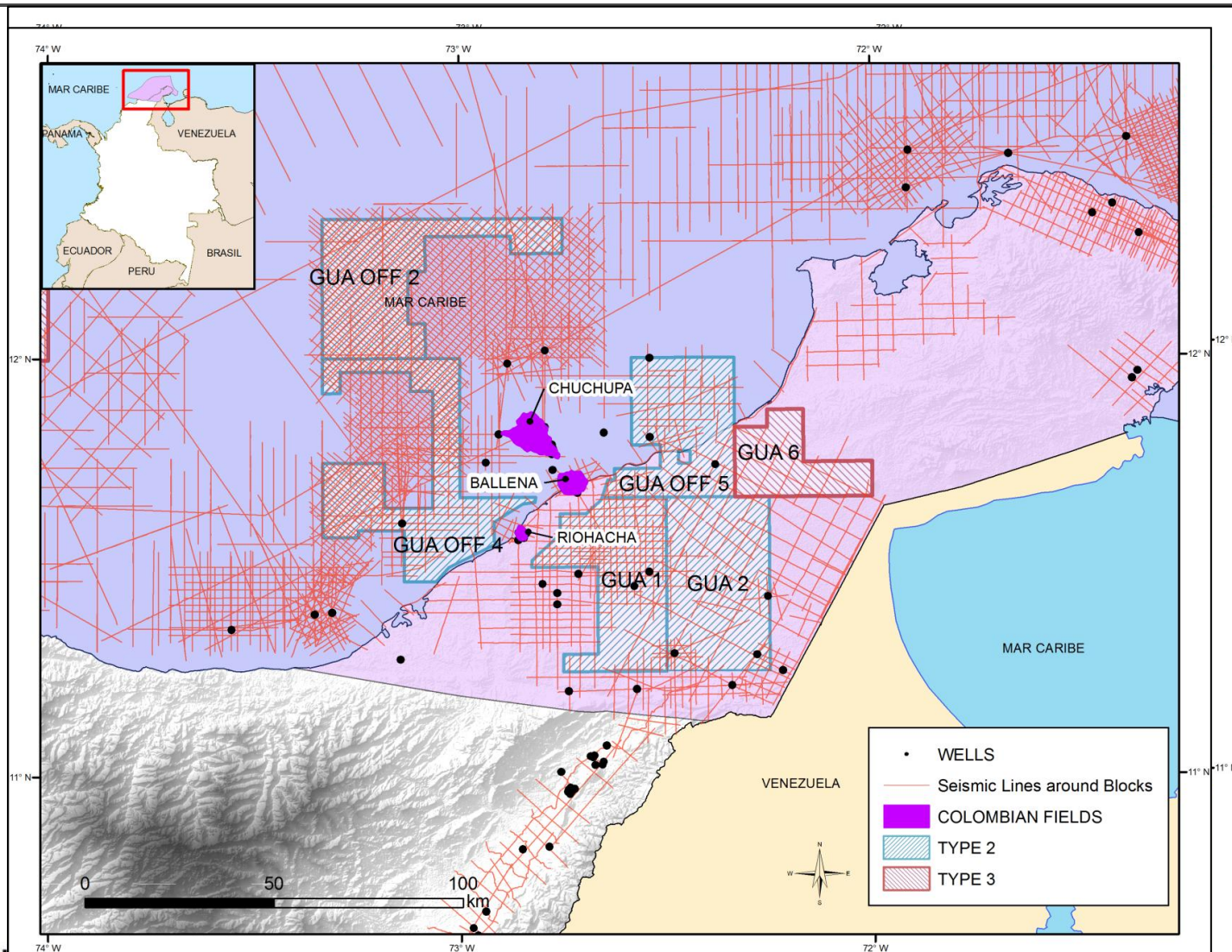
PETROLEUM SYSTEM

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

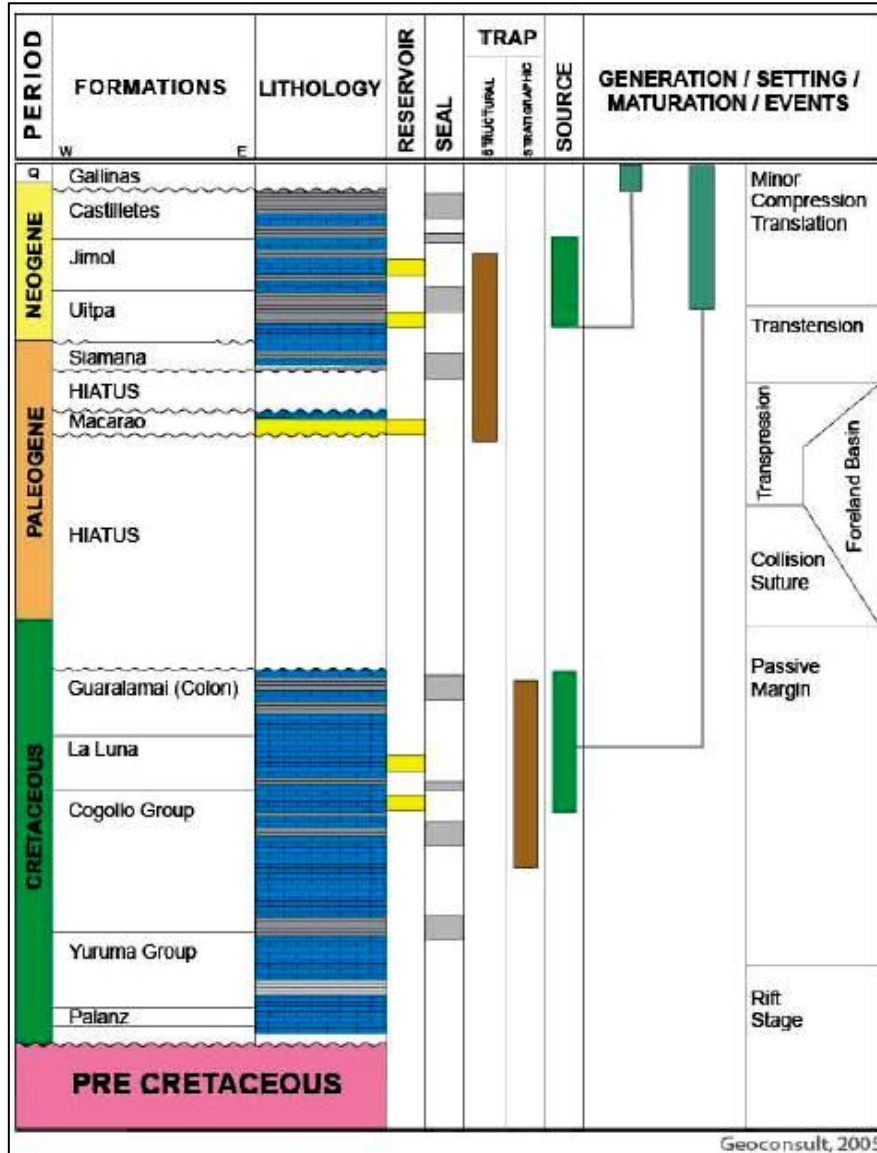


| | | SINU SUR | SAN JACINTO | VALLE INFERIOR DE MAGDALENA |
|--------------|------------|------------------|----------------------|-------------------------------|
| CUATRIENARIO | Holoceno | | | D10 |
| | Plistoceno | CORPA | SINCELEJOS | D9 |
| NEOGENO | Plioceno | U6 D8 | U6 D8 | U6 CORPA D8 |
| | MIOCENO | | | U5 TUBARA D7 |
| | | U5 PAJUIL D6 | U5 TUBARA D6 | U4 PORQUERO SUP. ? D6 |
| | | U4 FLORESANTO D5 | U4 CARMEN D5 | U4 PORQUERO INFERIOR ? D5 |
| PALEOGENO | OLIGOCENO | U3 PAVO D4 | U3 CIENAGA DE ORO D4 | U3 CIENAGA DE ORO Sup. D4 |
| | EOCENO | U2 MARALU D3 | U2 San Jacinto D3 | U2 CIENAGA DE ORO inferior D3 |
| SUPERIOR | PALEOCENO | | | ? |
| | | U1 ? D1 | U1 LA CANSONA D1 | ? |

