

Middle Magdalena Valley MMV BASIN



One Giant
and Three
Major oil
fields

Colombia
2005
2006

Location and Basin evolution

The Middle Magdalena Basin, located along the central portion of the Magdalena River valley between the Central and Eastern Cordilleras of the Colombian Andes, covers an area of 32,000 km².

The exploratory process has been oriented mainly towards the identification of structural traps in the Tertiary sequences. Stratigraphic subtle traps have not adequately been studied yet. The sedimentary record shows a succession of Jurassic continental deposits overlaid by Cretaceous sediments, both calcareous and siliciclastics, of transitional to marine origin. The Tertiary sequence is made up of siliciclastic rocks deposited mainly under continental conditions: alluvial fans and fluvial bodies with some marine influence. Three major deformational phases are present in the basin: rifting, thrusting and wrenching, responsible for all type of trap geometries.

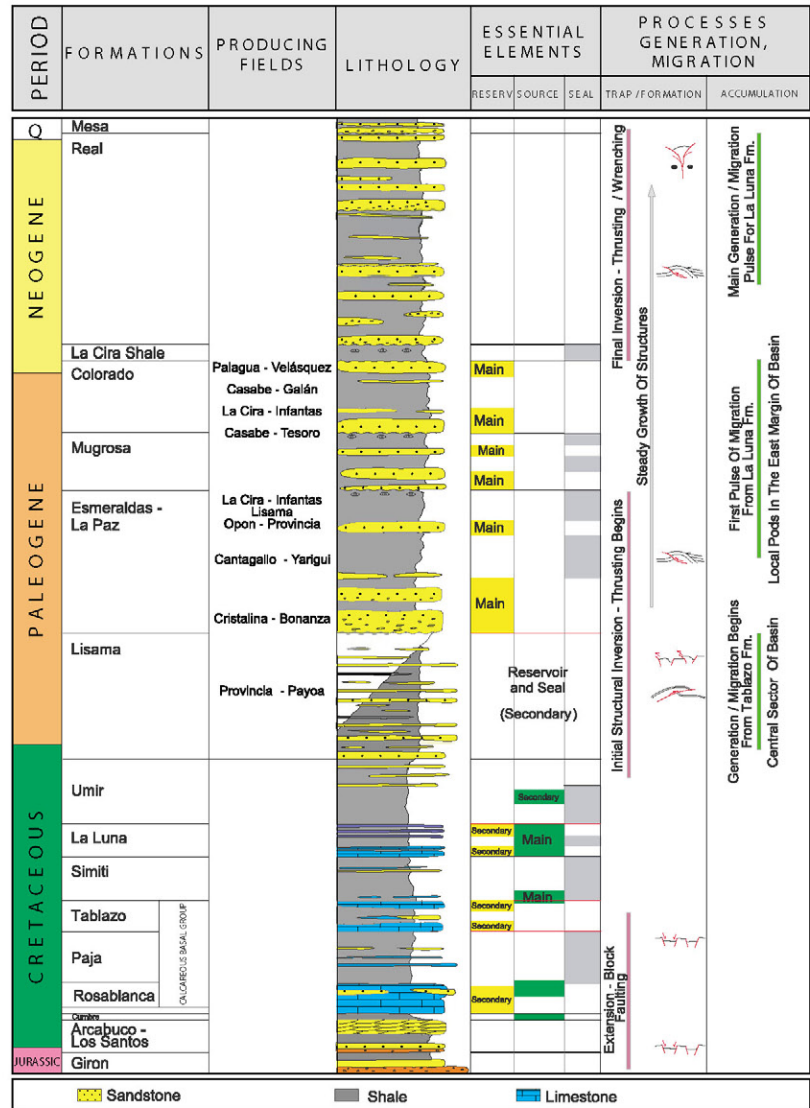
Hydrocarbon System

Hydrocarbon Evidence: A century of exploration history in the basin has led to the discovery of about 2,000 MBO, 2.5 TCFG and a total of 41 fields, including the first giant in Colombia, La Cira-Infantas.

Reservoirs: 97% of the proven oil in the basin, comes from continental Tertiary sandstones (Paleocene-Miocene): Lisama, Esmeraldas-La Paz and Colorado-Mugrosa formations, with average porosities 15-20%, and average permeabilities 20-600 md.

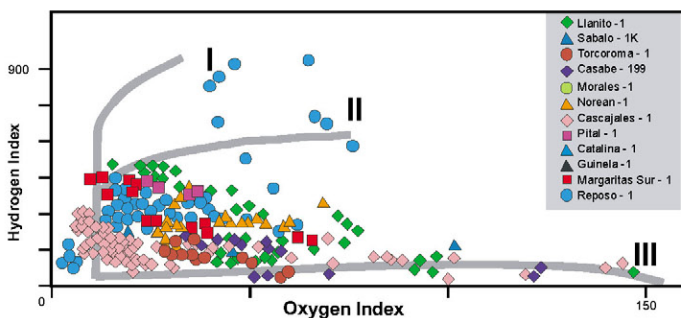
Lightly explored reservoirs are fractured systems of the Cretaceous limestones: Basal Limestone Group and La Luna formations.

Petroleum System Chart

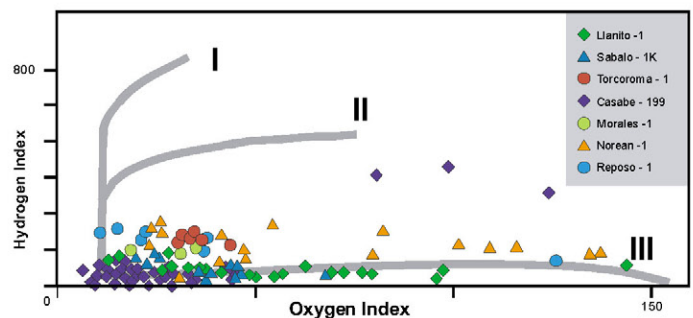


Modified from Barrero and Sanchez, 2003

Hydrocarbon System



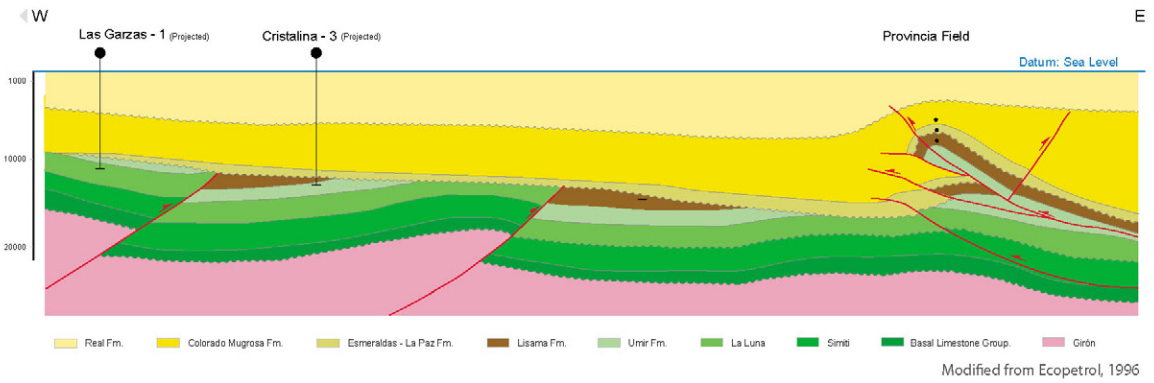
Van Krevelen Modified Diagram
La Luna Formation Rock Samples, MMV Basin, Colombia



Van Krevelen Modified Diagram
Calcareous Basal Group Rock Samples, MMV Basin, Colombia

