PACIFICO BASIN

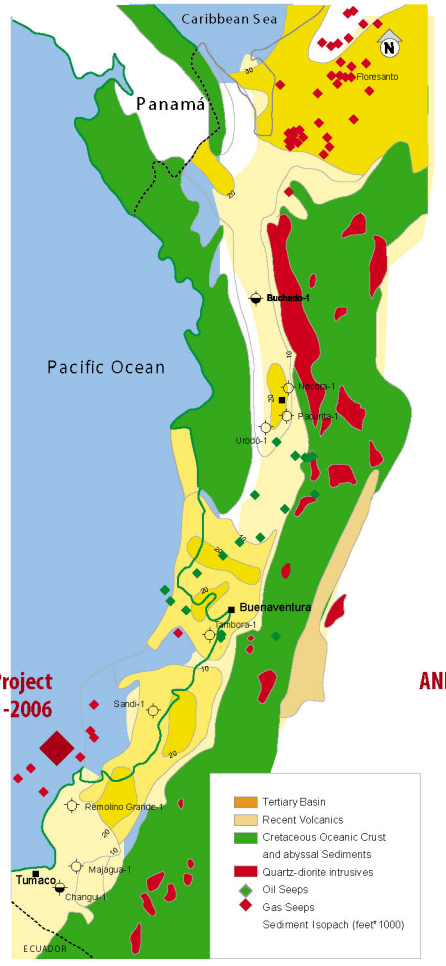
Future petroliferous province

Colombia

2005

2006

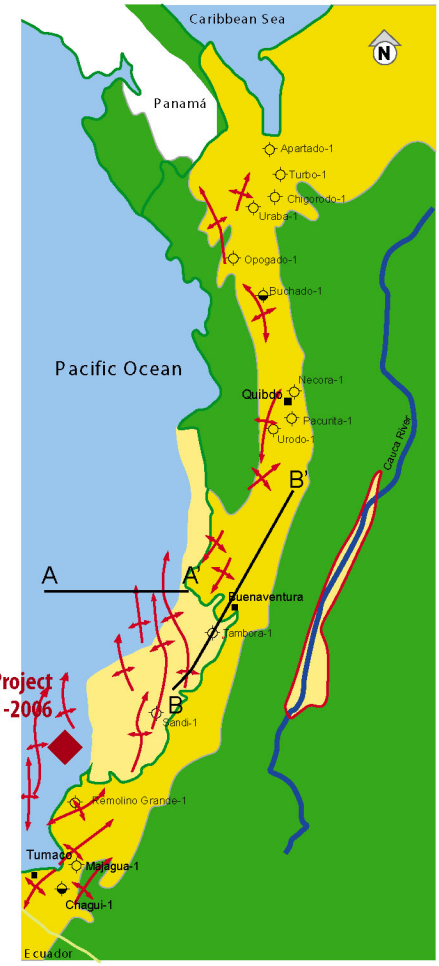
Pacifico Fore-arc Basin



ANH Pacific Project 2005 -2006

Modified from Ecopetrol, 1989

Main Structural Trends

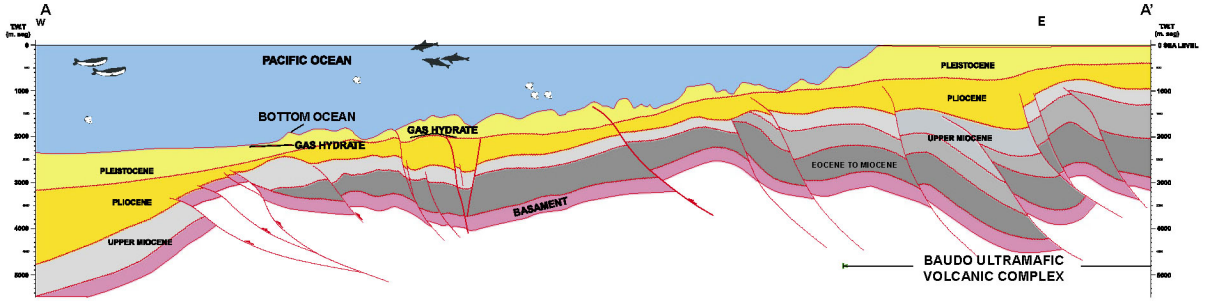


ANH Pacific Project 2005 -2006

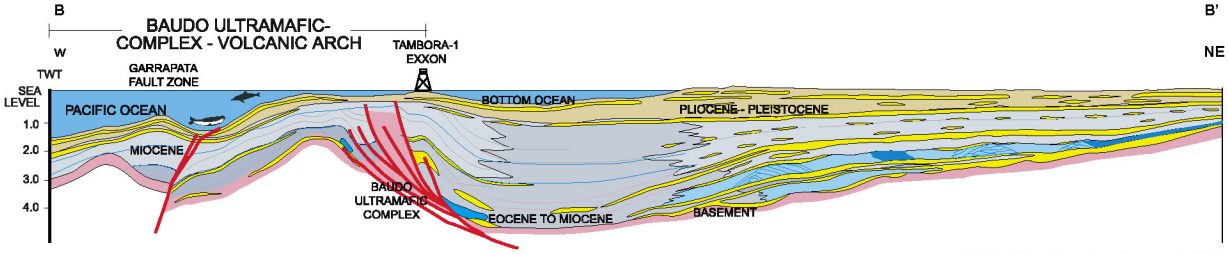
Modified from Ecopetrol, 1989

Structural / Stratigraphic Model

Schematic Cross-Section
CENTRAL REGION

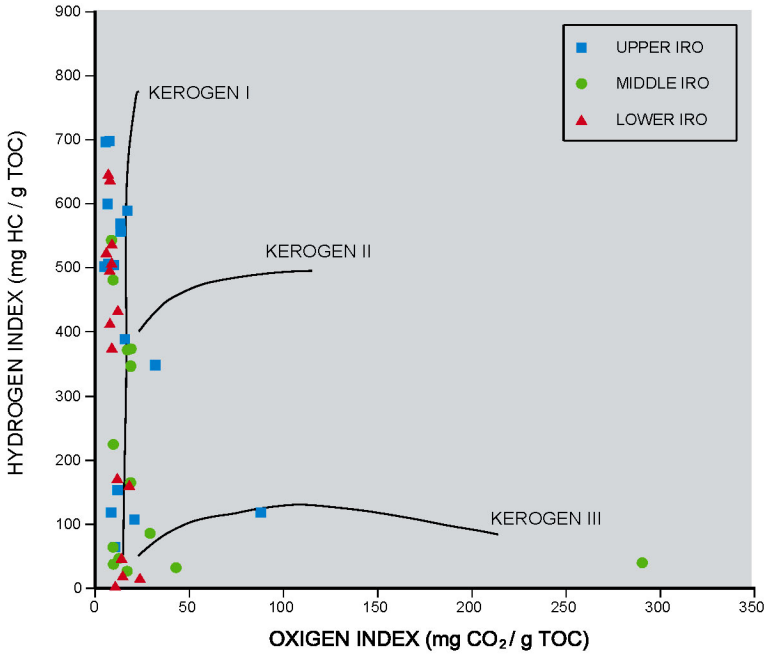


Schematic Cross-Section
ALONG CENTRAL REGION



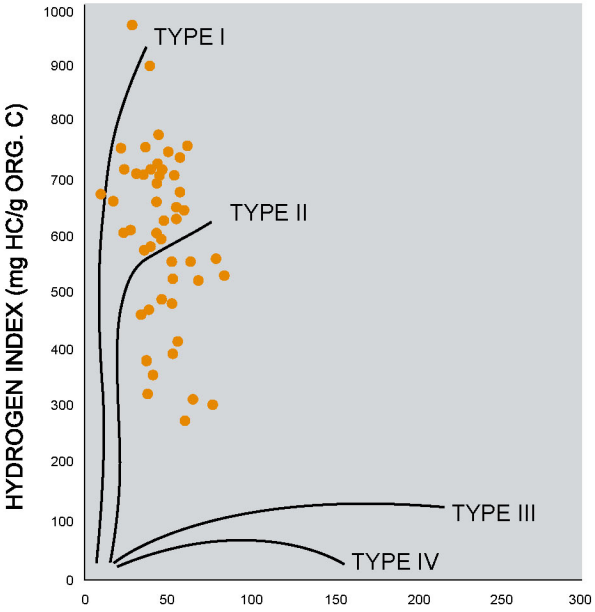
Modified from Petrobras-Ecopetrol, 2002

Organic Matter Type



VAN KRAVELEN MODIFIED DIAGRAM
(IRO FM - CENTRAL REGION)

Modified from Petrobras-Ecopetrol, 2002

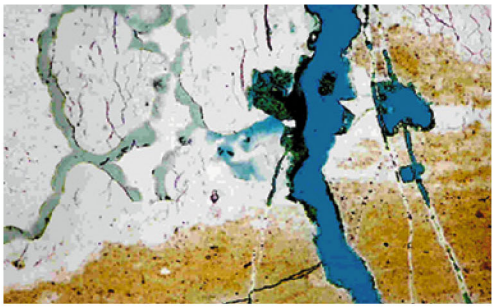


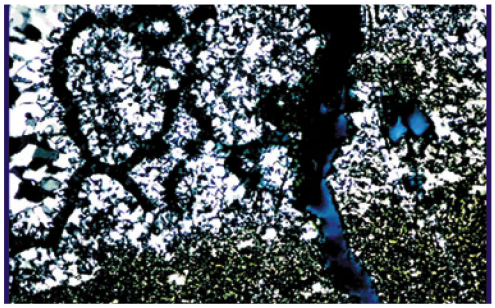
VAN KRAVELEN DIAGRAM
MONTEREY FM.- POINT ARGUELLO FIELD

