ANH
AGENCIA NACIONAL DE HIDROCARBUROS

SERVICIO GEOLÓGICO COLOMBIANO

BOGOTÁ, SEPTEMBER 2021

EVALUACIÓN DE LA CUENCA PALEOZOICA DE COLOMBIA,

Servicio Geológico Colombiano – Dirección de Hidrocarburos
Director: Humberto Andres Fuenzalida E.

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SERVICIO GEOLÓGICO COLOMBIANO

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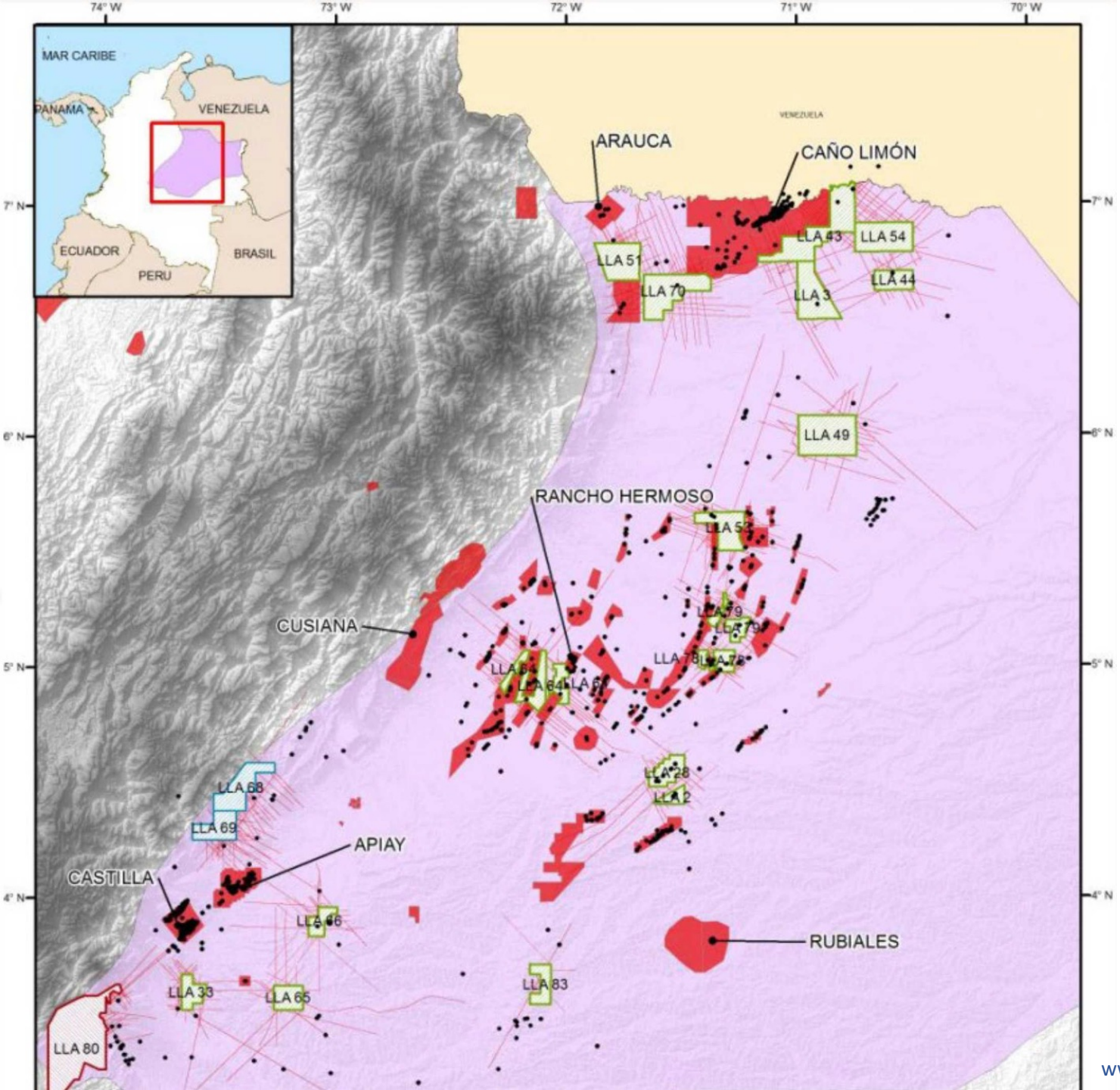
El futuro es de todos

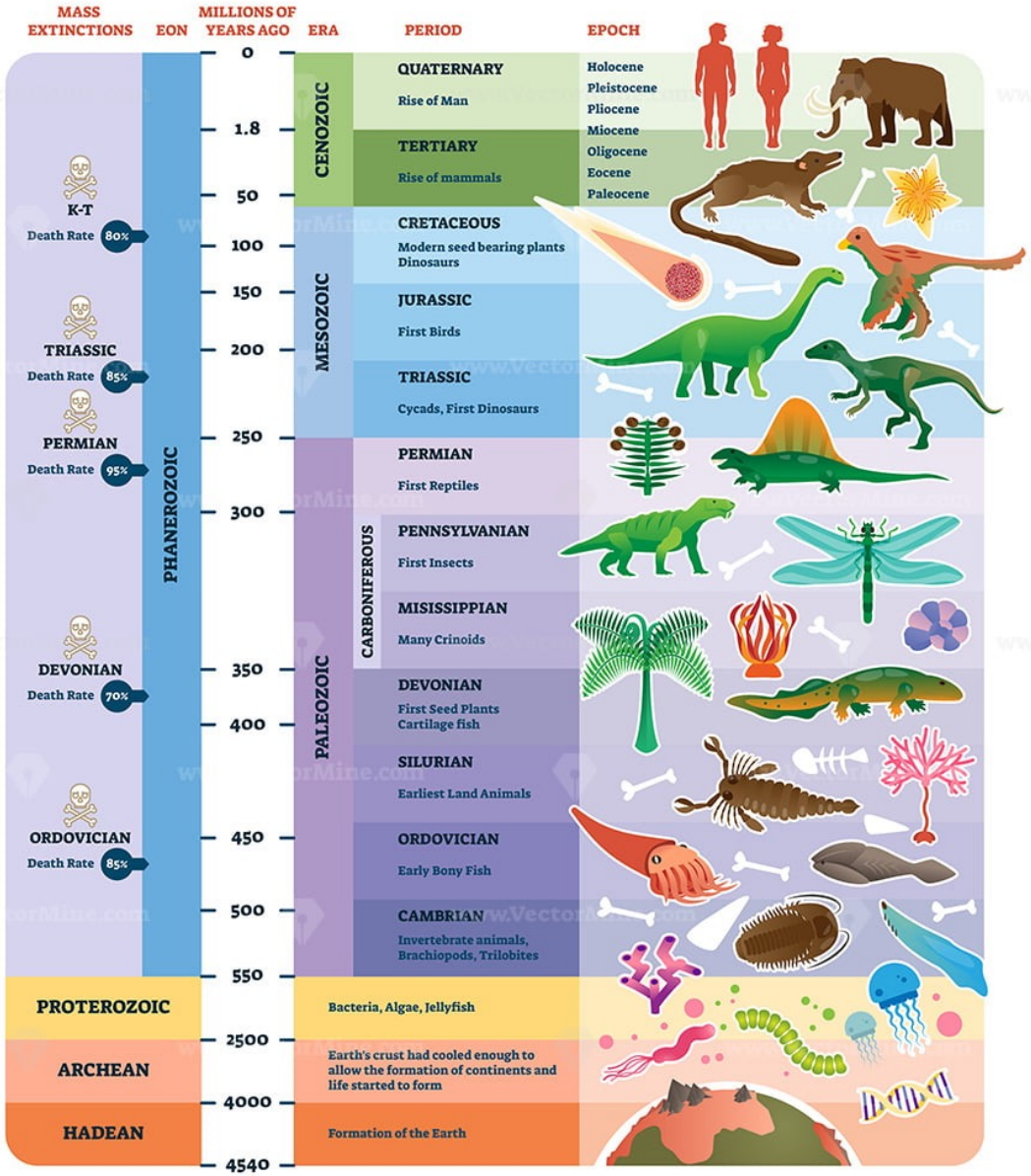
Minenergía



What is this project about?

Is there a Petroleum system in Pz-Pz or Pz-K/T?

GEOLOGIC TIMELINE



Oil and Gas industry started in 1918 in Colombia, since then the interest has been mainly in the last 145 million years

Palaeozoic is about 290 million years, twice the time from Cretaceous to today.

