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AGENCIA NACIONAL DE HIDROCARBUROS

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COLOMBIA ROUND 2021

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COLOMBIA ROUND 2021: UPPER MAGDALENA VALLEY BASIN AND CATATUMBO UNDEVELOPED ALREADY DISCOVERED RESERVOIRS

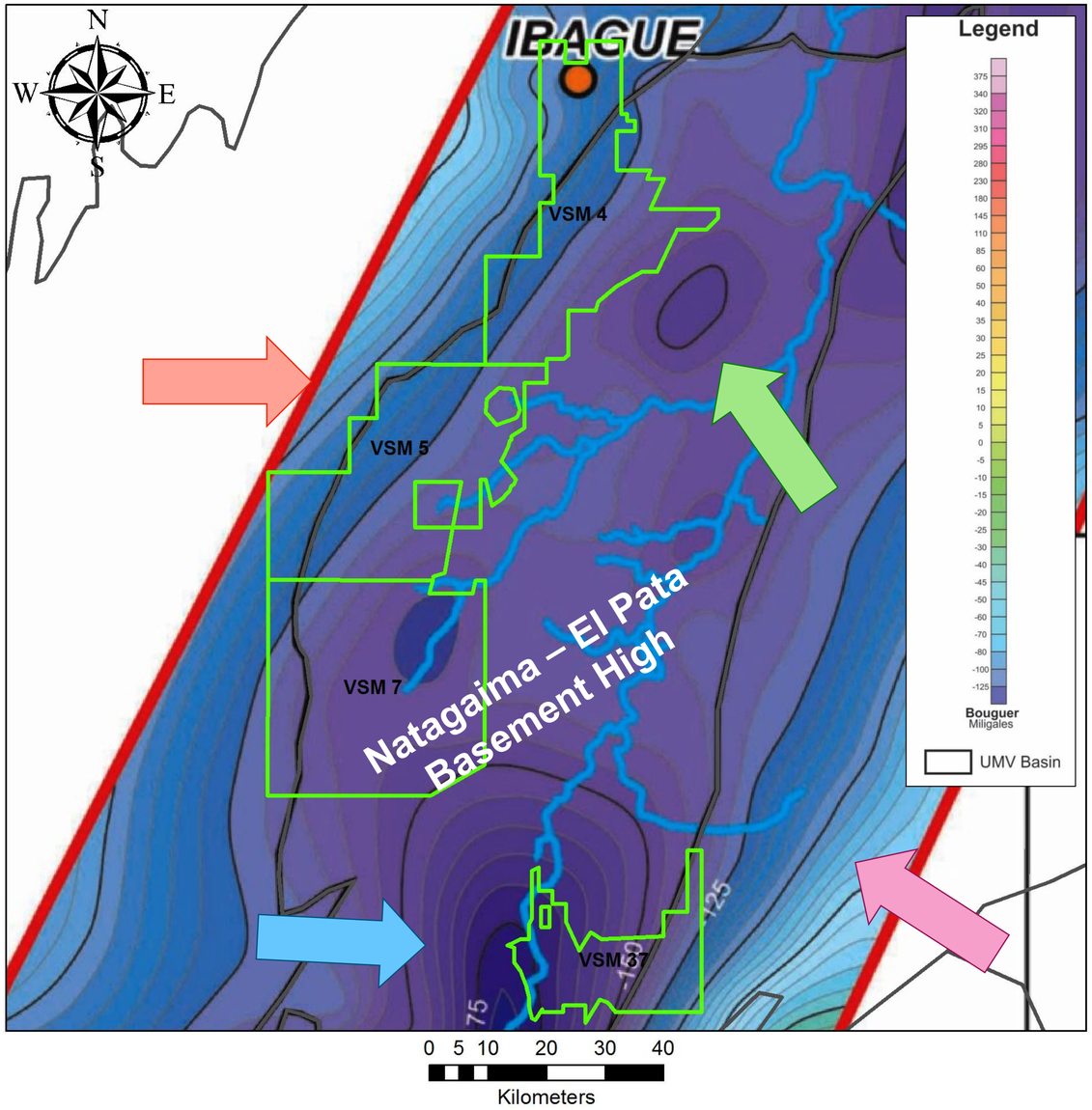
01/10/2021

COLOMBIA ROUND 2021

CONTENT

GEOLOGICAL FRAMEWORK UPPER MAGDALENA VALLEY

Bouguer Anomaly & General Structural Elements



- **Main Structural Elements**

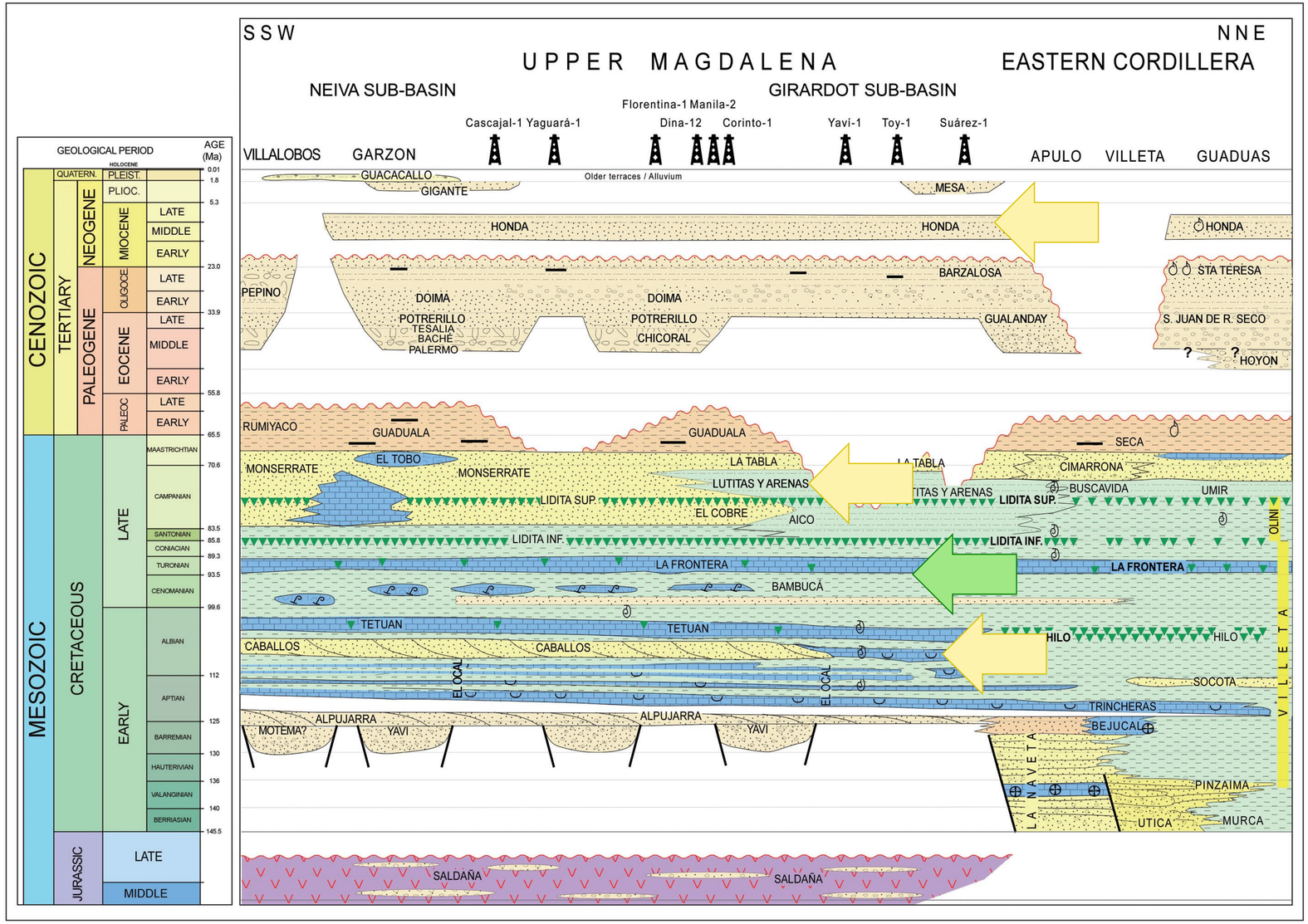
Negative anomaly associated to the Girardot sub-basin

Negative anomaly associated to the Neiva sub-basin

Positive anomaly associated with the Ibagué Batholith and the volcano-sedimentary units of Payandé and Saldaña Formations

Cretaceous outcropping due to thrusting with SE verging structures controlled by the Prado and Suarez fault systems (basement lifted by faults)

STRATIGRAPHIC SETTING



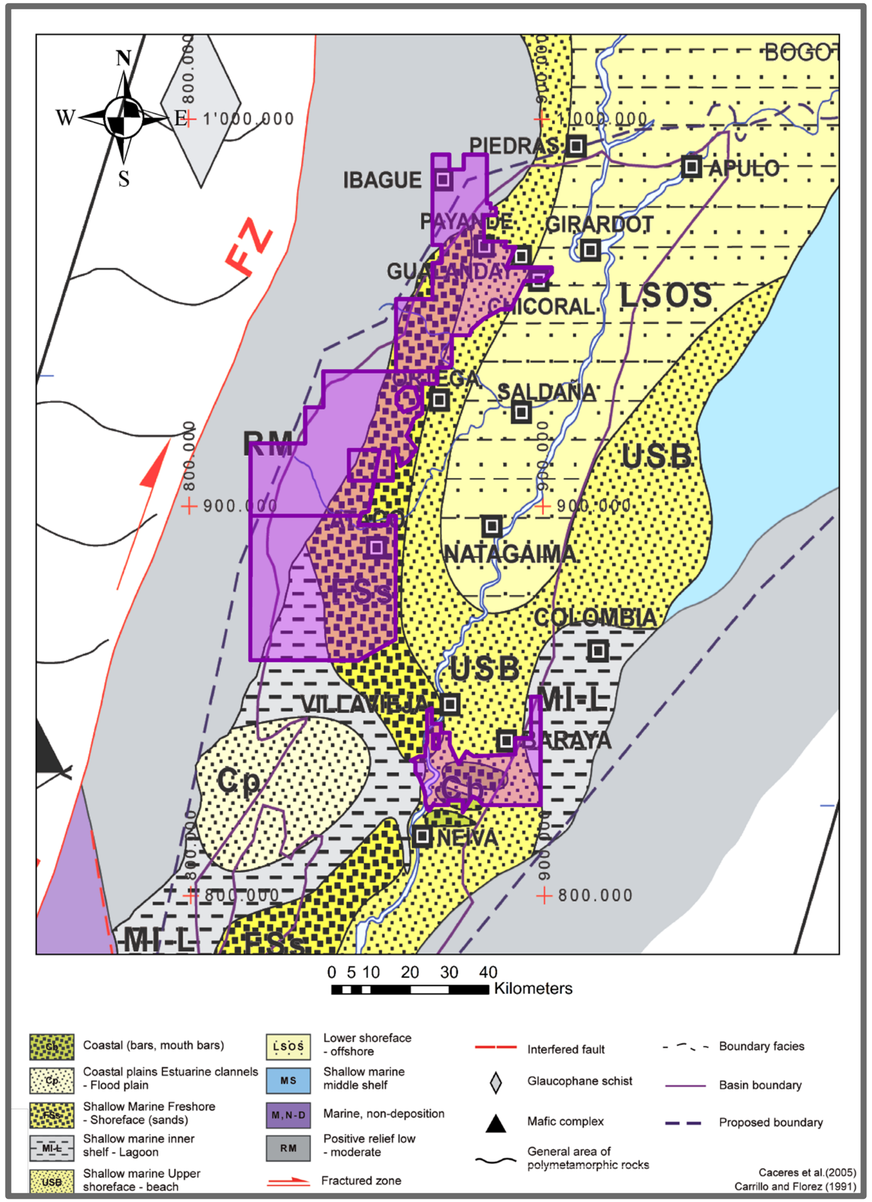
Main Reservoir

- **Caballos Fm.** Deltaic to Shoreface facies: Sandstone and Calcareous Sandstones
- **Monserrate Fm.** Platform sandstones (High Continuity)
- **Honda Group.** Sandstones of fluvial environments (La Victoria Fm.)

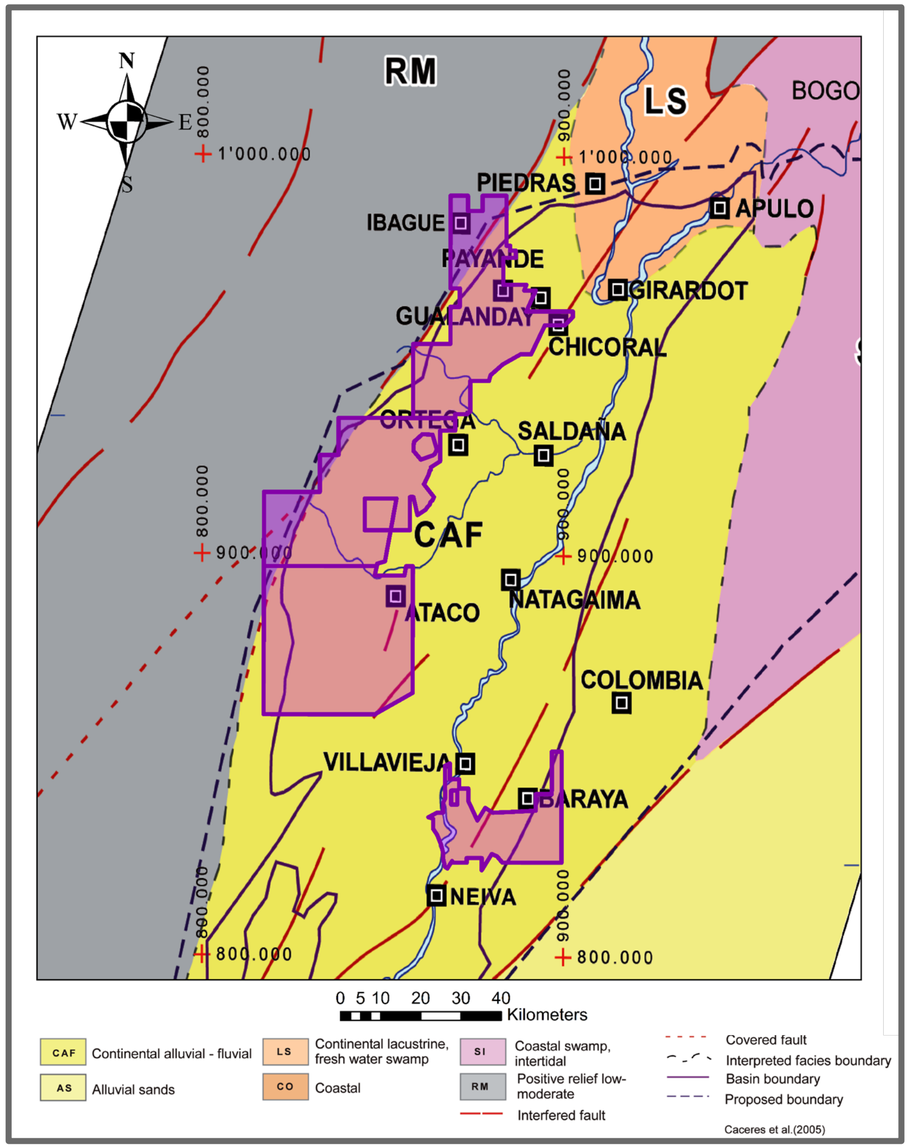
Main Source

- **Villeta Group:** Tetúan (Limestone), Bambucá (Shale), La Frontera (Limestone)

FACIES DISTRIBUTION: RESERVOIR UNITS



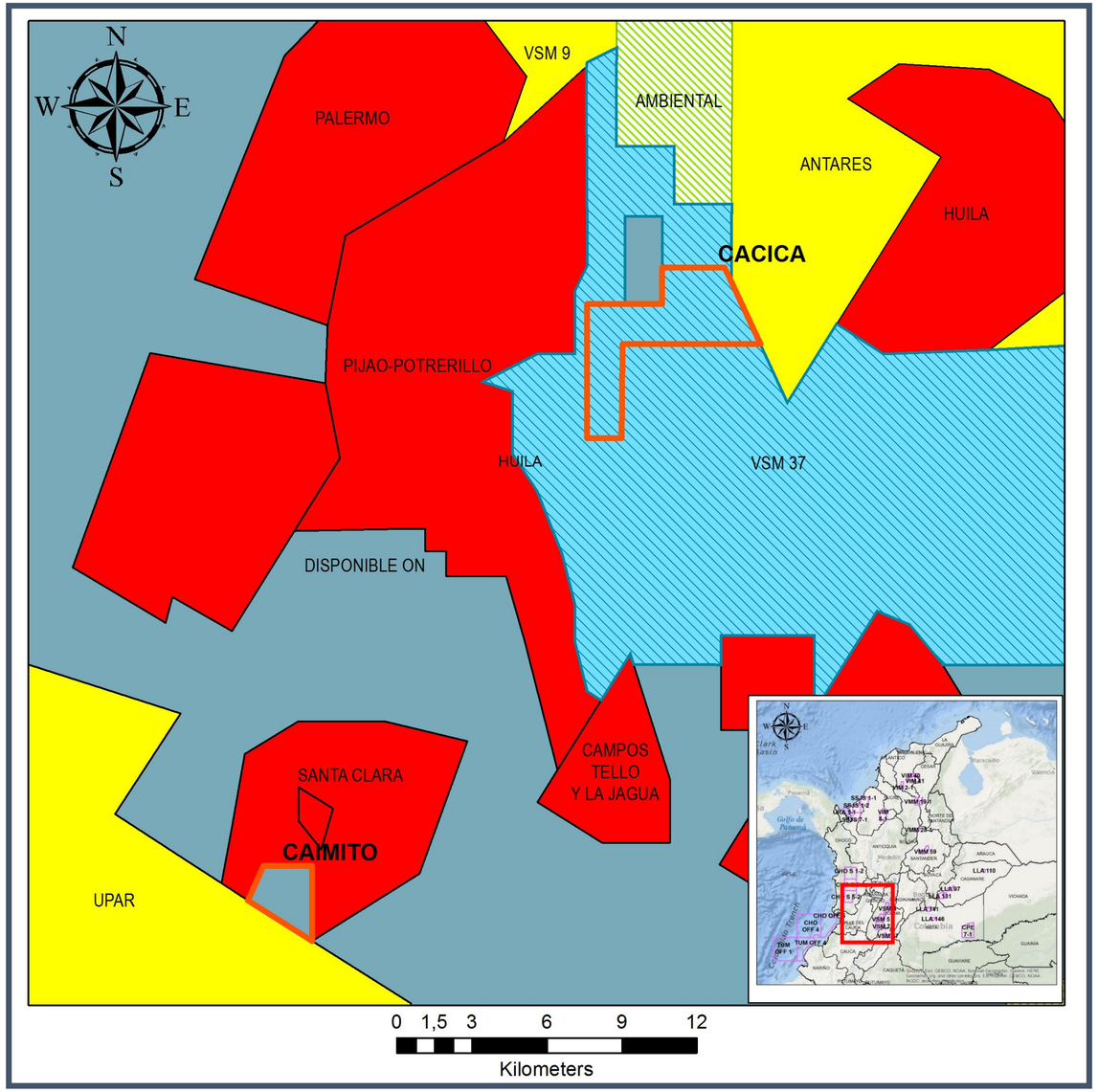
- **Caballos Fm.**



- **Honda Group**

CACICA (UMV)

LOCATION IN UPPER MAGDALENA VALLEY: CACICA & CAIMITO

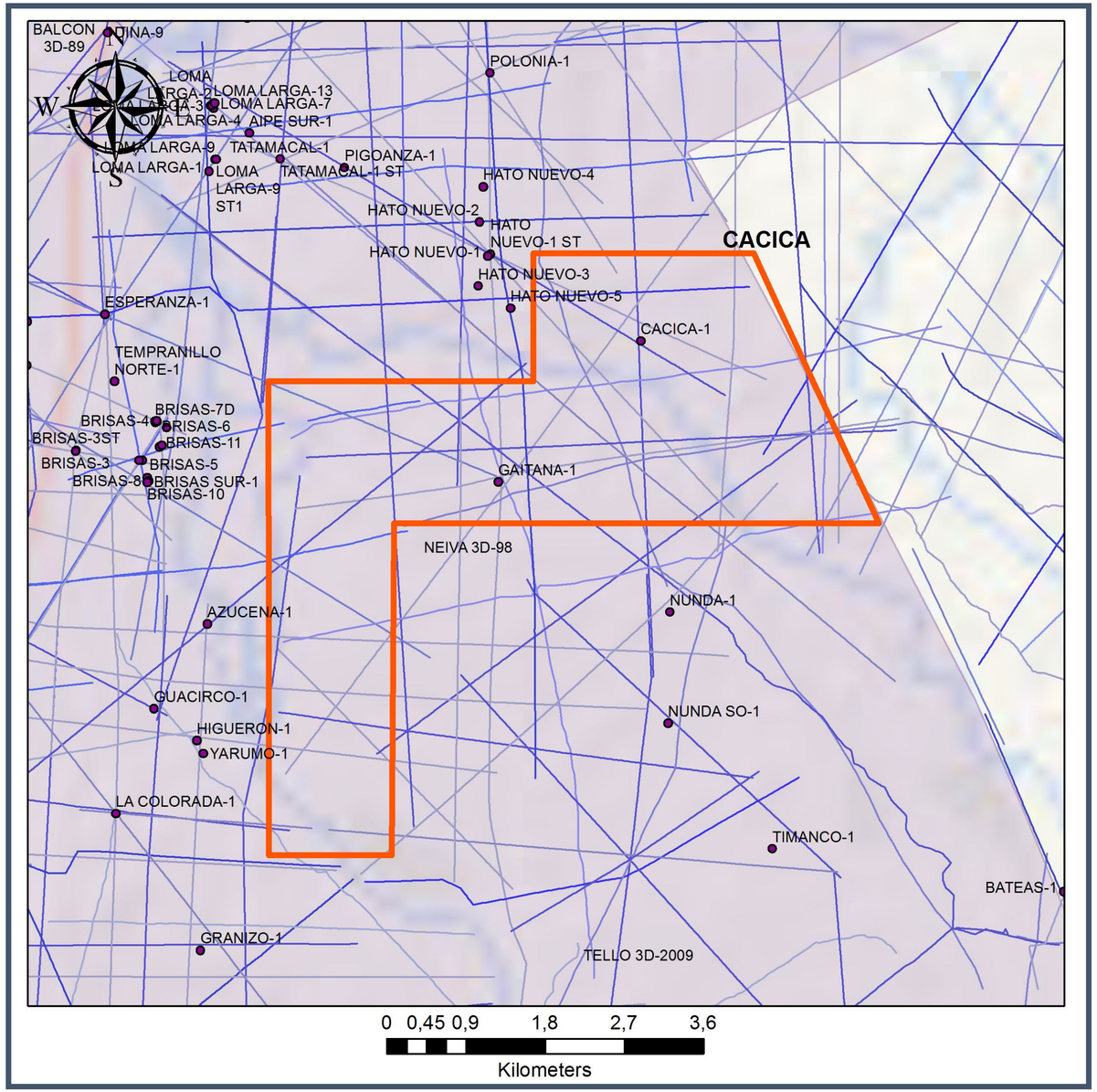


- **Block Areas**
- Cacica (2,006 Ha)
- Caimito (524 Ha)