From Mero et al.; 2005

Reservoir Quality

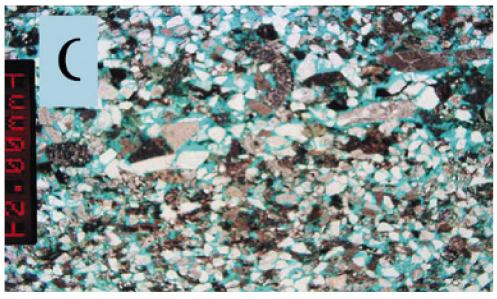
La Mojarra Fm.
Conglomerates and coarse sandstone



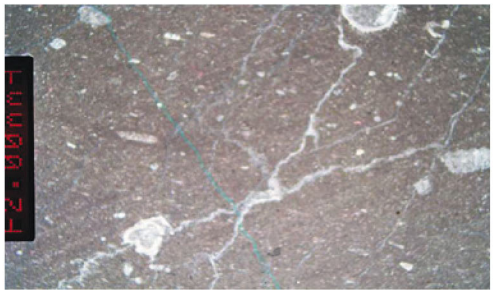


Chert corresponding to early silicification of lightly consolidated Calcareous and Phosphatic sediments, from the Lower Paleocene Iro Fm.

Iro Fm.
Mudstones and shales interbedded.



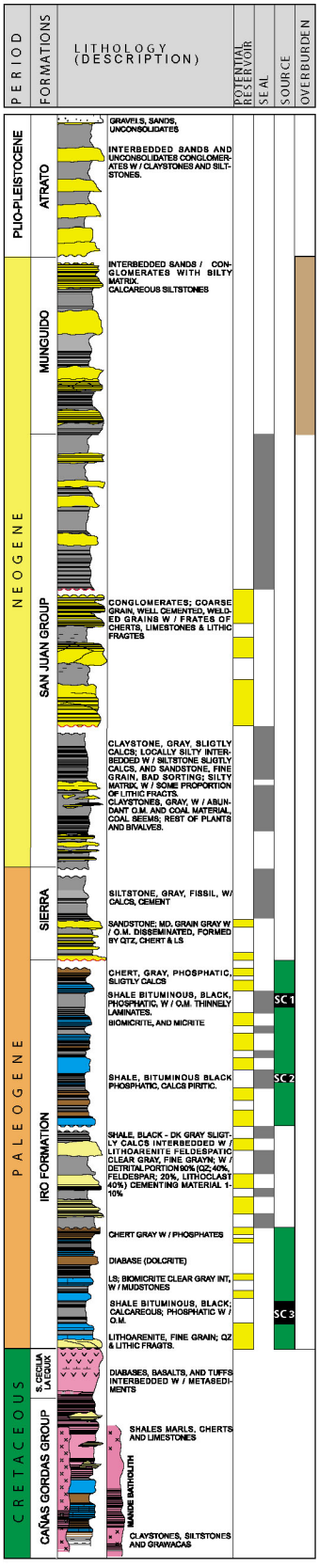
QM-I-003 Iro Fm.
Sandstones lithic fine grain section is open, intersticial matrix, decreasing the primary porosity 6%.



QM-I-003 Iro Fm.
Mudstone, micrite mainly. One of the three fracture directions is open, increasing the quality reservoir porosity 6%.

From Ecopetrol, 2002

Petroleum System Chart



Modified from Petrobras-Ecopetrol, 2002

Petroleum System

Sources: All the hydrocarbon (shows) found in the Pacific Basin are believed to have been generated primarily within the Iro Formation (geochemical analyses).