Guajira Onshore and Offshore Basins



Guajira Onshore and Offshore Basins



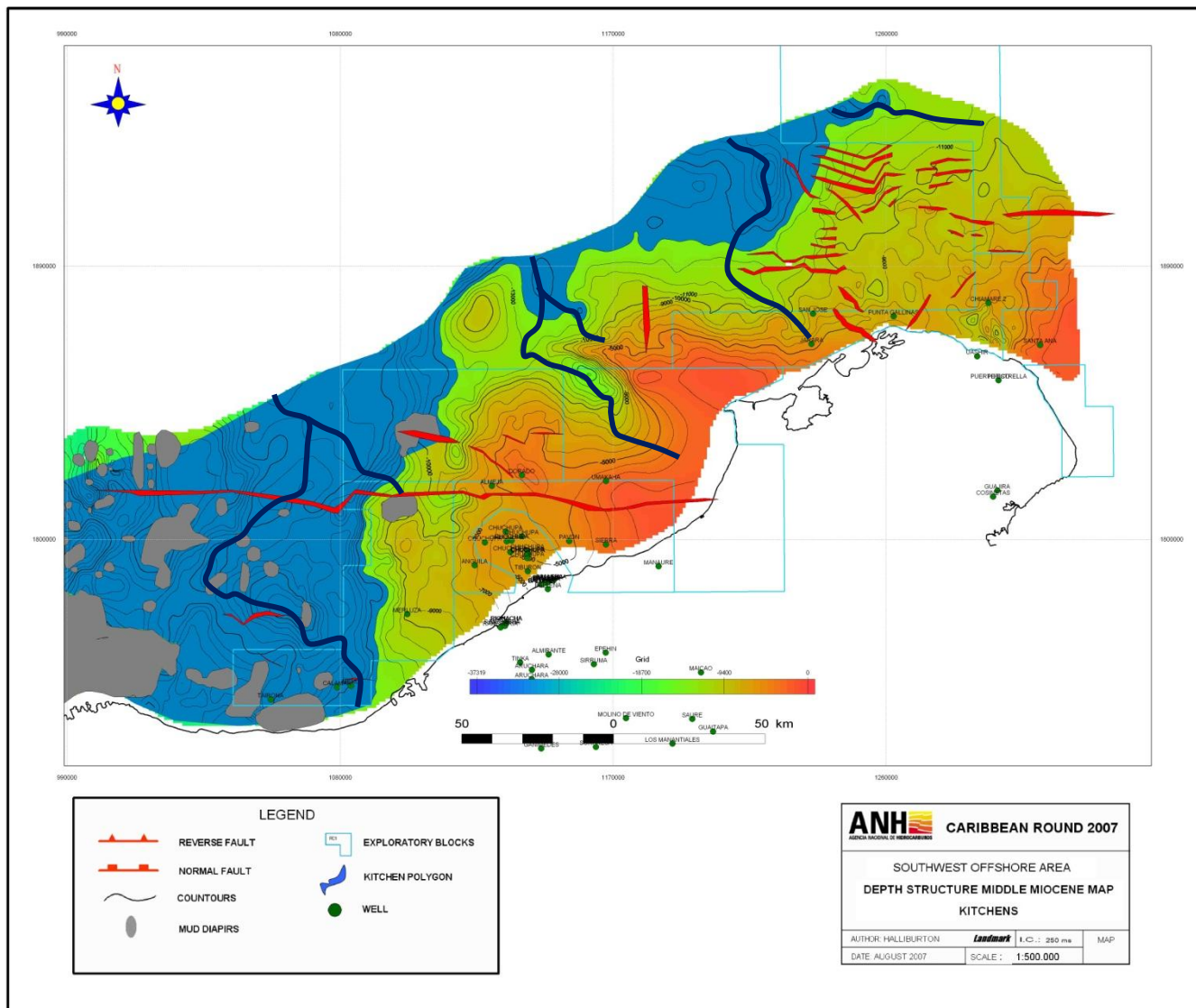
Geoconsult, 2005

PETROLEUM SYSTEM

K (La Luna) – **K** (La Luna)

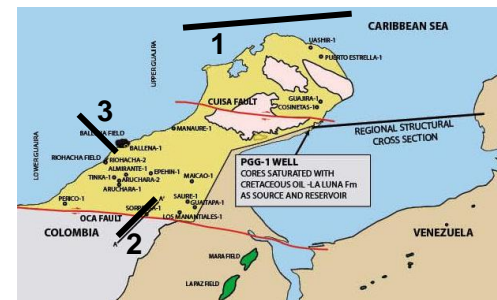
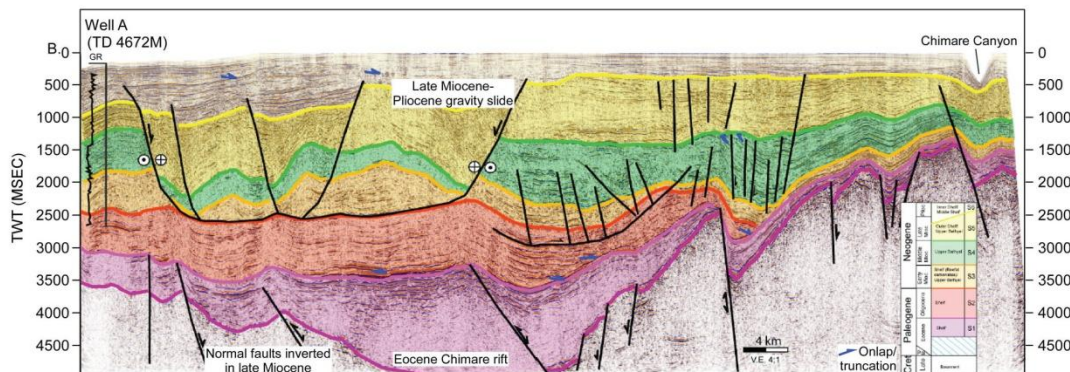
K (Uribante, La Luna) – **P-N** (Macarao, Uitpa)

