

COLOMBIA ROUND 2021

COLOMBIA ROUND 2021: UPPER MAGDALENA VALLEY BASIN EXPLORATORY OPPORTUNITIES

Location

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Infrastructure

Geological Framework

Well Summary

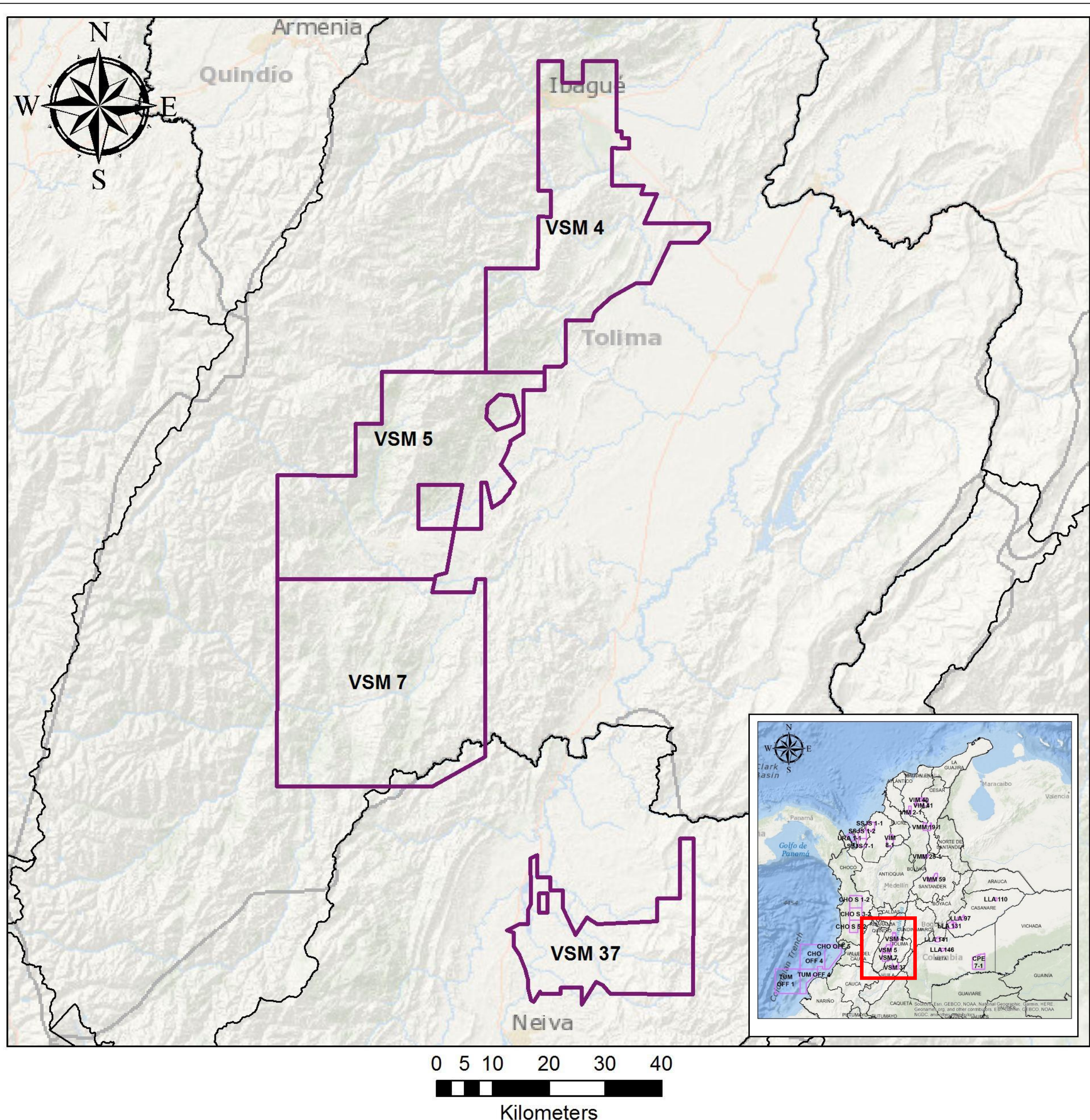
Seismic Interpretation

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Conclusions

INTRODUCTION

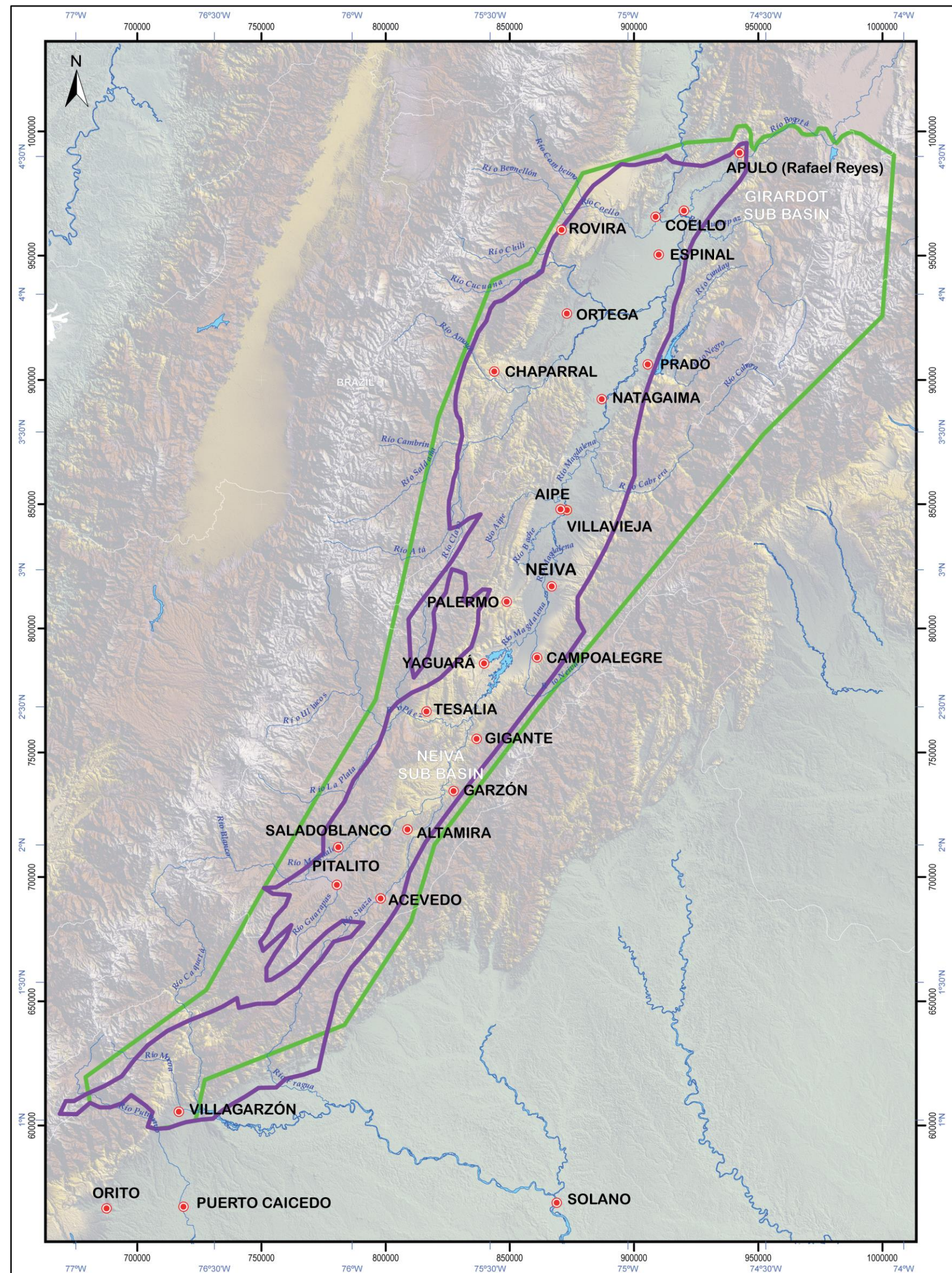
LOCATION



- **Block Areas**
- VSM-4 (97,051.52 Ha)
- VSM-5 (105,332.92 Ha)
- VSM-7 (132,381.88 Ha)
- VSM-37 (47,852.43 Ha)

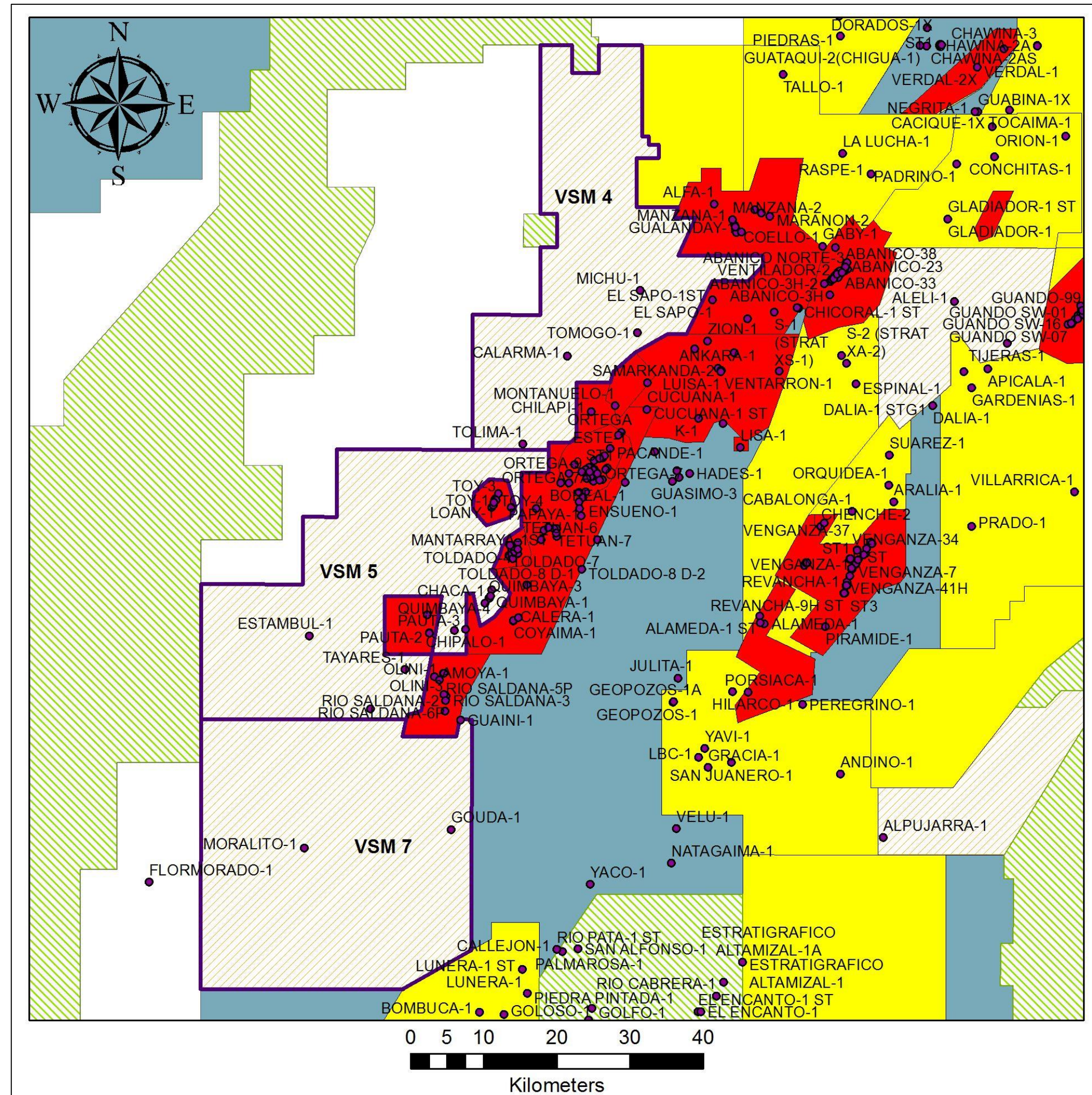
- **Departments**
- Tolima & Neiva

HISTORY OF EXPLORATION



- The UMVB (Upper Magdalena Valley Basin) is considered as the **third most productive** basin of Colombia
- It produces around **18 MMBO** per year from more than **30 fields**
- Exploration goes back to the Texas Petroleum Co field discovery of **Ortega Tetuan in 1951**
- According to ANH (2009) **630 MMBO** and **123 GCFG** have been discovered in 38 fields, 1210 wells have been drilled and 145 seismic programs have been acquired

DATABASE: WELLS (Northern Part)



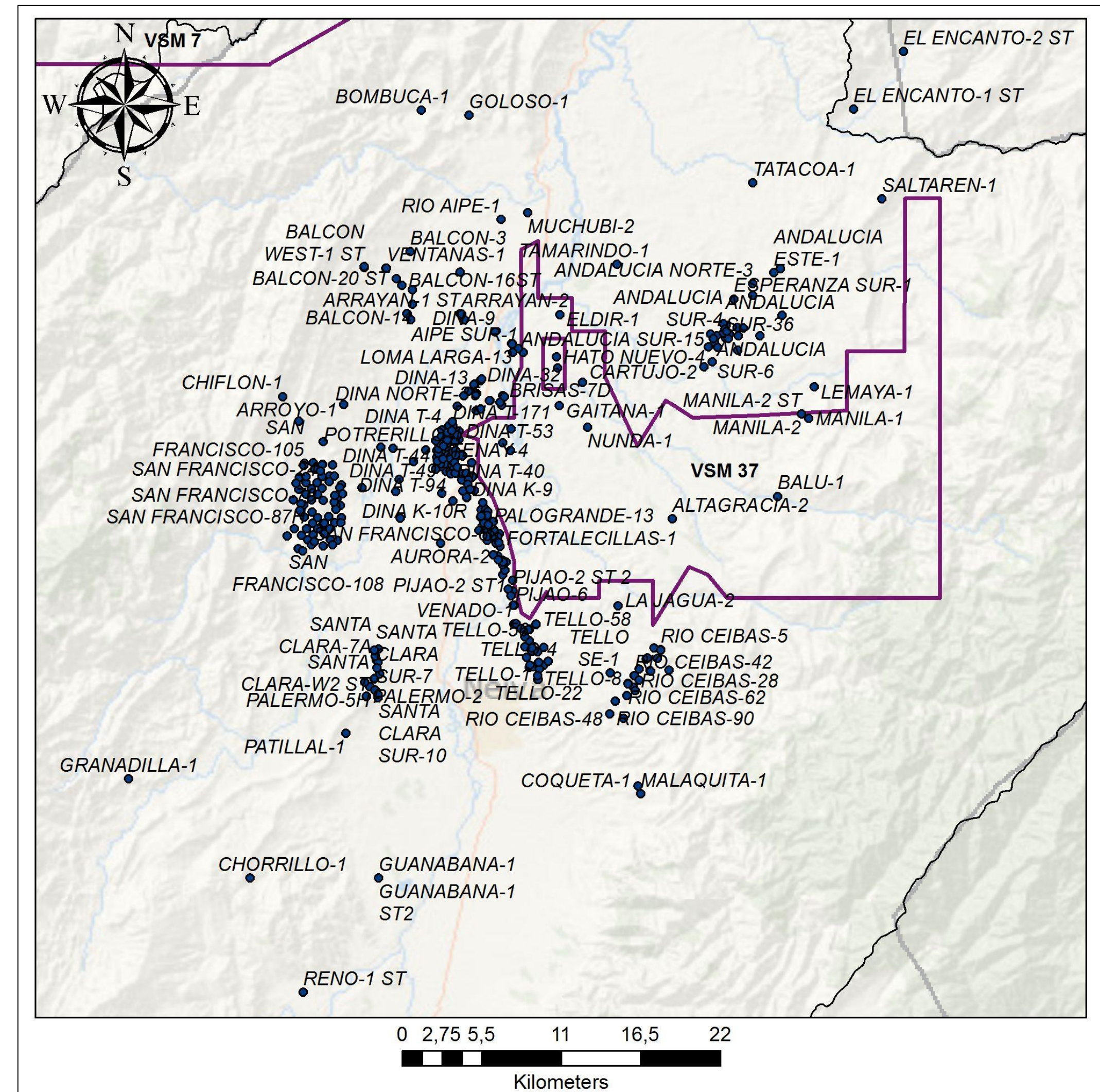
Well	Year	TD (ft)
Tolima - 1	1988	3,658
Michu - 1	1990	4,094
Tomogo - 1	1990	2,507
Calarma - 1	2004	5,509
Quimbaya - 2	1989	5,762
Quimbaya - 3	1994	5,018
Estambul - 1	2003	2,240
Gouda - 1	2010	5,641
Guaini - 1	2007	5,691

Contract	Contract Signed Since	First Well Drilled in the Area	# Of Wells
Buganviles	2000	1949	14
Chipalo	1998	1957	9
San Luis	1985	1957	2
Abanico	1996	2000	12
Ortega	2007	1951	15
Doima (Tetuan)	2001	1950	10
Toldado	2007	1987	8
Tolima (Rio Saldaña)	2015	1989	3
Chaparral	1987	1988	3

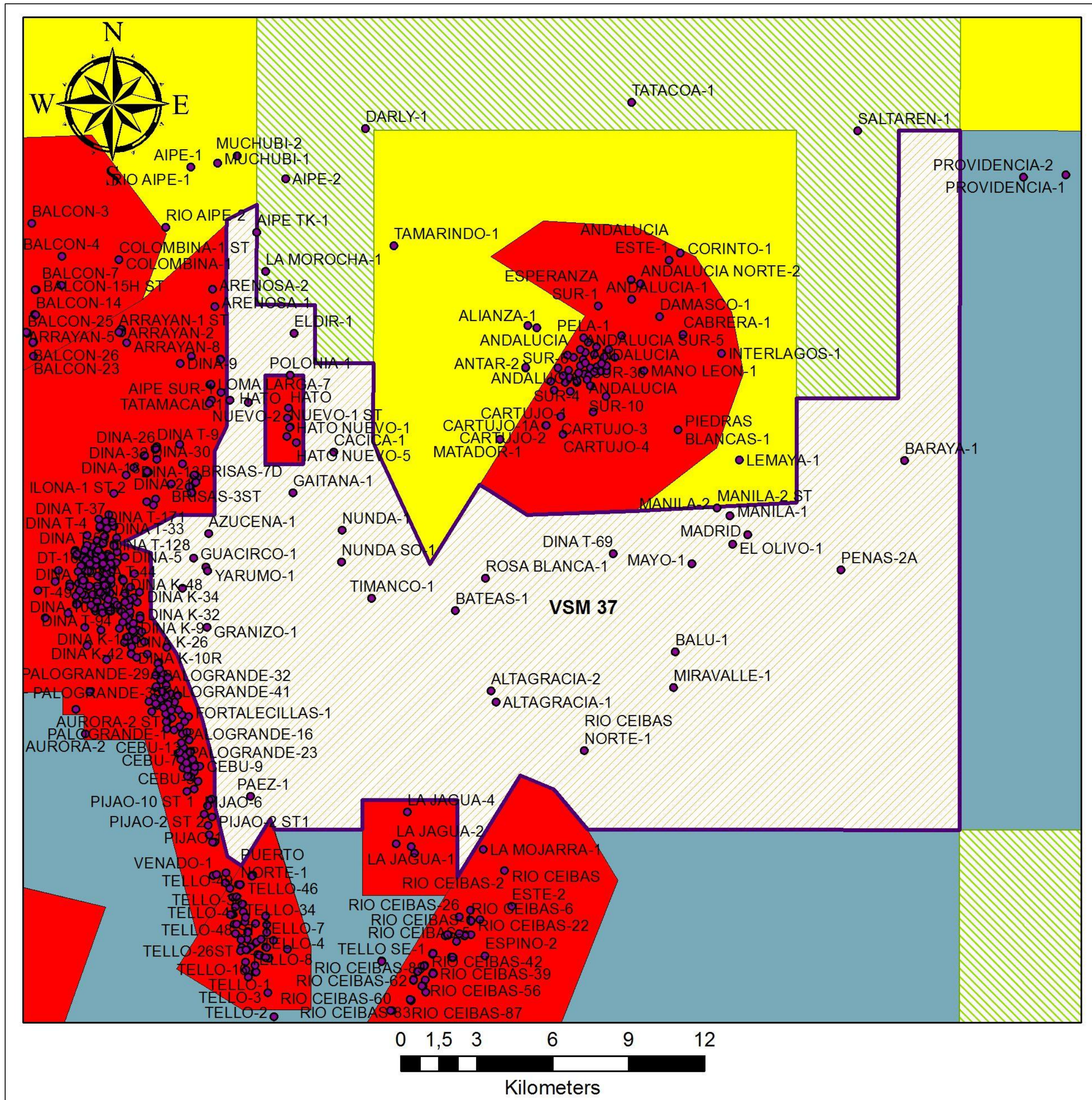
DATABASE: WELLS (Southern)

23 Wells

Well	Year	TD (ft)
Eldir-1	2014	4,500 (?)
Tatamacal - 1	1983	5,047
Azucena - 1	2006	5,238
Guacirco - 1	1977	7,360
Yarumo - 1	2009	9,414
Higueron - 1	1985	6,000
La Colorada - 1	1985	11,702
Granizo - 1	1985	10,797
Gaitana - 1	1984	7,211
Nunda - 1	2011	7,166
Altagracia - 1	1980	7,407
Altagracia - 2	1982	8,004
Balu - 1	2005	1,775
Manila - 1	1971	4,703
Manila - 2ST	1982	6,880 (?)
Cacica - 1	2014	6,300
Rosa Blanca - 1	1987	2,960
Timanco - 1	1986	7,650
Bateas - 1	1982	8,157
Mayo - 1	2004	8,600
Miravalle - 1	1988	2,634
El Olivo - 1	1991	3,560
Penas - 2A	1990	1,374

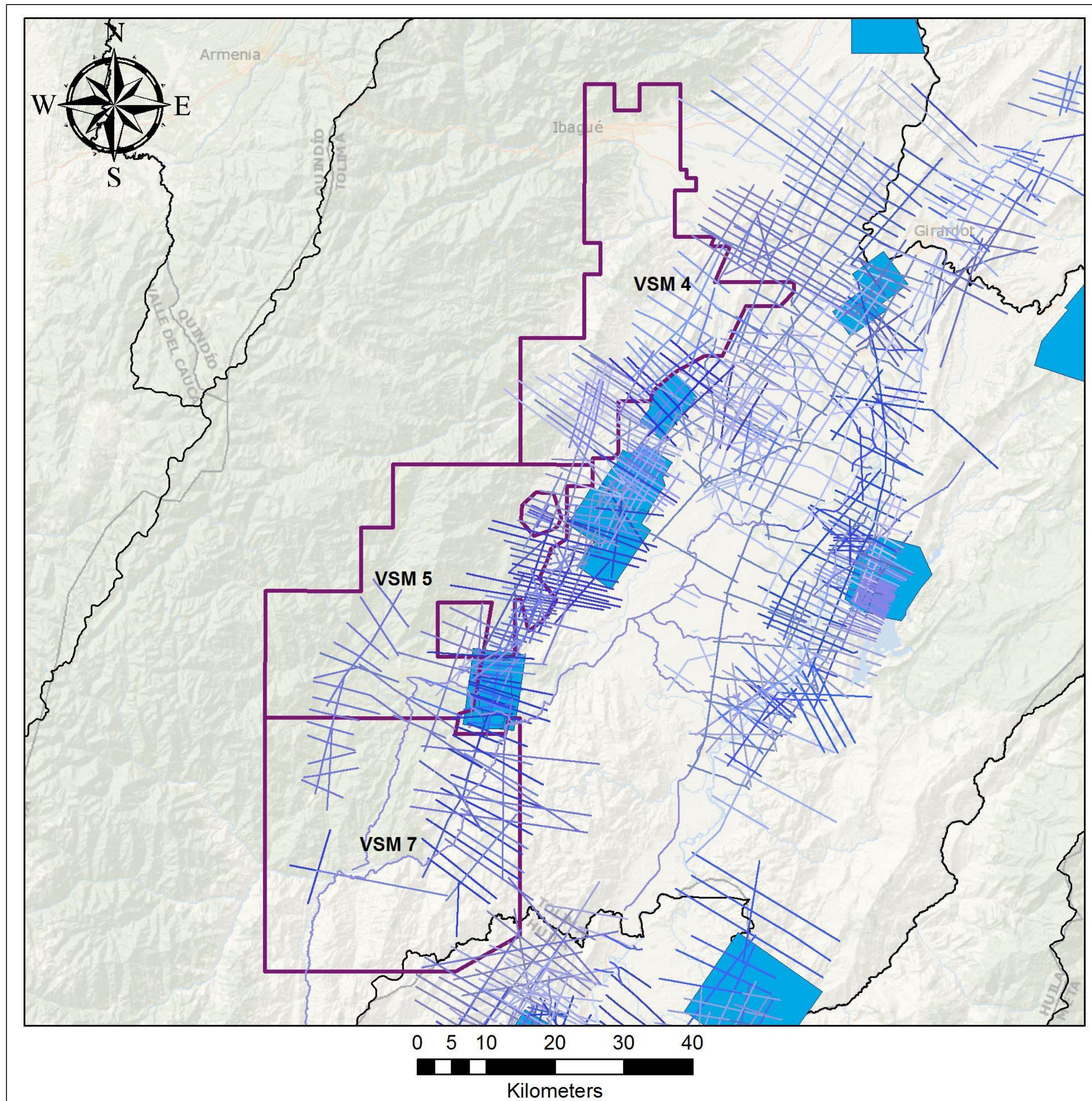


Fields Nearby (South)