The total organic carbon (TOC) content of the Iro Formation ranks from very good to excellent. Three condensed sections (CS) were analyzed. SC1 consists of a phosphatic shale with a thickness of 150 feet and TOC content between 4.3 and 24 %, SC2 consists of a highly-organic phosphatic shale with a thickness of 110 feet and TOC content between 2 and 14.6 %, kerogen type II and hydrogen index of 340 to 540 (mg HC/gr. rock), CS3 consist of highly bituminous shale with a thickness of 190 feet and TOC content between 1.5 and 11.0 %, kerogen type I and II, and Hydrogen index of 161 to 523 mg (HC/gr. rock). These condensed sections are excellent oil prone. In addition, cherts and shales from Iro Fm. with an average TOC of 3% are also potential sources.

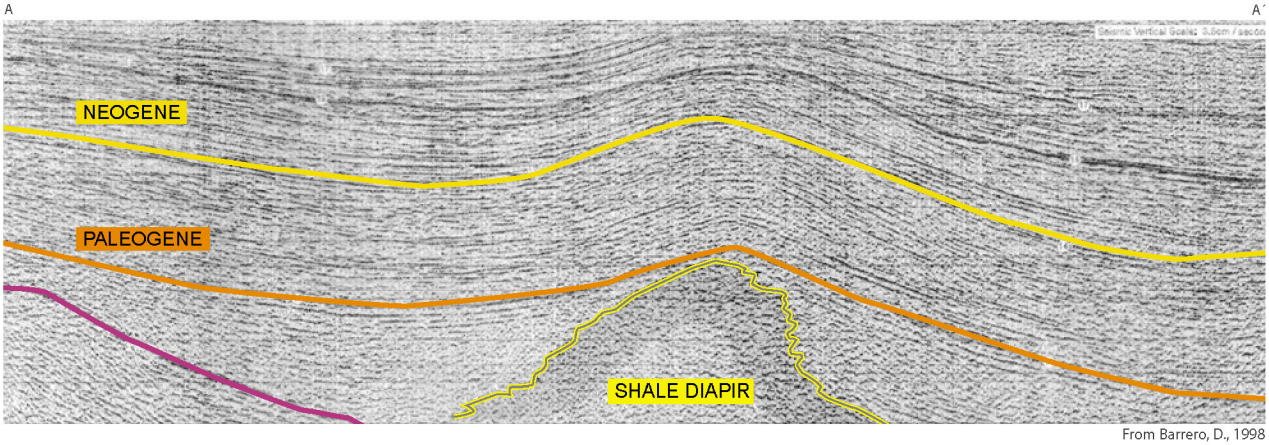
Reservoirs: Carbonate and siliciclastic rocks from Iro and La Mojarra formations (Middle Miocene) are the major potential reservoir rocks. Naturally fractured cherts, abundant in the basin, could be an important reservoir as seen in the Point Arguello oil field in Southern California (Analog example).

Traps: Several basement structural highs, mud-diapir core anticlines, diapir flanks, thrust anticlines, normal fault rollover, stratigraphic geometries, and highly fractured carbonates and cherts along fault zones, are all potential traps.

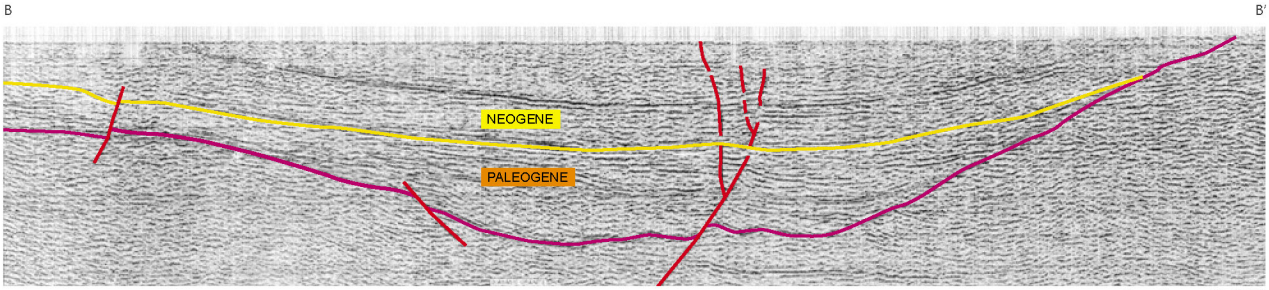
Seals: Seal units occur throughout the sedimentary column, represented by clay units. These units are homogeneous, laterally continuous, with excellent ductile properties. The Sierra Formation (Oligocene) and Istmina Formation (Lower Miocene) are regional seals.

Generation and Migration: Any oil generated must have migrated laterally up dip to the flanks of structures. Long distance lateral migration of hydrocarbons is suggested on the basis of geochemical and stratigraphic and structural data. Vertically migration pathways are associated to fault systems. Critical moment occurs after deposition of sealing units about 5 Ma. and migration continues up to date.

Seismic Expression of Underexplored Tertiary Plays



From Barrero, D., 1998



From Barrero, D., 1998

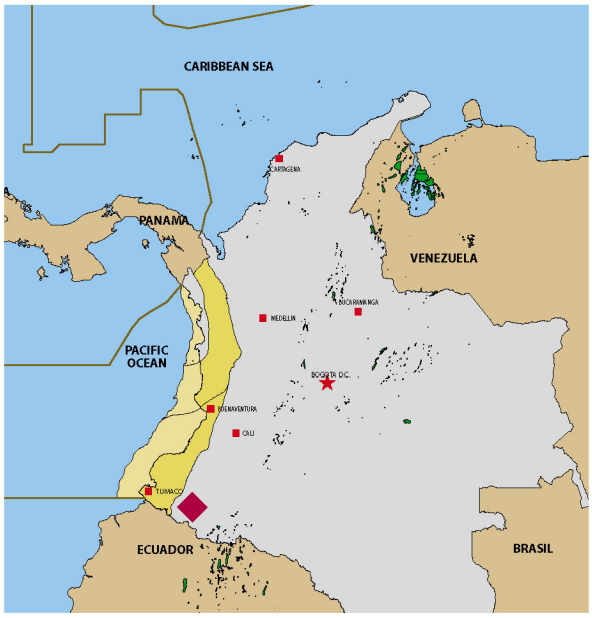
Modified from Ecopetrol, 1989

Prospectivity

In terms of wildcat density the basin is unexplored. Limited data are available for the pacific offshore and therefore a detailed level of assessment in not possible. Geochemical data indicate the existence of the Iro-Mojarra(?) petroleum system. Very high TOC content ranging from 4-24%, kerogene type II and III and Hidrogen Index ranging 370-700 mgHC/gr.rock indicate an excellent oil prone source rock.