Kitchen Areas

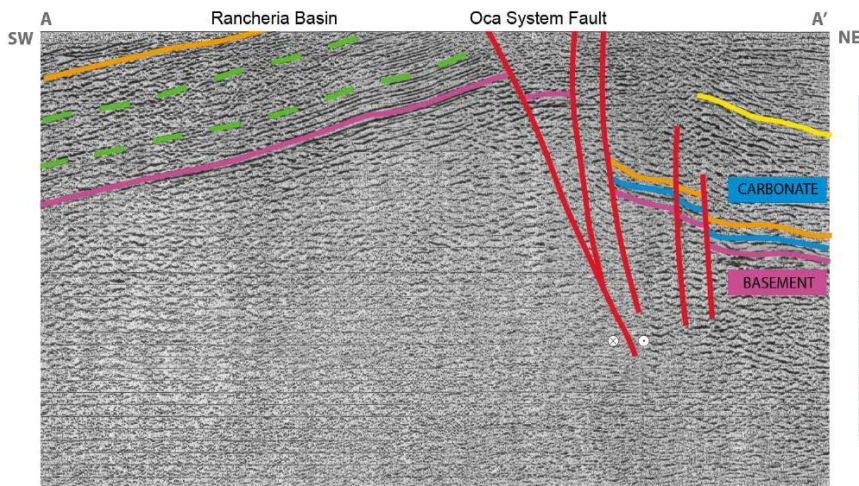


Structural Styles

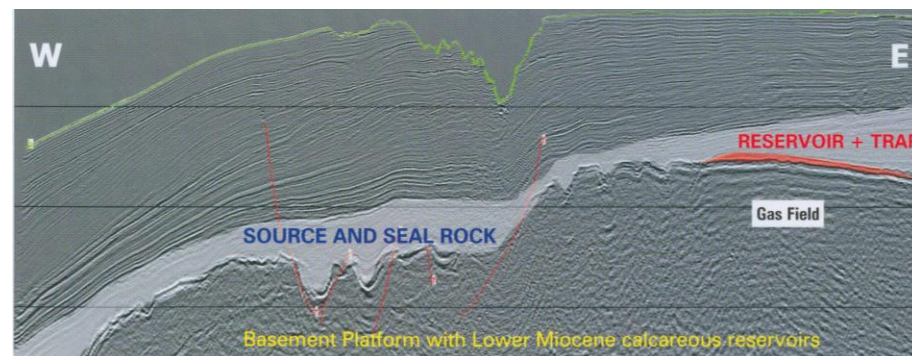
1- Normal Fault traps

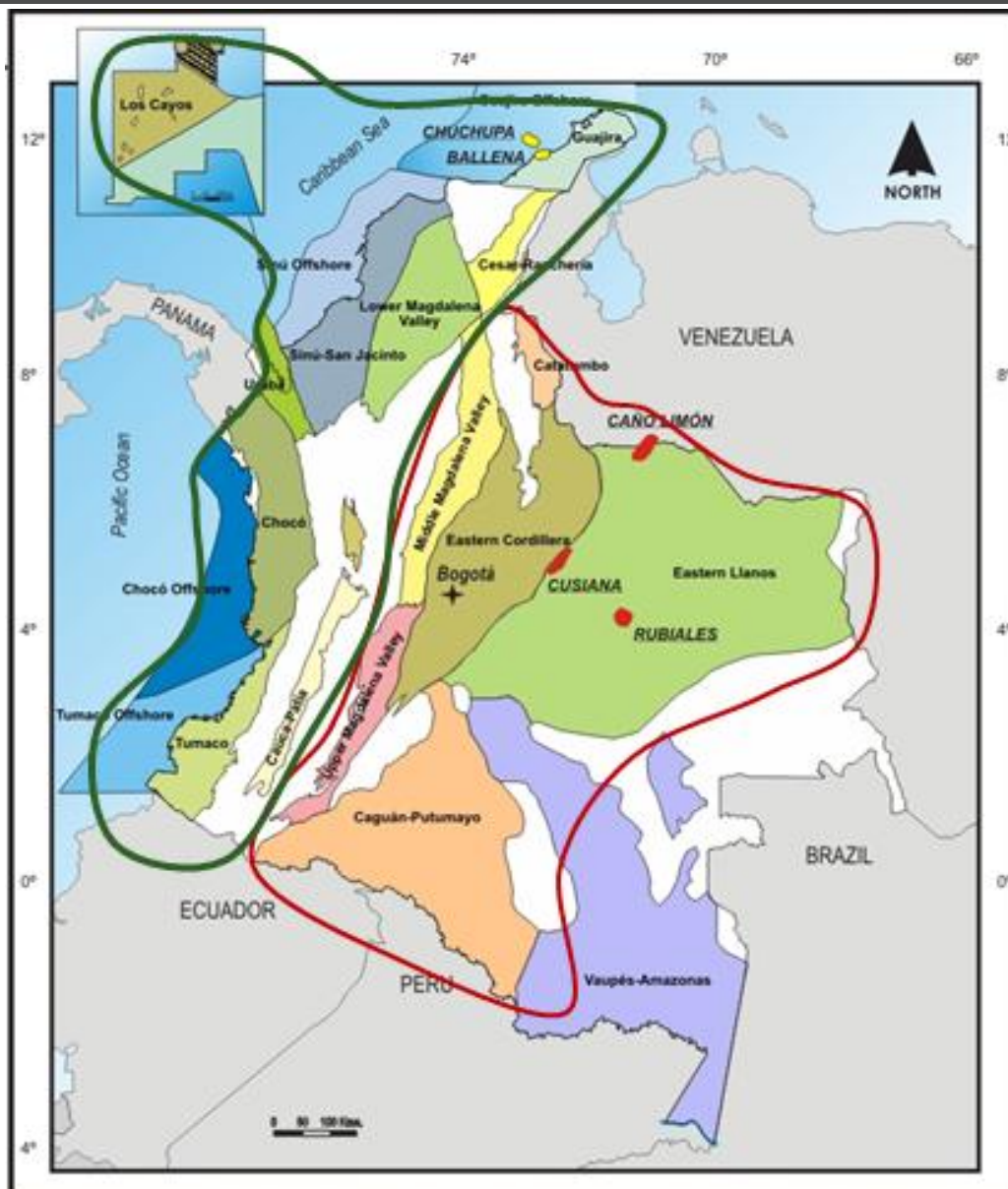


2- Oligocene carbonates strongly Fractured by the Oca Wrench System

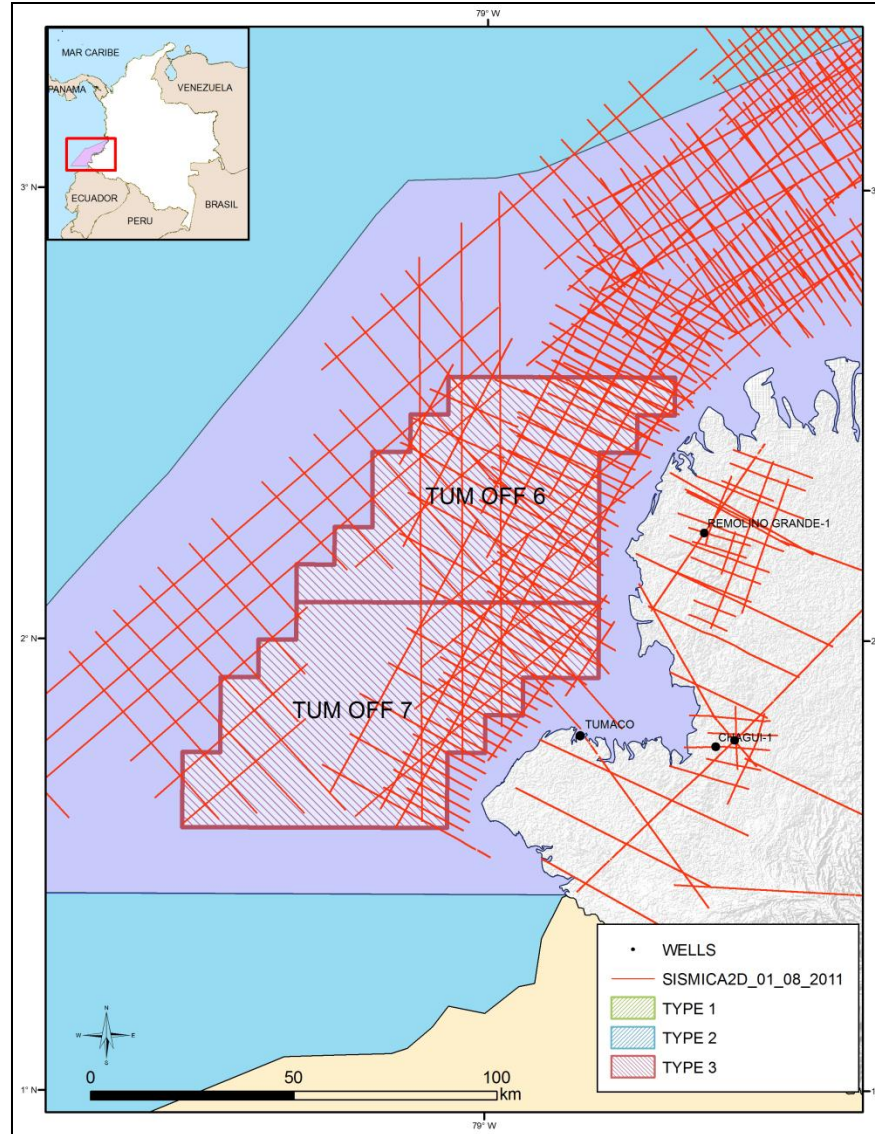