- **Departments**
- Huila

Contract	Contract Signed Since	First Well Drilled in the Area (Year)	# Of Wells
Pijao - Potrerillo	2009	(1963 – 2018)	204
Huila (Andalucia)	2009	1968	27
Santa Clara	2007	1962	36
Palermo	2015	1988	13

Seismic & Wells: Cacica



2D Seismic Surveys (11 Surveys)

- Neiva – 80
- Neiva – 81
- Neiva – 83
- Neiva – 84
- Neiva – 71
- Neiva – 72
- Neiva – 87
- Neiva – 88
- Neiva – 89
- Dina – 76
- Dina – 77

3D Seismic Surveys (1 Survey)

- Neiva 3D – 98 (483,05 Km²)

Well	Year	TD (ft)
Cacica – 1	2014	6,300
Gaitana - 1	1990	7,211

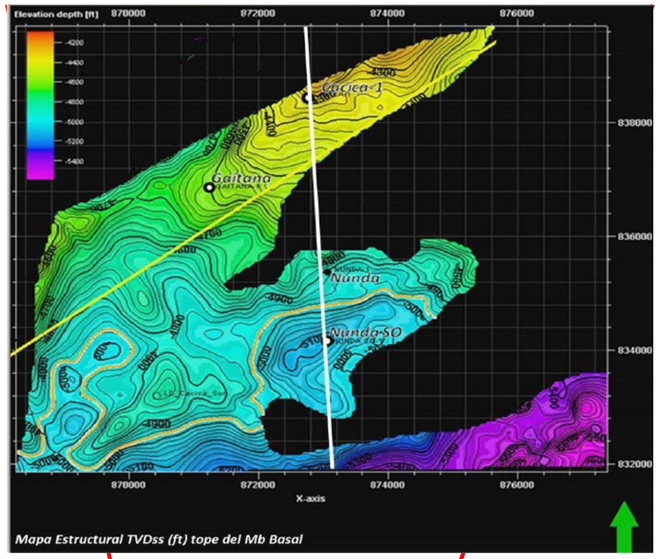
WELLS DRILLED

Cacica - 1

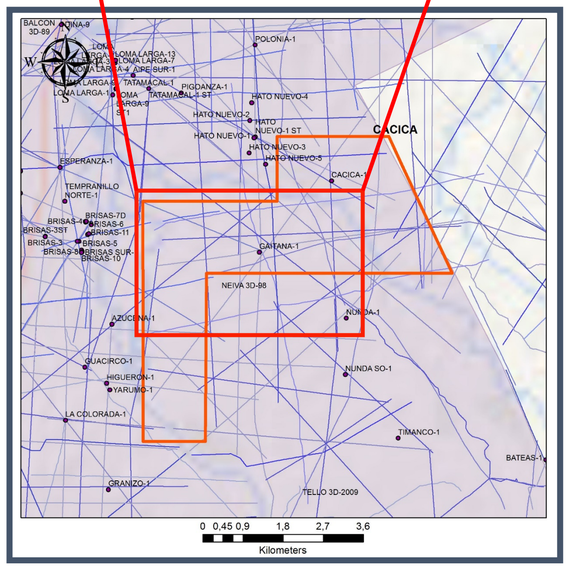
- Well drilled by Ecopetrol in 2014 with a Total Depth of 6,300’.
- The main target of the well was sandstones of La Victoria Fm (Honda Group).
- Gas shows from 5436’ at La Victoria Fm. Oil shows were present from 5,856 ti 6,010’. The well confirms presence of hc at Lower Member of La Victoria Fm
- Two tests were performed with a production of 60 bpd and 110 bpd

Gaitana - 1

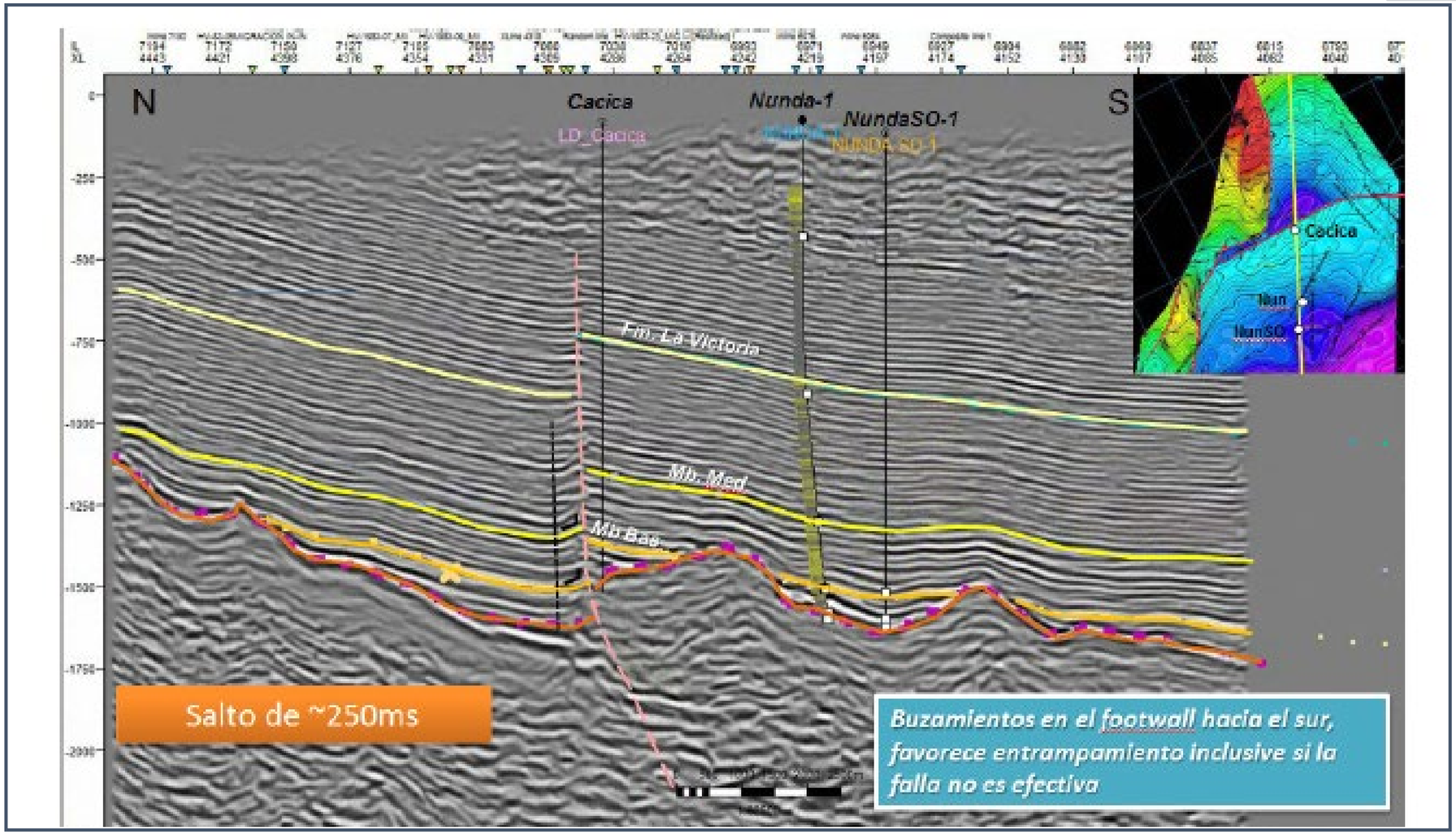
- Well drilled by Houston Oil Colombiana in 1984 with a Total Depth of 7,211’
- The main target of the well was the Caballos Formation, however it was not found during drilling
- Honda Fm. Was considered a second target
- The structure mapped previous to drilling was a closure of the basement

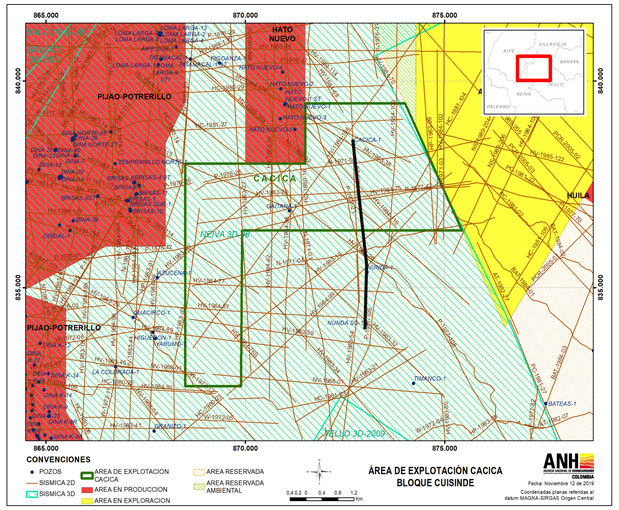


Taken from Ecopetrol (2014)



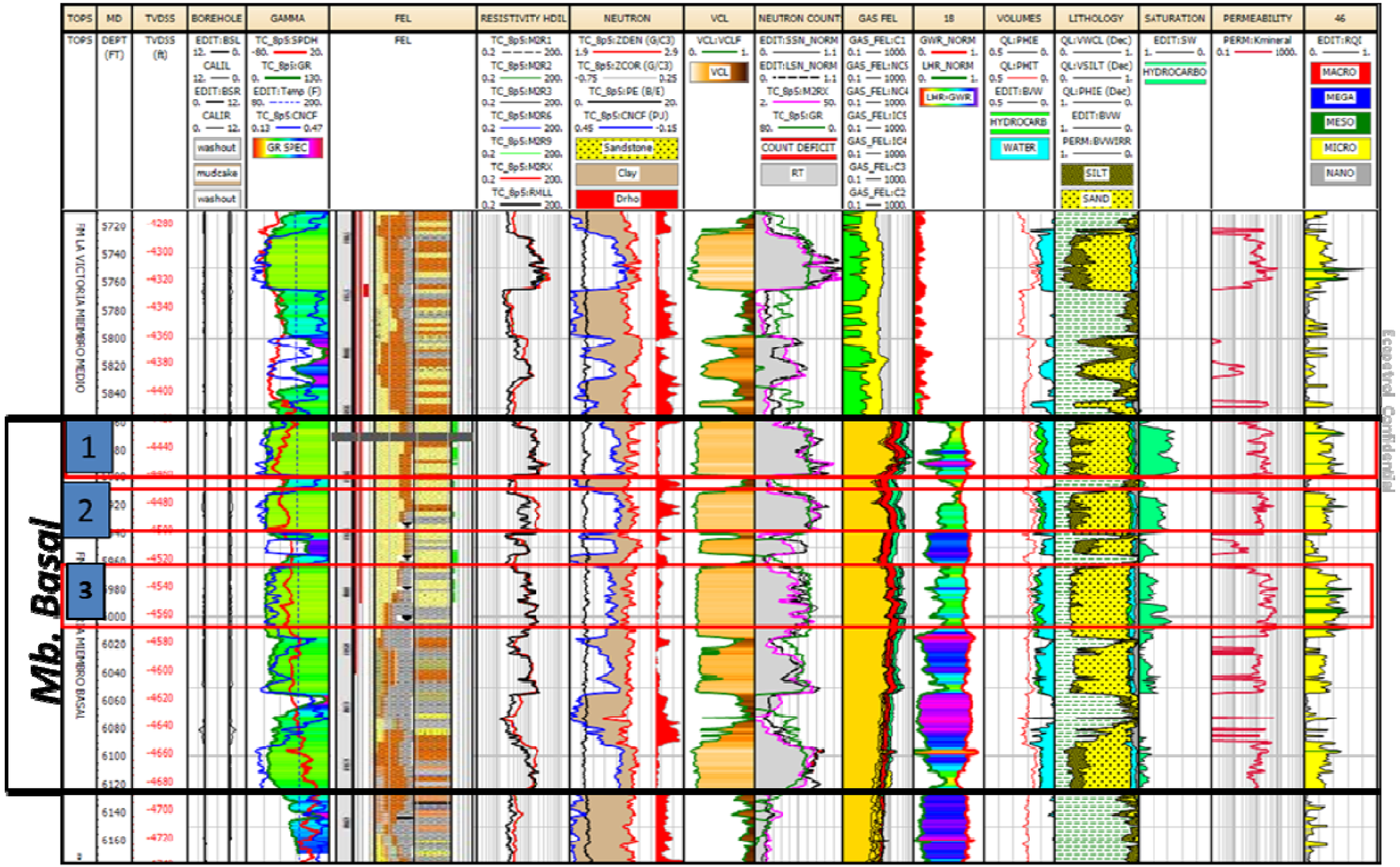
Cacica -1 Well Generalities





Arbitrary seismic line that shows the configuration of the structure and the relation of Nunda-1 and Nunda SO-1 wells with the Cacica-1 well

Cacica-1 Well Petrophysical Evaluation



Petrophysical interpretation by the opertator of the Basal Member in the Cacica-1 well

Intervalo	Tope (MD)	Espesor (ft)	PHIE_AVE	PERM_AVE
1	5858	41	0.12	13 md
2	5908	32	0.115	12 md
3	5960	40	0.12	13 md

Based on the analysis three prospective intervals were established by the operator

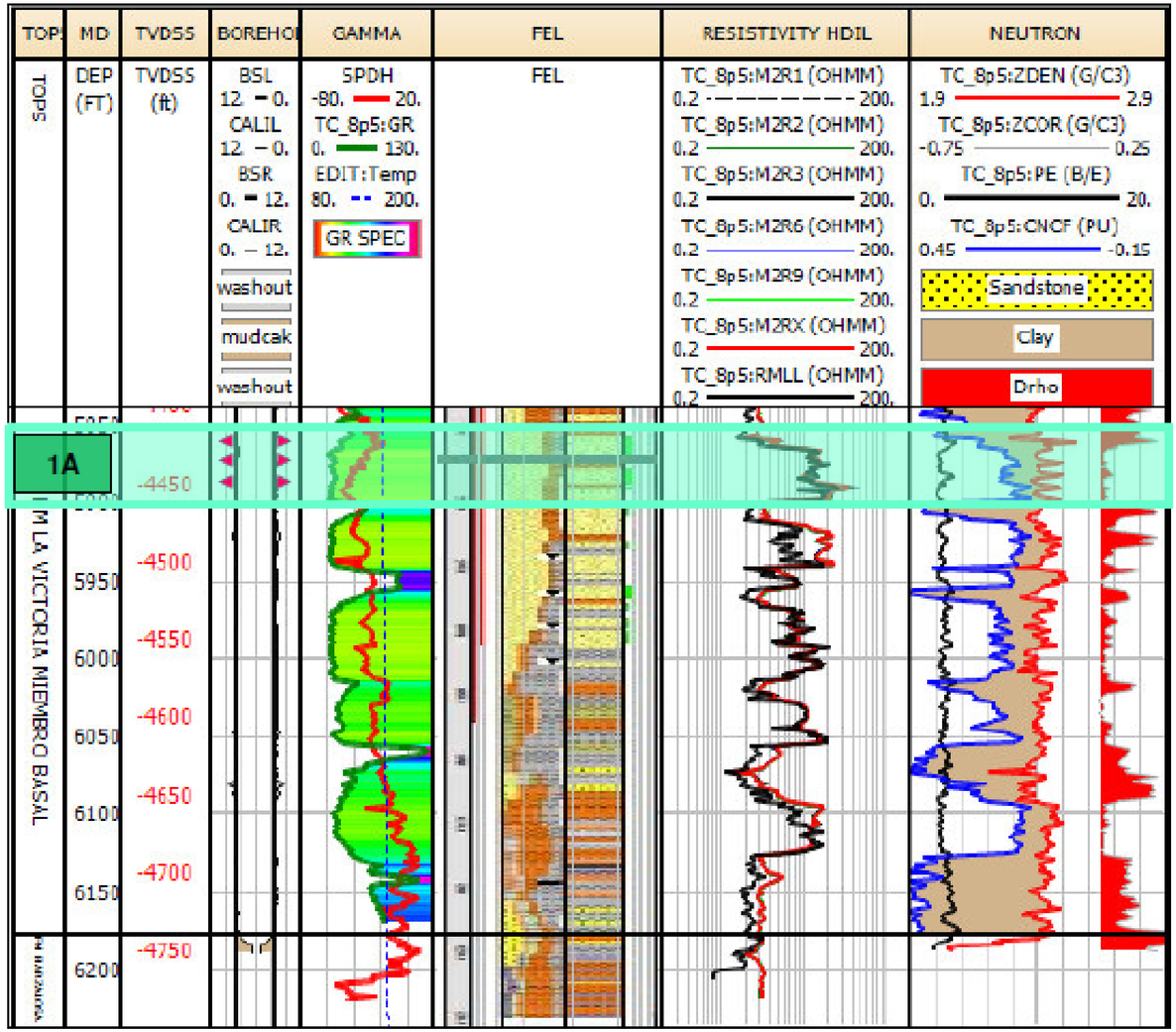
Cacica -1 Well Production Test

- The tests were carried out between September 16 & October 6 of 2014 with PCP artificial lifting system.
- The main objective was to evaluate the quality of the fluids stored in the Basal Member of La Victoria Formation (Honda Group)
- The well was considered in both tests (DST-1A and DST-2) as an **oil discovery** with low production potential

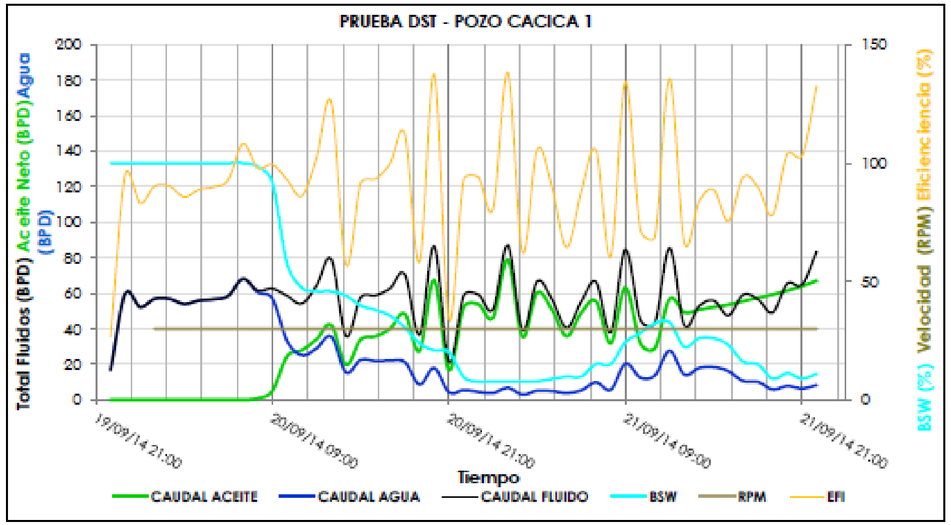
Prueba	Intervalo probado	Recuperado petróleo (barriles)	Recuperado salmuera* (barriles)	Recuperado agua (barriles)	Recuperado fluidos (barriles)
DST-1	5858′-5899′	0	0	0	0
DST-1A	5858′-5899′	67	48	0	115
DST–2 (Prueba de fluidos)	5858′-5899′, 5908′-5940′	266	55	22	343
Total por fluido		333	125		

Consolidation of recovered volumes. Initial tests Cacica-1 well.