Oil generated has migrated and is probable been trapped in large mud-core anticlines, rollovers associated to Listric Normal Faults, and large high-side closure in fault propagation folds, mostly south of Tambora-1 well. Large thrust-related anticlines together with numerous stratigraphic and traps place this basin as a prime exploration target.

Basin Location



HIGHLIGHTS

◆ ANH Pacific Projects 2005 -2006

Phase 1 18,000 km Aereal Gravity & Magnetic

Offshore 8,000 km Seismic 2D Lines

Bathymetry /Surface Geology Survey

Onshore 600 km Seismic 2D Lines

Magnetometry /Petrophysics/Geochemistry

Phase 2 Backestering and heat flow program

Piston core program (Geochemical evaluation)

Areas of Interest

Stratigraphic well

3D-Seismic

Leads/Plays

Basin Location:

The Pacific Basin covers about 103,000 km^2. Up to date 14 wells have been drilled, with a coverage of 7,360 km^2/well in the basin, a density much less than other basins in Colombia. Surface indications for oil and gas have been reported in numerous locations. Subsurface shows of oil and gas were encountered in the Buchado-1, Chagui-1 and Majagua-1 wells.

Produced by
Geoconsult Ltda

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Petroleum Engineer: Yolanda Ojeda

Design
Manttis Estudio

Cover Picture
Ecopetrol S.A.

Libertad y Orden

Agencia Nacional de Hidrocarburos
República de Colombia

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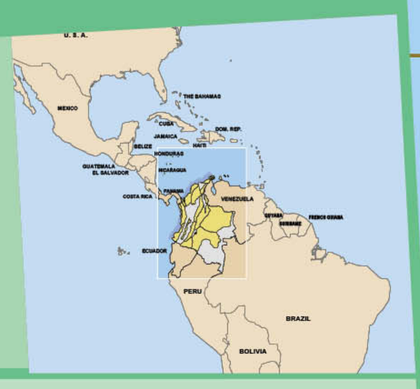
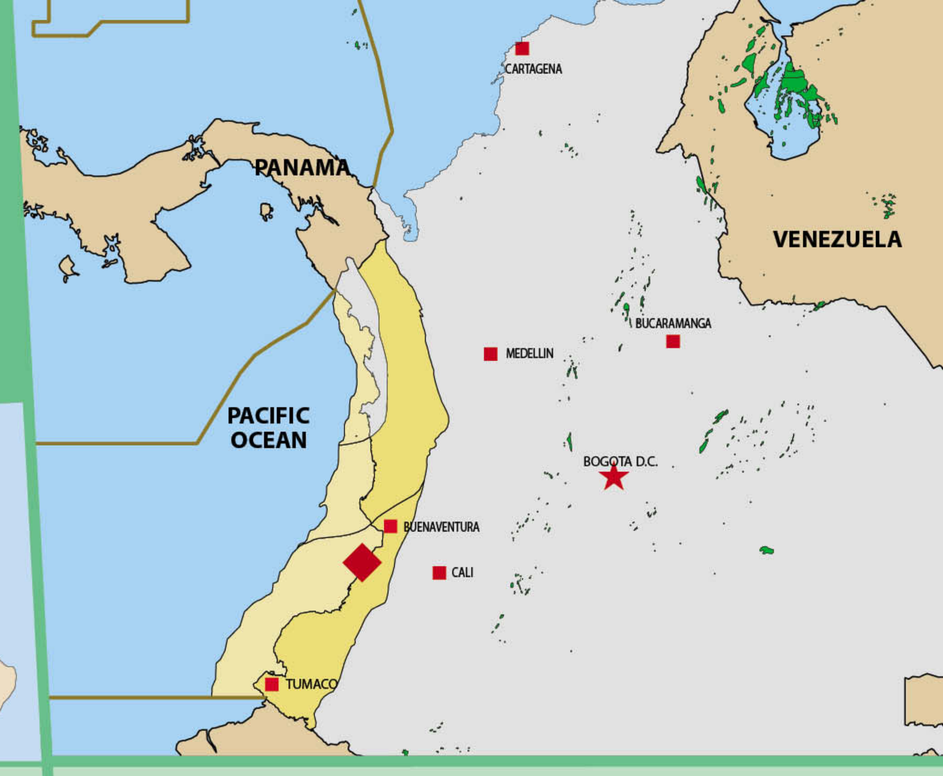
Pacifico Basin

Future petroliferous province





ANH Pacific Project 2005 -2006

Phase 1 | **18,000 km** Aereal Gravity & Magnetic

Offshore | **8,000 km** 2D Seismic Lines

Bathymetry /Surface Geology Survey

Onshore | **600 km** Seismic 2D Lines

Magnetometry /Petrophysics/Geochemistry

Phase 2 | Backestering and heat flow program

Piston core program (Geochemical evaluation)