3- Combined (structural and stratigraphic) traps



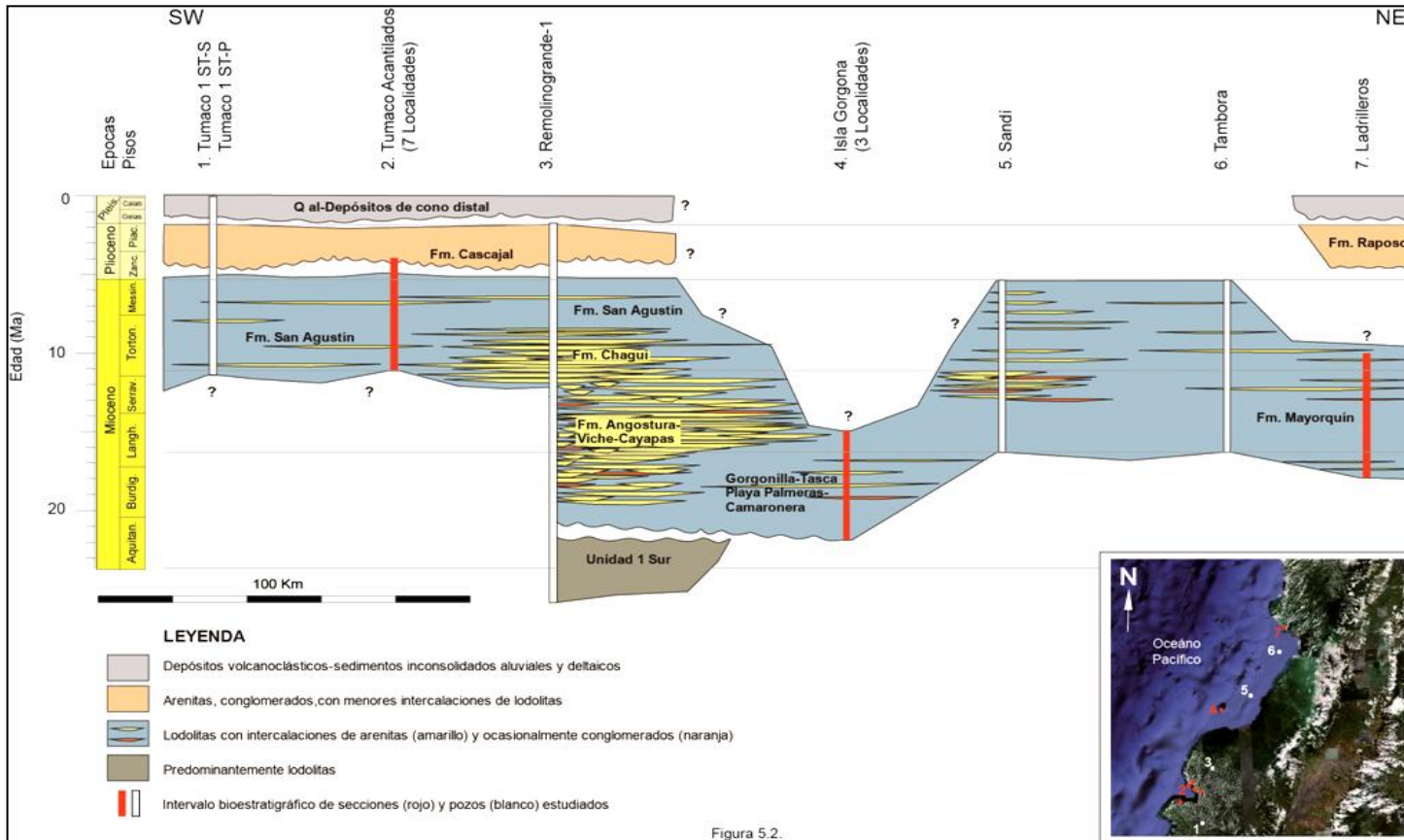


Tumaco Basin Offshore (Tum)



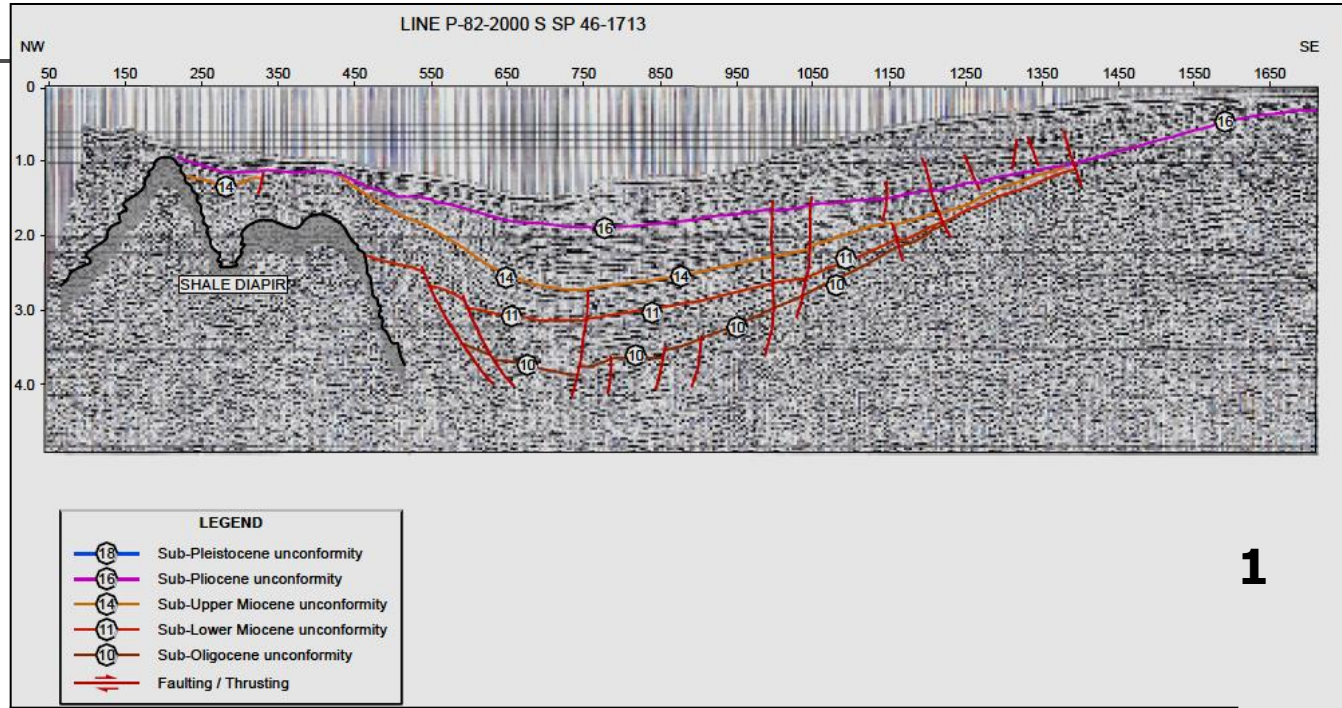
Tumaco Basin Offshore (Tum)

Stratigraphic chart

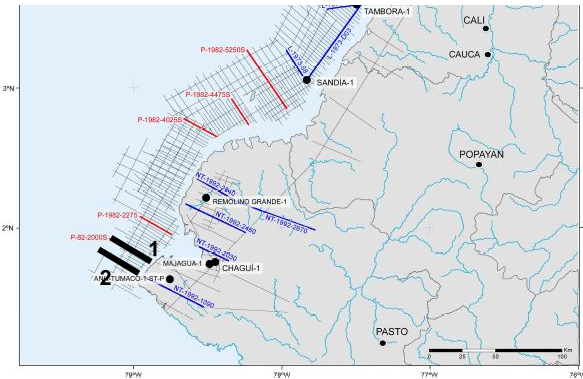
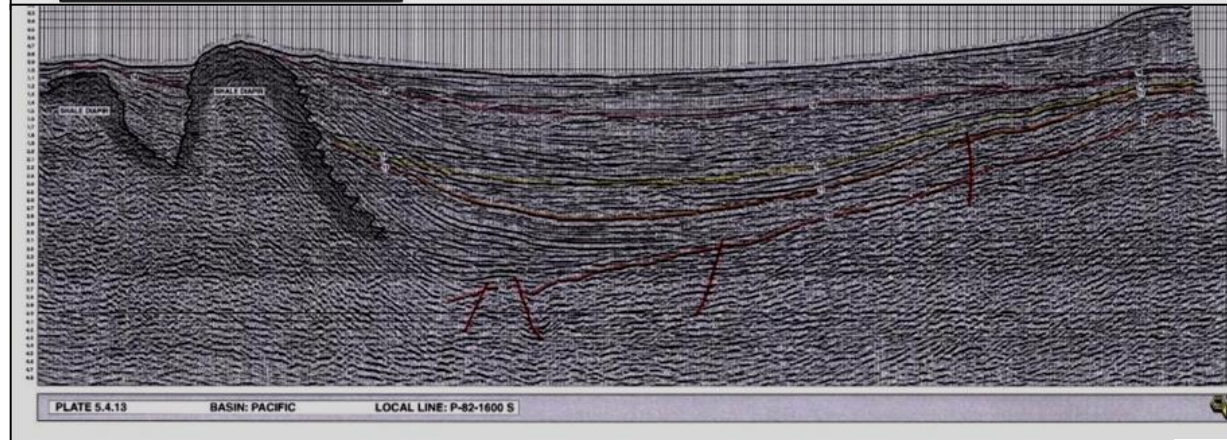


