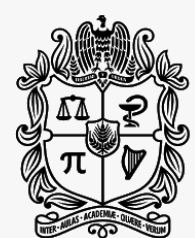


# COLOMBIA ROUND 2021



UNIVERSIDAD  
NACIONAL  
DE COLOMBIA



**Uptc**  
Universidad Pedagógica y  
Tecnológica de Colombia



**ACOGGP**  
ASOCIACIÓN COLOMBIANA DE GEÓLOGOS Y GEOFÍSICOS DEL PETRÓLEO



**AAPG**



**EAGE**



El futuro  
es de todos

Minenergía

# GEOLOGICAL INTEGRATION, PETROLEUM SYSTEMS AND PROSPECTIVITY OF COLOMBIA'S FRONTIER BASINS: LOWER MAGDALENA VALLEY – PLATO SUB-BASIN

MAY 7<sup>TH</sup> 2021

Plato sub-basin location

Stratigraphy

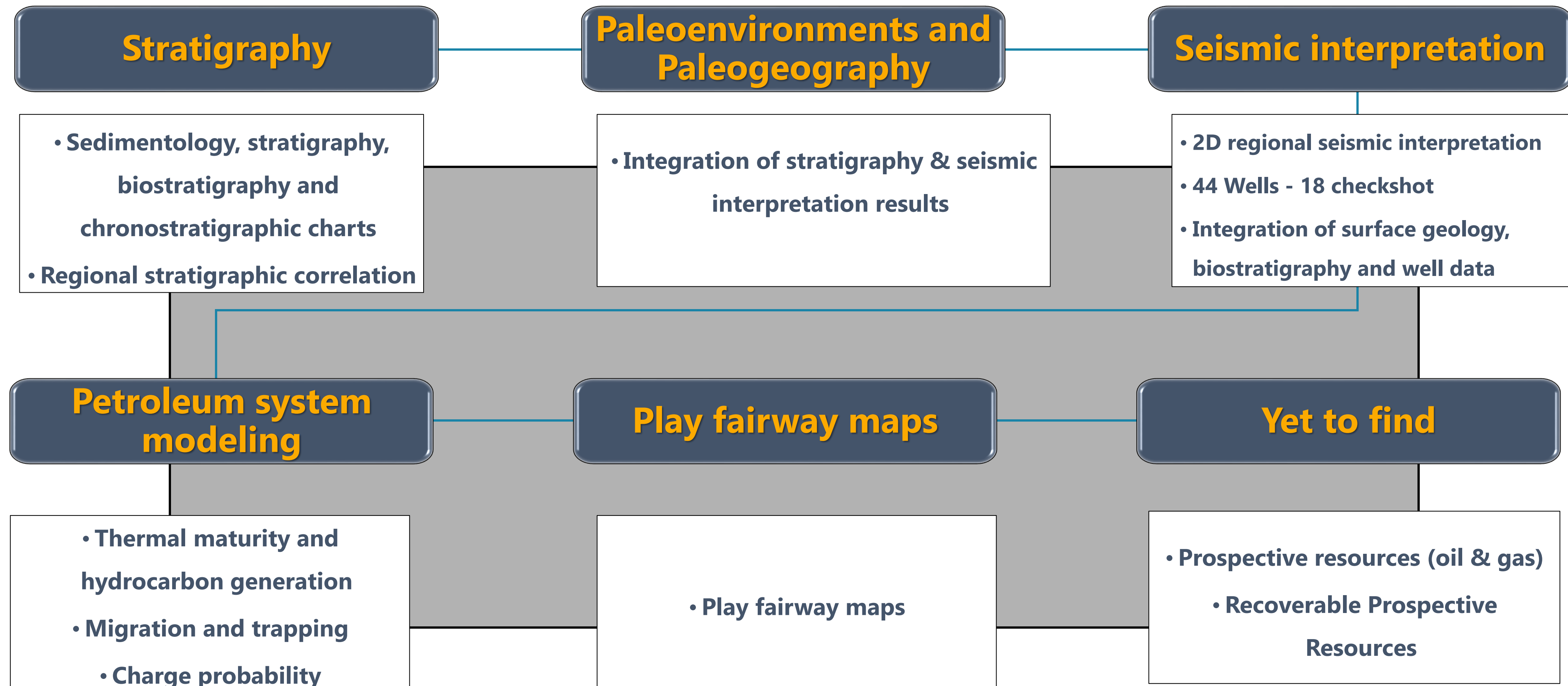
Paleoenvironments and paleogeography

Seismic interpretation

Petroleum system modeling

Play fairway maps

Yet to Find

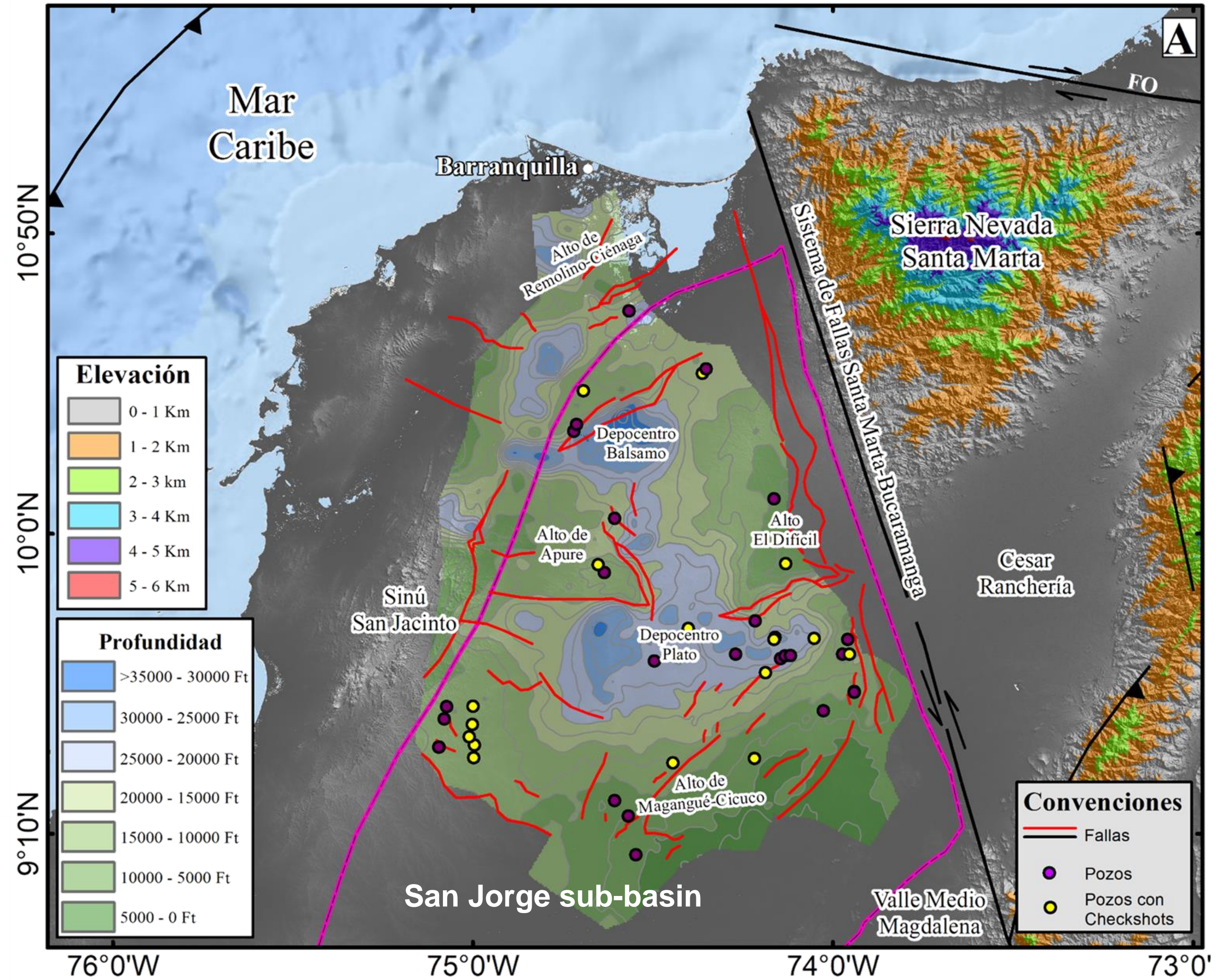
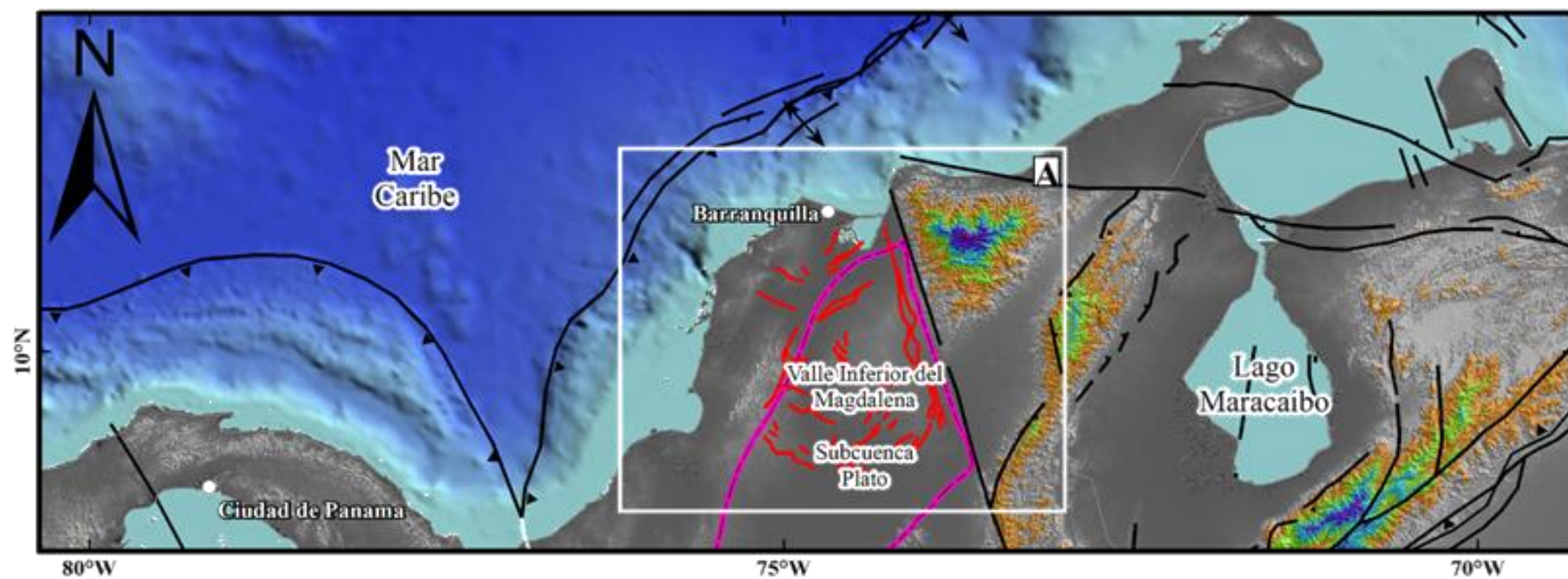


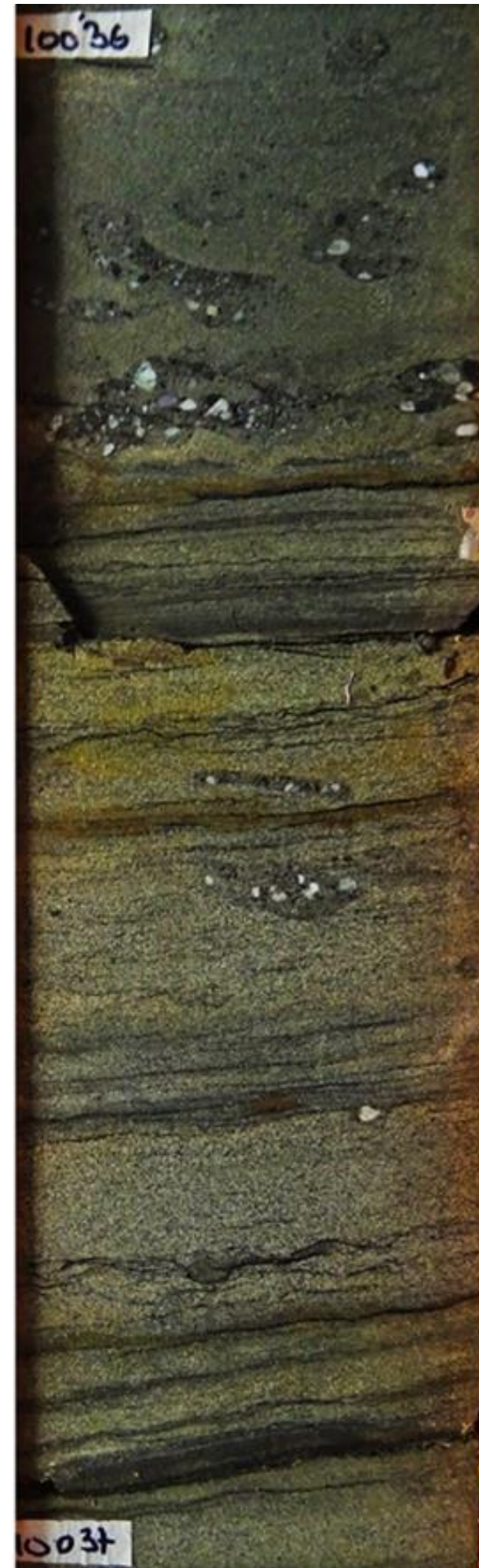
LOWER MAGDALENA VALLEY – PLATO SUB-BASIN

The Lower Magdalena Valley basin is located in the Caribbean region of Colombia, SW of the Sierra Nevada de Santa Marta.

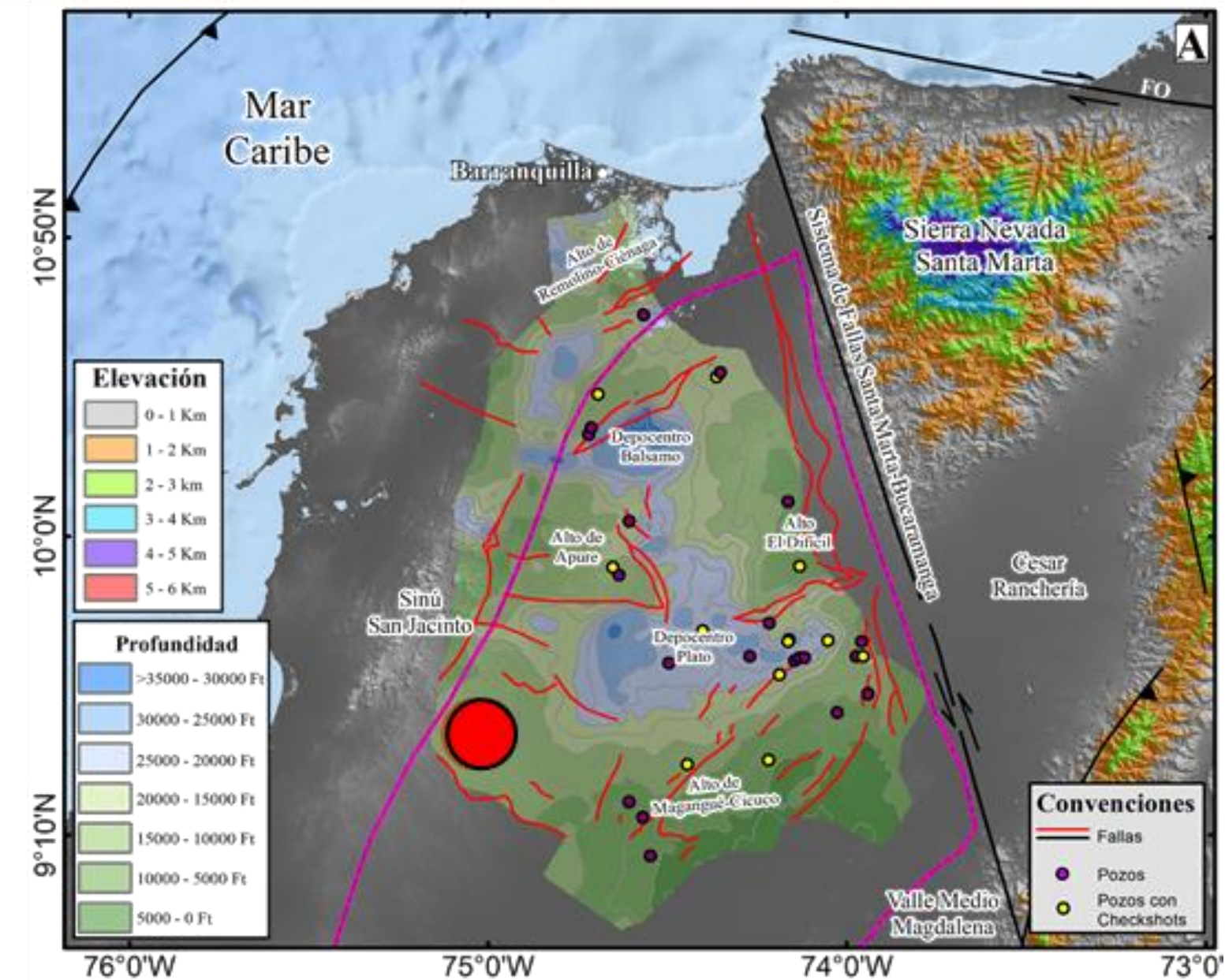
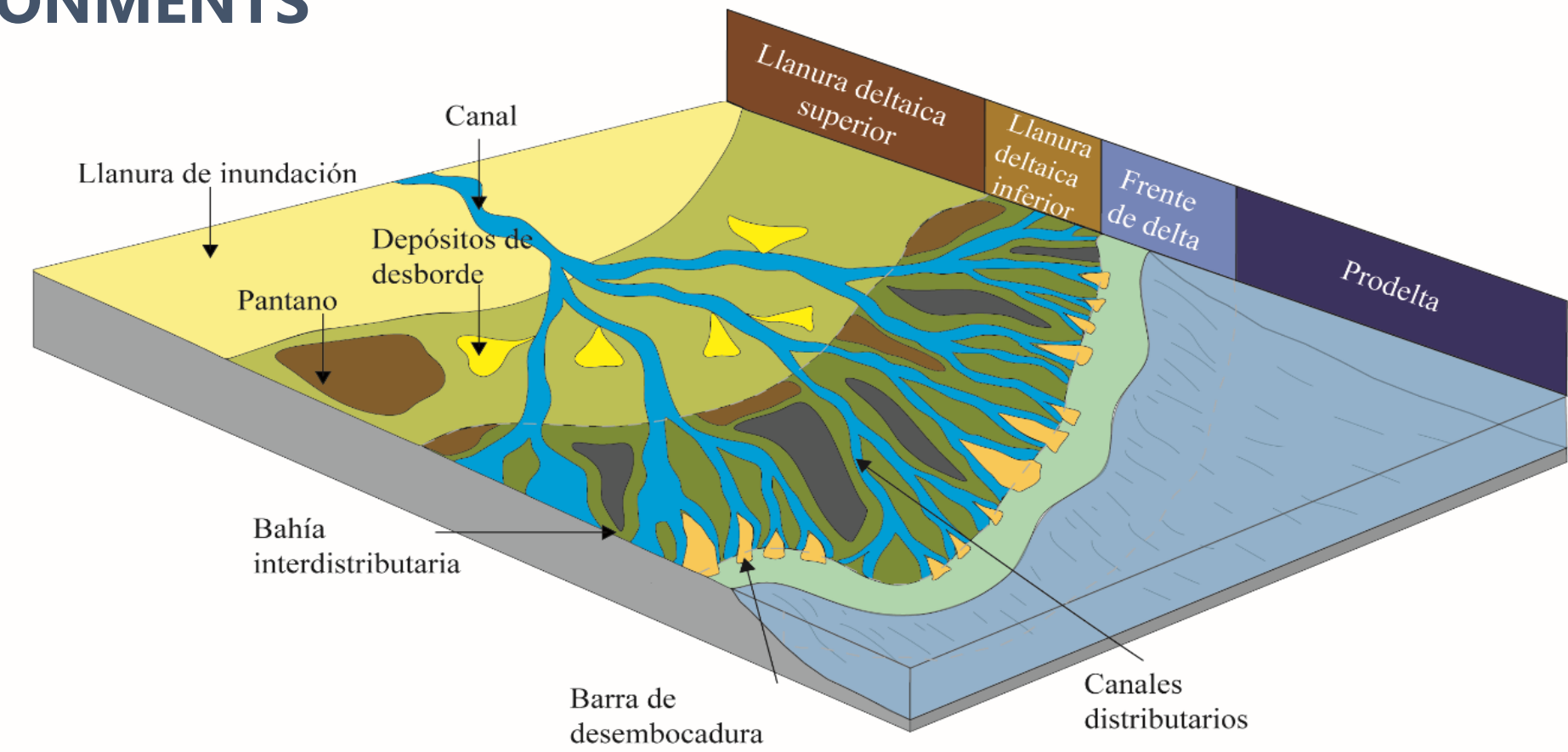
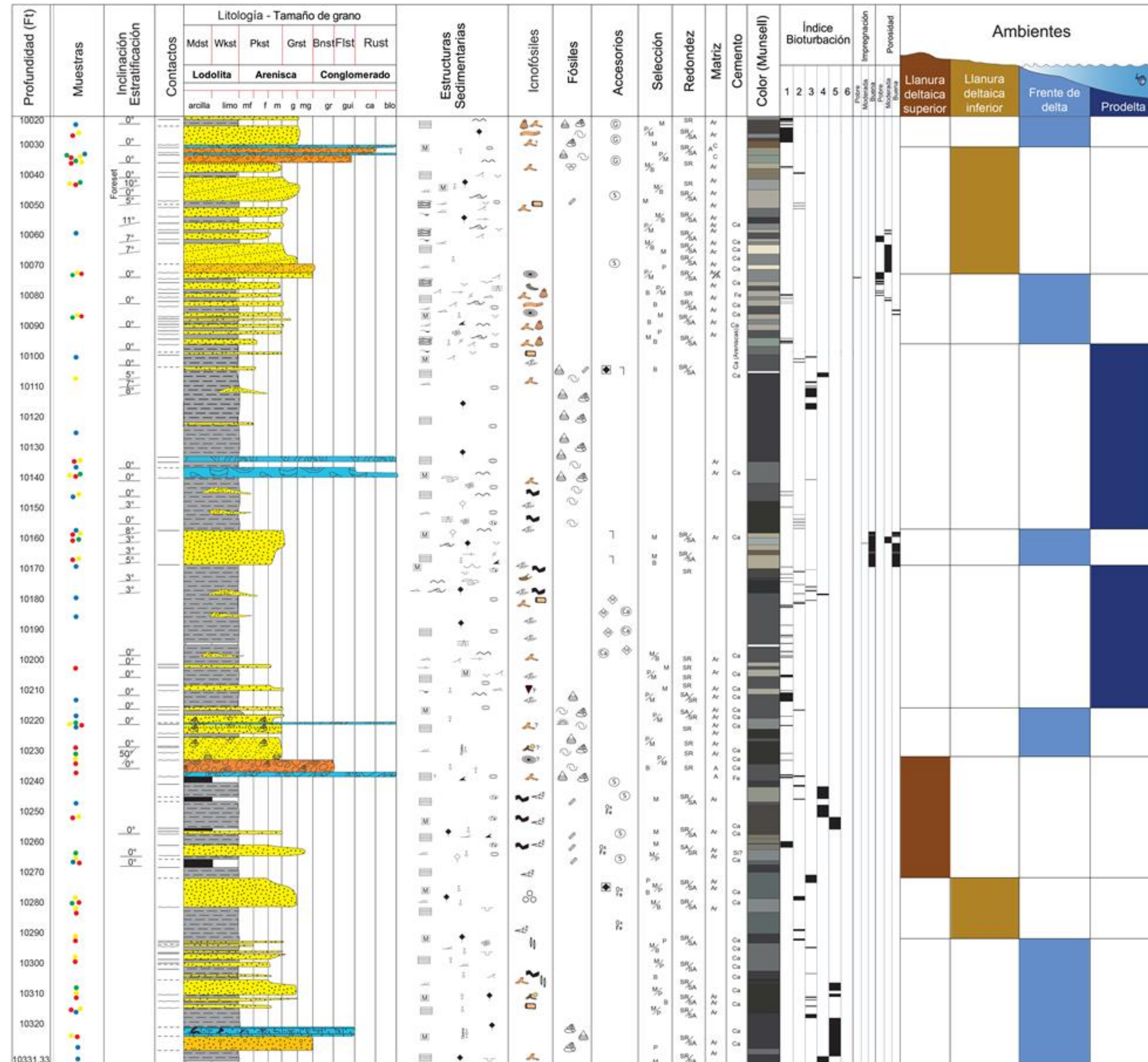
Geological borders

- North and West: Sinú - San Jacinto Fold belt
- East: Bucaramanga fault system, Cesar-Rancheria basin
- South – South West: San Jorge sub-basin