Cacica-1 Well Production Test

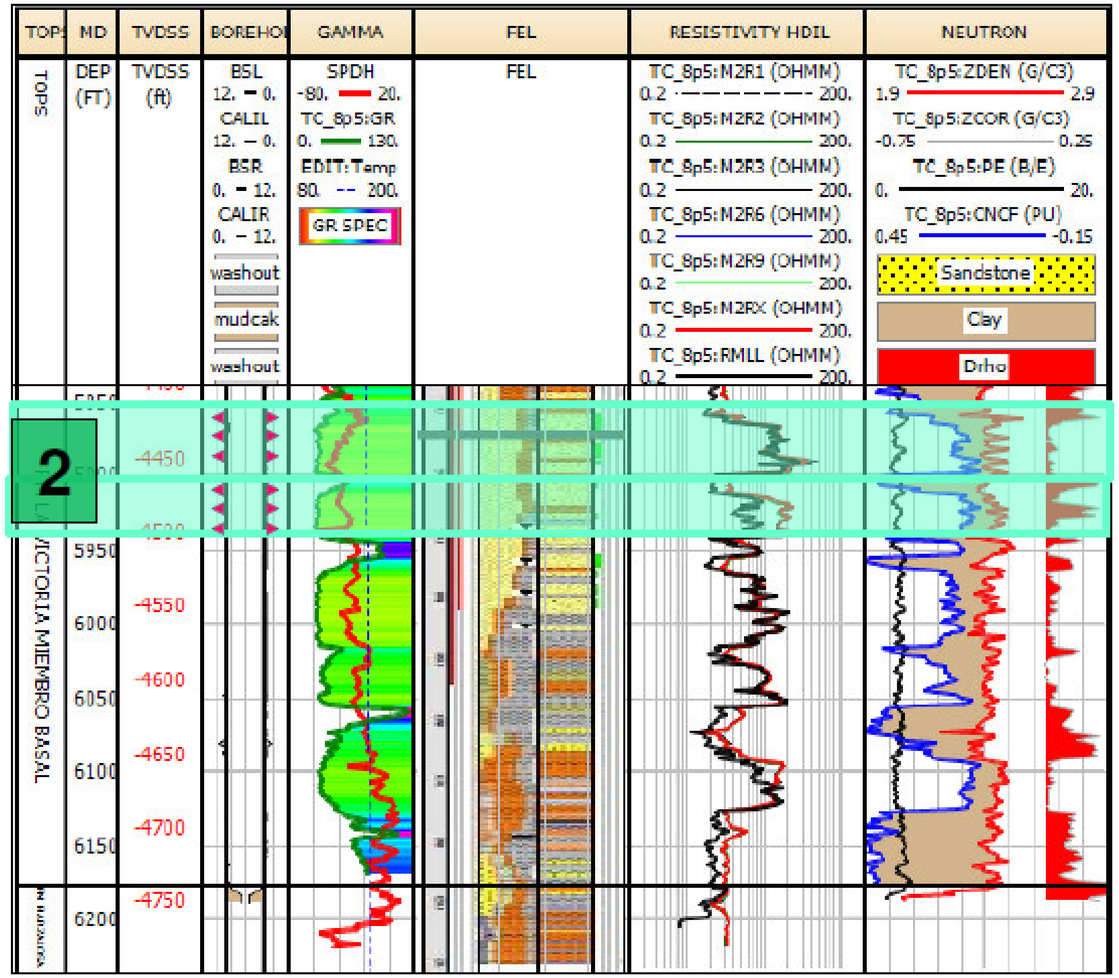


Petrophysical interpretation of the gunshot interval DST-1A. Interval 5858' – 5899'

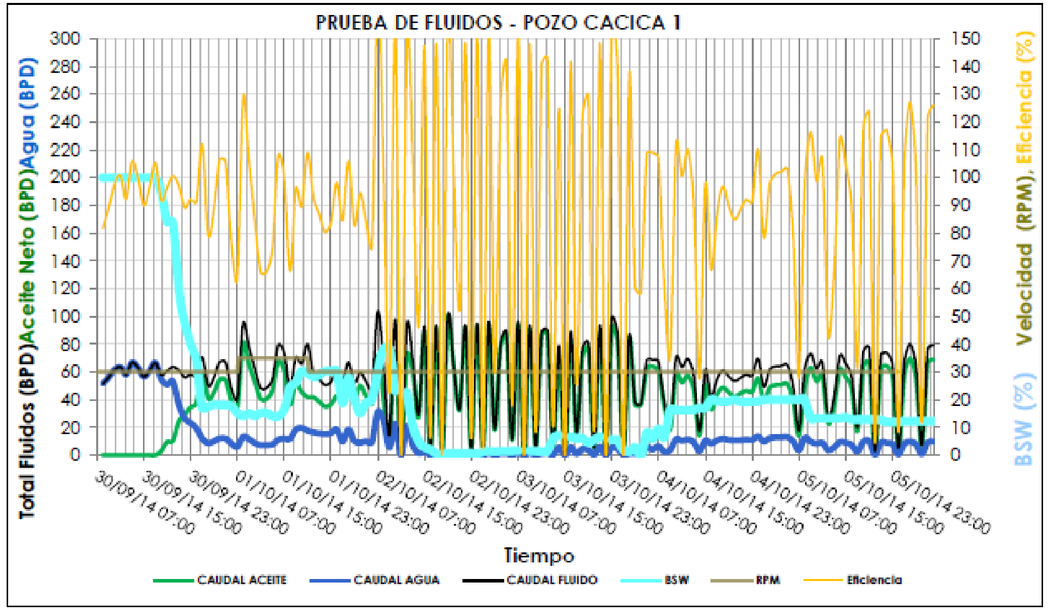


DST-1A test production behavior

Cacica-1 Well Production Test



Petrophysical interpretation of the gunshot interval DST-2. Intervals 5858′ – 5899′ & 5908′ – 5940′

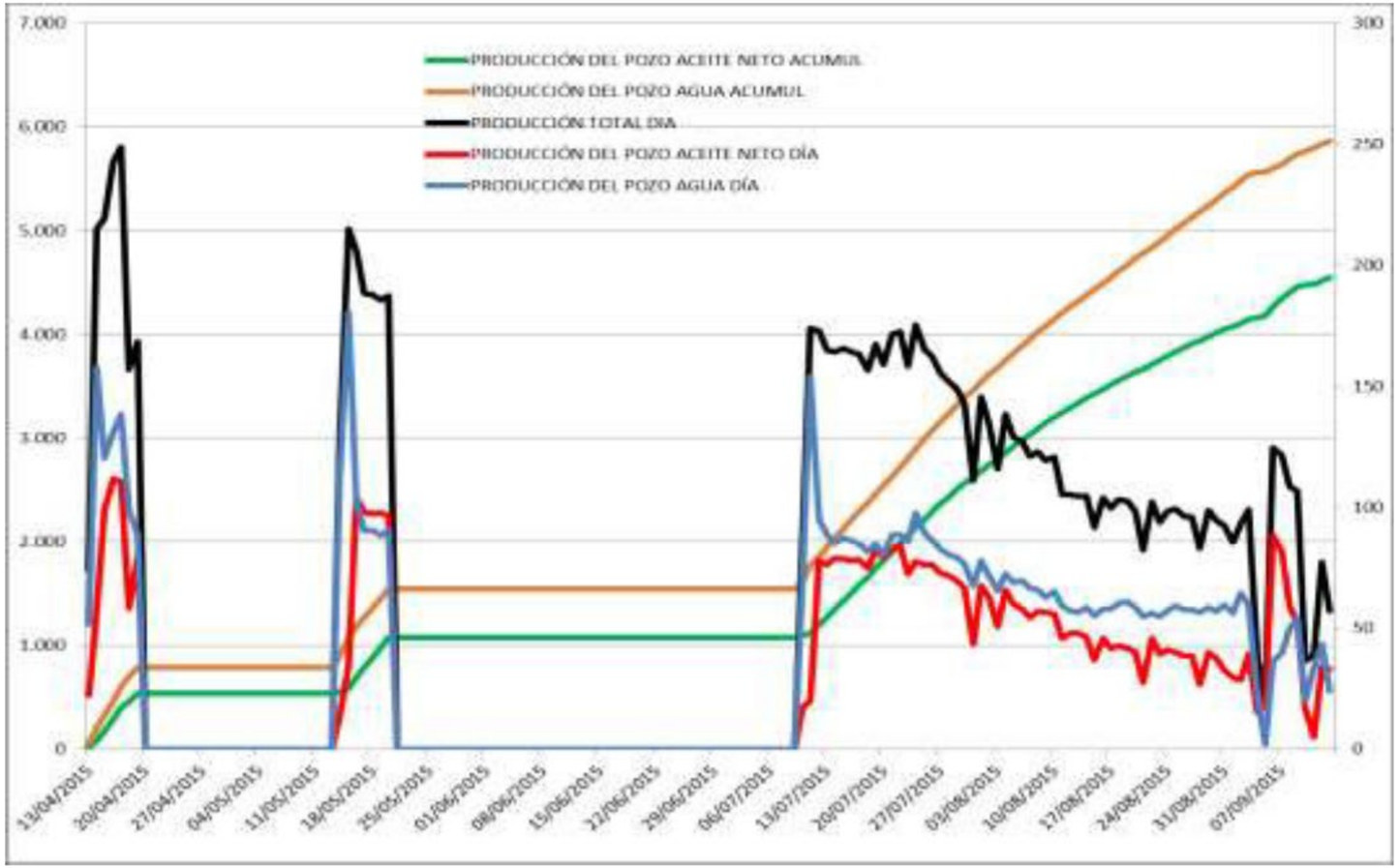


DST-2 Test Production Behavior

Production Behavior of the Cacica – 1 Well

- The production test of the Cacica-1 well was carried out in the Basal member of La Victoria Formation for an extensive period of four months (4) months from April 15 to August 14, 2015.

- Total production to September of 2015: **5700 barrels.**



Cacica- 1 Contingent Resources & Tests

The Cacica-1 well tested the presence of hydrocarbons in the basal sands for which preliminary contingent resources of 2.87 MMBLS were calculated in the MEAN.

	Unidades	P90	P50	P10	MEAN
OOIP	MMBLS	8.38	15.3	23.2	24.6
CONTINGENTES	MMBLS	1.93	2.72	4.02	2.87

Contingent resources Cacica-1 well

During 2014, there was hydrocarbon production associated with the production tests of the Cacica-1 well.

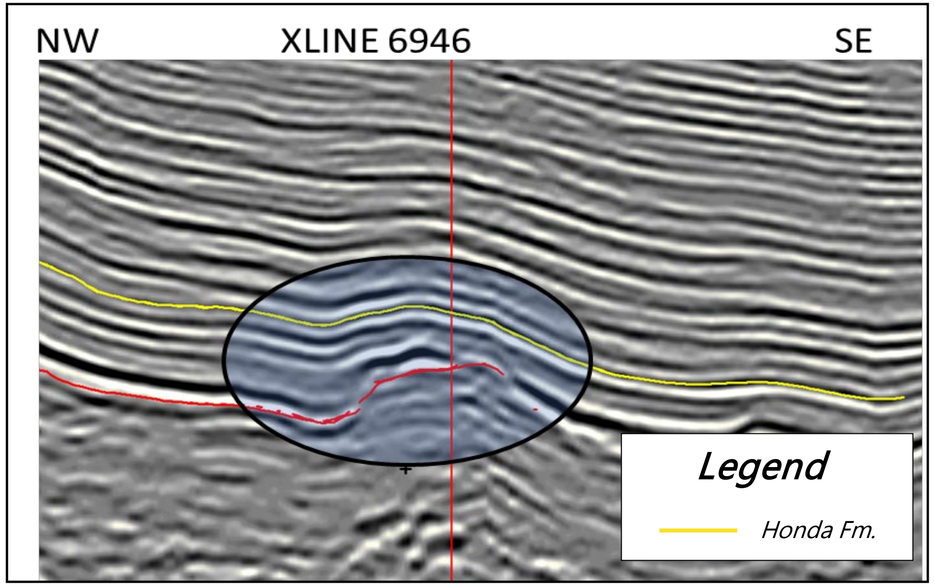
PRUEBA	PRODUCCION TOTAL (barriles)	AGUA (barriles)	PETRÓLEO (barriles)
DST-1A	115	48	67
DST-2	343	77	266
POST-FRACTURAMIENTO*	2902	1234	1667
TOTAL	**3360**	**1359**	**2000**

Production of the Cacica-1 well, associated with production tests

Seismic Interpretation: Cacica - Nunda

A

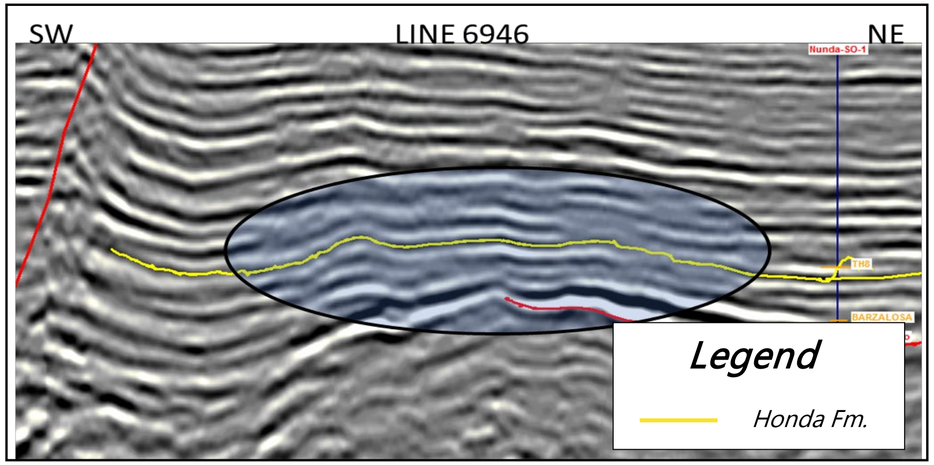
A′



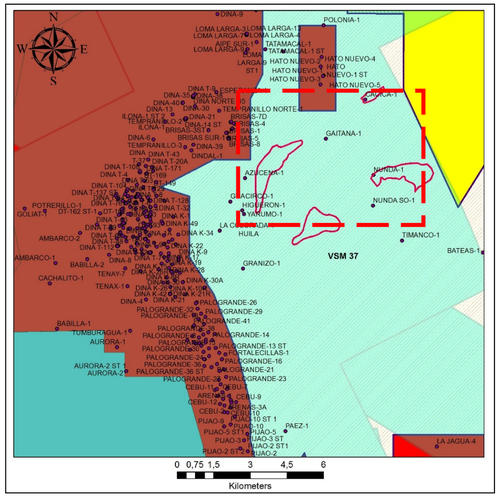
Dip Line

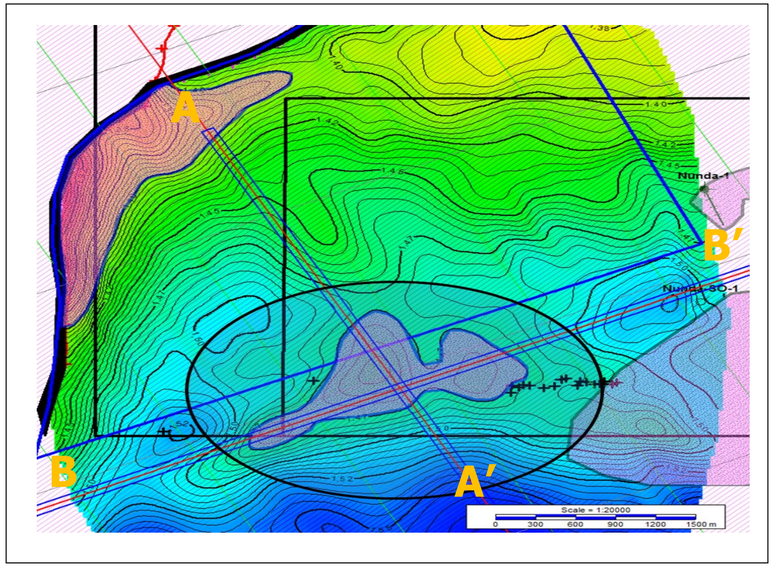
B

B′

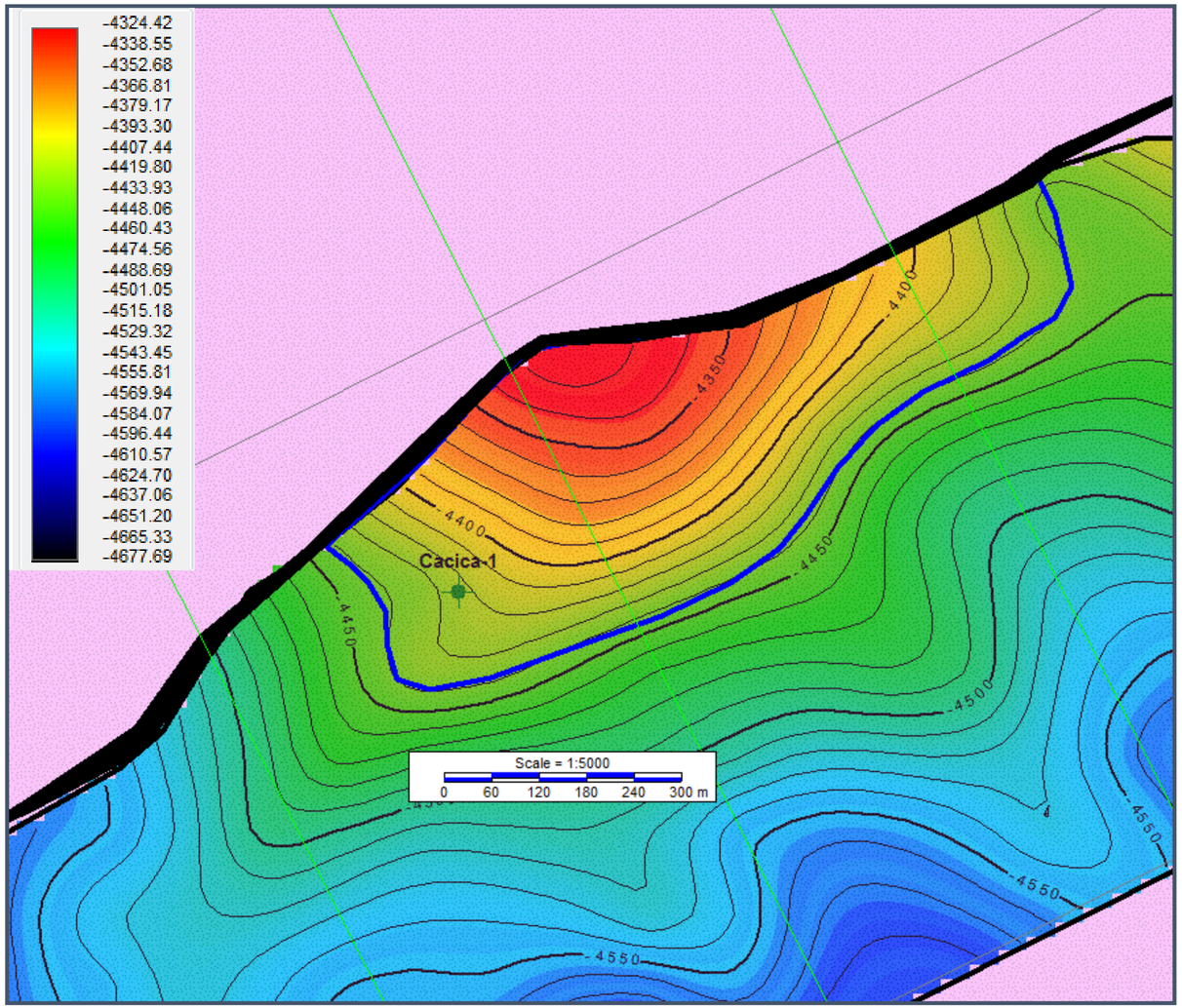


Strike Line



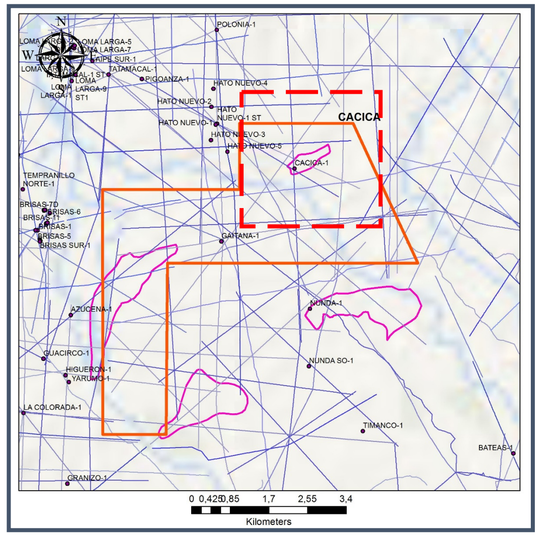


Structural Map Basal Member (La Victoria Fm) in TVDss

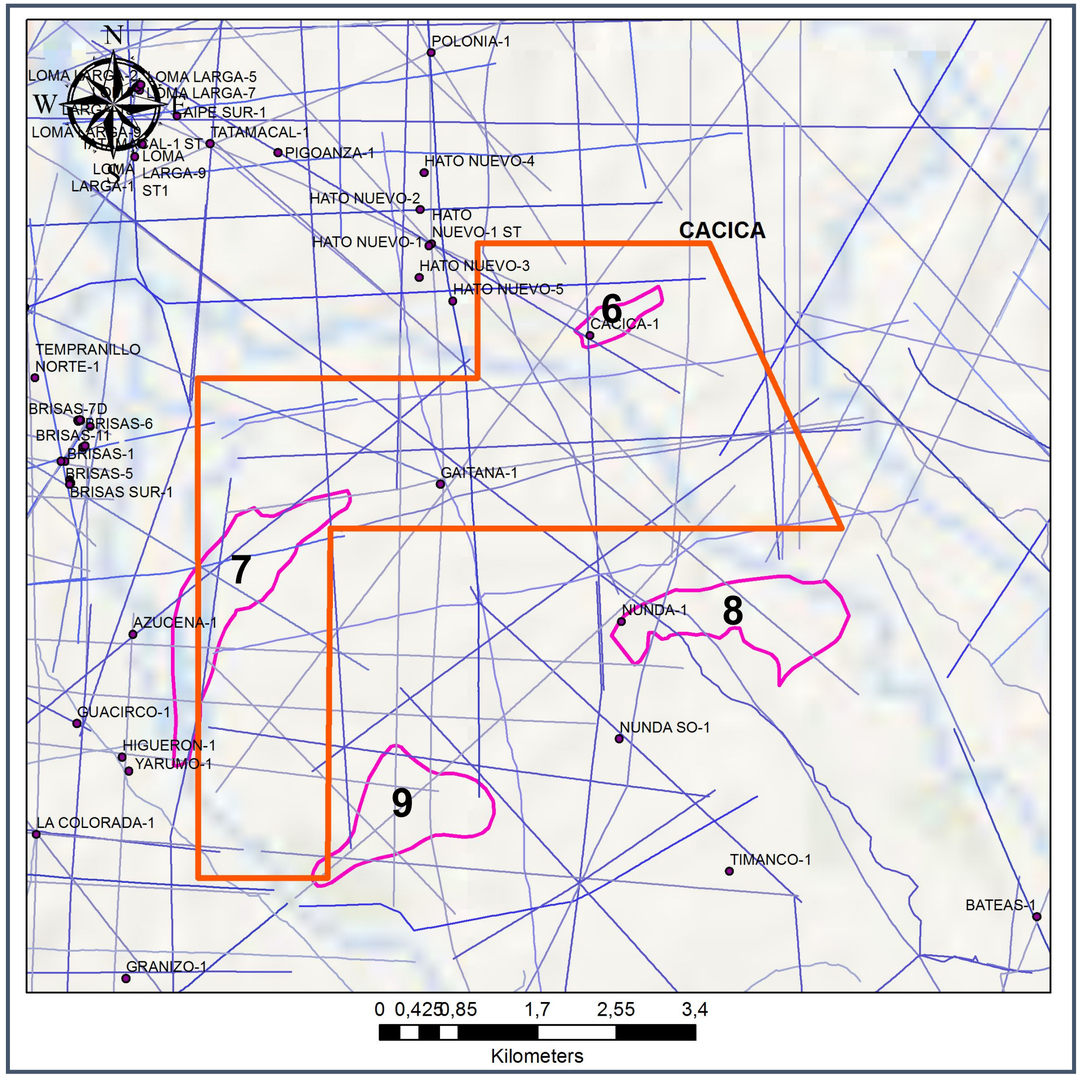


Contours: every 10 feet

- Maximum Closure Area: 63 acres
- Net Pay Thickness: 73 ft
- Porosity: 12%
- So: 30%
- Recovery Factor: 25%