PETROLEUM SYSTEM
P? () – N (Angostura -Cayapas)

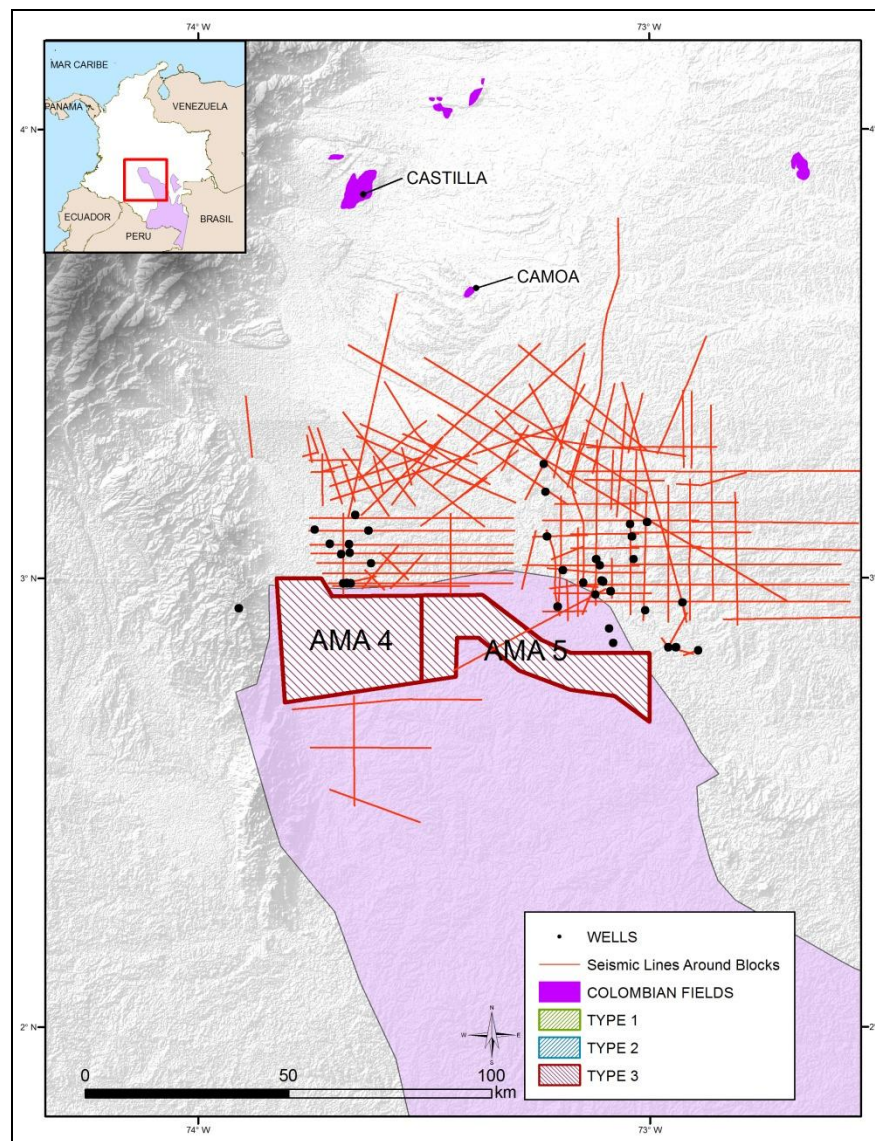
Structural Styles



1- 2 Normal faults and stratigraphic traps, diapiric structures



Vaupés-Amazonas Basin (Vau)



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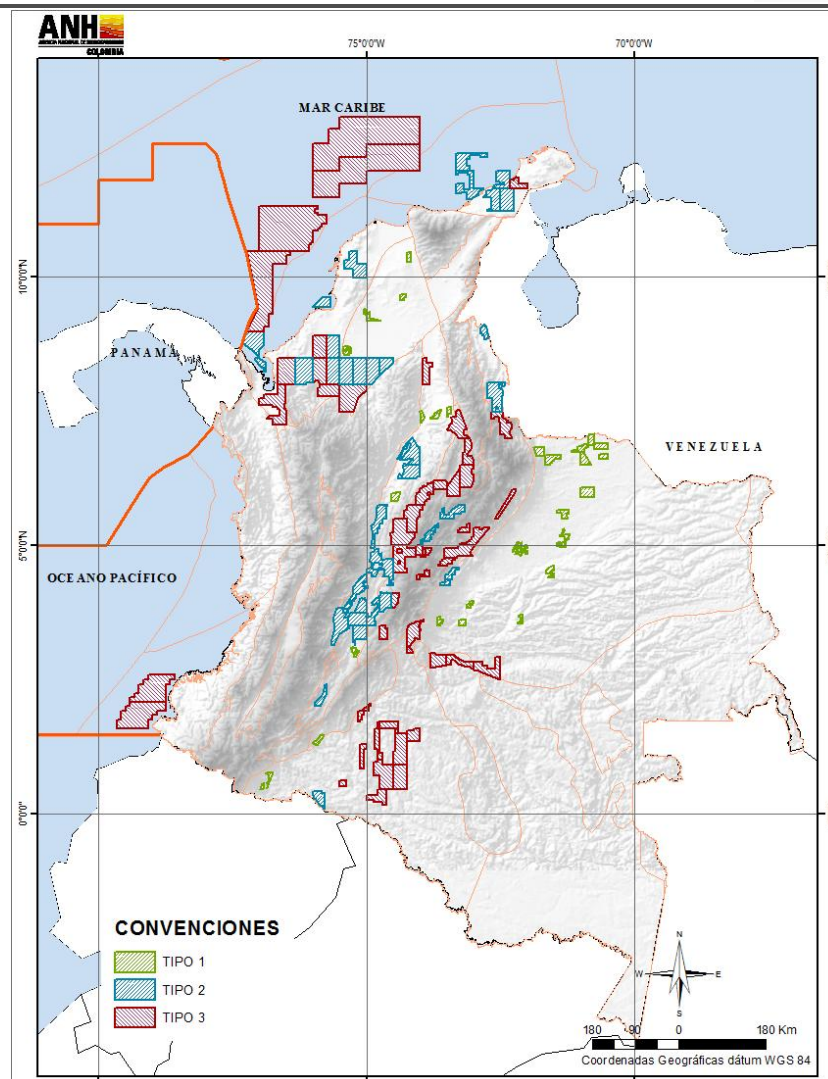