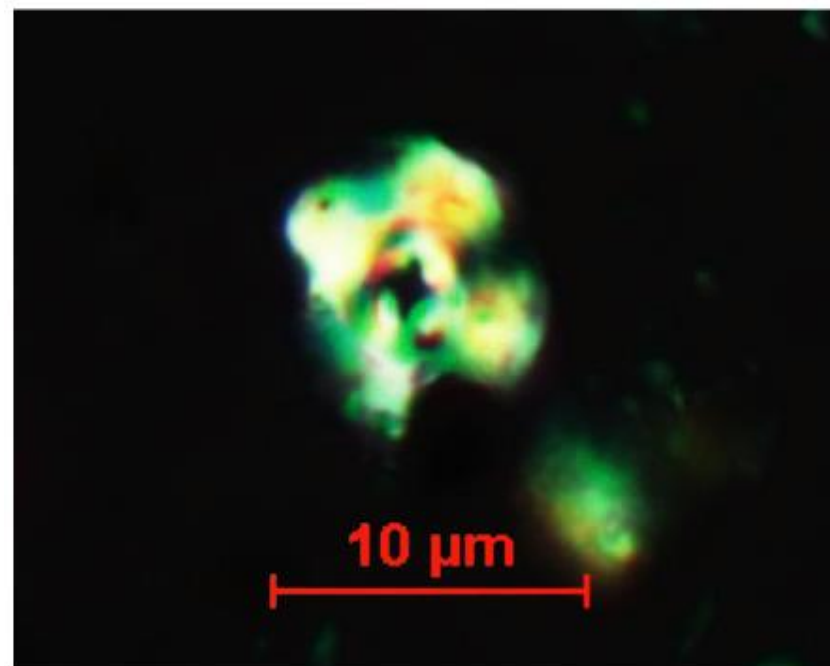
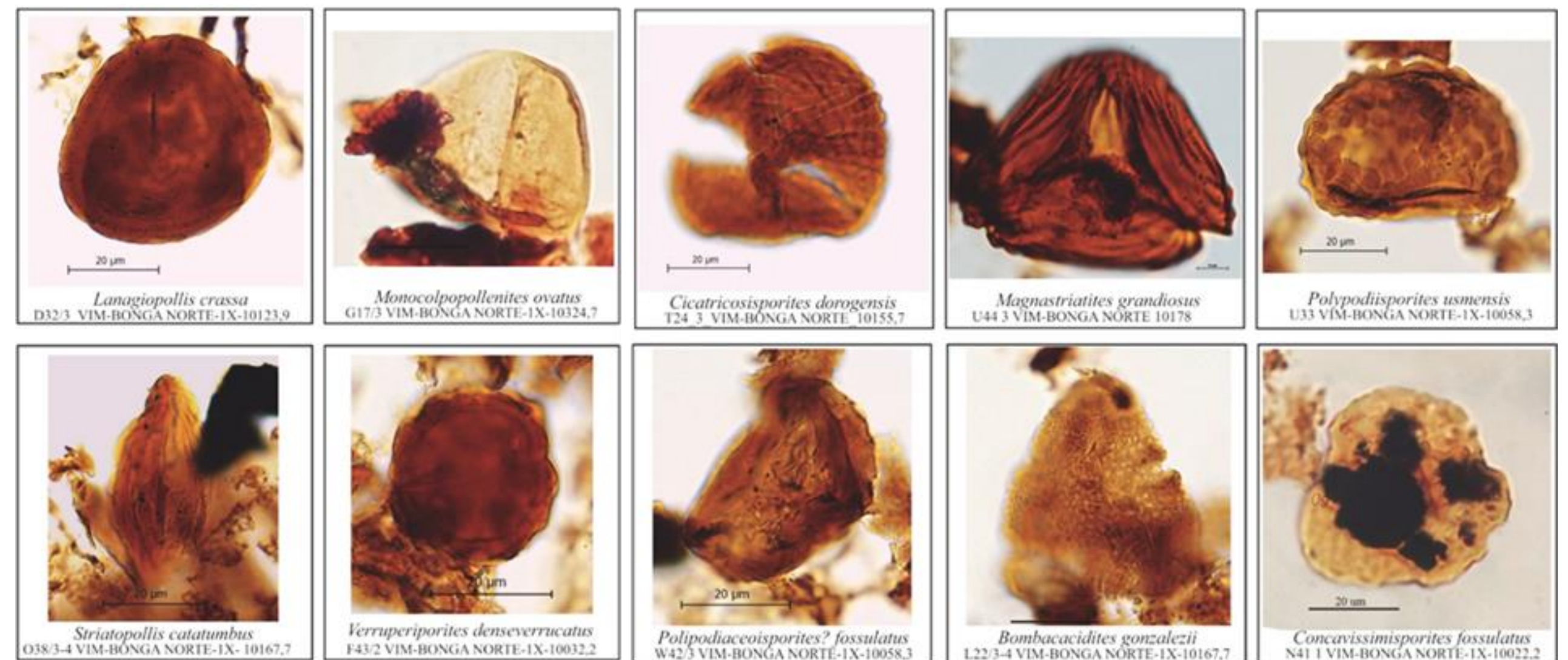
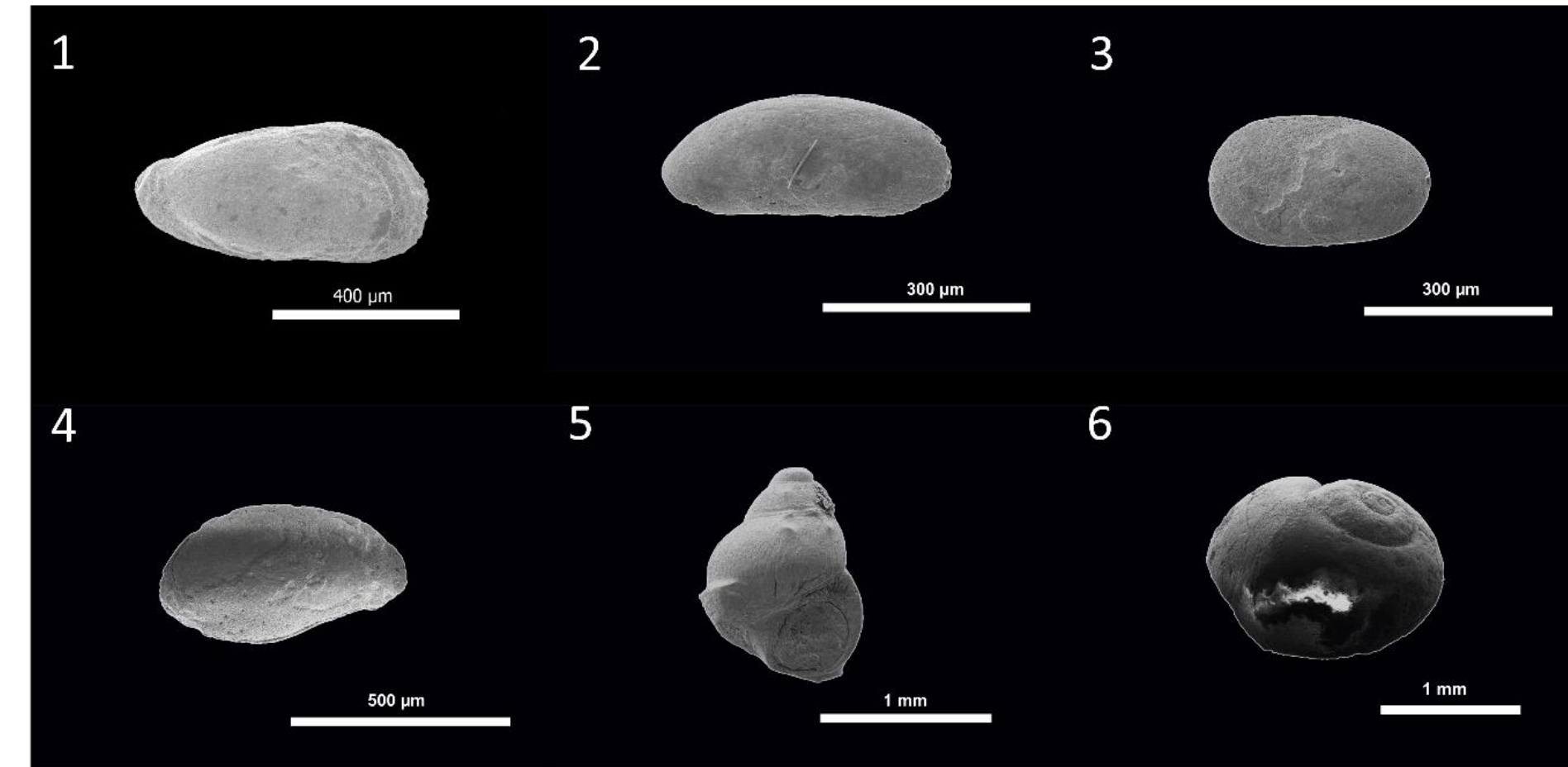
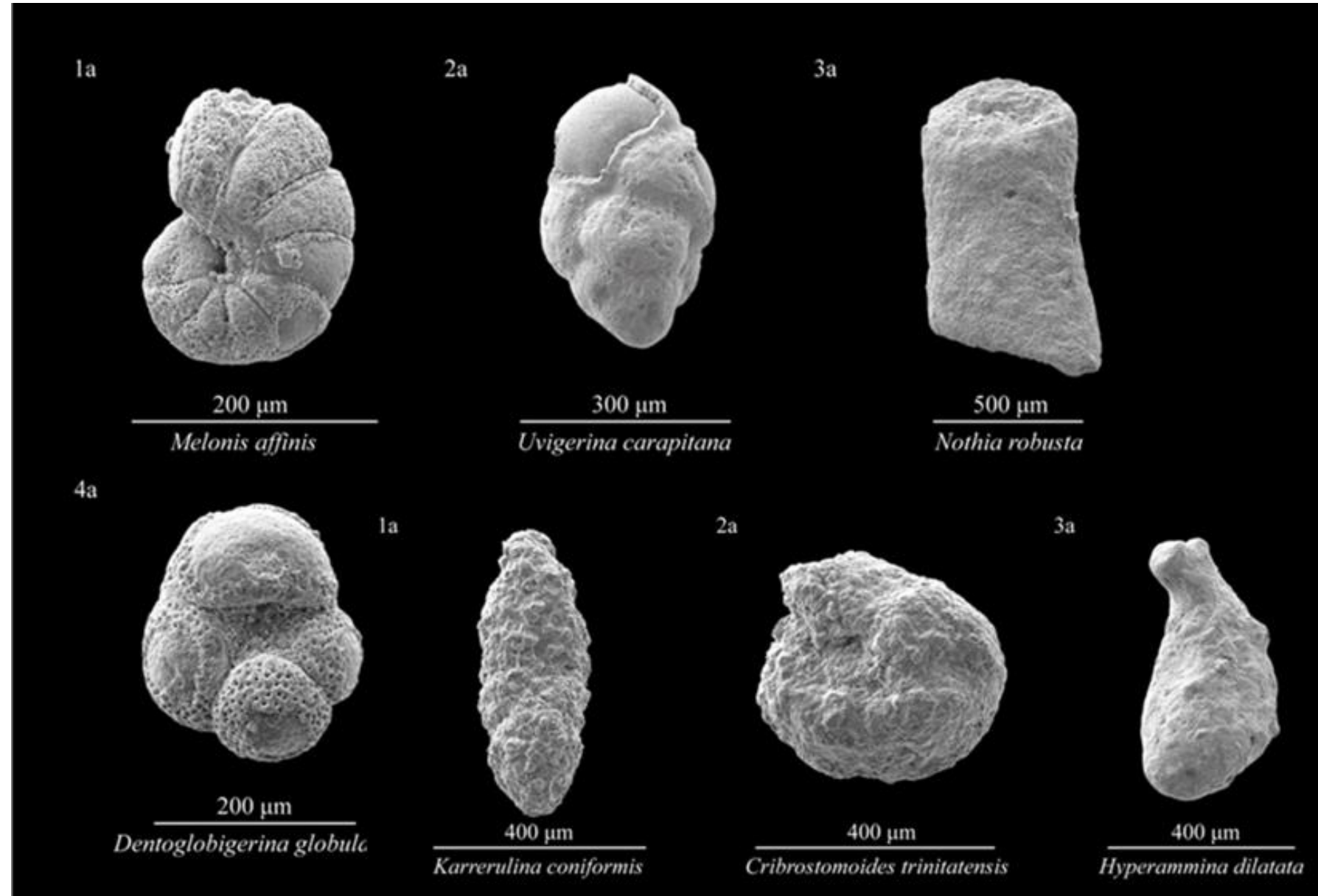




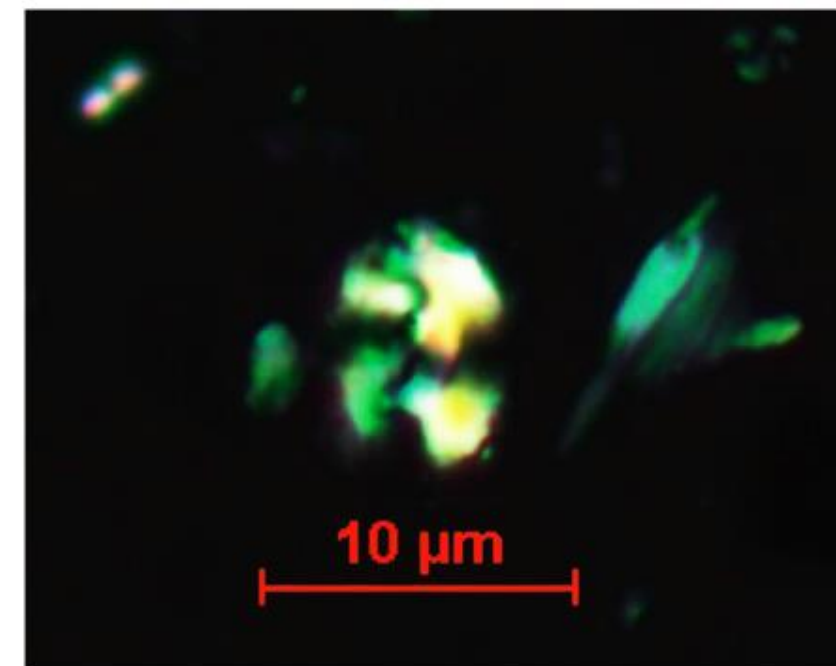
CORE DESCRIPTION, FACIES AND PALEONVIRONMENTS



MICROPALAEONTOLOGY (Bonga Norte)



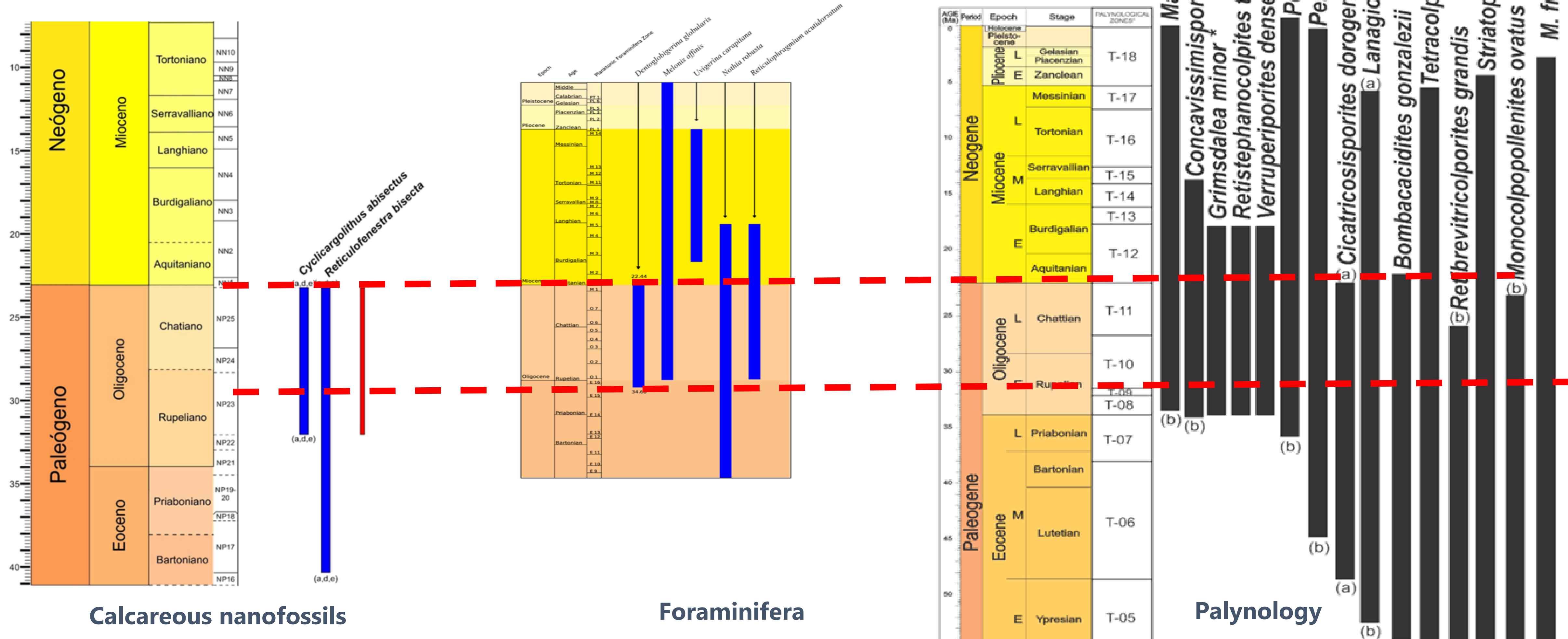
*C. abisectus*



*R. cf. bisecta*

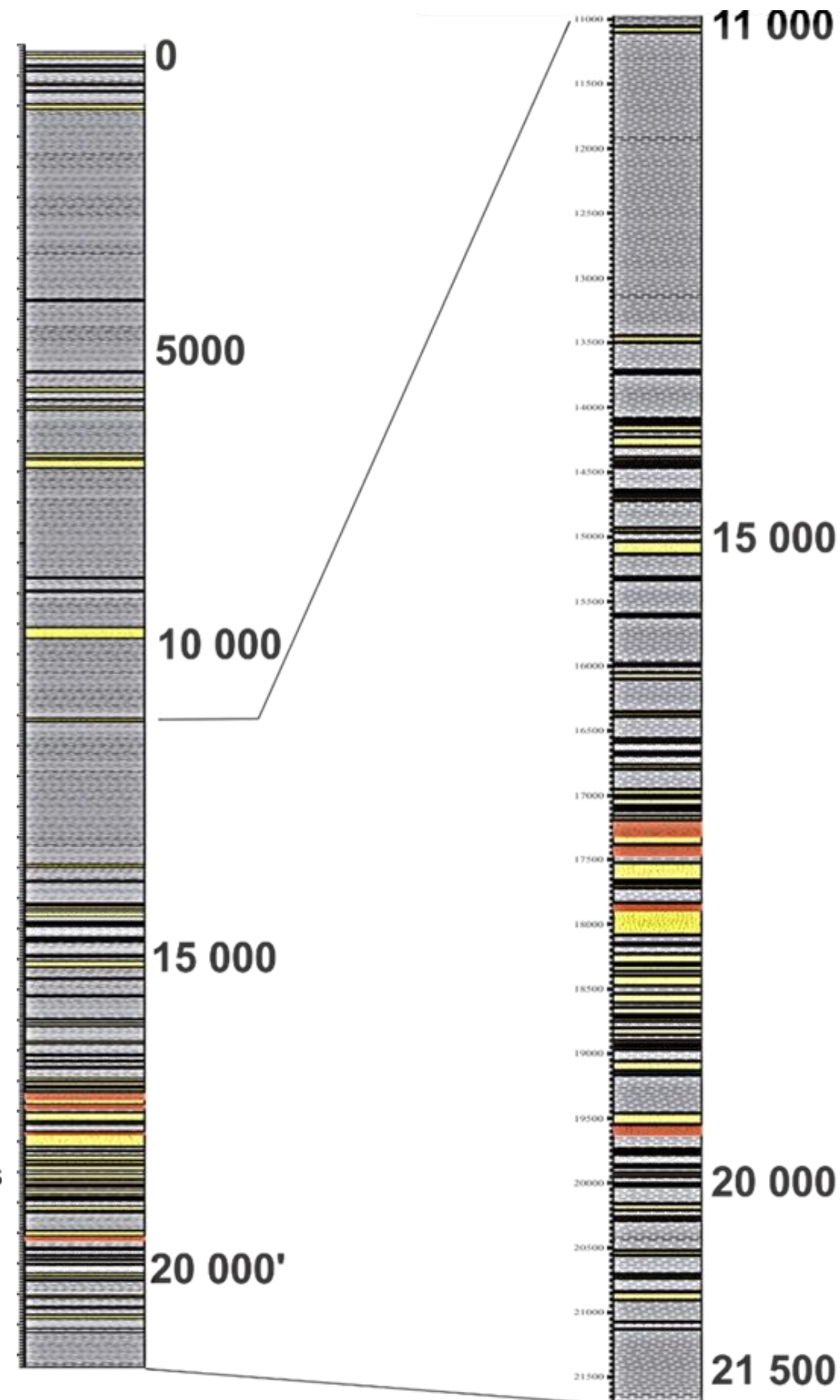


### BIOSTRATIGRAPHY (Bonga Norte)



# STRATIGRAPHY

## SEDIMENTOLOGY, STRATIGRAPHY, BIOSTRATIGRAPHY AND CHRONOSTRATIGRAPHIC CHARTS

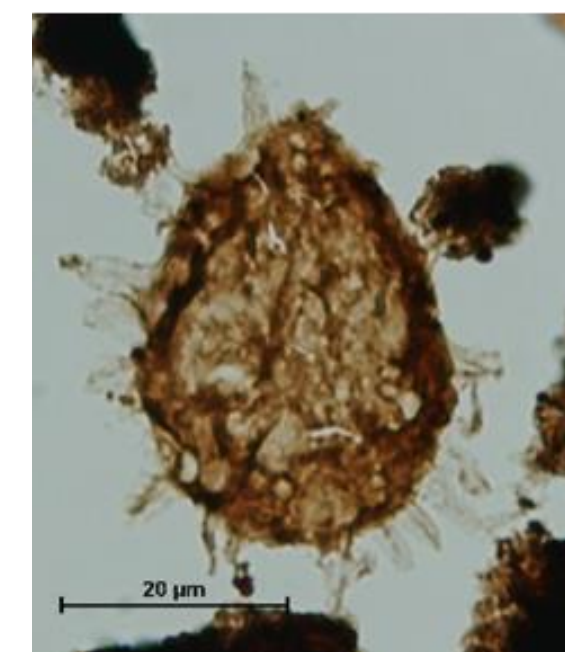
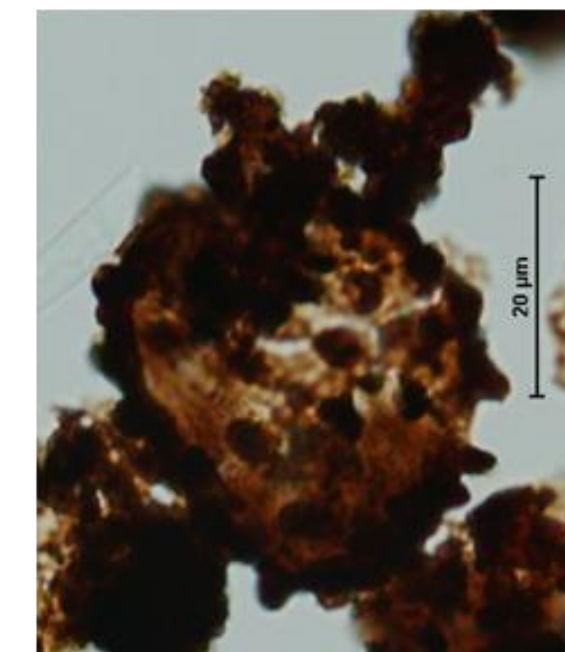
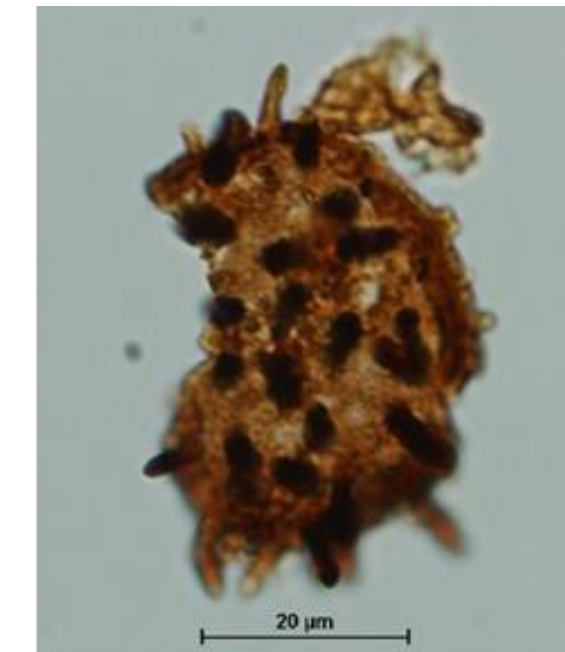
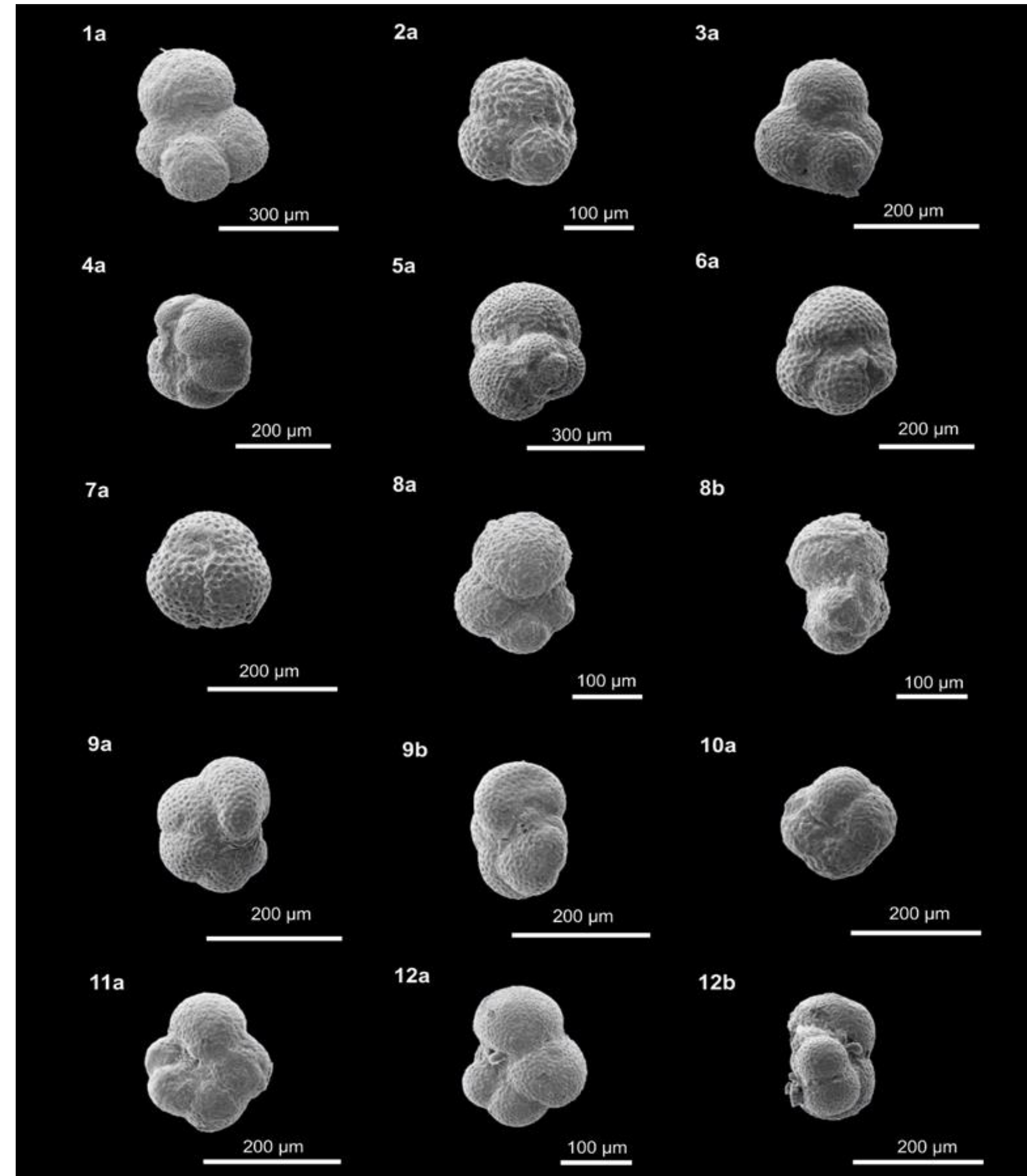
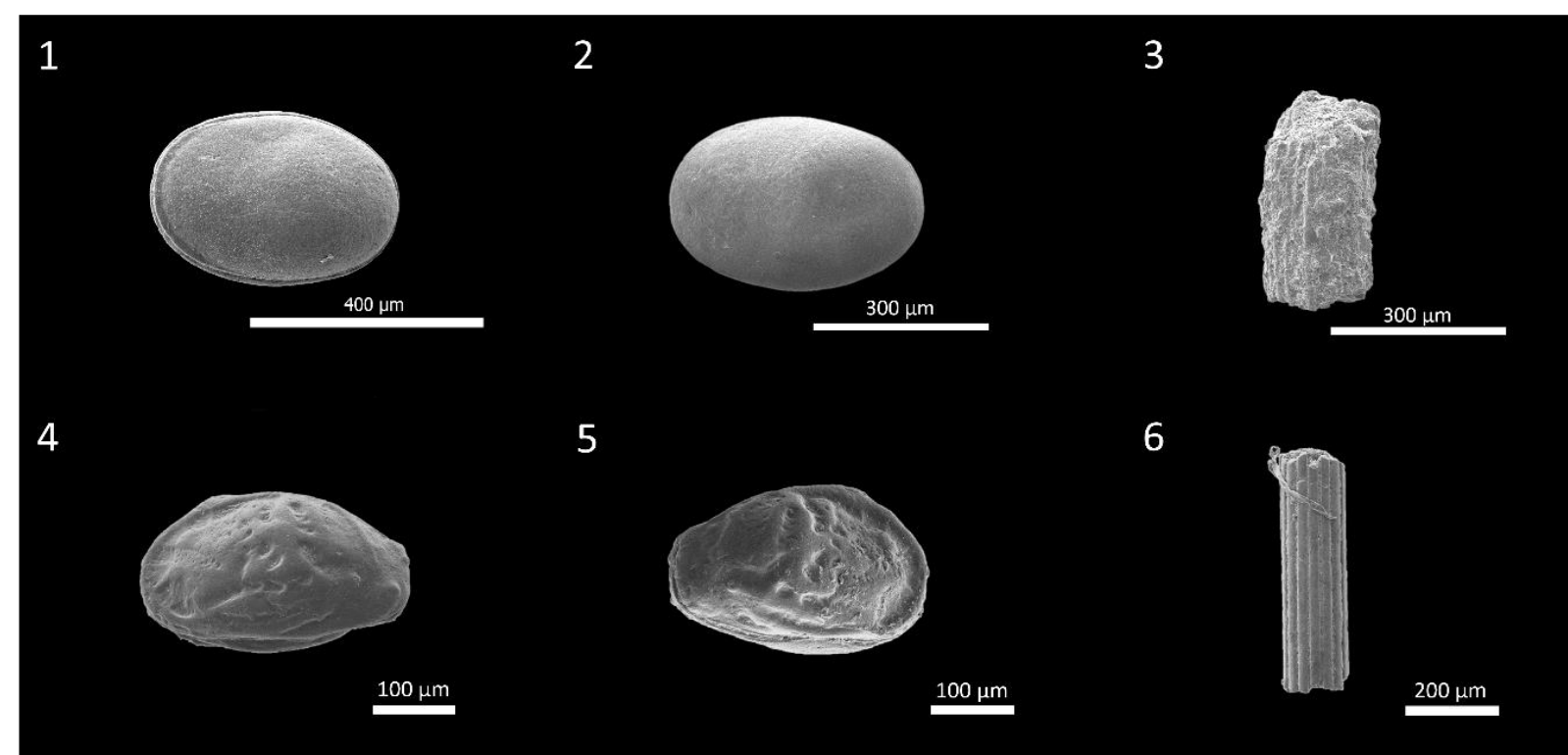
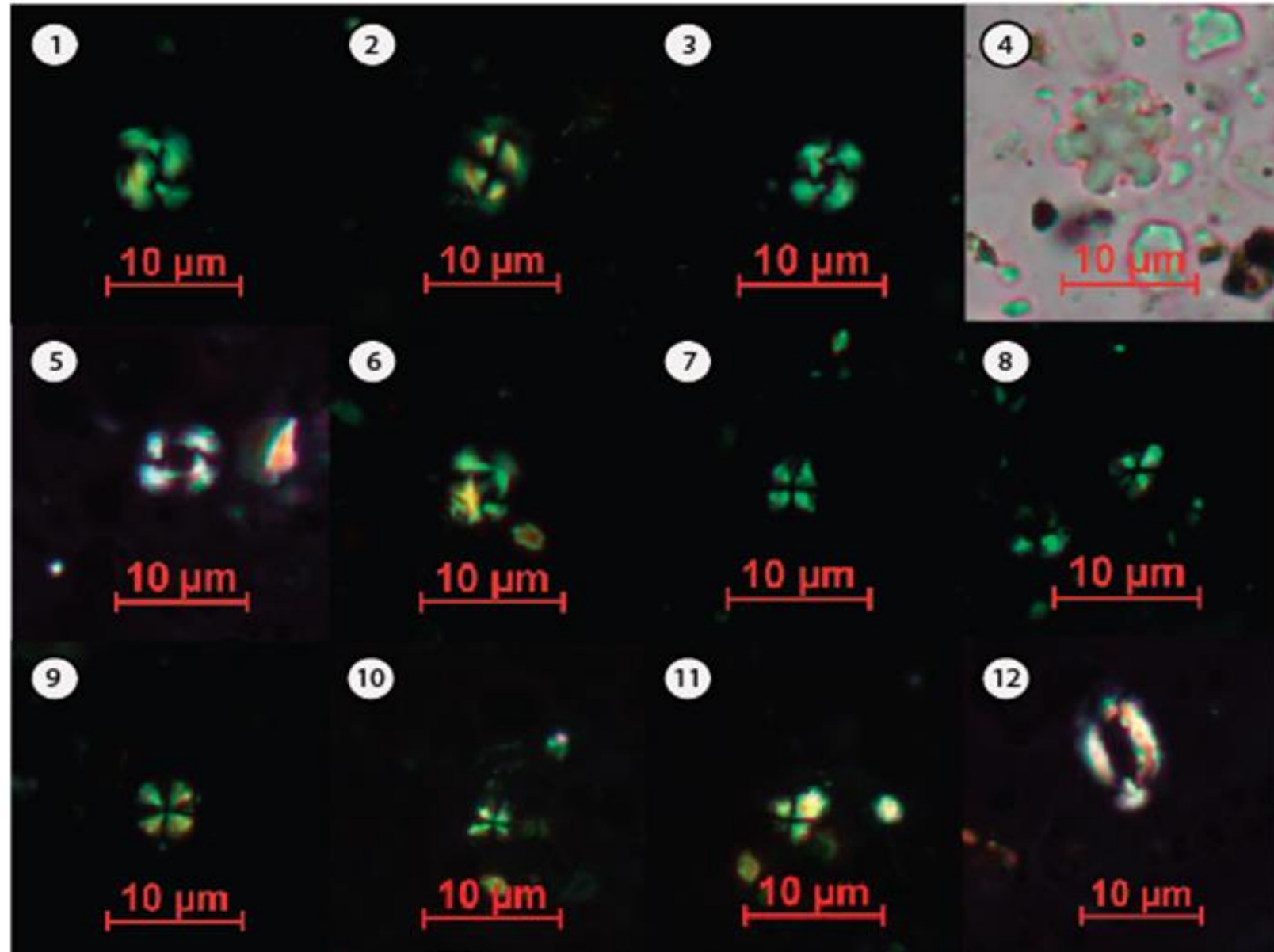