Contract	Contract Signed Since	First Well Drilled in the Area (Year)	# Of Wells
Pijao - Potrerillo	2009	(1963 – 2018)	204
Hato Nuevo	2006	1984	2
Huila (Andalucia)	2009	1968	27
Tello – La Jagua	2007	1971	33
Caguan (Rio Ceibas)	2015	1993	31

DATABASE: 2D & 3D SEISMIC



2D Seismic Surveys:

VSM 4:

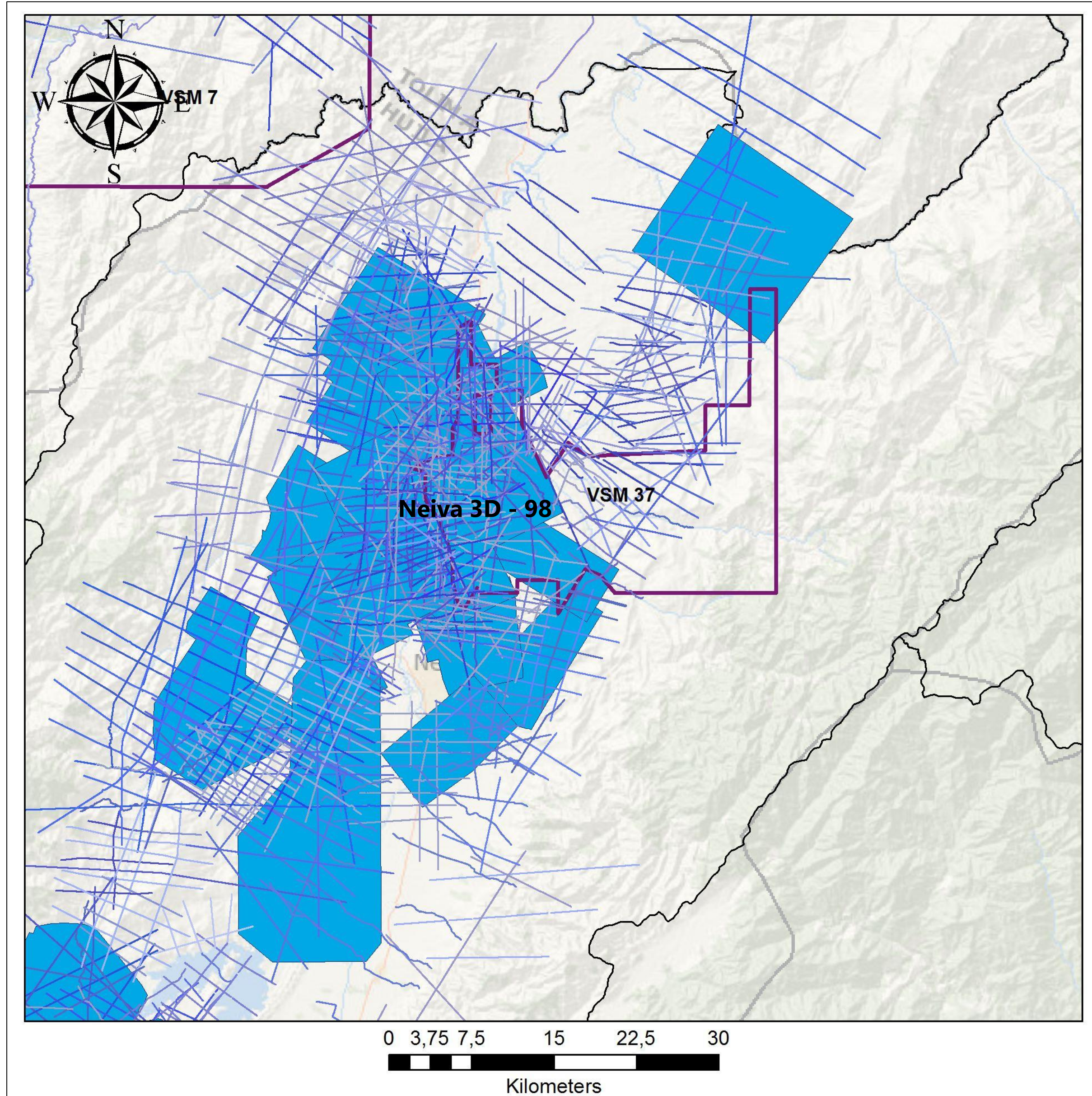
- 15 Seismic Surveys acquired from 1984 to 2006
- Total Length: 839.4 Km

VSM 5:

- 15 Seismic Surveys acquired from 1984 to 2011
- Total Length: 1107,3 Km

VSM 7:

- 11 Seismic Surveys acquired from 1987 to 2017
- Total Length: 932.14 Km



2D Seismic Surveys:

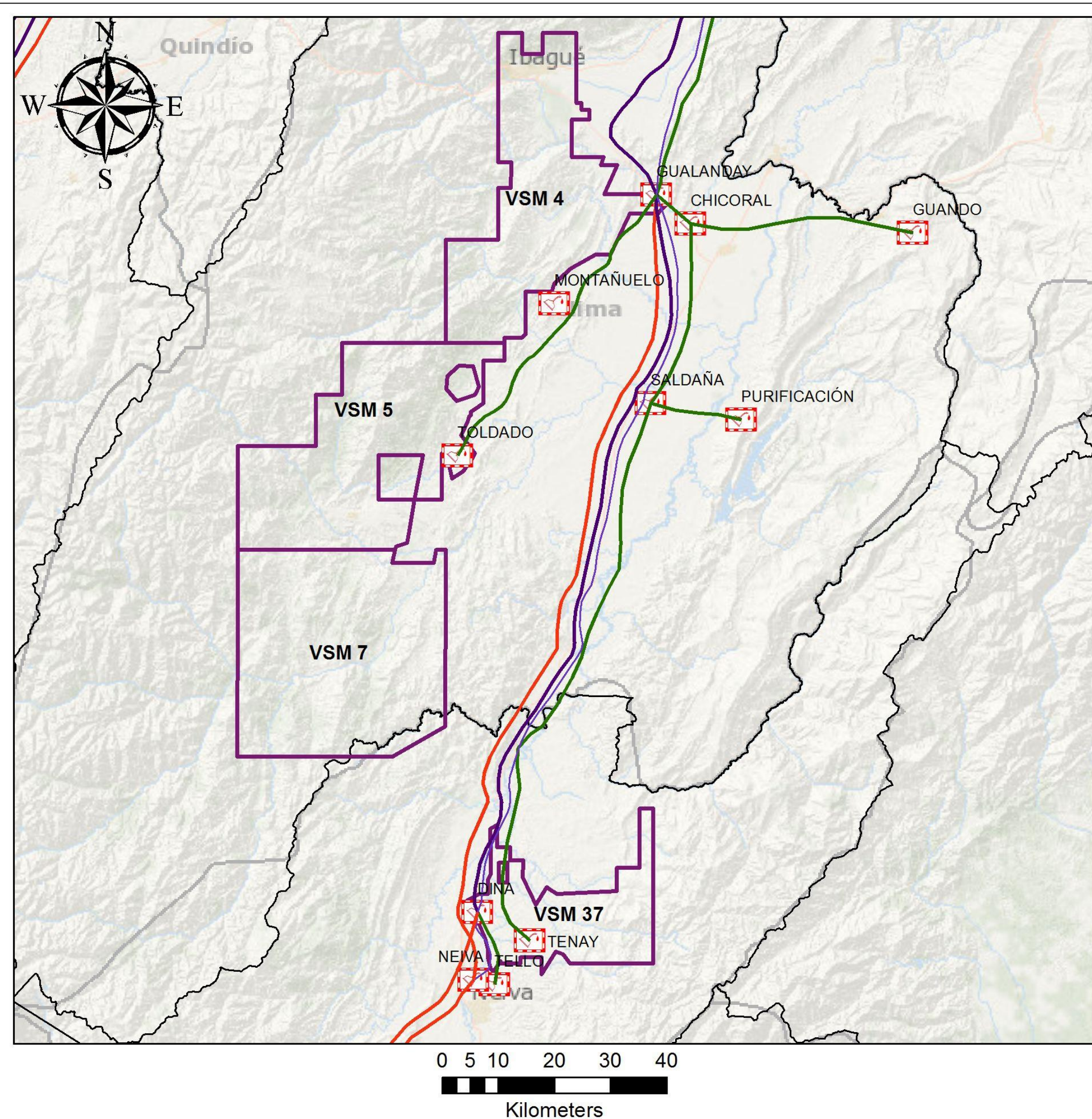
VSM 37:

- 21 Seismic Surveys acquired from 1971 to 2005 (2,102 Km)

3D Seismic Surveys:

VSM 37:

- **Neiva 3D – 98 (483,05 Km²)**
- Tello 3D – 2009 (71,15 Km²)
- Tello 3D – 92 (77,89 Km²)



Main Infrastructure nearby

Oil Pipeline

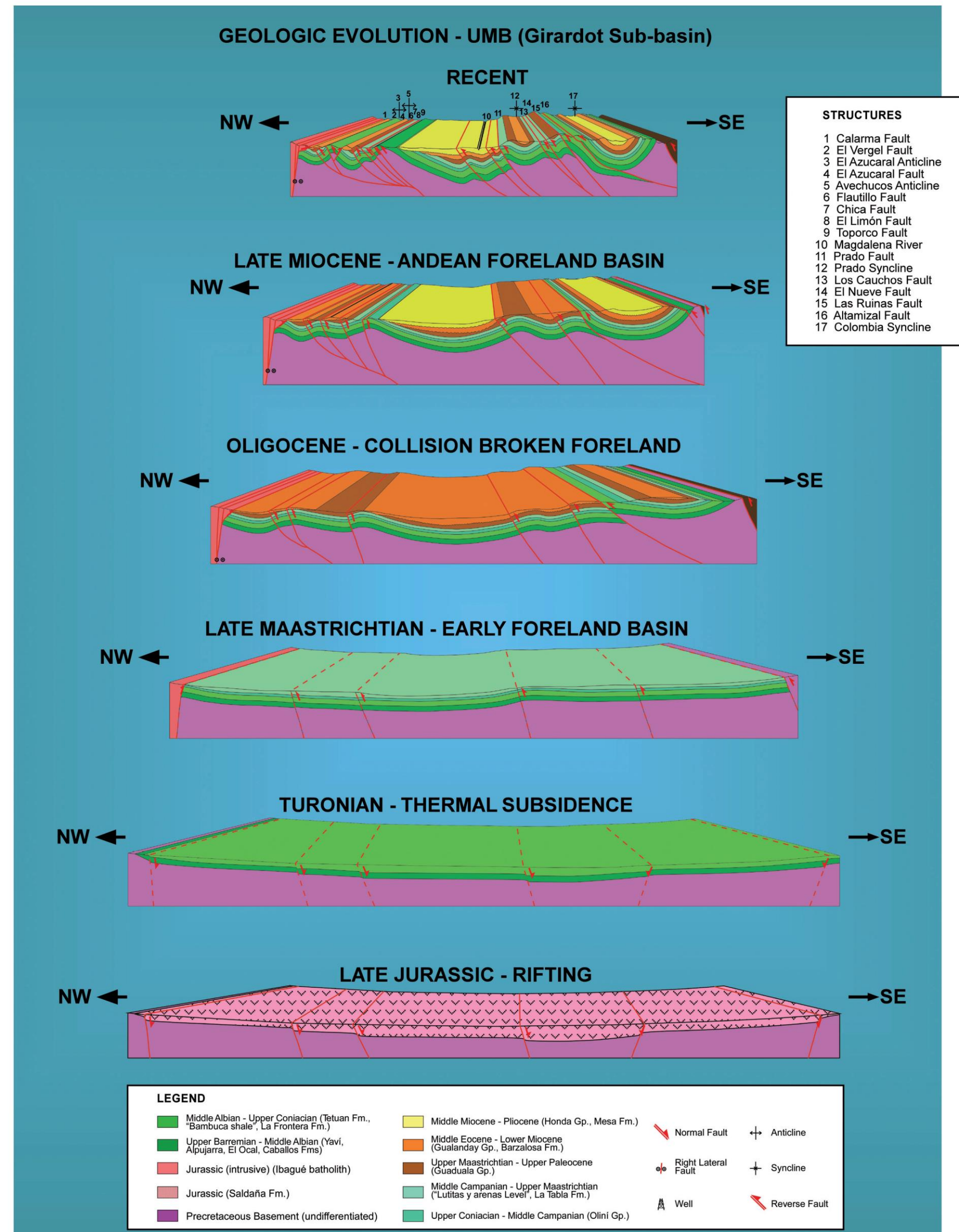
- Montañuelo (Closest to VSM 4 *c.a.* 5 Km)
- Toldado (Inside VSM 5)
- Tenay (Inside VSM 37)
- Tello (Closest to VSM 37 *c.a.* 10 Km)

Gas Pipeline

- Neiva (Closest to VSM 37 *c.a.* 20 Km)
- Dina (Inside VSM 37)

GEOLOGICAL FRAMEWORK

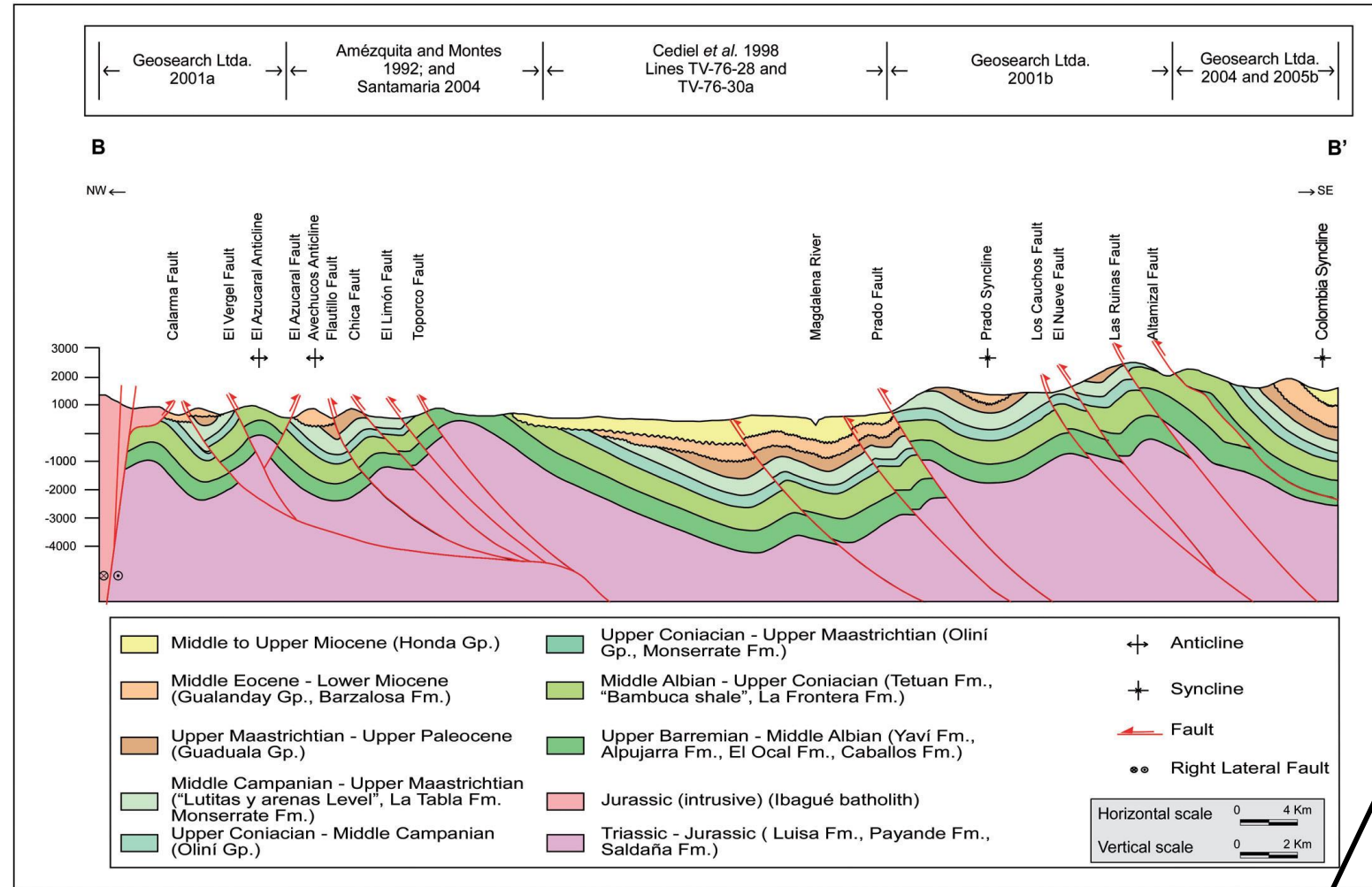
Basin Evolution



Taken from ANH (2011)

- The UMVB comprises superposition of **different stages of deformation**
- **Jurassic:** Tectonic extensional gained intensity leading to formation of complex rifts and occurrence of volcanic centers
- **Cretaceous:** Depositional environments changed from continental to a marine setting
- **Latest Cretaceous to Paleocene:** First stages of compressive deformation. Replacement of marine by continental conditions
- **Middle Eocene – Oligocene:** Several pulses of uplift of the Central Cordillera. Westward verging thrust belt associated with accumulation of syntectonic deposits. The UMVB behaved as a proximal foreland basin
- **Miocene:** Rises of Eastern Cordillera intensifies during main pulses of Andean Orogeny. Uplift starts with tectonic inversion of normal faults formed during previous extensive stage
- Sediments derived from the rising of both Cordilleras would have converted the UMB Basin into an intra-montane basin

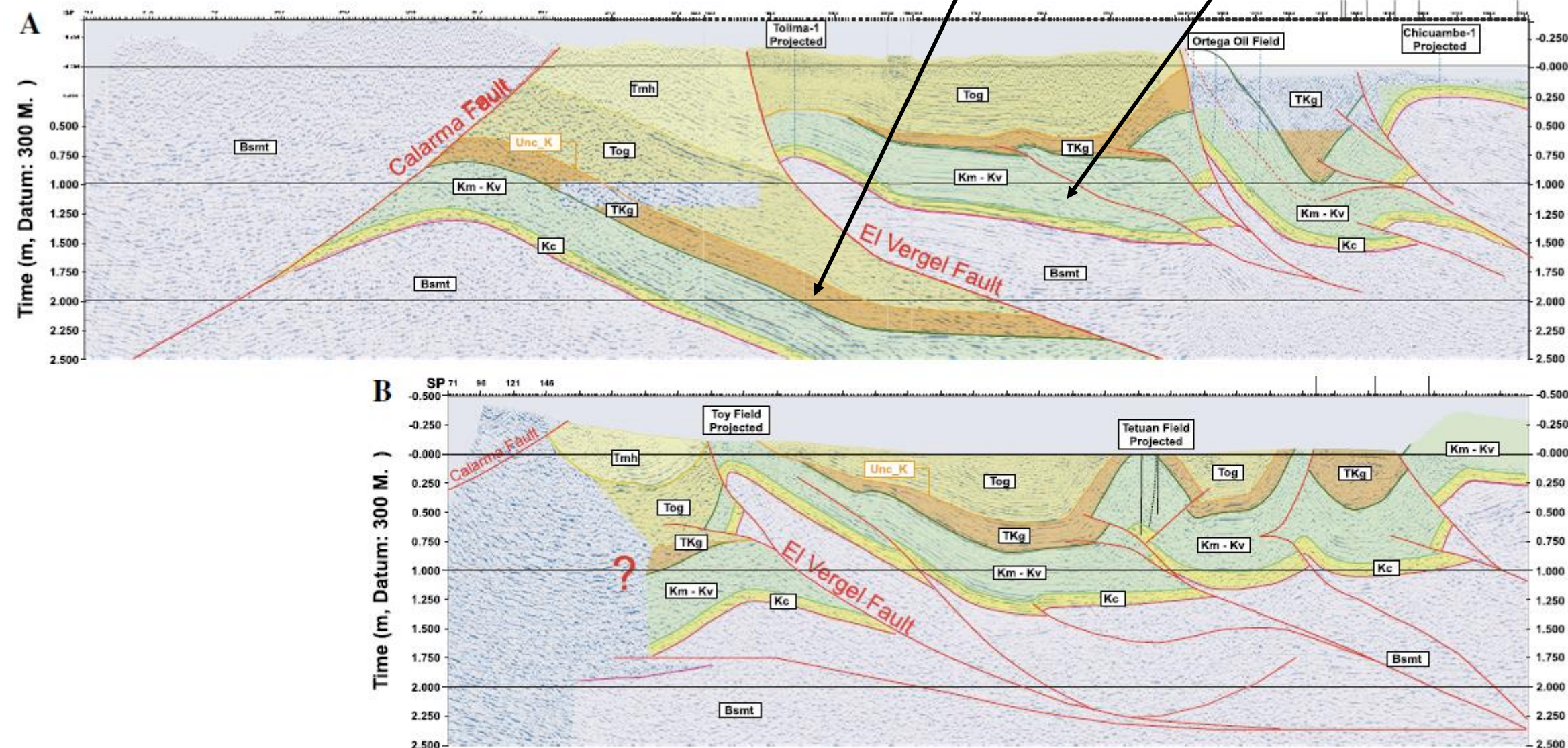
STRUCTURAL FRAMEWORK



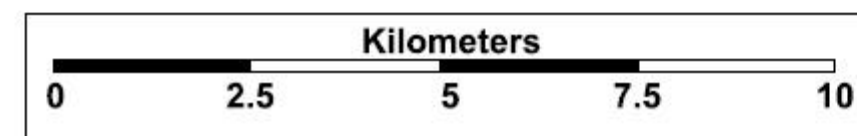
Chiquinima syncline

Avechucos Syncline

Taken from ANH (2011)