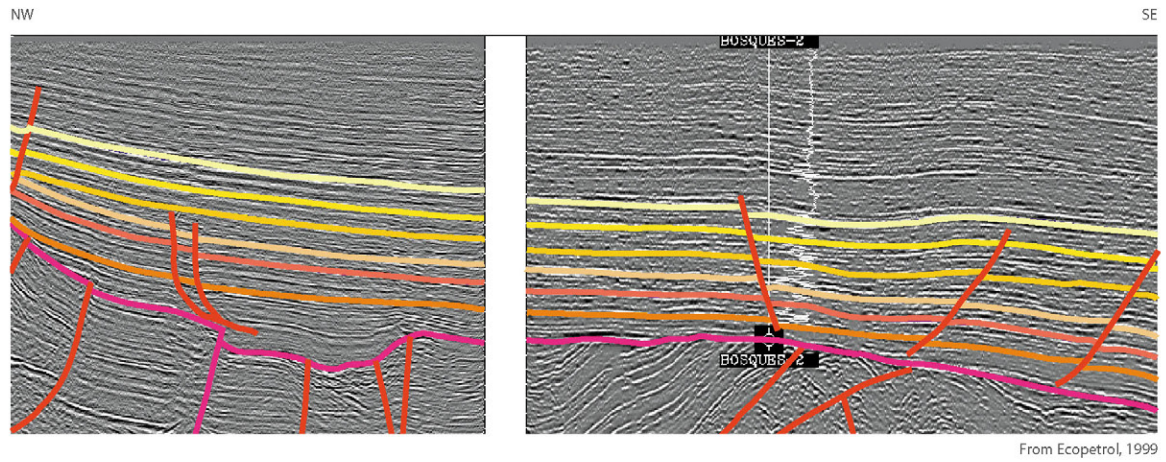
Underexplored Tertiary Plays

Geoseismic Profile

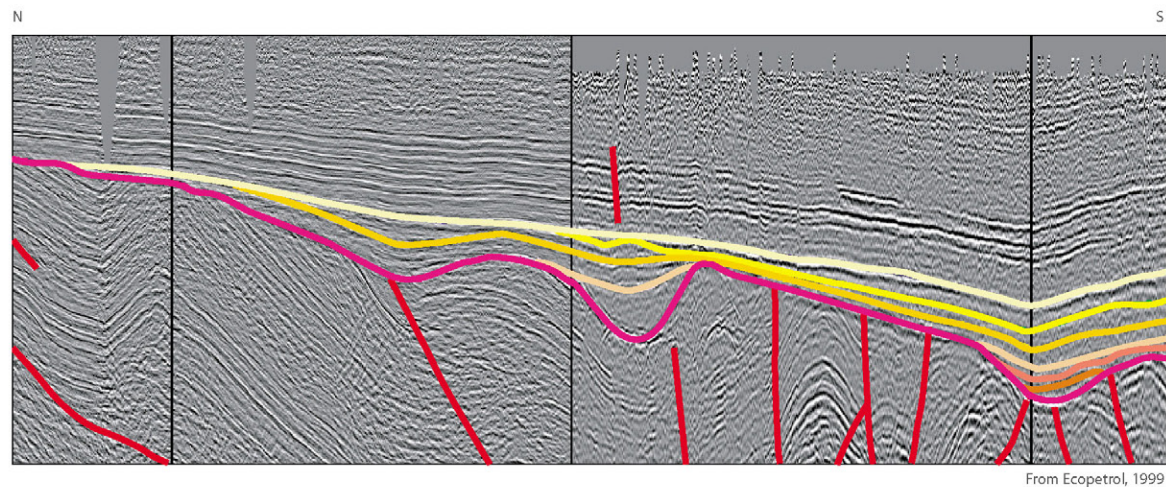


Seismic expression of Stratigraphic Traps

Line 1. Paleocene Incised Valley Sandstone Neogene Onlap PATURIA AREA

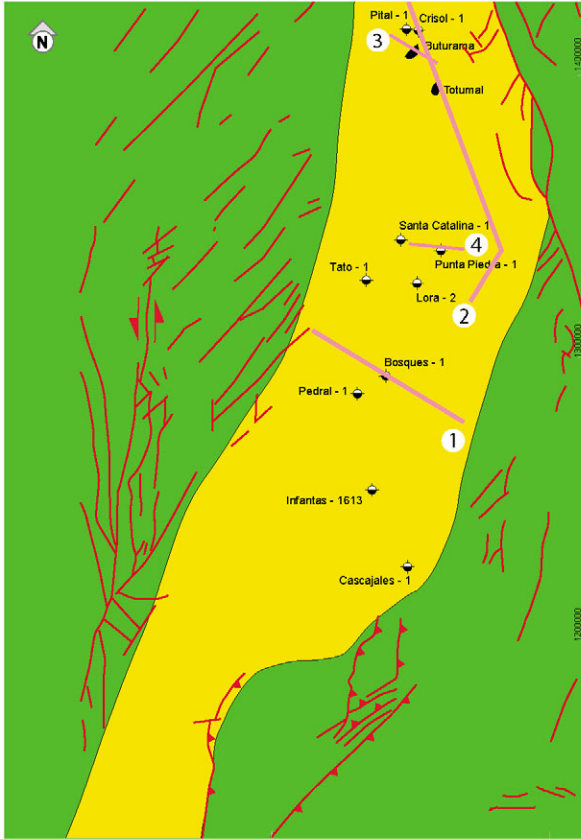


Line 2. Paleogene Onlap and Truncation NORTH AREA OF BASIN



Underexplored Cretaceous Plays

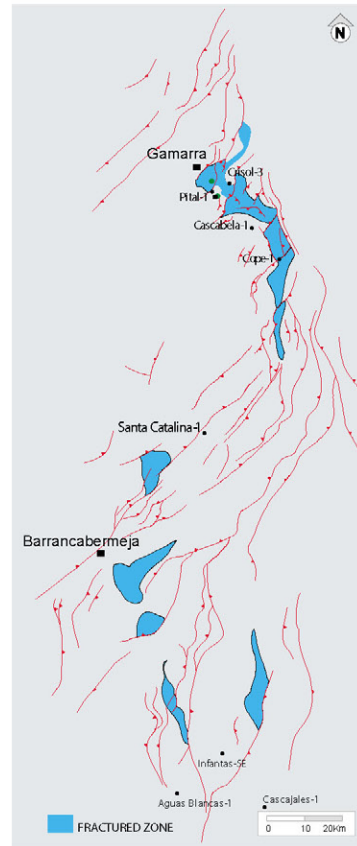
Cretaceous Oil Shows



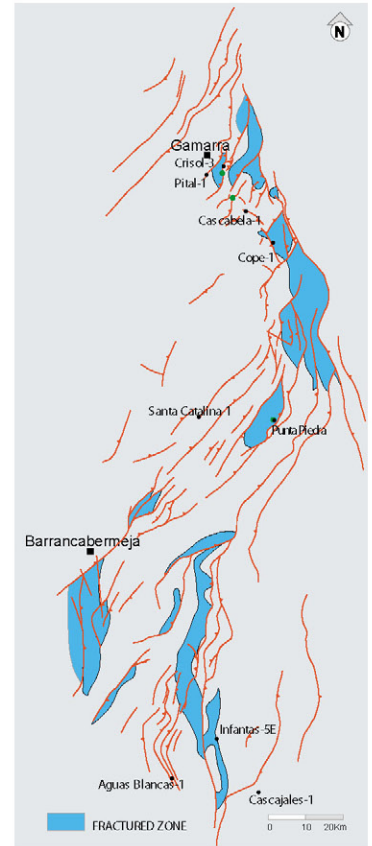
From Ecopetrol, 1998

Reservoir Distribution

LA LUNA PLAY



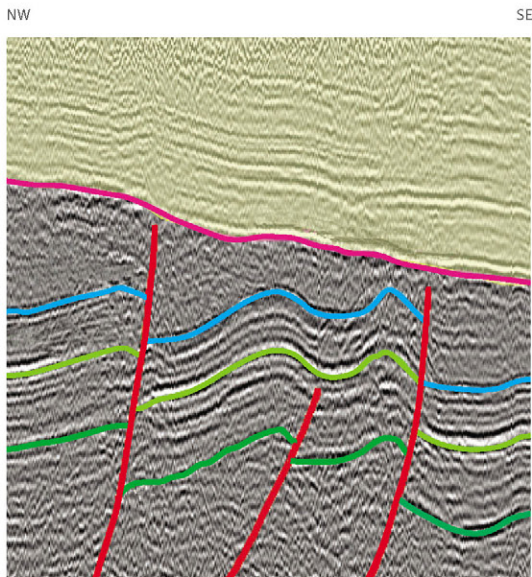
ROSABLANCA PLAY



From Ecopetrol, 1998

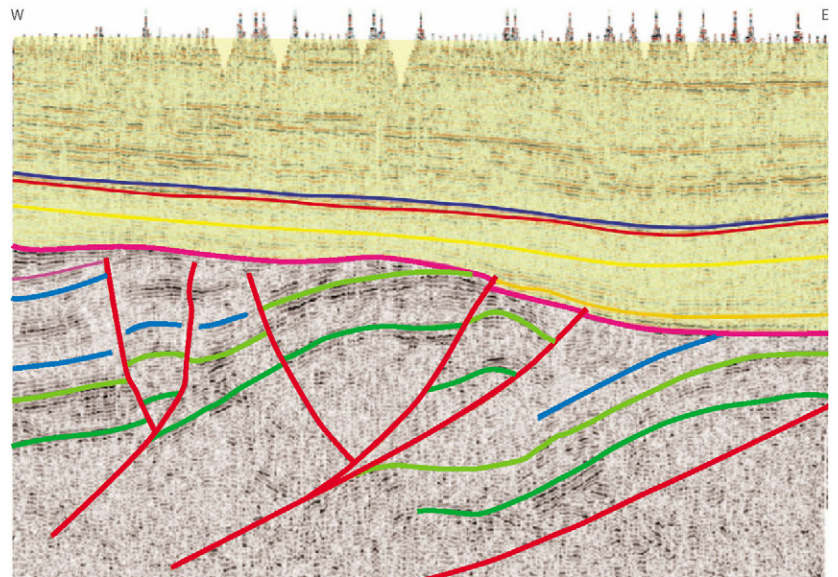
Seismic expression of Structural Traps

Line 3. Reactivated Normal Fault
BUTURAMA AREA



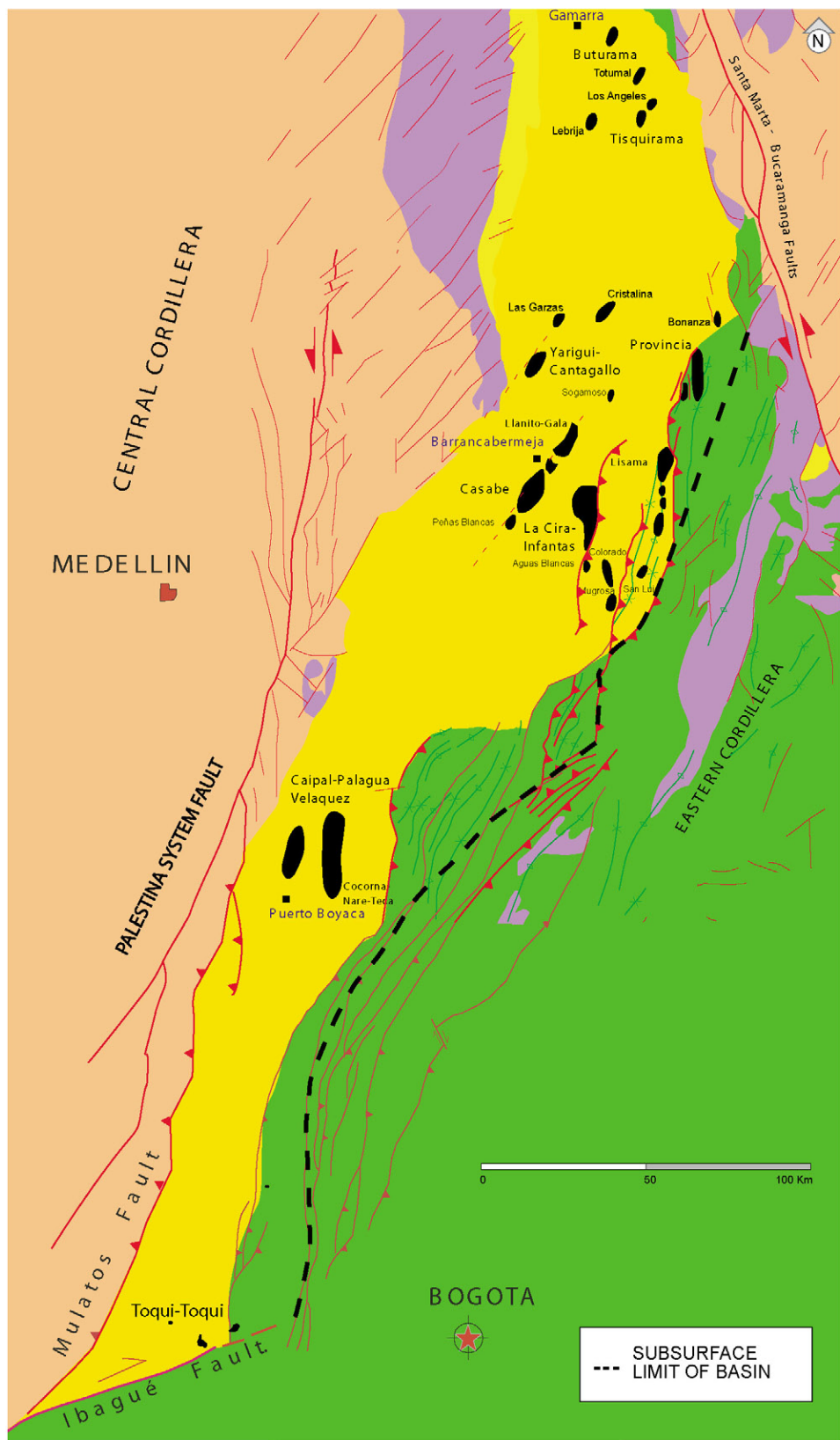
From Ecopetrol, 1998

Line 4. Cretaceous thrust anticline
PUNTAPIEDRA AREA



From Ecopetrol, 1998

Oil Fields and Shows



Modified from Gutierrez, M. and Nur, A., 2001

■ **Traps:** Exploration has been directed to prospecting accumulation in structures forming major asymmetric anticlines. Closure against faults is the trapping mechanism for Tertiary objectives.

■ **Sources:** Cretaceous limestones and shales from La Luna formation and the Calcareous Basal Group are the main source rocks in the basin. TOC values are high (1-6%) and organic matter is essentially type II. Ro reach values of 1.1-1.2% in some areas.