### ANH PLATO 1X-P WELL – BIOSTRATIGRAPHIC AND PETROGRAPHIC STUDIES

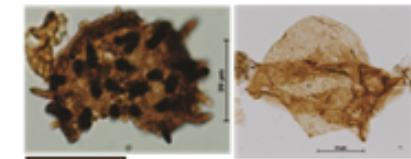
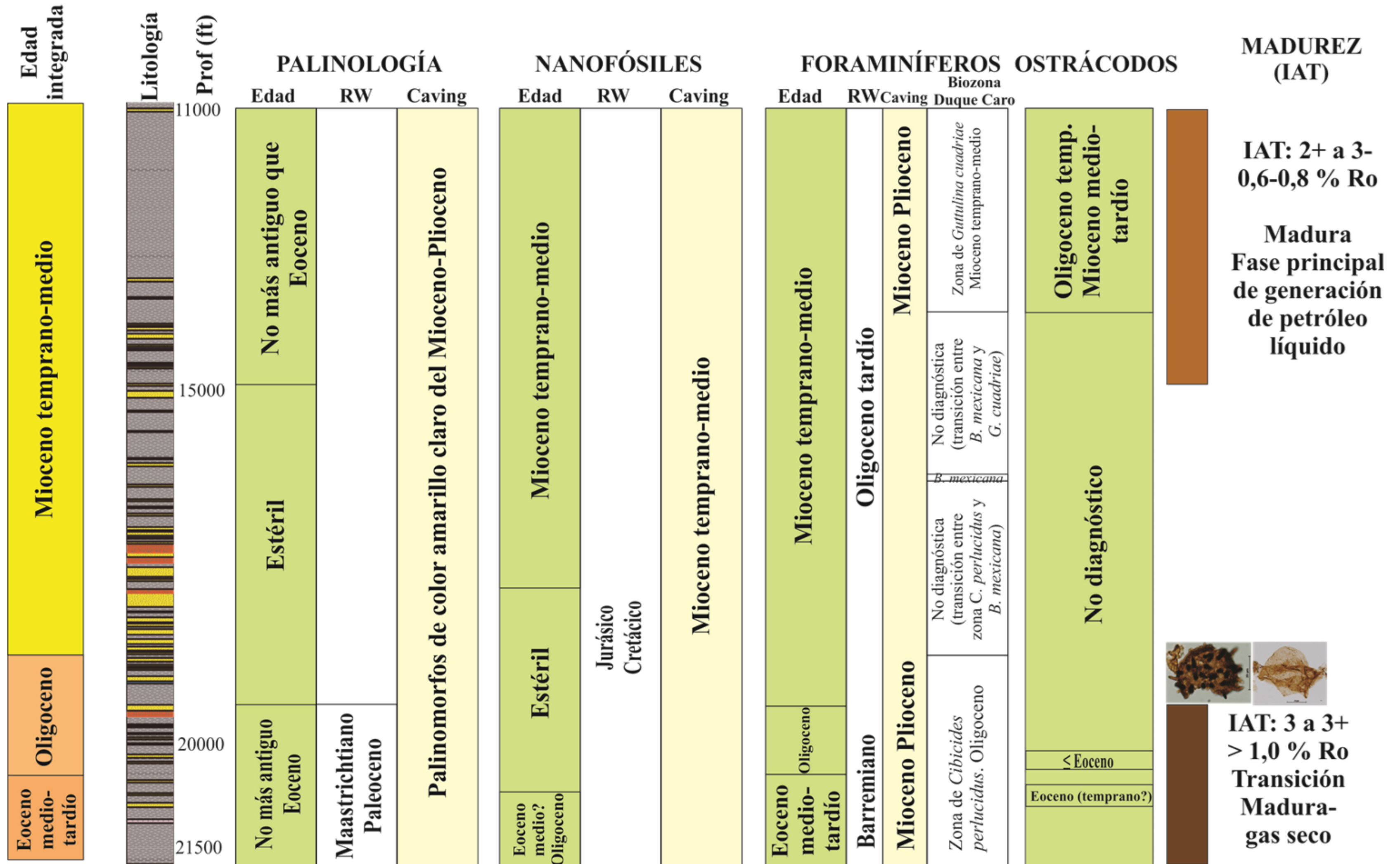
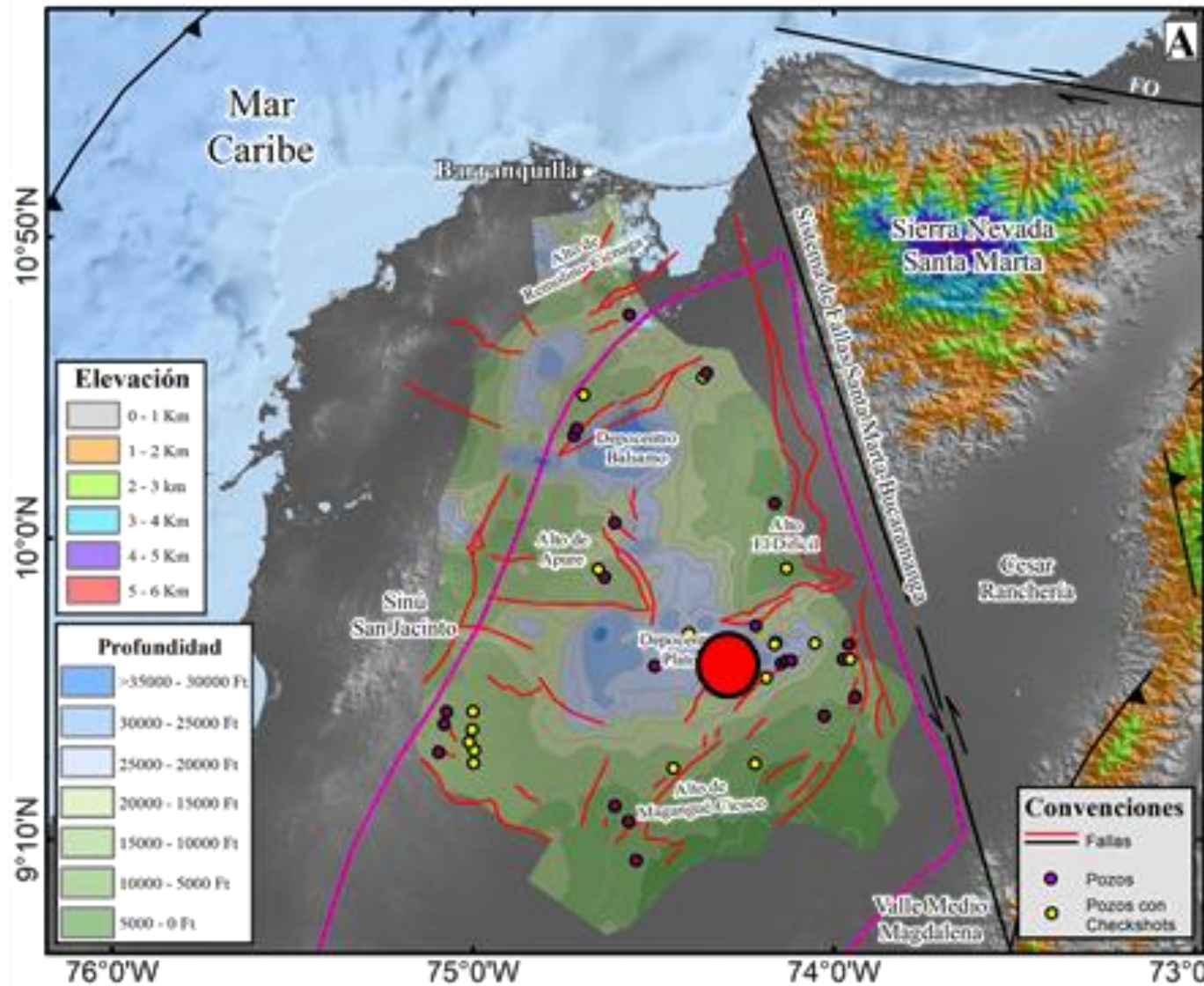
**Studied interval  
11,000' - 21,713'**

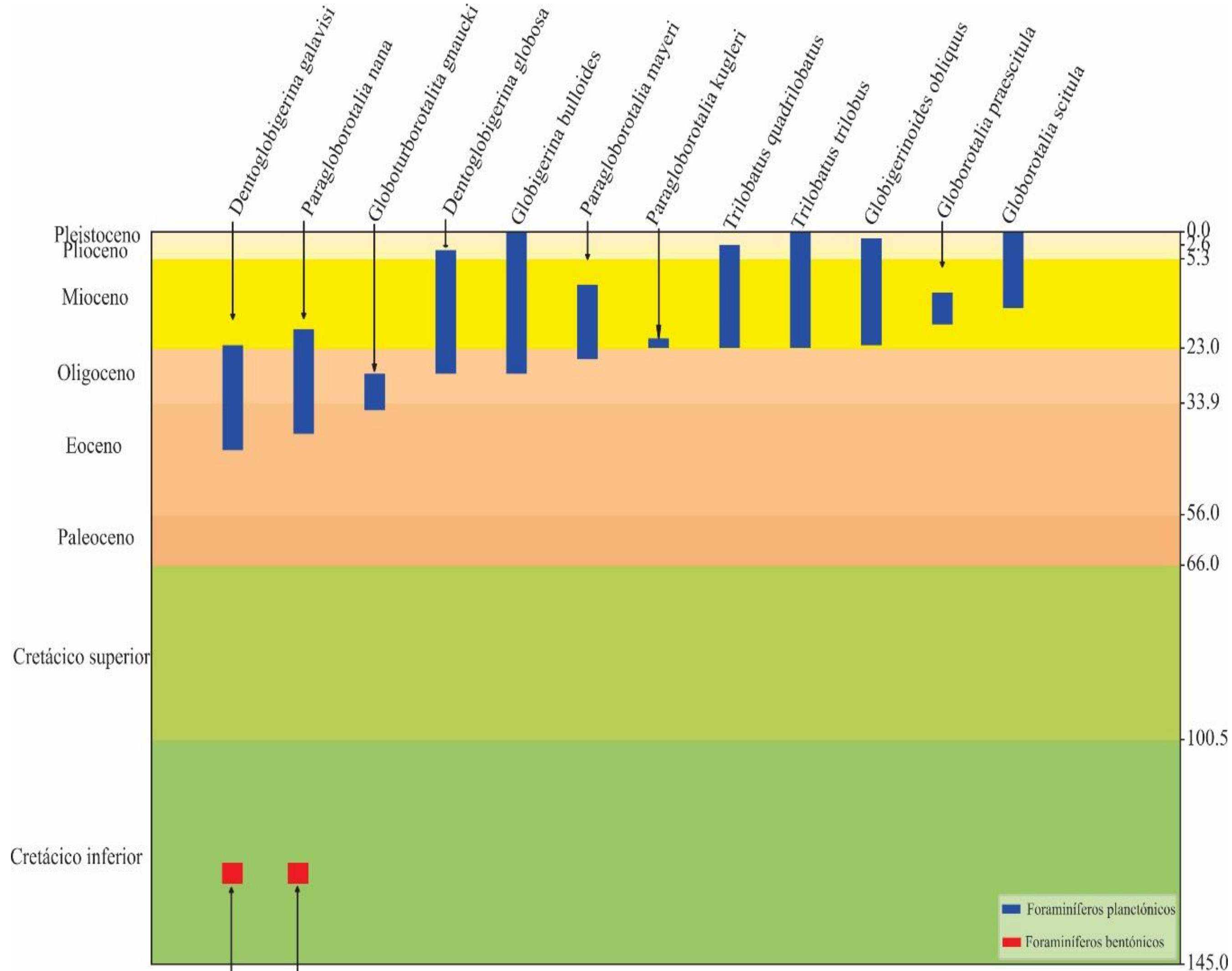
- 400 samples**
- ✓ Foraminifera
- ✓ Palynology
- ✓ Calcareous nannofossils
- ✓ Ostracods y molusks

- 100 samples**
- ✓ Cuttings petrography

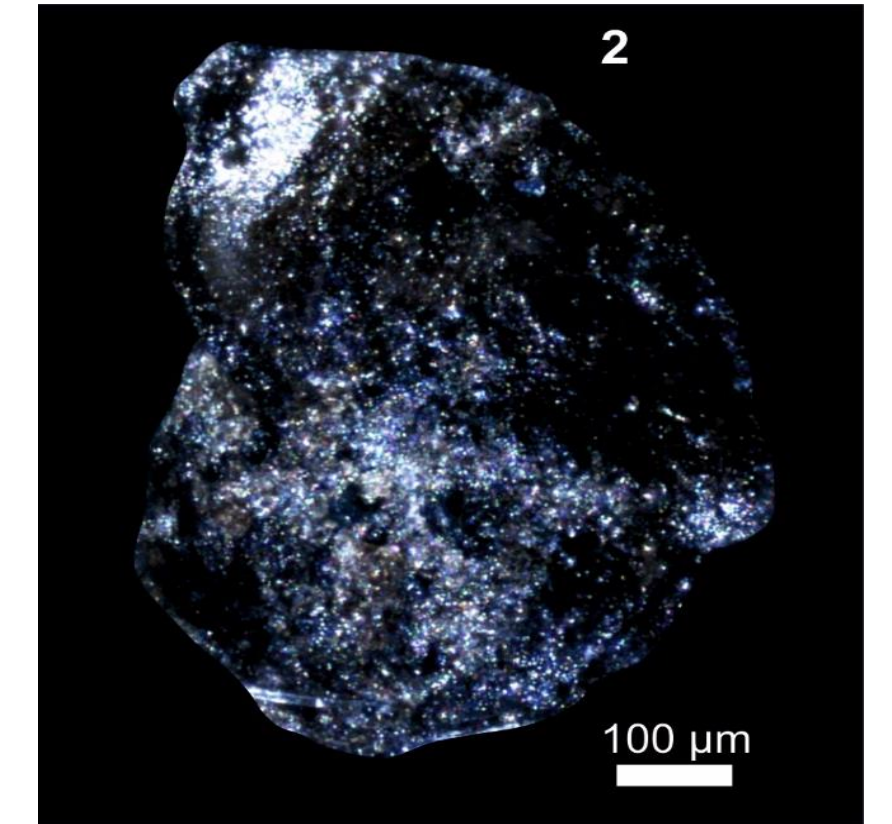
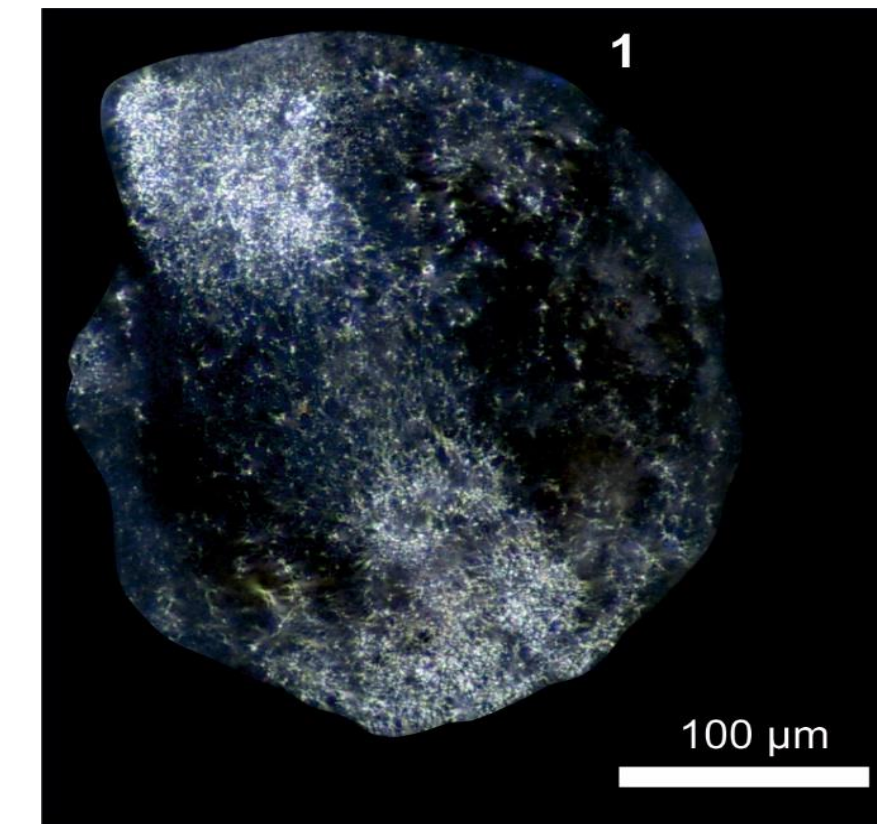


BIOSTRATIGRAPHY  
ANH Plato 1X-P well



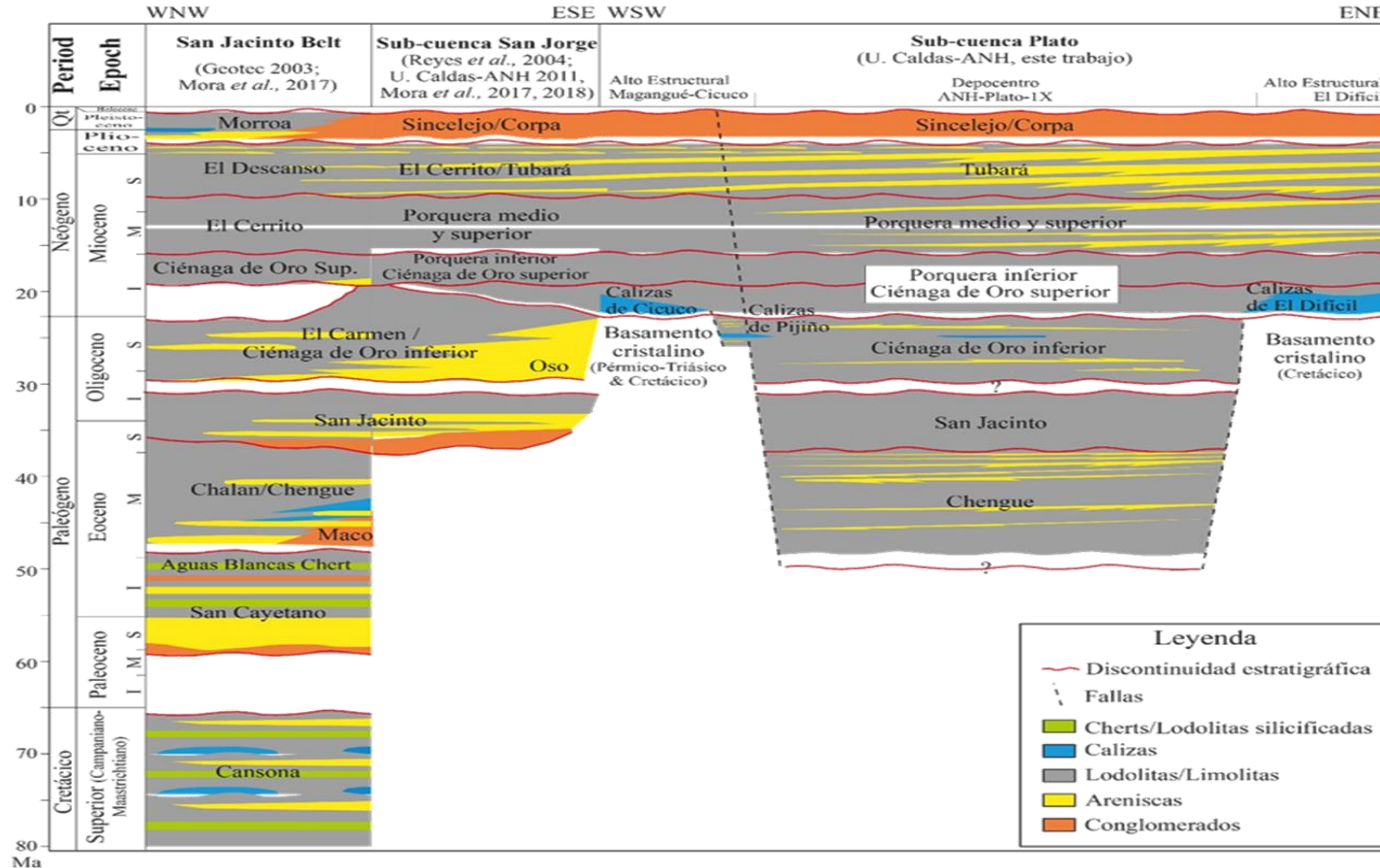


Evidence of reworked microfossils



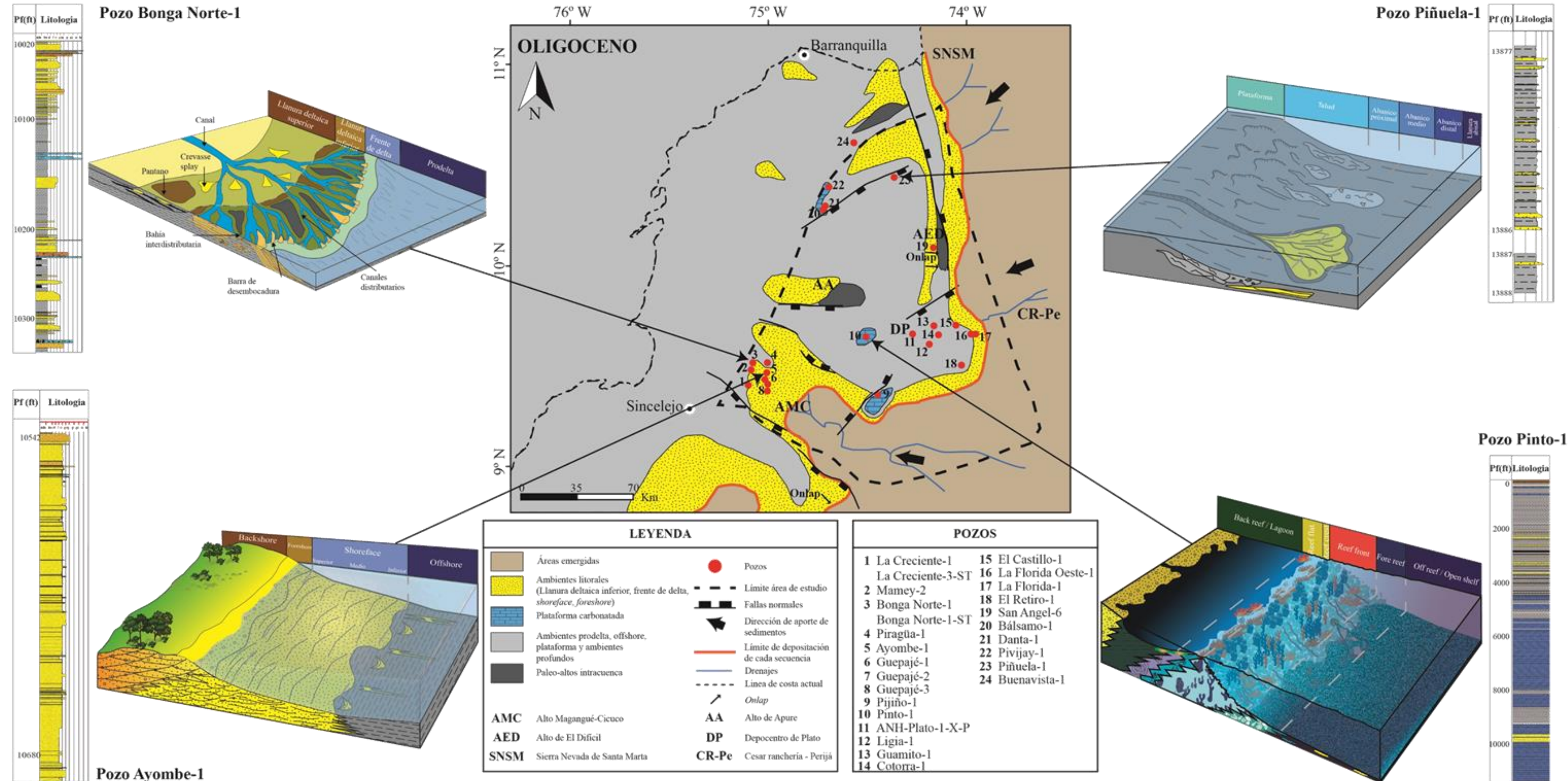
Early Cretaceous benthic foraminifera (late-middle Barremiano) 1- *Lenticulina einchenbergi* y 2- *Lenticulina praegultina*. *L. ouachitensis* Biozone .