VOLUMETRICS CACICA AREA



3 LEADS INSIDE

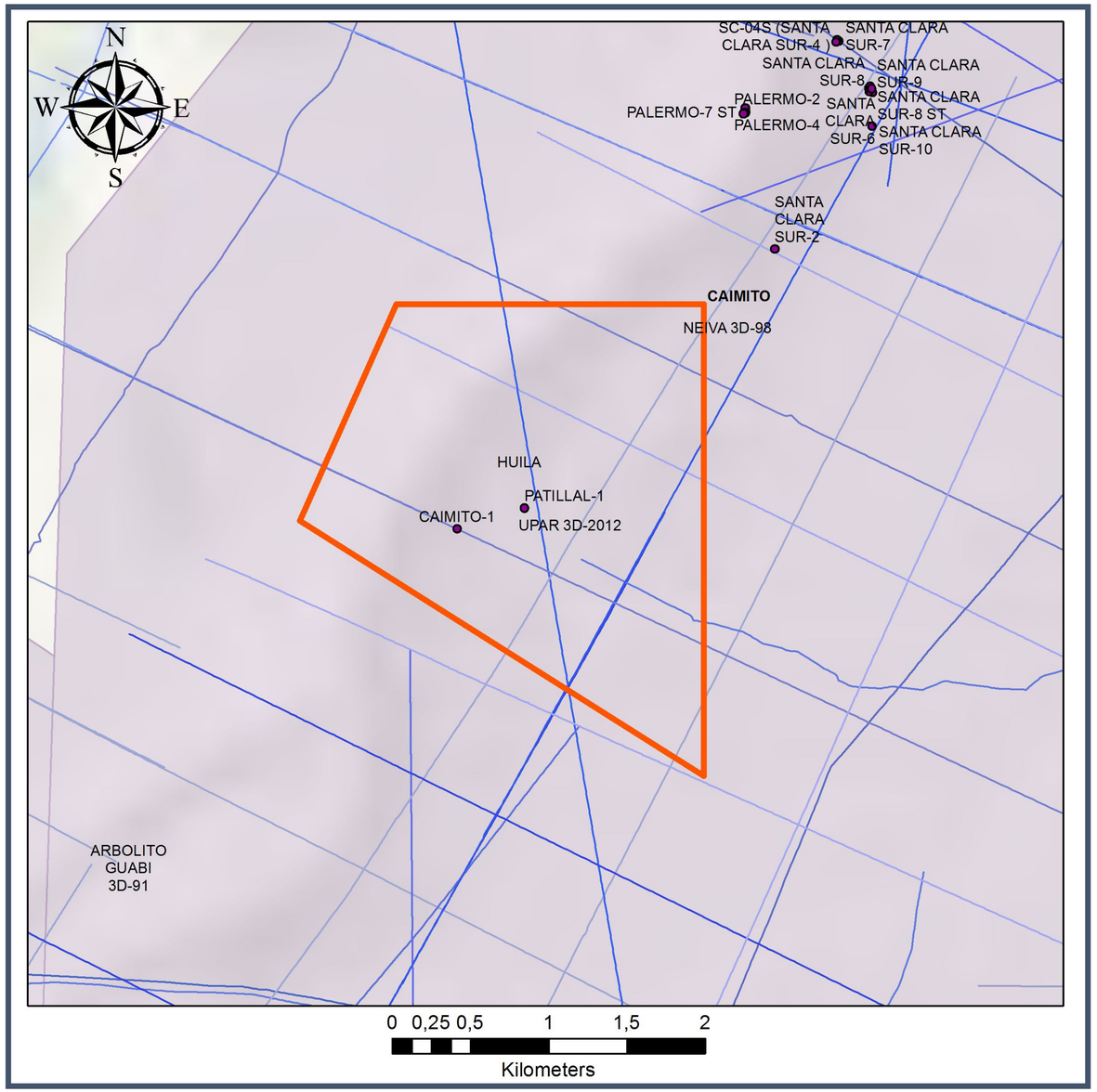
Recoverable Prospective Resources

Lead No	OOIP MMBO	Prospective Resources MMBO
6	**1.22**	**0.054**
7	**8.30**	**0.373**
8	7.42	0.334
9	6.35	0.285

Lead	Area
6	**0.25 km^2**
7	**1.7 km^2**
8	1.52 km^2
9	1.3 km^2

CAIMITO (UMV)

Seismic & Wells (Caimito)



2D Seismic Surveys (9 Surveys)

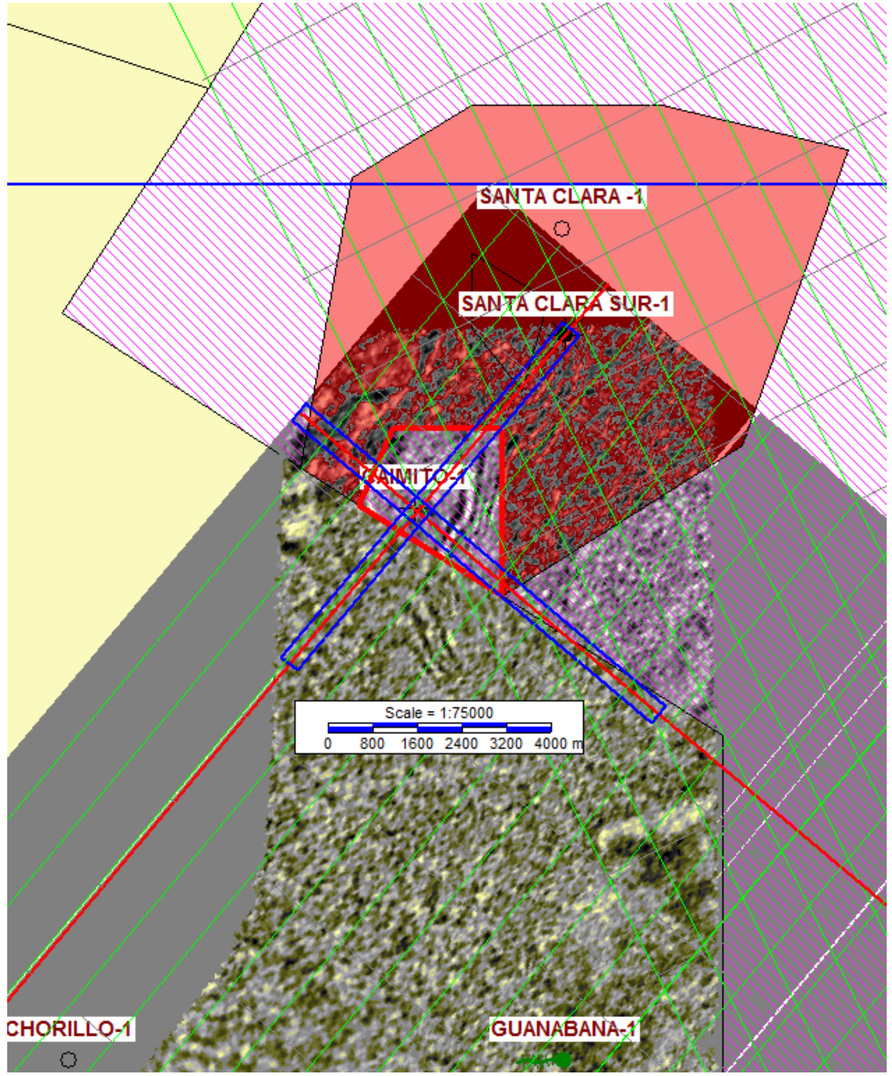
- Caguan – 84
- Neiva – 87
- Palermo - 86
- Palermo – 88
- Rio Bache – 93
- Rio Bache Sur – 92
- Rivera - 97
- Upar 2D – 2004
- Neiva Oeste - 88

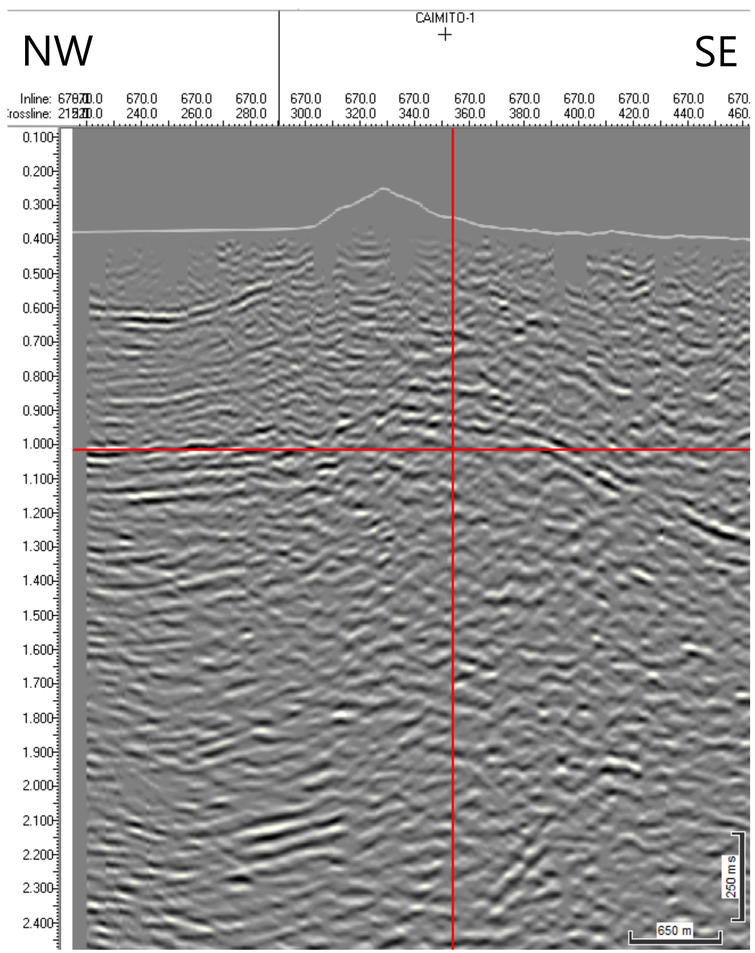
3D Seismic Surveys:

- Upar 3D - 2012

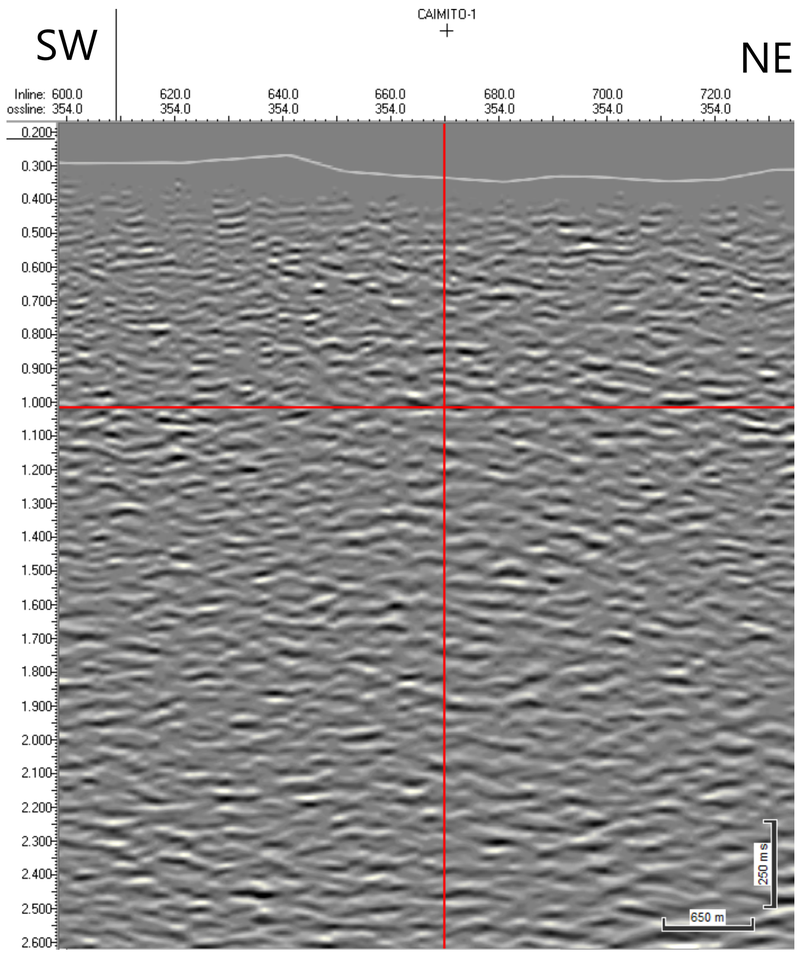
Well	Year	TD (ft)
Caimito - 1	1988	3,368
Patillal - 1	1988	3,134

Seismic Quality





Dip Line



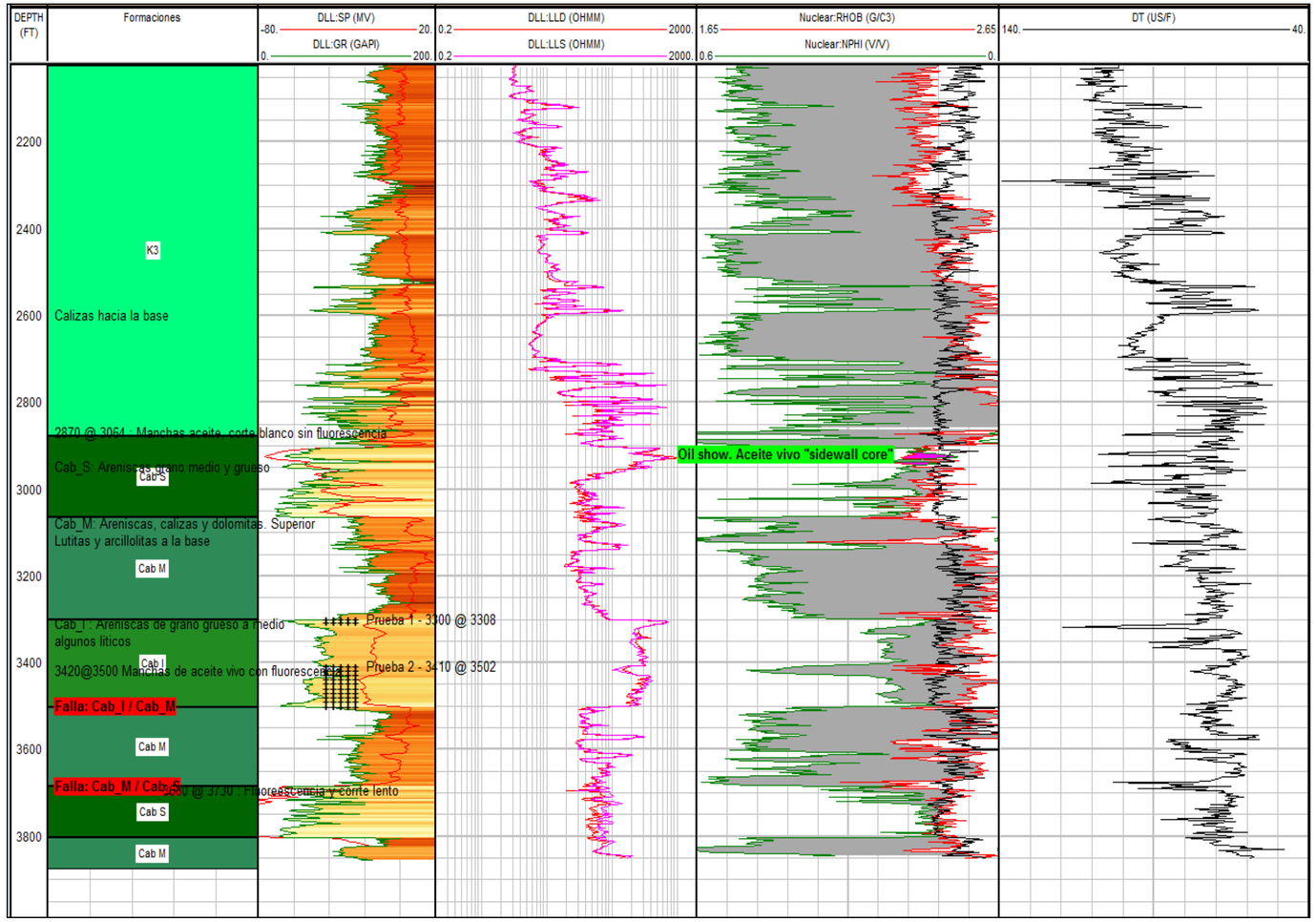
Strike Line

Caimito-1 Well Generalities

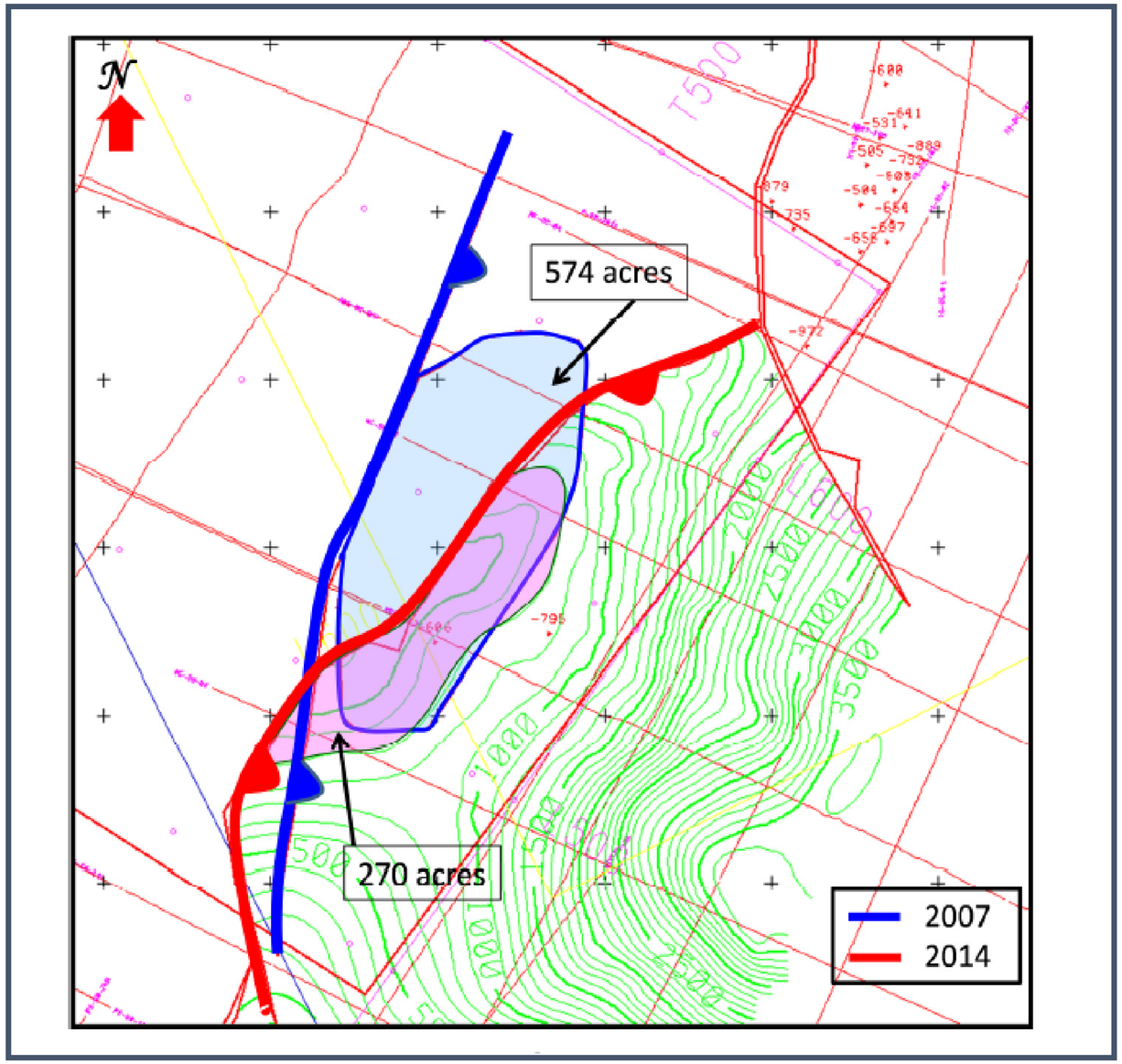
- Palermo Association Contract
- Operator: Hocol
- Spud date: August 17, 1988
- Final TD: MD 3877 ft – TVD 3368,7 ft
- Mechanically deviated reaching **Caballos Formation**.
- Discovery well

Well Tops

Formaciones	Tope MD (pies)
K4	170
K3	573
Caballos Superior	2877
Caballos Medio	3064
Caballos Inferior	3302
Caballos Medio	3502
Caballos Superior	3685
Caballos Medio	3803
TD	3877



Previous Interpretation (Operator)