■ **Seals:** The seals for Tertiary sandstone reservoirs consists of interbedded nonmarine ductile claystones, mainly from the Esmeraldas and Colorado formations. The seals for potential Cretaceous limestone reservoirs are marine shales of the Simiti and Umir formations.

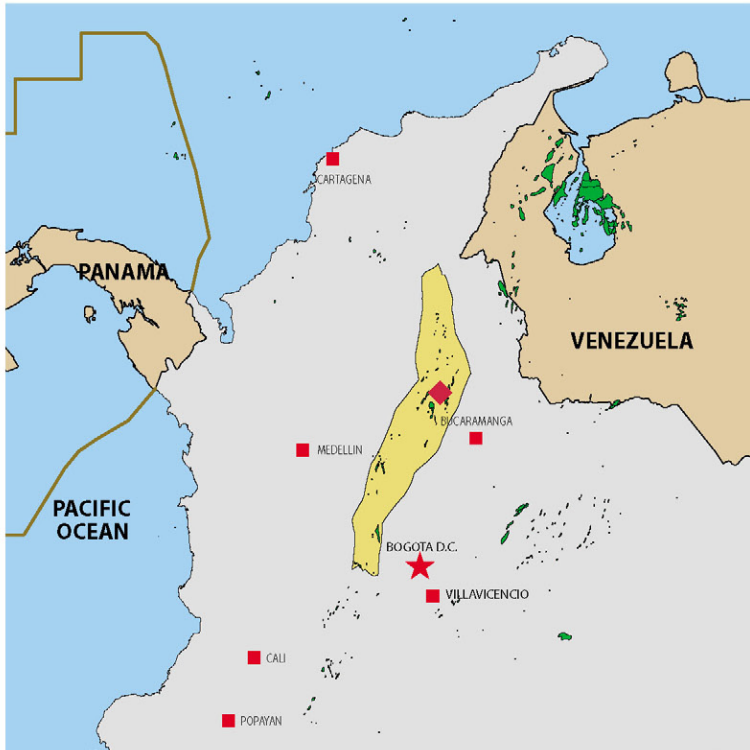
■ **Migration and Timing:** The Eocene unconformity separates the primary reservoir rocks in an angular discordance from the underlying active source rocks, forming a plumbing system for the migration of petroleum. Major migration pathways consist of: **1)** Direct vertical migration where La Luna subcrops the Eocene unconformity; **2)** Lateral migration along the Eocene sandstone carrier; **3)** Vertical migration via faults in areas where the La Luna does not subcrop the Eocene unconformity. Critical moment occurs during the Upper Neogene, about 5 my, and continues, locally today.

Prospectivity

The Middle Magdalena Basin, believed to be the most explored basin of Colombia, where 41 oil fields have been discovered on Tertiary deposits, is still one of the most prolific areas: the Cretaceous carbonate plays, are yet to be explored.

Potential exploration areas are mainly related to inverted normal faults and subthrust anticlines. Stratigraphic subtle traps associated with Miocene-Upper Eocene onlaps, incised channels and truncations are also major objectives for future exploration.

Basin Location



Infrastructure



HIGHLIGHTS

◆ ANH Projects **Heavy Oil Project**

Area **32,000 km²**
7,900,000 acres

Oil Field Discoveries **41**

Exploratory Wells **296**

Discovered Oil Reserves **1,900 MBO**

Discovered Gas Reserves **2.5 GCF**

Coverage **One exploratory Well/106 km²**

Produced by
Geoconsult Ltda

Manager: Nelson Álvarez

Technical Director: Darío Barreiro

Geologists: Yolanda Aguilar, Alfonso Robledo, Camilo Hernández,
Juan Fernando Martínez, Oliverio Rojas, Edwin Valencia
and Mercedes Álvarez

Petroleum Engineer: Yolanda Ojeda

Design
Mantis Estudio

Cover Picture
Ecopetrol S.A.



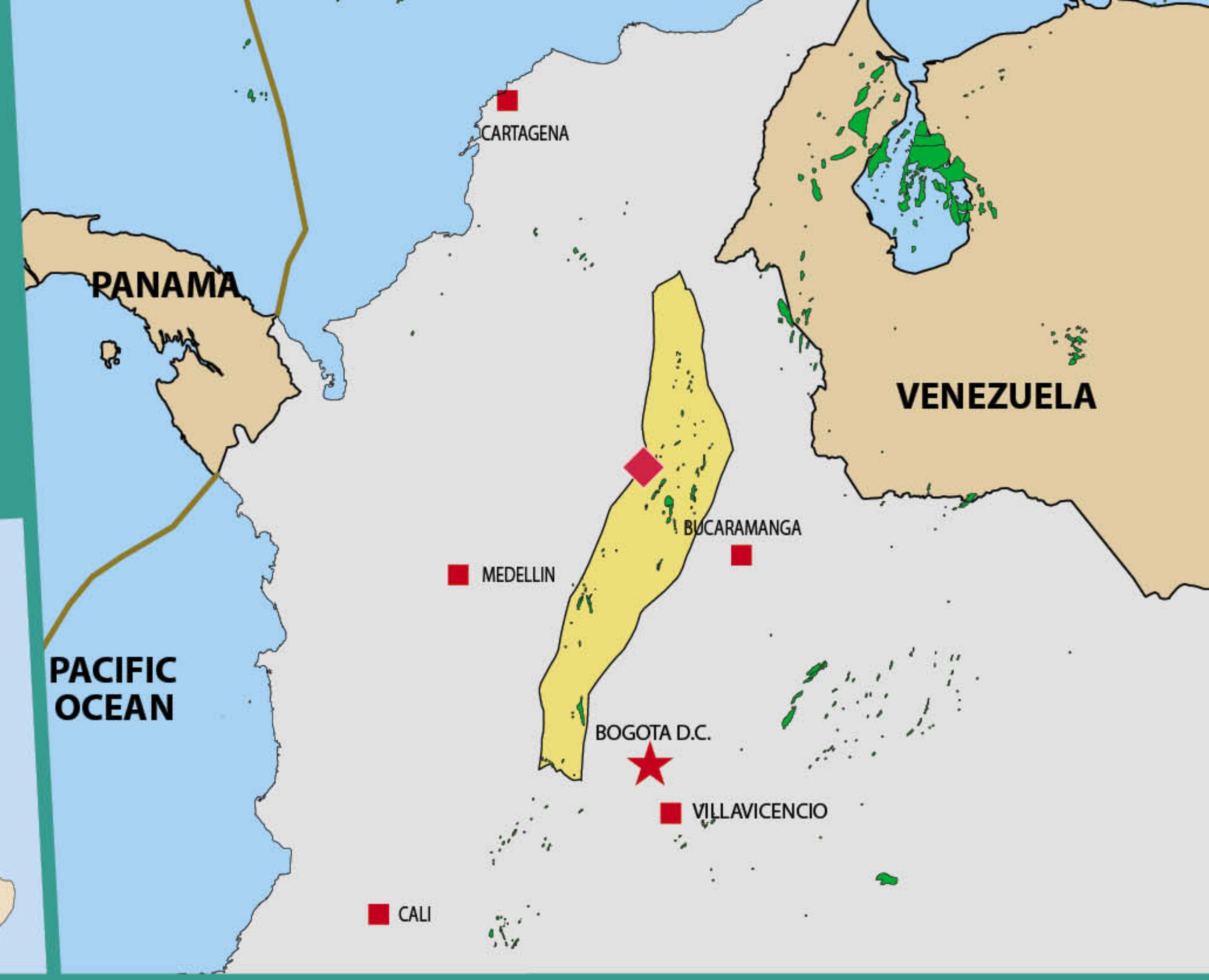
Agencia Nacional de Hidrocarburos
República de Colombia

Contact Information

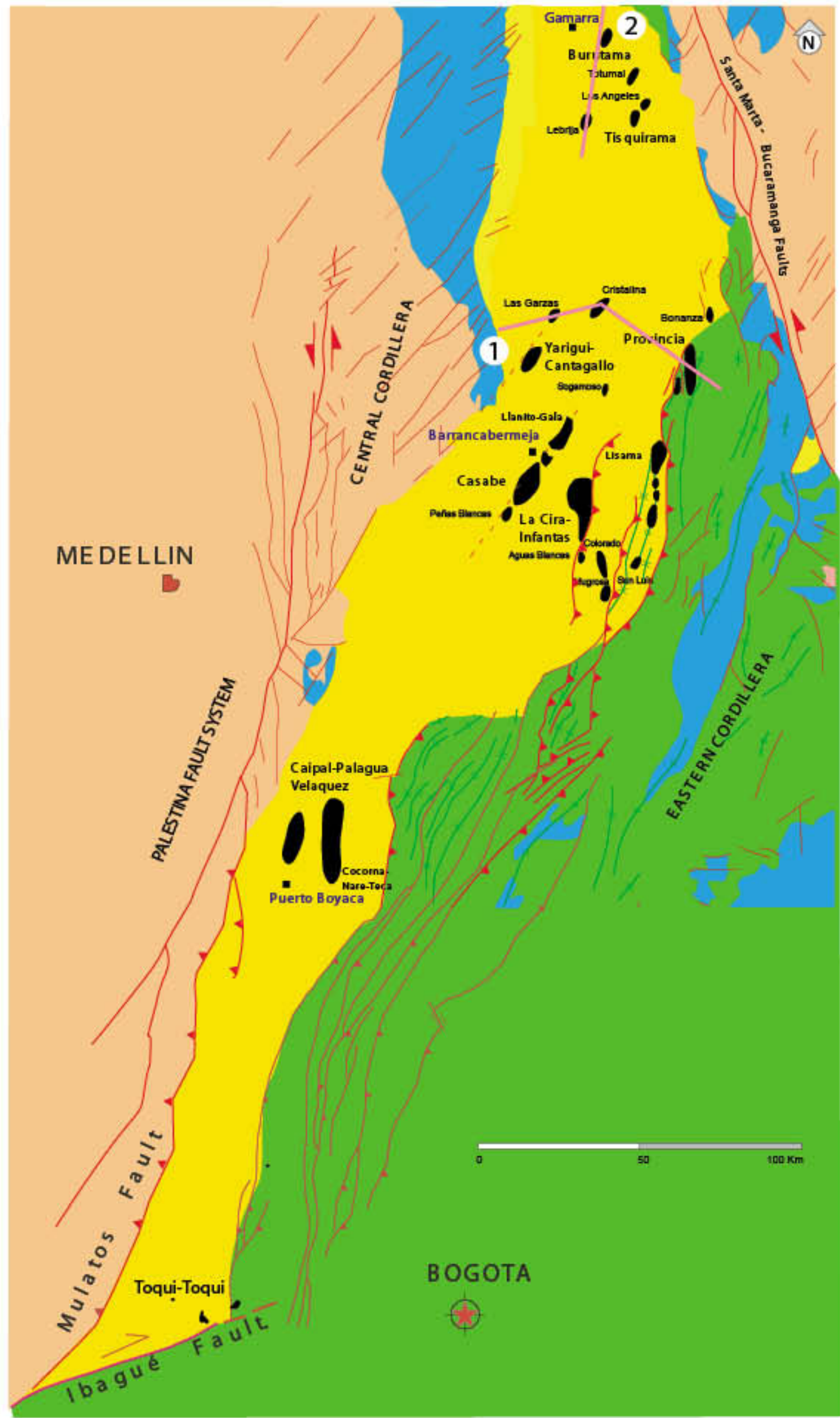
www.anh.gov.co | info@anh.gov.co | PBX: (571) 593 1717 | Fax: (571) 234 5712 | Calle 37 No. 7-43 piso 5 | Bogotá, Colombia, South América