However the Palaeozoic is still unknown

In the north of South America the Oil and Gas production comes from petroleum systems Cretaceous-Tertiary

The history of exploration and generation of knowledge in Colombia has been focused in these periods of the geologic time

The Palaeozoic has kept as a frontier exploration. The biggest amount of wells are stopped and the top of Palaeozoic

A big mistake of the industry has been declared Palaeozoic as “Economic Basement”

Figura 1. Mapa de ubicación de las Cuencas Andinas tratadas en este volumen. Gráficos estadísticos modificados de Rosso

Sistemas Petroleros de las Cuencas Andinas. Cruz C.E. et al. https://doi.org/10.3997/2214-4609-pdb.266.1

Is There a Petroleum System Pz-Pz or Pz-K/T ?

Elements of a Conventional Petroleum System

- Source Rock *
- Seal Rock
- Reservoir rock
- Overburden rock

Processes

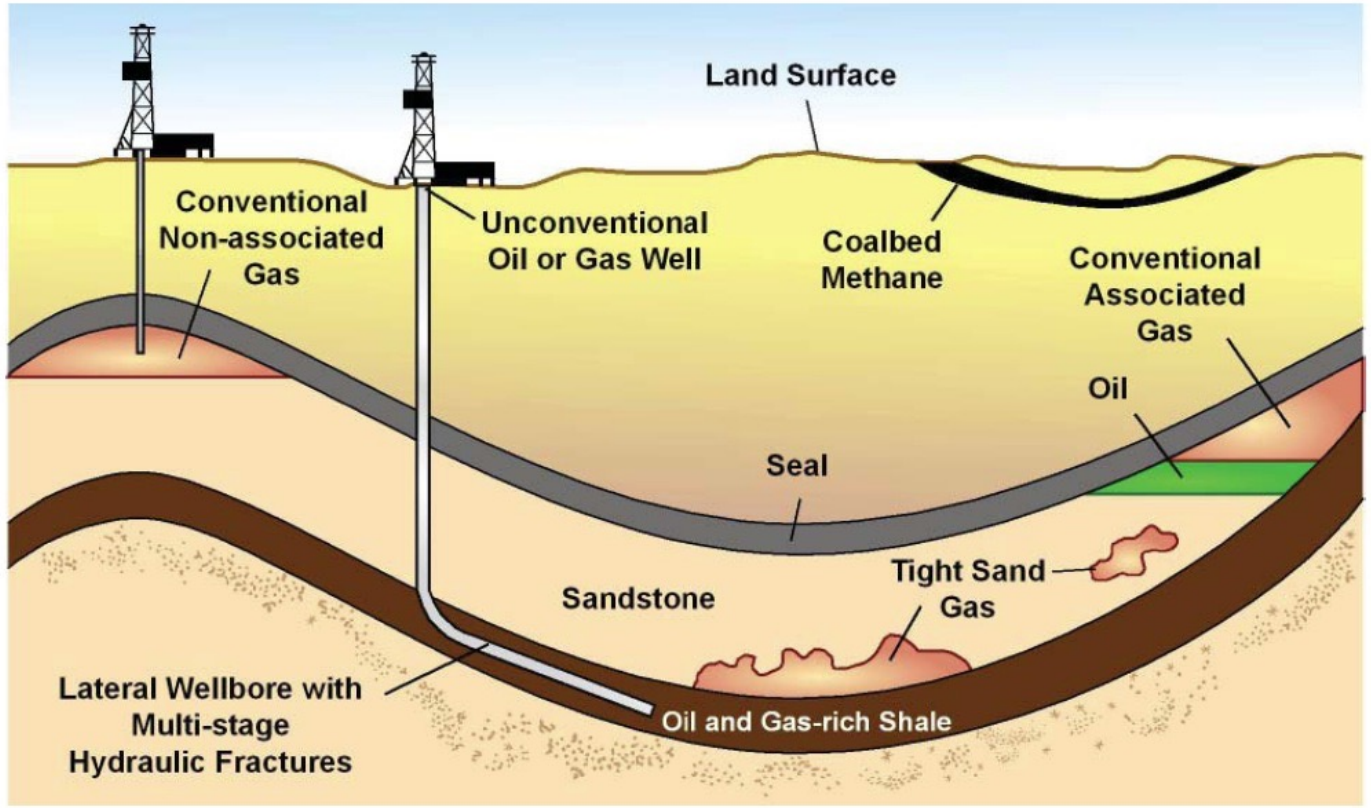
- Trap Formation
- Generation*- Migration - Accumulation

“The elements and processes must be correctly placed in time and space…”

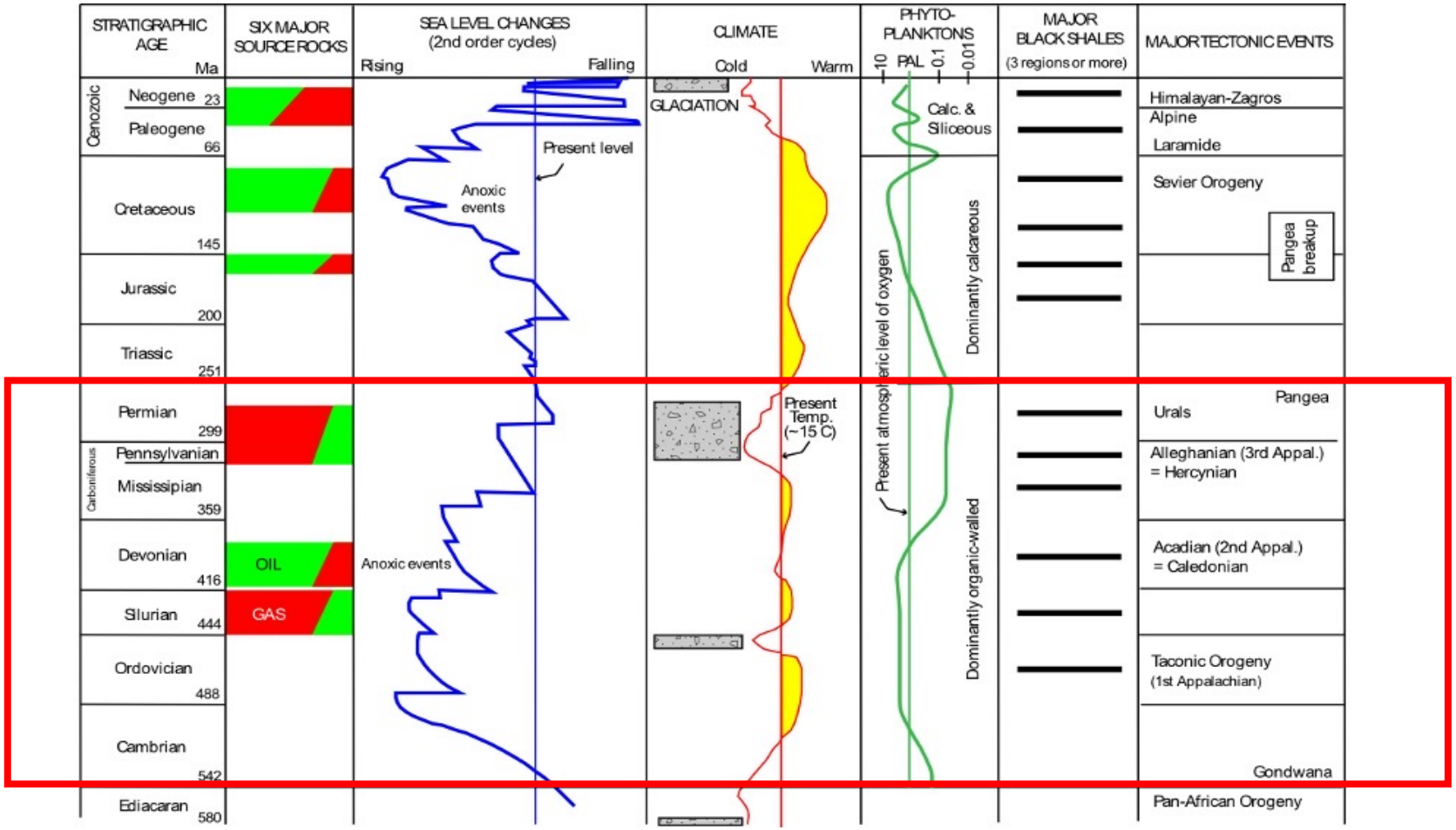
* Unconventional

Petroleum Systems. Magoon and Beaumont, 2003

The Geology of Conventional and Unconventional Oil and Gas



Source: EIA



Silurian (444-416 Ma)
Late Devonian (385-360 Ma)
Pensilvanian – Late Permian (318-270 Ma)
Late Jurassic (165-145 Ma)
Mid Cretaceous (125-89 Ma)
Oligocene - Miocene (34-5 Ma)