Comparison of 2007 -2014 models
Calculation of areas referred to contour -700 ft

Caimito – 1: Well Test Results

Oil show in sidewall core

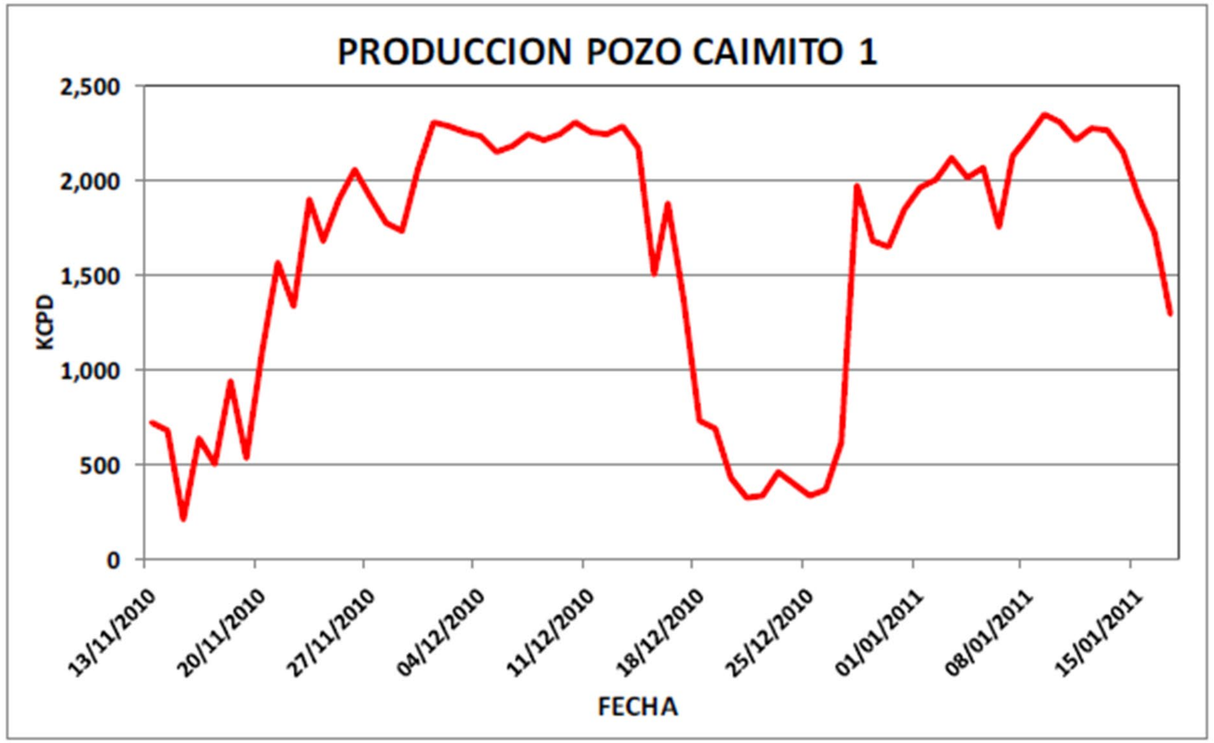
PRUEBA	INTERVALO			FORMACION	FECHA	PRODUCCION MPCD*	PSI CABEZA	PPM CL	RESIST
	TOPE	BASE	ESPESOR						
4	2906	2925	19	CAB_S	03-oct-88	673* - 2687*			
3	2945	2953	8	CAB_S	01-oct-88	684* - 2175*			
2	3410	3502	92	CAB_I	21-sep-88	AGUA	3000	700 @ 1300	4.2 @ 86°F / 3.4 @ 92°F / 3 @ 96°F
1	3300	3308	8	CAB_I	11-sep-88	472* - 1433*			
					PROMEDIO	2,233			
					MAX	6,295			
					MIN	1,829			

Suma de Gas Volume Kcf	oct-2010	nov-2010	dic-2010	ene-2011	feb-2011
Caimito	0	23100	47770	34720	0

KCF

Caimito Production

- The test started on November 13th, 2010
- The well started production with 0.709 CFD and it was gradually increased to reach a production of 2 .2 MMCFD.
- On January 17th 2011 the test was ended due to the entrance of water that created corrosión
- Problems in the transference lines



Suma de Gas Volume Kcf	oct-2010	nov-2010	dic-2010	ene-2011	feb-2011
Caimito	0	23100	47770	34720	0

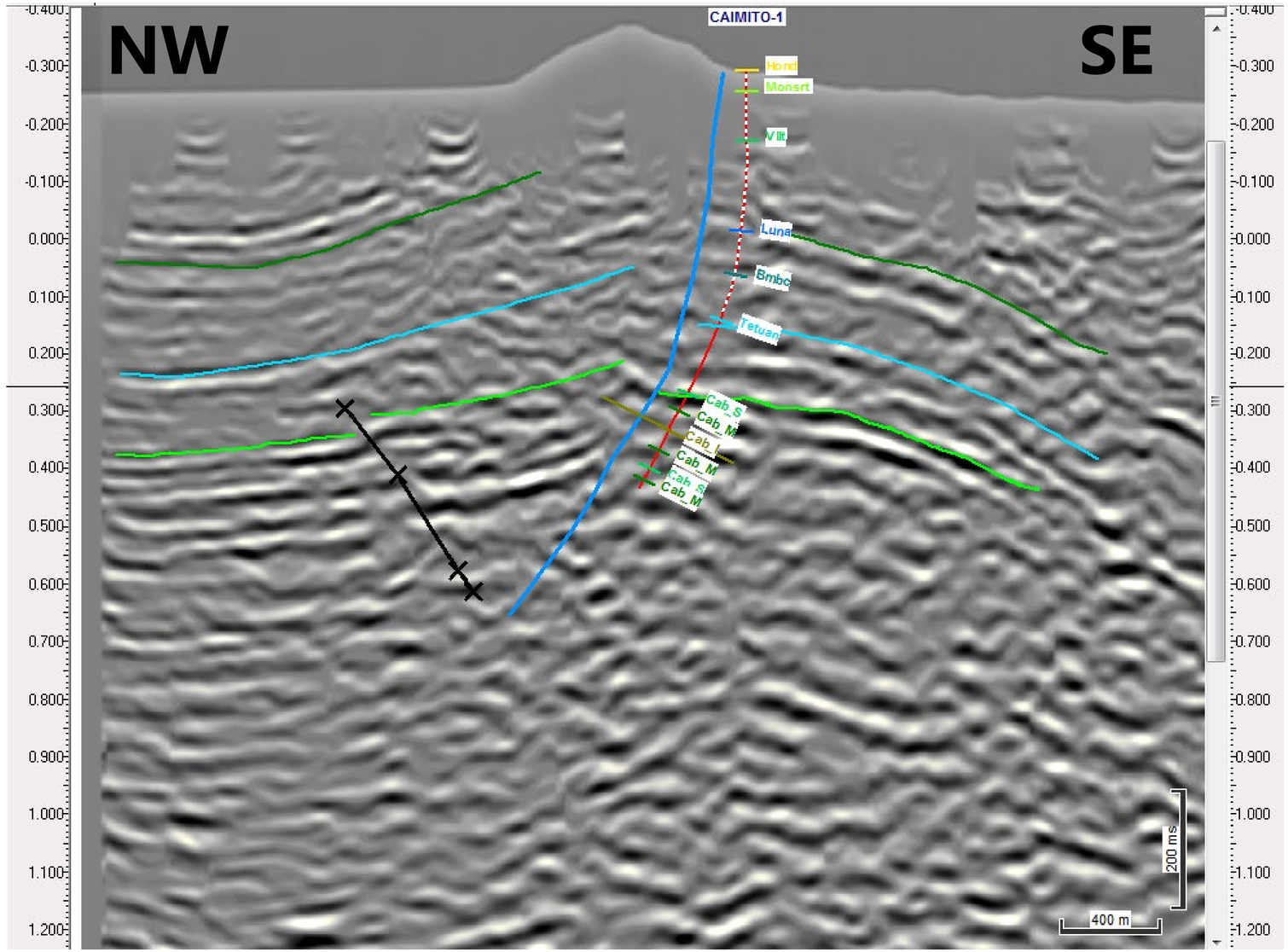
KCF

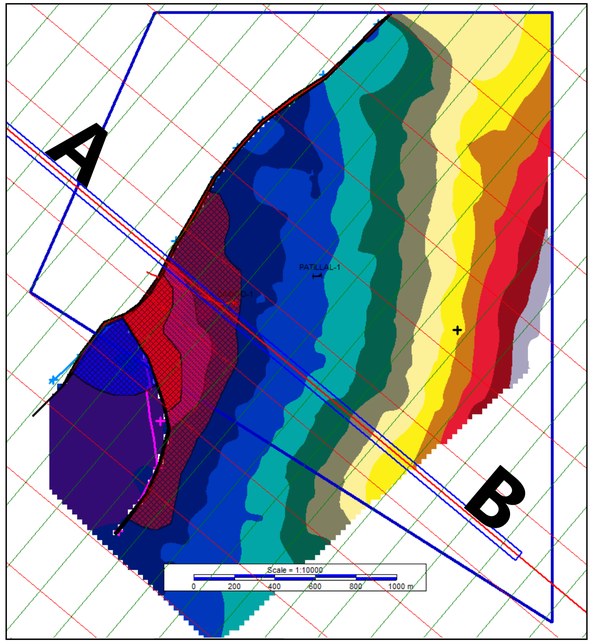
Cummulative Production at December 2012

Campo	Producción de Petróleo (Bls) Acumulado 31-Dic-2012	Producción de Agua (Bls) Acumulada 31-Dic-2012	Producción de Gas (KPC) Acumulado 31-Dic-2012
Caimito	-	-	105,566

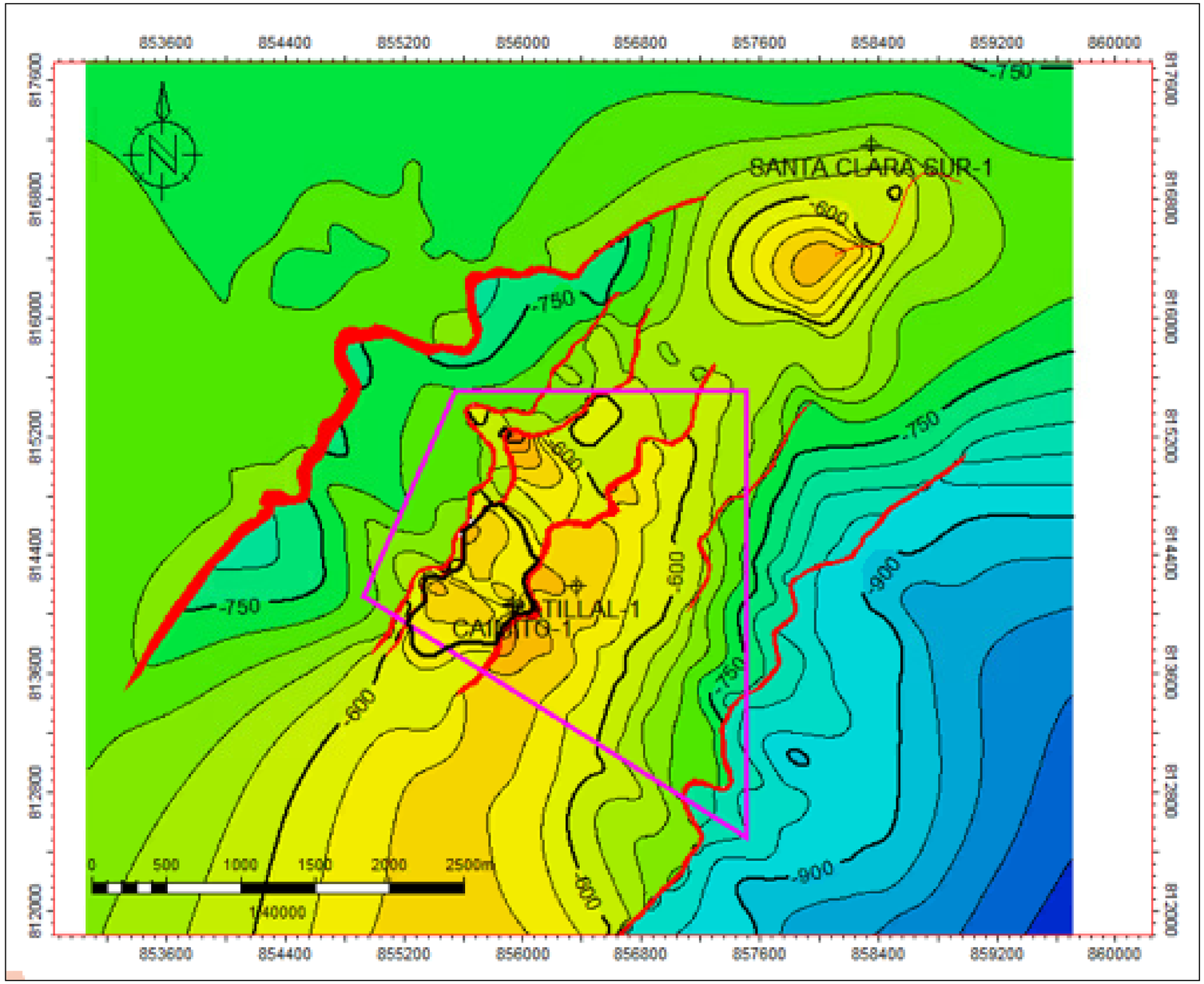
Tabla 2. Producción acumulada a diciembre de 2013 Campo Caimito.

Seismic Interpretation





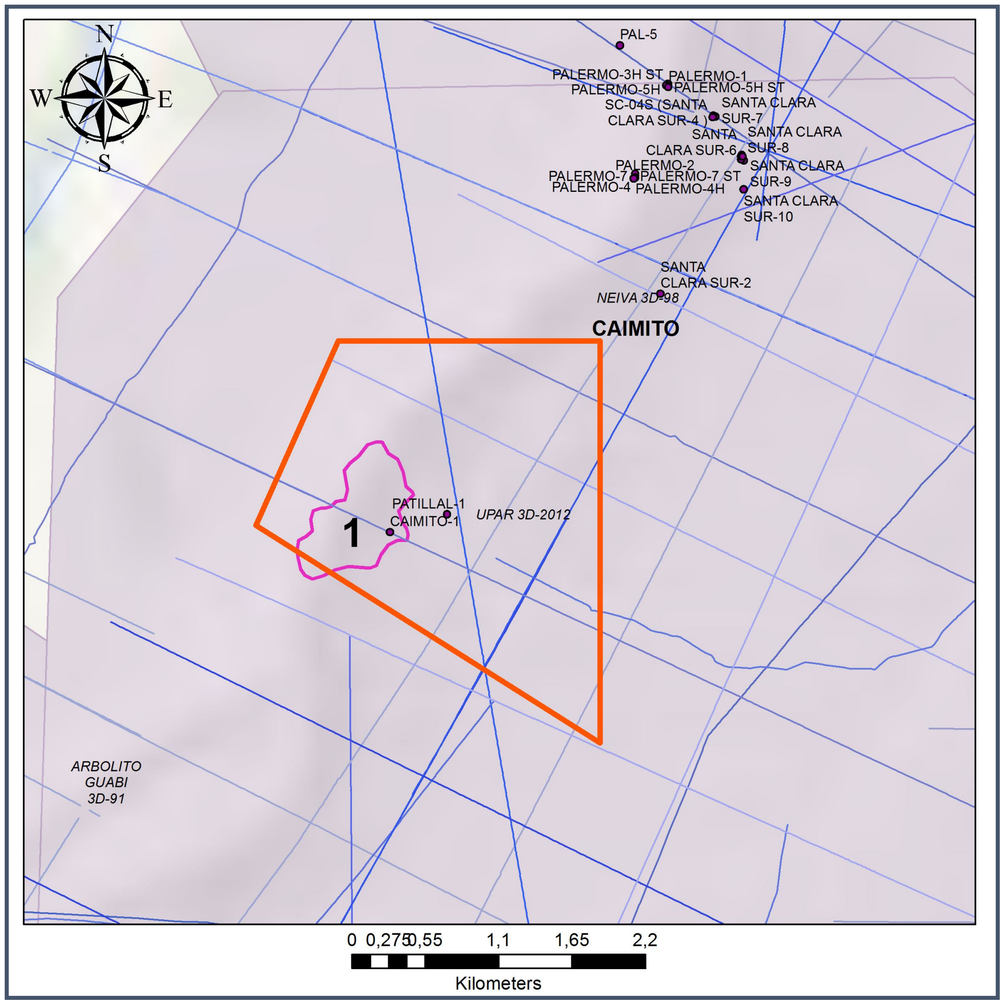
Structural Map in TWT made by ANH (2019)



Structural Map
Upper Caballos Formation.

Area = 123 Acres

ANH Volumetrics



1 LEAD INSIDE

Recoverable Prospective Resources

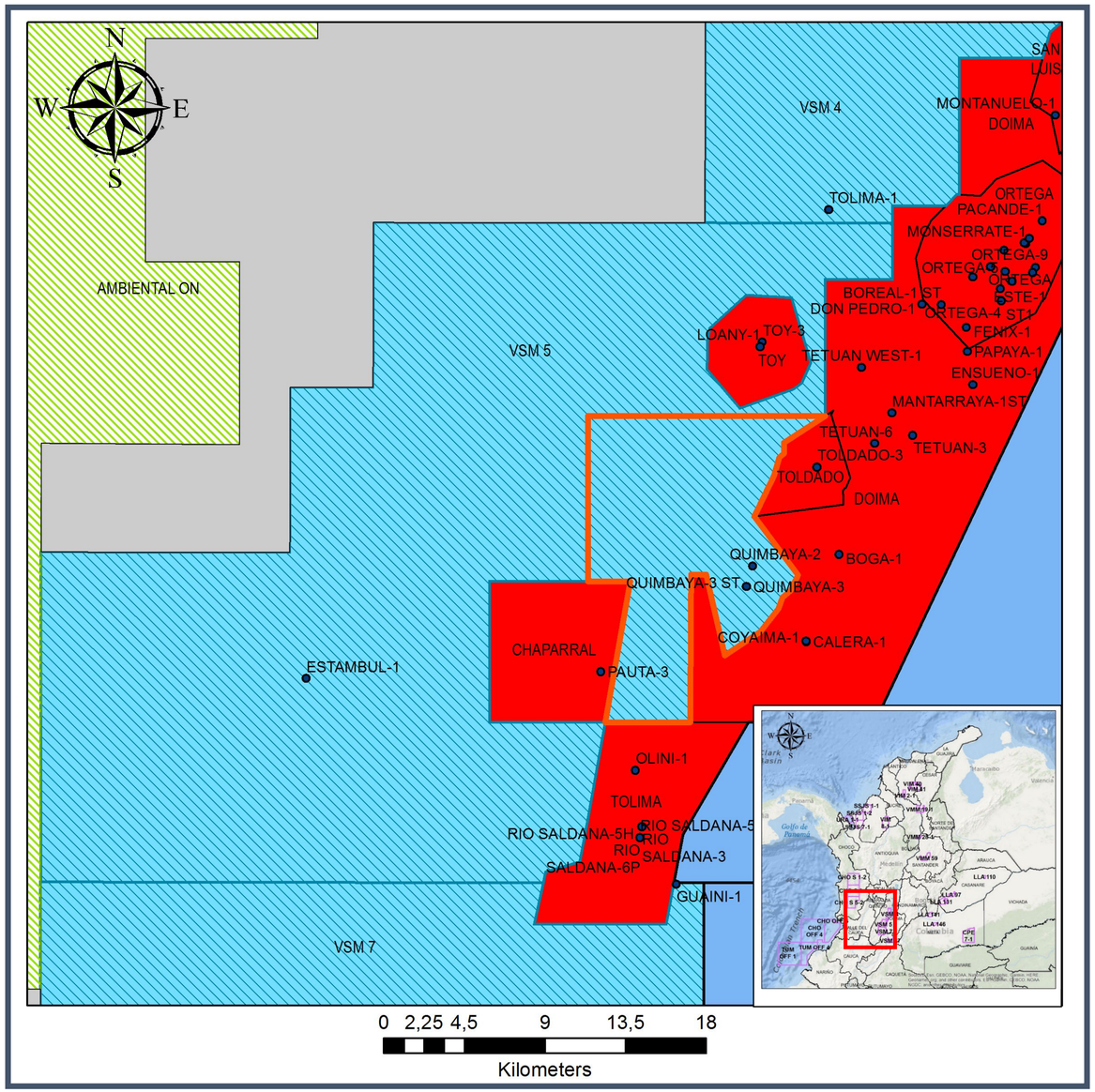
Lead No	OGIP BCF	Prospective Resources BCF
1	1,33	1,06

Lead	Area
1	117 acres

- Net Pay Thickness: 40 ft
- Porosity: 15%
- Sg: 78%
- Recovery Factor: 80%

QUIMBAYA WEST (UMV)