Middle Magdalena Valley Basin MMV Basin Broken Foreland

One Giant and Three Major oil fields



Oil Fields and Shows



Modified from Gutierrez and Nur, 2001

Crude Oil Families



From Mora, C., 2000

Highlights

◆ ANH Projects | **Heavy Oil Project**

Area | **32,000 km²**
7,900,000 acres

Oil Field Discoveries | **41**

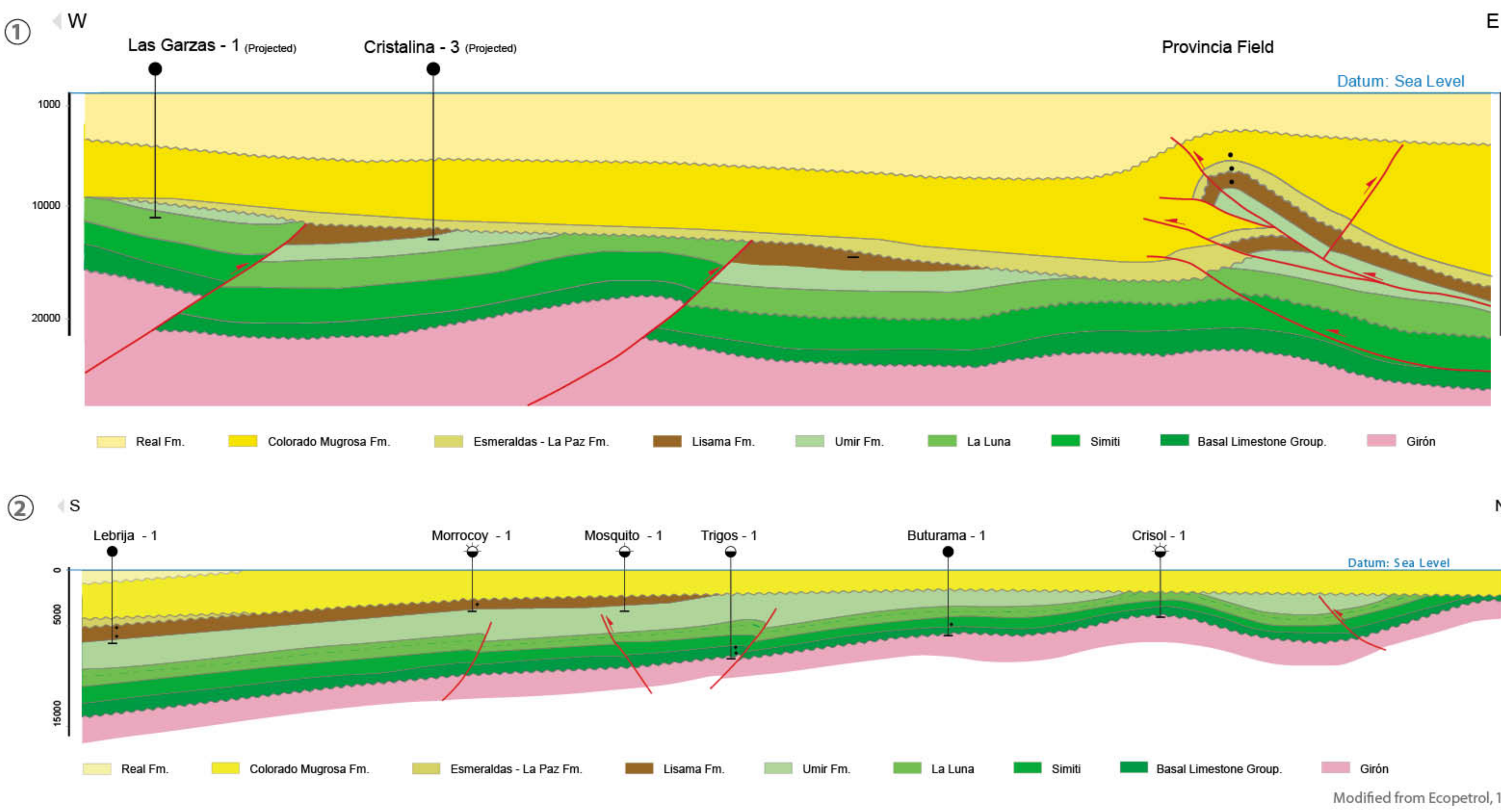
Exploratory Wells | **296**

Discovered Oil Reserves | **1,900 MBO**

Discovered Gas Reserves | **2.5 GCF**

Coverage | **One exploratory Well/106 km²**

Geoseismic Profile



Modified from Ecopetrol, 1996

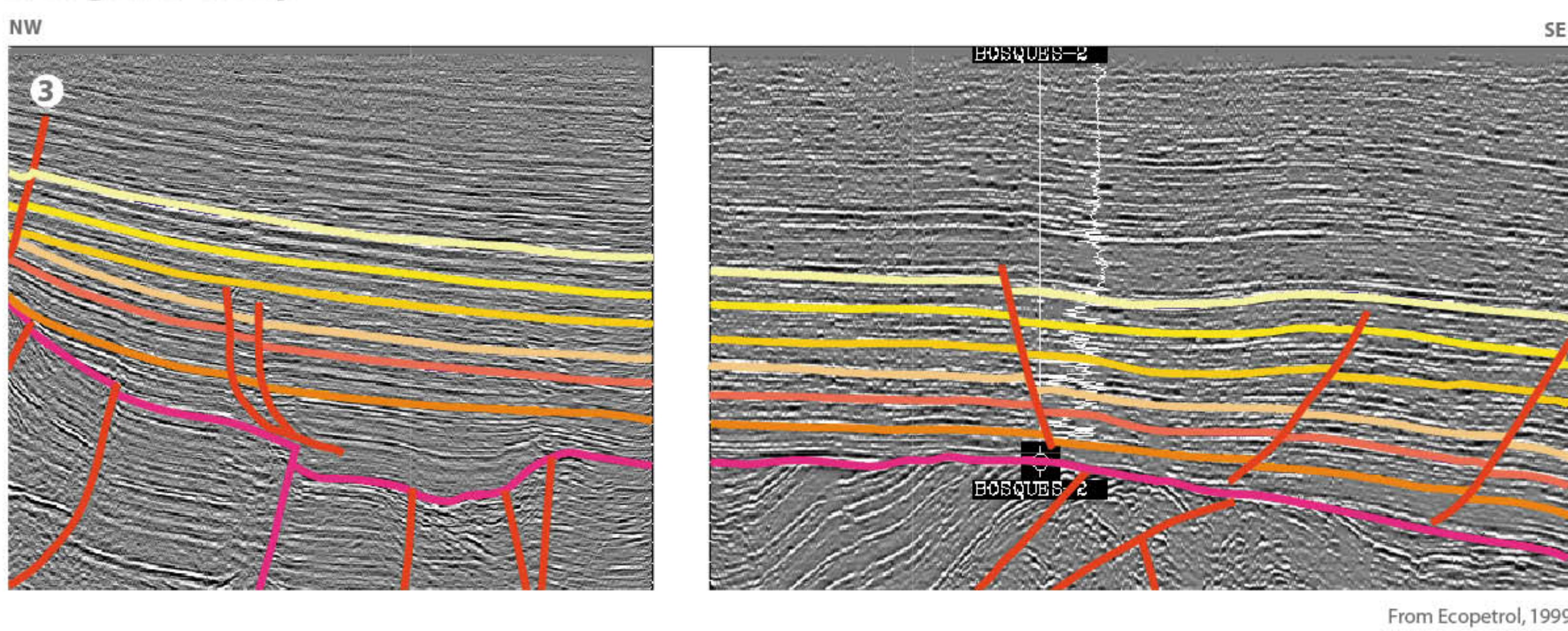
Petroleum System Chart

PERIOD	FORMATIONS	PRODUCING FIELDS	LITHOLOGY	ESSENTIAL ELEMENTS		PROCESSES GENERATION, MIGRATION
				RESERVOIR	SEAL	
NEOGENE	Mesa					Final Accretion - Thrusting / Wrenching Shallow Growth Of Structures Main Generation / Migration From La Luna Fm. Local Pools In The East Margin Of Basin
	Real					
	La Cira Shale Colorado	Paraguá - Viquez Casabe - Cattan La Cira - Infantas Casabe - Tesoro				
PALEOGENE	Mugrosa					Shallow Growth Of Structures Final Accretion - Thrusting / Wrenching Main Generation / Migration From La Luna Fm. Local Pools In The East Margin Of Basin
	Esmeraldas - La Paz	La Cira - Infantas Llaneta Opón - Provincia Cartagallo - Varigu				
	Lisama	Cristalina - Bonanos Provincia - Payaya				
CRETACEOUS	Umír					Reservoir and Seal (Secondary) Local Structural Inversion - Thrusting / Wrenching Generation / Migration From La Luna Fm. Local Pools In The East Margin Of Basin
	La Luna					
	Similiti					
	Tablazo					
	Paja					
ROSEABLANCA	Rosablanca					
ARCAIC	Arcaicuipo - Los Sarrinos					
BASEMENT	Girón					