CHRONOSTRATIGRAPHIC CHART



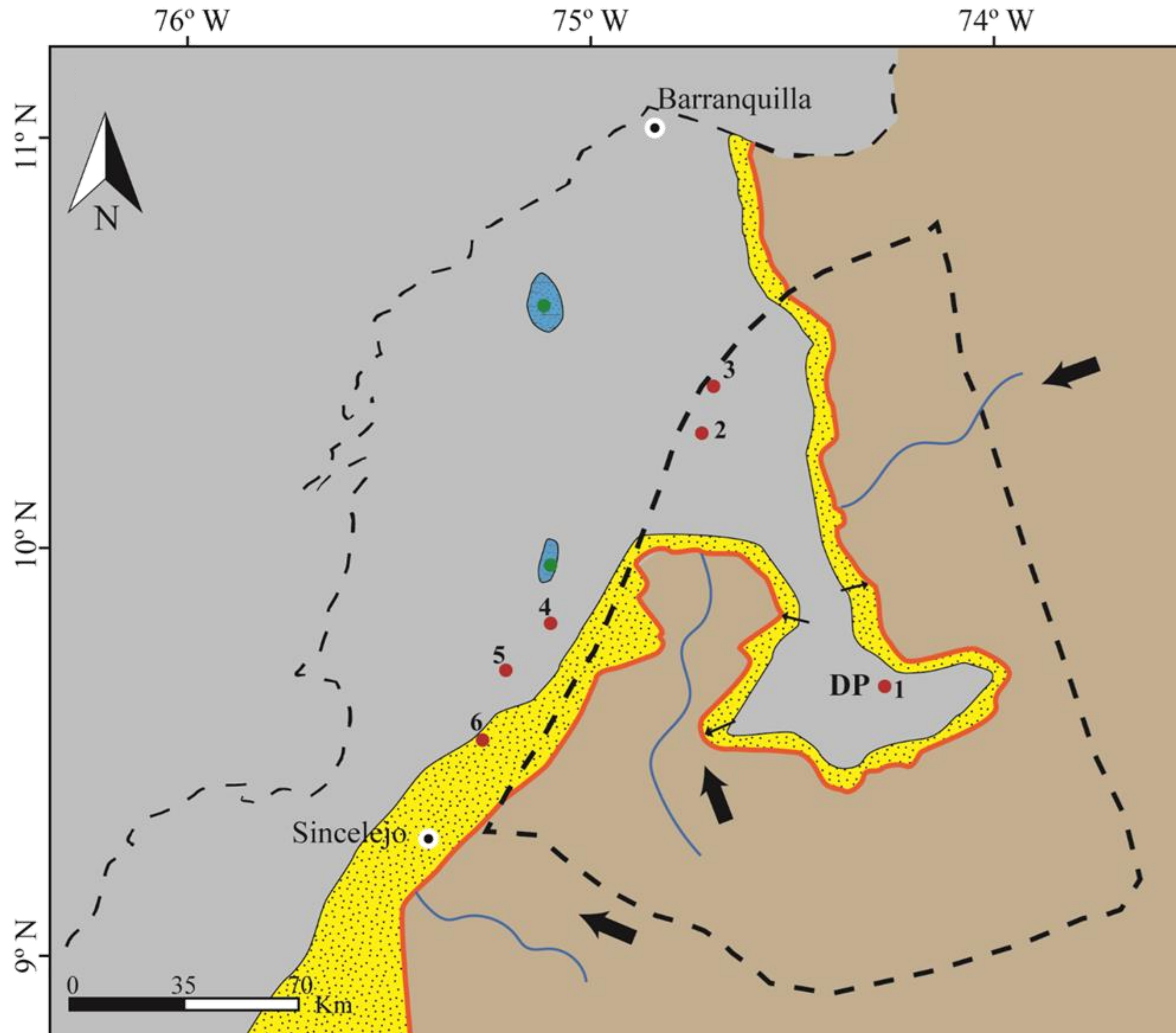
Based on biostratigraphic analysis of 14 wells and previous information of the basin

### SEDIMENTOLOGICAL MODELS

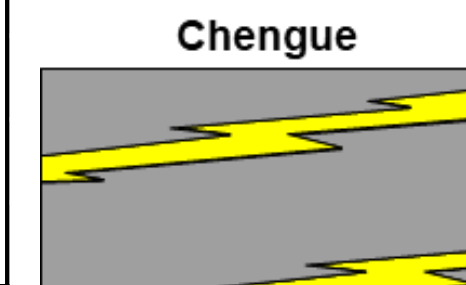


# PALEOGEOGRAPHIC MAPS

## LATE-MIDDLE EOCENE



POZOS	
1	ANH Plato-1X
2	Balsamo-1
3	Pivijay-1
5	ANH-P8
6	ANH-P12

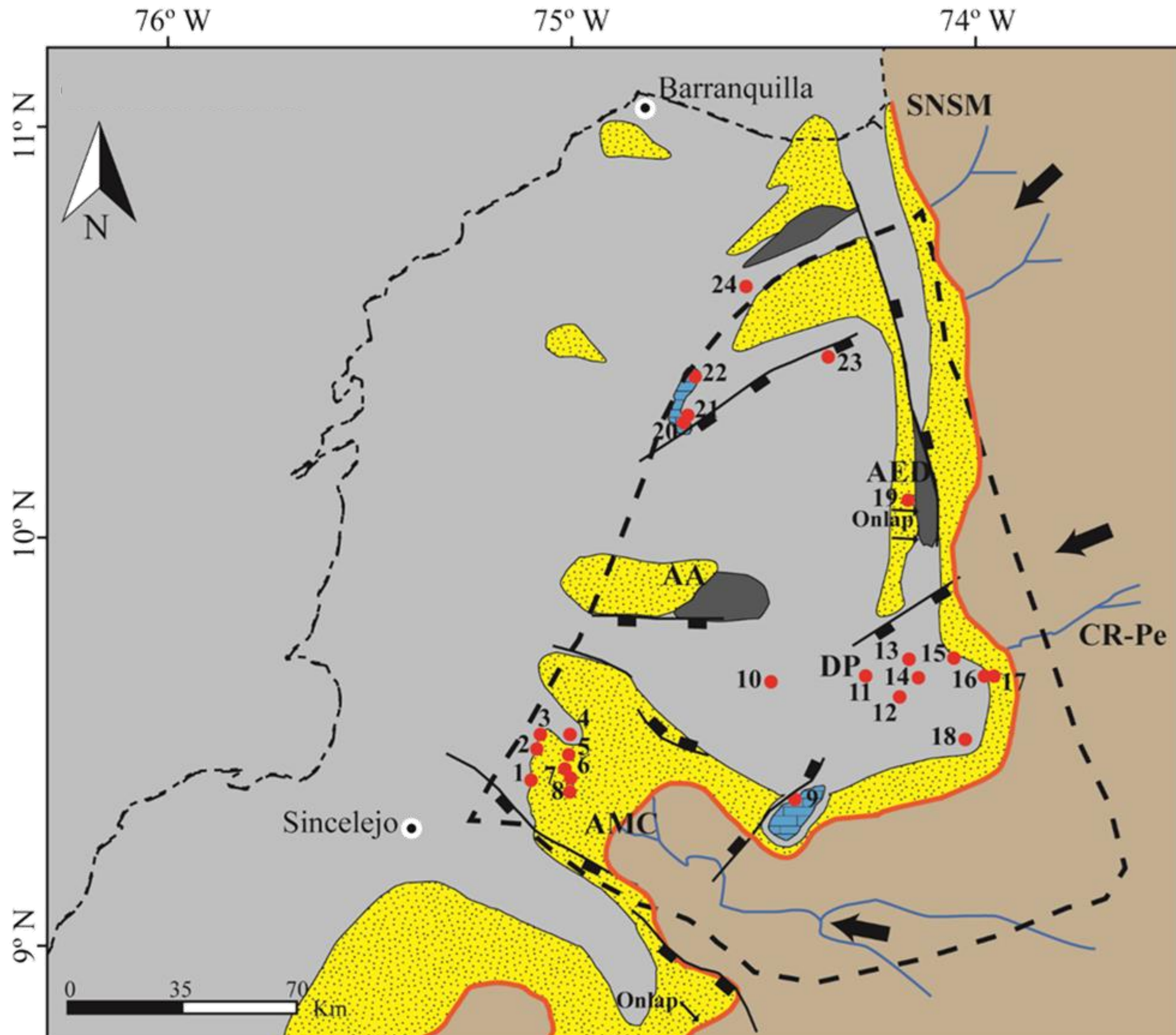


LEYENDA			
	Áreas emergidas		Pozos
	Ambientes litorales (Llanura deltaica inferior, frente de delta, <i>shoreface, foreshore</i> )		Información secundaria
	Sistemas carbonatados-siliciclásticos		Límite área de estudio
	Ambientes prodelta, offshore, plataforma y ambientes profundos		Fallas normales
<b>DP</b>	Depocentro de Plato		Dirección de aporte de sedimentos
	Línea de costa actual		Límite de deposición de cada secuencia
			Drenajes
			<i>Onlap</i>



# PALEOGEOGRAPHIC MAPS

## OLIGOCENE



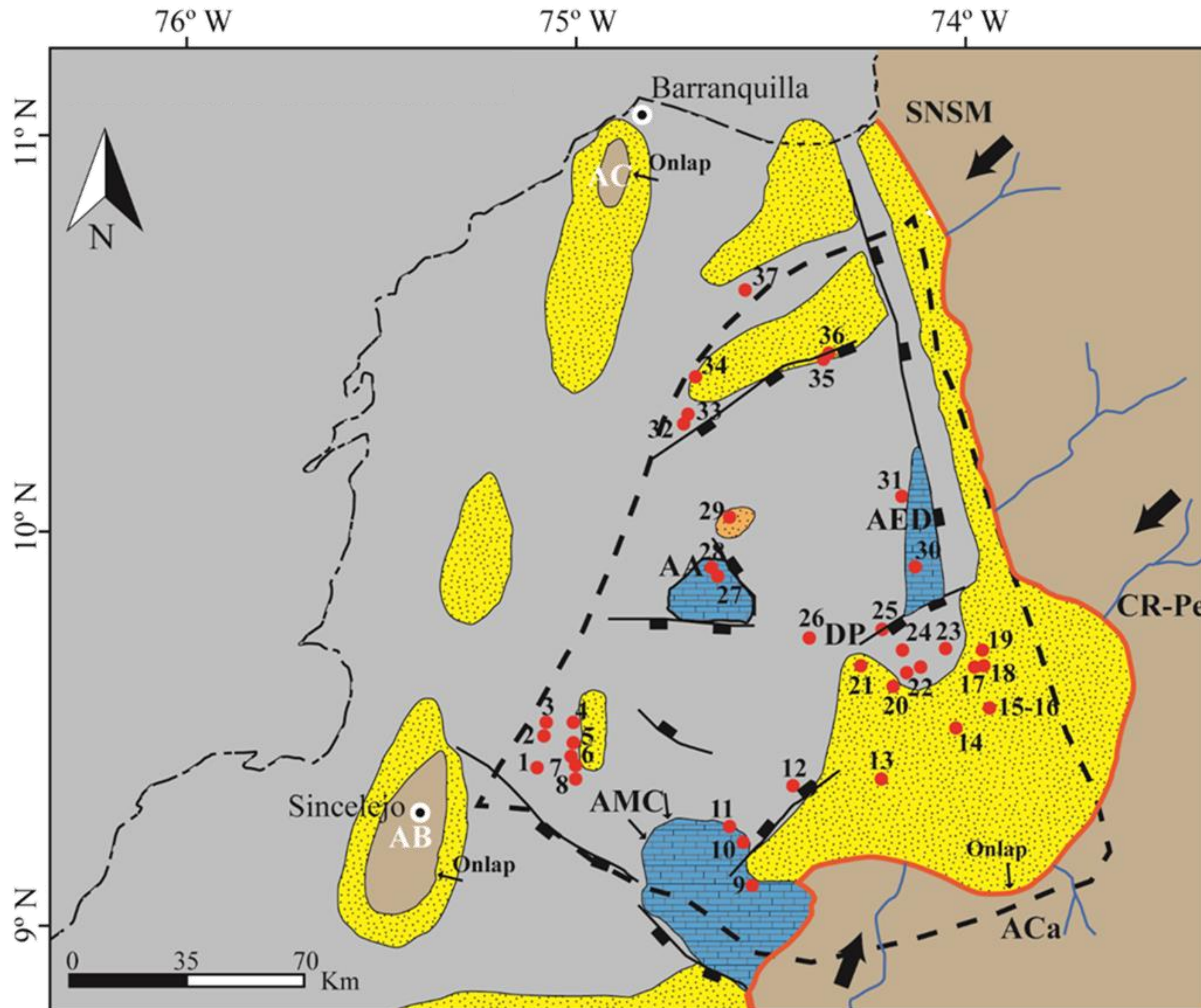
POZOS	
1 La Creciente-1	15 El Castillo-1
2 Mamey-2	16 La Florida Oeste-1
3 Bonga Norte-1	17 La Florida-1
4 Bonga Norte-1-ST	18 El Retiro-1
5 Piragüa-1	19 San Angel-6
6 Ayombe-1	20 Bálsamo-1
7 Guepajé-1	21 Danta-1
8 Guepajé-2	22 Pivijay-1
9 Guepajé-3	23 Piñuela-1
10 Pijiño-1	24 Buenavista-1
11 ANH-Plato-1-X-P	
12 Ligia-1	
13 Guamito-1	
14 Cotorra-1	



LEYENDA	
Áreas emergidas	Pozos
Ambientes litorales (Llanura deltaica inferior, frente de delta, <i>shoreface, foreshore</i> )	Límite área de estudio
Plataforma carbonatada	Fallas normales
Ambientes prodelta, offshore, plataforma y ambientes profundos	Dirección de aporte de sedimentos
Paleo-altos intracuenca	Límite de deposición de cada secuencia
	Drenajes
	Línea de costa actual
	<i>Onlap</i>
<b>AMC</b> Alto Magangué-Cicuco	<b>AA</b> Alto de Apure
<b>AED</b> Alto de El Difícil	<b>DP</b> Depocentro de Plato
<b>SNSM</b> Sierra Nevada de Santa Marta	<b>CR-Pe</b> Cesar ranchería - Perijá

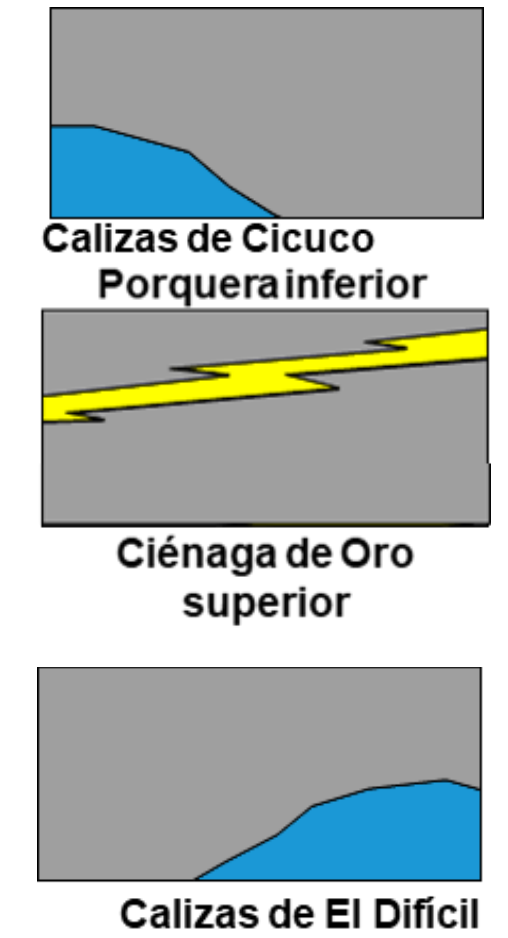
# PALEOGEOGRAPHIC MAPS

## EARLY MIOCENE

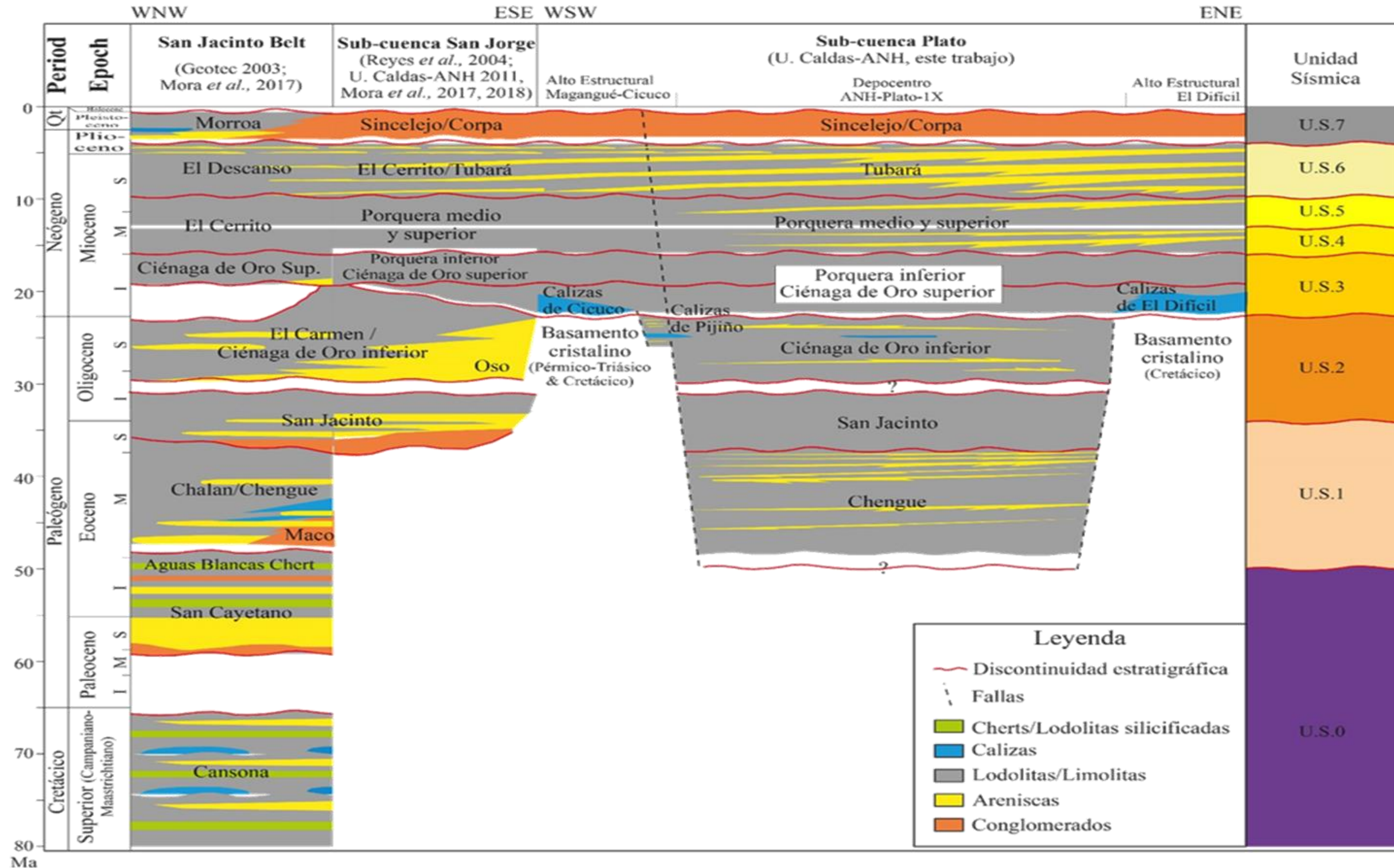


POZOS		
1 La Creciente-1	15 Arjona-1	30 Alejandria-1
2 Mamey-2	16 Arjona-6	31 San Angel-6
3 Bonga Norte-1	17 Florida Oeste-1	32 Bálsamo-1
4 Piragüa-1	18 La Florida-1	33 Danta-1
5 Ayombe-1	19 Brillante SE-1X	34 Pivijay-1
6 Guepajé-1	20 Ligia-1	35 Piñuela-1
7 Guepajé-2	21 ANH-Plato-1-X-P	36 Caraballo-1
8 Guepajé-3	22 Capure-1X,	37 Buenavista-1
9 Boquilla-1	23 Cotorra-1X	
10 Boquete-2	24 El Castillo-1	
11 Cicuco-22	25 Guamito-1	
12 Pijiño-1	26 La Pinta-1	
13 Buena Fe-1	27 Costa Rica-1	
14 El Retiro-1	28 Granate-1	
	29 Apure-1	
	29 Tupale-1	

LEYENDA	
Áreas emergidas	Pozos
Ambientes litorales (Llanura deltaica inferior, frente de delta, <i>shoreface, foreshore</i> )	Límite área de estudio
Reef	Fallas normales
Ambientes prodelta, offshore, plataforma y ambientes profundos	Dirección de aporte de sedimentos
Arenitas de ambientes profundos (turbiditas?)	Límite de deposición de cada secuencia
<b>AMC</b> Alto Magangué-Cicuco	Drenajes
<b>AED</b> Alto de El Dificil	Línea de costa actual
<b>SNSM</b> Sierra Nevada de Santa Marta	Onlap
<b>AB</b> Alto de Betulia	<b>AA</b> Alto de Apure
<b>ACa</b> Alto de Cachira	<b>DP</b> Depocentro de Plato
	<b>CR-Pe</b> Cesar ranchería - Perijá
	<b>AC</b> Alto de Cibarco

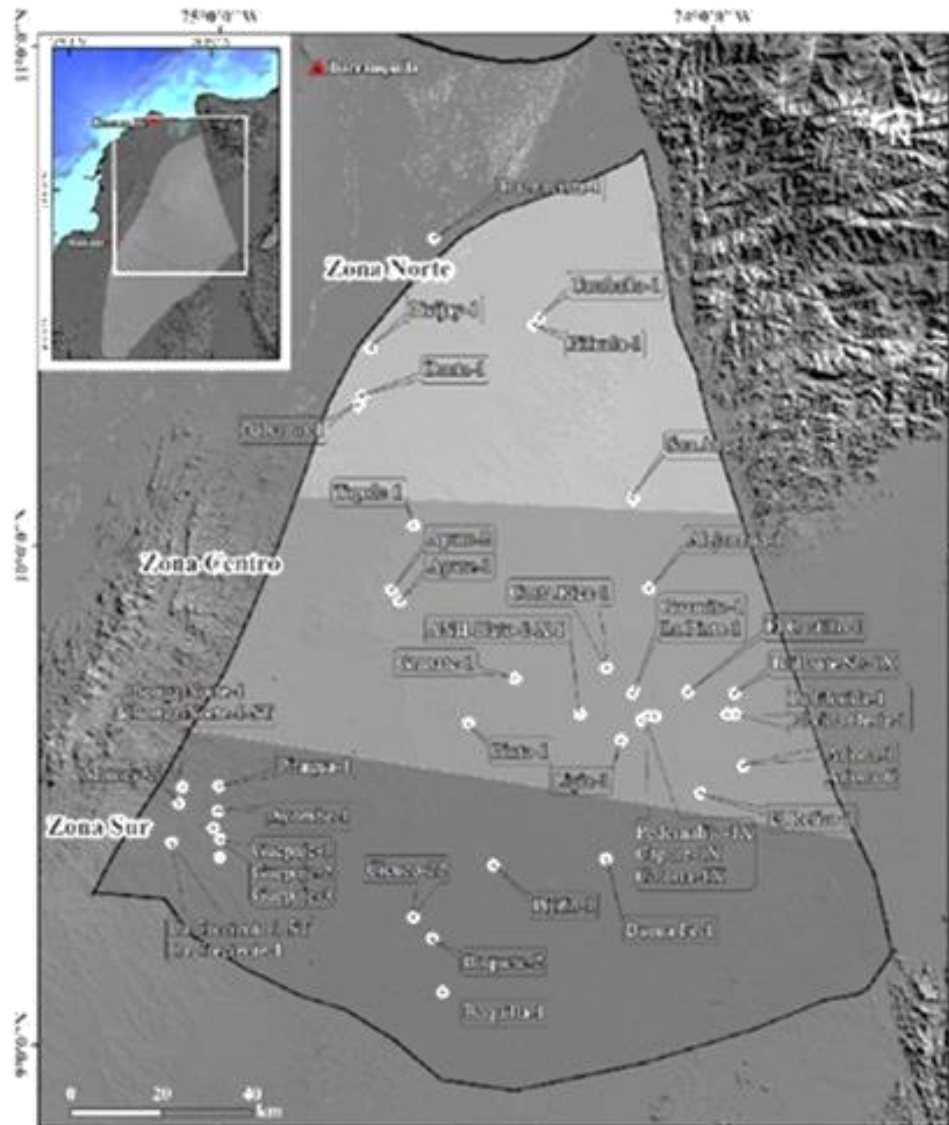
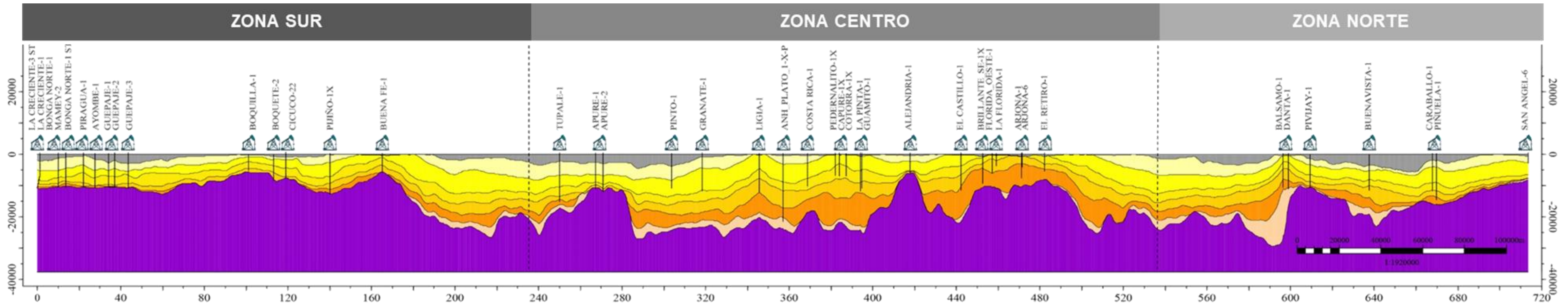