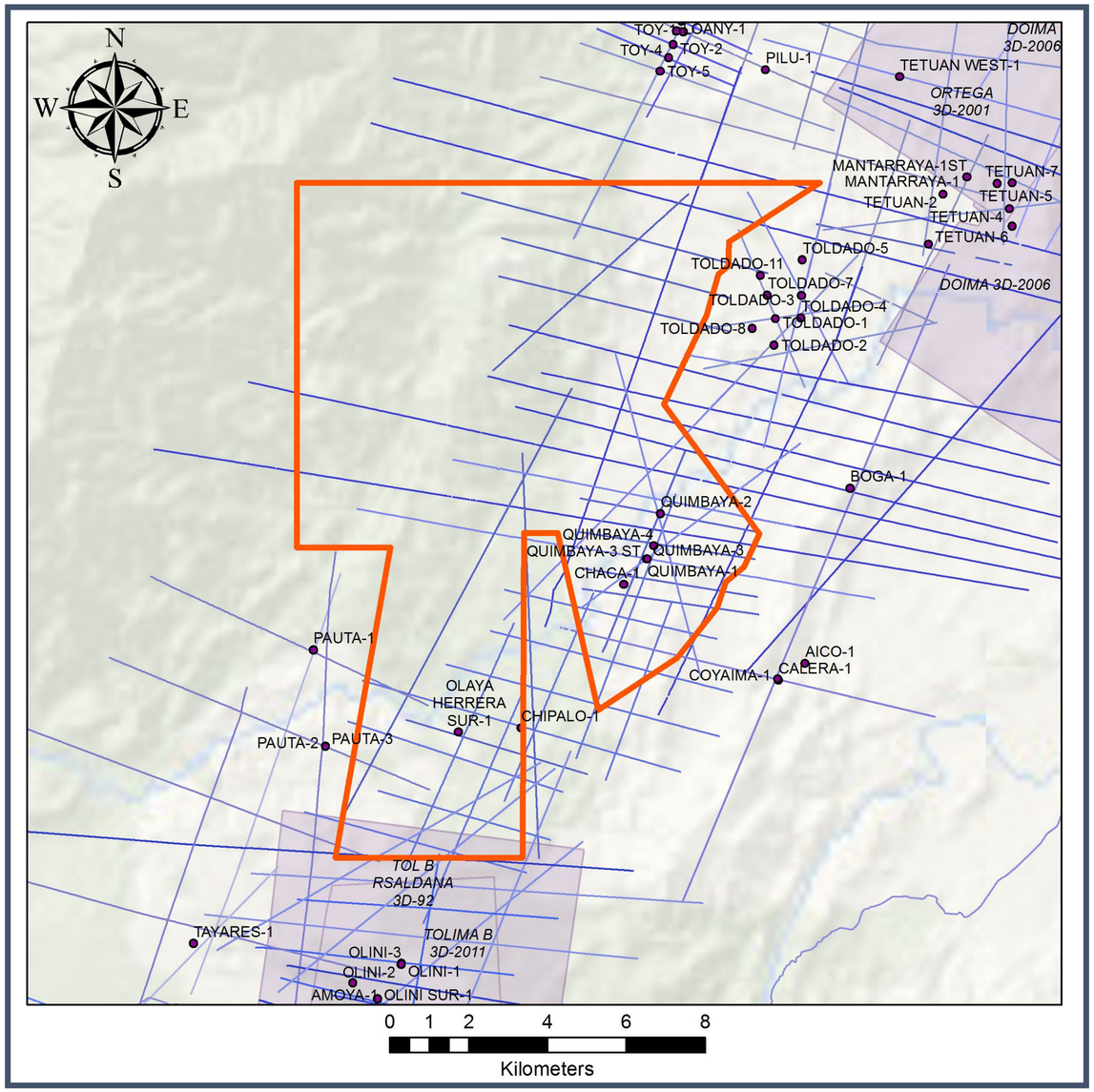
LOCATION QUIMBAYA



- **Block Areas**
- Quimbaya West (14,234 Ha)
- **Departments**
- Tolima

Contract	Contract Signed Since	First Well Drilled in the Area (Year)	# Of Wells
Toldado	2007	1987	8
Doima	2001	1950	10
Chaparral	1987	1988	3
Tolima	2015	1989	3
Toy	2007	1987	8

QUIMBAYA DATABASE: SEISMIC & WELLS



2D Seismic Surveys:

- Chaparral – 87
- Chaparral – 88
- Doima 2D – 2007
- Ortega – Tetuan – 87
- Ortega – Tetuan – 88
- Ortega – Tetuan – 89
- Ortega – 91
- Tolima Det – 90
- Tolima B - 90
- Coyaima – 88

3D Seismic Surveys:

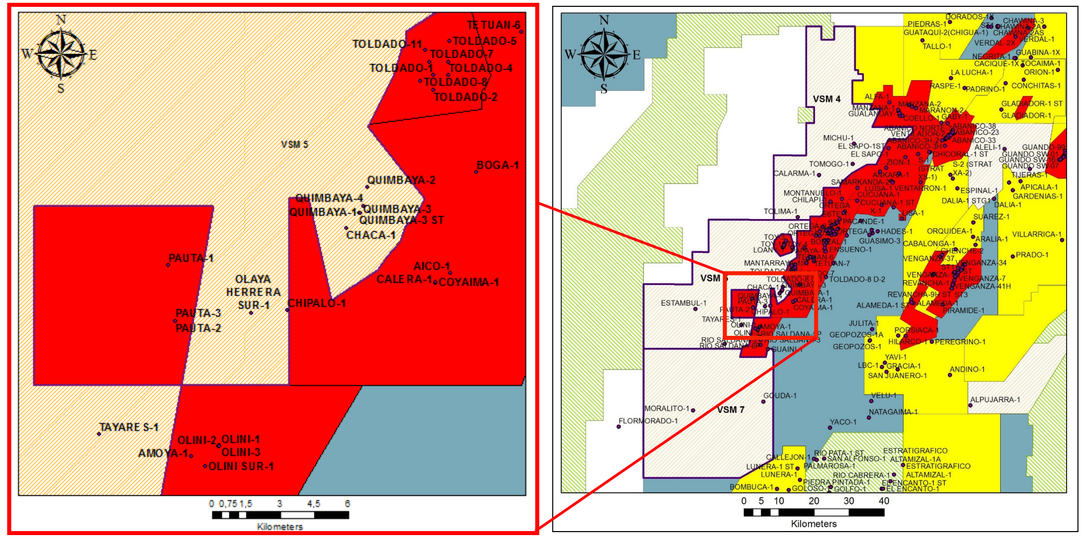
- Tolima 3D - 2011

Well	Year	TD (ft)
Chipalo - 1	1988	4,021
Quimbaya - 1	1988	6,140
Quimbaya - 2	1989	5,762
Quimbaya - 3	1994	5,018
Quimbaya – 3ST	1994	5,018
Quimbaya - 4	1995	5,587

WELLS NEARBY: QUIMBAYA WEST

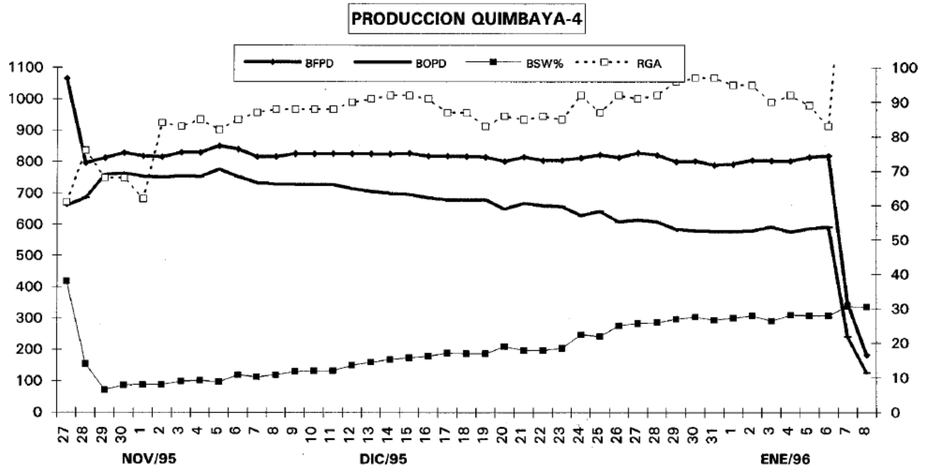
Quimbaya – 1 & Quimbaya - 2

- Well drilled by Ecopetrol in 1988 with a Total Depth of 6,152' proving hydrocarbons at sandstones in the Upper Caballos Formation
- The well Quimbaya – 2 drilled in 1989 with a Total Depth of 5,760 despite of showing hydrocarbons at the Caballos Fm was abandoned due to production of water during testing
- The structure of the Quimbaya field is associated with a system of reverse faults with Eastward vergence



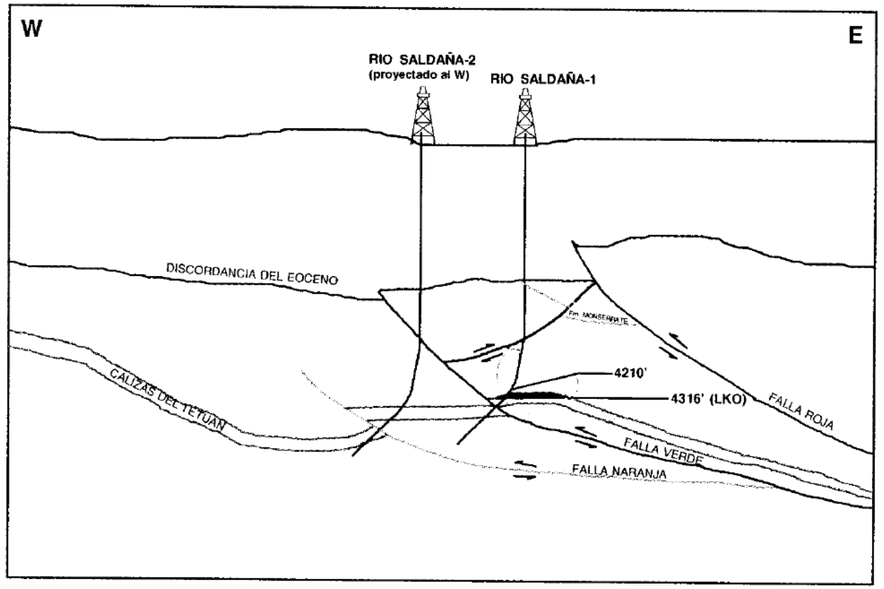
Quimbaya - 4

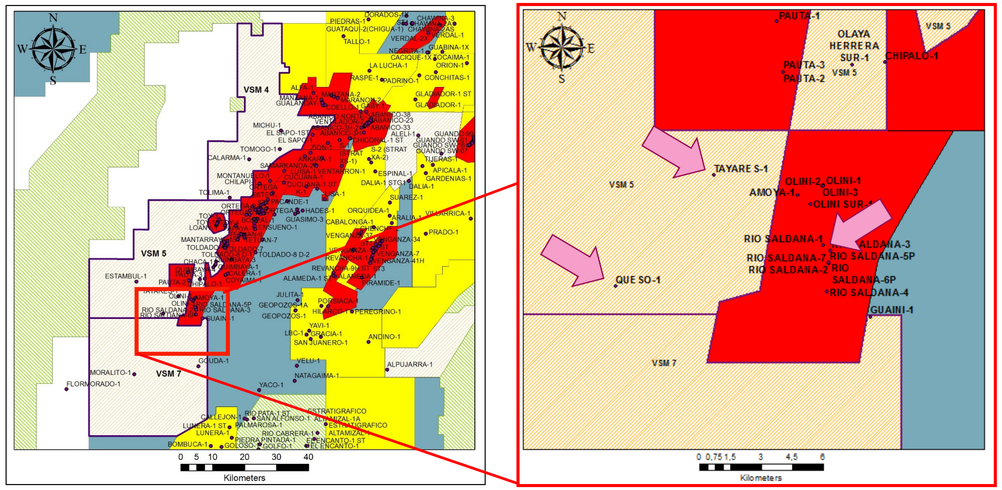
- Well drilled by Hocol in 1995 with a Total Depth of 5,587'
- 3 DSTs were taken in the Upper Caballos Formation with production of Oil with API of 17.5° and saturations above 50%
- The well had a production of 750 BOPD in average from November of 1995 to January of 1996



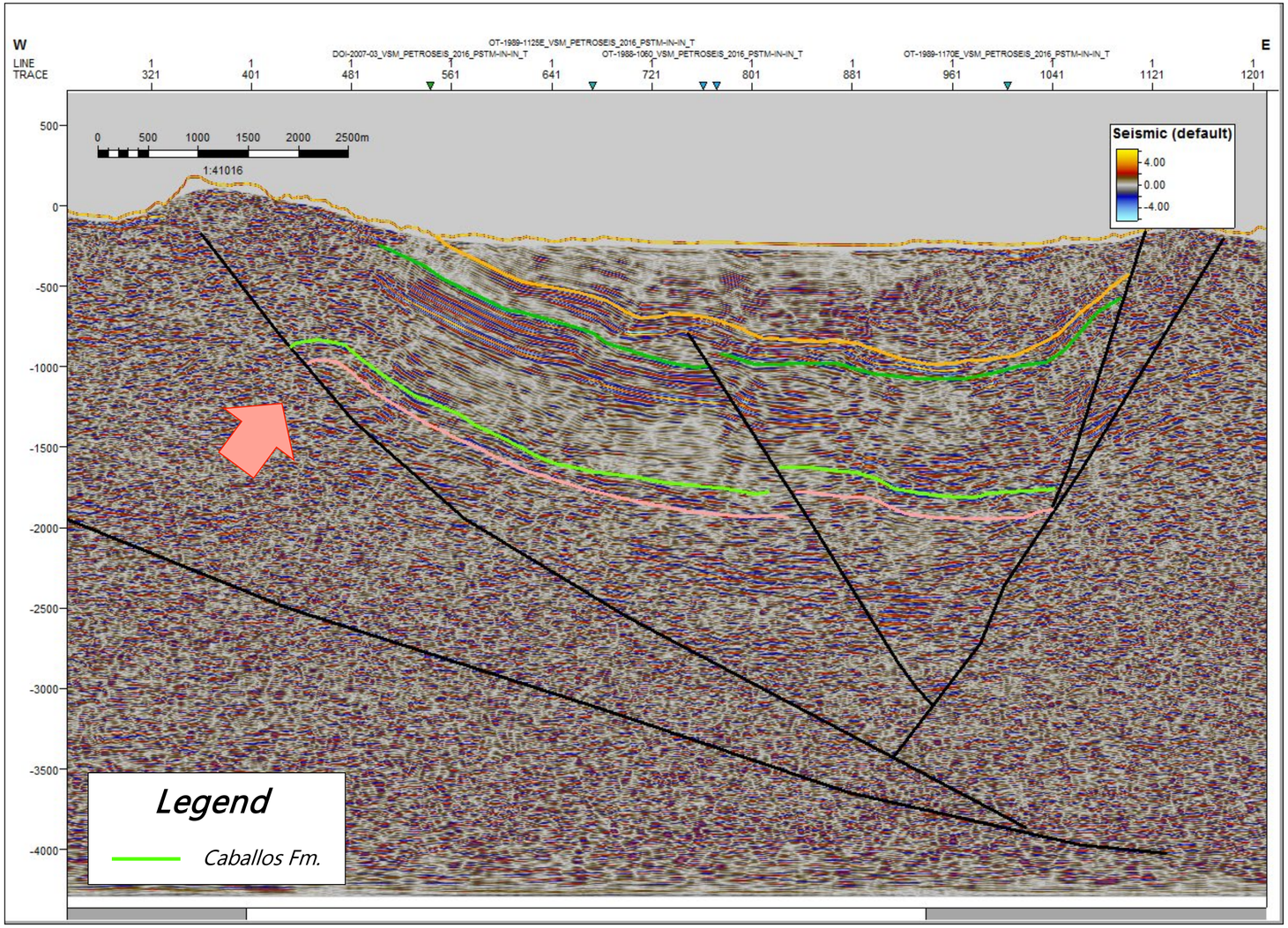
Rio Saldaña - 1

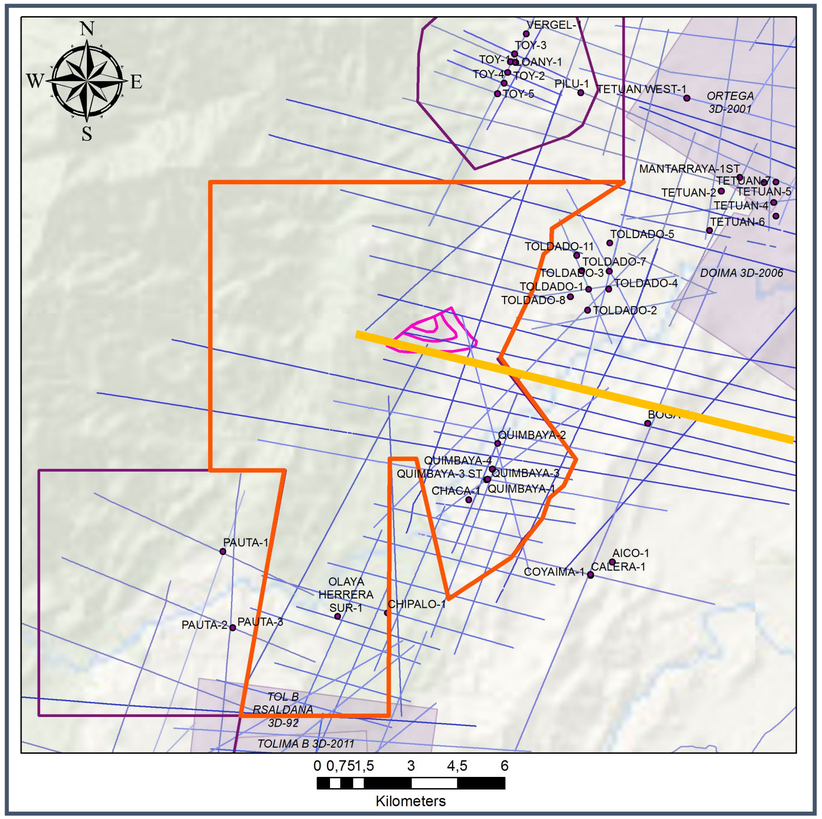
- Well drilled by Hocol in 1987 with a Total Vertical Depth of 5344'.
- Despite of having the target at the **Caballos Formation** sands, the producer level is located at the **Tetúan Formation in calcareous sandstones.**
- Structure: NW/SE trending faulted anticline created by a series of east dipping imbricate back-thrusts spawned from a major west dipping thrust faults
- **Drawdown** at **Tetuan Limestone** with a value of **1.6 MMSTB**