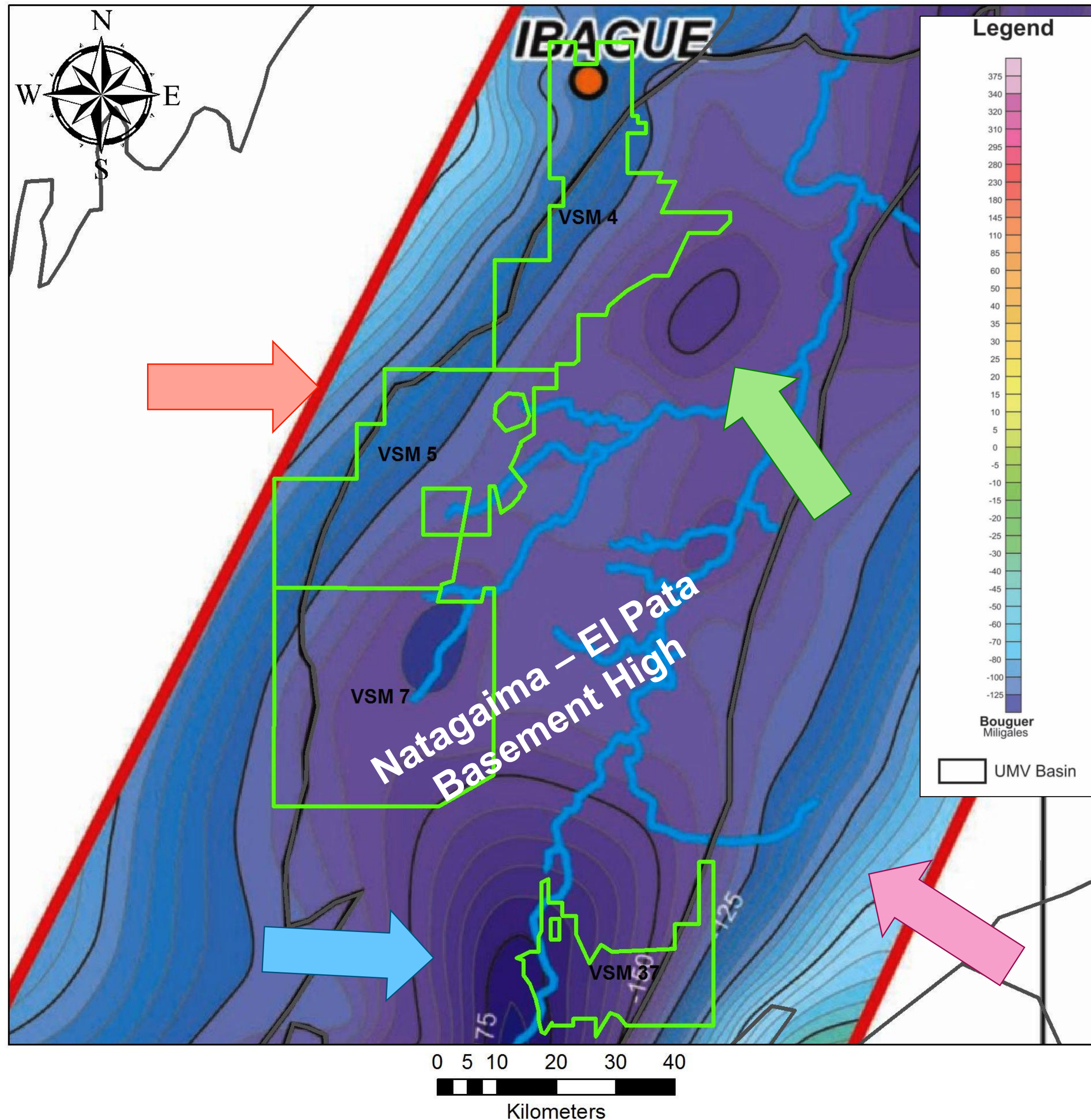
Taken from Ramon & Rosero (2004)



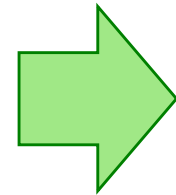
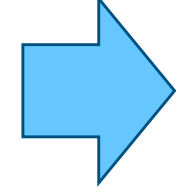
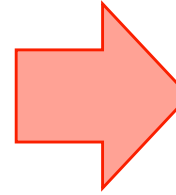
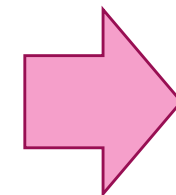
The structural framework here presented follows the proposal by Ramon and Rosero (2004)

- UMVB is a structural depression oriented SSW – NNE
- Limited at both flanks by compressive and transpressive fault systems
- These fault systems transport the pre-Cretaceous basement and its sedimentary cover
- It is likely that the Girardot and Neiva sub-basin were a single basin until the Early Miocene
- The Girardot sub-basin might be divided in four zones according to its geometry: 1) Western margin with echelon synclines, 2) southern central with shallow basement and thin Honda Fm cover, 3) northern – central with a thick Tertiary cover and 4) eastern margin with a thin Tertiary cover and complex Cretaceous sheets.
- Part of the shortening is taken up by the synclines and their internal associated thrusts with prospective folds

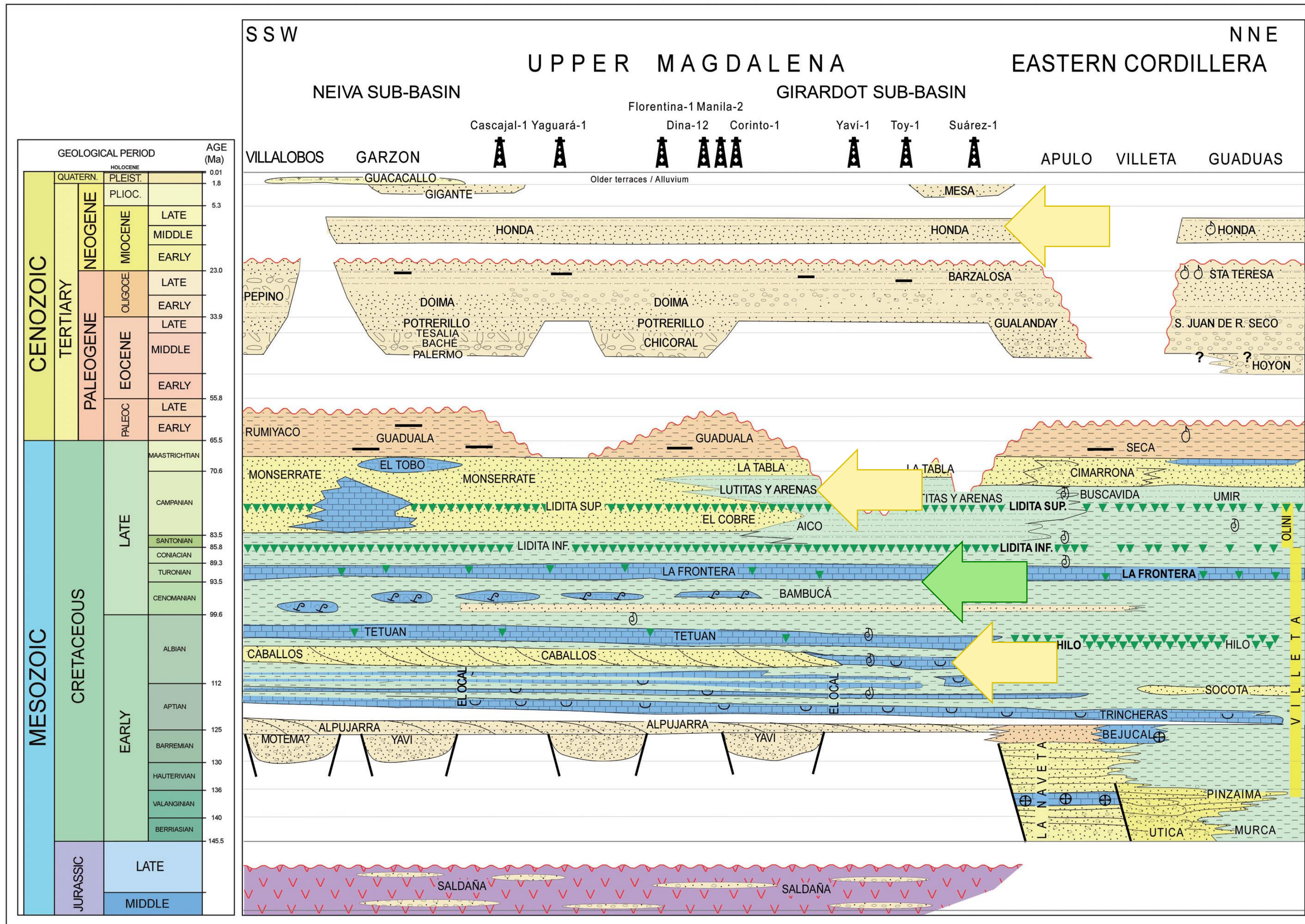
Bouguer Anomaly & General Structural Elements



■ 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

Main Source

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

WELL SUMMARY & ANALOGUE FIELDS

Tolima - 1

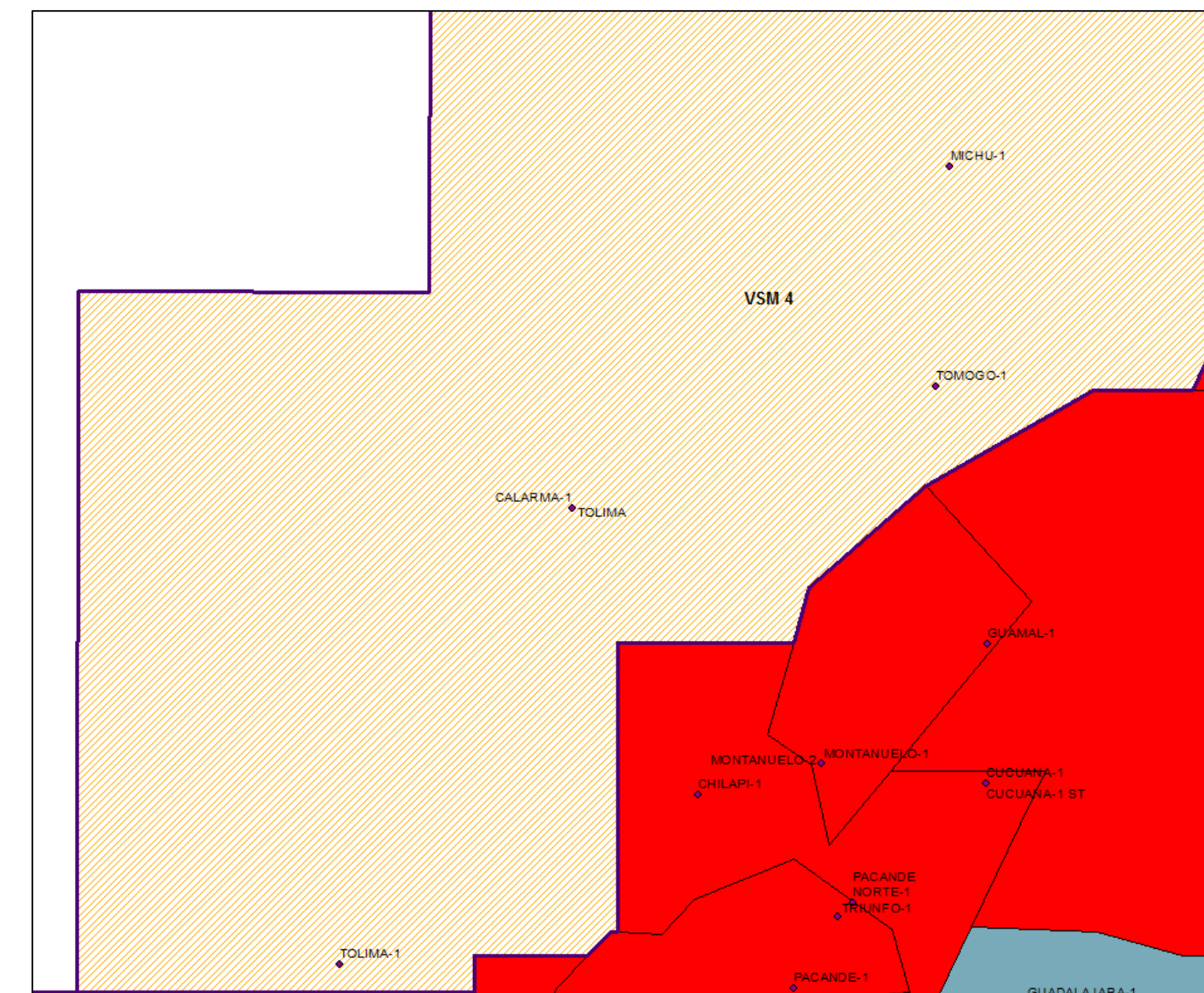
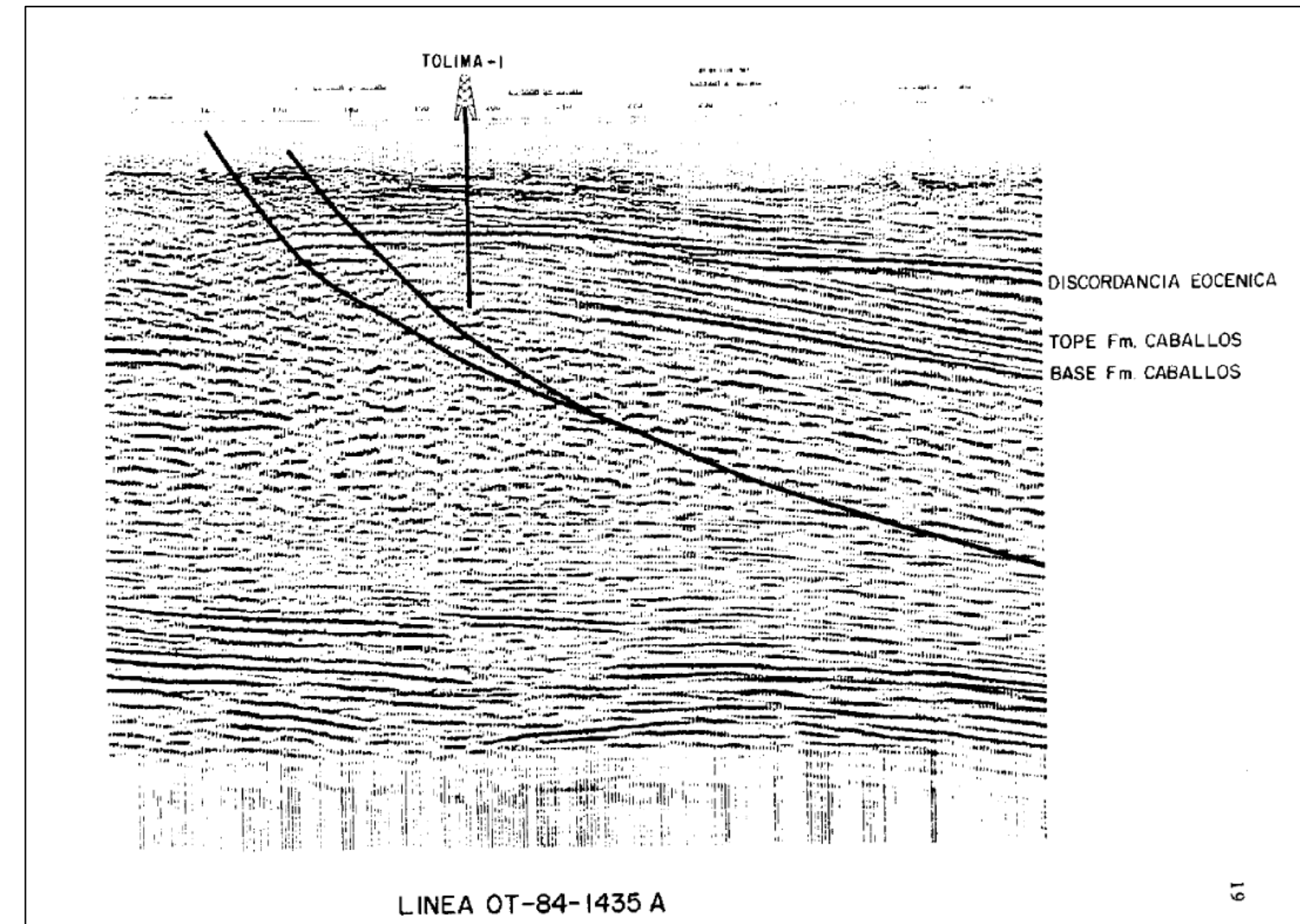
- Well drilled by Ecopetrol in 1988 with a Total Depth of 3690' with target at the Caballos Fm (top at 2875').
- From 9 DSTs in the Yavi, Caballos and Villeta Formation 7 did not have fluid intake. The other 2 Tests with fluid intake produced 47 barrels of water. Then the well was abandoned

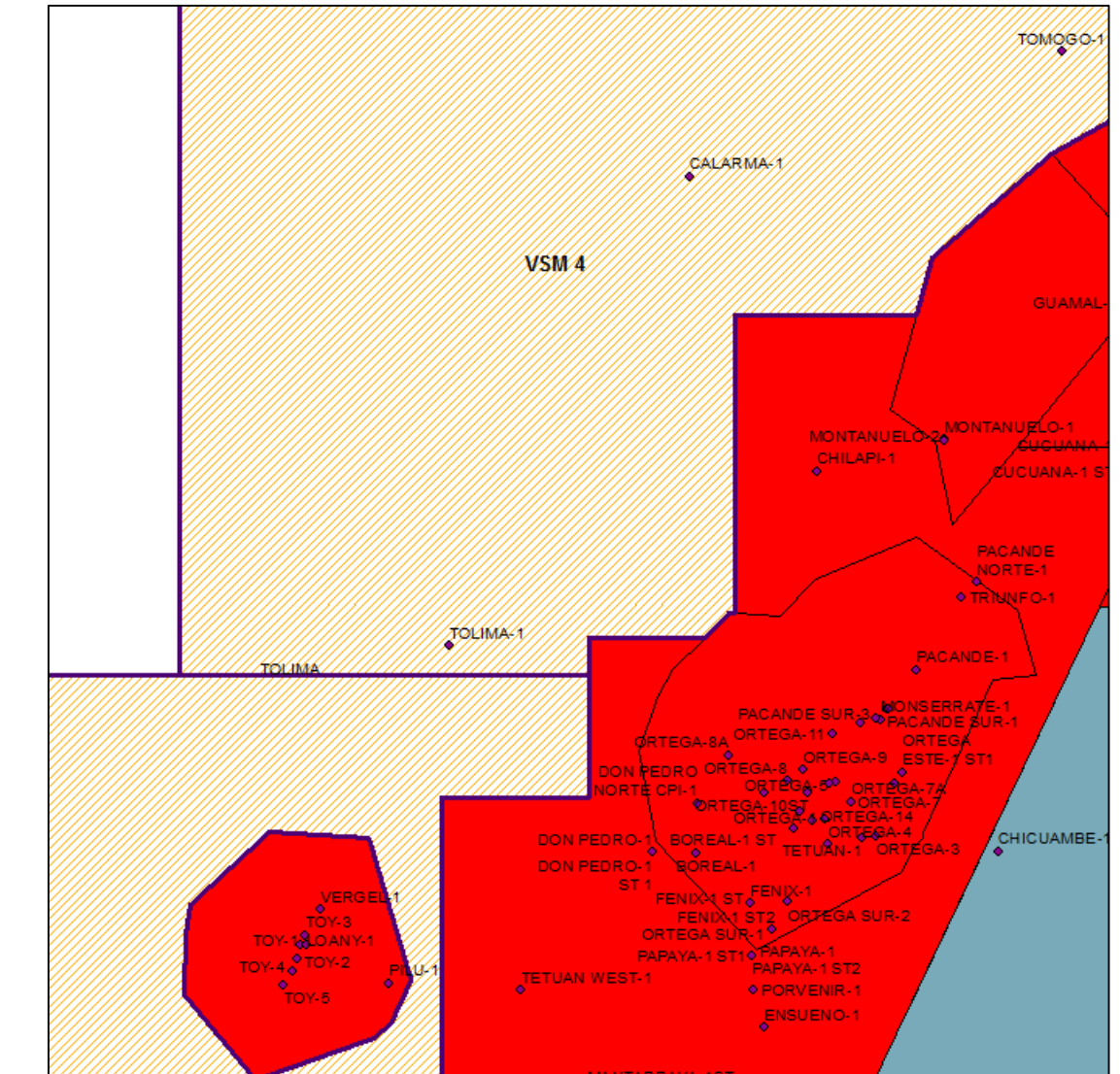
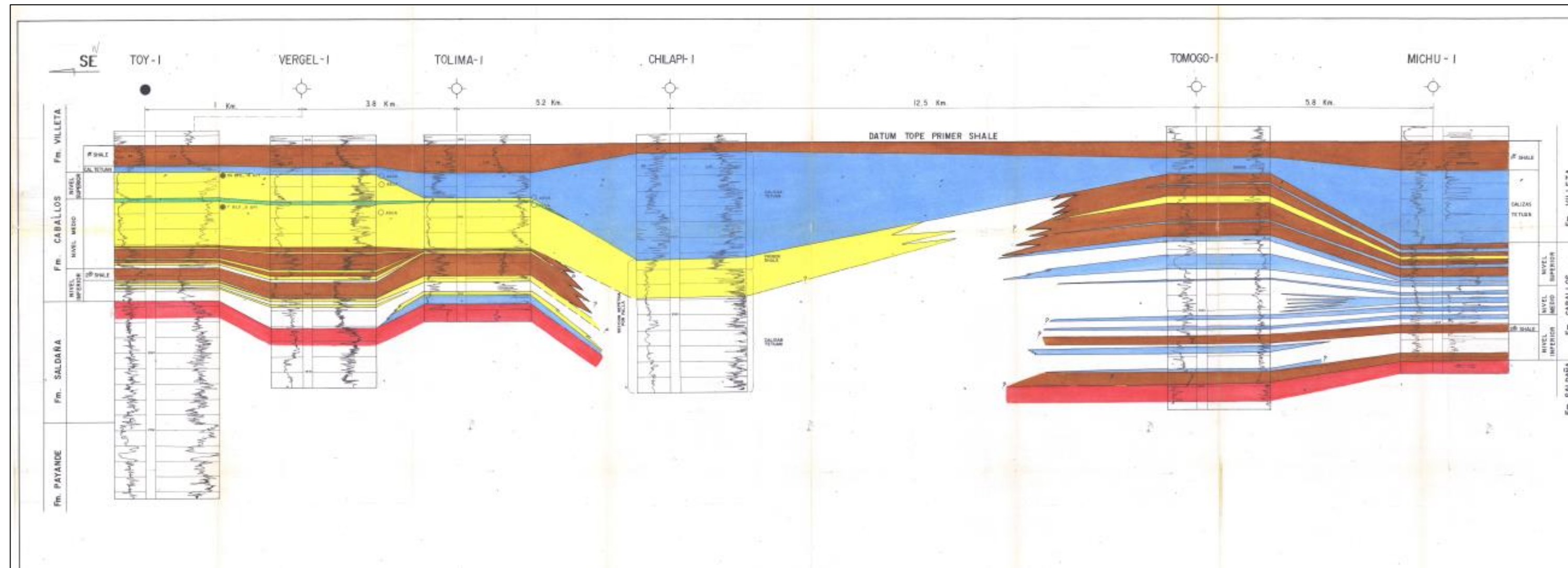
Tomogo - 1

- Shallow well drilled by Hocol in 1990 with a Total Depth of 2,507. The target was the Luisa sandstone from the Upper Caballos Formation. There are no data about tests