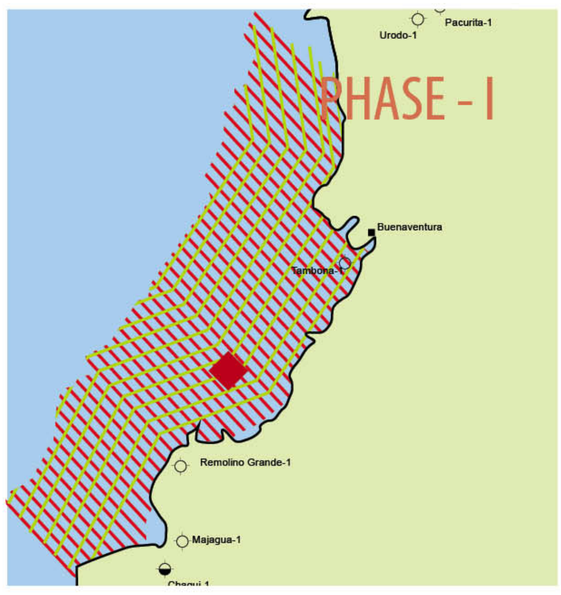
Areas of Interest

Stratigraphic well

3D-Seismic

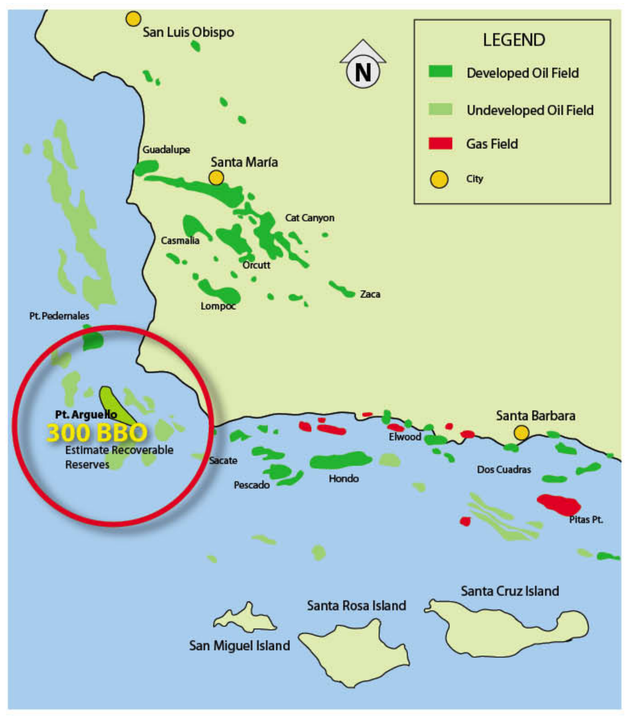
Leads/Plays

Location 2D Seismic Program



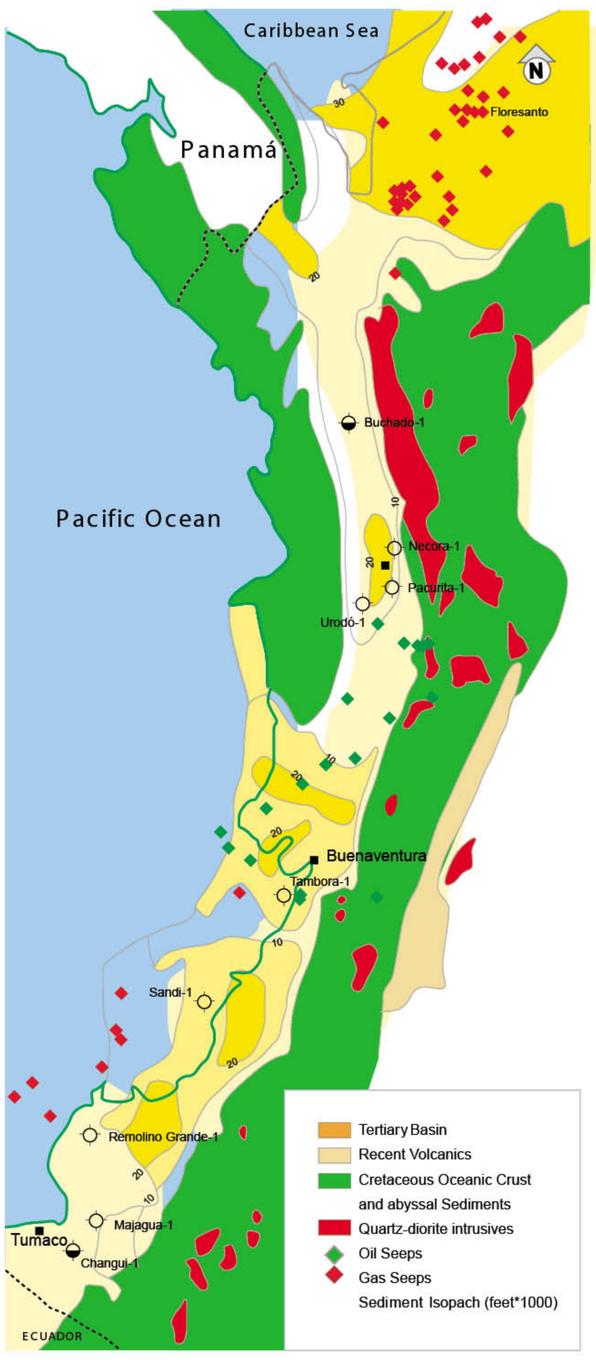
California Fore-arc Basin

Argüello Field Analog



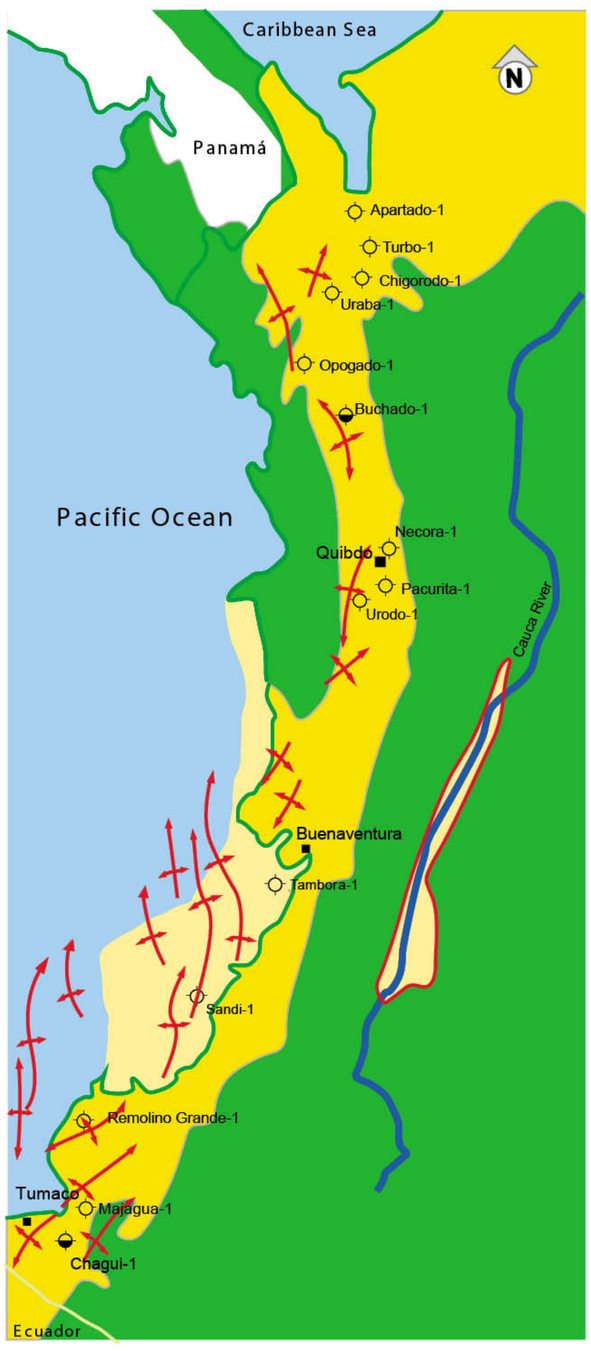
http://www.plainsxp.com/

Pacific Fore-arc Basin



Modified from Ecopetrol, 1989

Main Structural Trends



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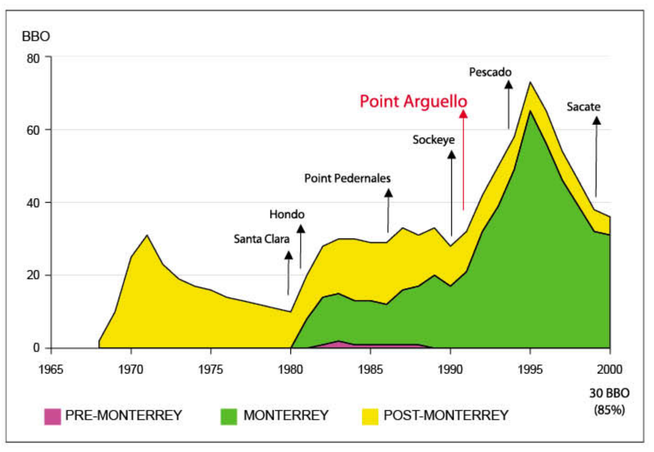