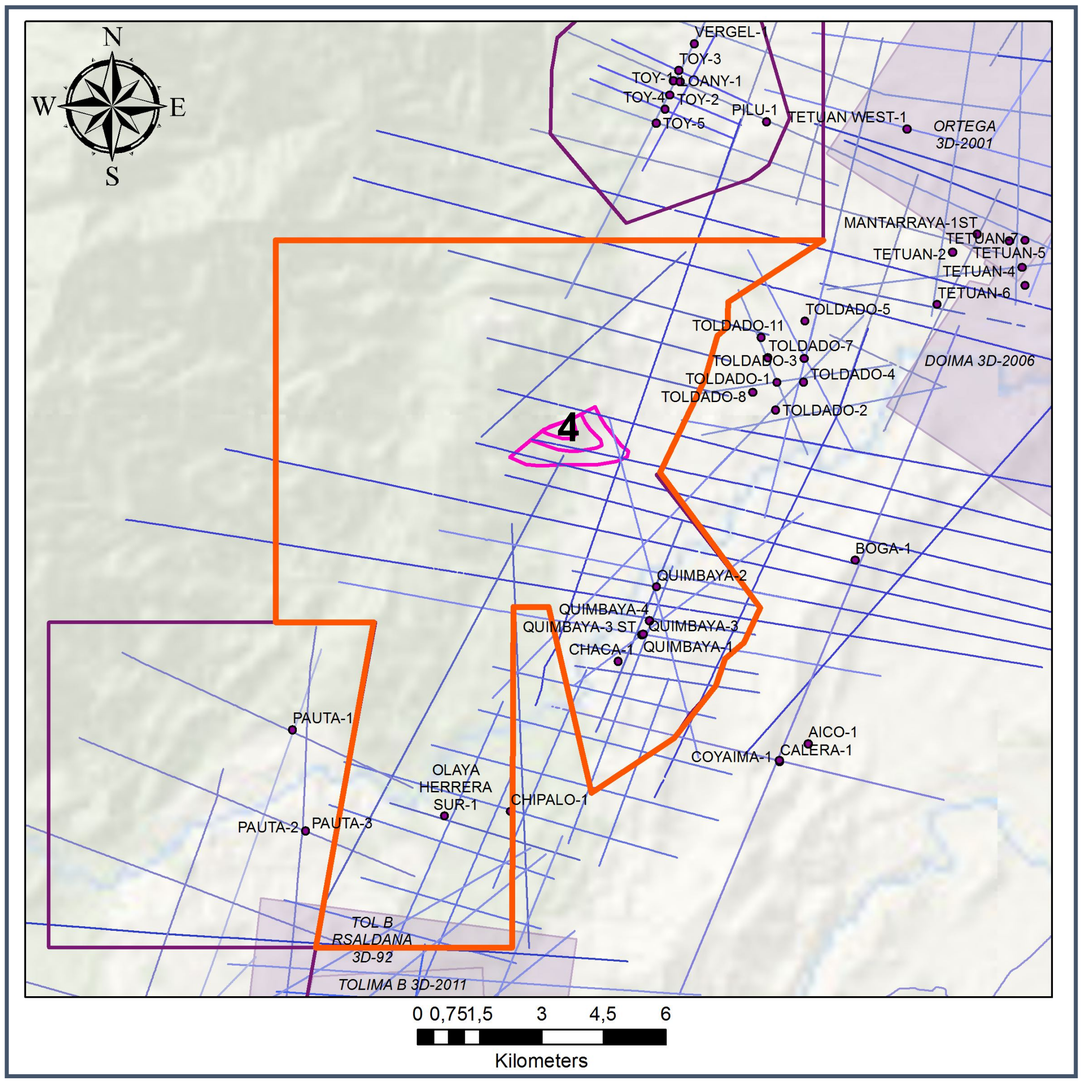


Seismic Interpretation Quimbaya West





VOLUMETRICS VSM - 5



2 LEADS

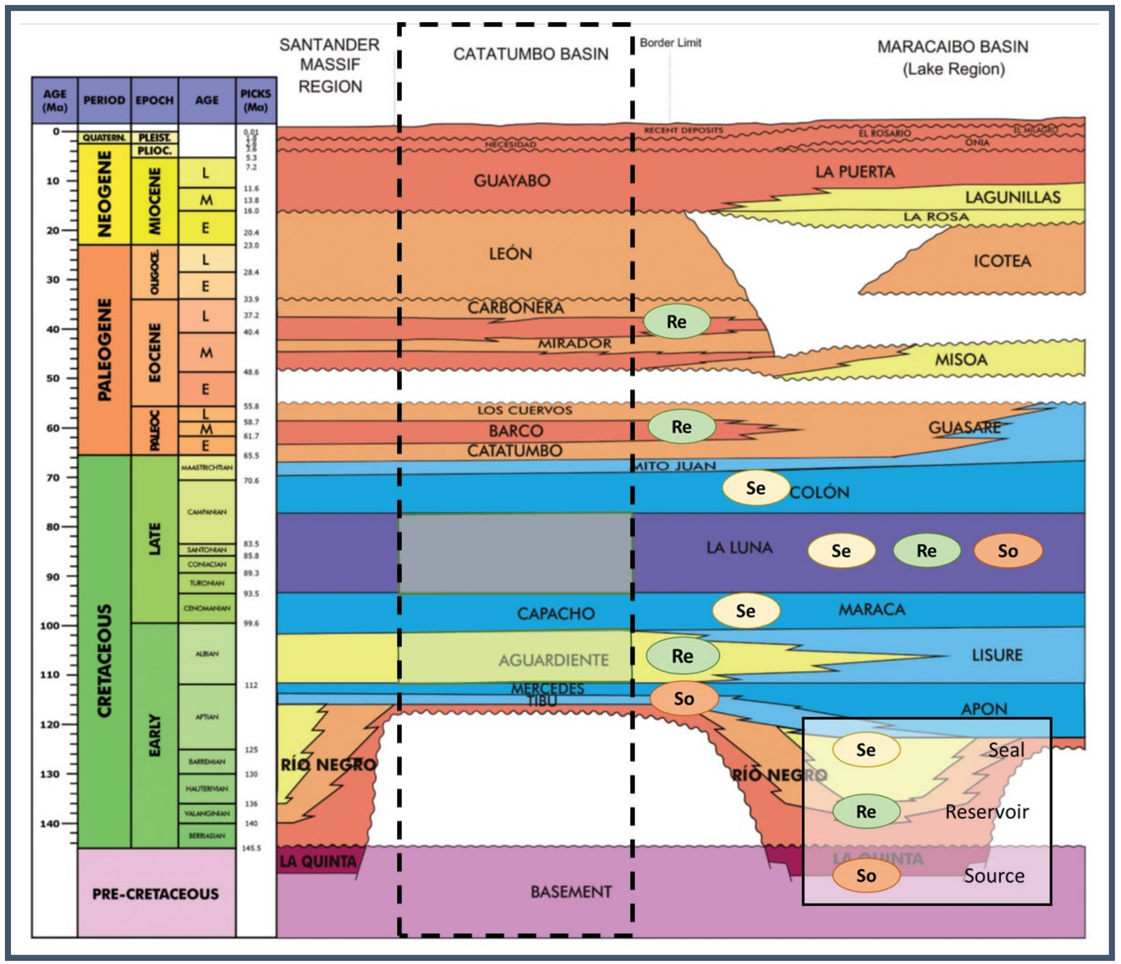
Recoverable Prospective Resources

Lead No	OOIP MMBO	R. Prospective Resources MMBO
4	91.75	4.13

Lead	Area
4	2.34 km^2

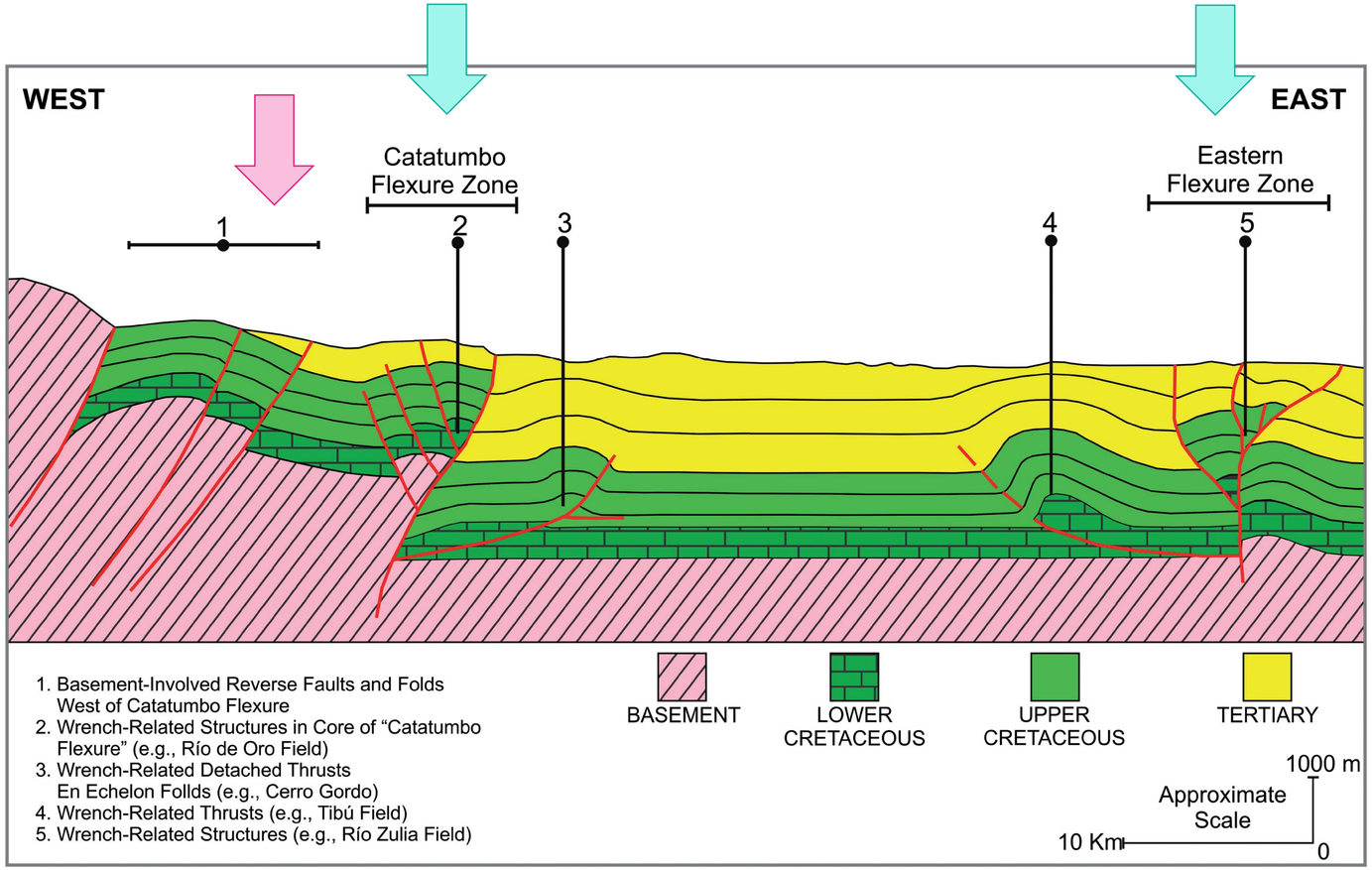
GEOLOGICAL FRAMEWORK CATATUMBO

STRATIGRAPHIC SETTING



- **Carbonera, Mirador and Barco** have been identified as the main reservoirs in the Astilleros, Carbonera and Río Zulia West area
- **La Luna and Aguardiente Formations** have been identified as the main reservoirs in the Sardinata and Cerro Gordo area.
- **La Luna** acts as its own source and seal. The reservoirs as in Cerro Gordo field are associated to secondary porosities due to natural fracture of limestones.
- **Tibú and Mercedes** act as the source of the gas that could be present Aguardiente Formation
- The reservoirs of the Aguardiente Formation are mainly **shoreface sandstones** of high lateral continuity

STRUCTURAL FRAMEWORK

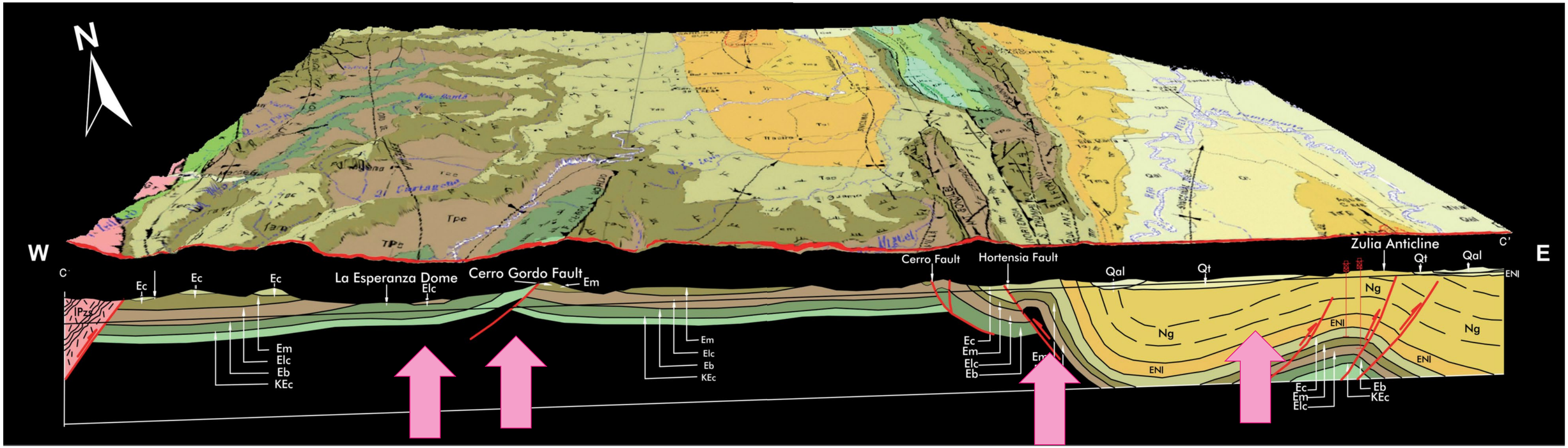


- **Two major styles have been proposed in the literatura**
- **1) One dominated by:**
- Reverse faults that affect the basement (thick skin)
- Folds that occurs on the Western Side.
- **2) A second one characterized by:**
- Thrust faults associated with wrenching
- Reverse faults and folds associated to bending in the western and eastern sides (flexure zone)
- Miocene to Pliocene age

Producer Units by Field

	Target Unit	Unit	Producer Field
Main Targets	Channel Sands	Carbonera	Río Zulia Carbonera
	Channel and Shoreface Sands	Mirador	Río Zulia
	Channel Sands	Los Cuervos	**Tibú** Carbonera: La Silla Río Zulia
	Basal Sands	Barco	Sardinata
		Catatumbo	**Campo Yuca** Carbonera Orú Río de Oro Sardinata **Tibú**
	Upper part Sands	Colón y Mito Juan	Río de Oro Oru **Campo Yuca** Carbonera: La Silla
	Calcareous units	La Luna	**Tibù** Petrolea Cerro Gordo Cerrito
	Platform Sandstones	Capacho - Cogollo	Pto Barco **Tibú** Sardinata **Petrolea**
	Platform Sandstones and Calcareous Units	Uribante Group	Río de Oro Pto Barco **Tibú** Sardinata **Petrolea**

STRUCTURAL SETTING LA ESPESRANZA – CERRO GORDO – RIO ZULIA



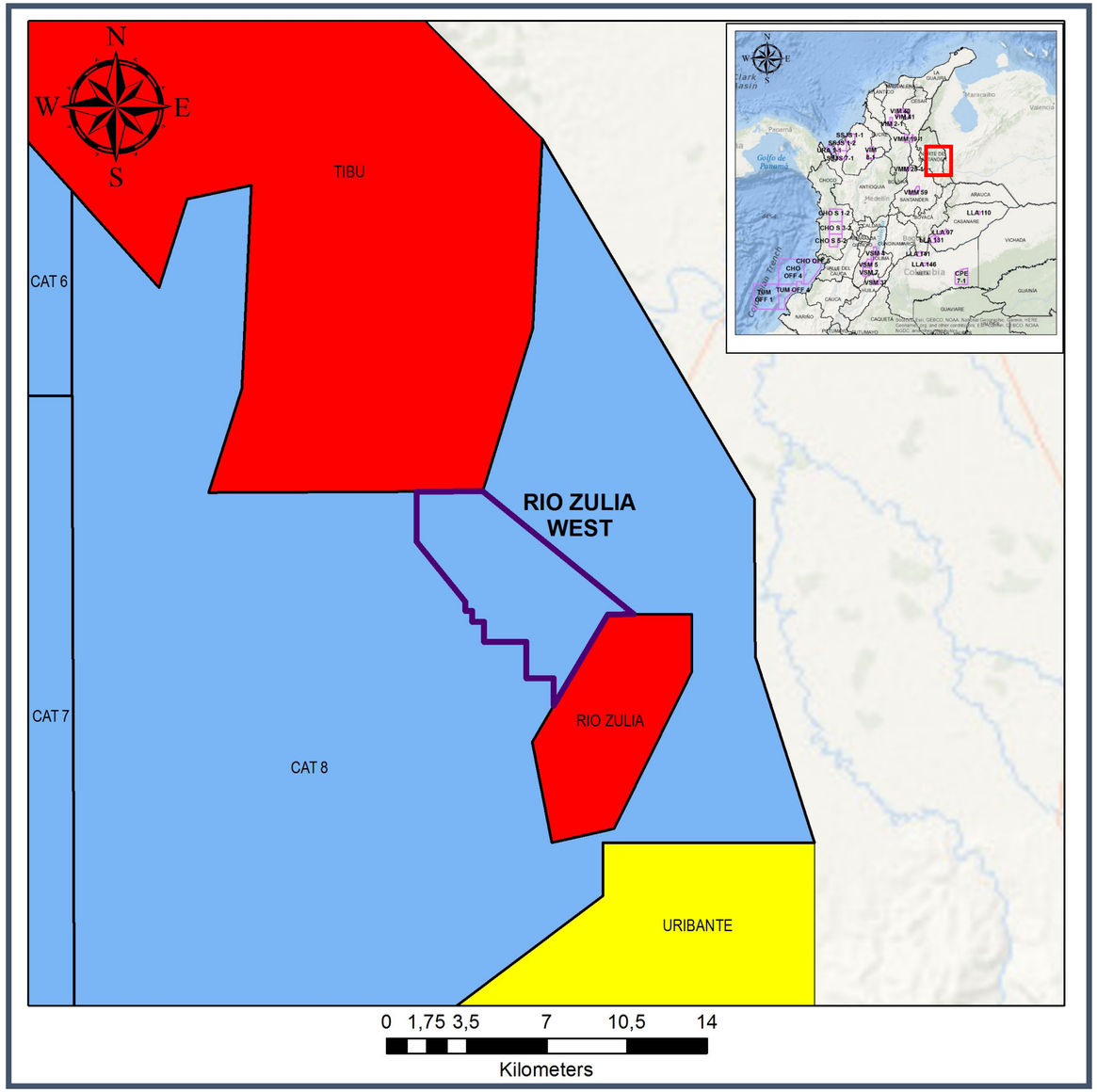
Opportunities identified by the ANH

LEGEND

Ng	Guayabo Group	**Kco**	León Formation
Enl	León Formation	**Kl**	La Luna Formation
Ec	Carbonera Formation	**Kc**	Capacho Formation
Em	Mirador Formation	**Ka**	Aguardiente Formation
Elc	Los Cuervos Formation	**Km**	Mercedes Formation
Eb	Barco Formation	**Kt**	Tibú Formation
KEc	Catatumbo Formation	**Kr**	Río Negro Formation
Kmj	Mito Juan Formation	**Jlq**	La Quinta Formation

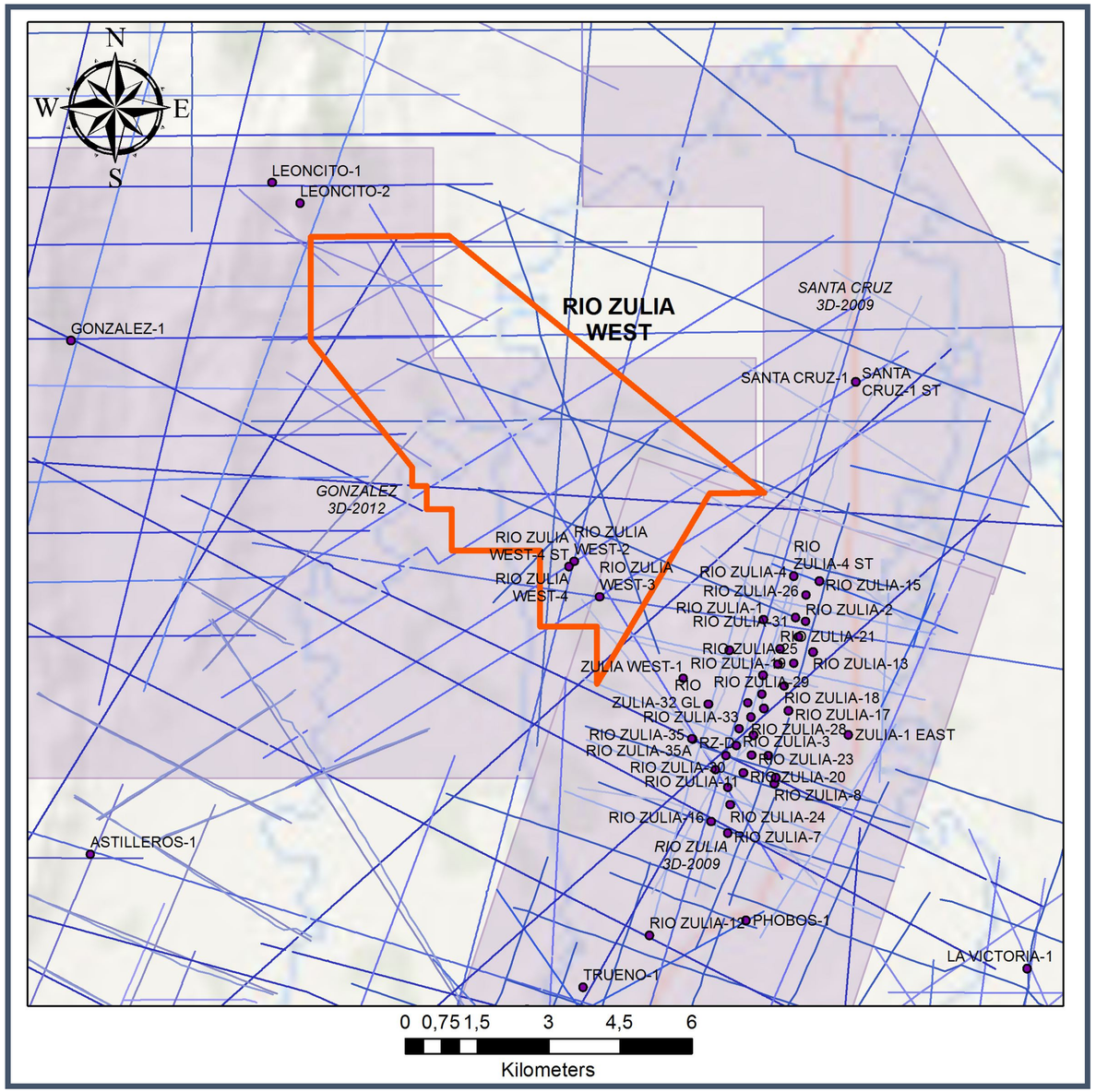
RIO ZULIA WEST (CATATUMBO)

LOCATION IN CATATUMBO: RIO ZULIA WEST



- **Block Areas**
- Río Zulia (3,981 Ha)
- **Department**
- Norte de Santander

RIO ZULIA WEST DATABASE: WELLS & SEISMIC



2D Seismic Surveys:

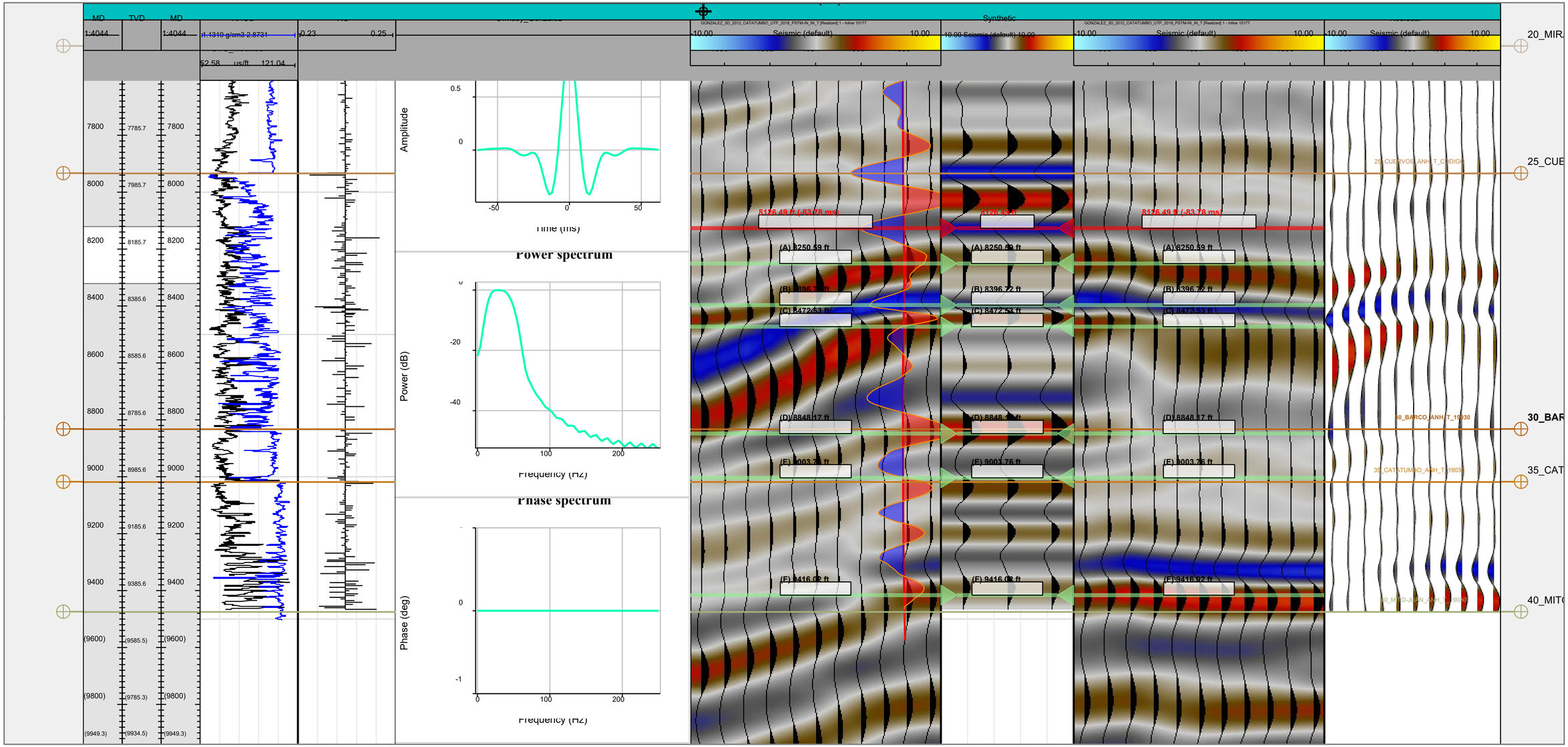
- Rio Zulia – 83
- Carbonera – 87
- Carbonera – 90
- Catatumbo – 77
- Rio Zulia – 63
- Astilleros – 71
- Leoncito – 99
- Rio Zulia – 1978
- Rio Zulia – 1998
- Gonzalez 2D – 2008
- Uribante - 2005