Michu - 1

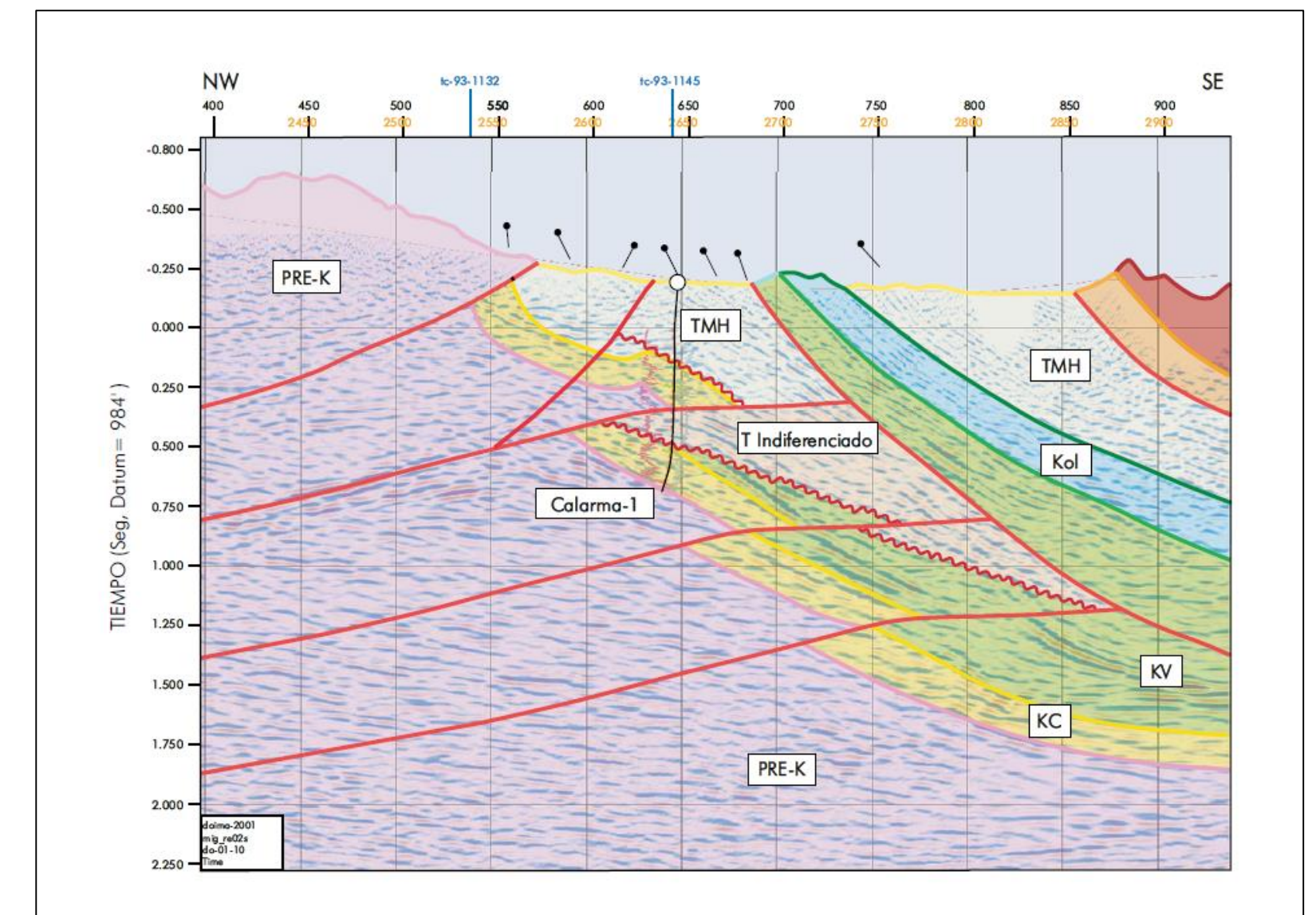
- Well drilled by Hocol in 1990 with a Total Depth of 4,094'. It had numerous gas shows in the Villeta and Caballos Fm. That was not of interest at that time.





Calarma - 1

- Well drilled by Hocol in 2004 with a Total Depth of 5525' with target in the Caballos Fm sandstone with calcareous intervals in this area
- 2 MDTs were taken at 2310' (Villeta Fm - Tetúan) with total gas of 31651 ppm and at 3875' (Villeta Fm) with total gas of 18392 ppm. Additionally 19 RFT points were measured.
- Structure failed due to possible lack of correct timing between structure and migration.



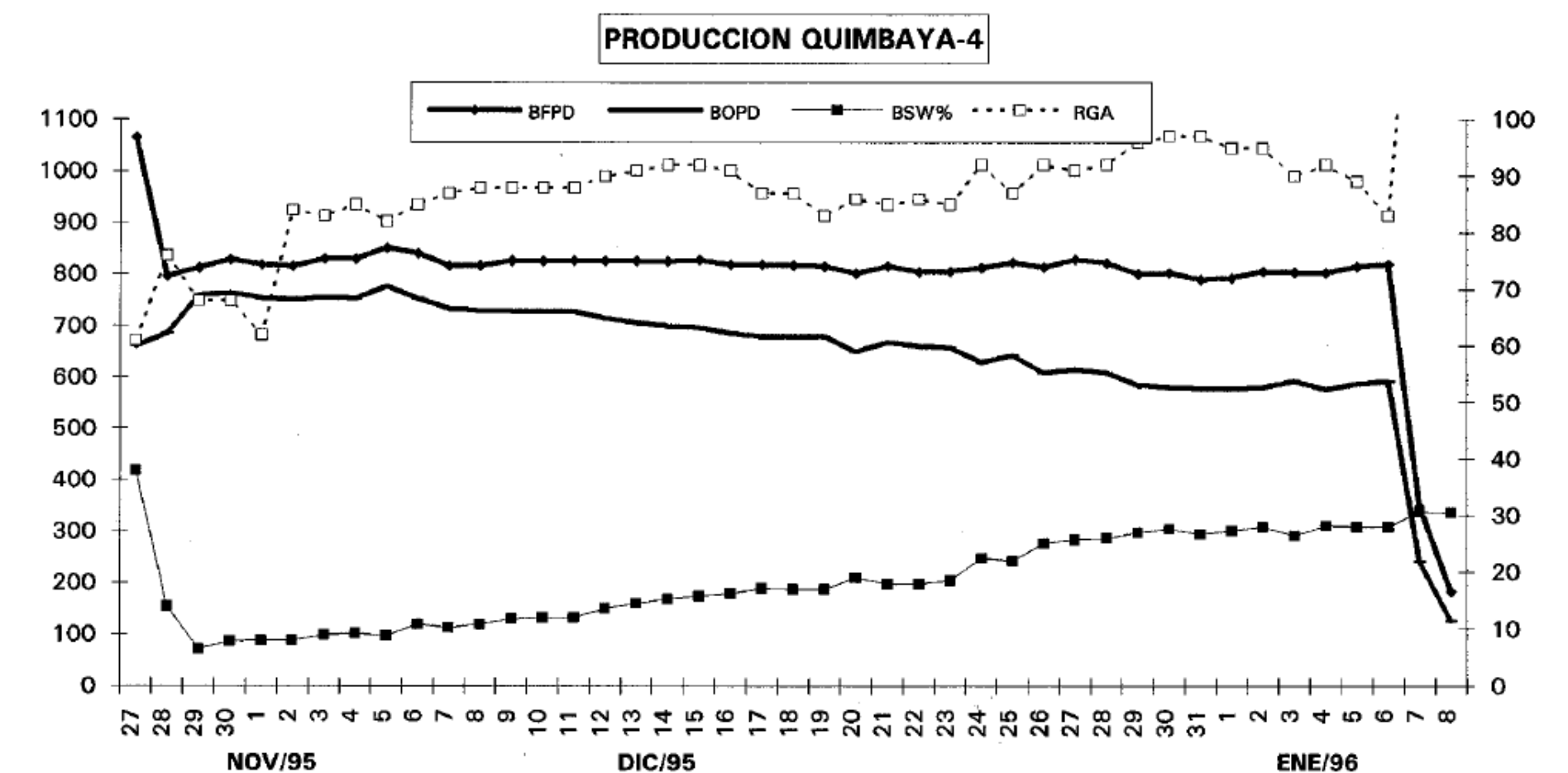
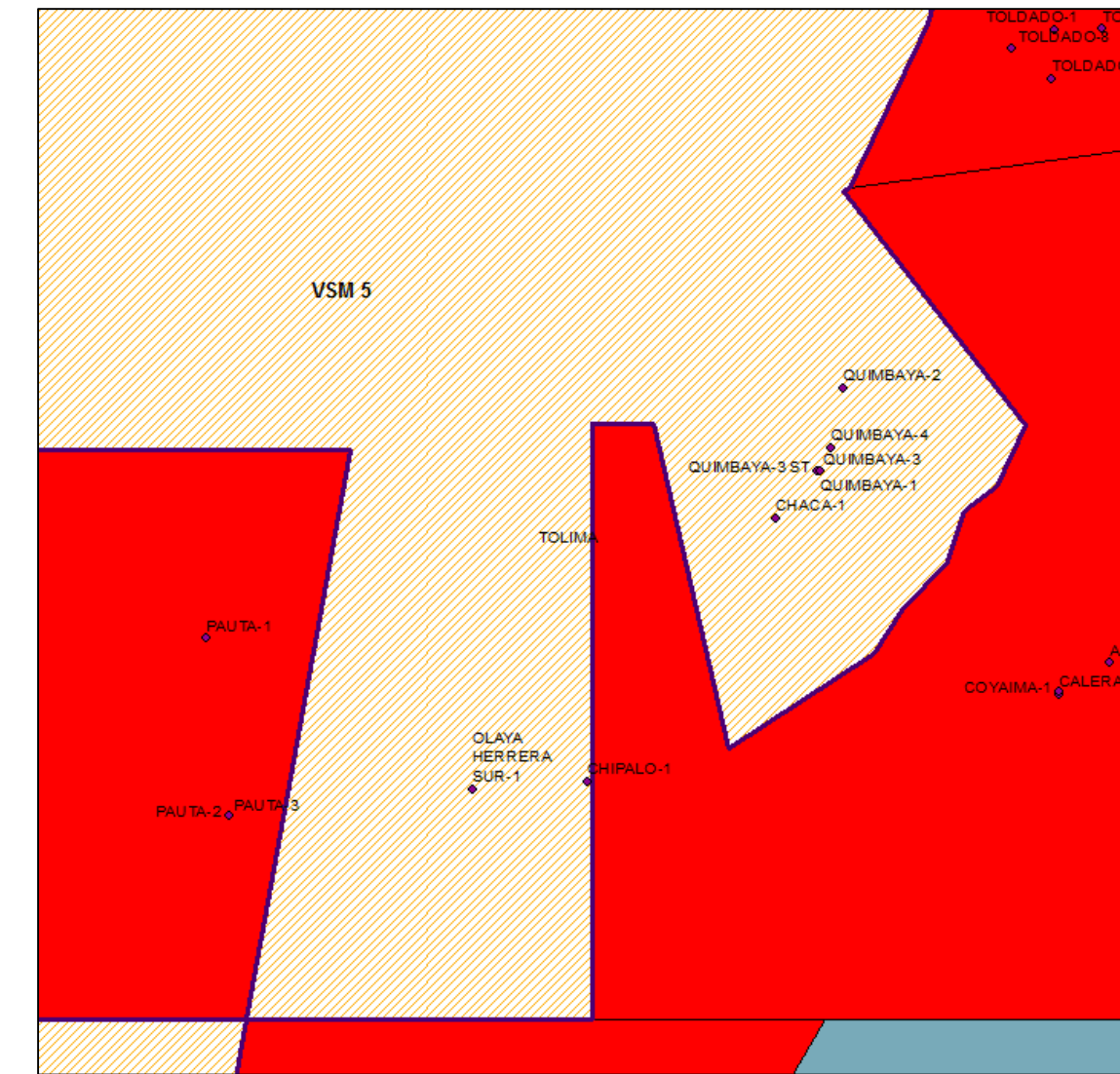
VSM 5

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

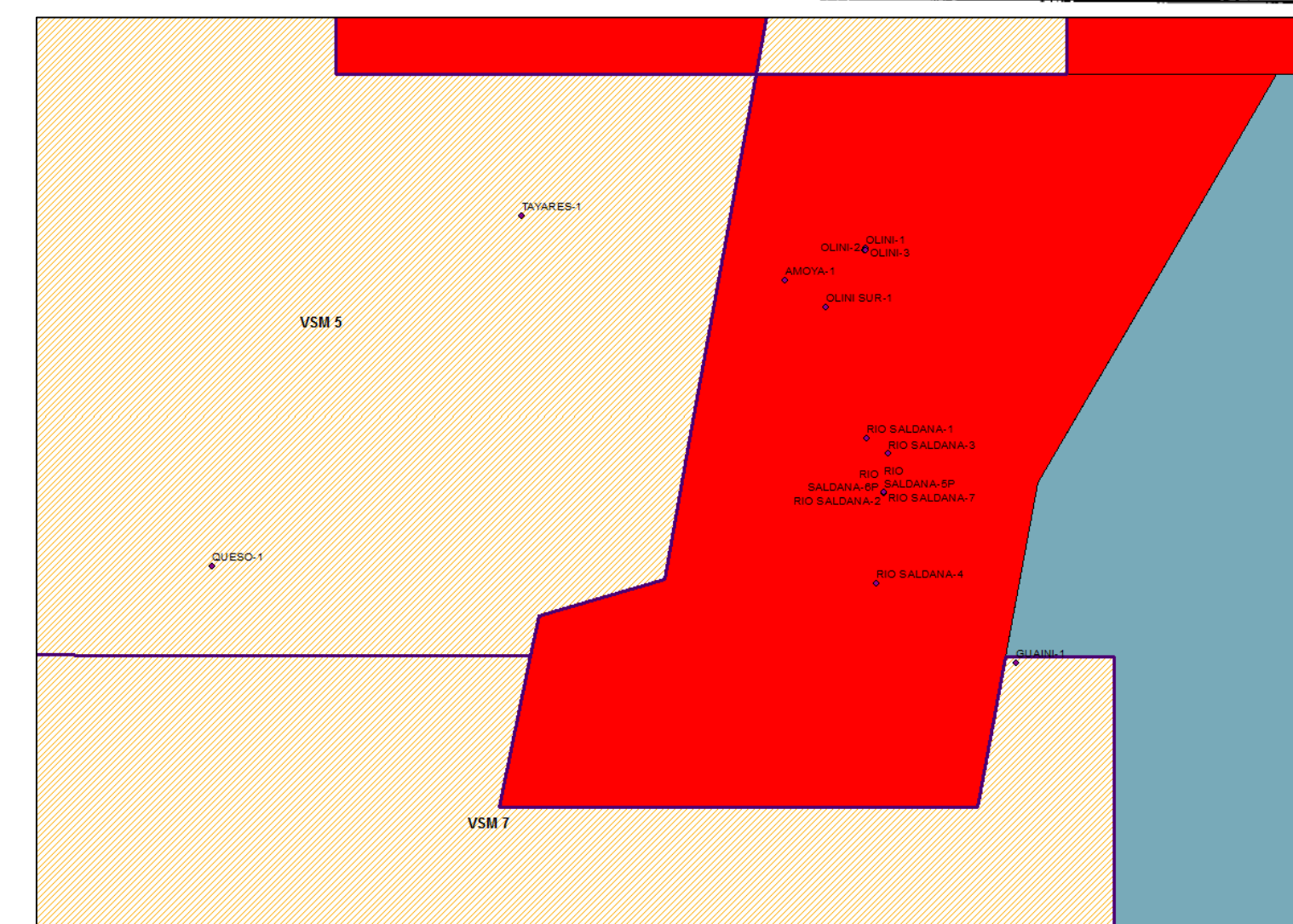
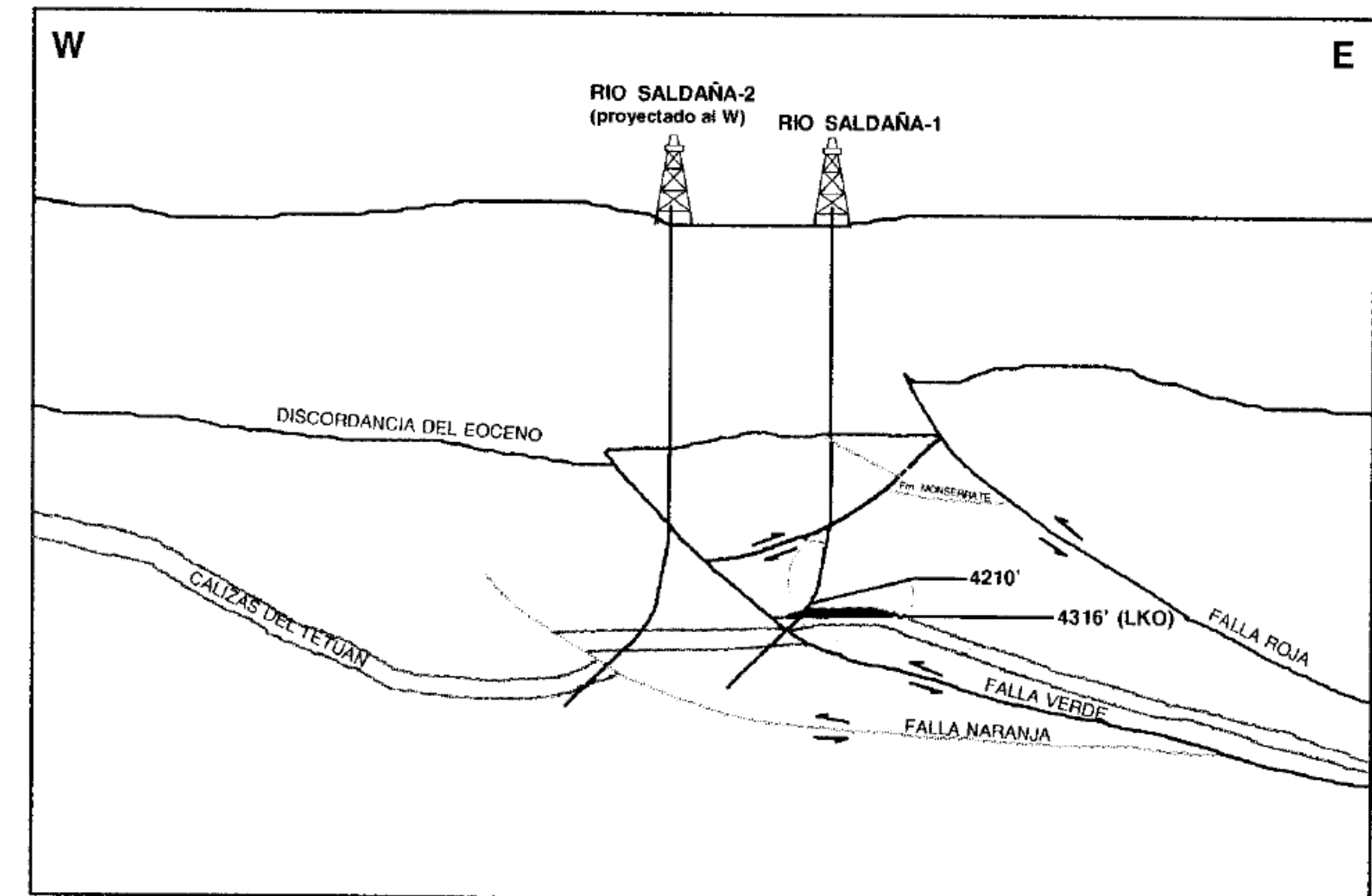
Quimbaya - 4

- 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



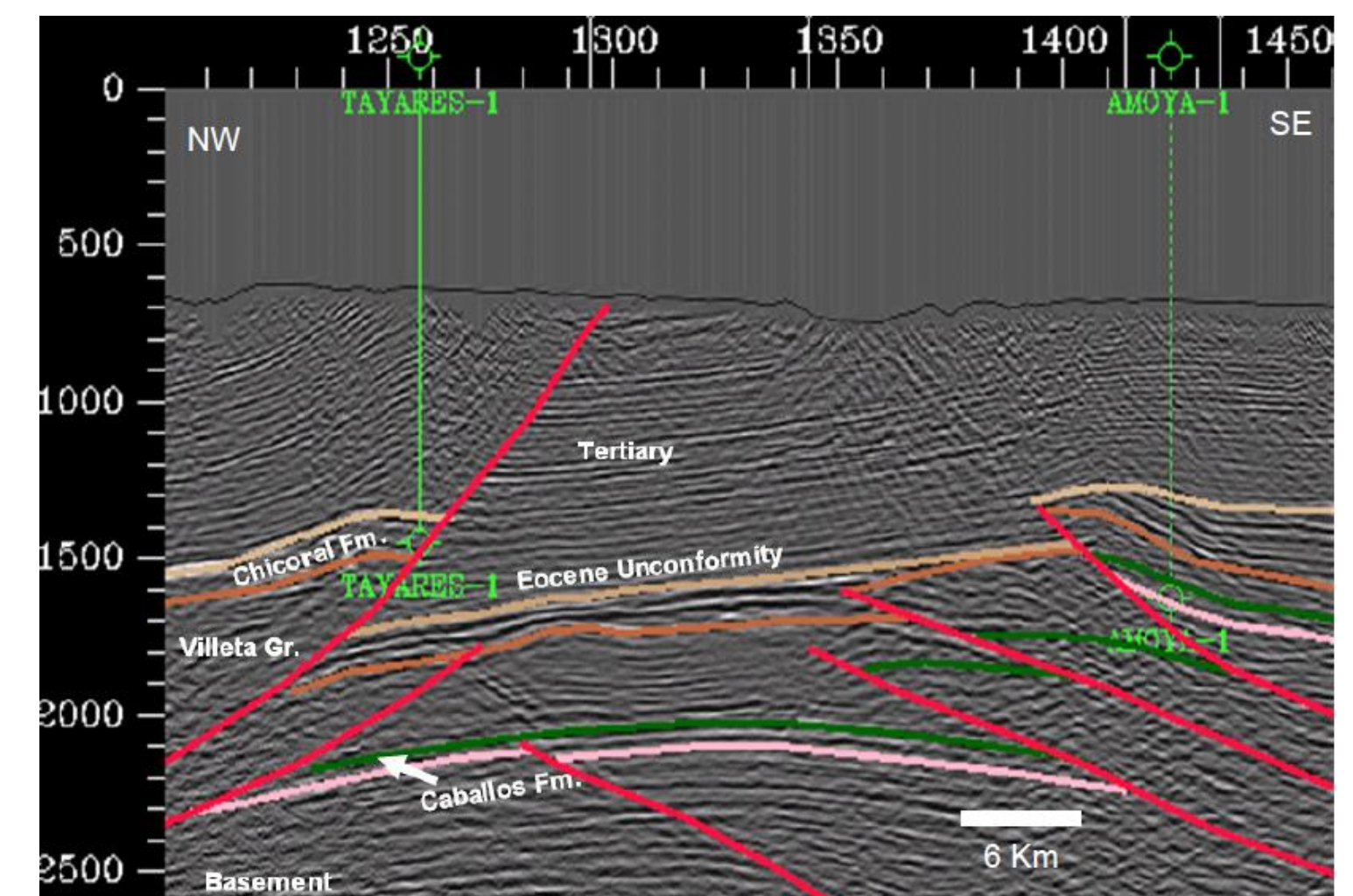
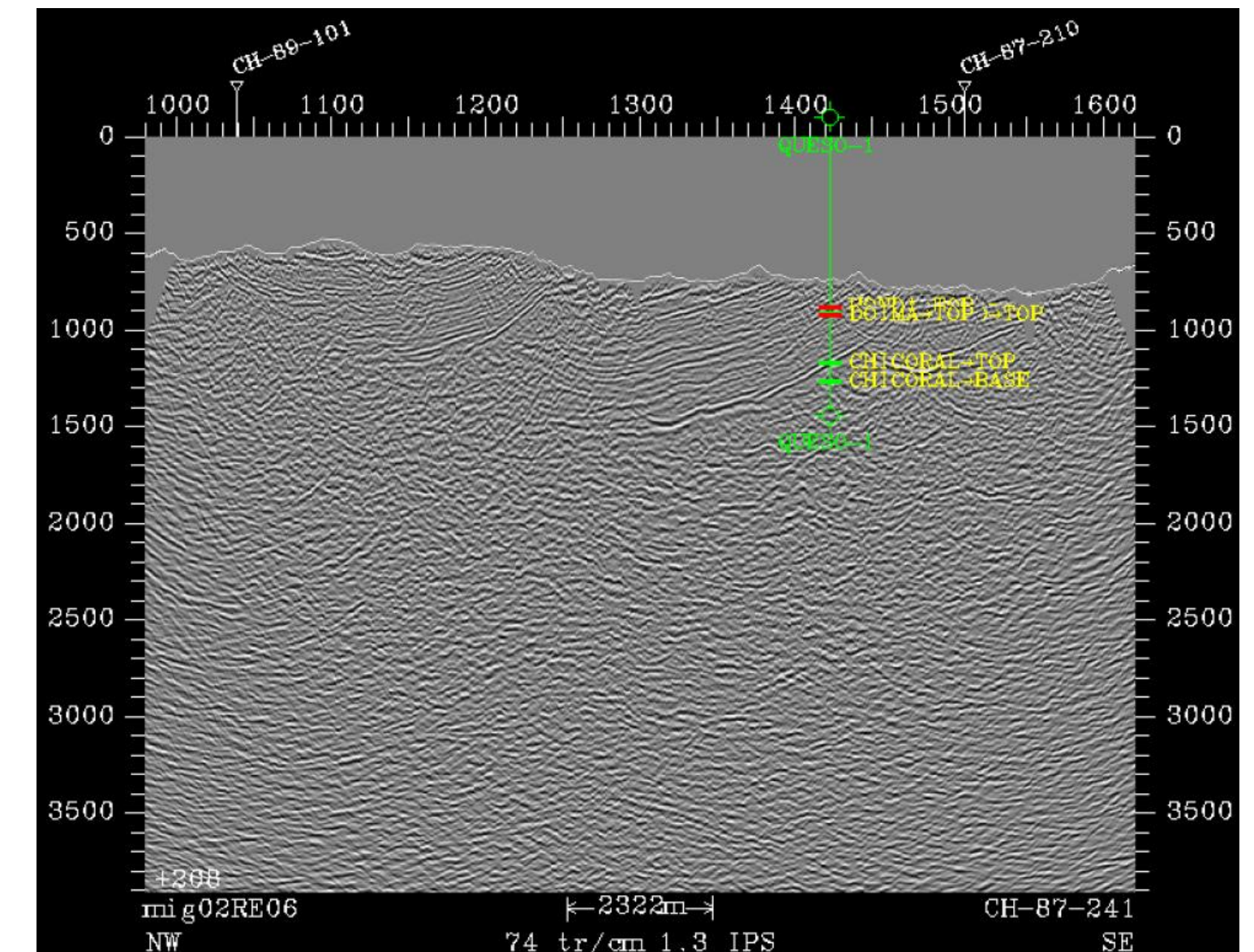
VSM 5