Modified from Barrero, D. and Sánchez, A. 2003

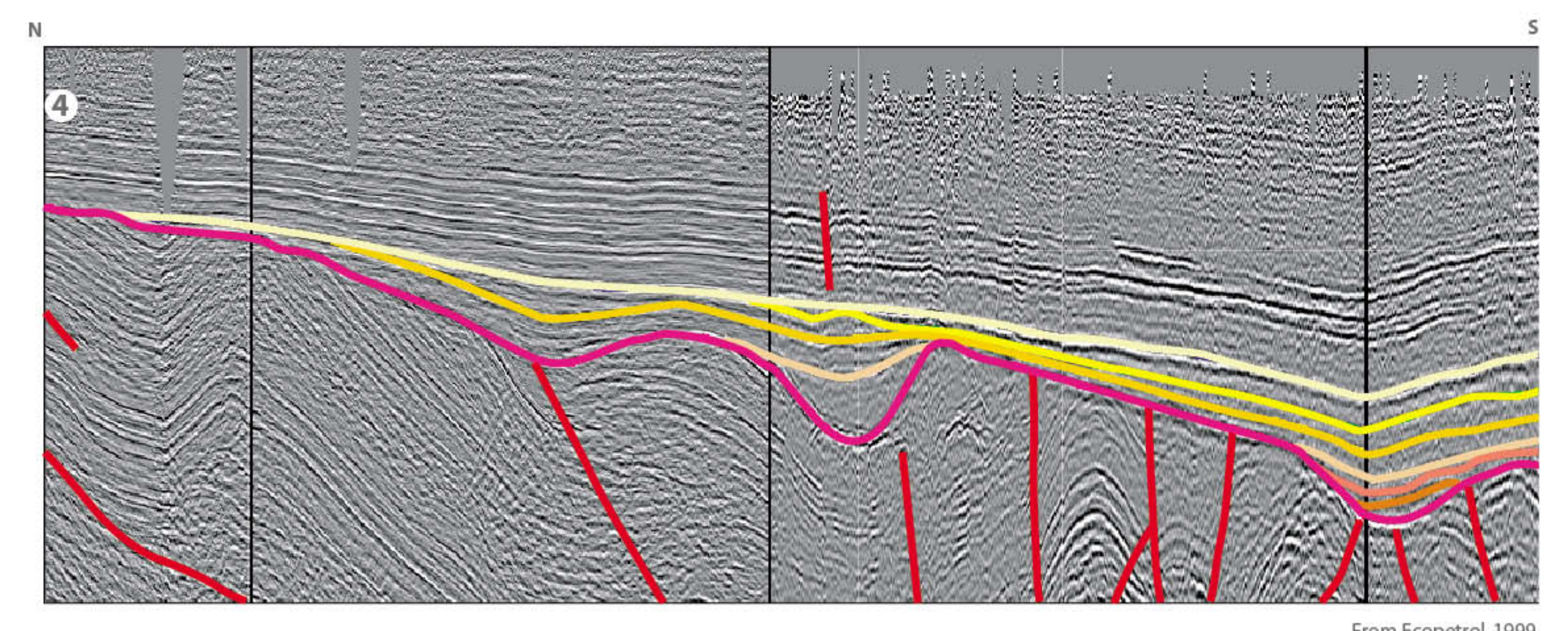
Underexplored Tertiary Plays

Paleocene Incised Valley Sandstone Neogene Onlap



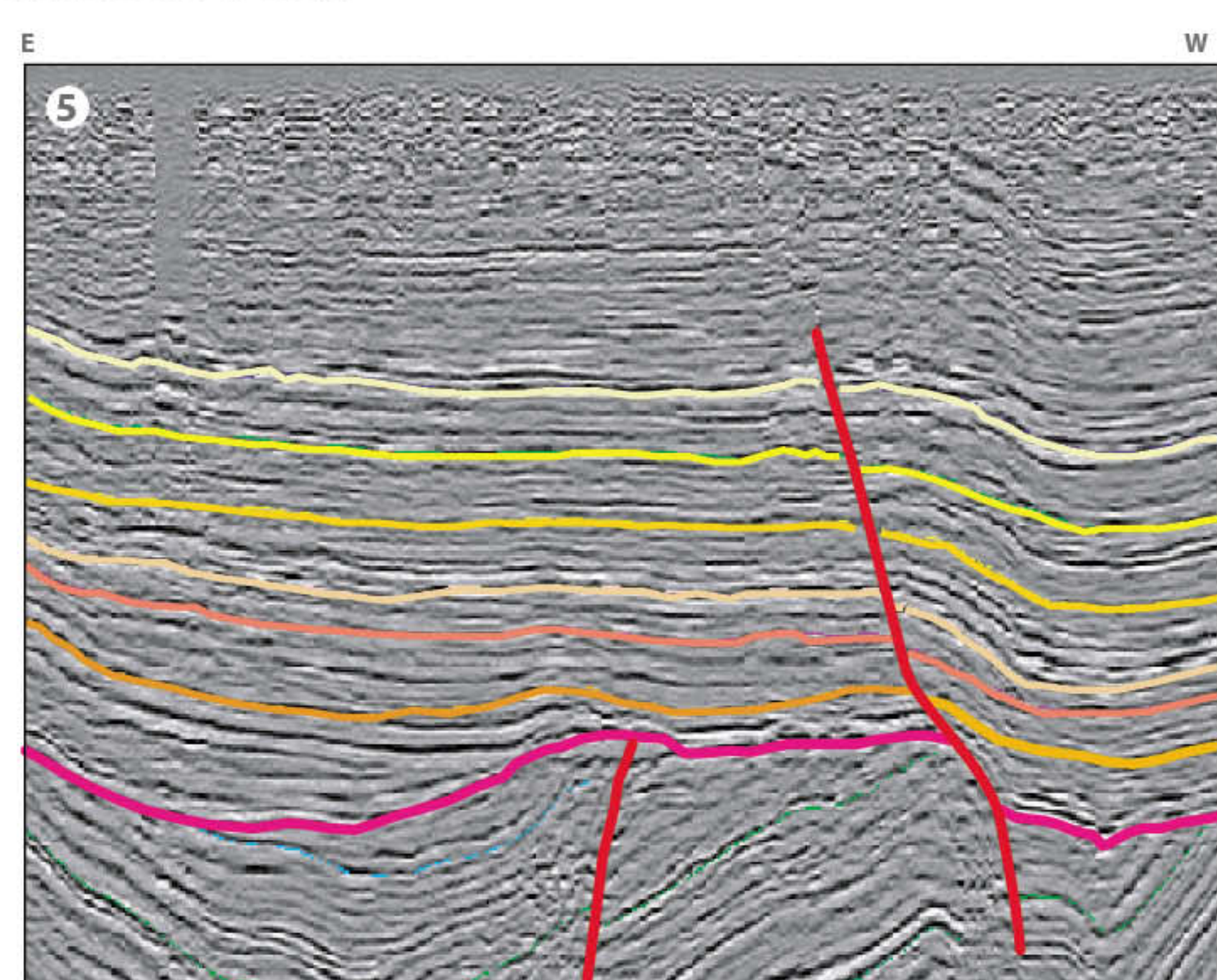
From Ecopetrol, 1999

Paleogene Onlap and Truncation NORTH AREA OF BASIN



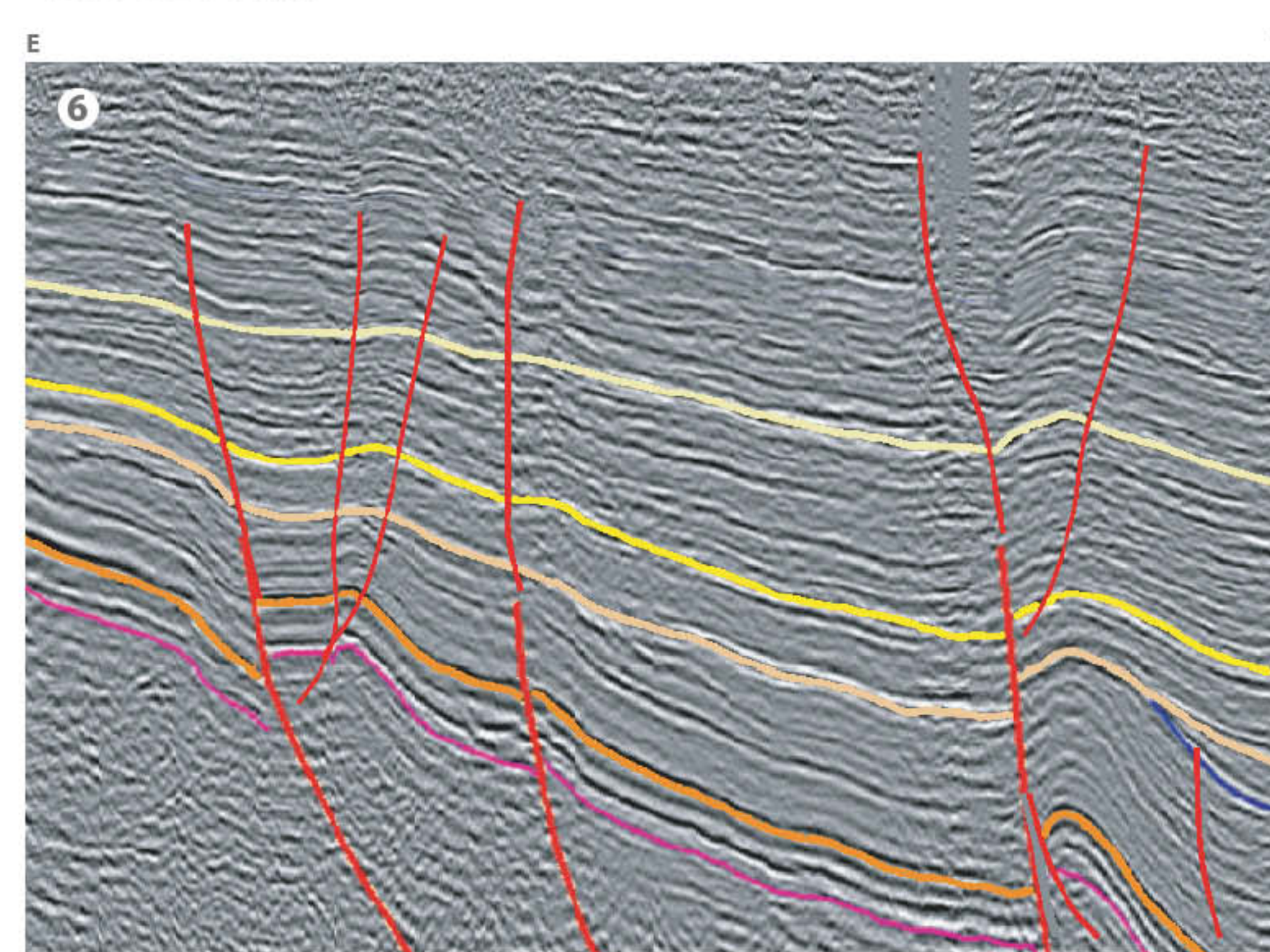
From Ecopetrol, 1999

Multiple Plays: Onlap, Inverted Normal Fault, Channels. ARENOSA AREA



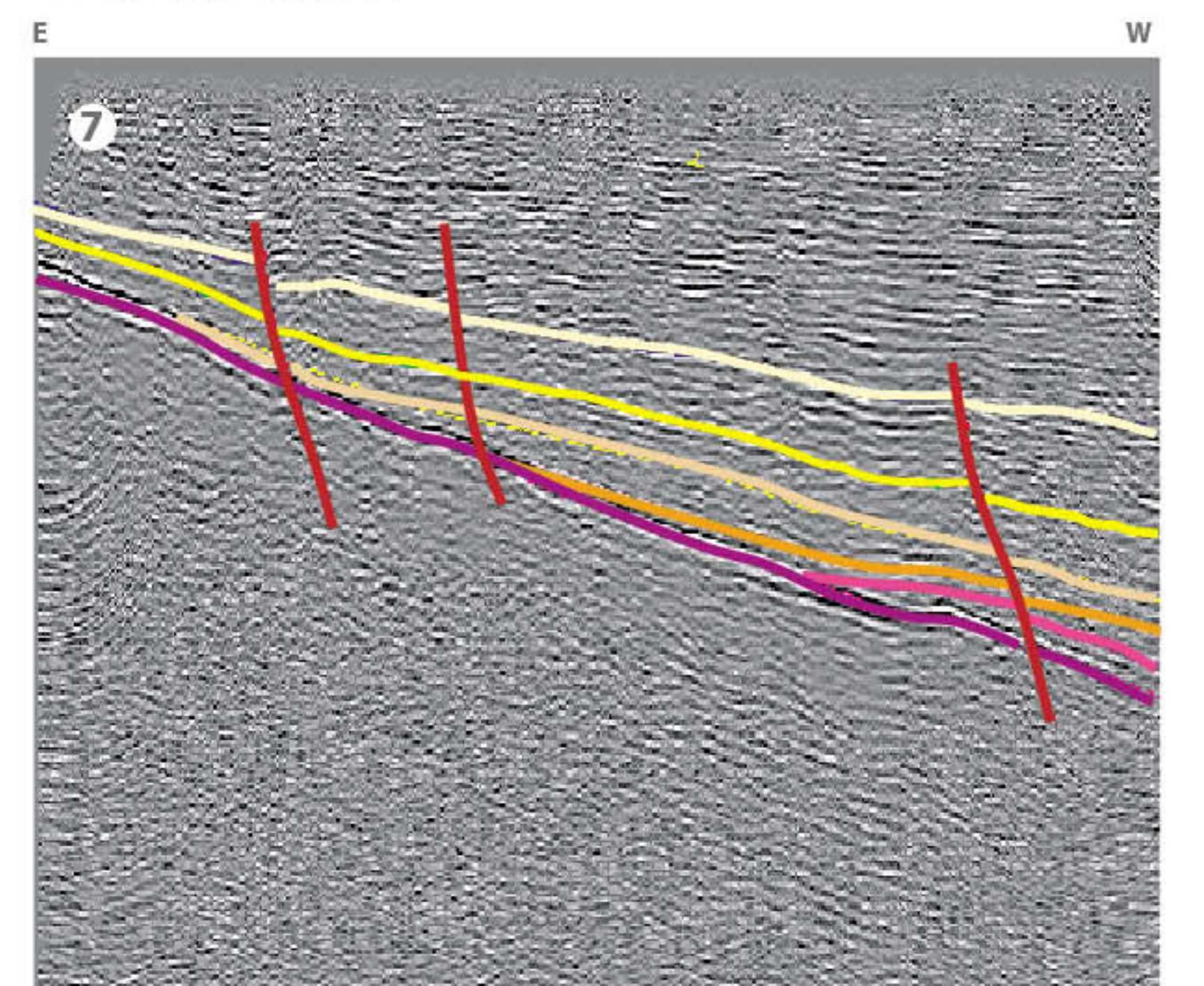
Modified from Ecopetrol, 1999

Wrench Anticline Play CASABE AREA



Modified from Ecopetrol, 1999

Eocene / Miocene Onlap Play CENTRAL AREA



From Ecopetrol, 1999



Agencia Nacional de Hidrocarburos