3D Seismic Surveys:

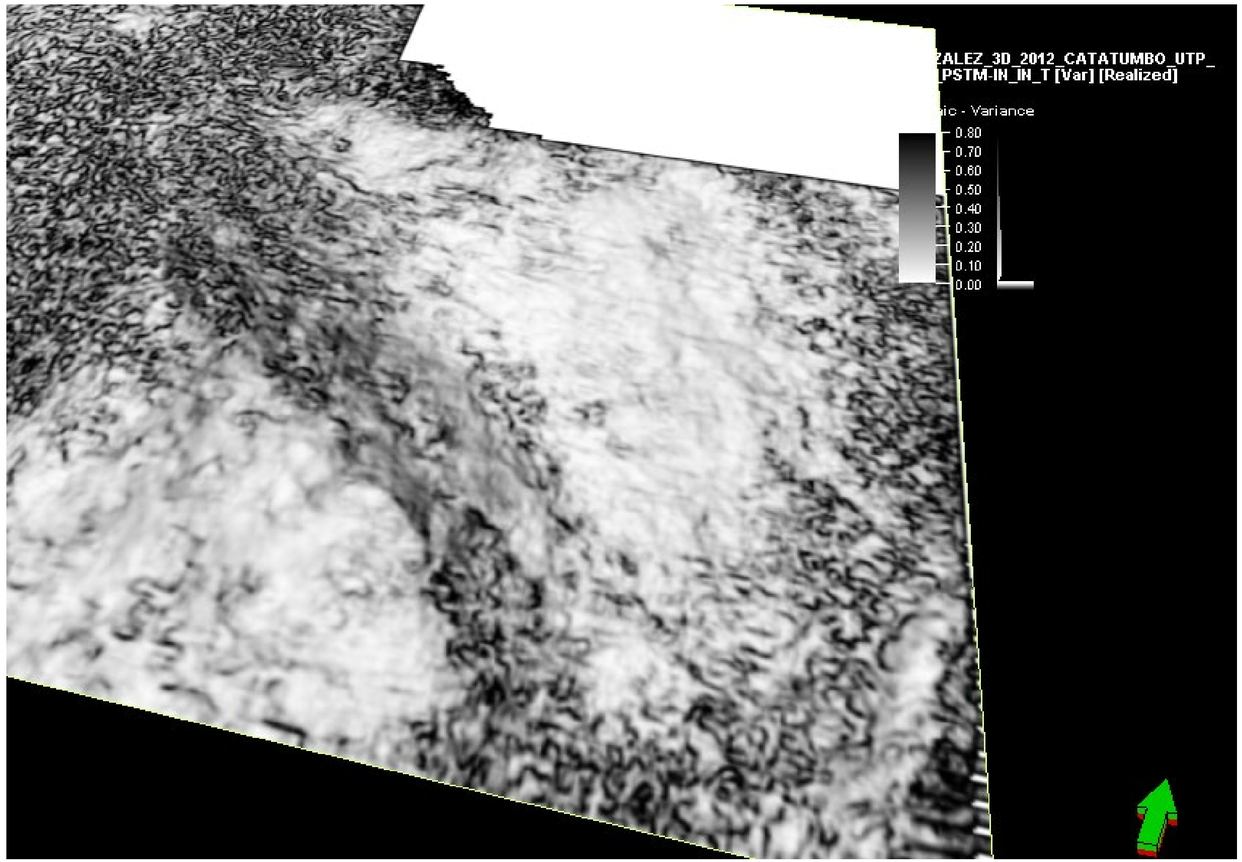
- Gonzalez 3D – 2012
- Rio Zulia 3D - 2009

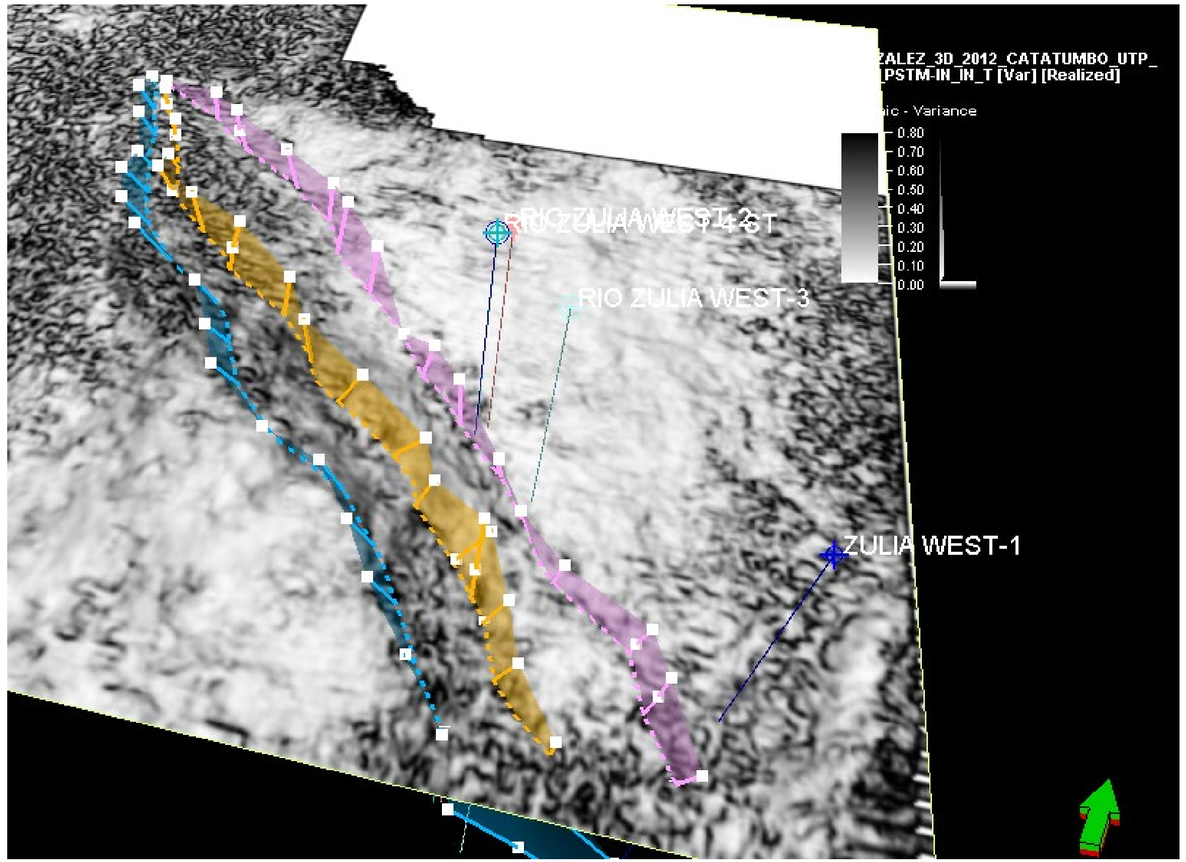
Well	Year	TD (ft)
Rio Zulia West – 1	1963	7,769
Rio Zulia West – 2	2002	9,480
Rio Zulia West - 3	2010	9,705
Rio Zulia West – 4	2010	9,006
Rio Zulia West – 4 ST	2004	5,509

Well Tie: Rio Zulia West – 4 ST

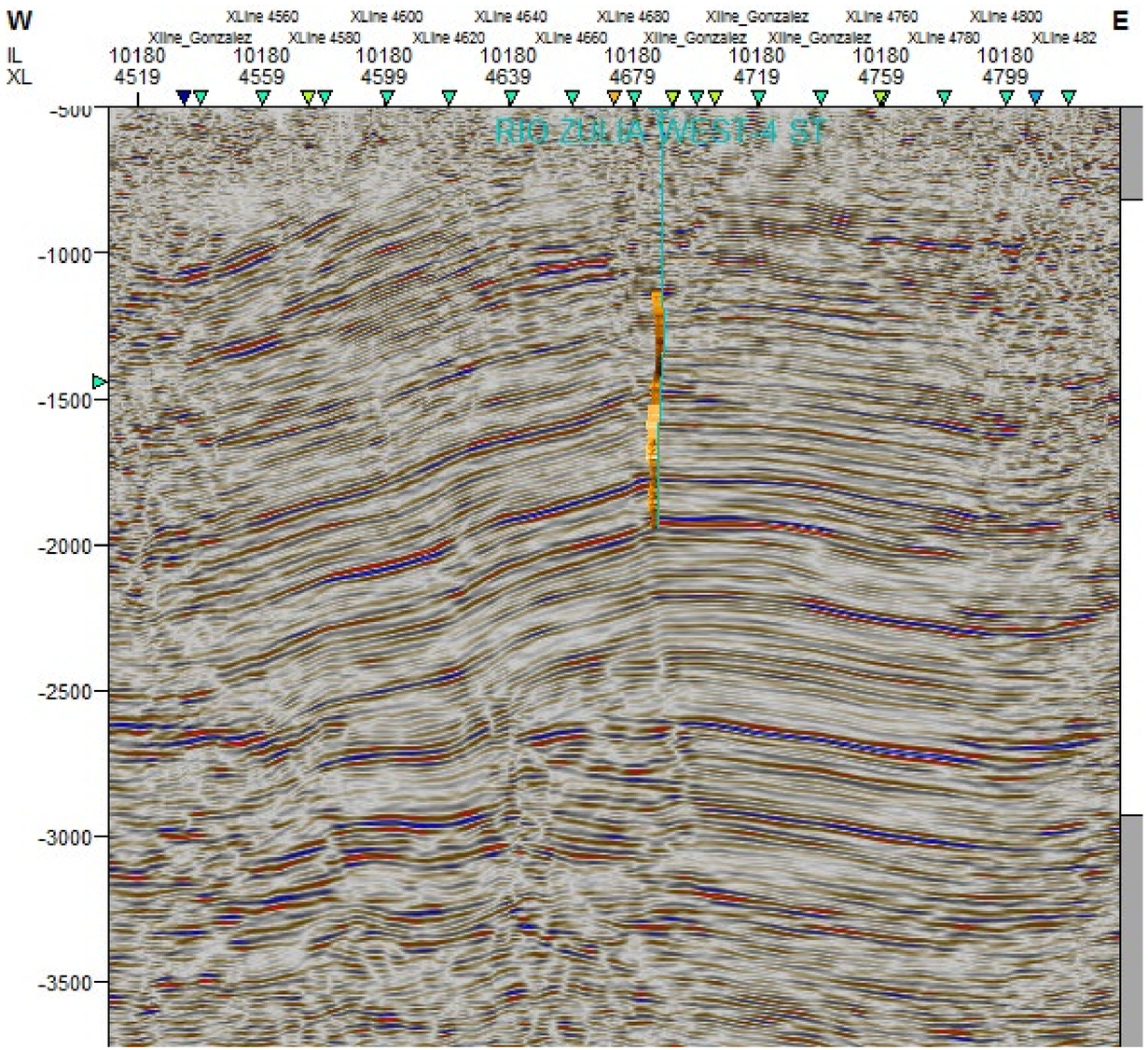


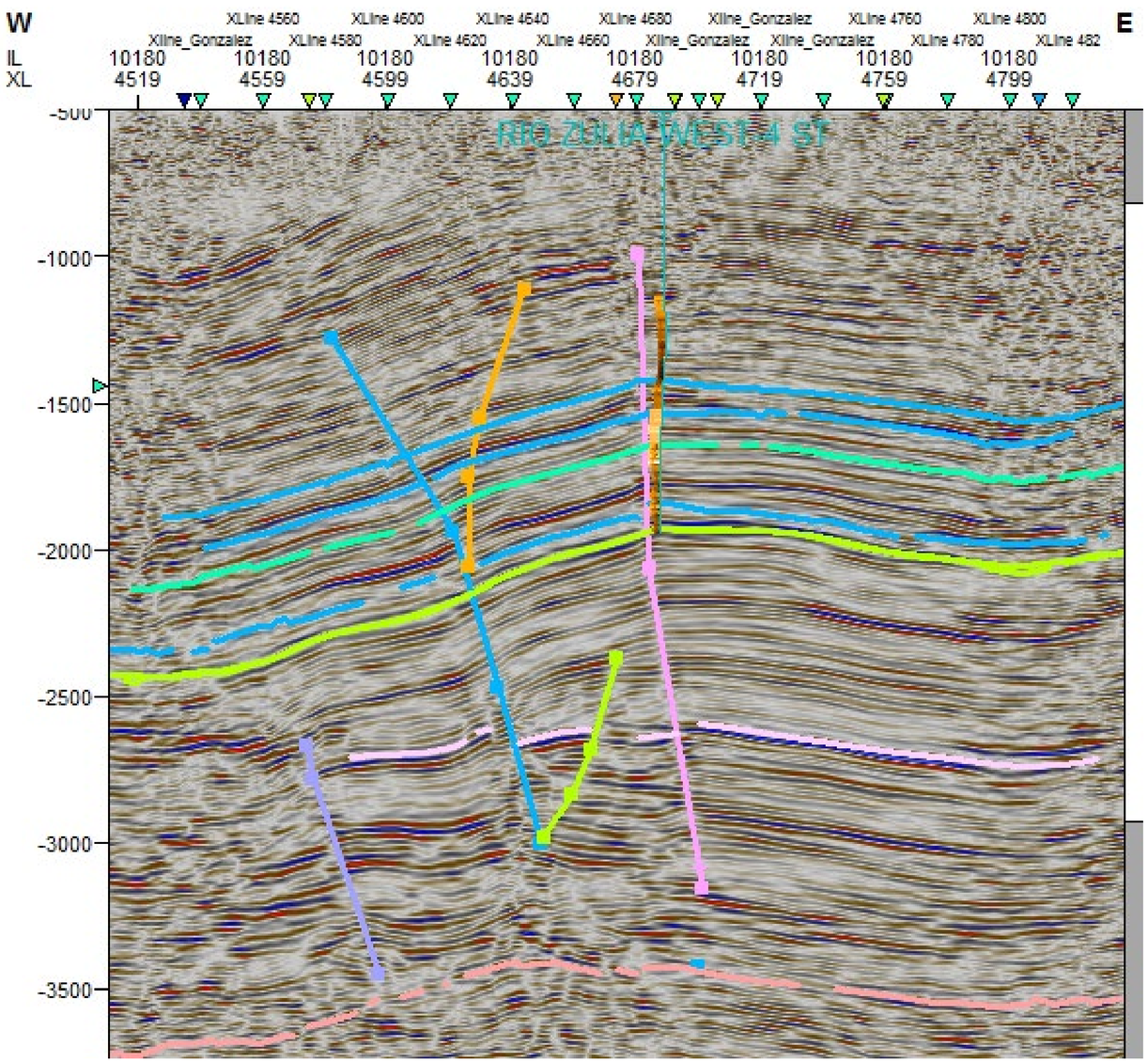
Fault Model Rio Zulia West



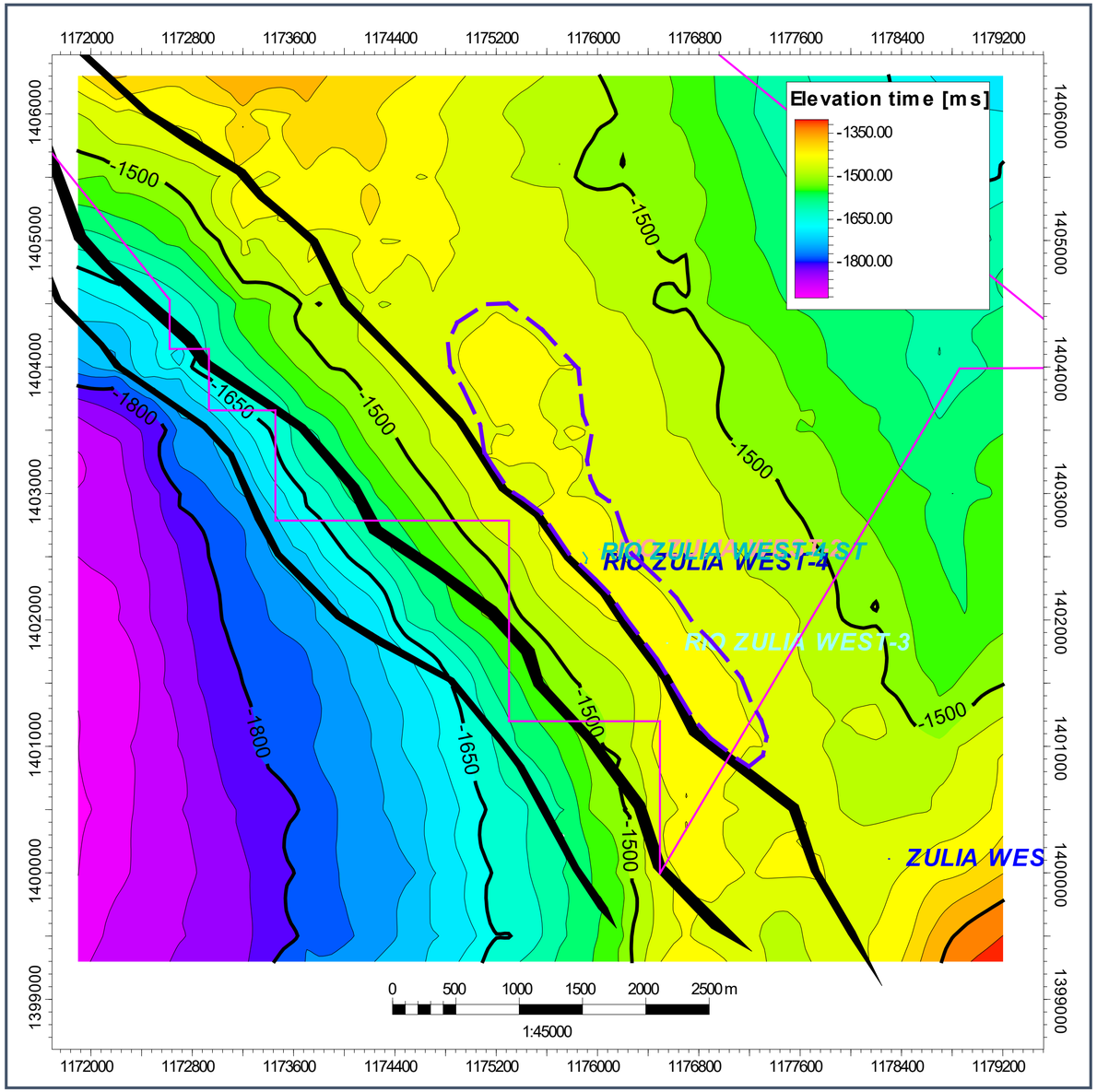


Gonzalez 3D – 2012: Inline





Contour Map: Carbonera Fm & Volumetrics



PROSPECT	AREA (Acres)	THICKNESS (Net Pay) (Ft)	POROSITY (%)	SO (%)	Boi	OOIP (BLS)	FR (%)	RESOURCES (BLS)
Rio Zulia west Barco Fm.	850	12	0.13	0.75	1.5000	5,143,554	0.22	1,131,582
Rio Zulia West Fm Carbonera	324	17	0.10	0.60	1.0690	2,398,376	0.17	407,724

CONCLUSIONS

- Three blocks considered as undeveloped already discovered reservoirs (Quimbaya West, Cacica & Caimito) are offered in the Upper Magdalena Valley and one is offered in the Catatumbo Basin (Rio Zulia West)

- The Upper Magdalena Valley Basin is considered the third most productive basin of Colombia. It produces around **18 MMBO** per year from more than **30 fields**. The **main source** at the Upper Magdalena Valley basin is considered the **Villeta Group** and the **main reservoirs** at the blocks offered by the ANH are considered the **Upper Caballos** and **Honda Formations**

- The Catatumbo basin has a very **long history of production since 1920s** with 872 wells drilled and 3,874 km of 2D seismic acquired. Twelve (12) Oil & Gas fields have been discovered and more than 21 isolated exploratory wells have been drilled

- 10 wells some of them with **production** and **successful tests** were drilled in the Upper Magdalena Valley and 4 wells were drilled in the Rio Zulia West structure **producing and proving hydrocarbons**.

- Most of the areas offered are covered completely by 3D seismic surveys, except Quimbaya West that only have a good 2D seismic coverage. From the data availability and proven petroleum system point of view, the areas could be considered as excellent opportunities.

- Most of the wells drilled in the UMVB reached a **maximum depth of 6000'** with the main target at the **Caballos and La Victoria Formation (Honda Group)** showing plenty of gas shows. One of the main challenges to avoid reservoir problems is to assess better the reservoir quality using new technologies such as 3D seismic with QI evaluations.

- 4 opportunities have been identified by the ANH in three blocks in the UMVB with the following resources: Cacica (0,427 MMBLS), Caimito (1,06 BCF) and Quimbaya West (4,13 MMBLS)

- The opportunity identified in the **Catatumbo basin** at the **Rio Zulia West** opportunity **1,5 MMBLS** of resources have been calculated for the **Barco and Carbonera Fm.**

Thanks

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