Queso - 1

- Well drilled by Hocol in 1984 with a Total Depth of 2630' and target at Tertiary units (**Chicoral Fm**).
- From 2130' to TD the rocks are crystalline, representing a hypoabissal (or subvolcanic) basement, unlike the initial interpretation as sedimentites.
- It's appealing that the log records the presence of oil at several horizons but there is no optical signal of crude in the samples (Petrochac, 2006).

Tayares - 1

- Well drilled by Texas Petroleum Company in 1954 with a TD of (5348') drilling mainly a Tertiary sequence.
- Current structure interpretation show that the well was drilled on the northwestern flank of a failed anticline structure (hanging block).
- The **main causes of failure** were the lack of seismic information for well planning related to the structure drilled, the **lack of a reservoir unit (Caballos Fm)**, the ineffectiveness of the seal rock and the trap.

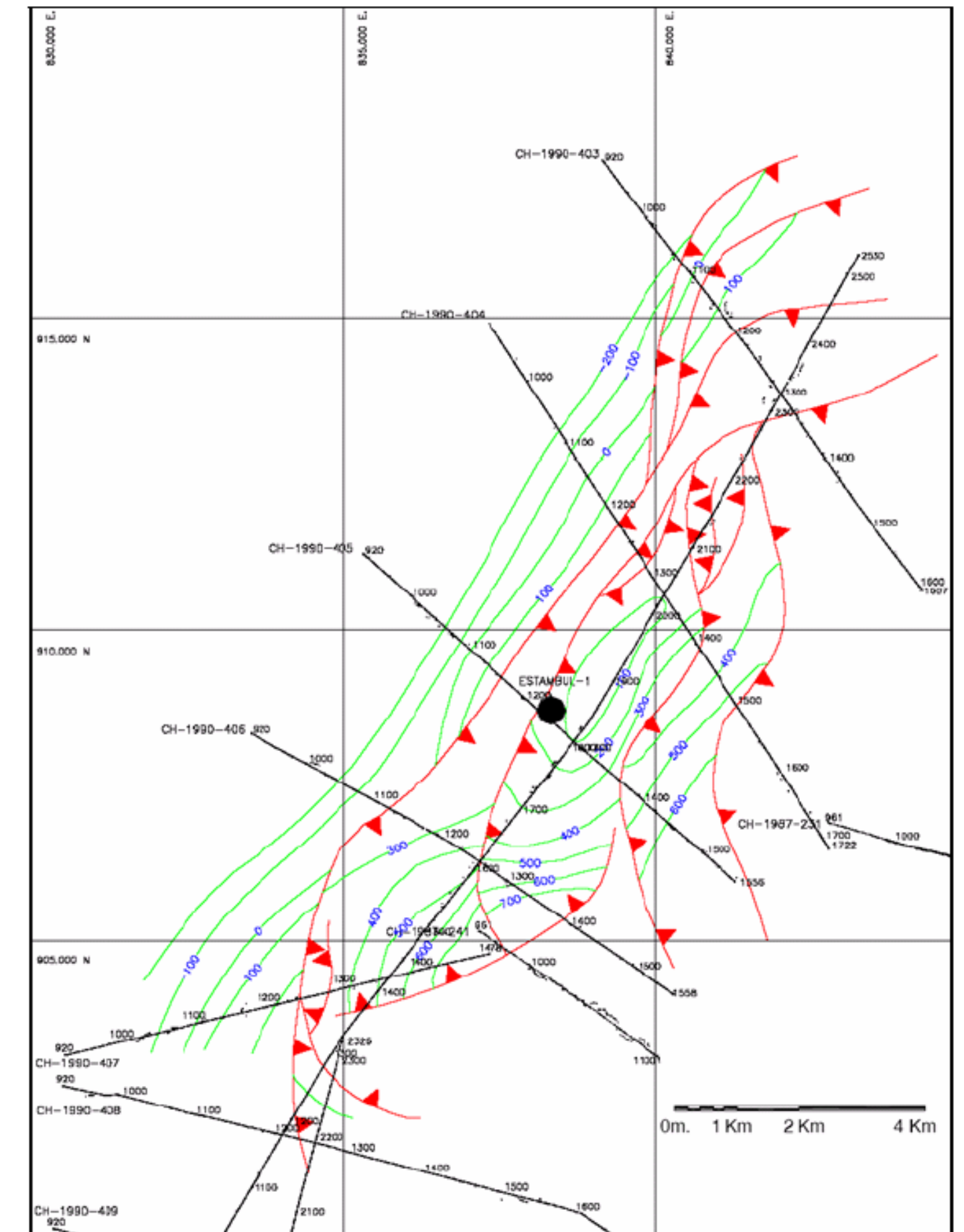


Olaya Herrera - 1

- According to the Coyaima contract report in 1989, the **well wasn't drilled**.

Estambul - 1

- Well drilled in 2003 by Kappa Resources Colombia with a TD of 2240'.
- The well was drilled in a faulted anticline structure
- The well had oil shows in calcareous levels at the lower section of the Villeta Group. Lower gas shows were present as well.
- Either of the shows were not commercial
- Source and reservoir rock thicknesses were thinner than expected
- Geochemically, from seeps and mud logging, it could be said that there is a proven system



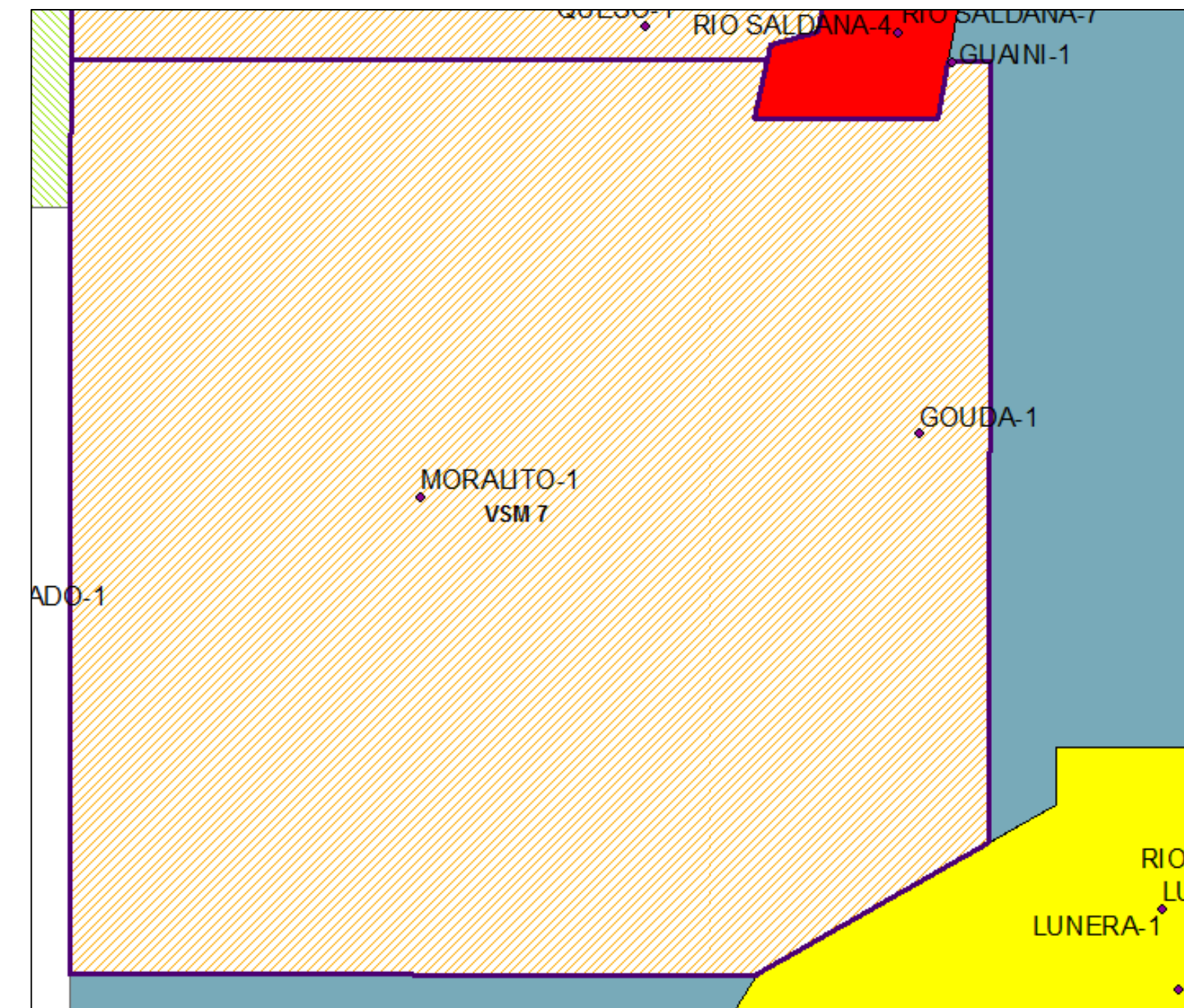
Taken from Nexen (2006)

Gouda - 1

- Well drilled by Repsol in 2010 with a Total Depth of 5650' MD, with target at the Upper Caballos Formation. and Chipalo sands from Tetuán Formation.
- The well had bad hole conditions, and the results were negatives due to the absence of target. No shows reported in the mud log and the well was not tested.

Guainí - 1

- Well drilled by Nexen Petroleum Colombia Ltd. in 2006, with a total depth of 5729', where the well was drilled to test partially four way dip closed structure at the Caballos reservoir objective.
- The well found only Yaví Fm. (surface-810') and Villeta Group (810'- 5729'). Formations was not tested, but the limestones of Villeta Group had poor hydrocarbons shows, with C1-C5 chromatography.

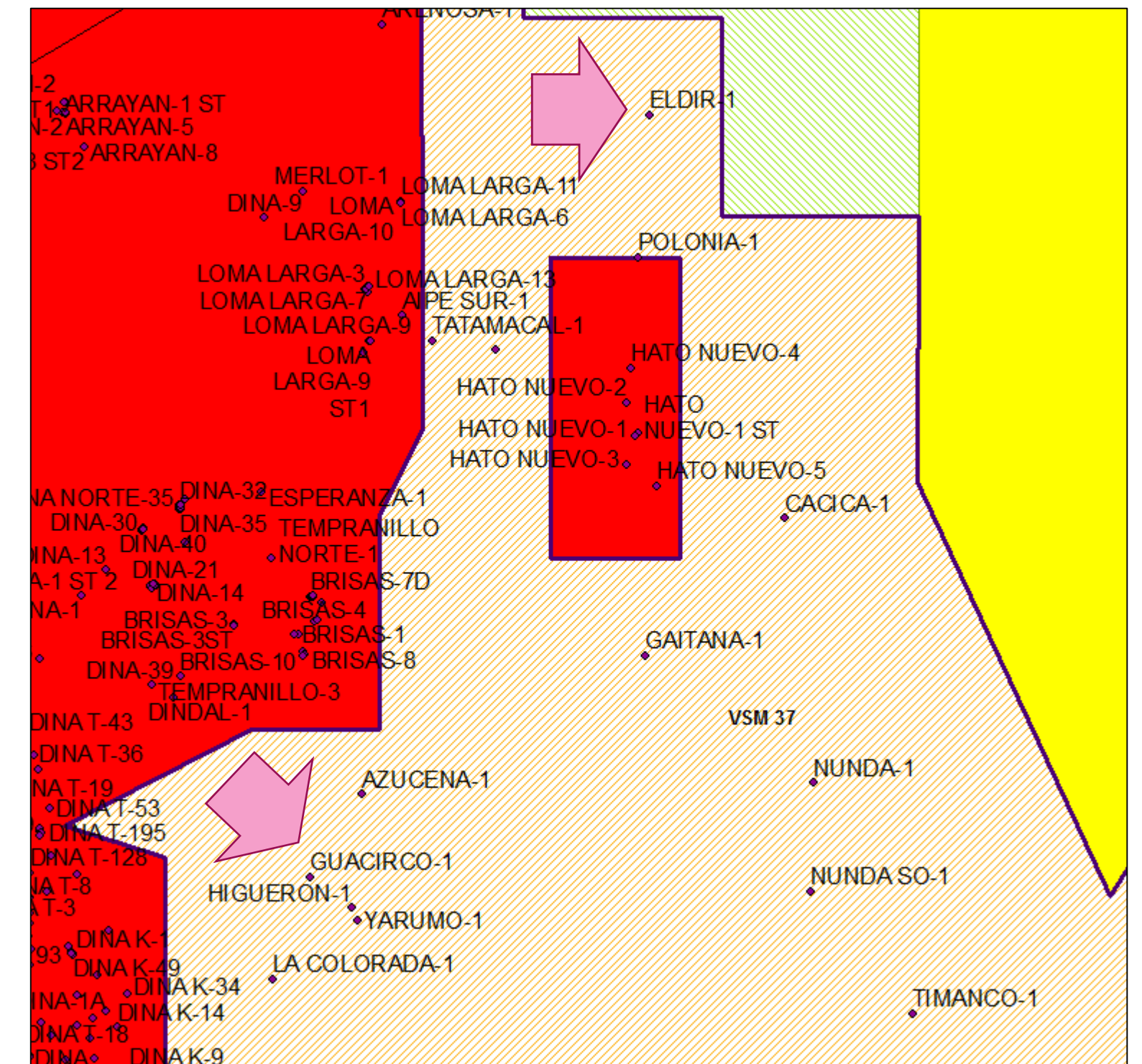


Eldir - 1

- Well drilled by Ecopetrol in 2014, with a Total Depth of 4500' MD, with target at the Basal sands of Honda Group.
- The well had hydrocarbon shows in the basal Honda Group and Barzalosa Formation, but the pressure tests showed low productivity in the intervals, and the fluid samples showed gas presence.

Guacirco - 1

- Well drilled by Petr leos Colombo – Brasileiros S.A. in 1977, with a total depth of 7360', where the well was drilled to test the Guacirco anticline, where the target was Monserrate K-4 Fm.
- The well had poor gas shows, were logged within the Guadula Fm, and minor gas and some poor oil shows were reported in the Monserrate K-4 Formation. DST 1 was given in the Monserrate Formation. In 7064' opened tester with a good blow during 45 minutes of 12", and blow died, and it recovered water with mud.

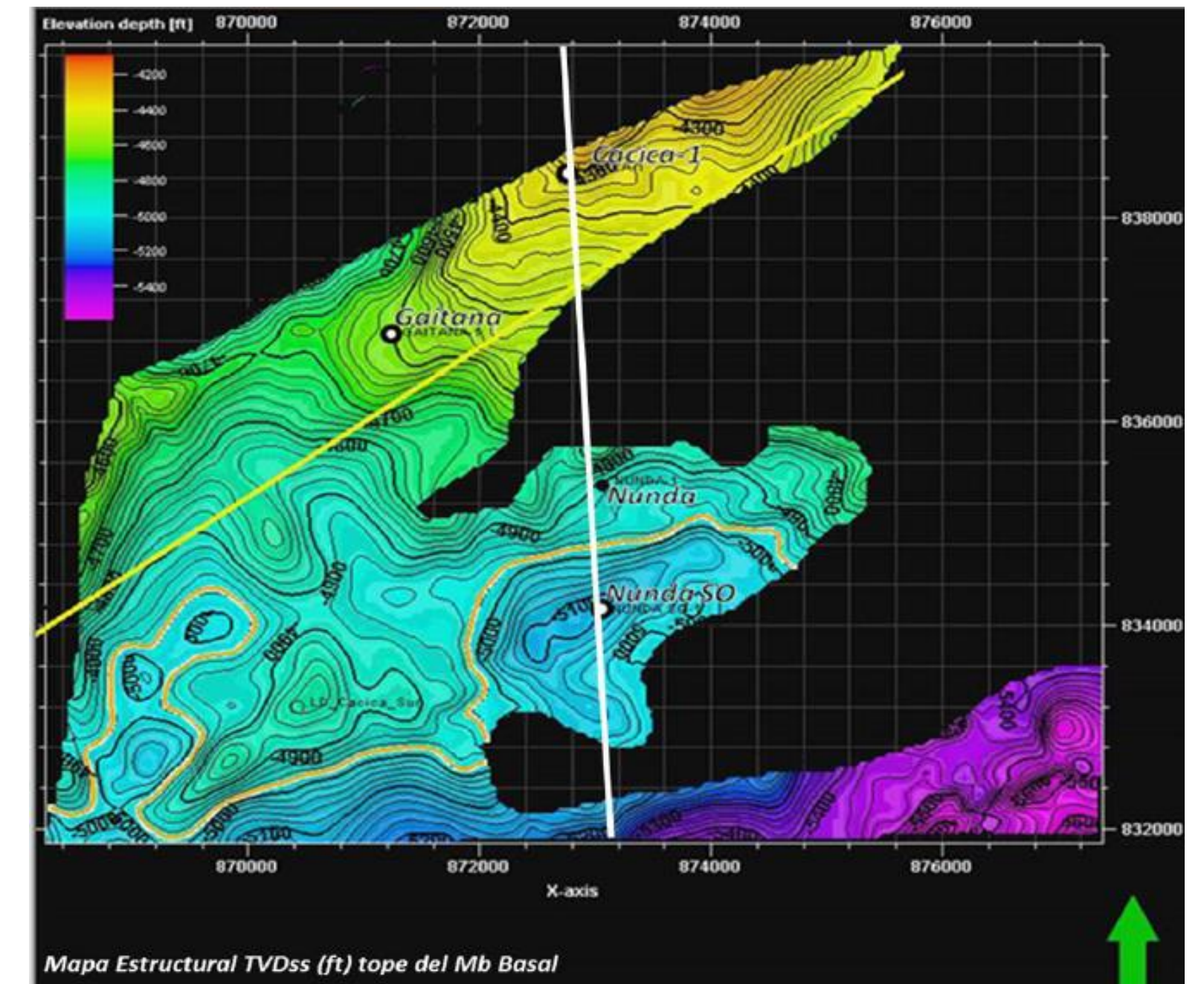


Nunda - 1

- Nunda-1 was a deviated well, drilled by Ecopetrol in 2011, with a total Depth of 7371'. Where the target was the **TH8 horizon from Honda Group**, in an incised valley filled by channel deposits.
- The well confirmed hydrocarbons in the TH8 horizon, with 408' of thickness. From 6 DSTs, the three first intervals had production (6715'- 6734'), with 134 bbls of oil with 30° API. The rest of intervals had high BSW.
- The extensive tests produced 3500 bbls of water (Cl- 2000 ppm) and 185,49 bbls of oil with 29,1°API @ 60°F. The (Extended Well Test) results showed low values of Kh and productivity index, which makes it economically not viable, and they decided not to continue with the production program.