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Colombia Round 2012

| | 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 |



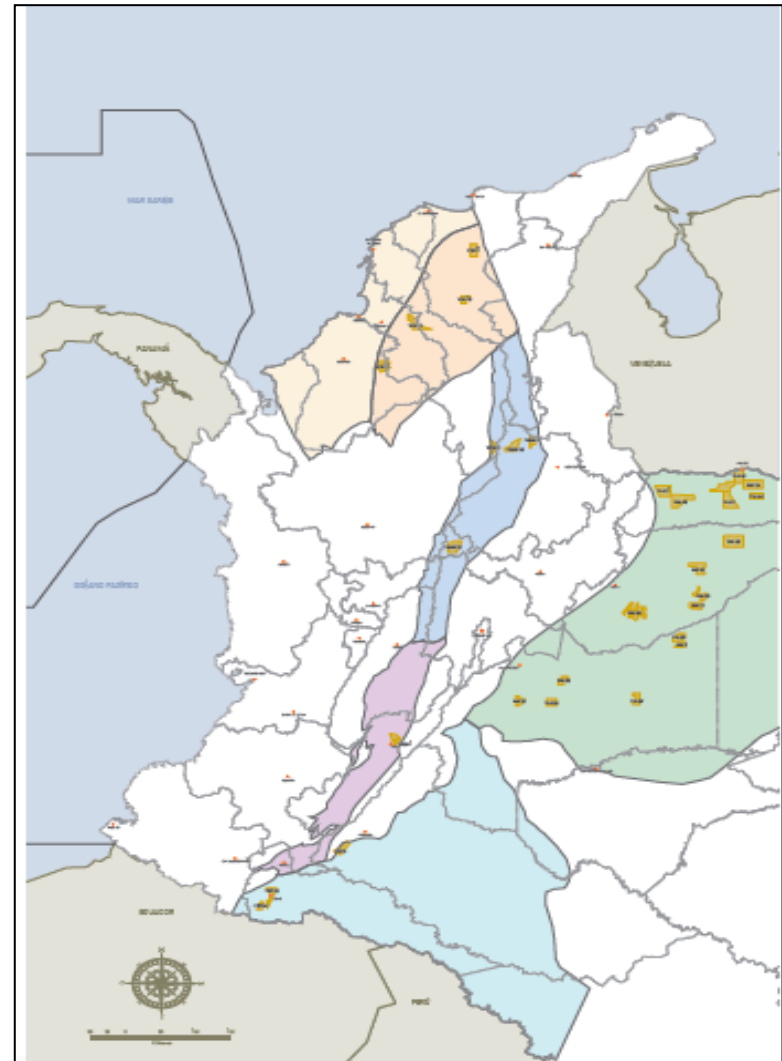
Type 1 Blocks

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

| Type 1 | | |
|--------|-------------------------------|-------------------------------|
| Blocks | Total Area (km ²) | Size 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 • Middle Magdalena • Upper Magdalena • Caguán-Putumayo • Llanos |



Type 2 Blocks

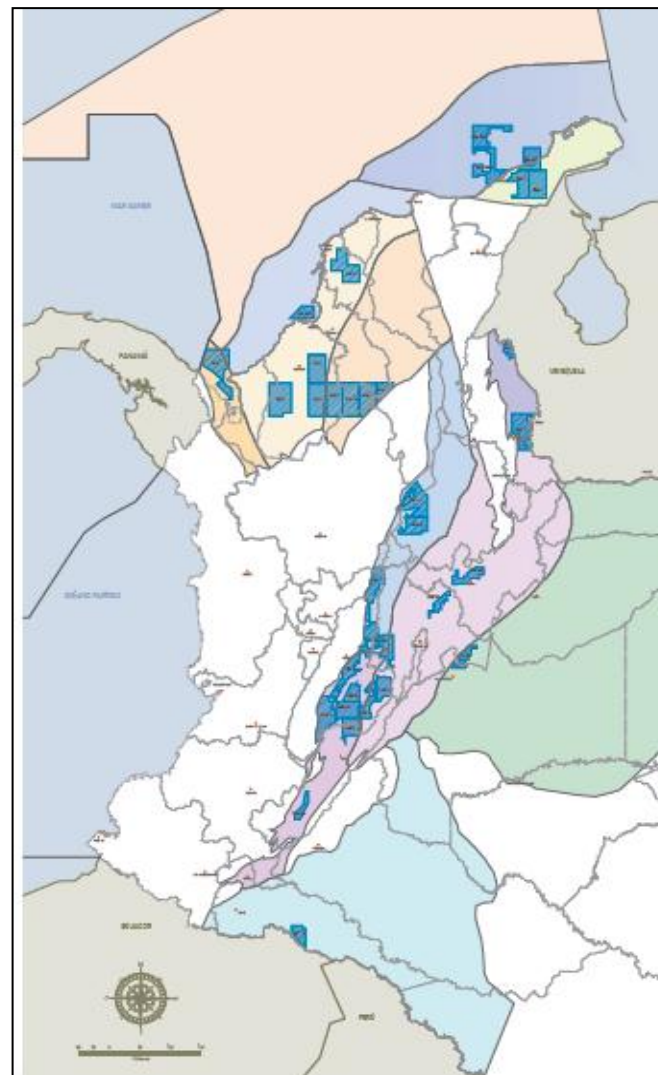
- ✓ Blocks in emerging areas.
- ✓ E&P contracts.

| Type 2 | | |
|--------|-------------------------------|-------------------------------|
| Blocks | Total Area (km ²) | Size 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 • Upper Magdalena • Caguán-Putumayo • Llanos • Eastern Cordillera • Catatumbo |
|---|---|



Type 3 Blocks

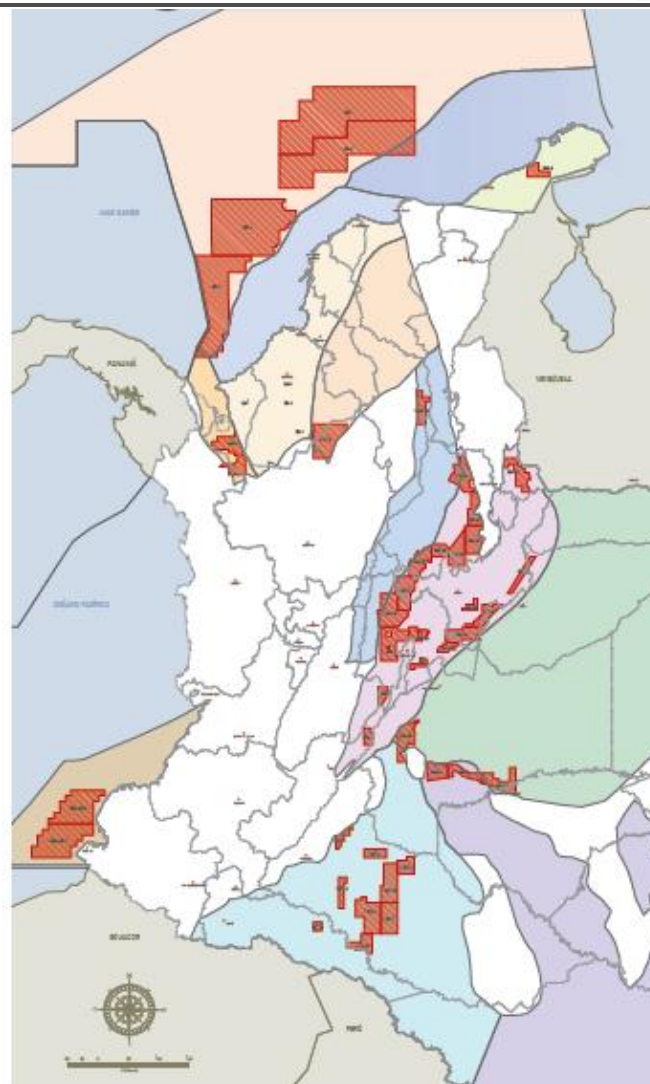
✓ Exploration Blocks in frontier areas for Technical Evaluation Agreements (TEA)

| Type 3 | | |
|--------|-------------------------------|-------------------------------|
| Blocks | Total Area (km ²) | Size 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 • Tumaco Offshore | <ul style="list-style-type: none"> • Vaupés-Amazonas • Middle Magdalena • Caguán-Putumayo • Llanos • Eastern Cordillera |
|--|--|



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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 (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



| 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 down to 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 bathymetric survey / 10 km ² of area. |