República de Colombia

Libertad y Orden

Colombia
2005

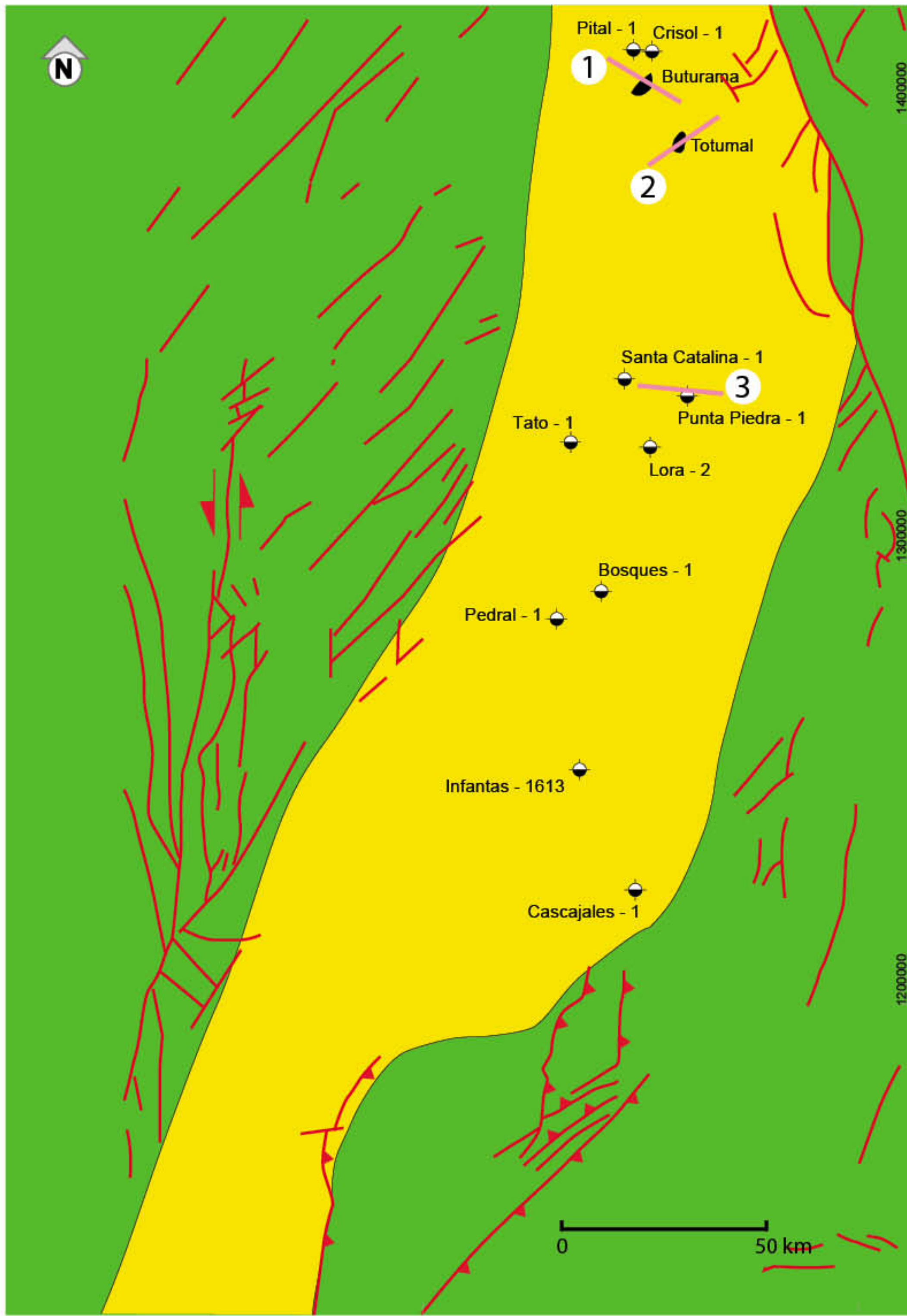
Middle Magdalena Valley Basin MMV Basin

Underexplored Cretaceous plays

Cretaceous Coverage: One exploratory Well/1,890 Km²

Cretaceous Oil Fields and Shows

Production

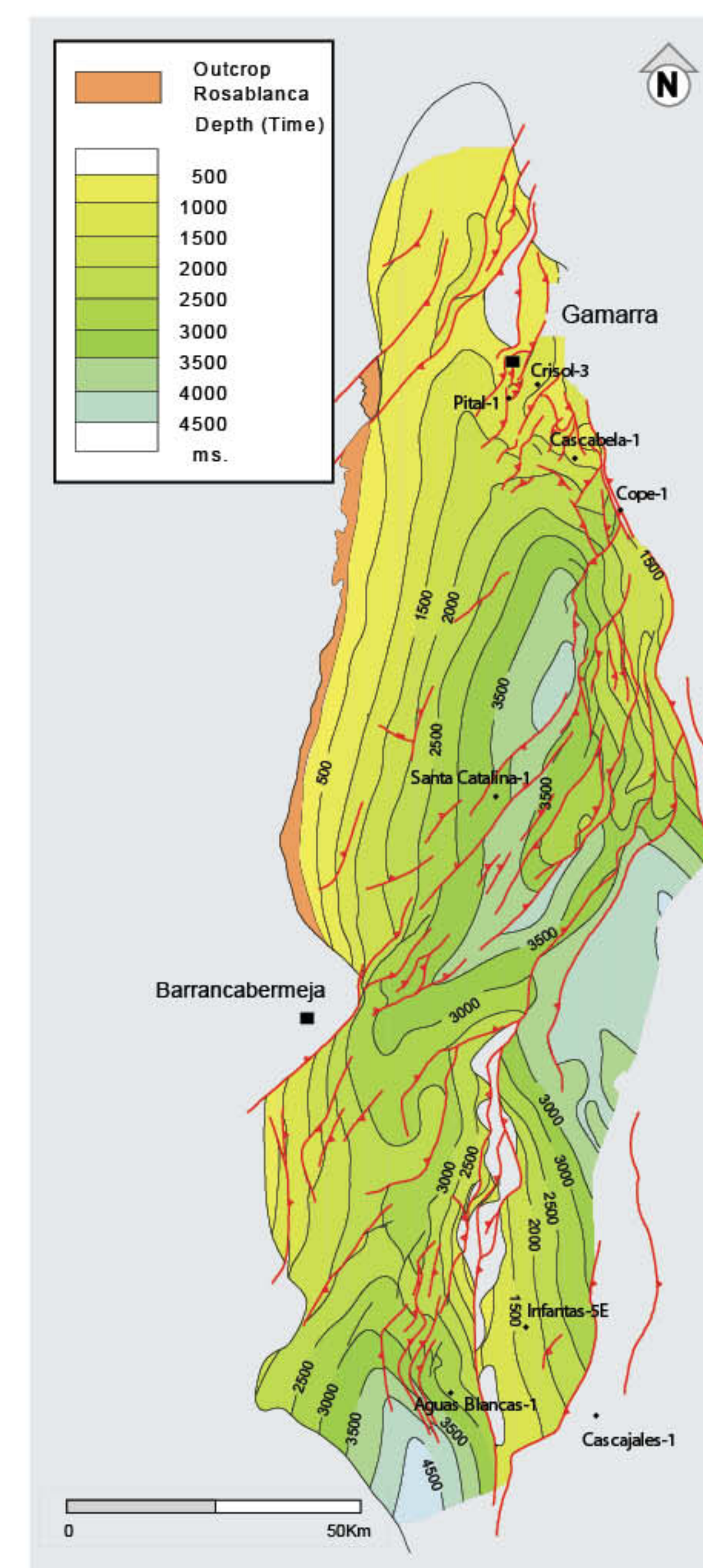


Modified from Ecopetrol, 1998

WELL/FIELD	YEAR	PRODUCTION	API	RESERVOIR
TOTUMAL-1	1951	50 OBD	25	LA LUNA
BUTURAMA-1	1952	150 OBD	36	GCB
CANTAGALLO-14	1953	150 OBD	22	LA LUNA
INFANTAS-1613	1954	20 OBD	44	SIMITI
BOSQUES-1	1955	2 OBD	40-45	GCB
LAS GARZAS-1	1957	SHOWS	*	LA LUNA
PUNTAPIEDRA-2	1979	110 OBD	18-20	TABLAZO
LAS LAJAS-1	1990	5.3 OBD	20	LA LUNA