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 to 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



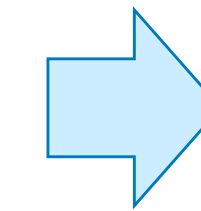
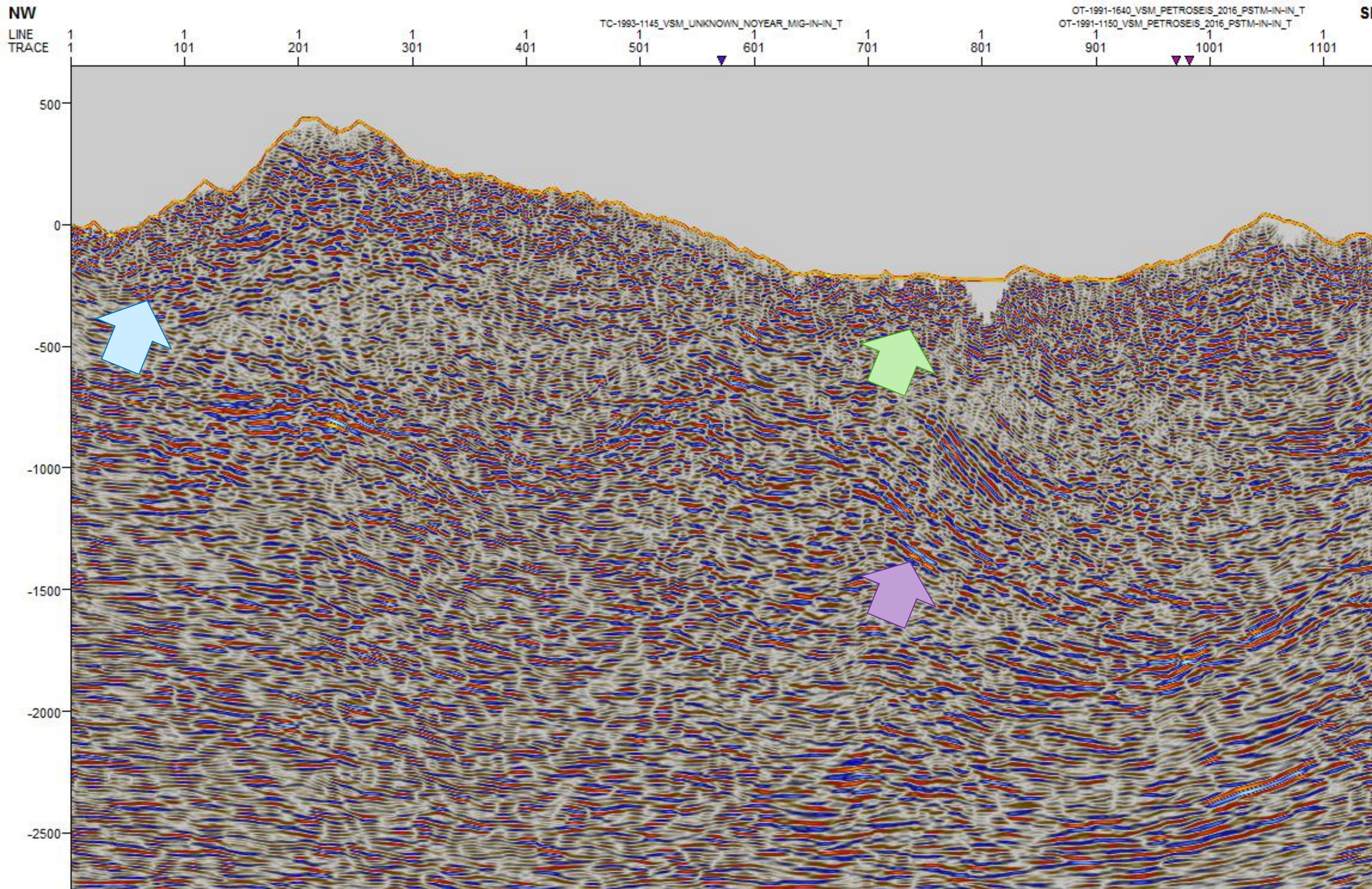
Taken from Ecopetrol (2014)

Fiscalized Production 2020 Nearby Fields

AREA NEARBY	CONTRACT	2020 AVERAGE PRODUCTION PER DAY OIL (BBL)	2020 AVERAGE GAS PRODUCTION (MCFPD)
VSM - 4	San Luis	109	-
VSM - 5	Abanico	438	0.1
VSM - 5	Ortega	537	0.22
VSM - 5	Toldado	45	0.15
VSM - 5	Tolima	1069	0.41
VSM - 37	Pijao - Potrerillo	21312	3.51

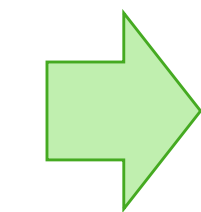
SEISMIC QUALITY

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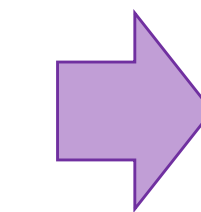


Chaotic reflections associated to basement lifting and high velocity rocks such as Saldaña Fm

(Pull ups anomalies in units underneath and high frequencies naturally filtered)



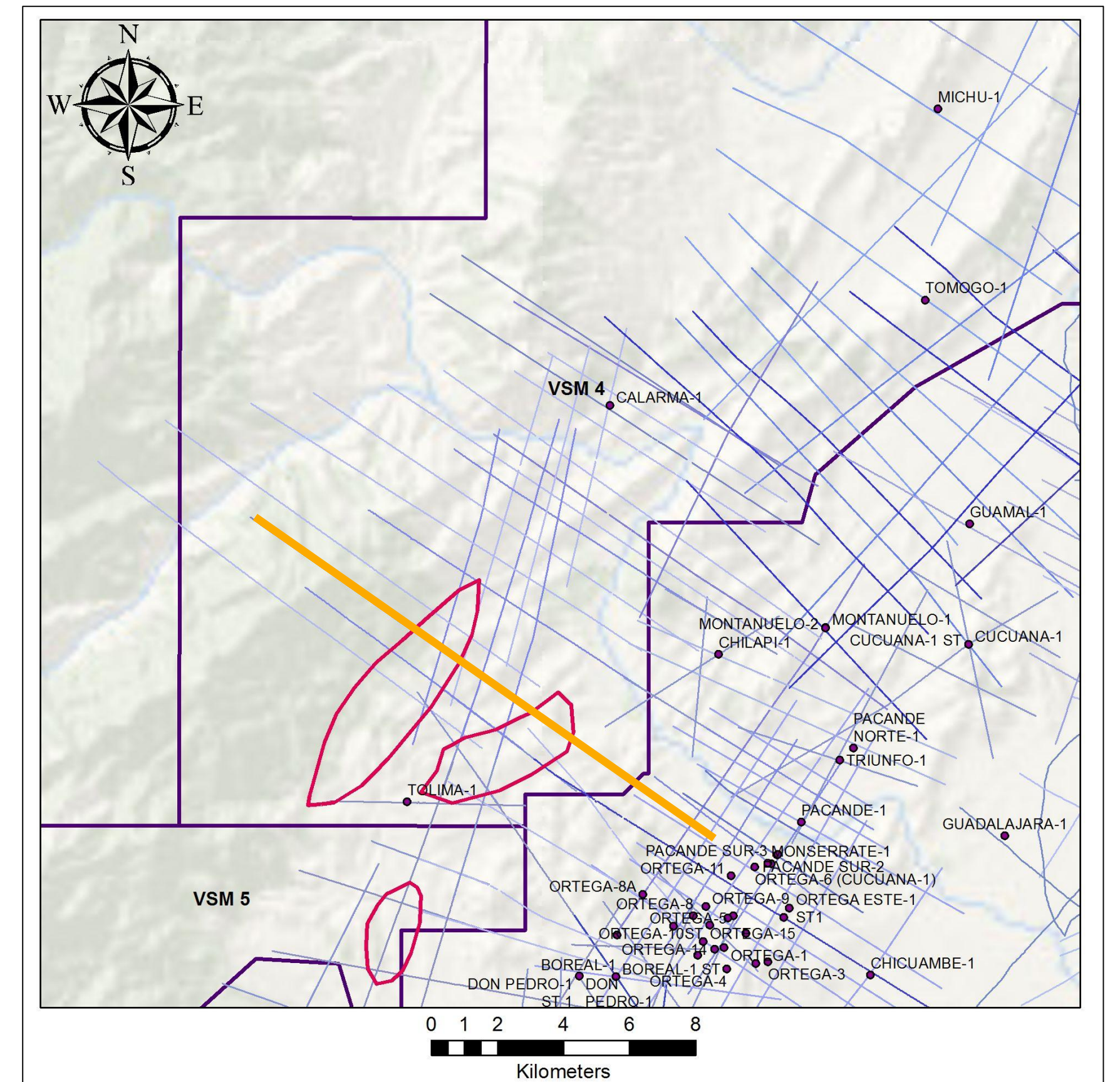
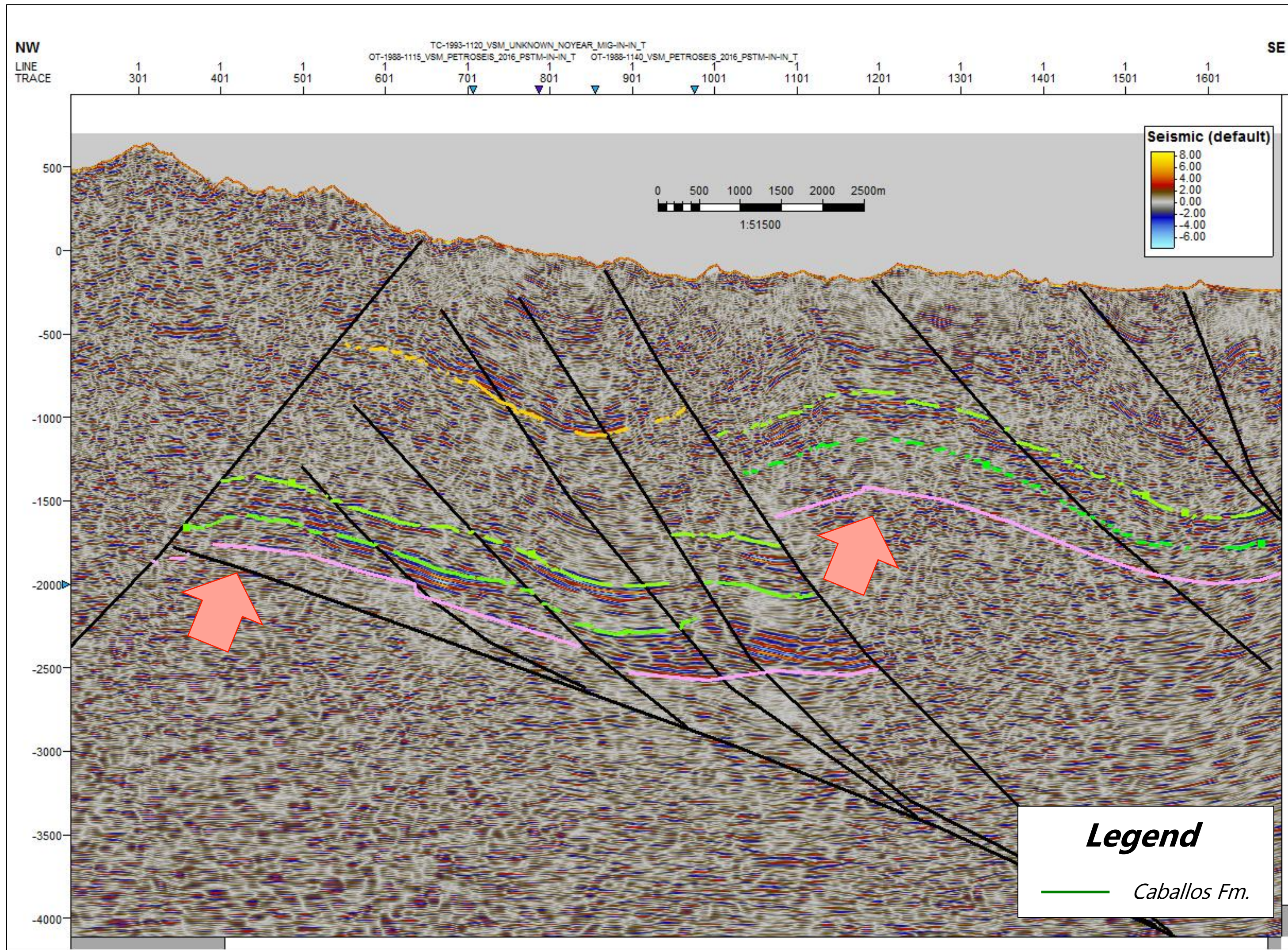
Major challenges in the area due to static corrections: Topographic challenges and a thick weathered layer



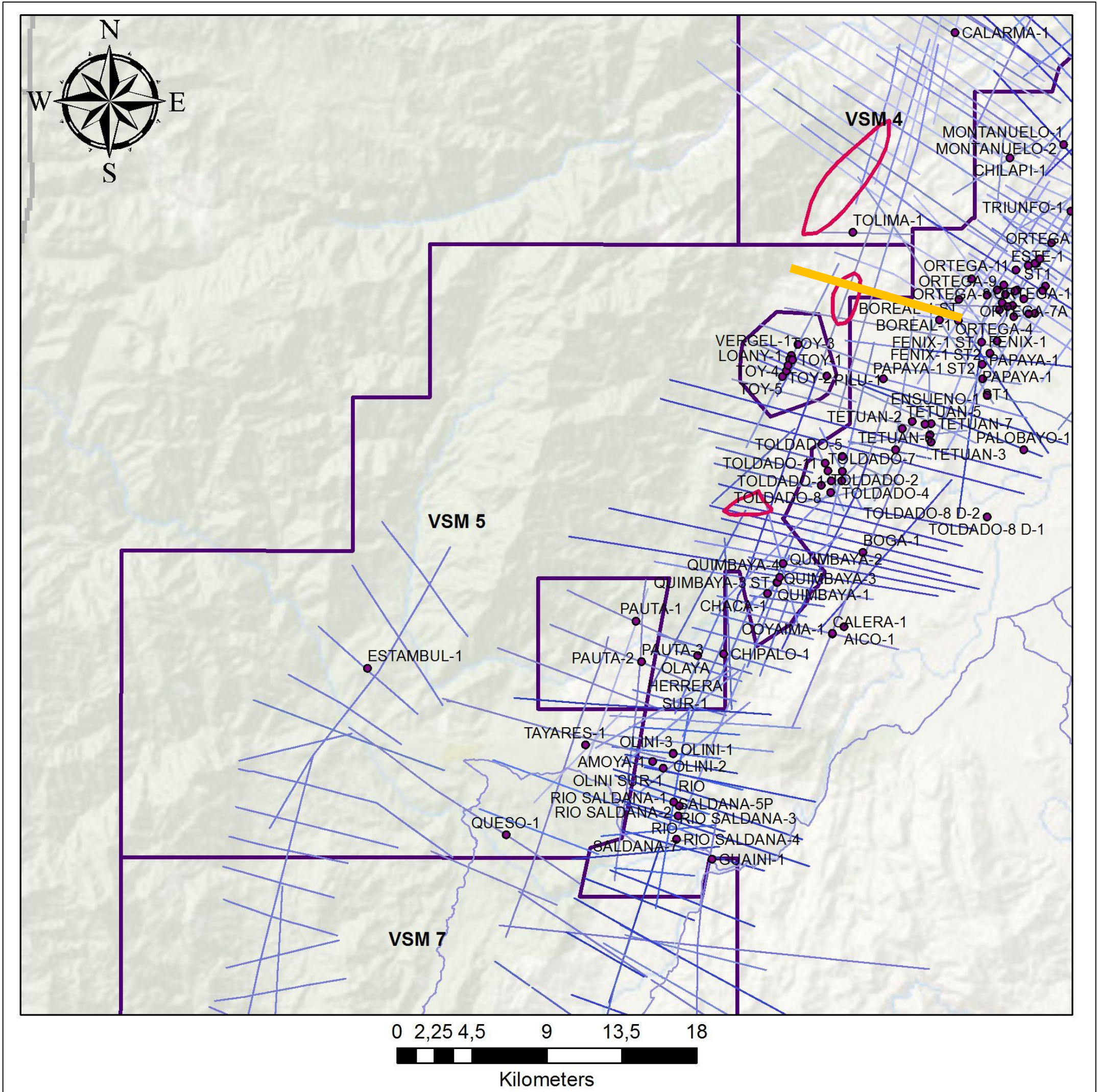
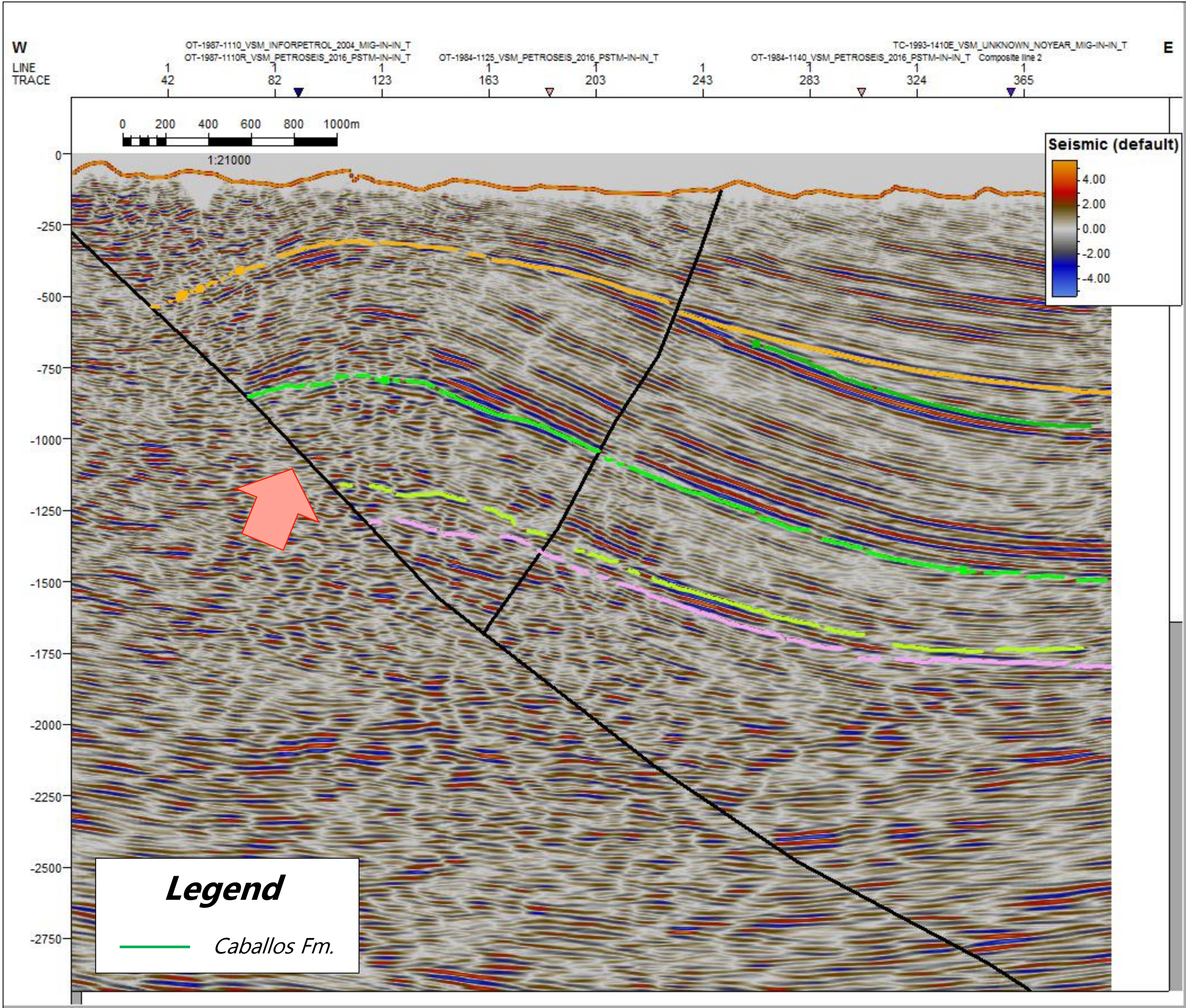
Lack of continuity of high amplitude reflections due to intense faulting with low angle and opposite verging faults

SEISMIC INTERPRETATION

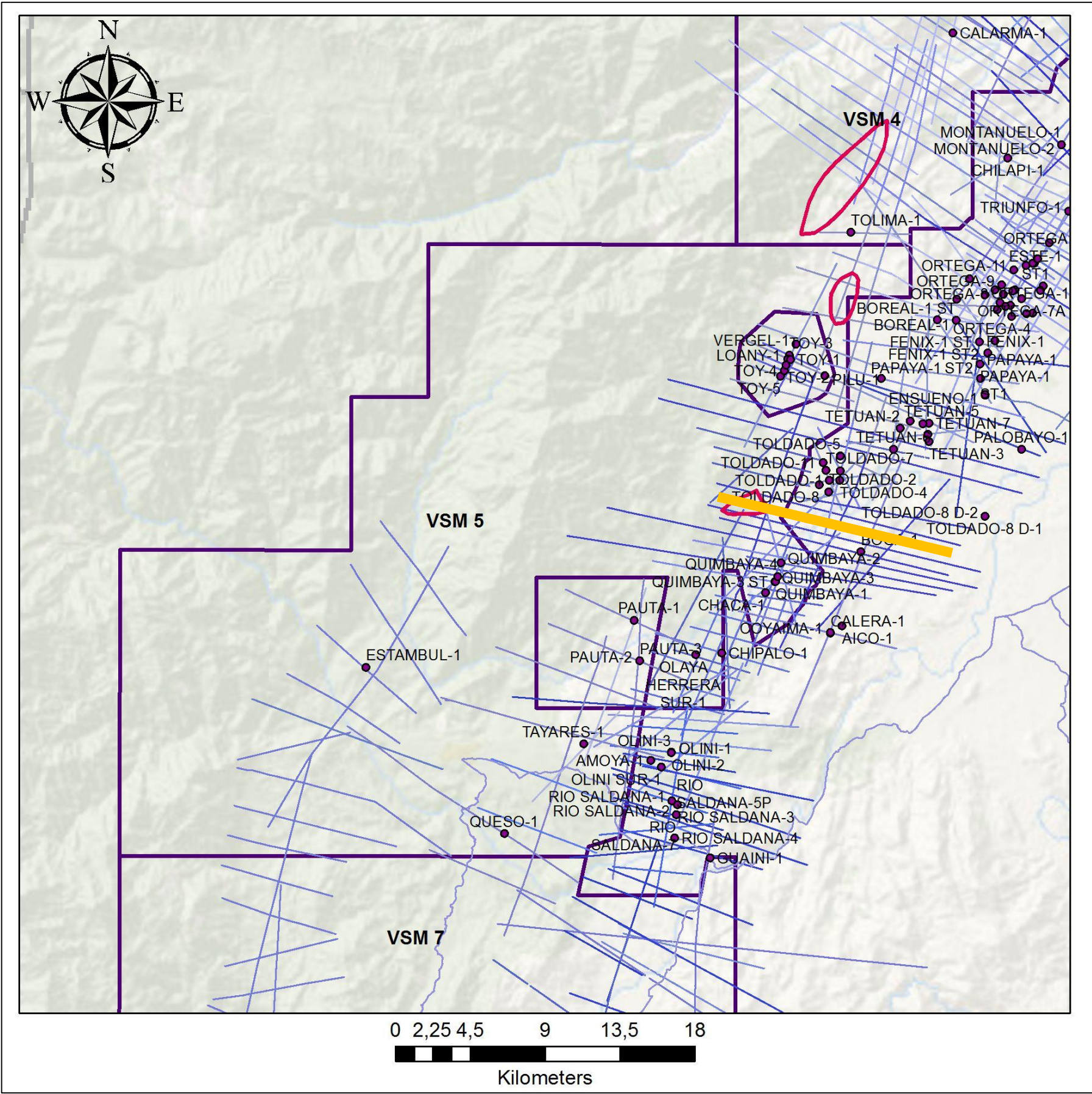
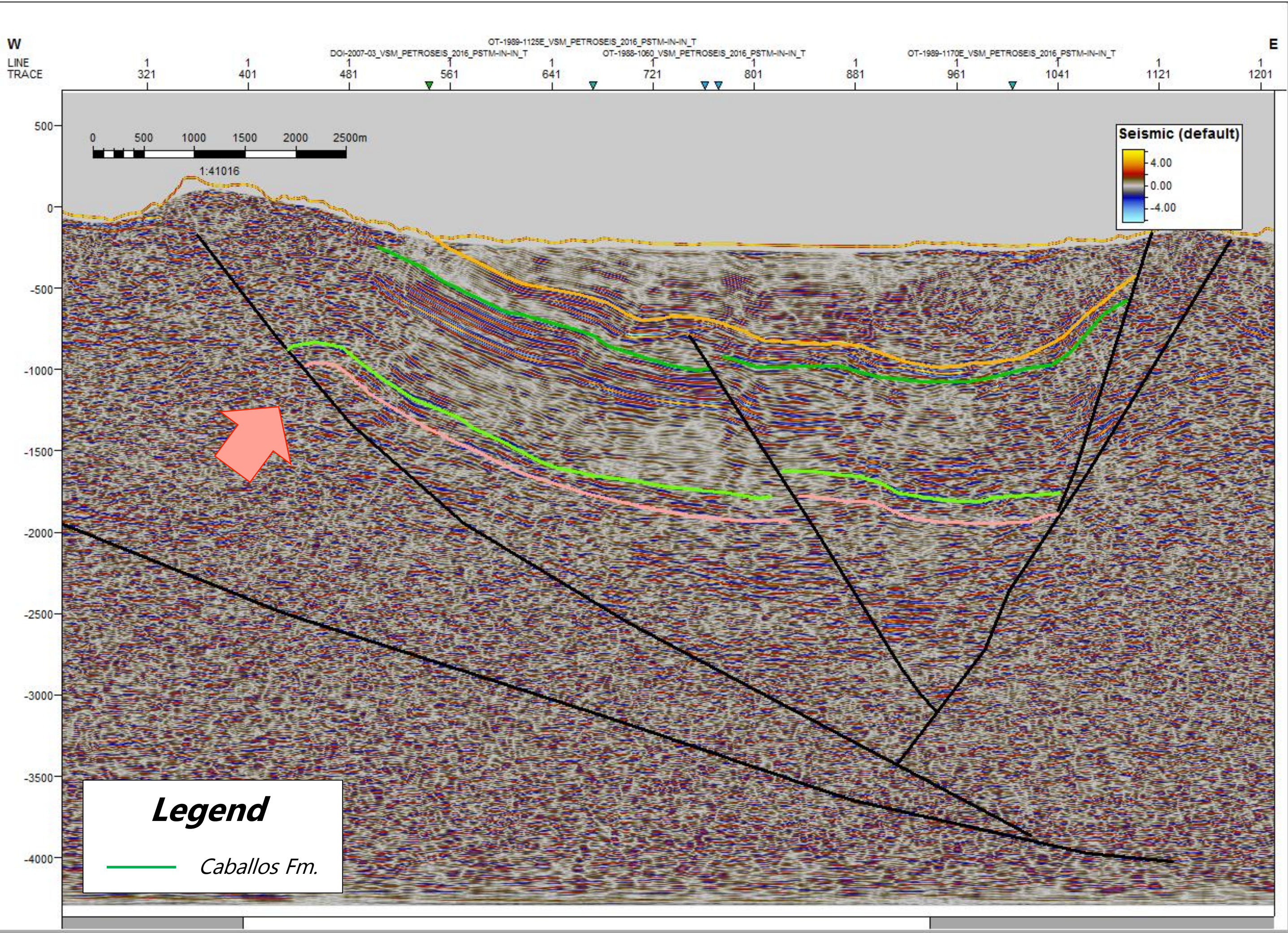
SEISMIC INTERPRETATION: VSM – 4 FLAUTILLO