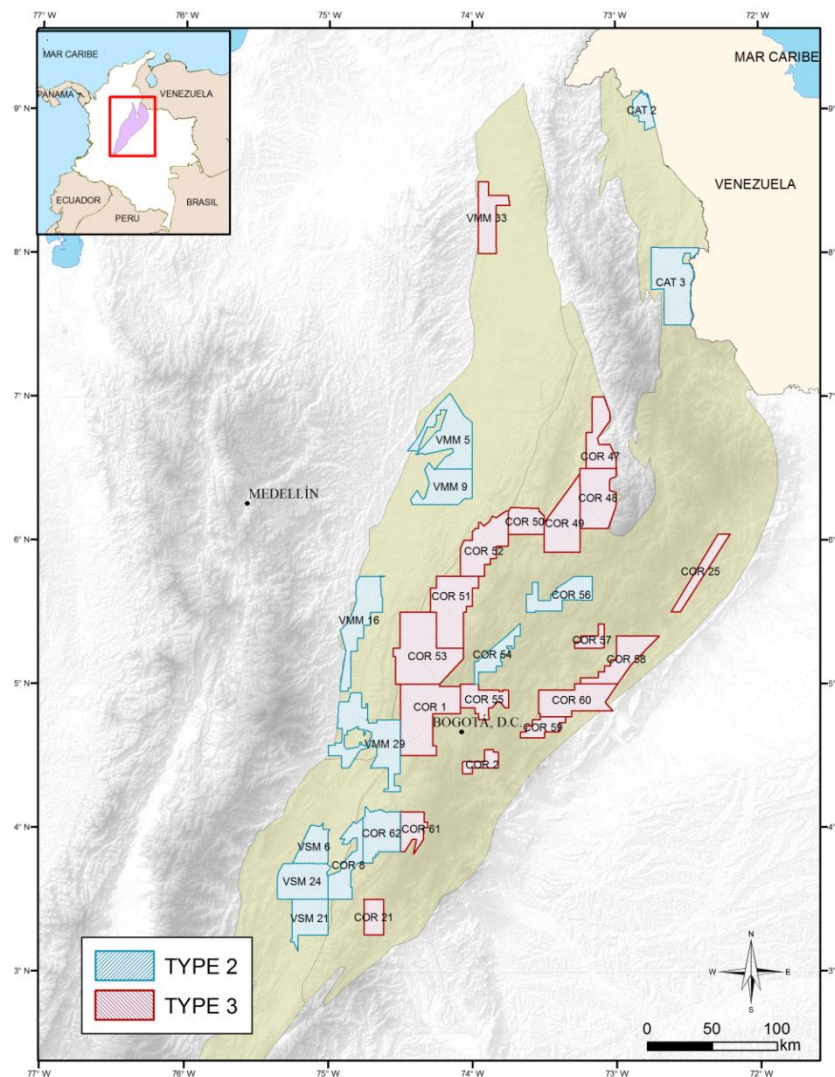
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Prospective Areas for Unconventional Resources

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



Unconventional Resources

(Preliminary Assessment, 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 |

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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

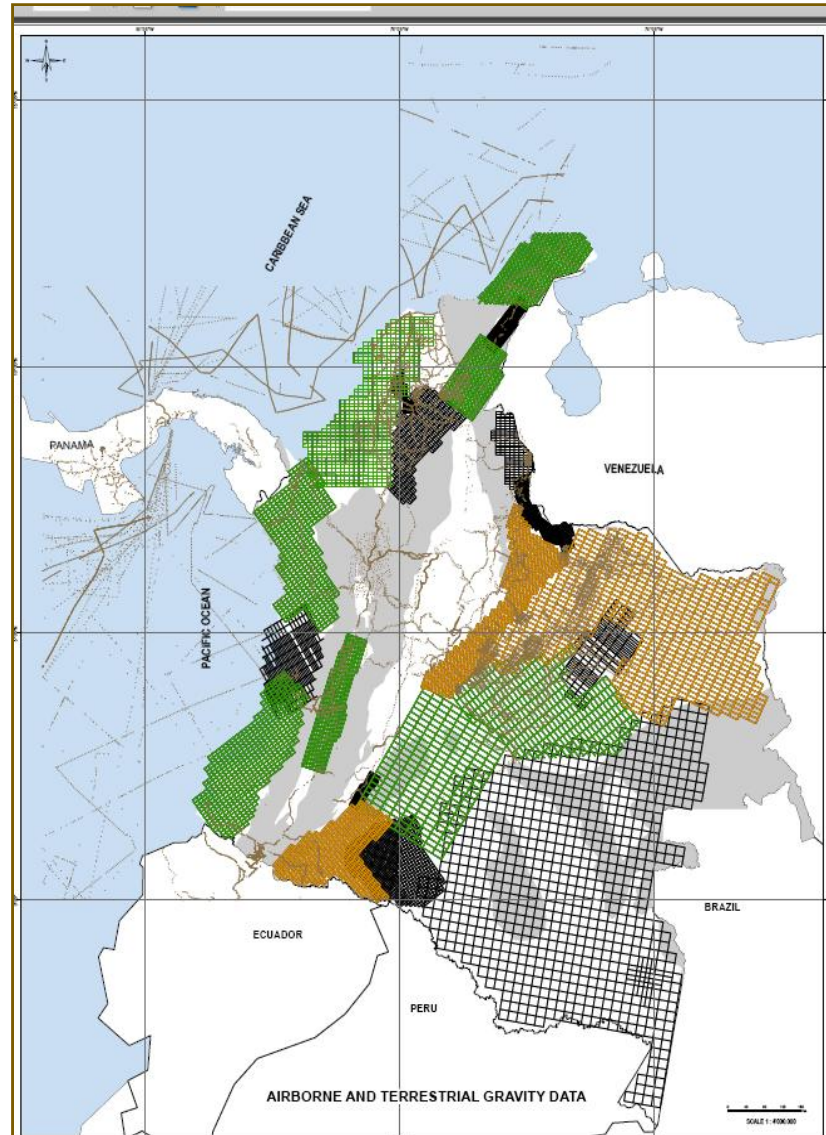


| Onshore Unique Phase (3 years) |
|---|
| ✓ Geological mapping, scale 1:25.000, or larger, minimum 50% of the block area. |
| ✓ 2D Seismic, minimum 1km /10 km ² . |
| ✓ Regional analysis (i.e. mapping with remote sensing or airborne geophysical methods). |
| ✓ 2 (two) stratigraphic wells, with physical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

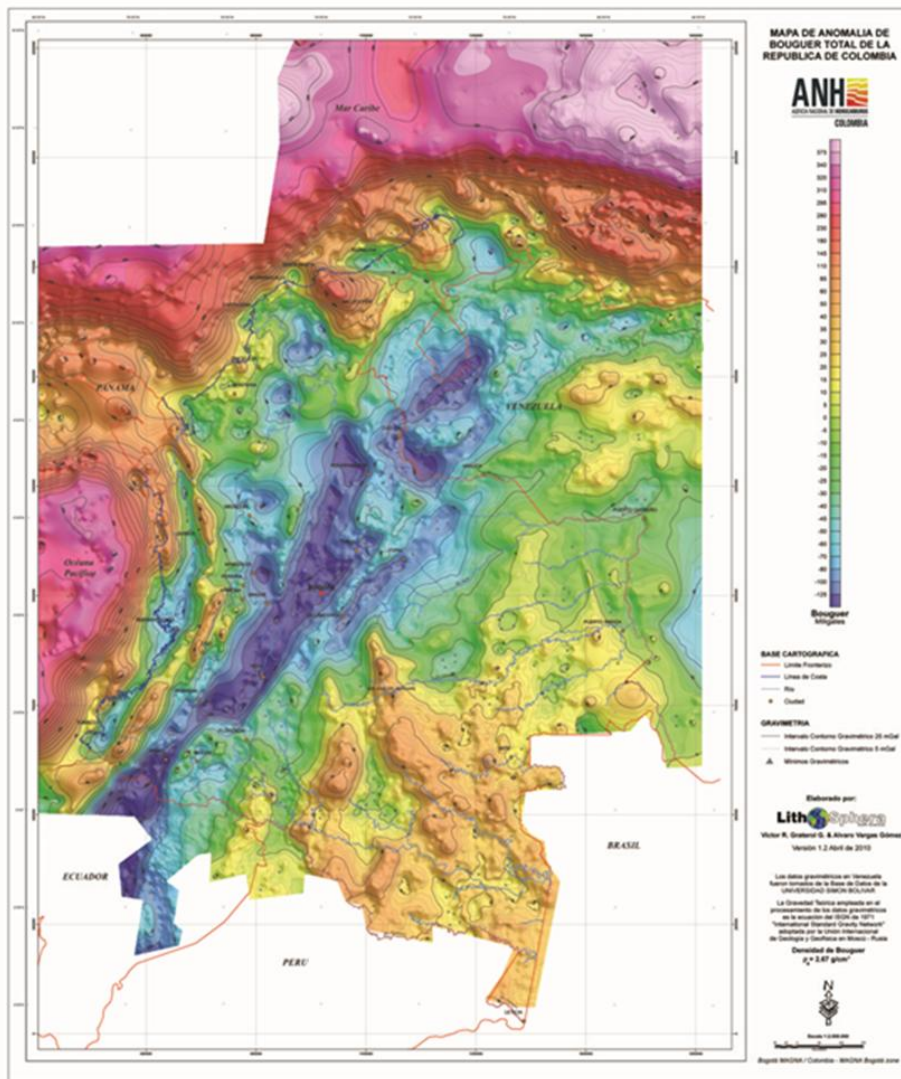
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Airborne Geophysical Coverage