CHRONOSTRATIGRAPHIC CHART – SEISMIC UNITS



Based on biostratigraphic analysis of 14 wells and previous information of the basin

WELL PENETRATION CHART



CONVENCIONES

US7	No Diferenciado
US6	Fm Tubará
US5	Fm Porquera Superior
US4	Fm Porquera Medio
US3	Fm Ciénaga de Oro Sup.
US2	Fm Ciénaga de Oro Inf.
US 1	Fm Chengue
US 0	Basamento

✓ 44 Wells analyzed

- 10 wells partially cored

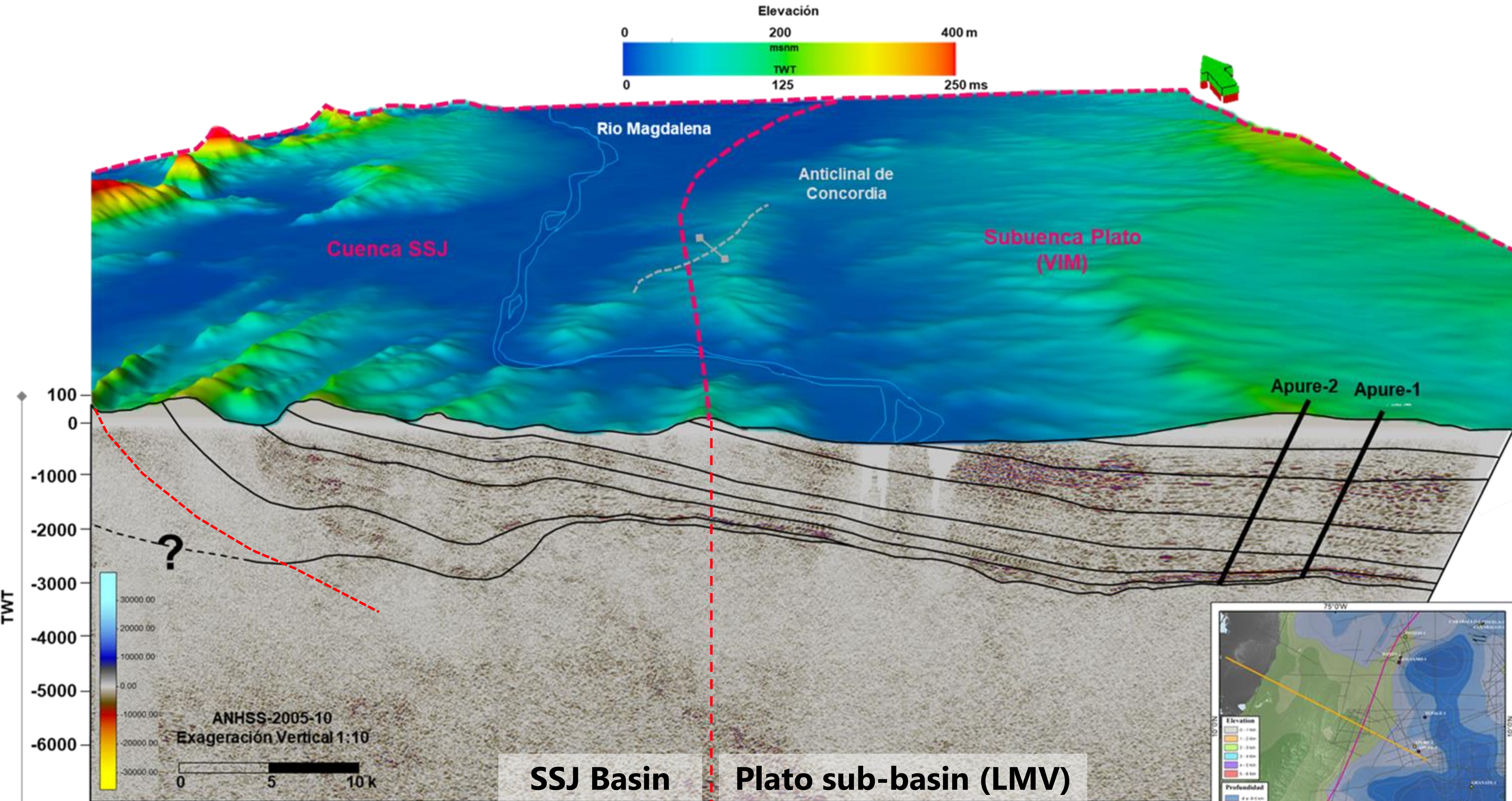
- 4 ditch cuttings (including ANH Plato 1-X)

✓ Depest well drilled in de basin ANH Plato 1X @ 21713 ft

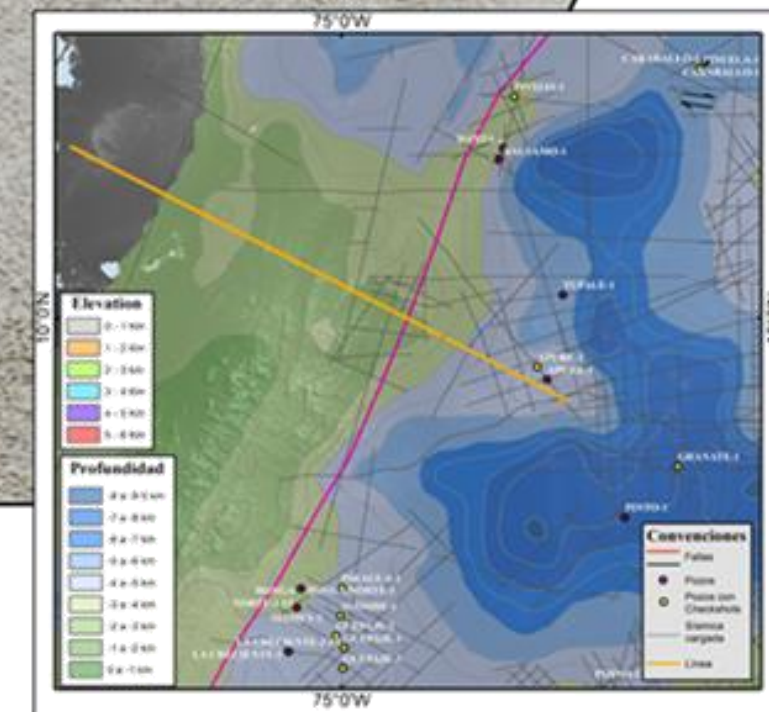
Representation of the depth reached by the wells drilled in the basin. Not equivalent to a seismic profile.

# SEISMIC INTERPRETATION

## REGIONAL SEISMIC INTERPRETATION – GENERAL OBSERVATIONS

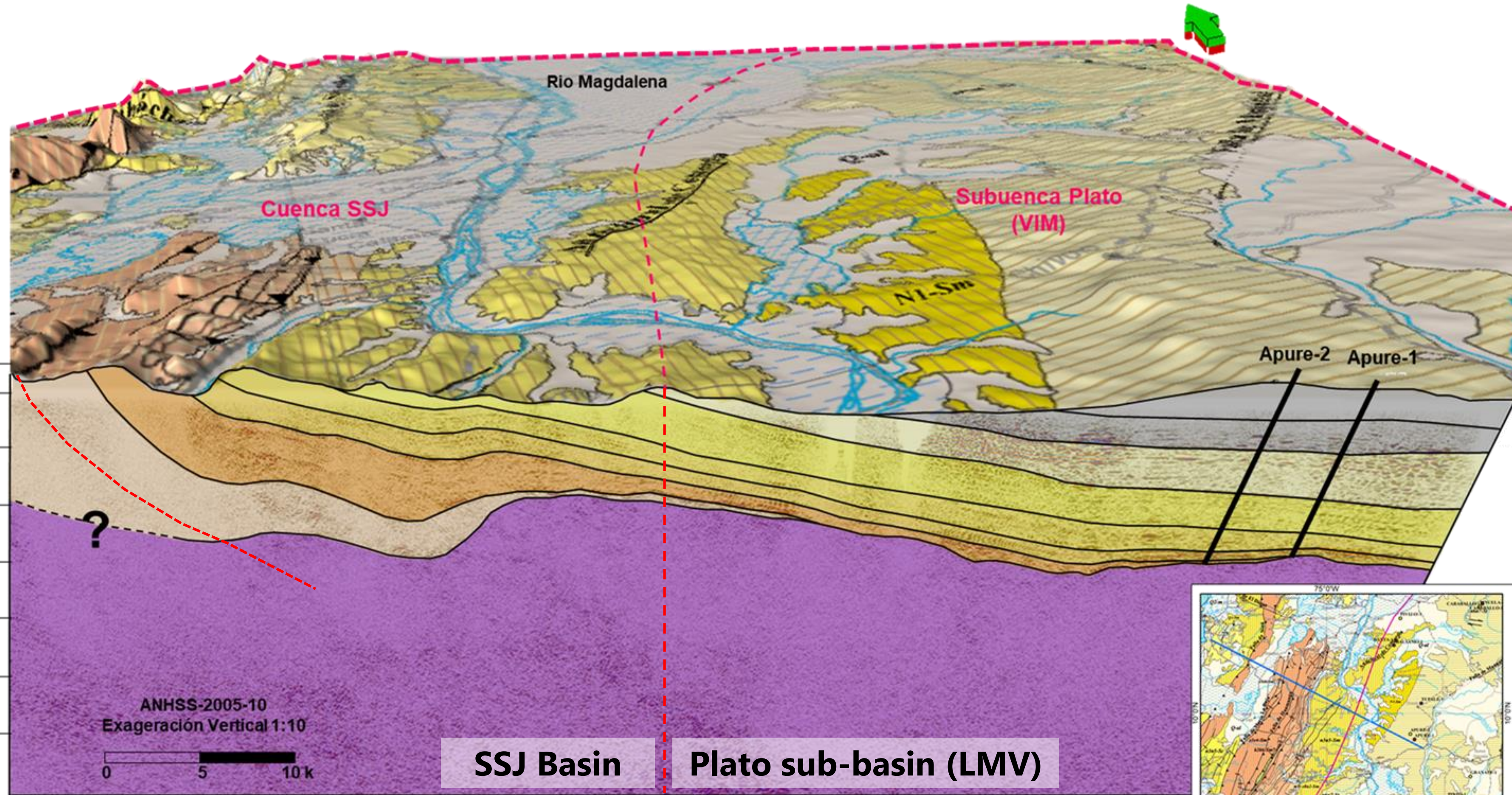


- ✓ Data QC
- ✓ Well seismic tie (44 Wells – 18 Chekshot)
- ✓ Surface geology – Well- Seismic tie
- ✓ Interpretation of 10.700 km 2D seismic lines
  
- ✓ SEISMIC SEQUENCES
- ✓ REFLECTOR CHARACTER
- ✓ SEISMIC FACIES



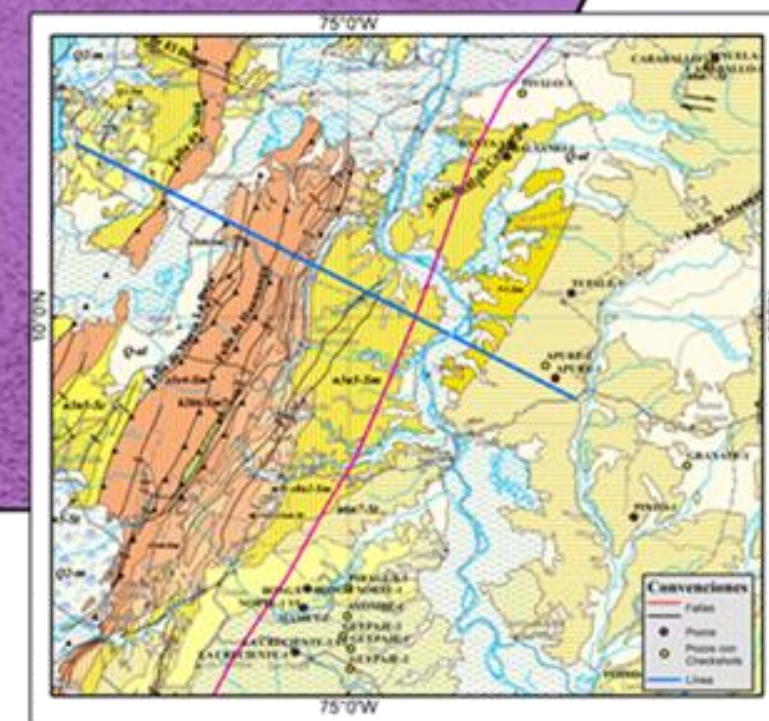
# SEISMIC INTERPRETATION

## REGIONAL SEISMIC INTERPRETATION – GENERAL OBSERVATIONS



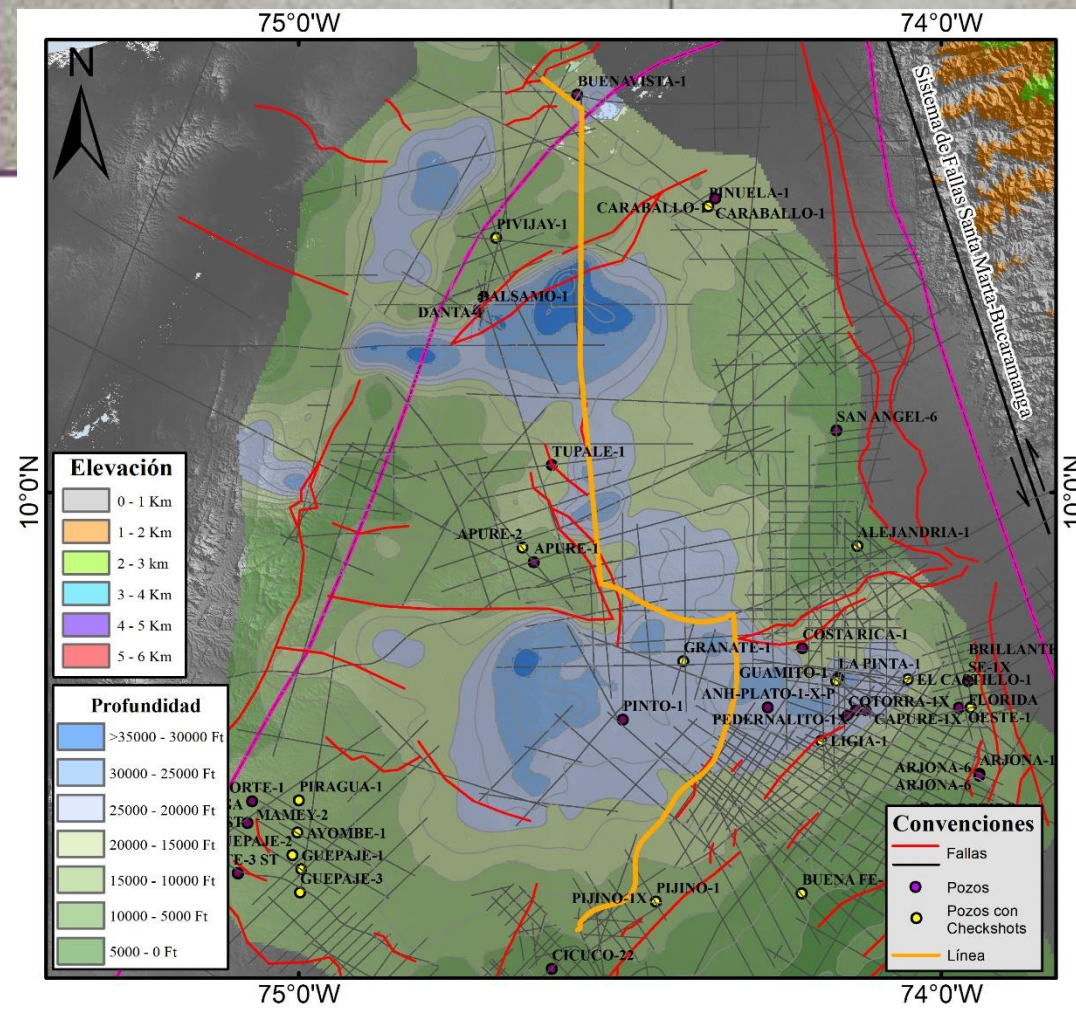
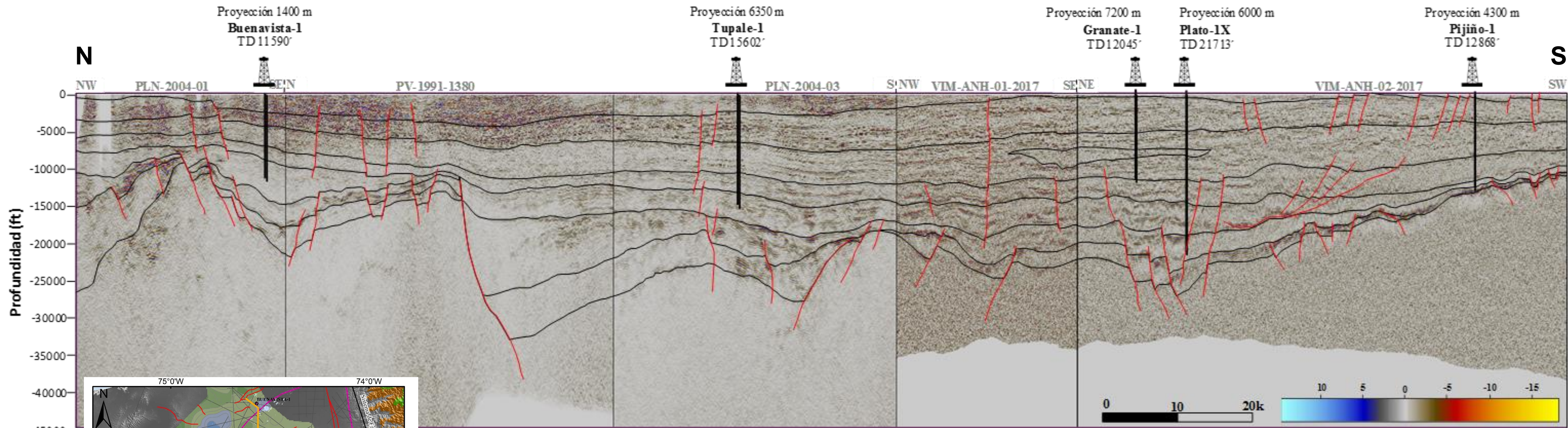
**CONVENCIONES**

		US7 No Diferenciado
		US6 Fm Tubará
		US5 Fm Porquera Superior
		US4 Fm Porquera Medio
		US3 Fm Ciénaga de Oro Sup.
		US2 Fm Ciénaga de Oro Inf.
		US 1 Fm Chengue
		US 0 Basamento



# SEISMIC INTERPRETATION

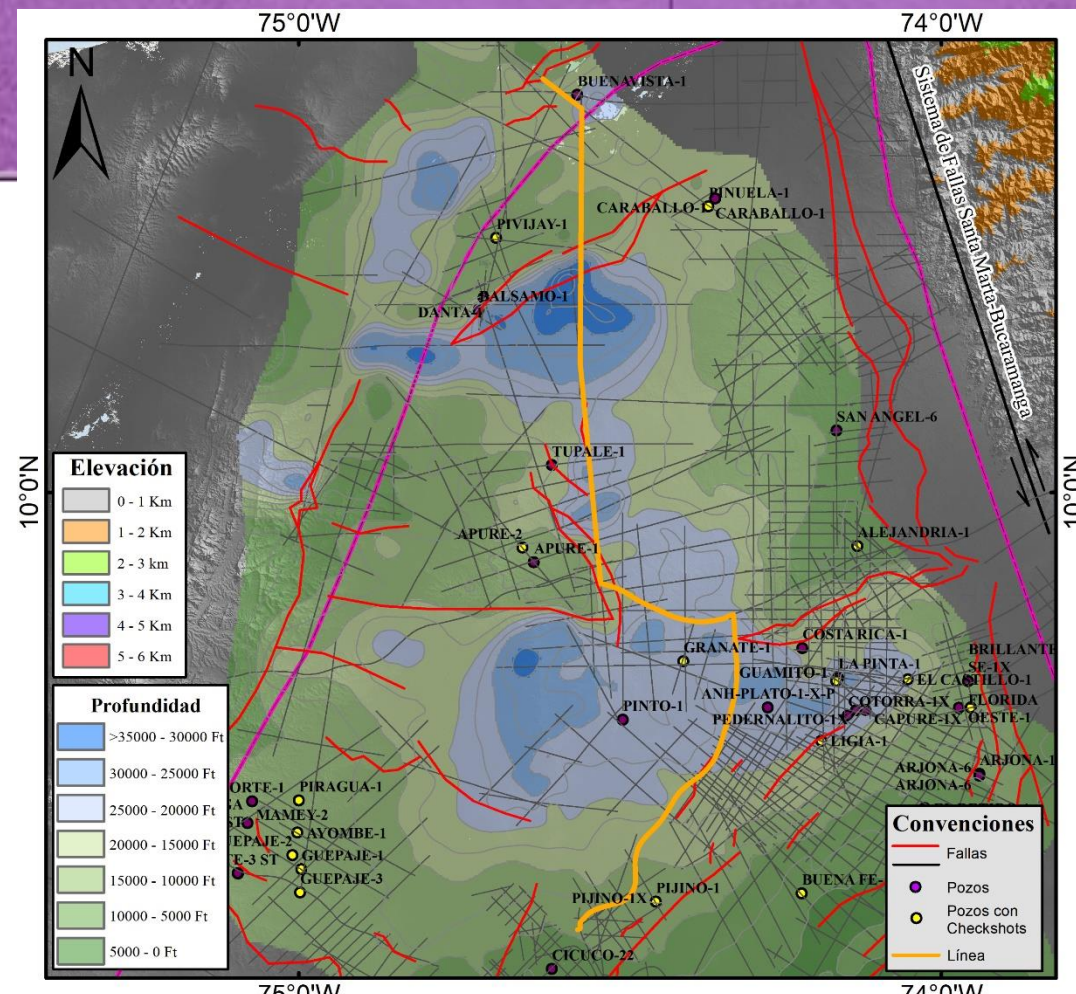
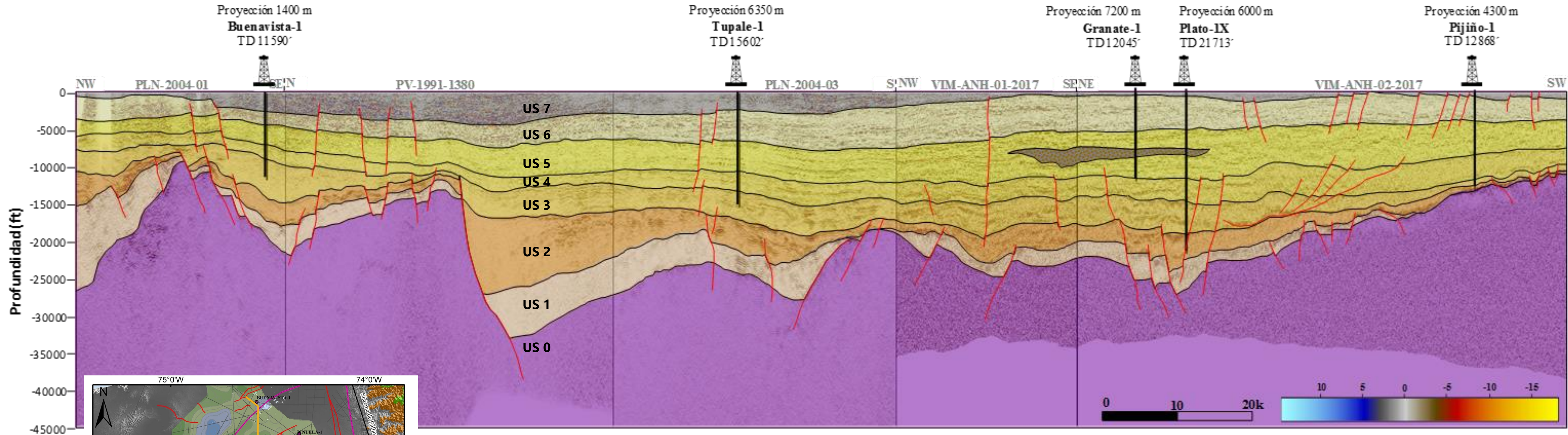
## REGIONAL SEISMIC INTERPRETATION – GENERAL OBSERVATIONS