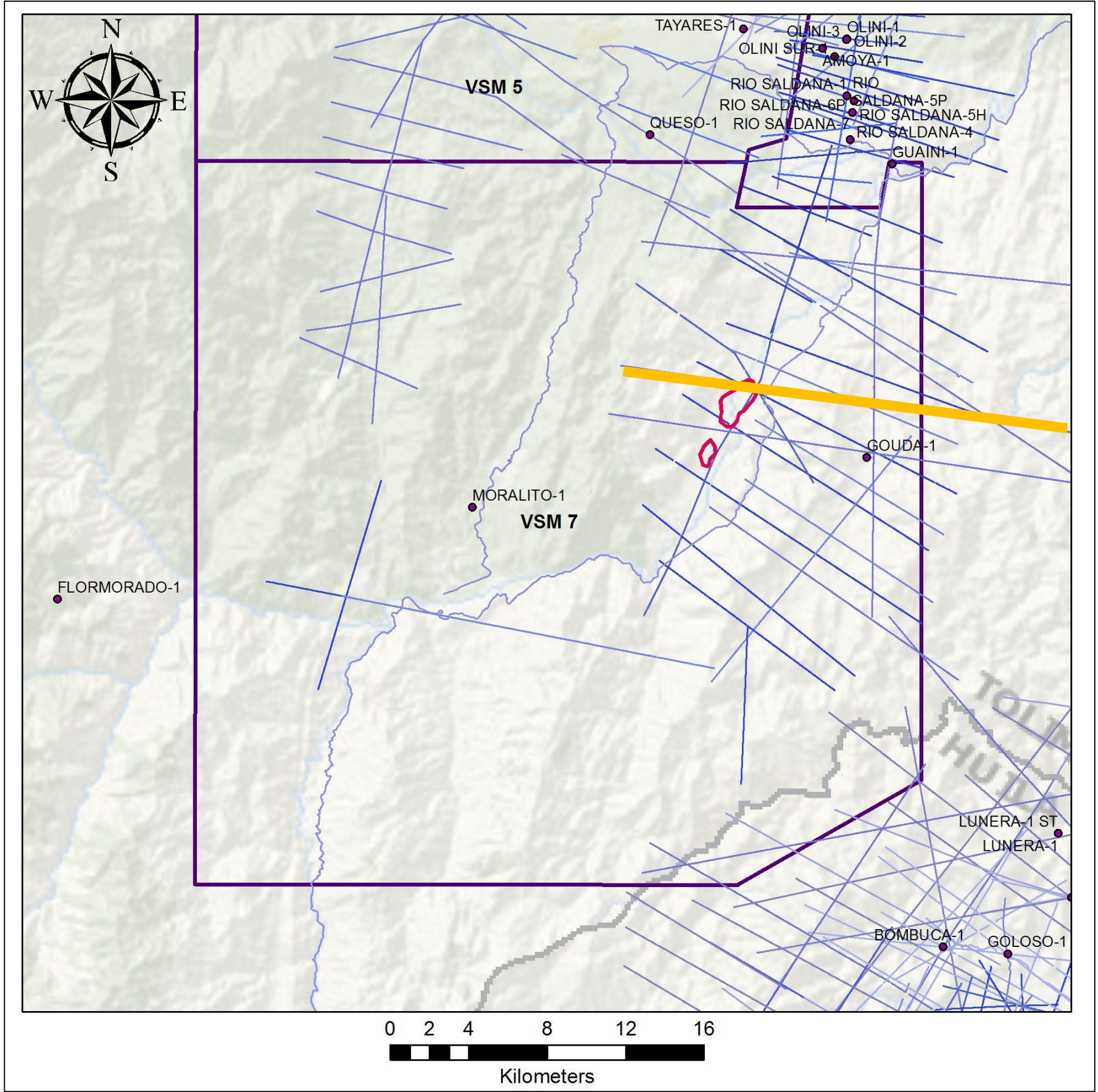
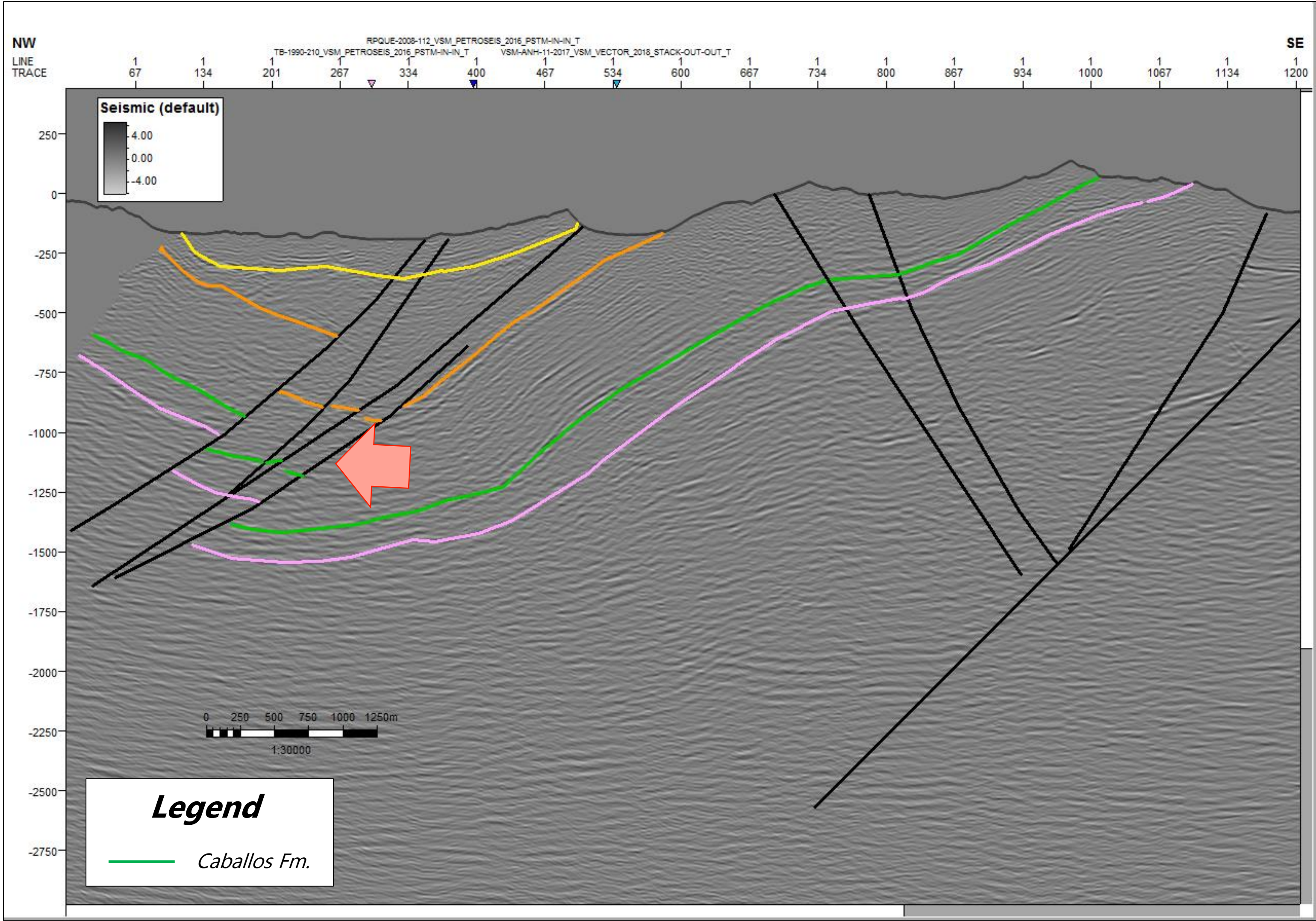
SEISMIC INTERPRETATION: VSM – 5 North Vergel



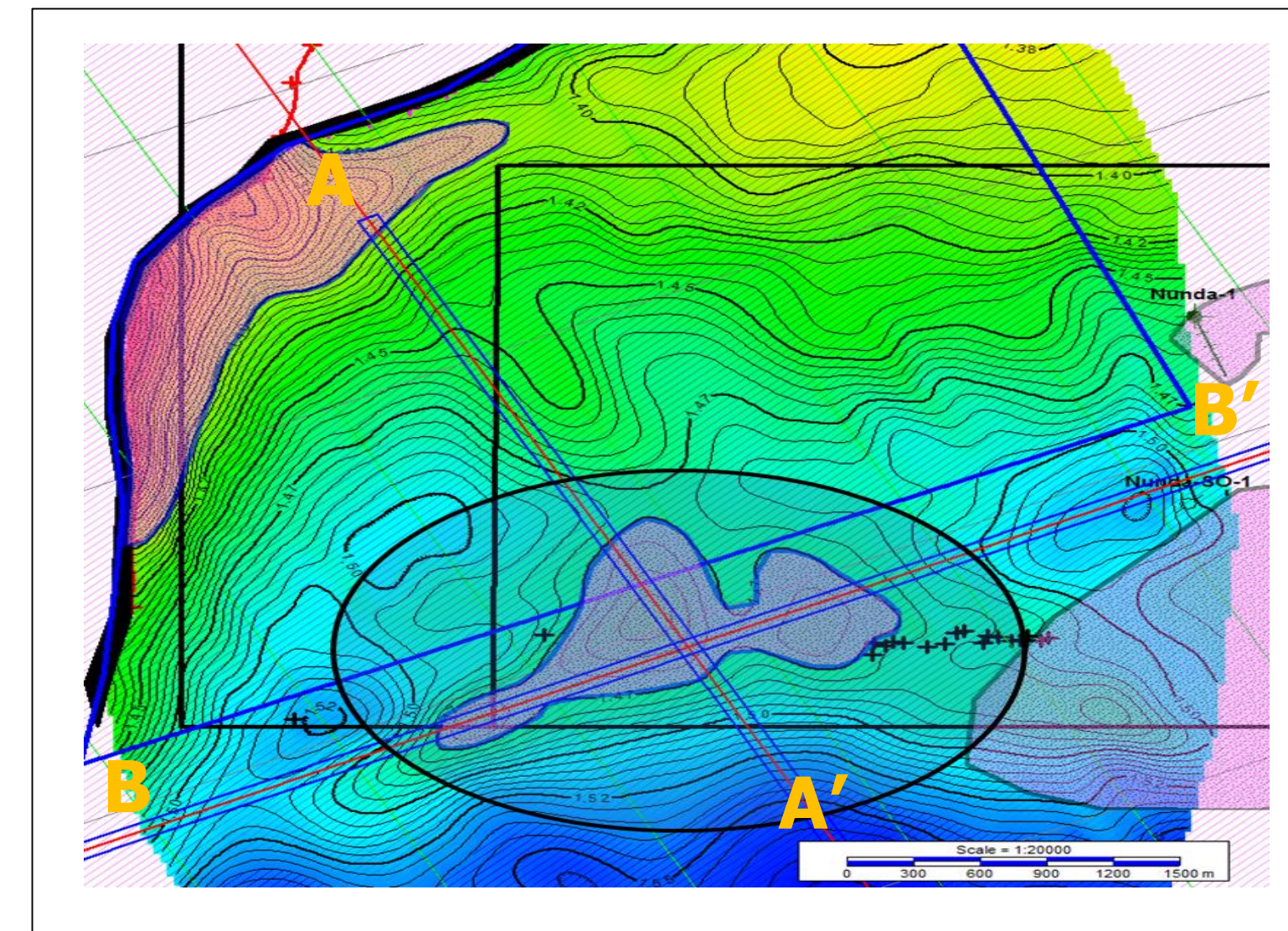
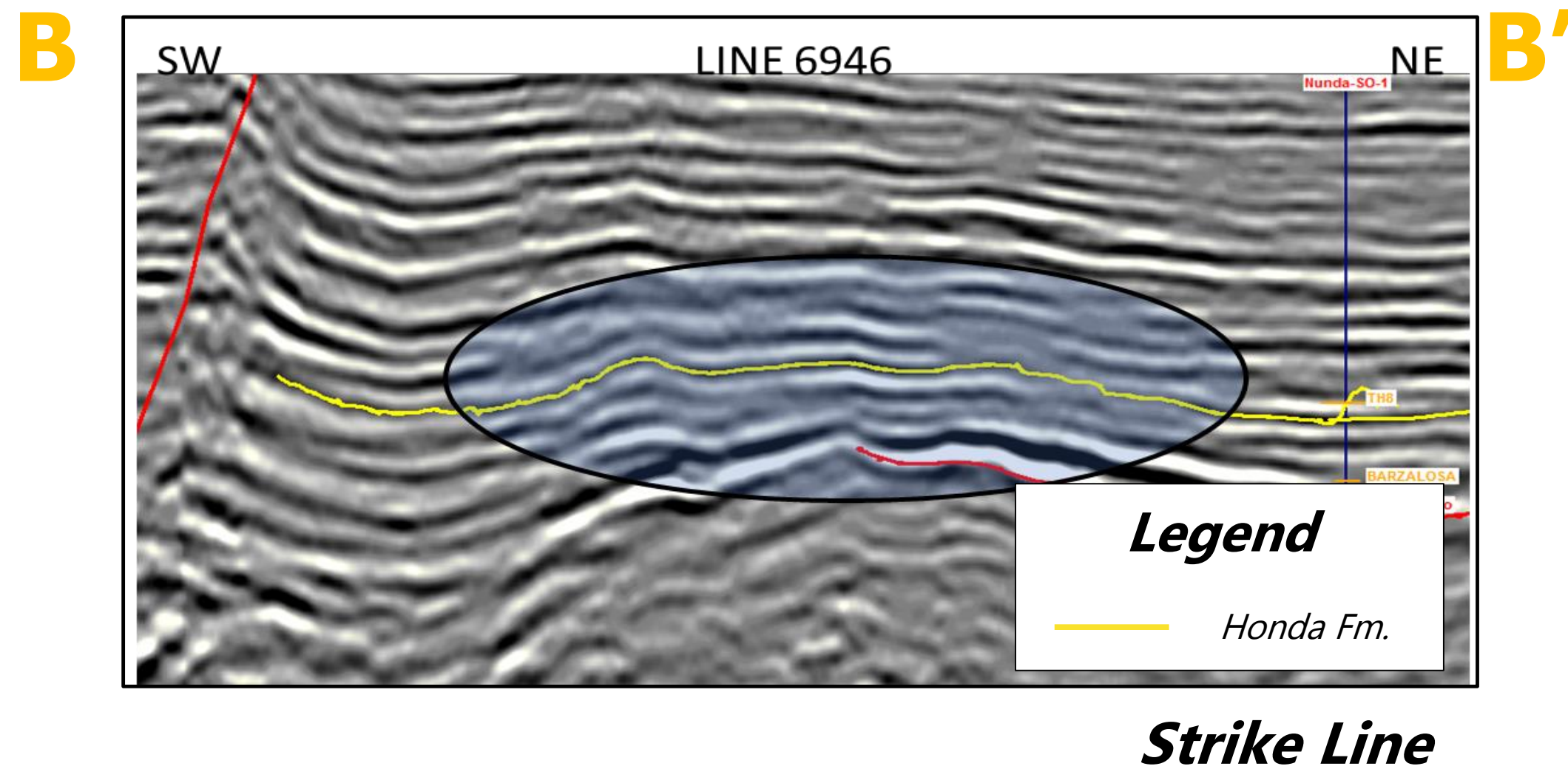
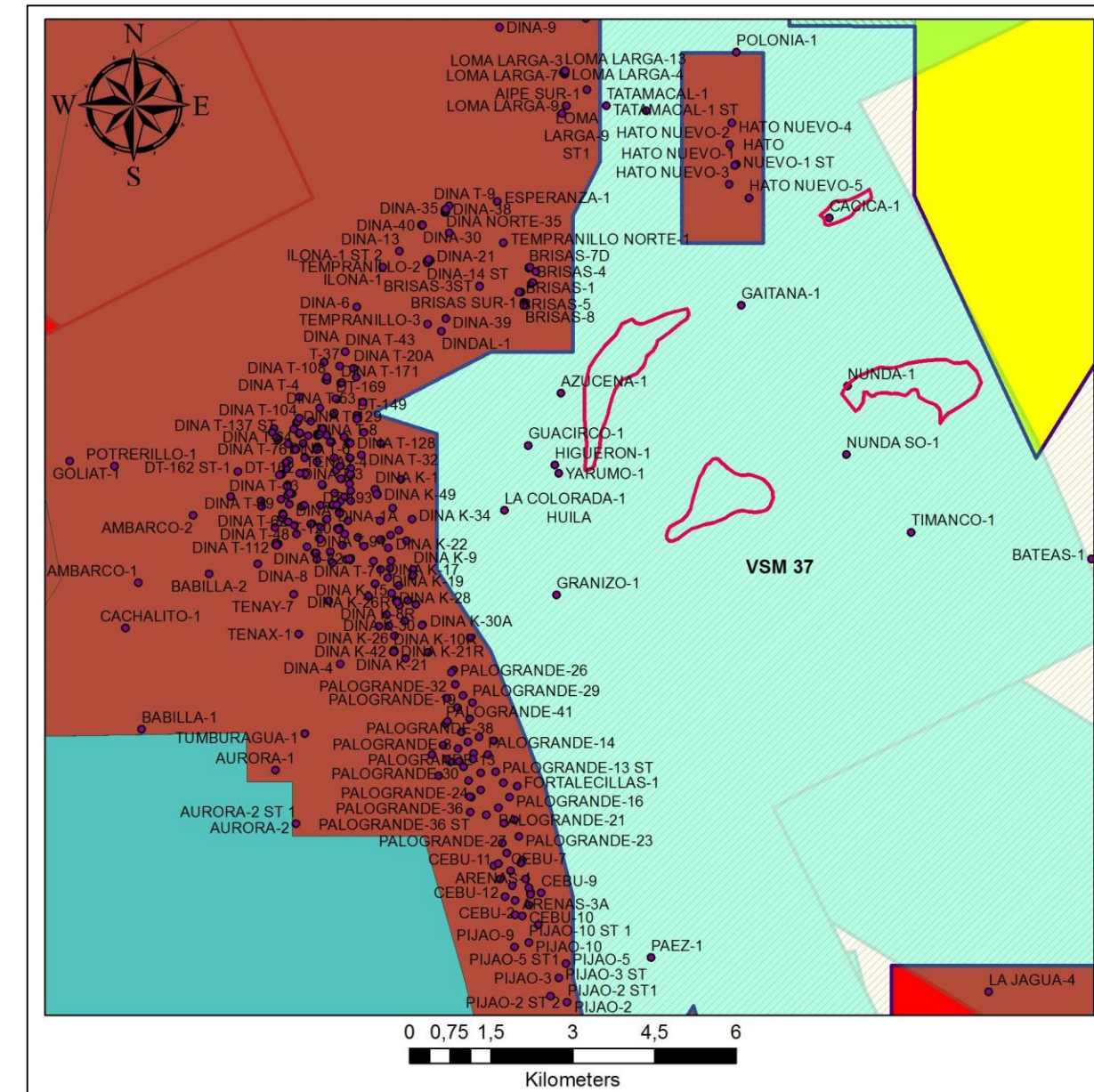
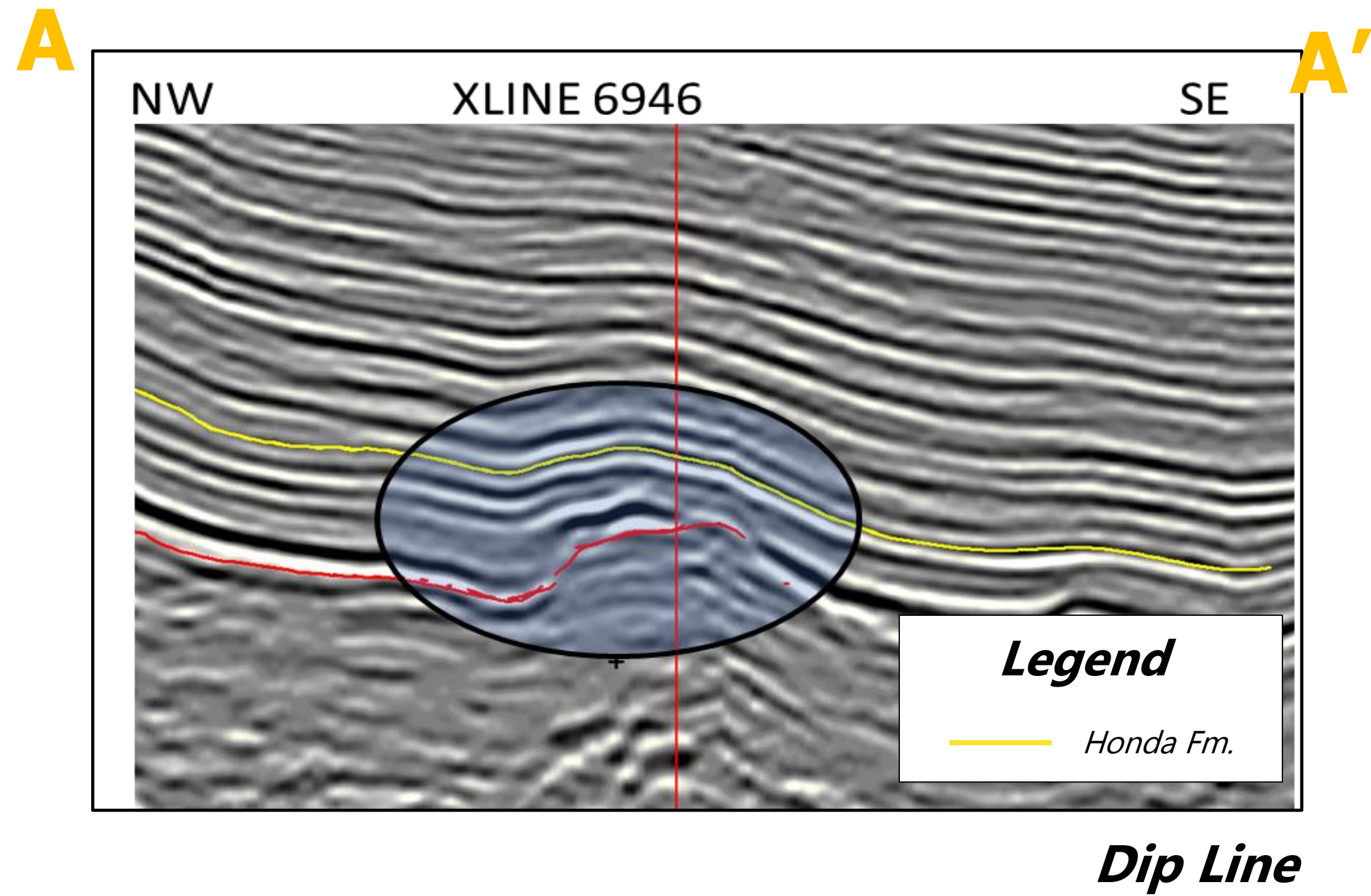
SEISMIC INTERPRETATION: VSM - 5 Quimbaya West