34% Phanerozoic time

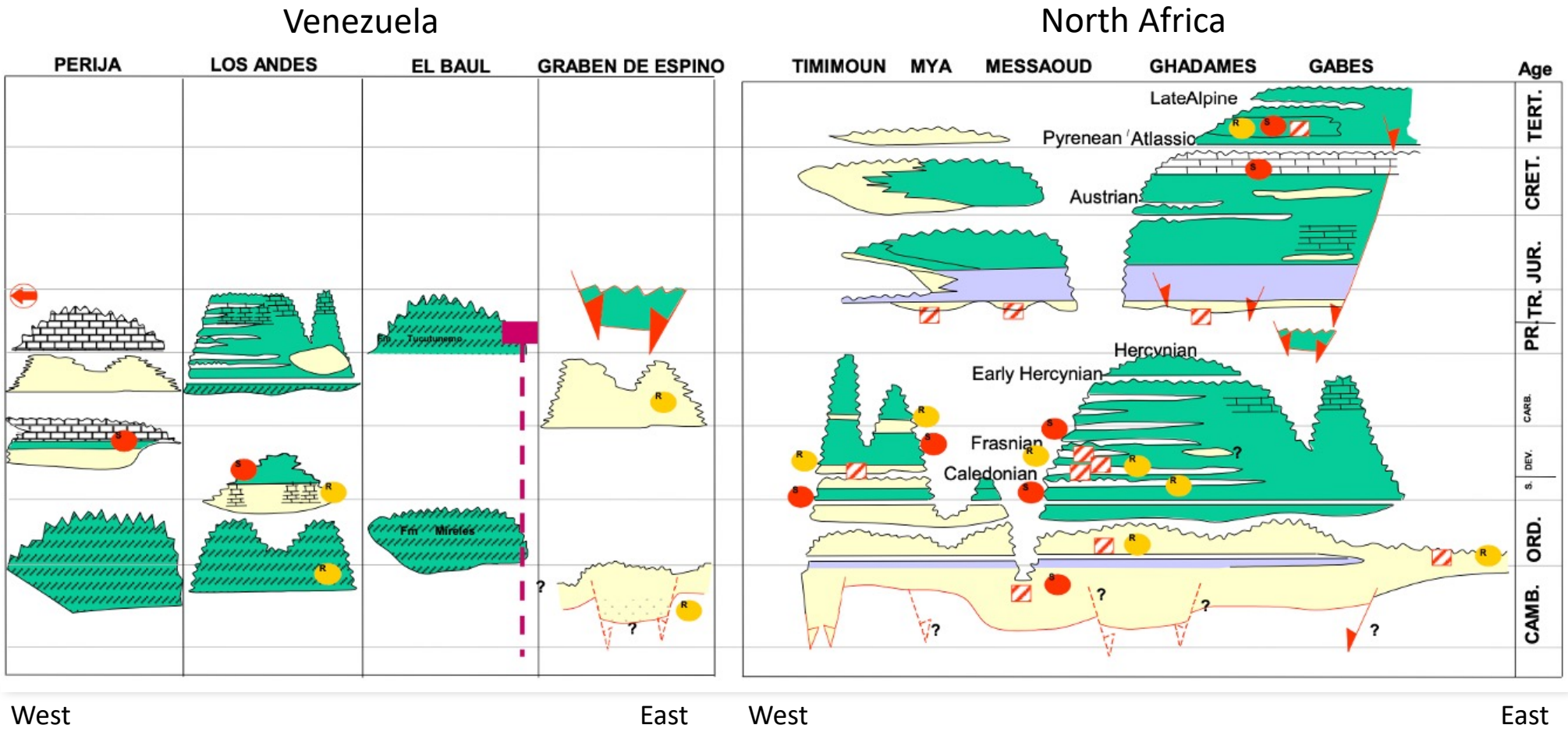
> 90% world oil and gas

https://www.geoexpro.com/articles/2016/02/rich-petroleum-source-rocks

Pz Analogous

- **Reservoirs:** They produce oil but mainly gas and related with matrix dissolution and dolomitization more than primary porosity
- **Source and Charge** : Mainly shales with kerogen type I and II:
  - Anadarko, Permian, Michigan (Silurian)
  - Arkoma Indiana-Ohio Basins (PLP)
  - McArthur Basin (Australia, 1400-1600 Ma).
  - Lena-Tunguska (Siberia, Upper Proterozoic - Pz)
  - Oman (Ediacaran - Cambrian).
  - Ordos, Tarim, Sichuan and Dohai Bay Basin (China, Cryogenian limestones).
  - South Africa (Archaic).
  - Toudeni Basin (Gas, Northern Mali, Precambrian)
- **Seals** mainly evaporites and shales
- **Traps** related with paleo-highs, slope areas and platform margins

Pz Analogous



Sandstones

Mudstones

Salt

Limestones

Low Metamorphism

Intrusions

Opening

R Reservoirs

S Source

Macgregor Duncan (1998)

Project contribution

Myths about the Colombian Palaeozoic

- Metamorphism (Regional, Contact and Dynamic)
- TOC (Absent of very low)
- Organic matter post-mature
- Very tight rocks
- High Tectonic deformation and fracturing

The Palaeozoic in Colombia is a frontier - The aim of this Project is to find out whether or not there is some potential in these sequences.

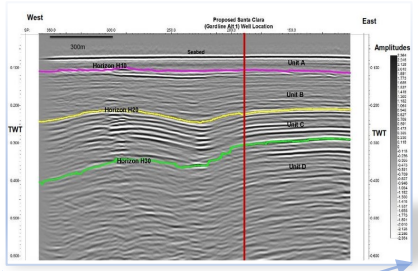
In the case of finding a good source rocks, Pz can have interest for Conventionals and Unconventionals.

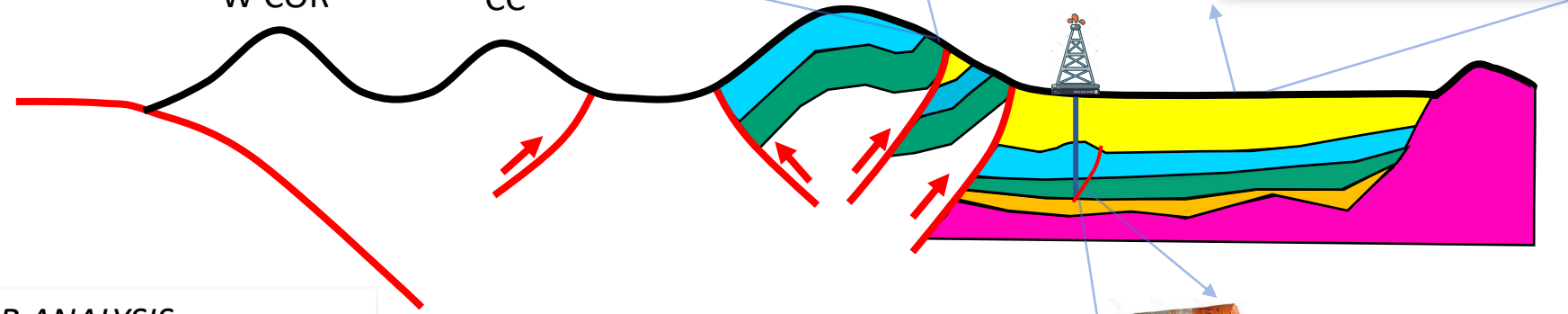
To propose areas that can have good conditions for continuing acquiring more Information to prove the potential in the Palaeozoic

PROJECT SCOPE?

SURFACE GEOLOGY

SEISMIC INTERPRETATION





CORES AND CUTTINGS

LAB ANALYSIS:

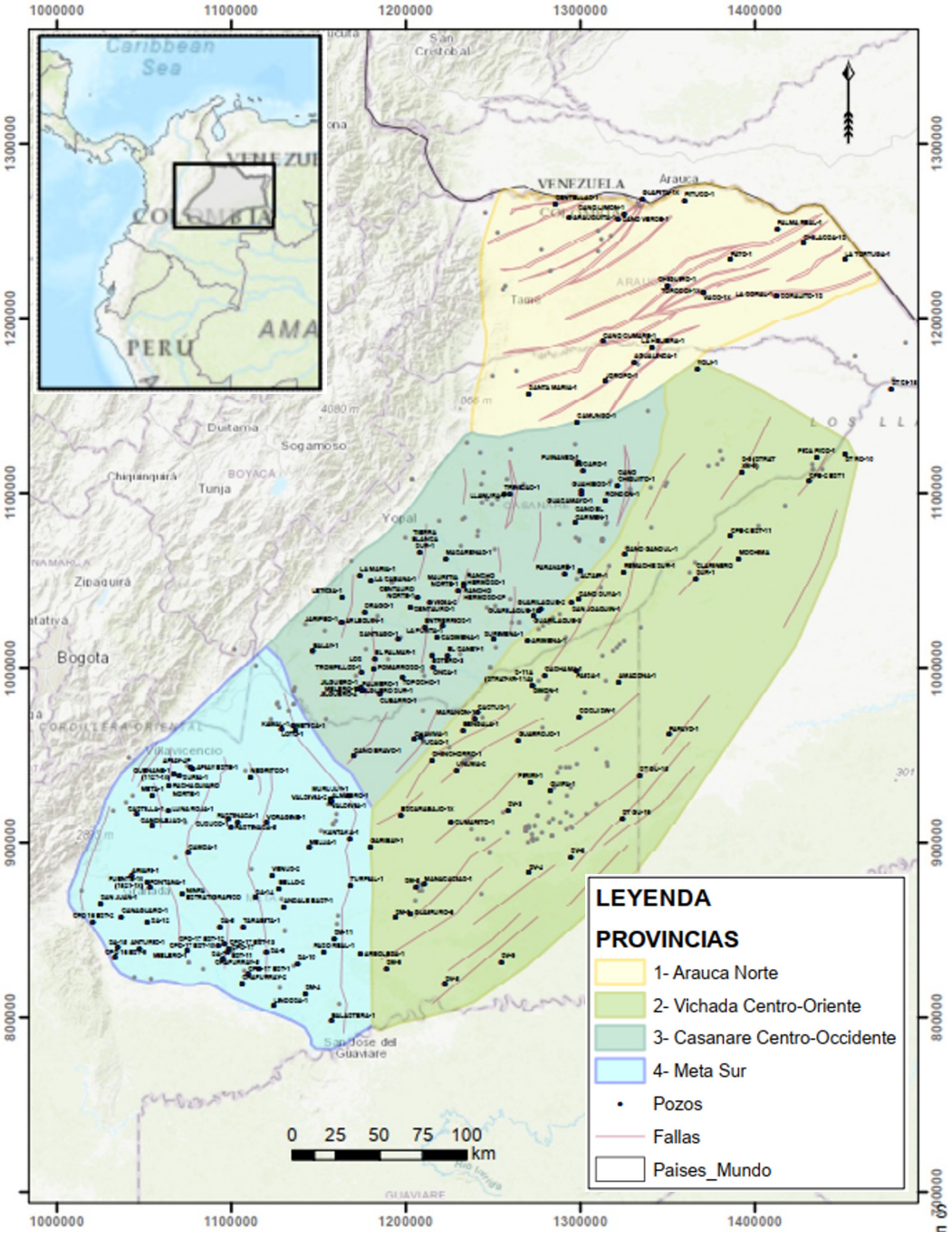
Petrography
Petrophysics
Geochem
Palaeontology
DRX

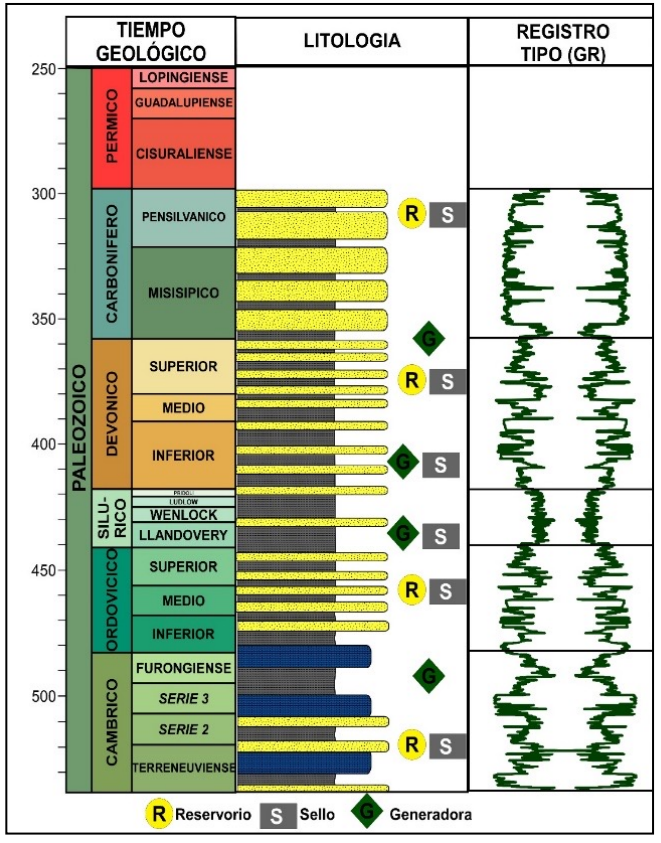
WHAT HAS BEEN DONE? SURFACE GEOLOGY

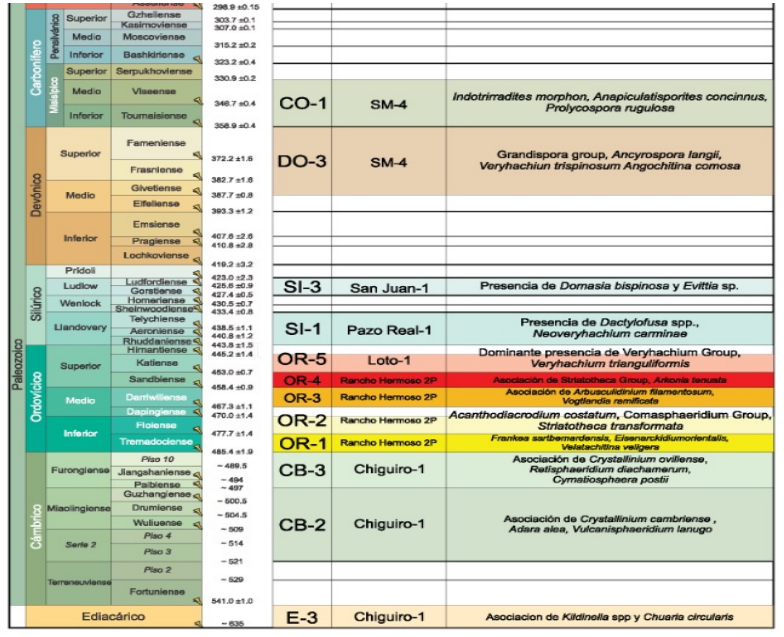
Rio Bata: 3515 meters, included intervals covered
Ariari: 890 meters
Guacavia: 832 meters, so far …

WHAT HAS BEEN DONE? SEISMIC INTERPRETATION

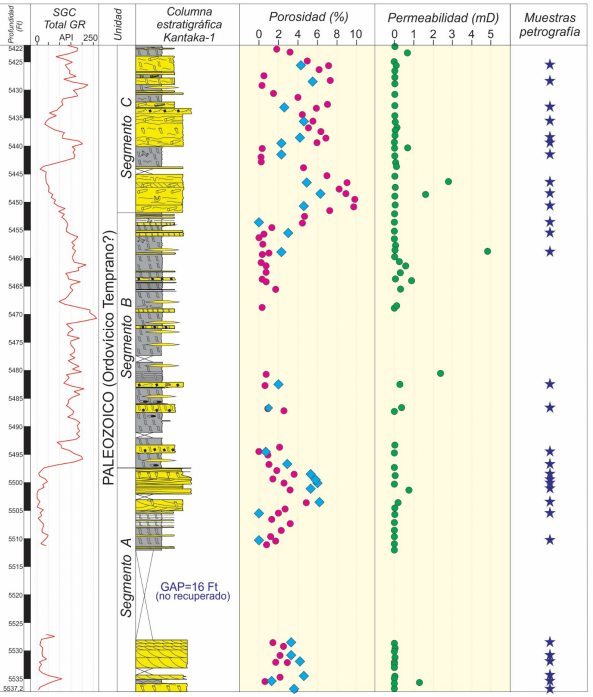
Petrel Seismic Project
406 Wells included
15000 km of seismic information
6 Regional seismic sections
50 wells studied and analysed (Report)
Identification of Structural Provinces