**N – S cross section - structural highs and depocenters throughout Plato sub-basin**

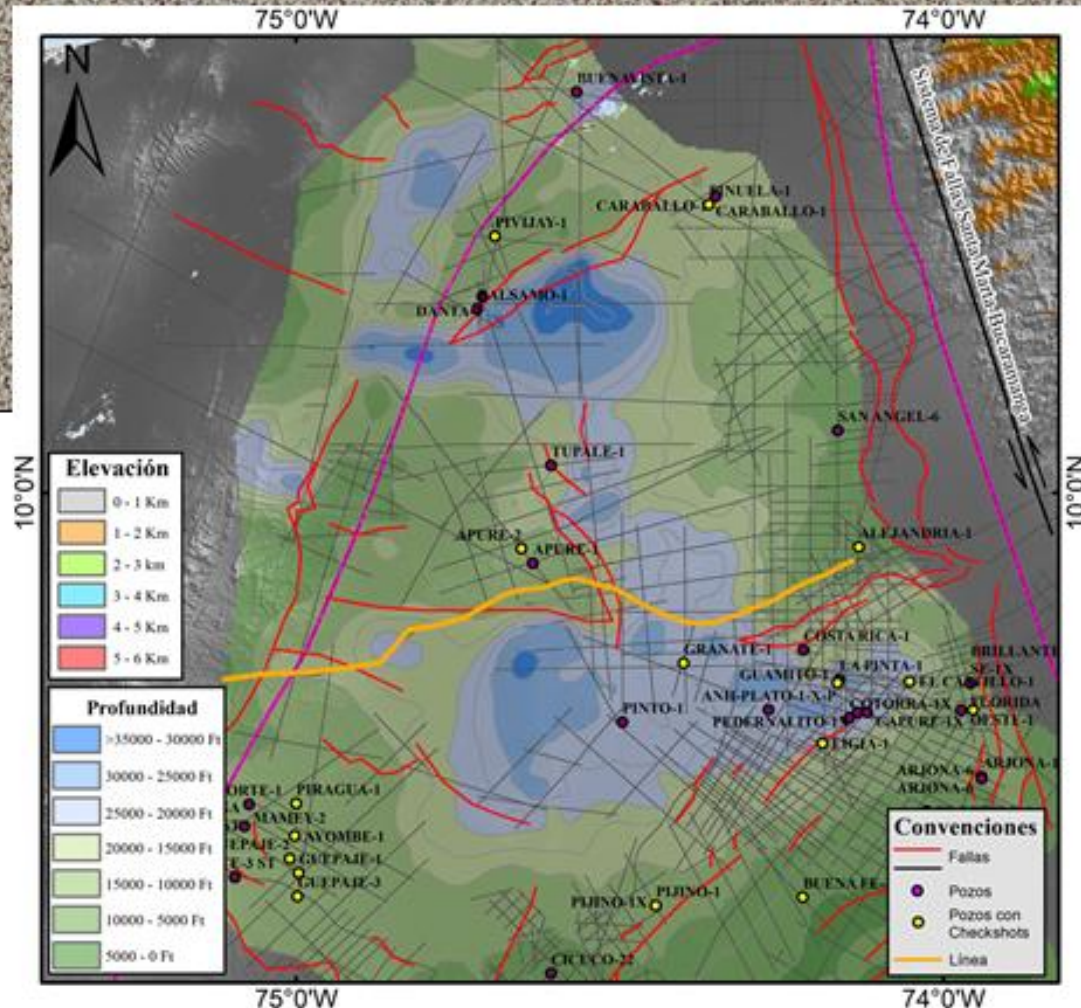
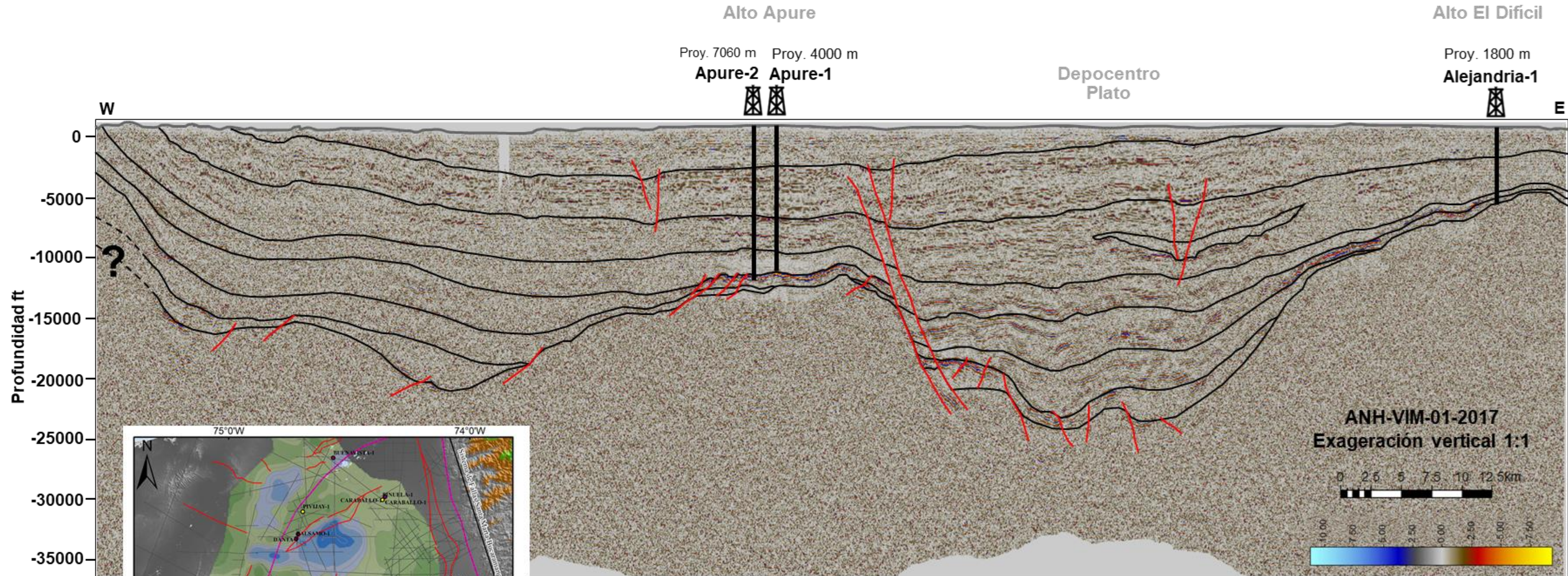
# SEISMIC INTERPRETATION

## REGIONAL SEISMIC INTERPRETATION – GENERAL OBSERVATIONS



CONVENCIONES					
	US3	Fm Ciénaga de Oro Sup.		US7	No Diferenciado
	US2	Fm Ciénaga de Oro Inf.		US6	Fm Tubará
	US 1	Fm Chengue		US5	Fm Porquera Superior
	US 0	Basamento		US4	Fm Porquera Medio

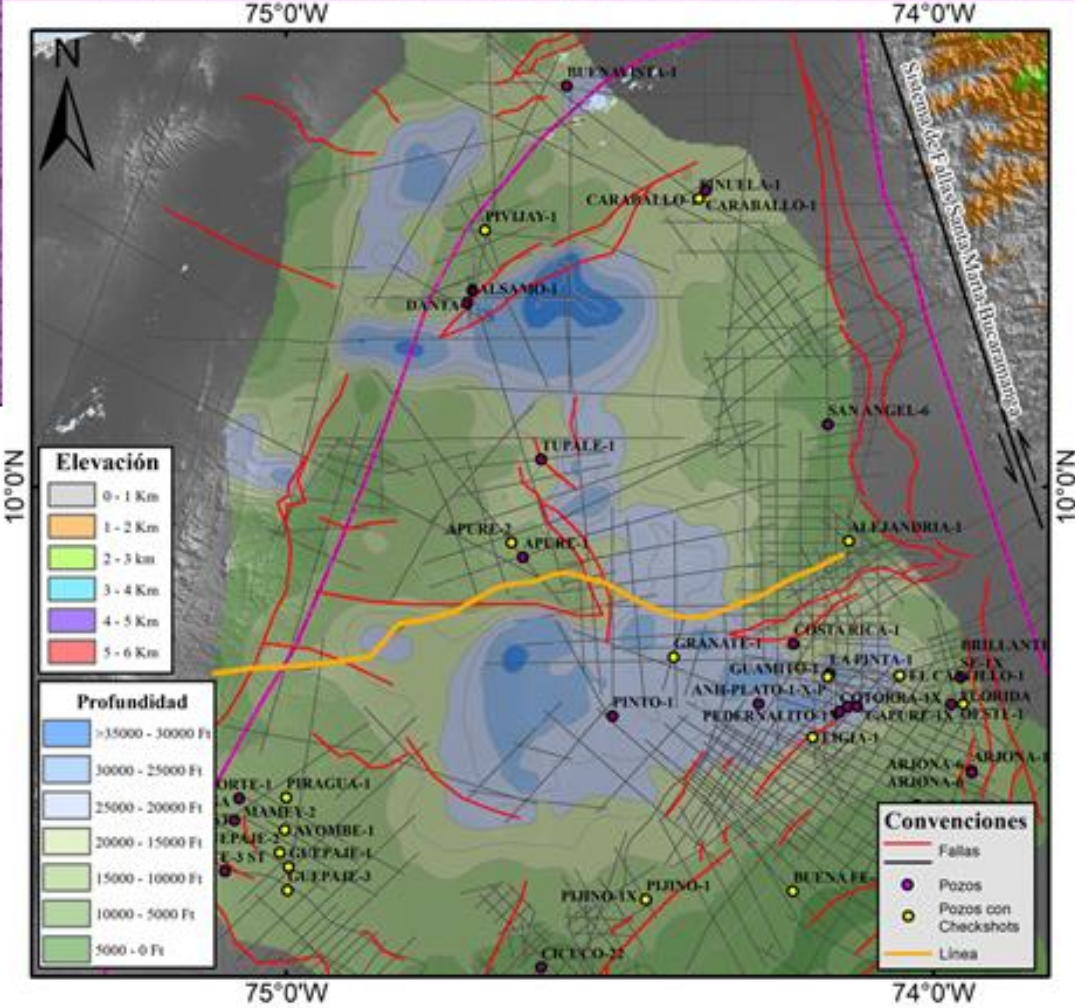
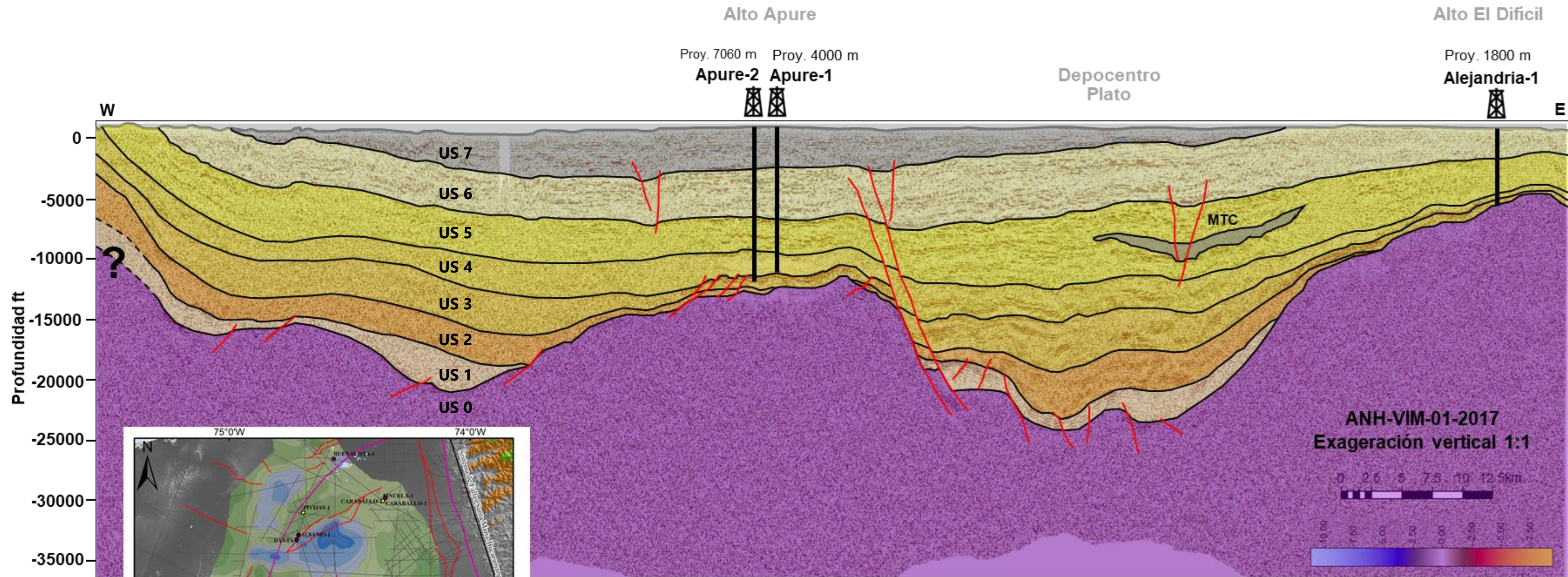




W – E cross section - structural highs and depocenters throughout Plato sub-basin

# SEISMIC INTERPRETATION

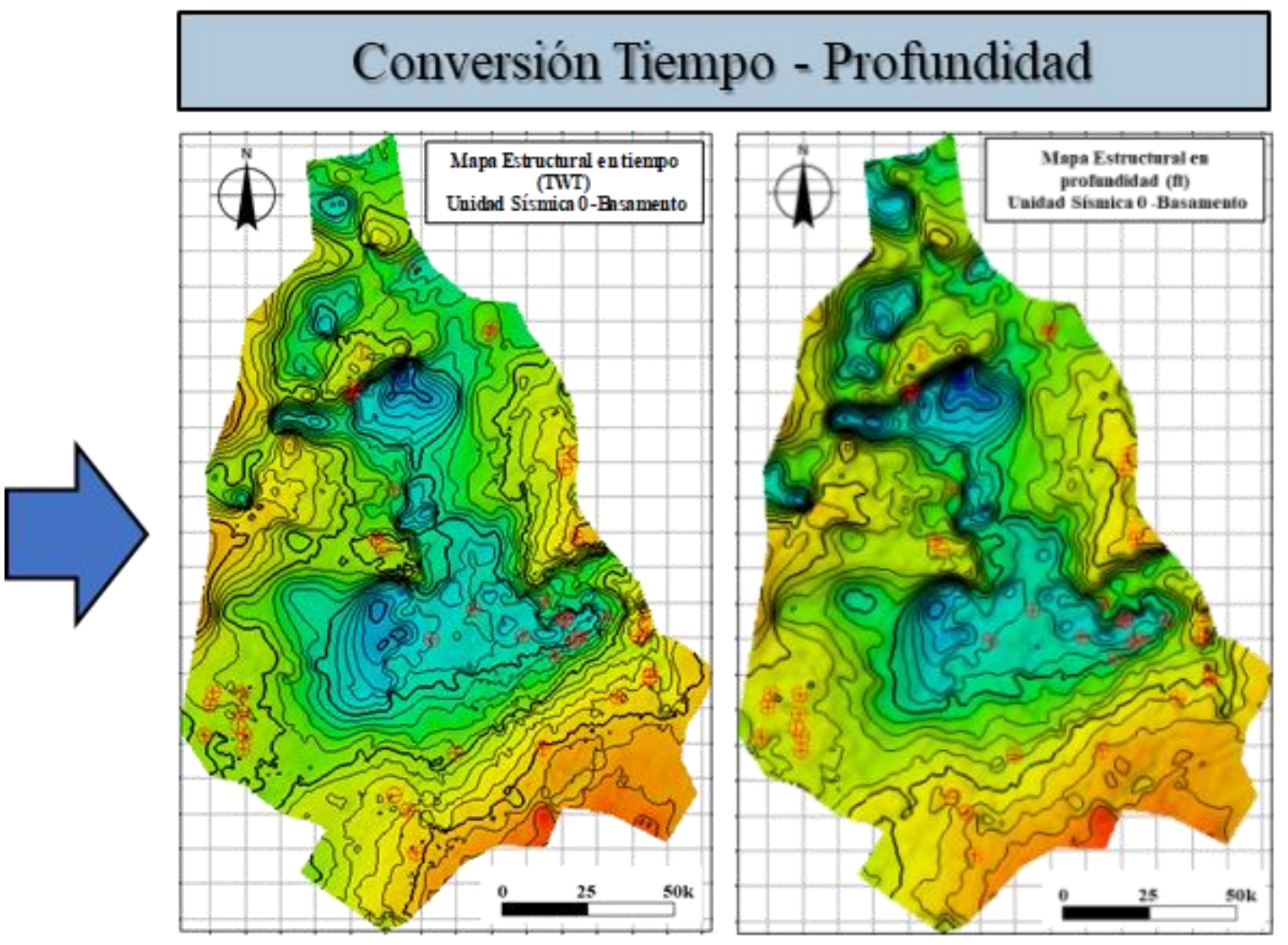
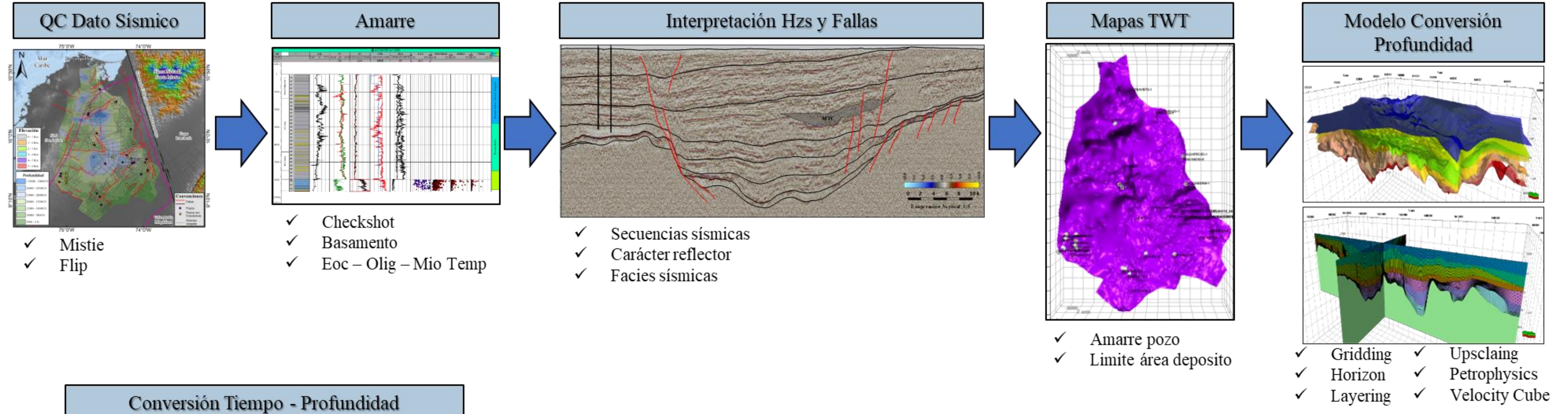
## REGIONAL SEISMIC INTERPRETATION – GENERAL OBSERVATIONS



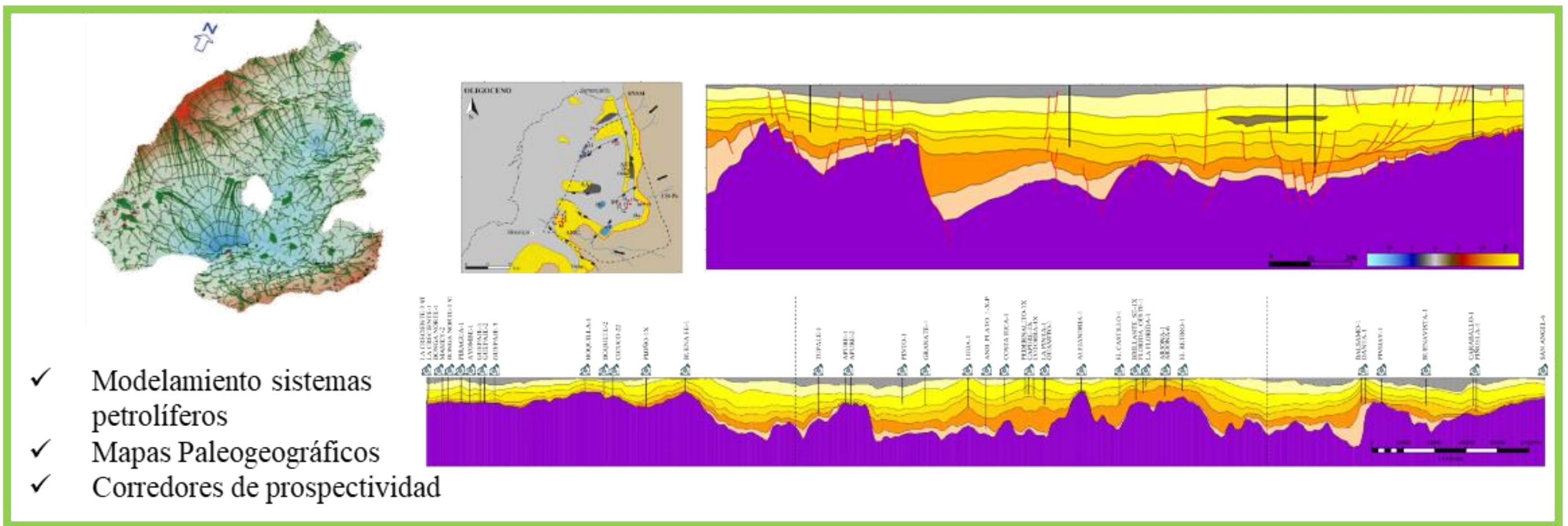
CONVENCIONES					
	US3	Fm Ciénaga de Oro Sup.		US7	No Diferenciado
	US2	Fm Ciénaga de Oro Inf.		US6	Fm Tubará
	US 1	Fm Chengue		US5	Fm Porquera Superior
	US 0	Basamento		US4	Fm Porquera Medio

# SEISMIC INTERPRETATION

## WORK FLOW SUMMARY

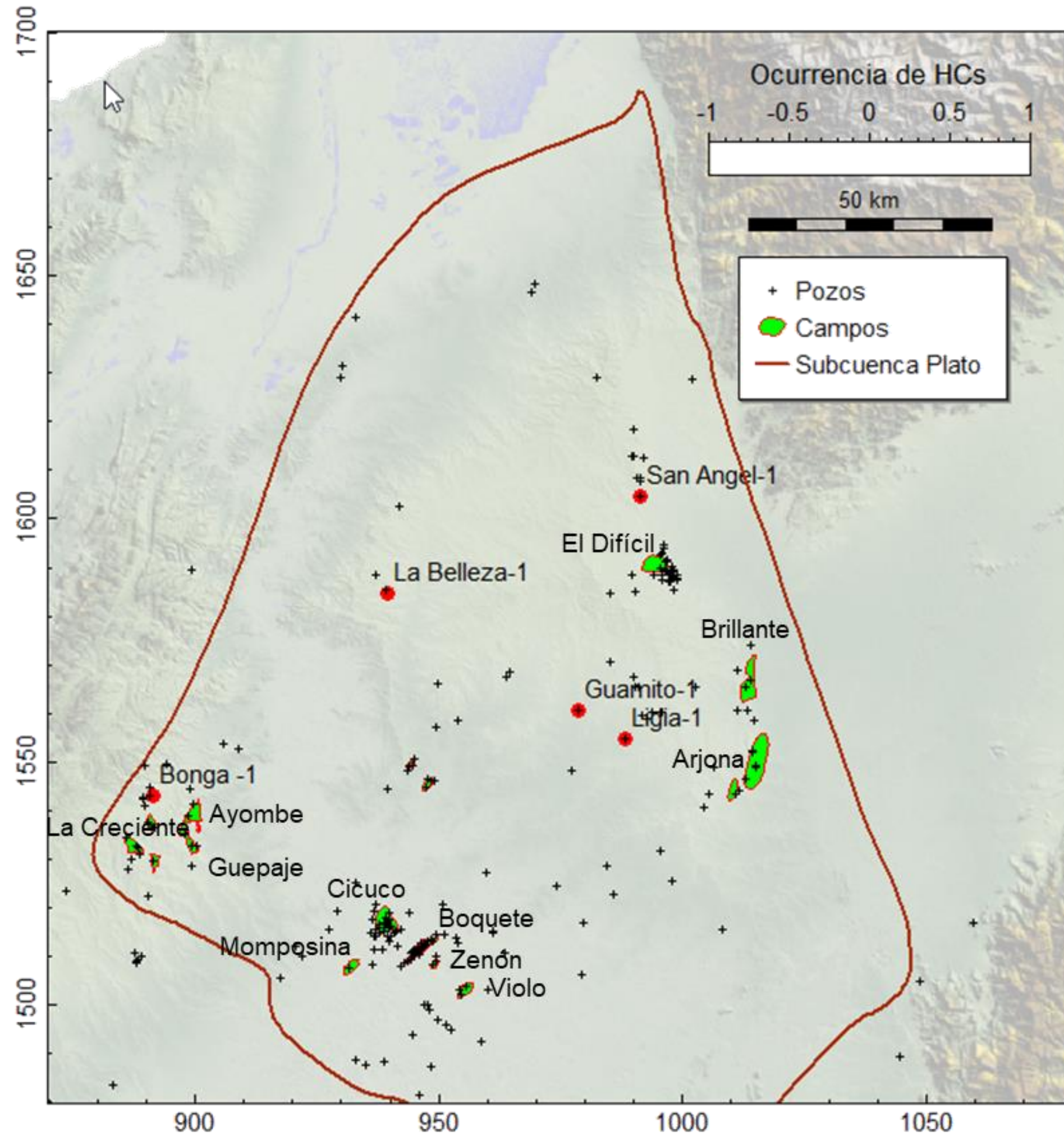


**ENTRADA**



# PETROLEUM SYSTEM MODELING

## HYDROCARBONS OCCURRENCE

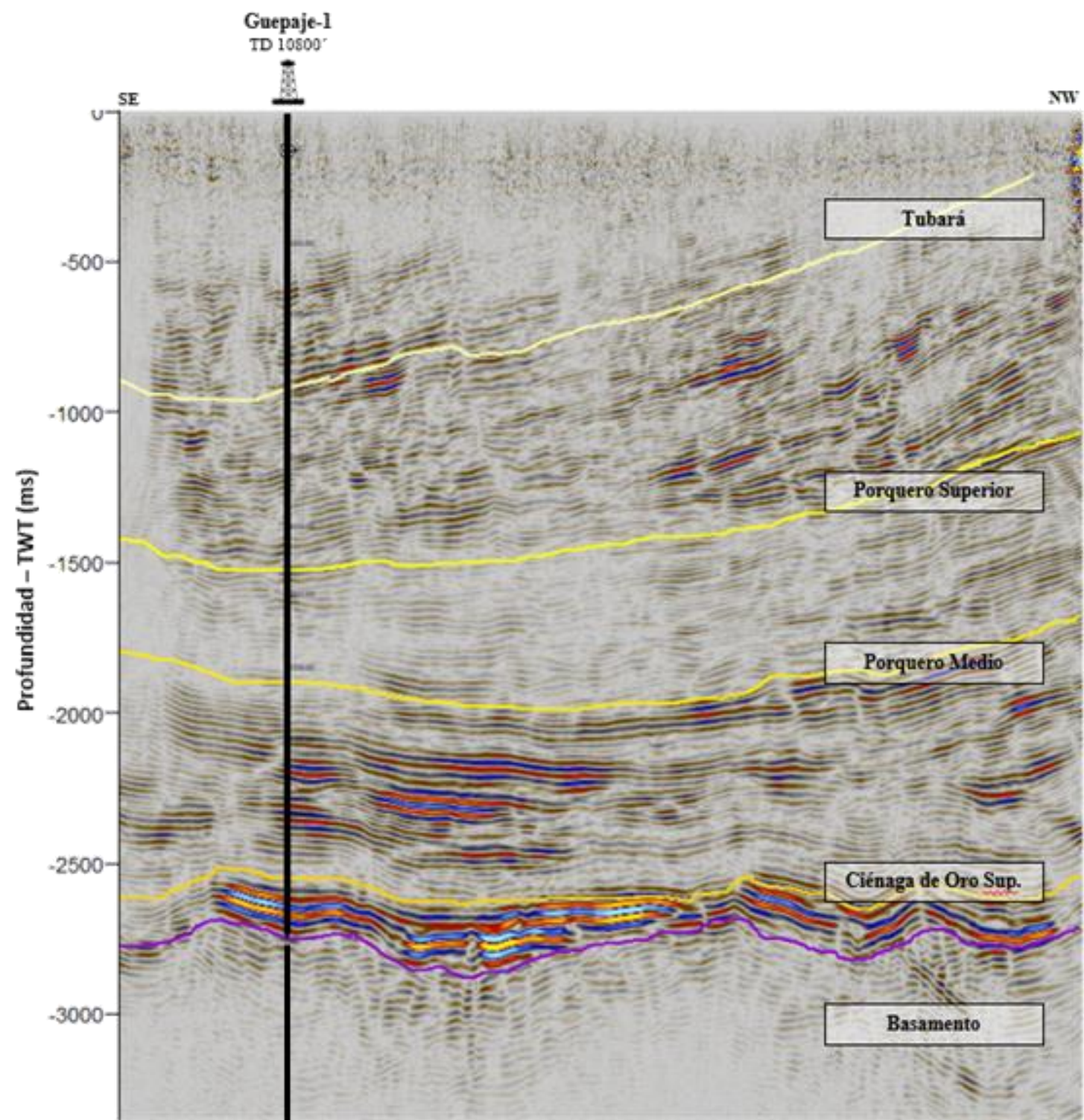


POZO	HCs
La Belleza-1	Gas/Condensado
Bonga -1	Gas
Guamito-1	Gas/Crudo Liviano
Ligia-1	Gas/Crudo Liviano
San Angel-1	Gas
El Difícil	Gas/Condensado
Brillante	Gas
Arjona	Gas
Cicuco	Gas Húmedo/Crudo
Boquete	Gas Húmedo/Crudo
Zenón	Gas
Violo	Gas
Mompesina	Gas/Condensado
Guepaje	Gas Seco
Ayombe	Gas Seco
La Creciente	Gas