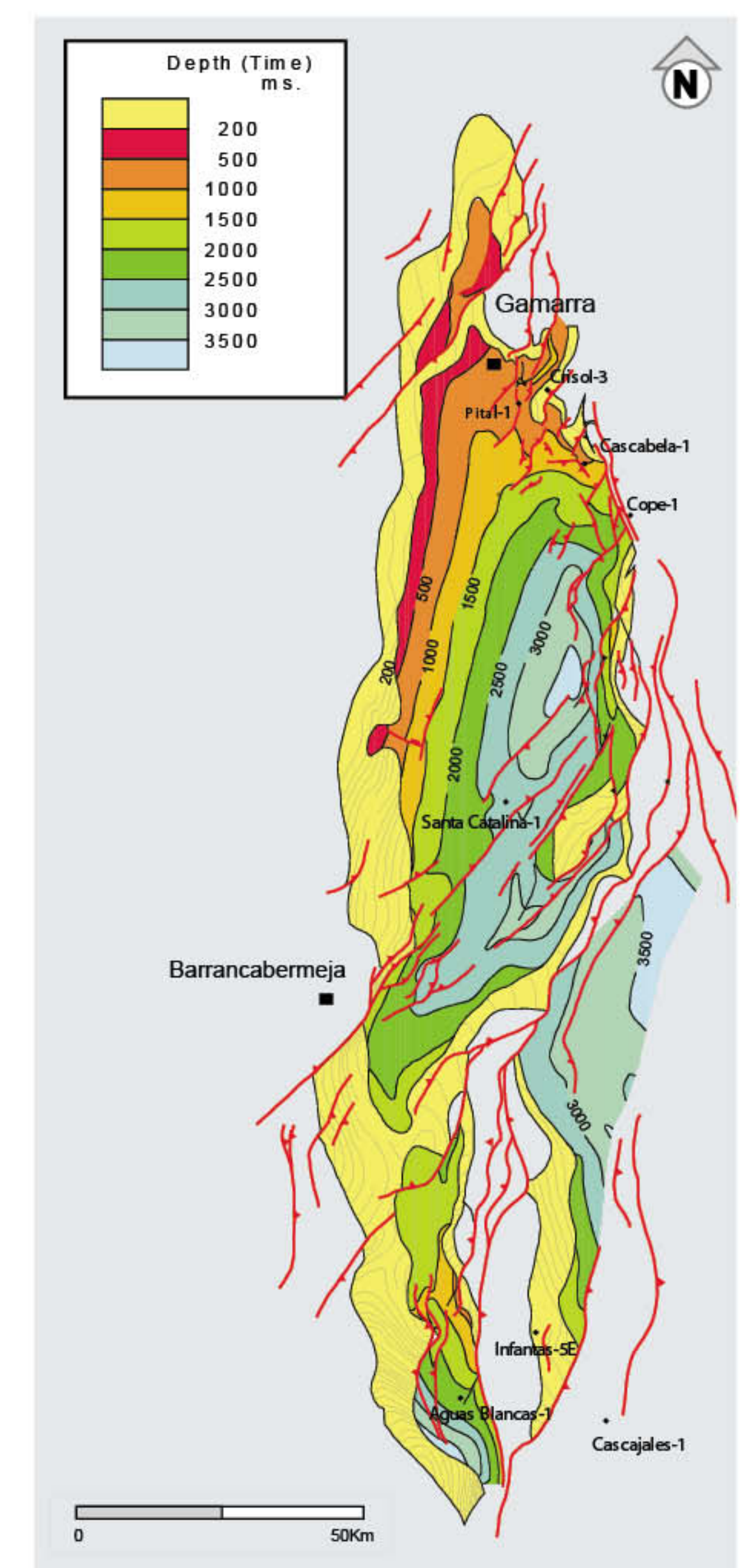
Structural Maps

ROSA BLANCA FRACTURE PLAY



From Ecopetrol, 1998

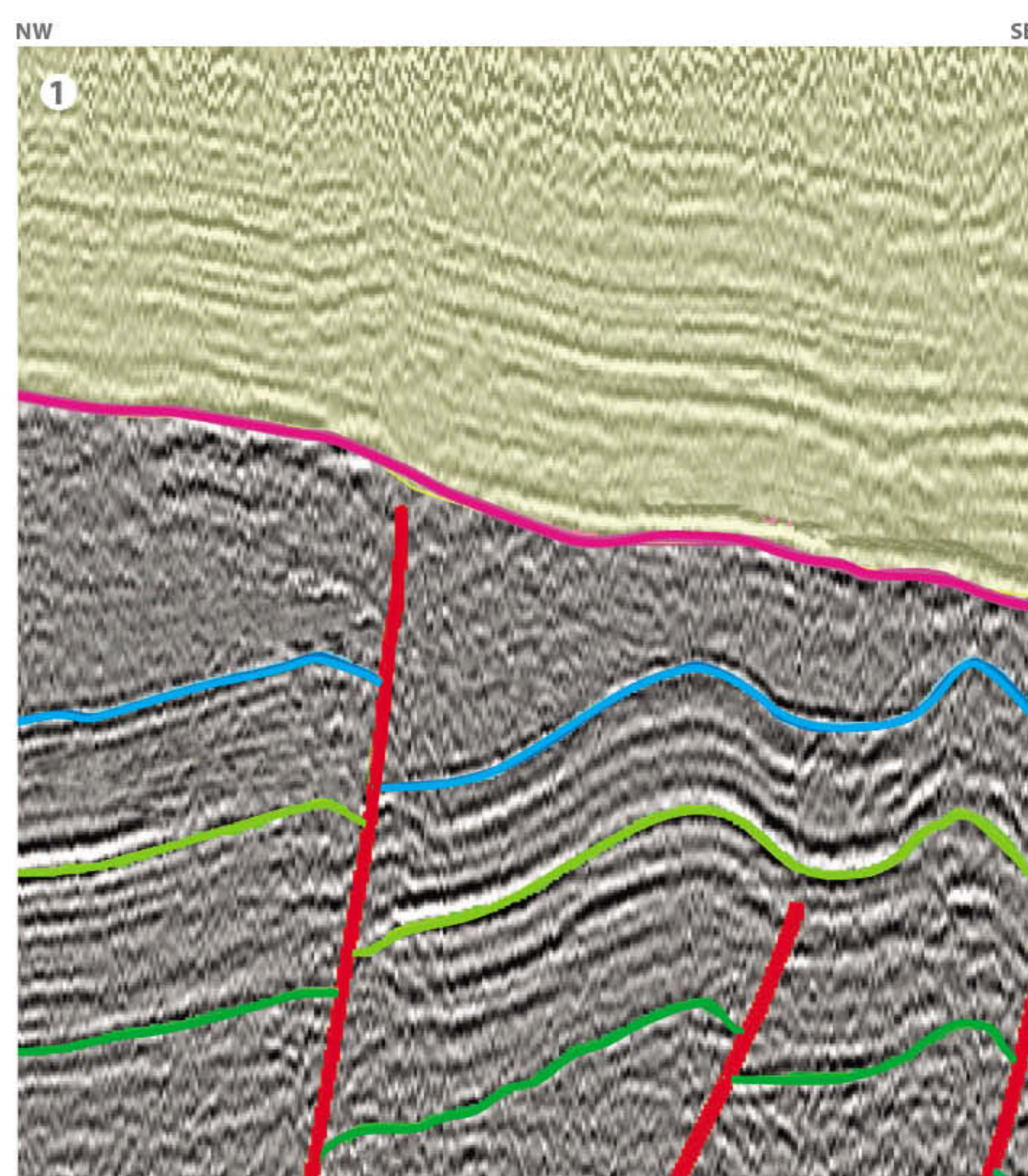
LA LUNA FRACTURE PLAY



From Ecopetrol, 1998

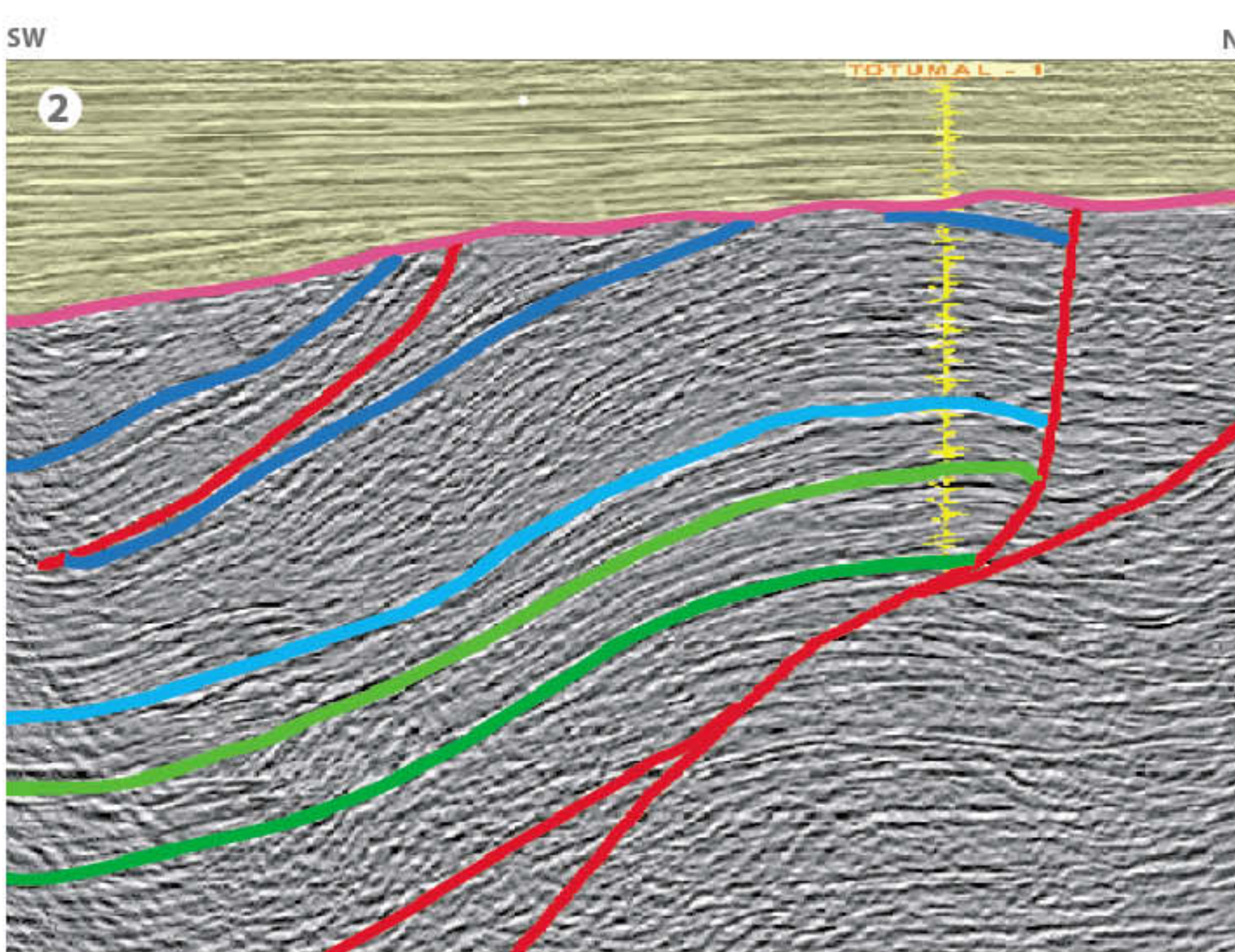
Underexplored Play Types

Reactivated Normal Fault Play
BUTURAMA AREA



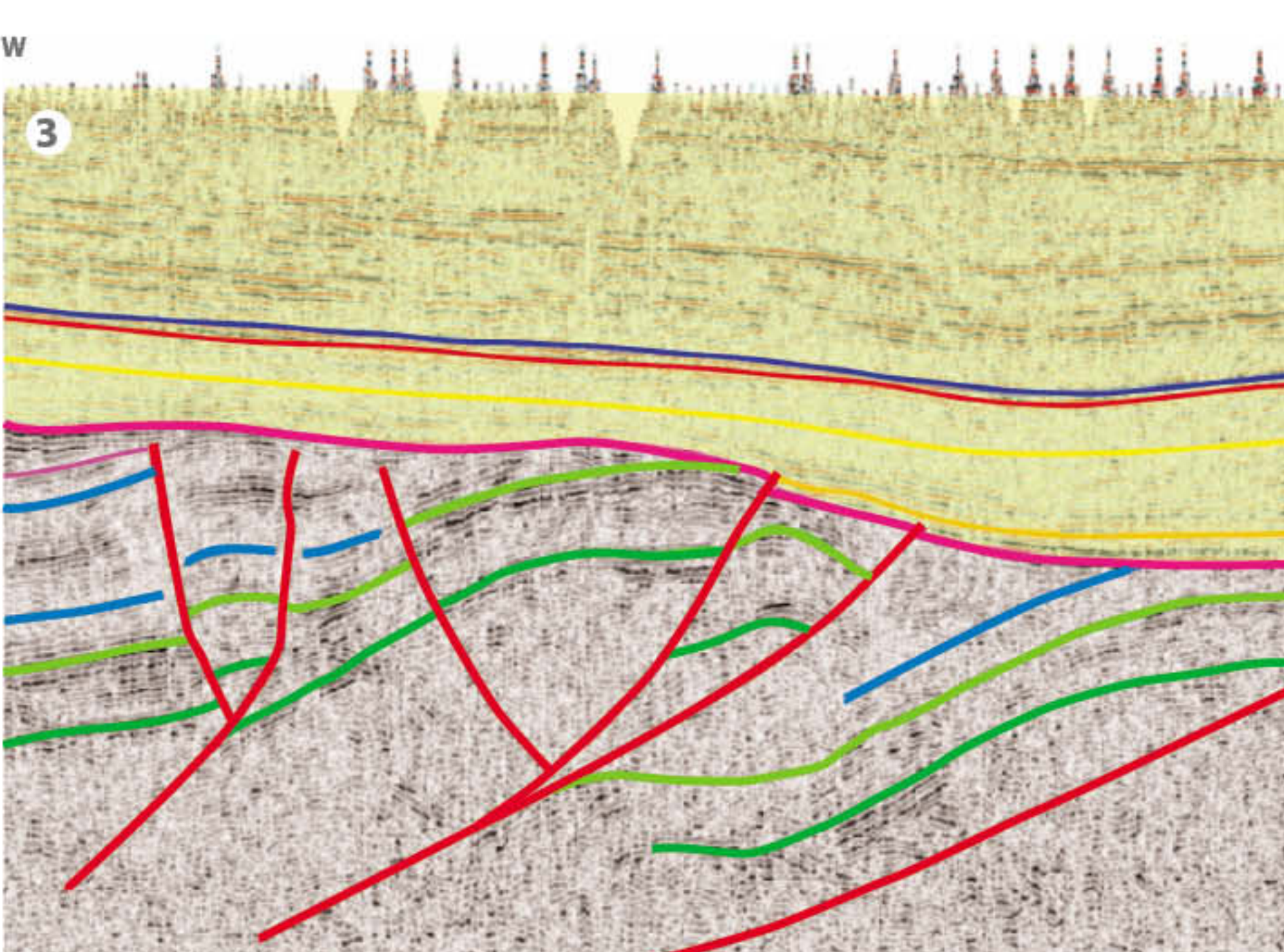
From Ecopetrol, 1998

East vergent thrust play