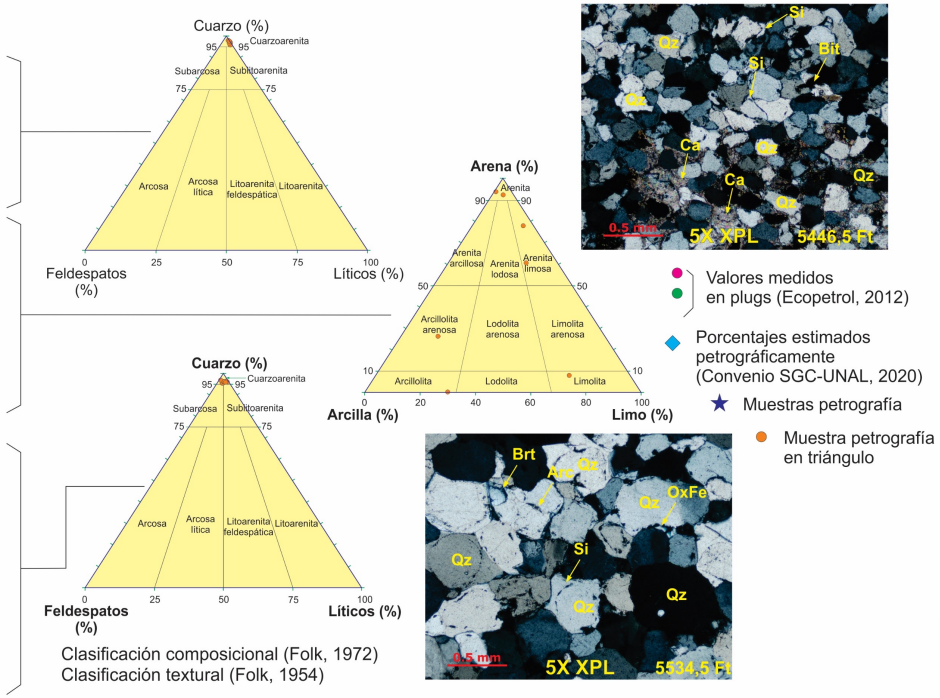






WHAT HAS BEEN DONE? CORE AND CUTTINGS





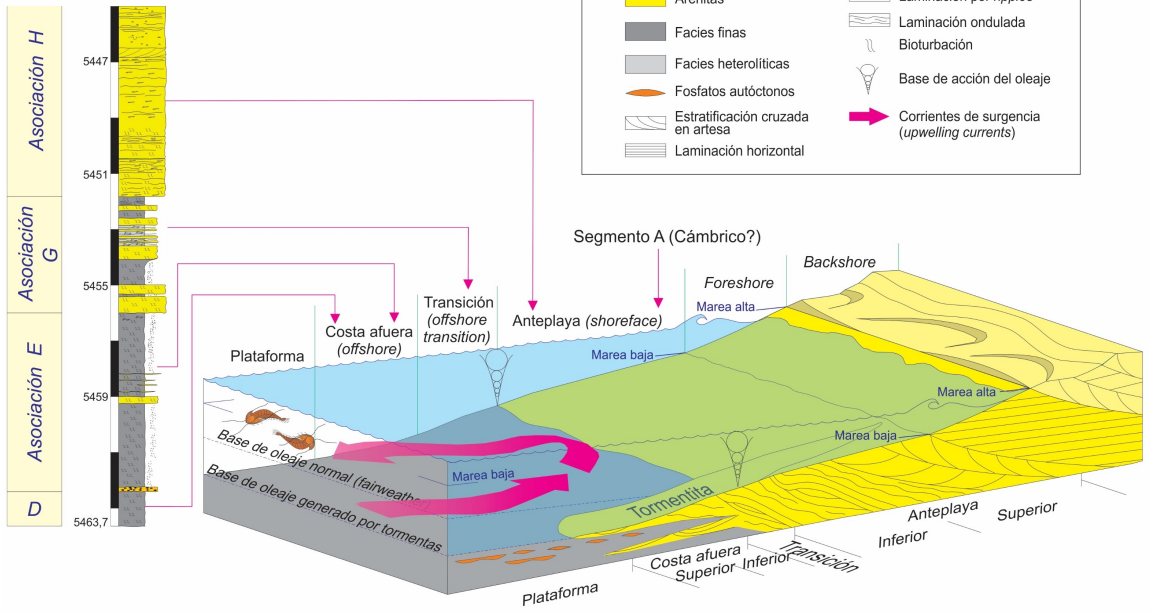
Valores medidos en plugs (Ecopetrol, 2012)

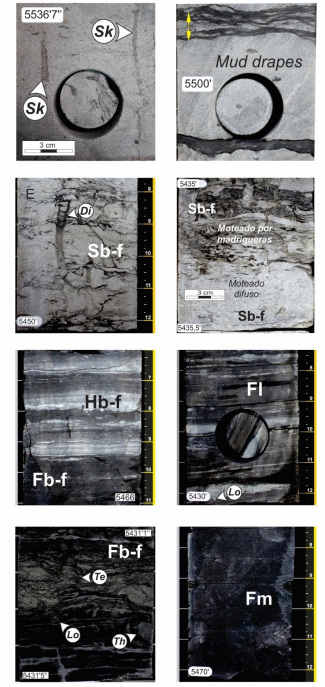
Porcentajes estimados petrográficamente (Convenio SGC-UNAL, 2020)

★ Muestras petrografía

● Muestra petrografía en triángulo

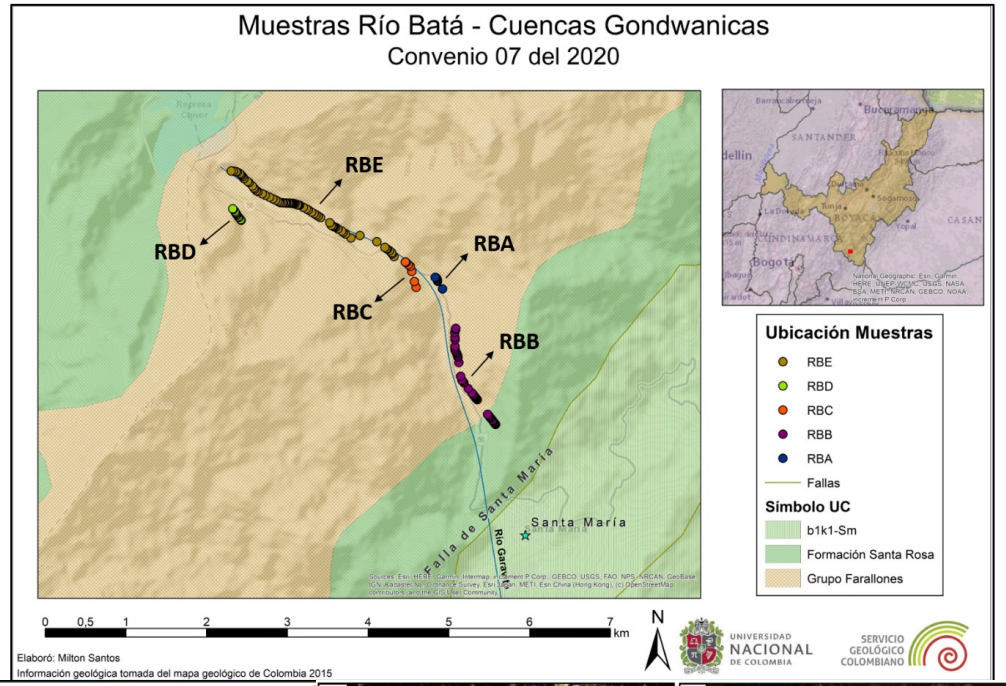
- 27 wells selected for making stratigraphic sections
- 6 wells with cuttings were analysed
- More than 600 sample picking for lab analysis

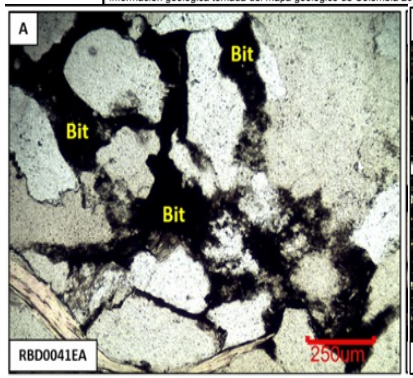


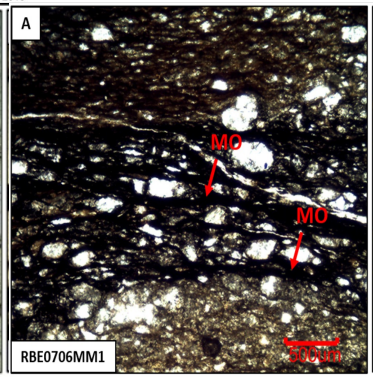


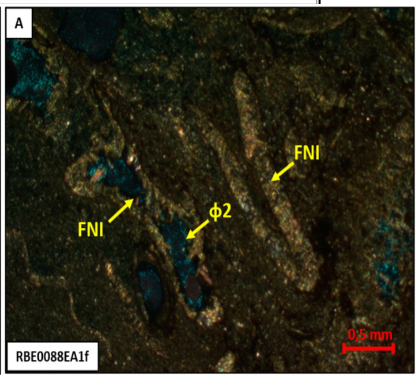
WHAT HAS BEEN DONE? LAB ANALYSIS

Lab Analysis of Rio Bata (Santa Maria – Boyaca)
157 samples were studied (U. Nal)