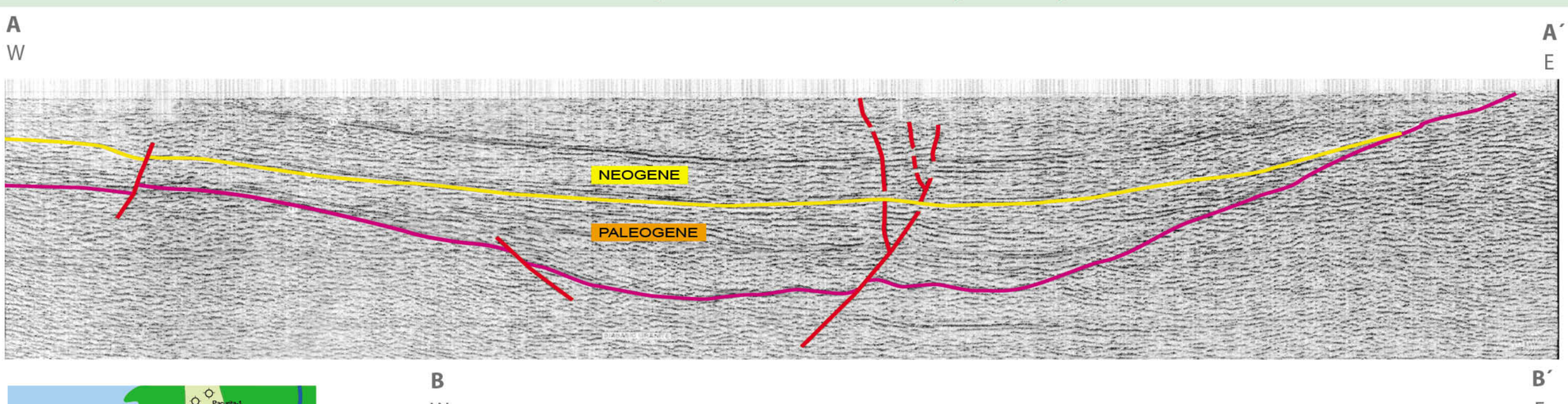
http://www.plainsxp.com/

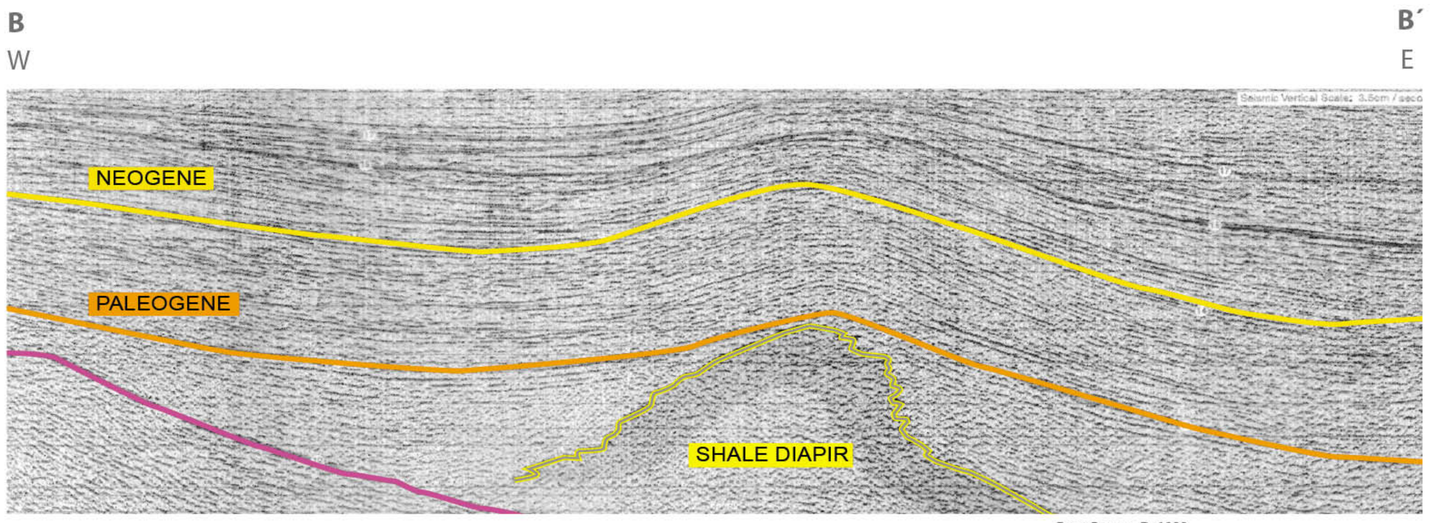
Oil from Bottom of the Sea

California Point Arguello

http://www.mms.gov

Underexplored Tertiary Plays





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República de Colombia
Libertad y Orden