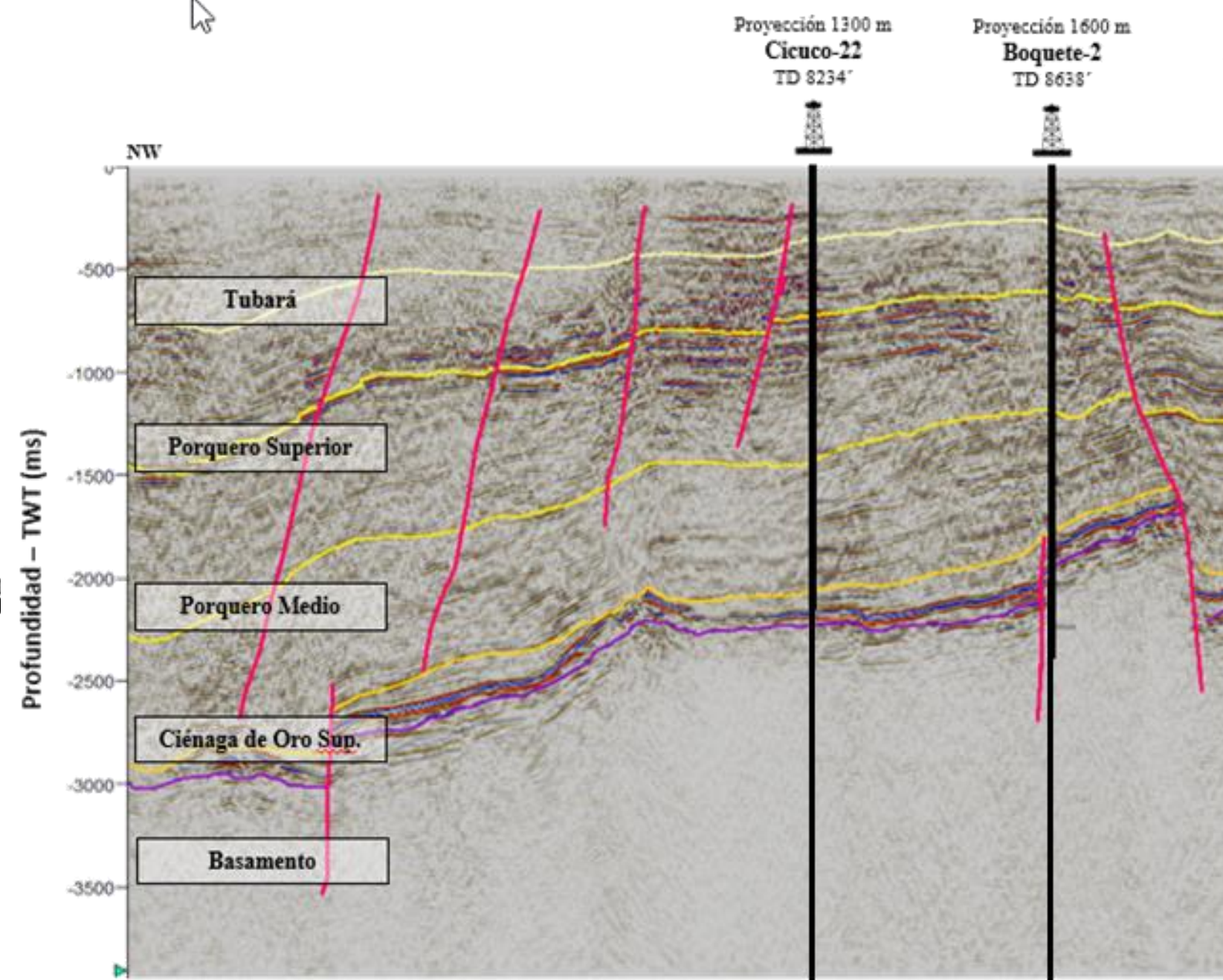
Campo	OOIP (mbpe)
CICUCO	252,7
EL DIFÍCIL	144,7
CAPURE	136,5
BOQUETE	79,1
LA CRECIENTE A	51,9
PEDERNALITO	30,9
MAMEY	25,3
COTORRA	23,2
PALMER	9,2
BONGA	9,0
LA CRECIENTE D	5,8
TORONJA	5,6
ARJONA	3,4
APAMATE	2,5
LA CRECIENTE I	1,6
<b>TOTAL</b>	<b>781,4</b>

# PETROLEUM SYSTEM MODELING

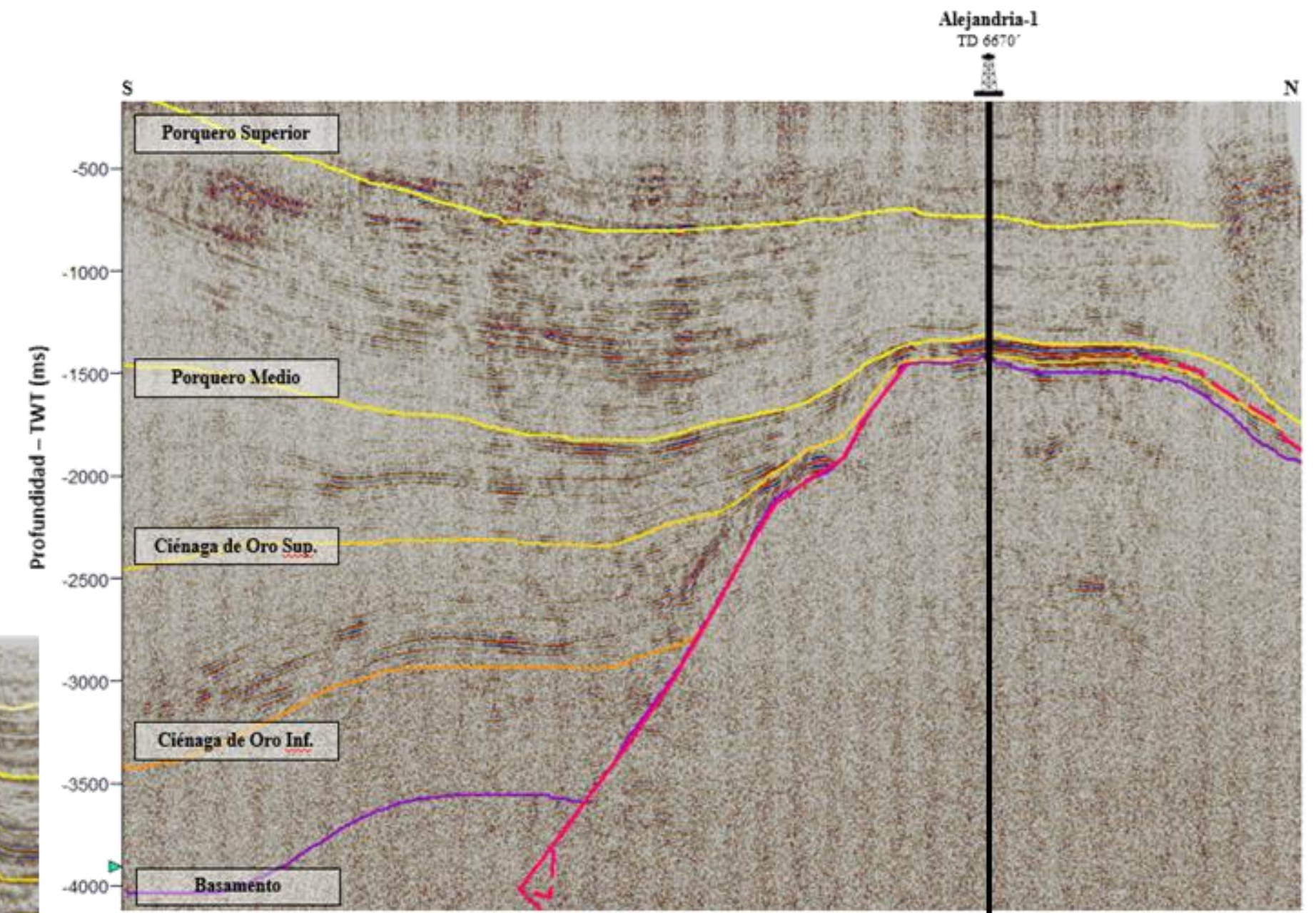
## PROVEN PLAYS



**Guepaje 136 MMboe**



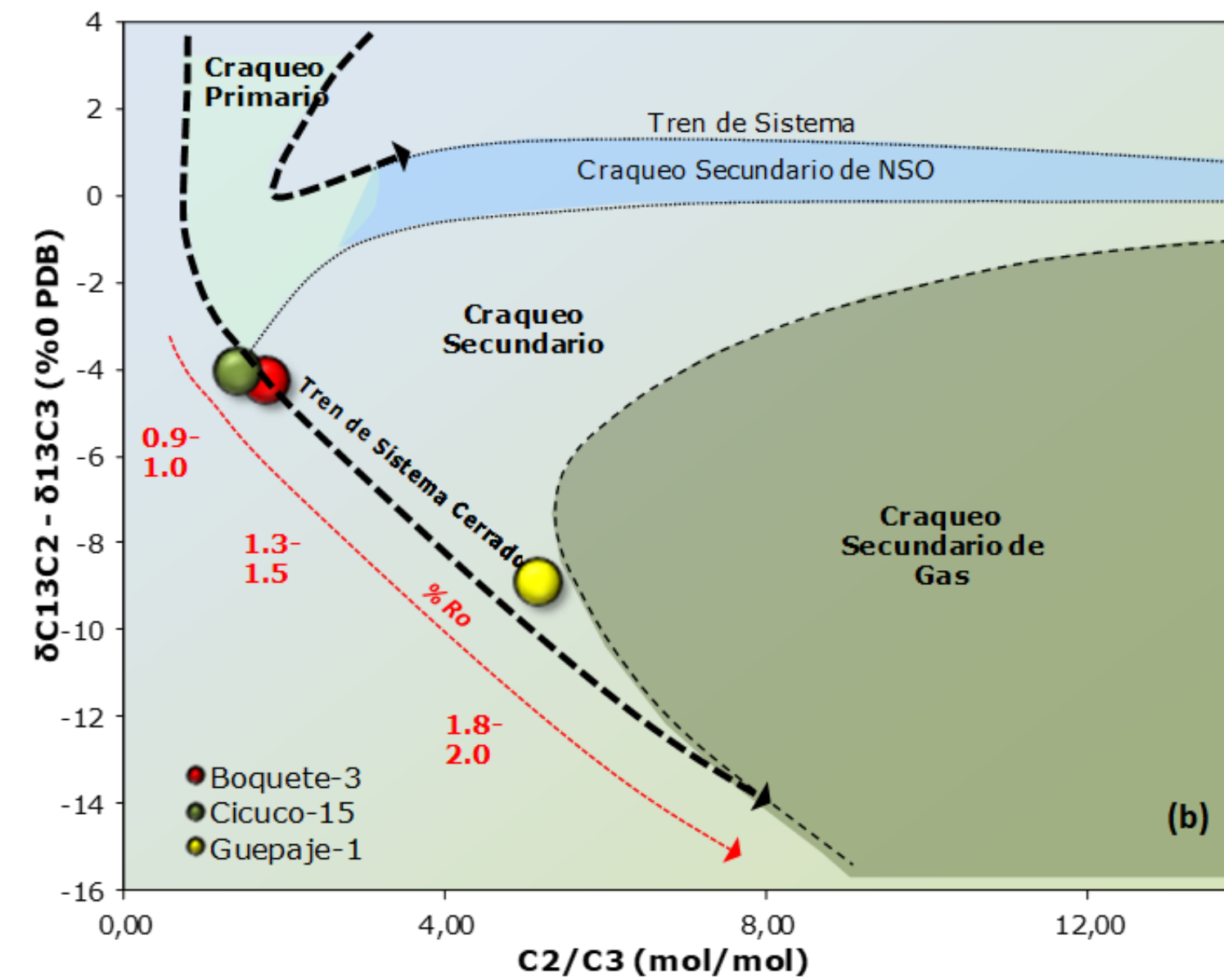
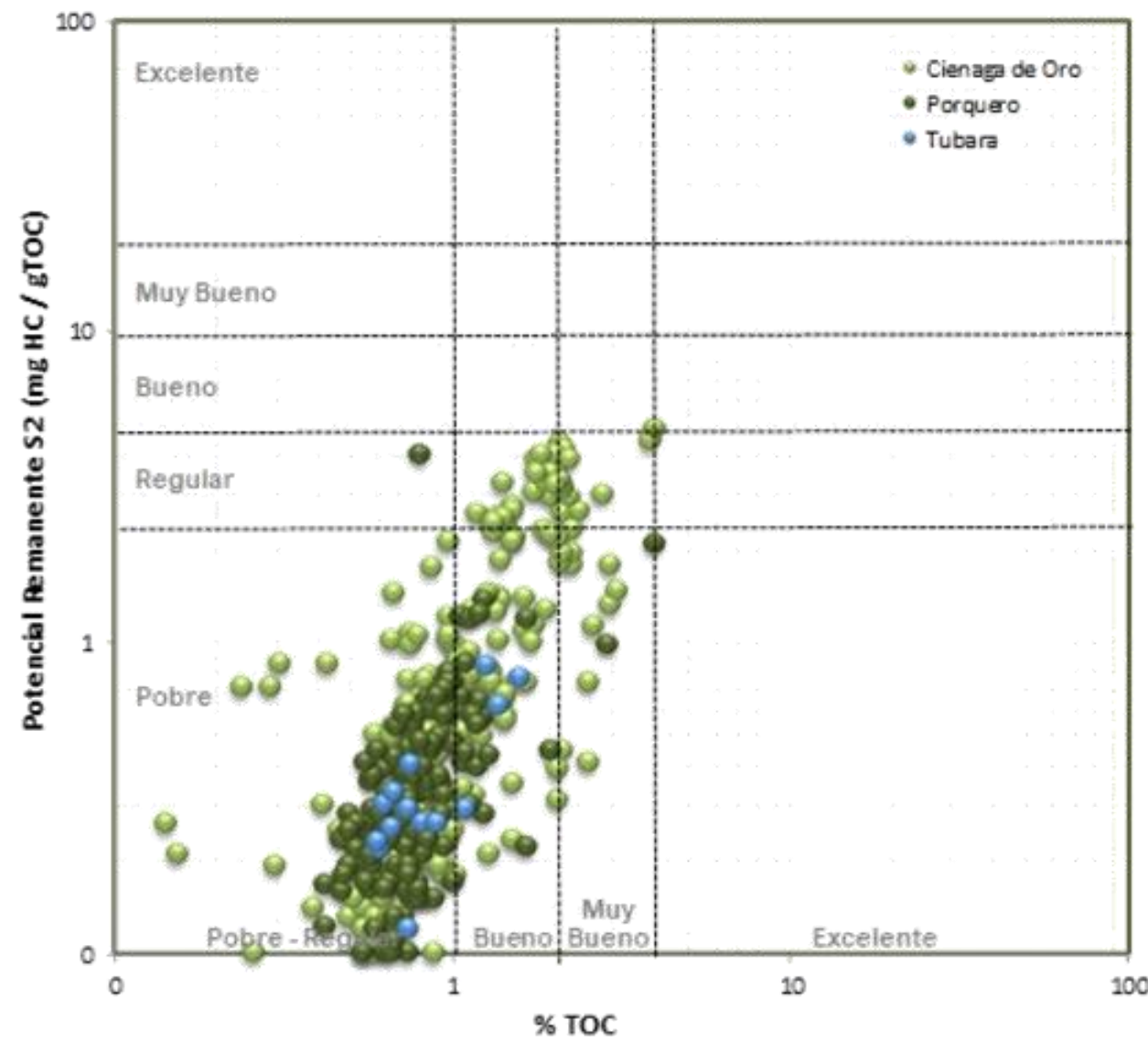
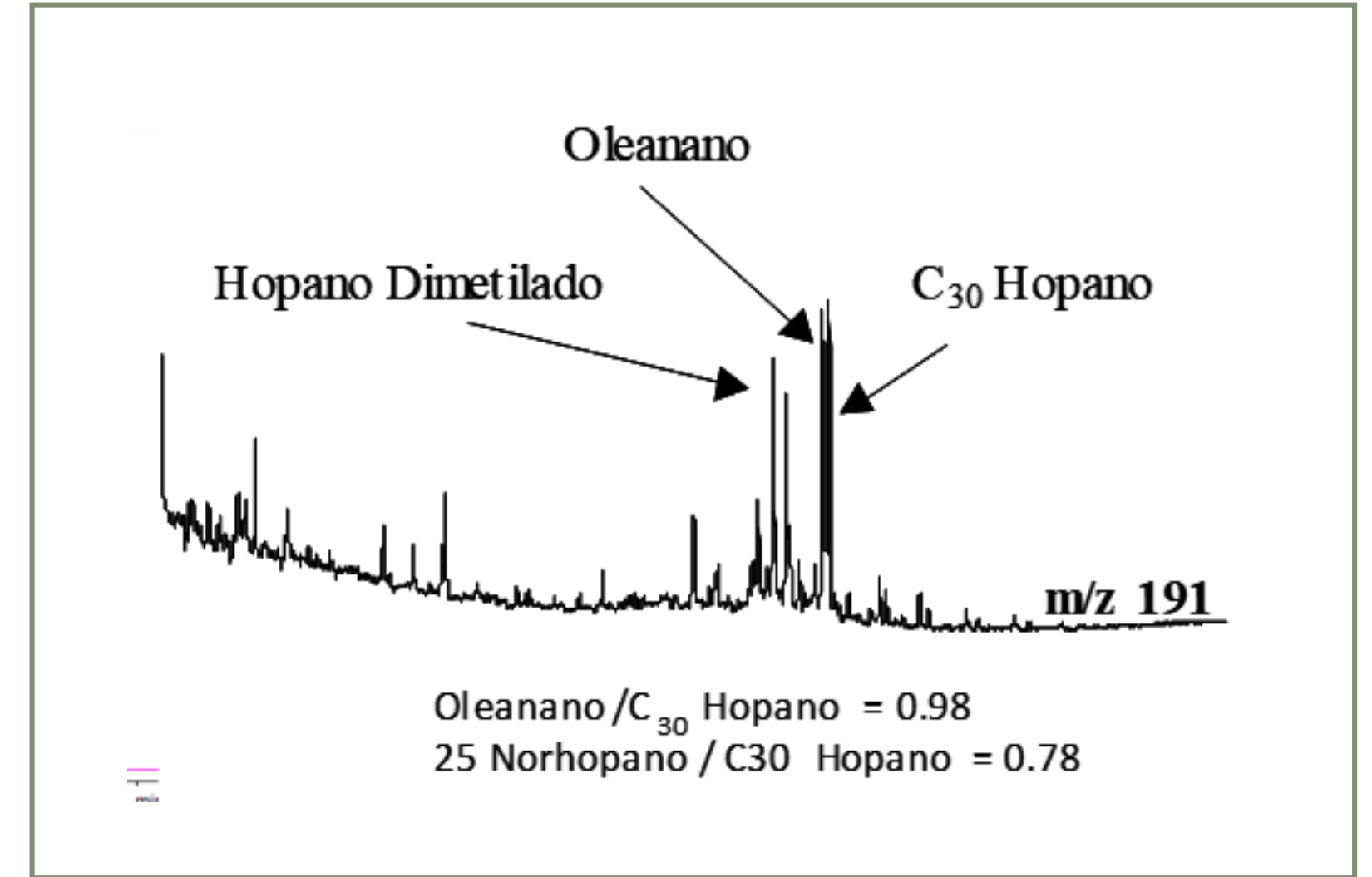
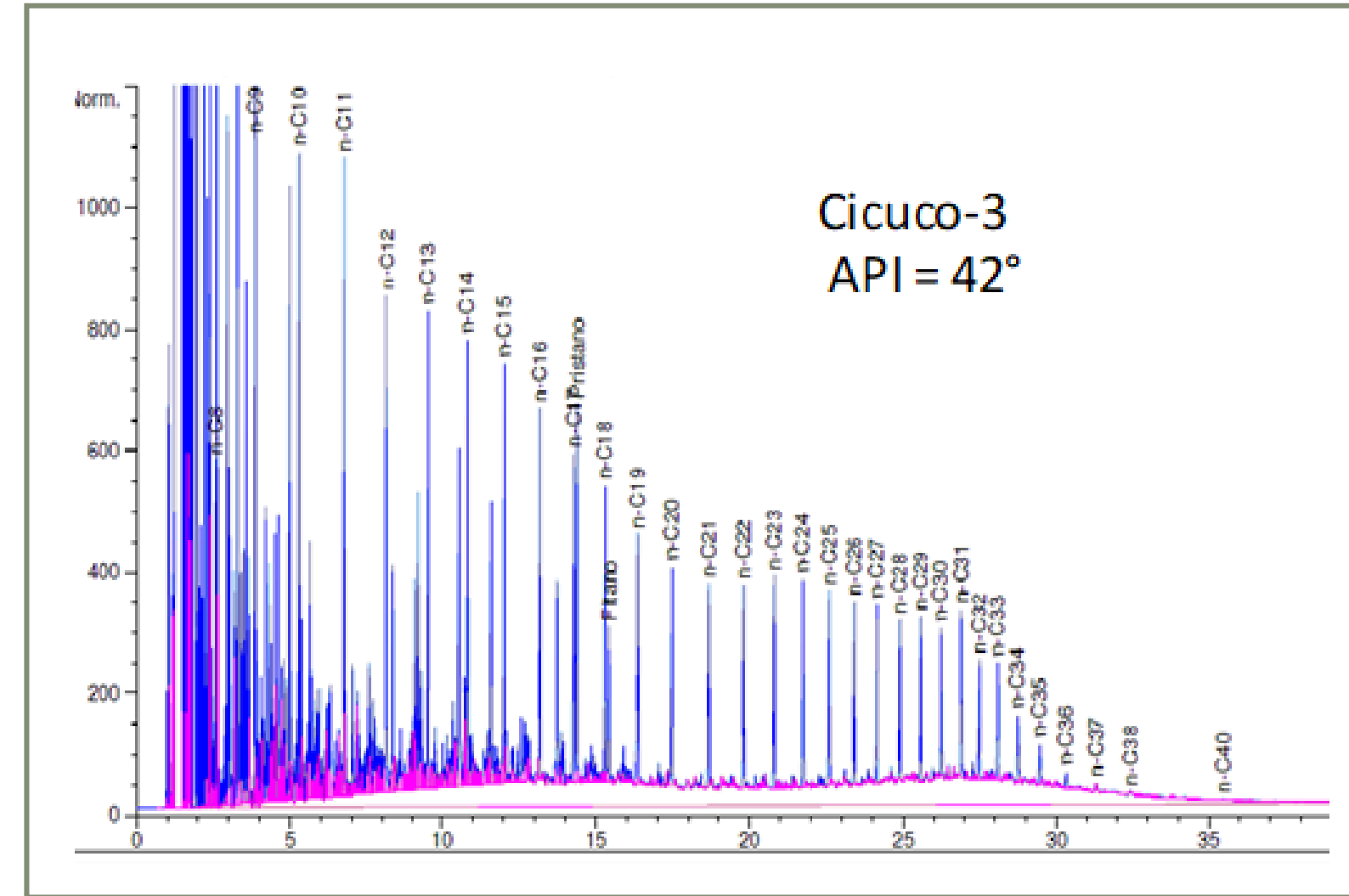
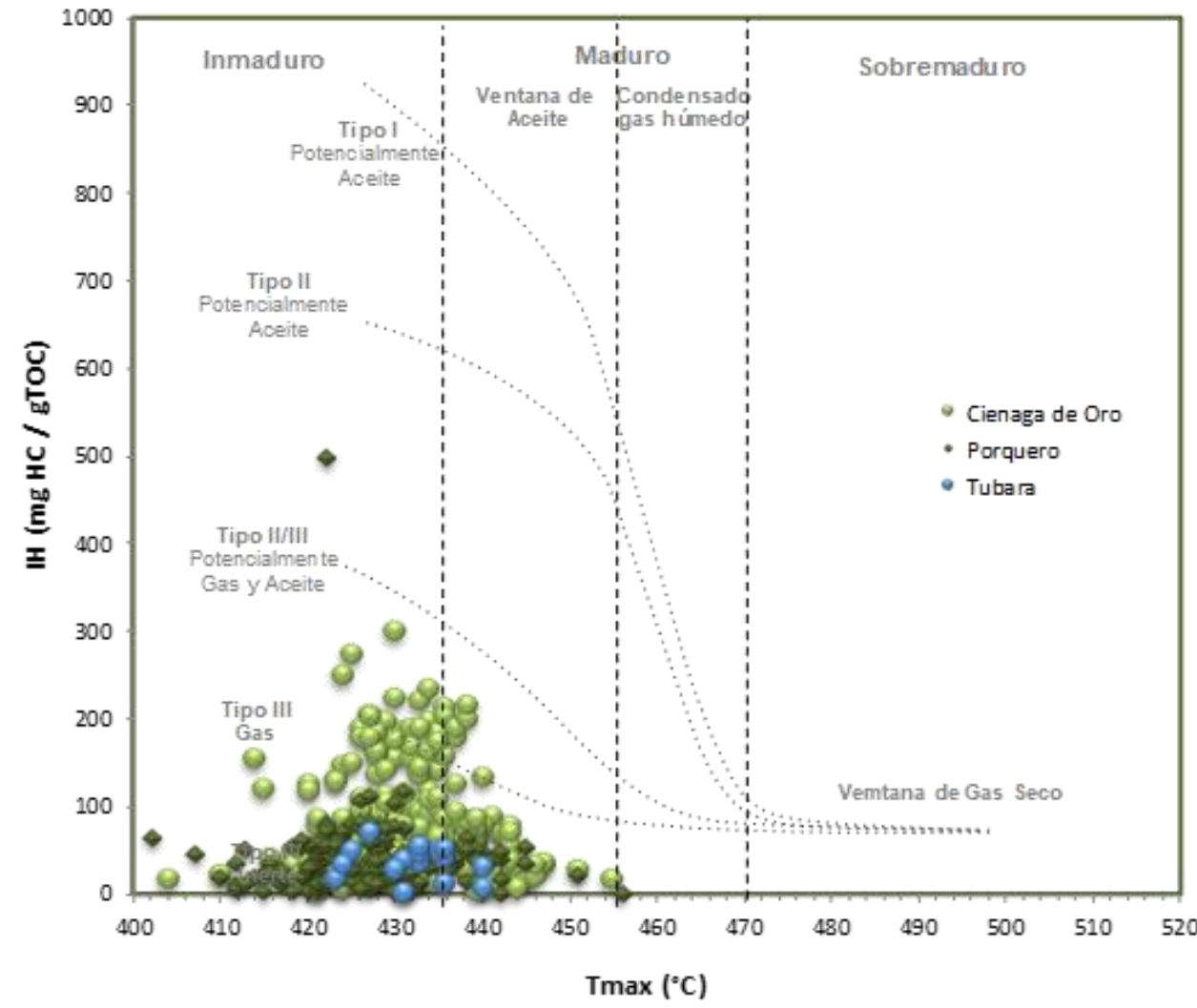
**Cicuco 252 MMboe Boquete 79 MMboe**