TOTUMAL AREA



From Ecopetrol, 1998

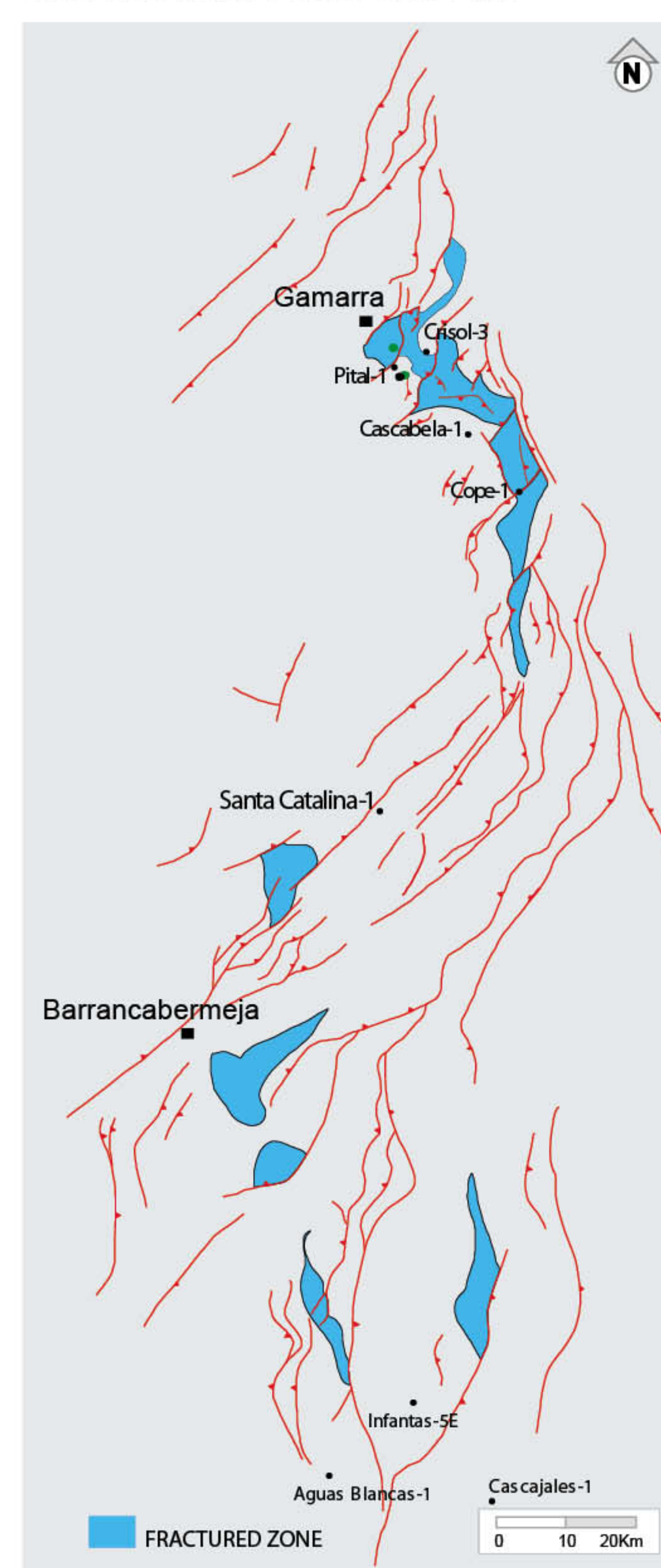
East vergent thrust play
PUNTAPIEDRA AREA



From Ecopetrol, 1998

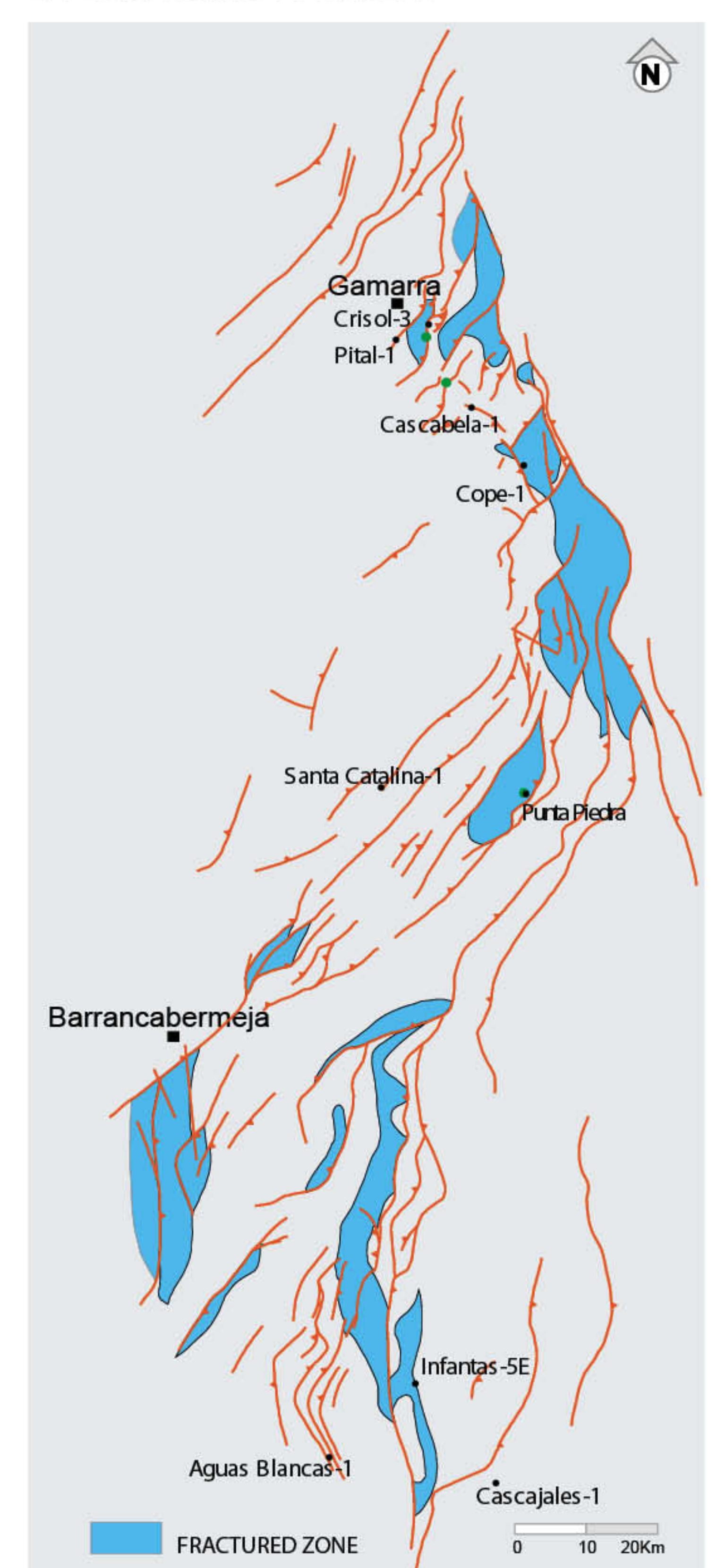
Reservoir Distribution

ROSA BLANCA FRACTURE PLAY



From Ecopetrol, 1998

LA LUNA FRACTURE PLAY



From Ecopetrol, 1998



Agencia Nacional de Hidrocarburos
República de Colombia

Colombia
2005