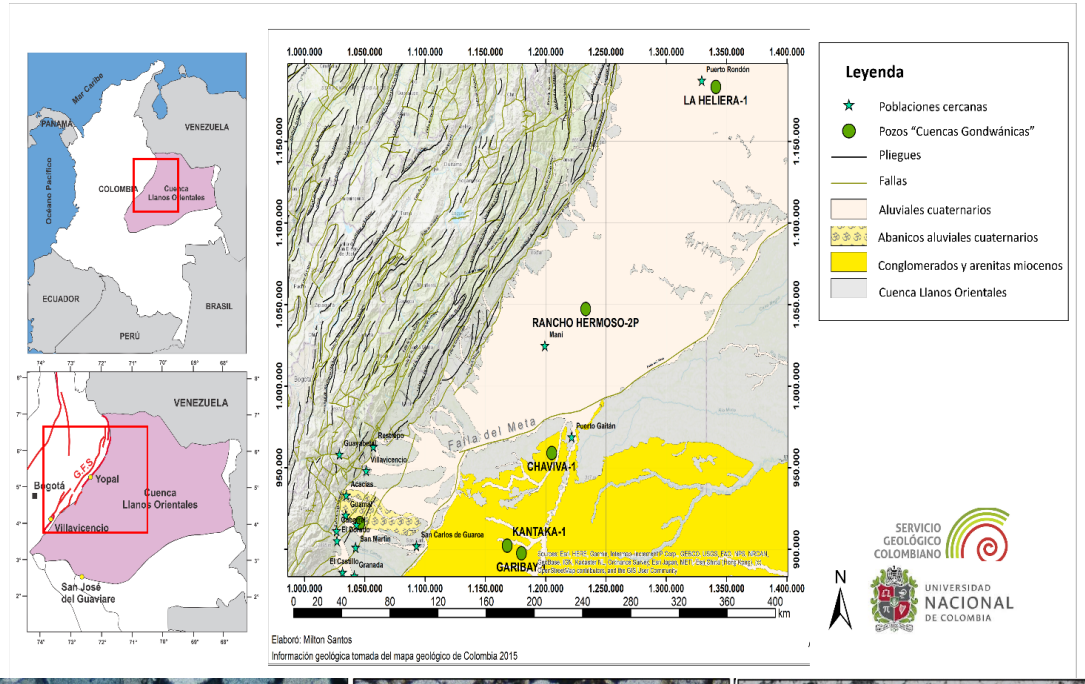


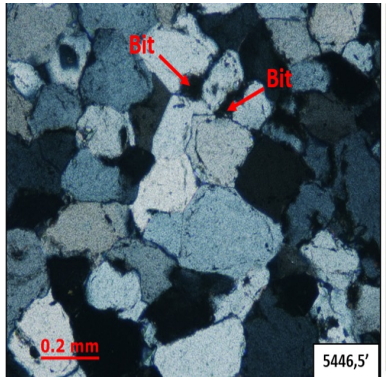


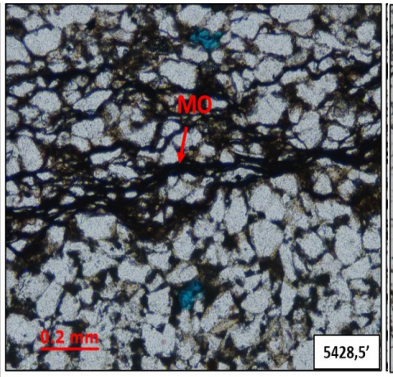


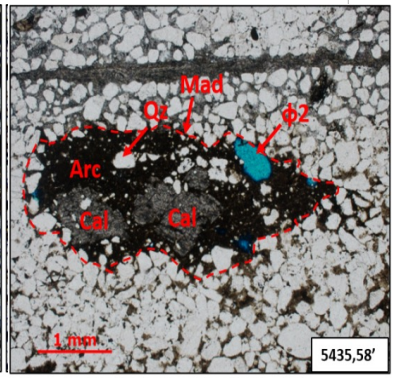


Lab Analysis of Cores and Cuttings
46 samples sent to lab for petrographic analysis









SOME FINDINGS (Source Rock)

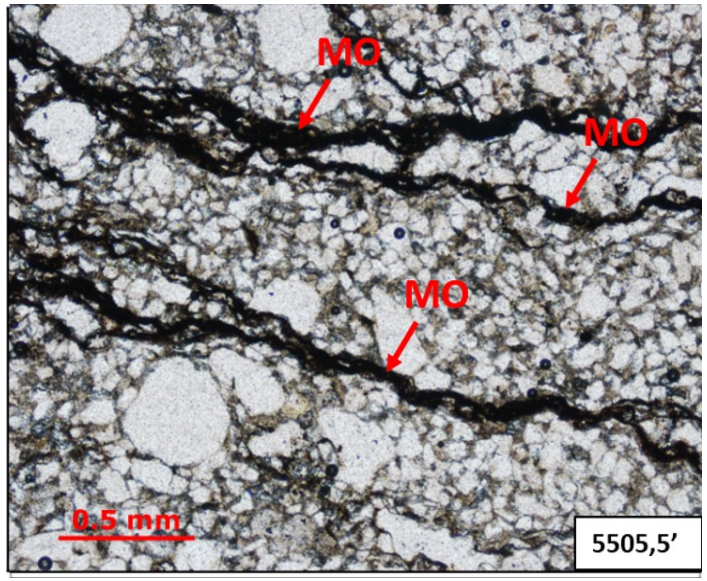
Fossiliferous levels have been seen in cores, surface and thin sections (Lower Ordovician?, Carboniferous? Silurian ? and Devonian?).

There are black shales in Palaeozoic outcrops and cores

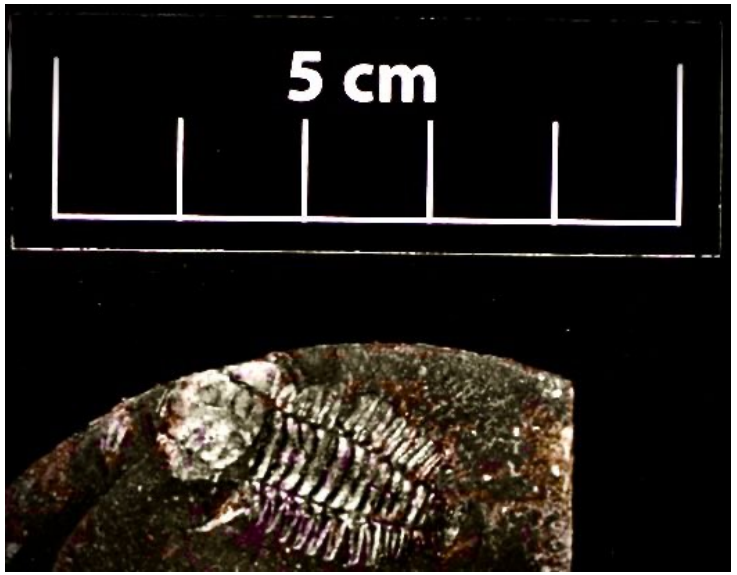
There is Organic Matter Layers in the Rio Bata section and in the cores studied

Some cores display oil impregnations in palaeozoic sandstones (Venus-2, Venus-3 and Valdivia-2).

From available information (e.g. Almagro-1), some wells at the south of the basin shows low TOC values and high thermal maturity. At the north of the basin the thermal maturity is low



Layers of Organic Matter in Kantaka-1 well



Fossiliferous level in CPO17 EST 12. Trilobites (Lower Ordovician ?)

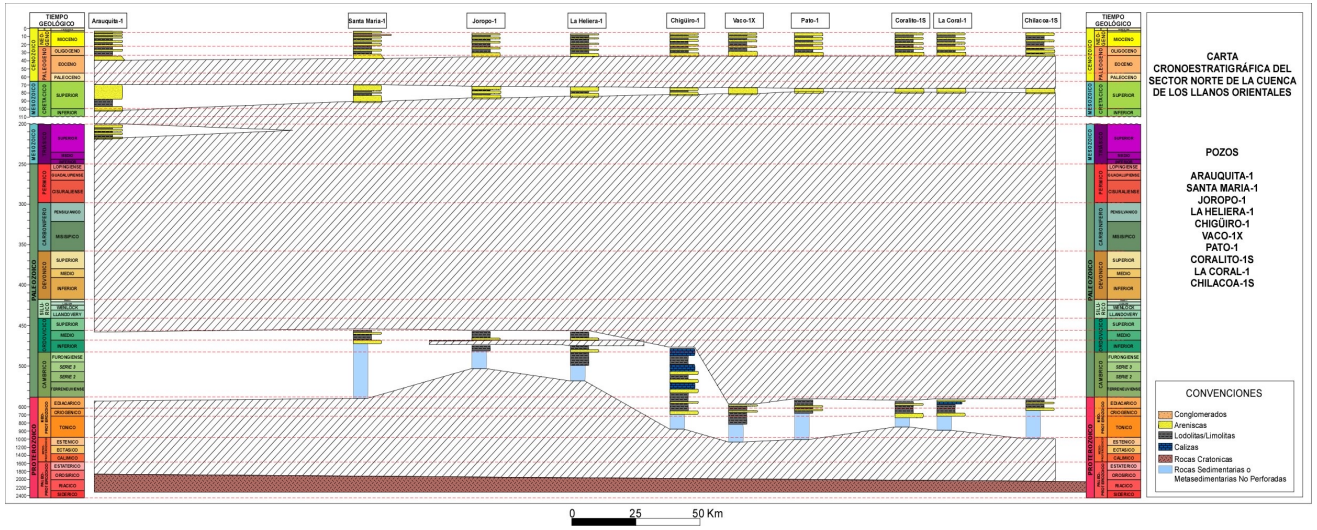

Fossiliferous level in Quebrada San Isidro (San Juanito-Meta). Crinoids ?.