Colombia 2005 2006

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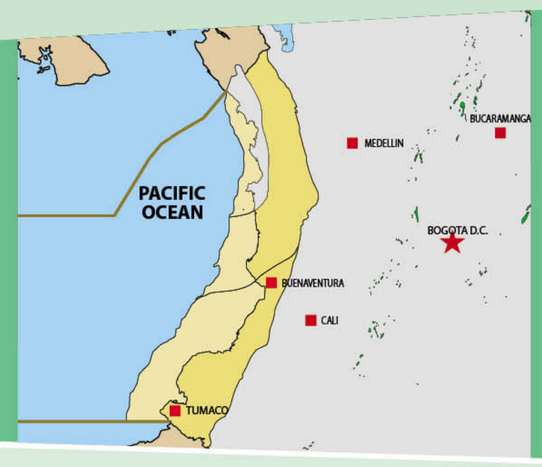
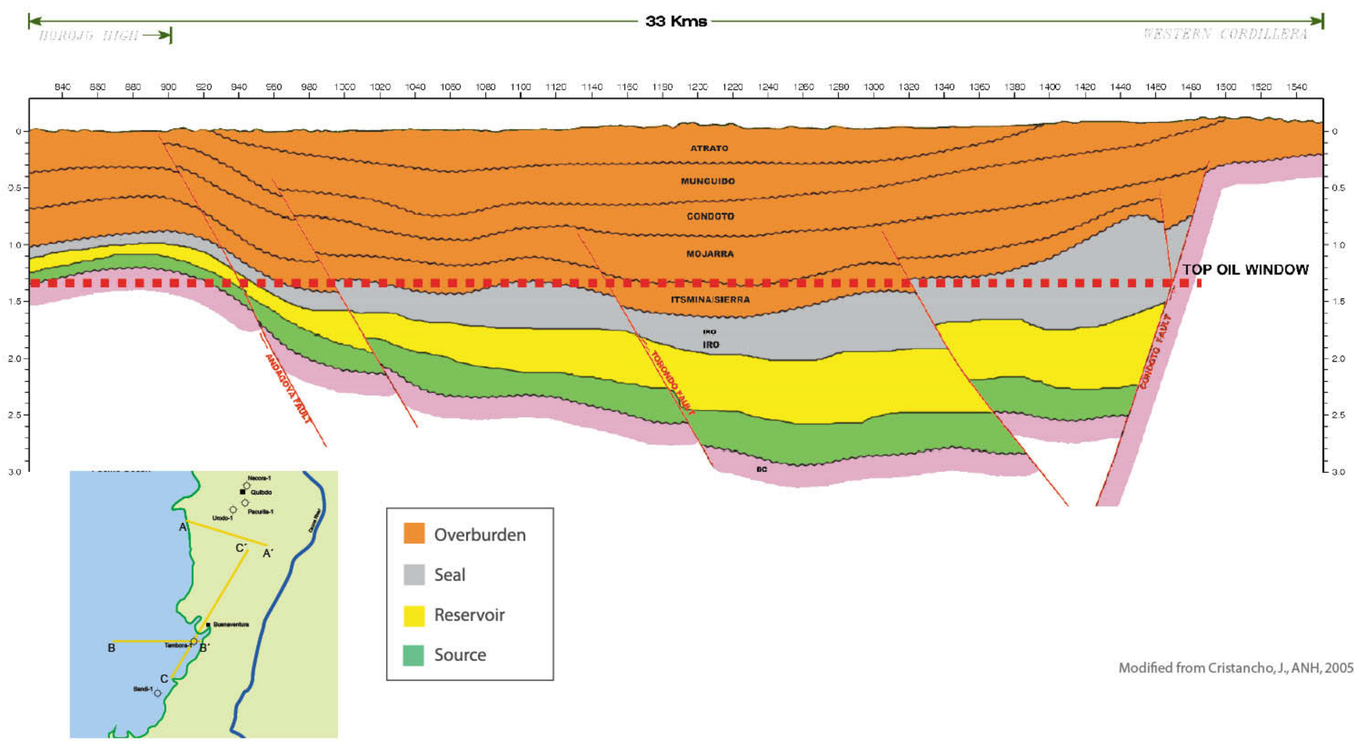
Pacifico Basin