SEISMIC INTERPRETATION: VSM – 7 Ataco Syncline

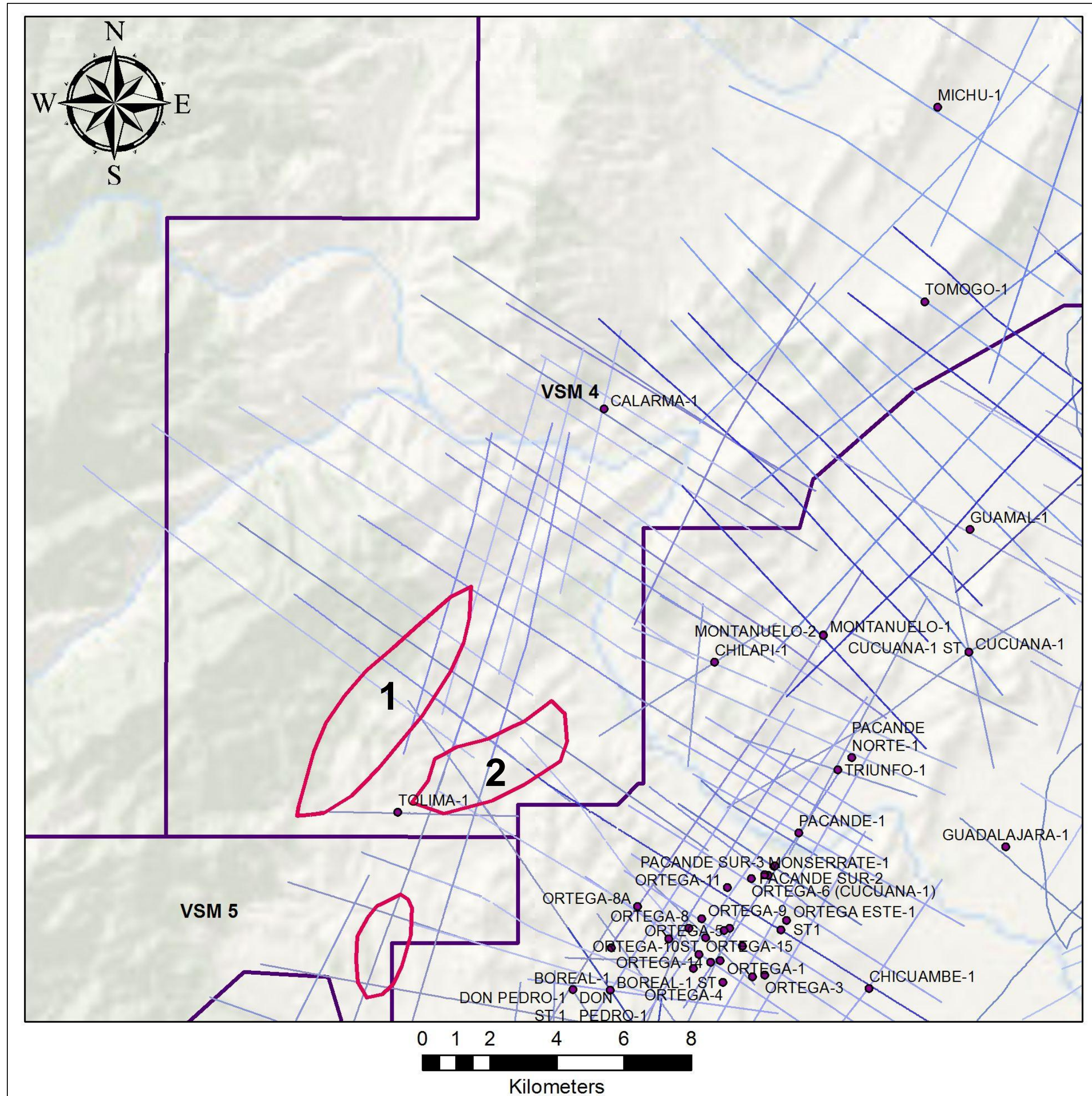


SEISMIC INTERPRETATION: VSM – 37 Nunda W



RECOVERABLE PROSPECTIVE RESOURCES

VOLUMETRICS VSM - 4:

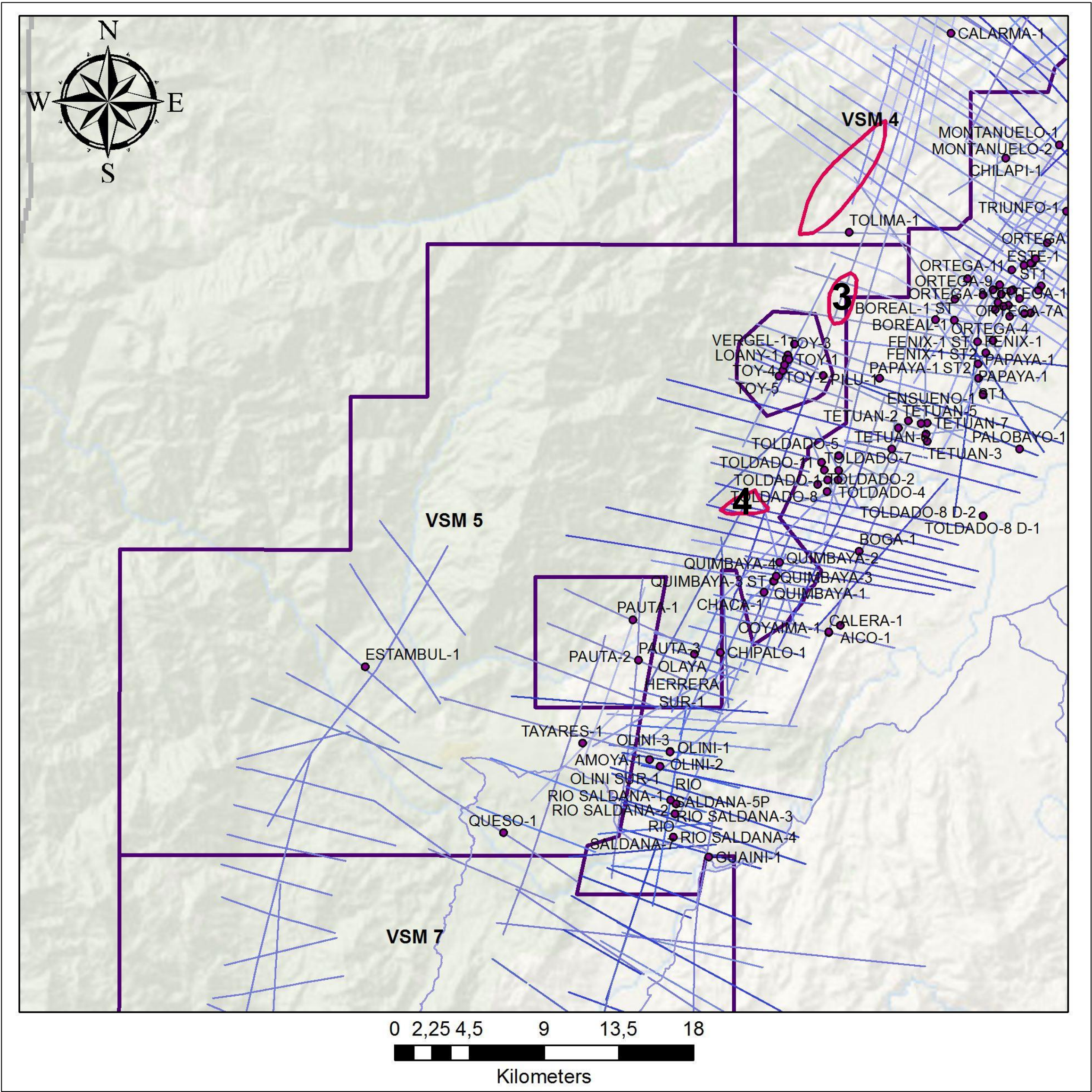


2 LEADS Recoverable Prospective Resources

Lead No	OOIP MMBO	R. Prospective Resources MMBO
1	516.03	23.21
2	297.62	13.4

Lead	Area
1	13.16 km ²
2	7.59 km ²

VOLUMETRICS VSM - 5

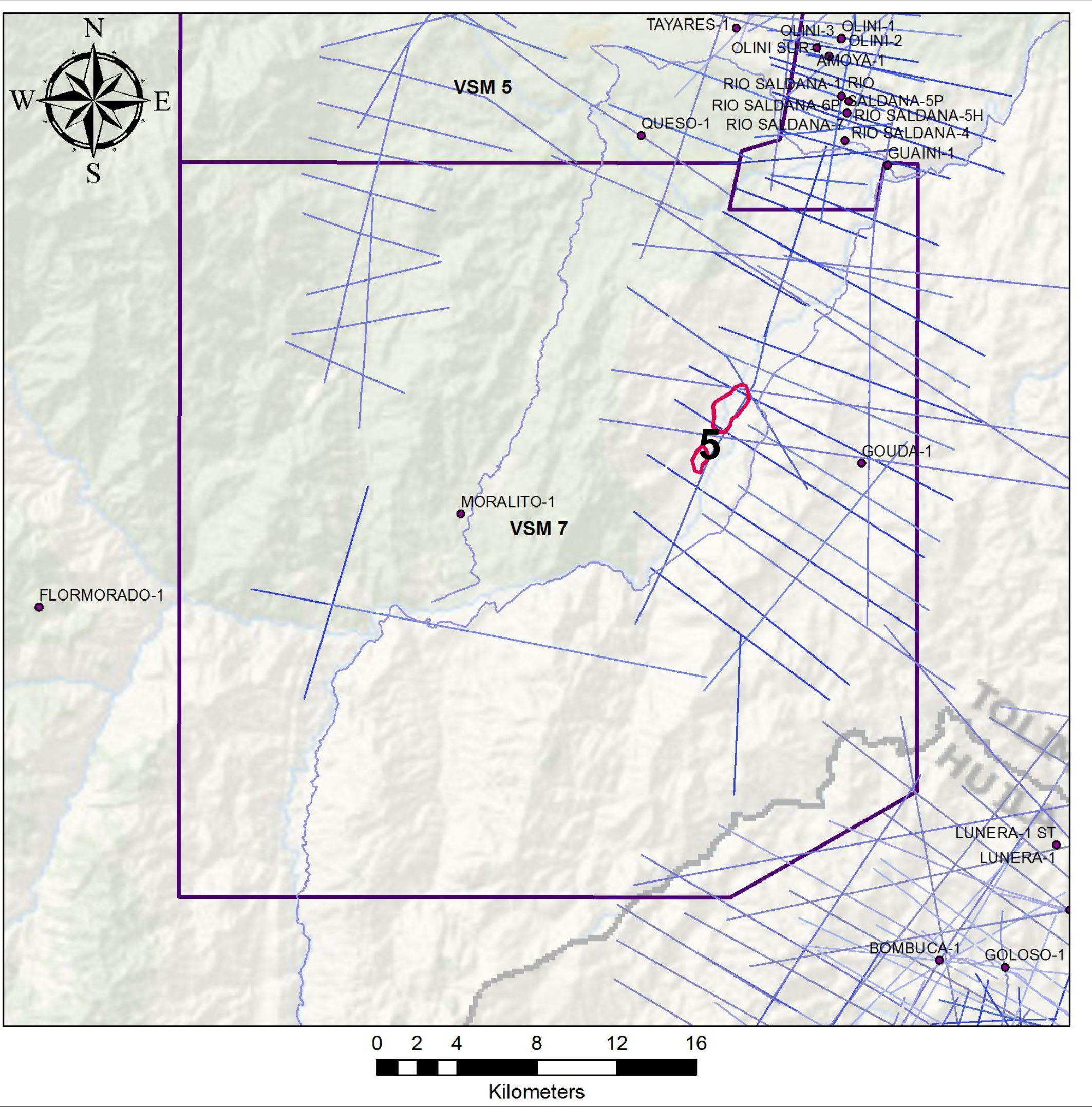


2 LEADS Recoverable Prospective Resources

Lead No	OOIP MMBO	R. Prospective Resources MMBO
3	141.55	6.37
4	91.75	4.13

Lead	Area
3	3.61 km ²
4	2.34 km ²

VOLUMETRICS VSM - 7

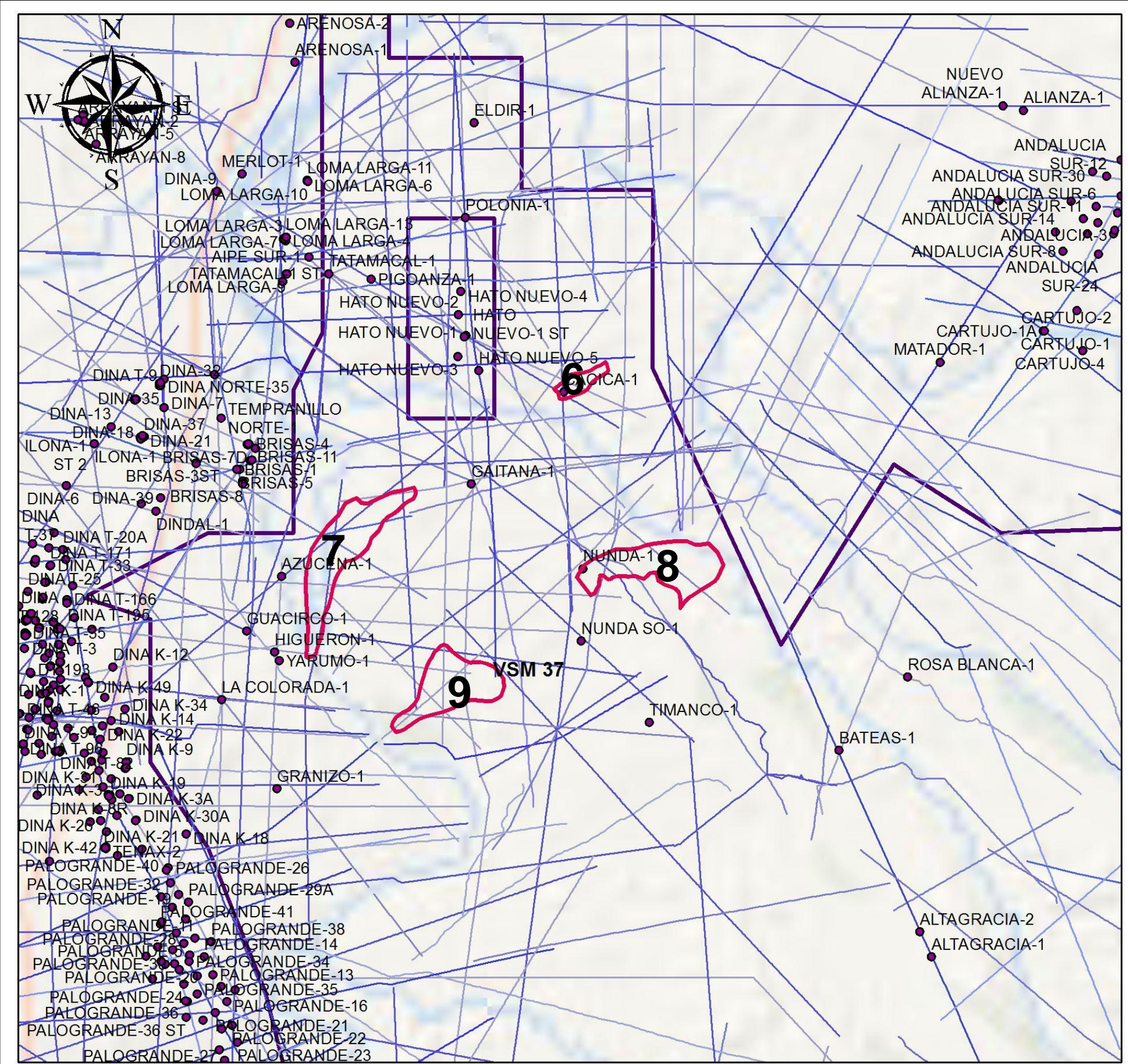


1 LEAD Recoverable Prospective Resources

Lead No	OOIP MMBO	Prospective Resources MMBO
5	123.13	5.54

Lead	Area
5	3.14 km ²

VOLUMETRICS VSM - 37

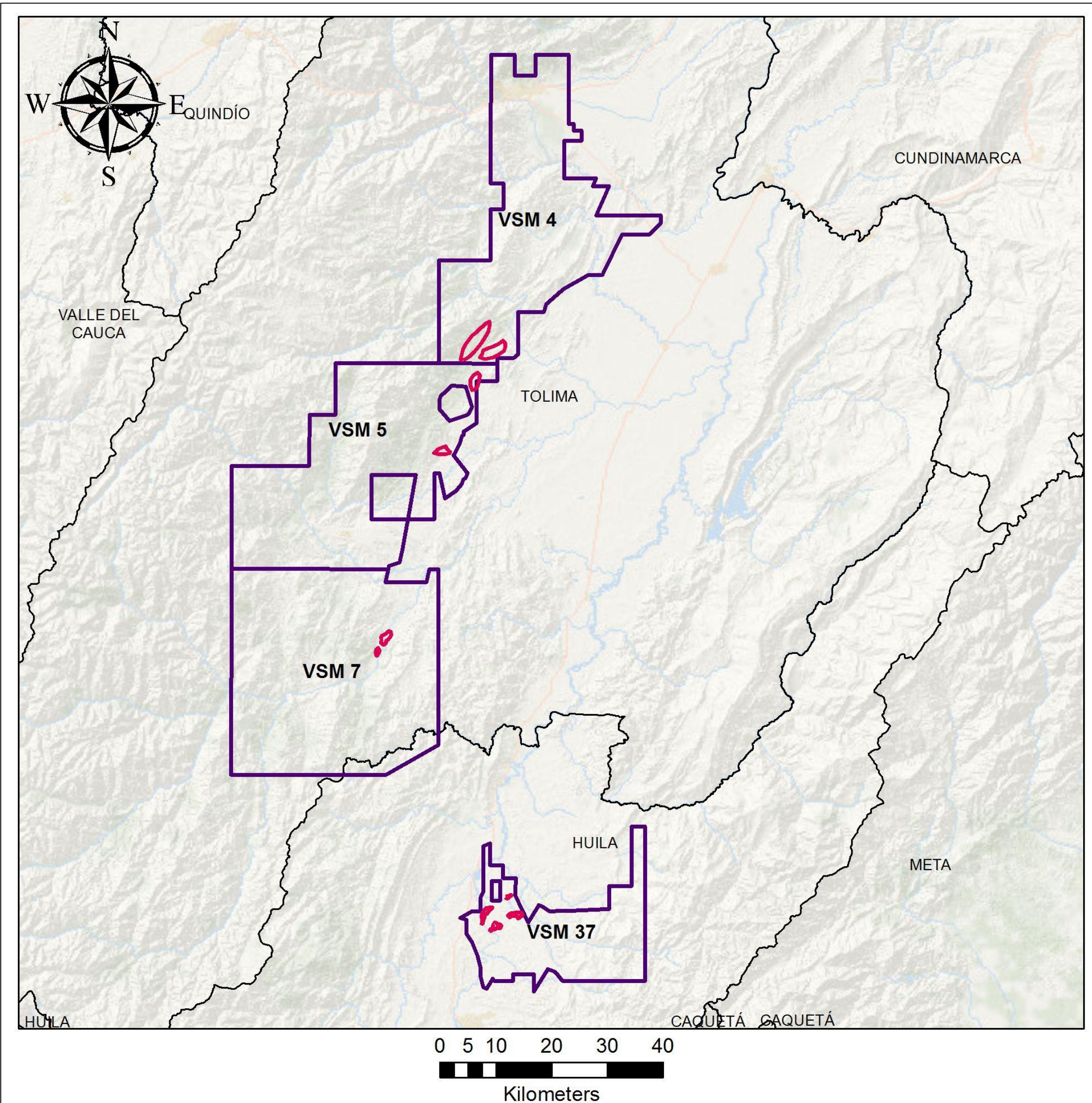


4 LEADS

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



Oil (Deterministic)

- **9 leads in total**
- **OOIP: 1,193.38 MMBIs**

Recovery factor 25%
Chance of success 18%

- **Prospective Resources**

High Estimate	53.70 MMBIs
Best Estimate	26.85 MMBIs
Low Estimate	5.37 MMBIs

CONCLUSIONS

- Three of the **four blocks offered by the ANH** VSM-4, VSM-5 and VSM-7 are located at the north-western part the of Upper Magdalena Basin in the Girardot Sub-basin. The block VSM-37 is located between the Pijao-Potrerrillo and Huila contracts in the Neiva Sub-basin.
- 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**
- **9 wells** have been drilled in the northern blocks **VSM-4, VSM-5** and **VSM-7** while in the southern block (**VSM-37**) **23 wells** have been drilled
- In the northern blocks (VSM-4, VSM-5, VSM-7) **41 2D seismic surveys** have been acquired from 1984 to 2017. In the southern block **21 2D seismic surveys** and **5 3D seismic surveys** have been acquired from 1971 to 2009
- The UMVB is a depression oriented SSW – NNE with superposition of different stages of deformation with tectonic inversion at the Miocene. The main structures at the Girardot area are en echelon synclines with associated thrusts that repeat mainly the lower Cretaceous Sequences (Caballos and Villeta Formations)
- Most of the wells drilled at the Girardot sub-basin reached a **maximum depth of 6000'** with the main target at the **Caballos Formation** showing plenty of gas shows. One of the main challenges to avoid reservoir problems is to assess better the quality using new technologies such as 3D seismic with QI evaluations.
- The seismic interpretation carried out by the ANH have shown shallow **leads associated to imbrications with low angles** and SE verging faults. A lead into the faulted Ataco syncline is proposed where the juxtaposition of the Villeta Group with the sandstones of the Upper Caballos Formation creates prospectivity at this area
- Inside the areas offered by the ANH, **9 shallow leads have been mapped** using seismic interpretation with a **best estimate of recoverable prospective resources of 26,85 MMBO**.

Thanks

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