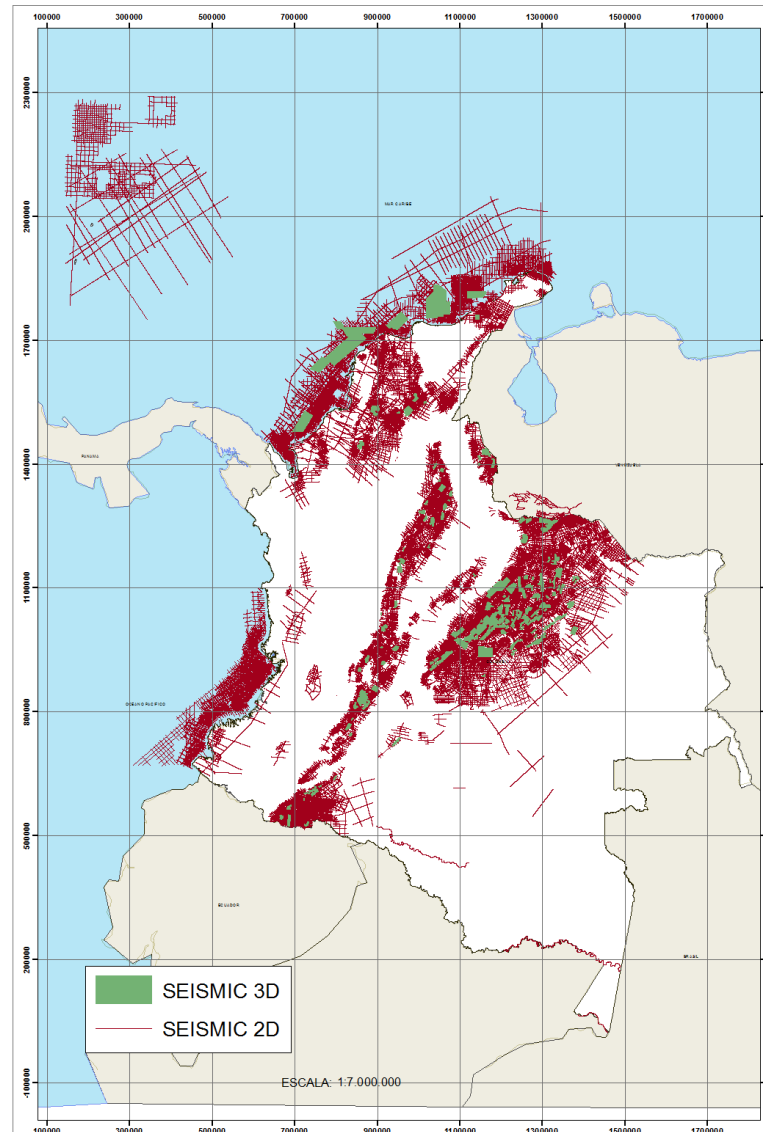
-  ANH 2005-2007
-  ANH 2008-2009



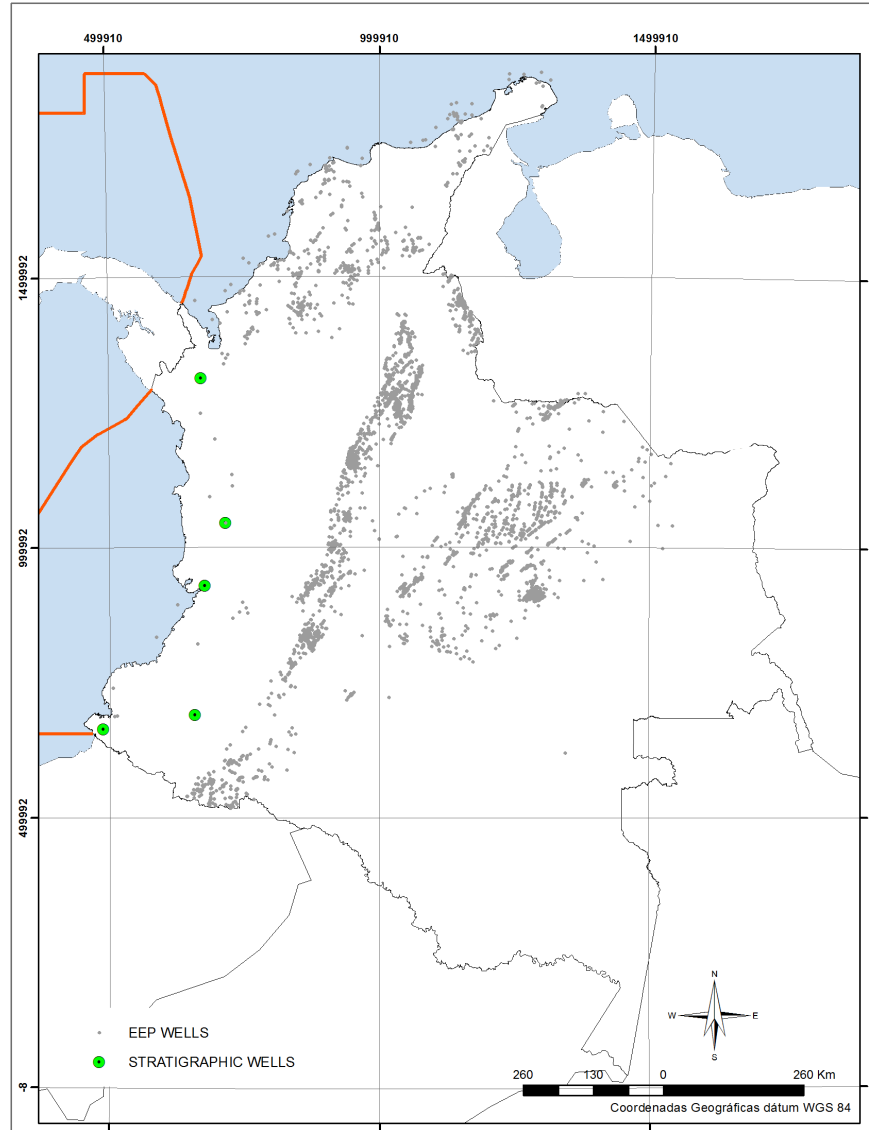
Gravity and Magnetic Anomalies Maps



2D and 3D Seismic Coverage



Exploration, Evaluation, Production and Stratigraphic Wells Map



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 |
| TOTAL | 504 | 2,996 | 20 | 285 |

Information Packages



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

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Reglamento de Reservas

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Todas las preguntas y respuestas del Proceso de la Ronda Colombia 2012, se publicarán a través del Sitio web 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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NOVEDADES

ANH
AGENCIA NACIONAL DE HIDROCARBUROS
Ronda Colombia 2012
Enero de 2012

ANH
AGENCIA NACIONAL DE HIDROCARBUROS
PLAN DE ACCIÓN 2012
Enero de 2012

ANH
AGENCIA NACIONAL DE HIDROCARBUROS
INFORME DE GESTIÓN 2011
Enero de 2012

Canal RSS
Nuevo

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



Thank you.