Exploring and Unexplored

Central Region

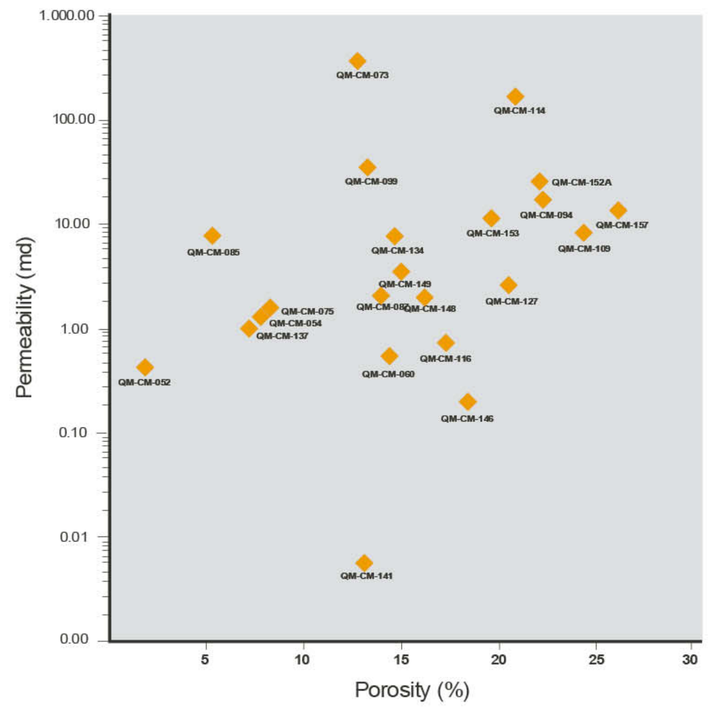


Petroleum System



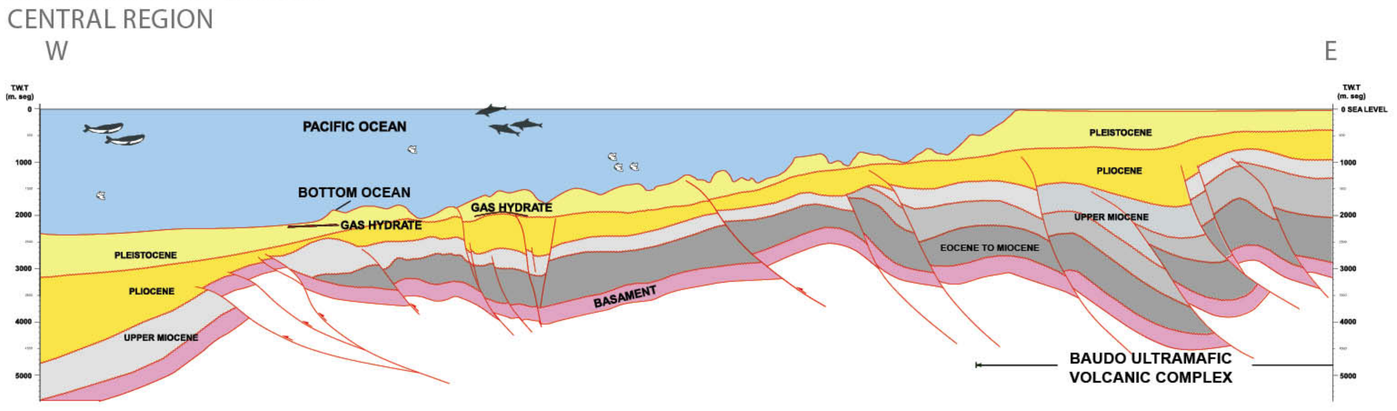
Modified from Cristancho, J., ANH, 2005

Reservoir Petrophysics



Structural / Stratigraphic Model

Schematic Cross-Section
CENTRAL REGION



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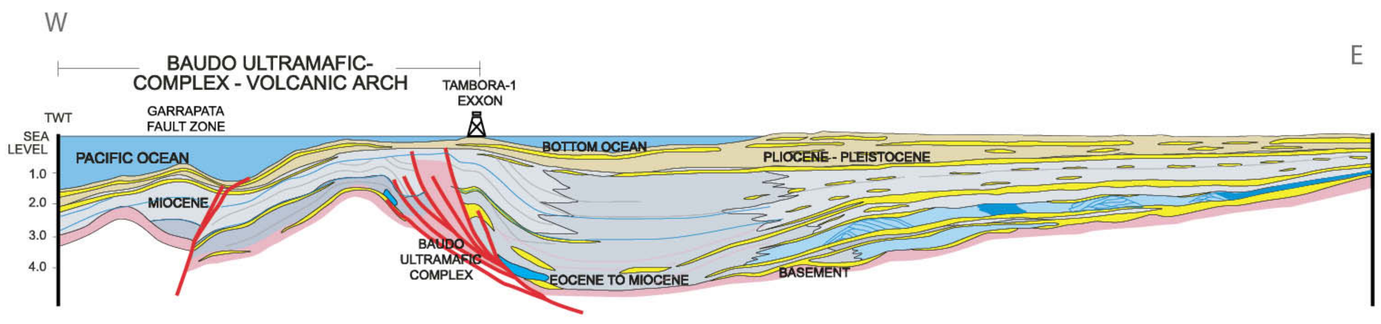
Schematic Cross-Section
ALONG CENTRAL REGION



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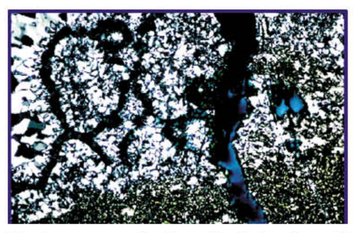
Reservoir Quality

La Mojarra Fm.
Conglomerates and coarse sandstone

Iro Fm.
Mudstones and shales interbed.



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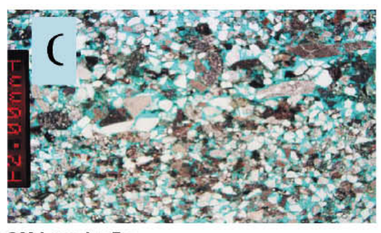

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Sandstones lithic fine grained section is open, intersticial matrix, decreasing the primary porosity 6%.

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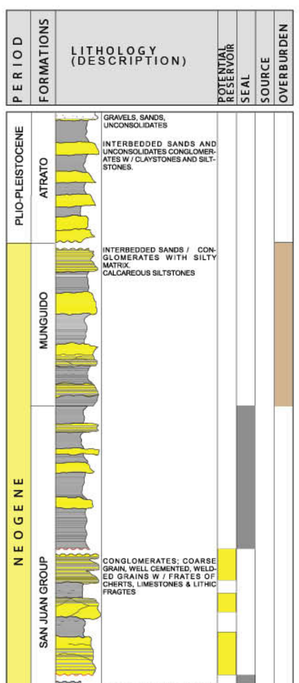
Taken from ECOPETROL

Petroleum System Chart



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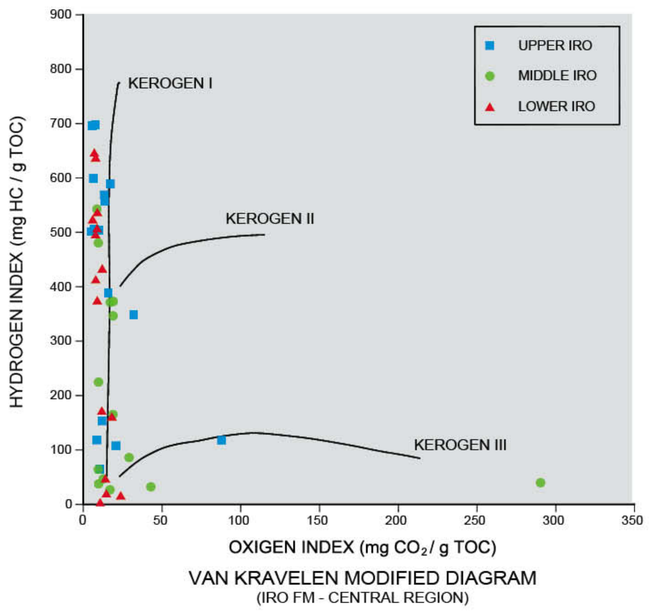
Organic Matter Type



Modified from Cristancho, J., ANH, 2005

From Mero, et al.;2005

Summary
Hydrocarbon Elements

The Pacific Project will be carried out in western Colombia and will cover a combined area of over 103.130 square kilometers. Up to date fourteen wells have been drilled in the basin, a much lower density than in other basins of Colombia. Surface indications for oil and gas have been reported in numerous locations. Subsurface shows of oil and gas were encountered in the Buchado-1, Chagui-1 and Majagua-1 wells.

Source: All the hydrocarbon (shows) found in the Pacific Basin are believed to have been generated primarily within the Iró Formation, on the basis of geochemical analyses.
The total organic carbon (TOC) content of the Iró Formation ranks from very good to excellent. Three condensed sections (CS) were analyzed. SC1 consists of phosphatic shale with a thickness of 150 feet and TOC content between 4.3 and 24 percent. SC2 consists of highly-organic phosphatic shale with a thickness of 110 feet and TOC content between 2 and 14.6 percent, kerogen type II and hydrogen index of 340 to 540 (mg HC/gr. rock). CS3 consist of highly bituminous shale with a thickness of 190 feet and TOC content between 1.5 and 11.0 percent, kerogen type II and I. Hydrogen index of 161 to 523 mg HC/gr. rock). Excellent oil prone. The average T.O.C. of the shale and chert of the Iró Formation is over 3 percent.

Reservoir: Carbonates and siliciclastics of the Iró and La Mojarra formations (Middle Miocene) are the main potential reservoir rocks. As an analog, naturally fractured chert facies abundant in the basin, could be a very important reservoir as it happens in the Point Arguello oil field of Southern California.

Trap: Several basement structural highs, mud-diapir core anticlines, diapir flanks, thrust anticlines, normal fault rollover, stratigraphic geometries, and highly fractured carbonates and cherts along fault zones, are all potential traps.

Seal: Seal units occur throughout the sedimentary column, represented by clay units. These sections are homogeneous, laterally continuous, with excellent ductile properties. The Sierra Formation (Oligocene) and Istmina Formation (Lower Miocene) are regional seals.

Generation and Migration: Any generated oil must have migrated laterally up dip to the flanks of the structure. Lateral migration distances are likely based on a relationship of geochemistry stratigraphy and structural data. Vertical migration pathways are associated to fault systems. Critical moments occur after deposition of sealing units about 5 Ma? ago and migration continues up to date.

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