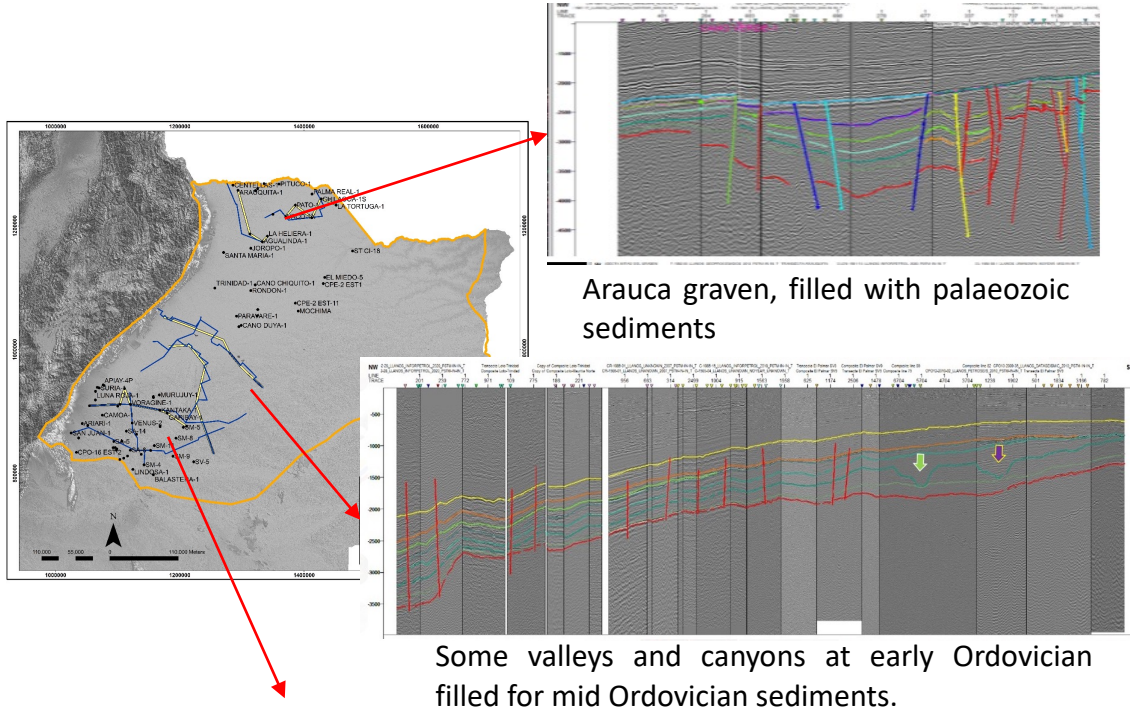
SOME FINDINGS (Geometries - Traps)

In the seismic interpretation different horizons have been identified and picked for the Cambrian, Ordovician, Devonian, Silurian and Carboniferous. Permian ?

4 structural provinces have been identified in the basin

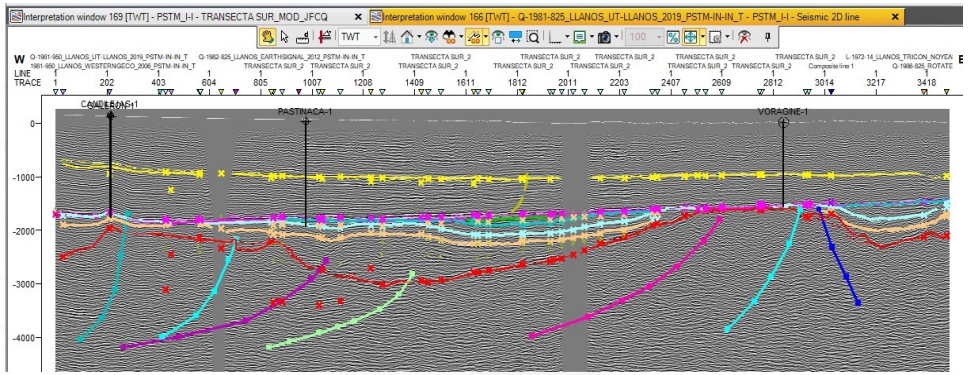
Palaeozoic has interesting geometries.





Arauca graven, filled with palaeozoic sediments

Some valleys and canyons at early Ordovician filled for mid Ordovician sediments.

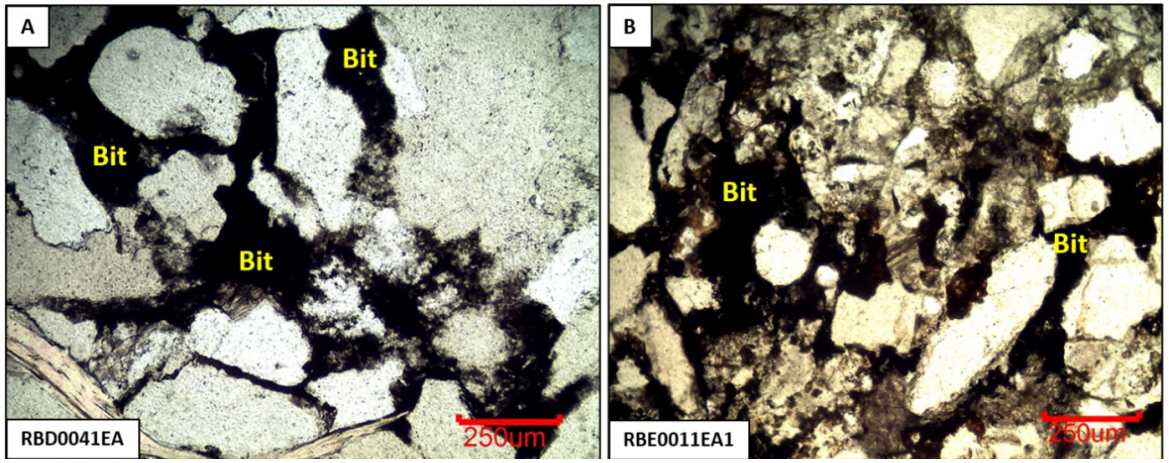


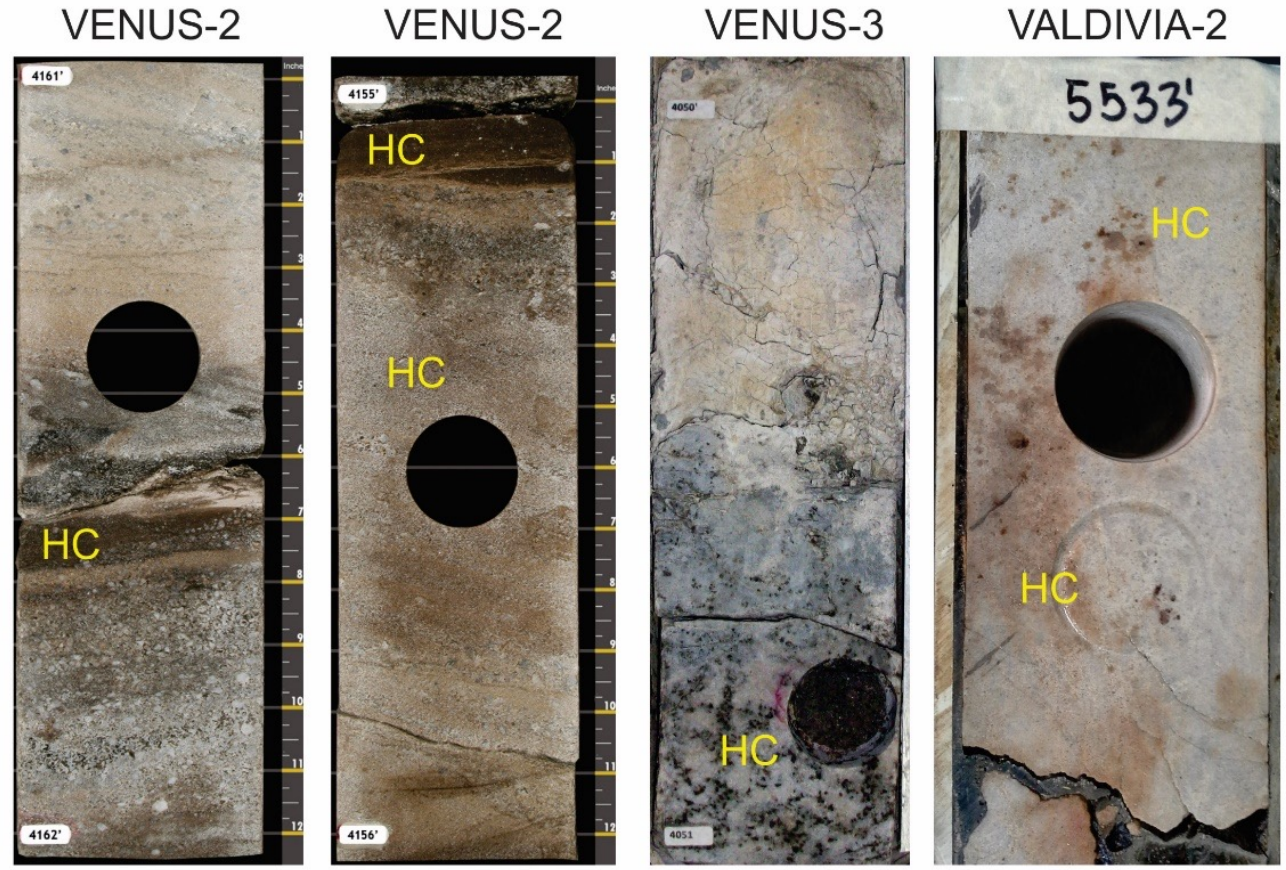
Greater distribution of the Ordovician and Silurian sequences

SOME FINDINGS (Migration)

Thin sections have shown Bitumen

HC stains in cores





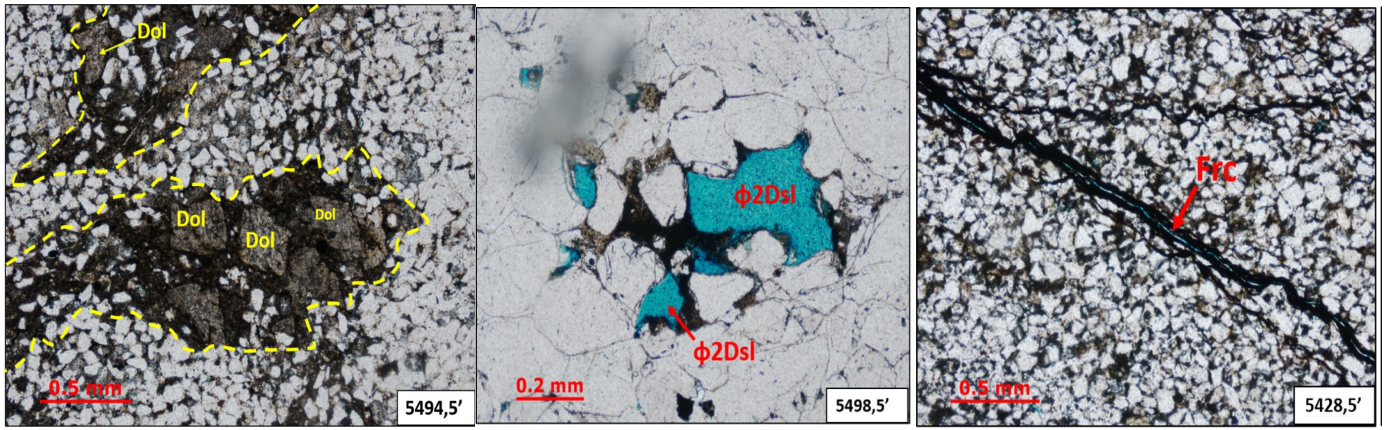
SOME FINDINGS (Reservoirs and seals)

Petrography have shown secondary porosity for different horizons in the Palaeozoic (Rio Bata and Cores)

In Surface the outcrops show intense deformation and fracturing (i.e. Quebrada la Cristalina)

In Quebrada La Cristalina, dolomitization processes were recognized, pending on petrography confirmation

Foto Calizas en la Qbda La Cristalina



Secondary porosity due to Dolomitization, Dissolution and Microfracturing

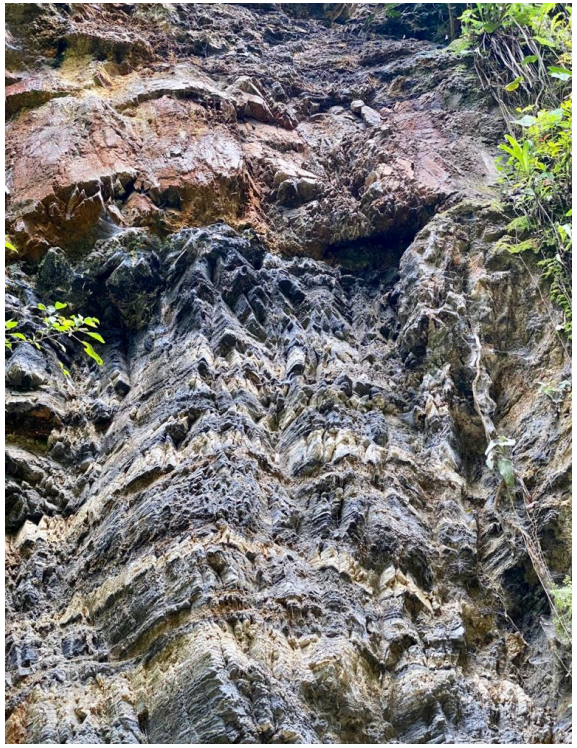
OTHER INTERESTING FINDINGS

In Ariari area has been proposed a faulted contact between the gabbros and the palaeozoic limestones . The Surface team found evidence of the intrusive contact.

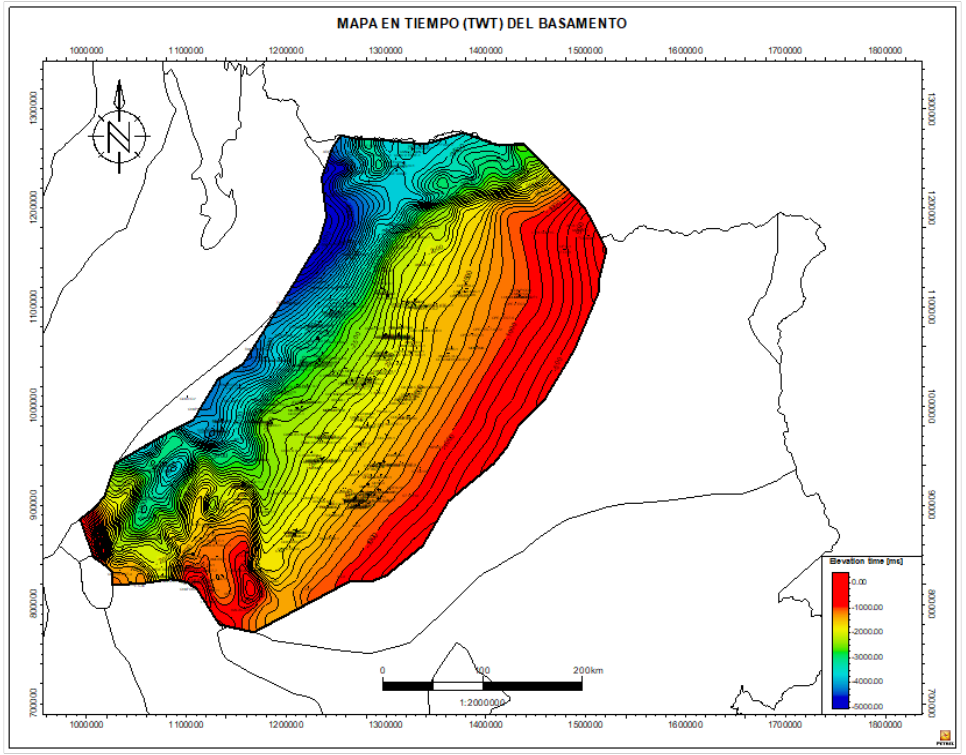
There are different types of gabbros emplaced (implications on maturation --- Barton M.)

In analysis of cores red sandstones and paleo soils have been found, similar facies to the ones found in Surface in Quebrada Pipiral, Quebrada El Diamante and Quebrada La Sapa

There is and important unconformity between Low Ordovician and Mid Ordovician. That event show how an important depocenter changed the location in the basin



Relation between the gabbros and the palaeozoic limestones. Some xenoliths are visible within the gabbro



To be completed

- Lab analysis for Surface and well samples:
    - Geochem: (Rock Eval, TOC, Vitrinite)
    - Petrophysics
    - Petrography
    - Palaeontology (micro and macro)
    - DRX
- To finish stratigraphic model
- *Fission Tracks (Geochronology)*
- *Chemistry of gabbros (3 different samples)*
- *Crude-Rock relation**
- *Paleo magnetometry*
- *To include Venezuela and Putumayo in the same model*

- *Understand Source, Reservoir and Seal rocks*
- *Define future action to reduce Uncertainty*

GRACIAS…!

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Quebrada San Isidro (San Juanito – Meta)