**El Difícil 144 MMboe**

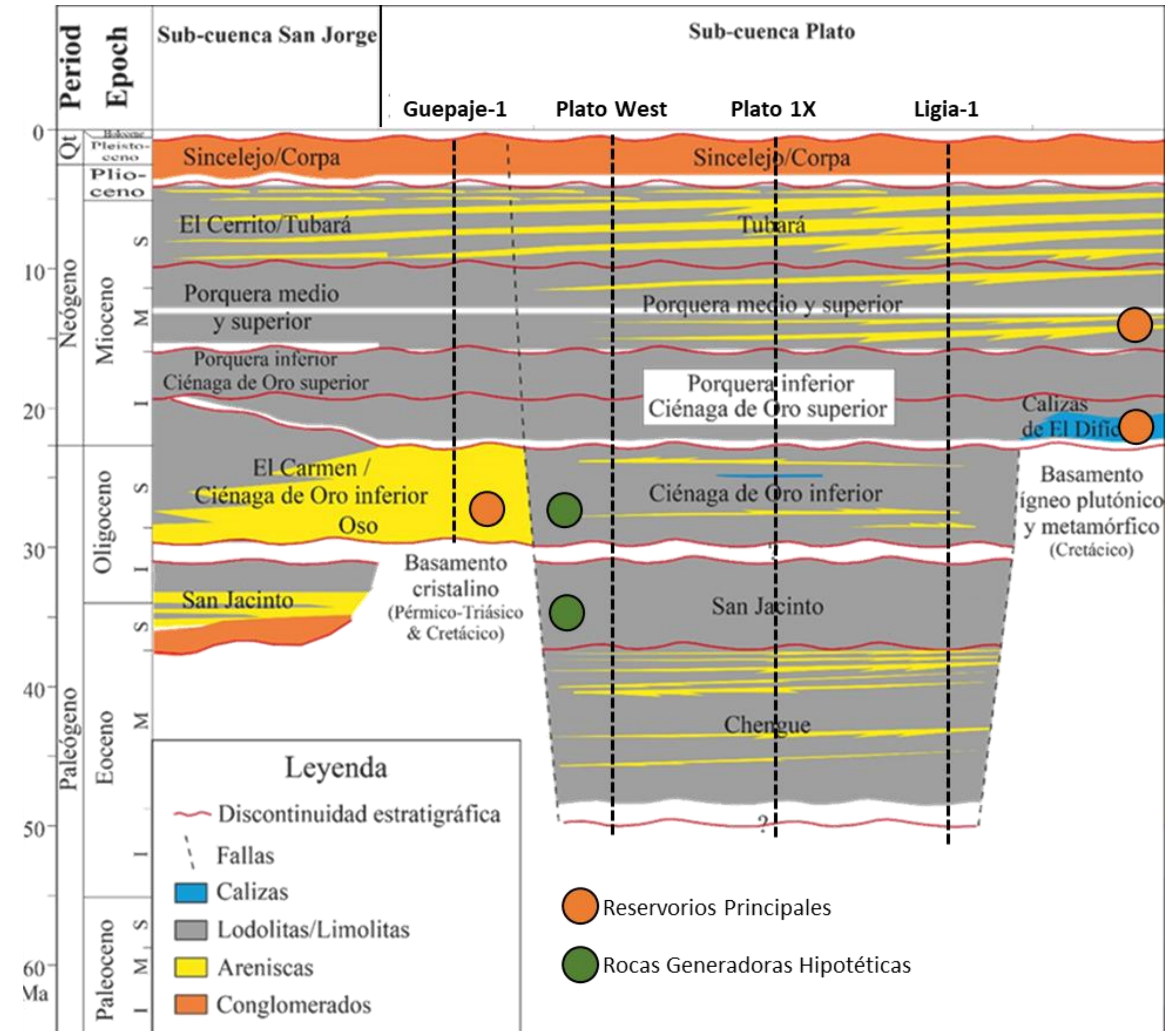
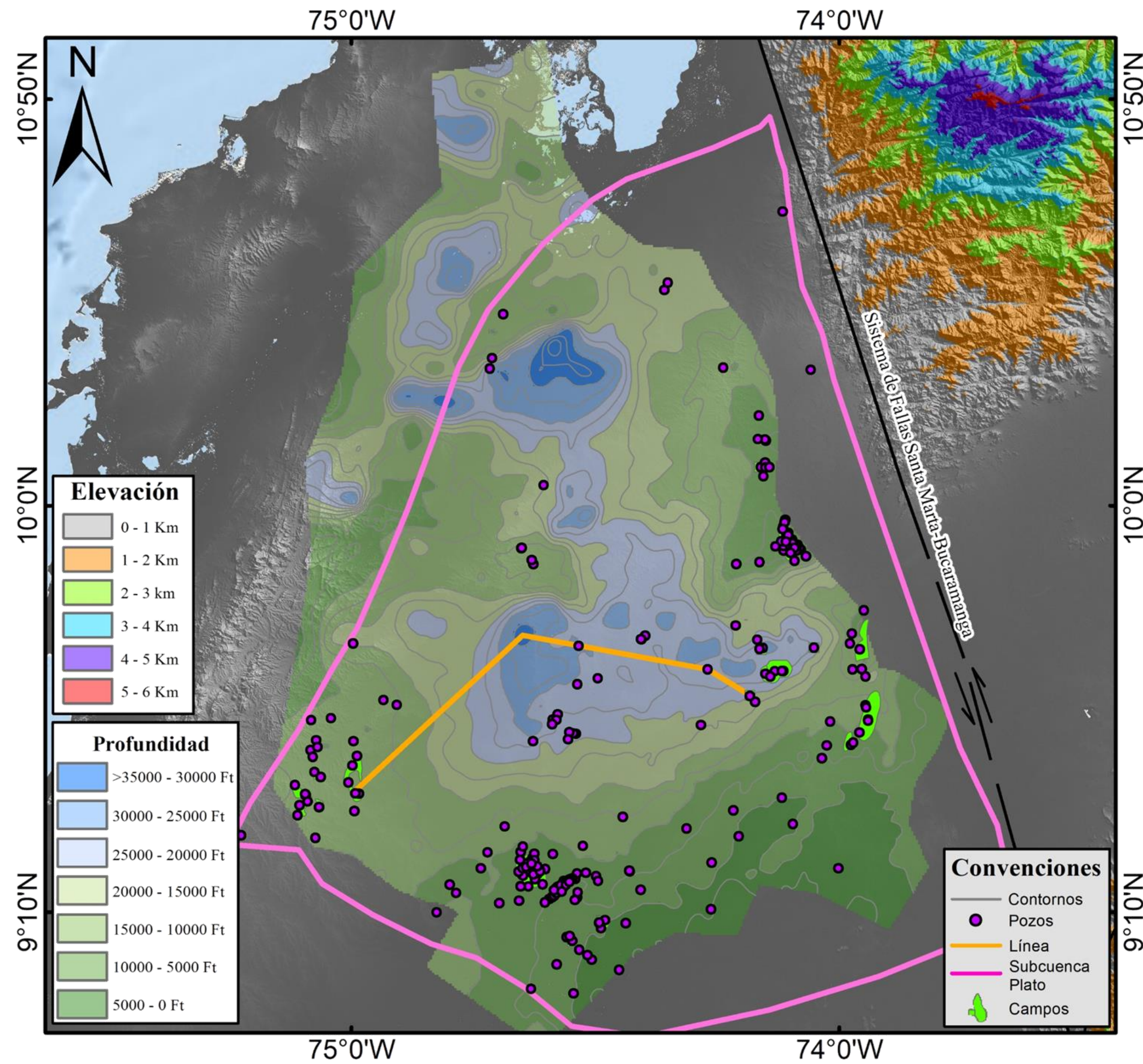
# PETROLEUM SYSTEM MODELING

## PETROLEUM GEOCHEMISTRY



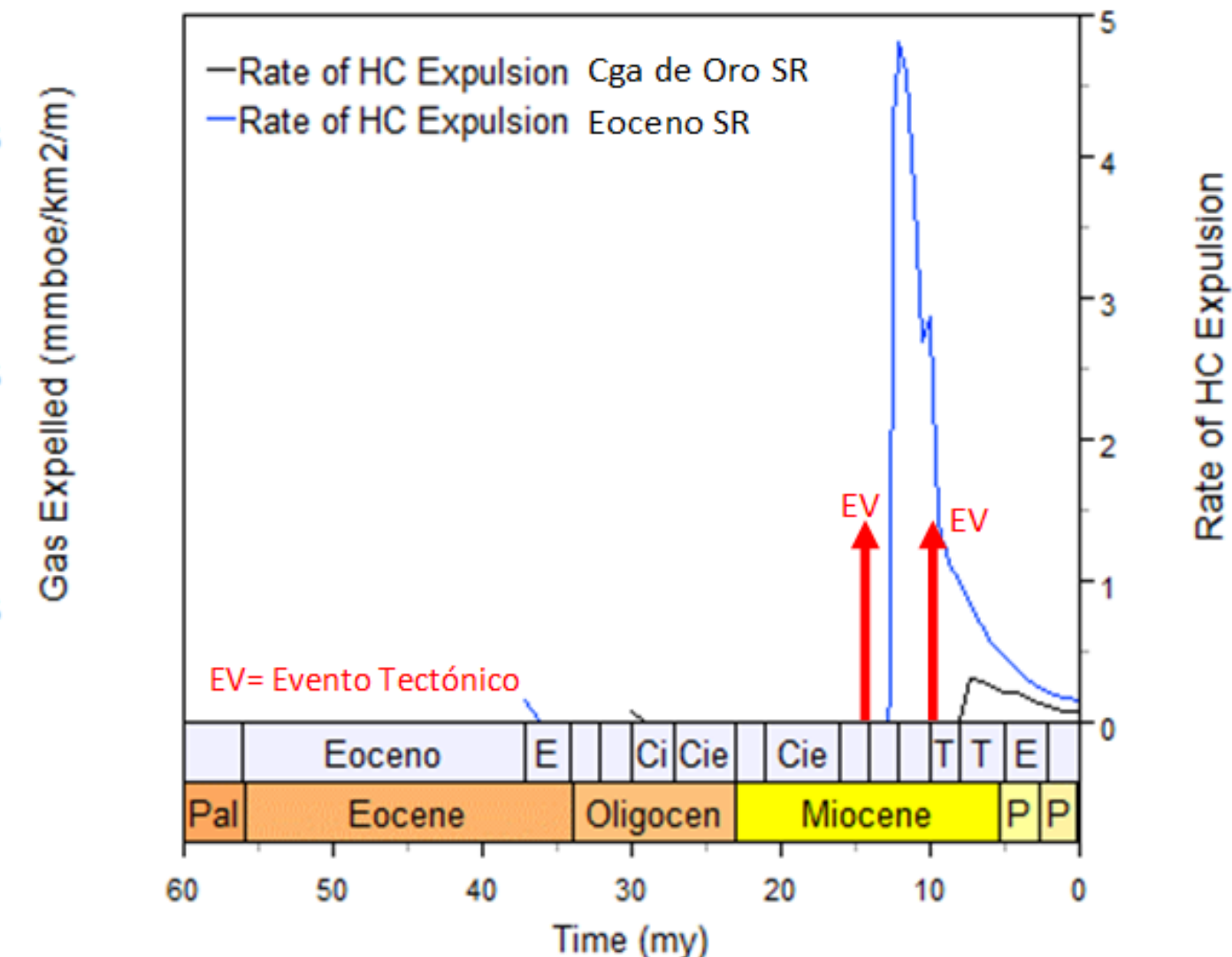
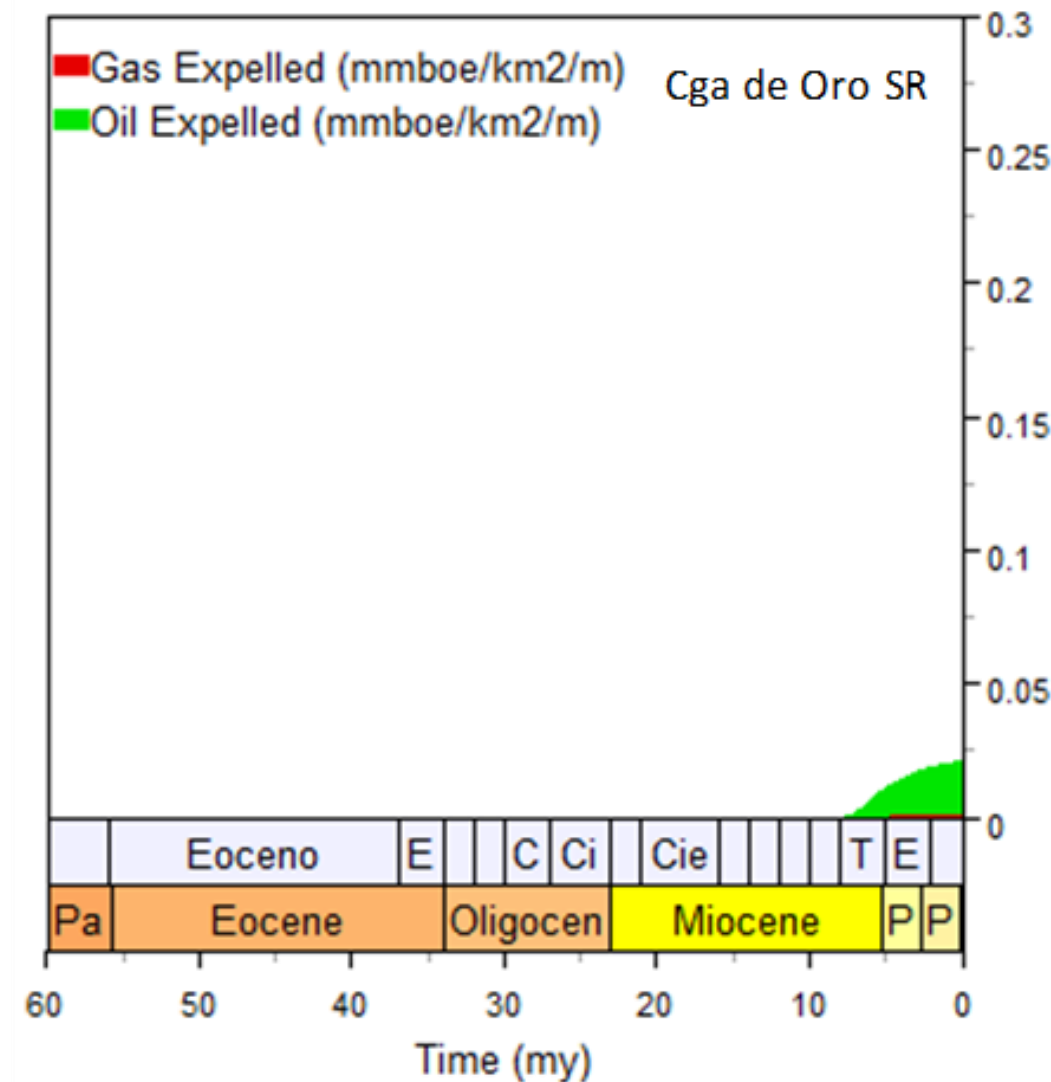
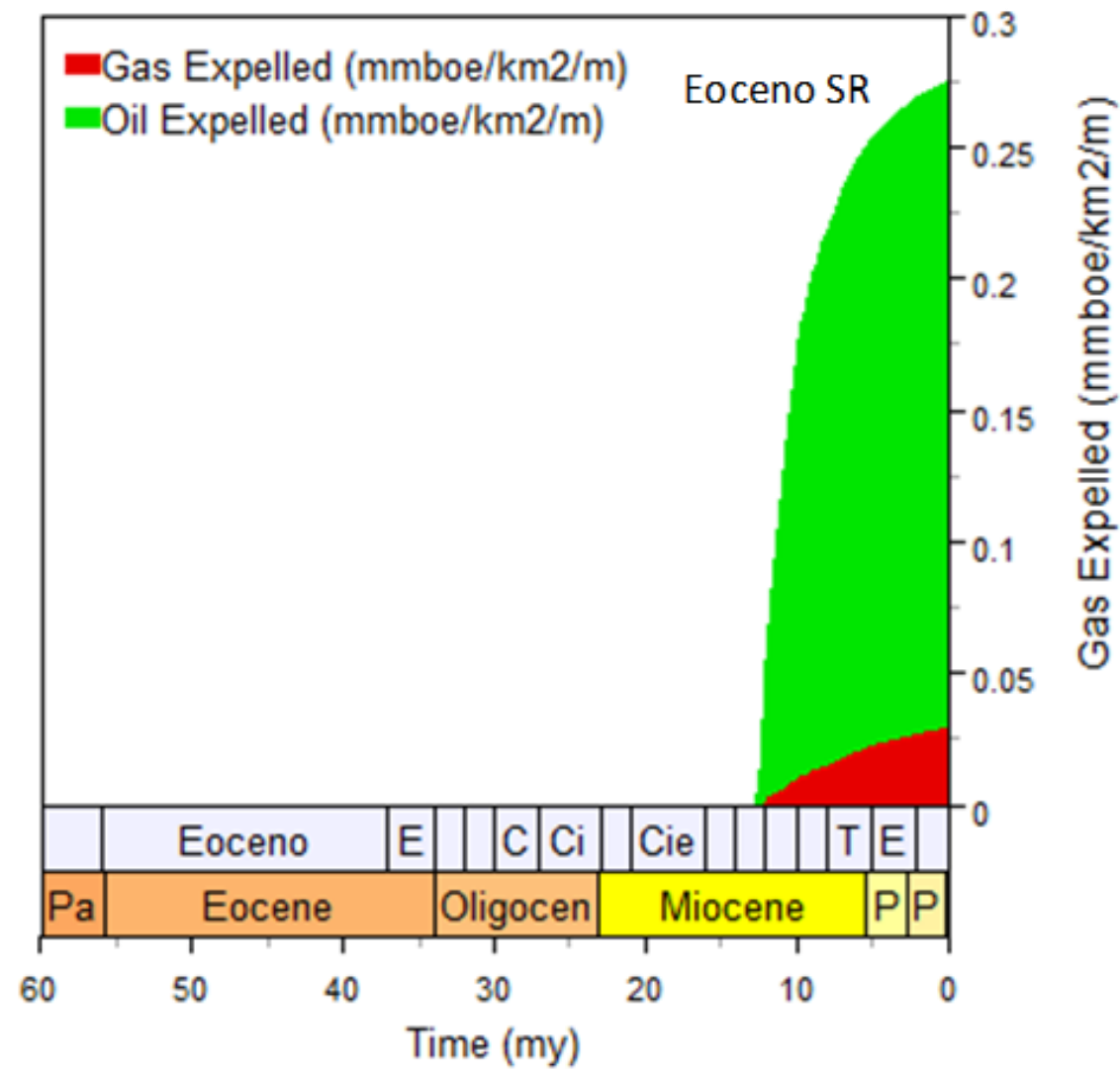
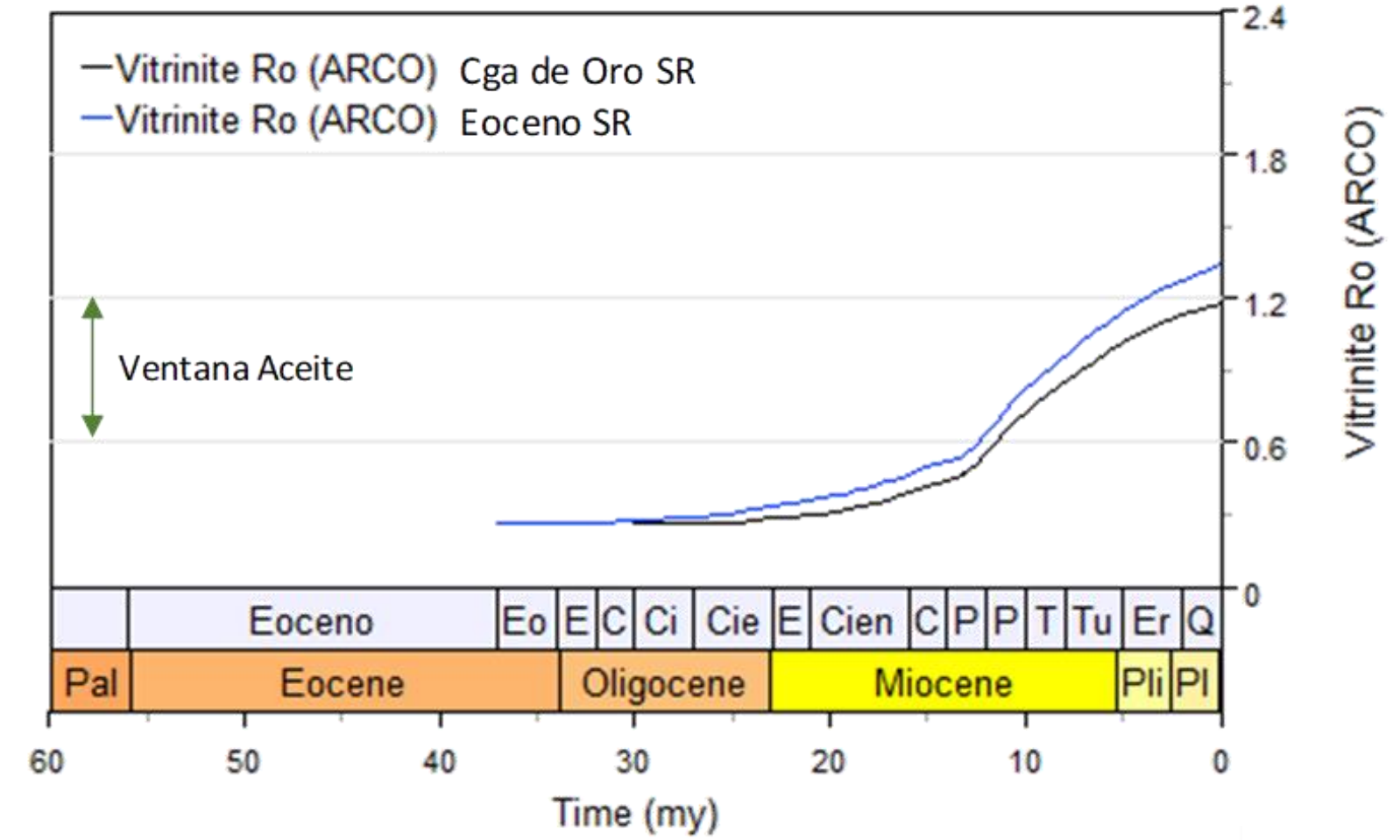
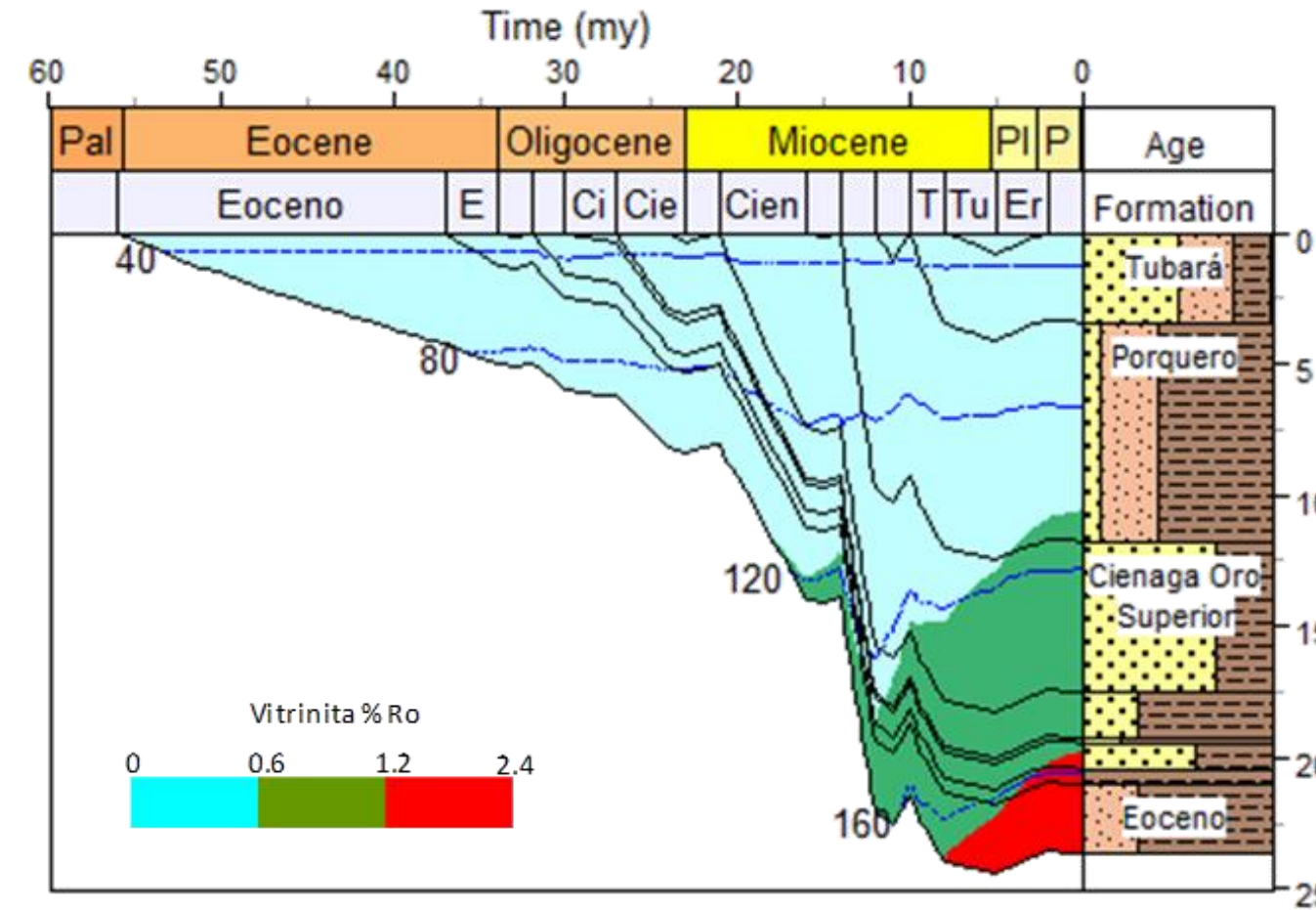
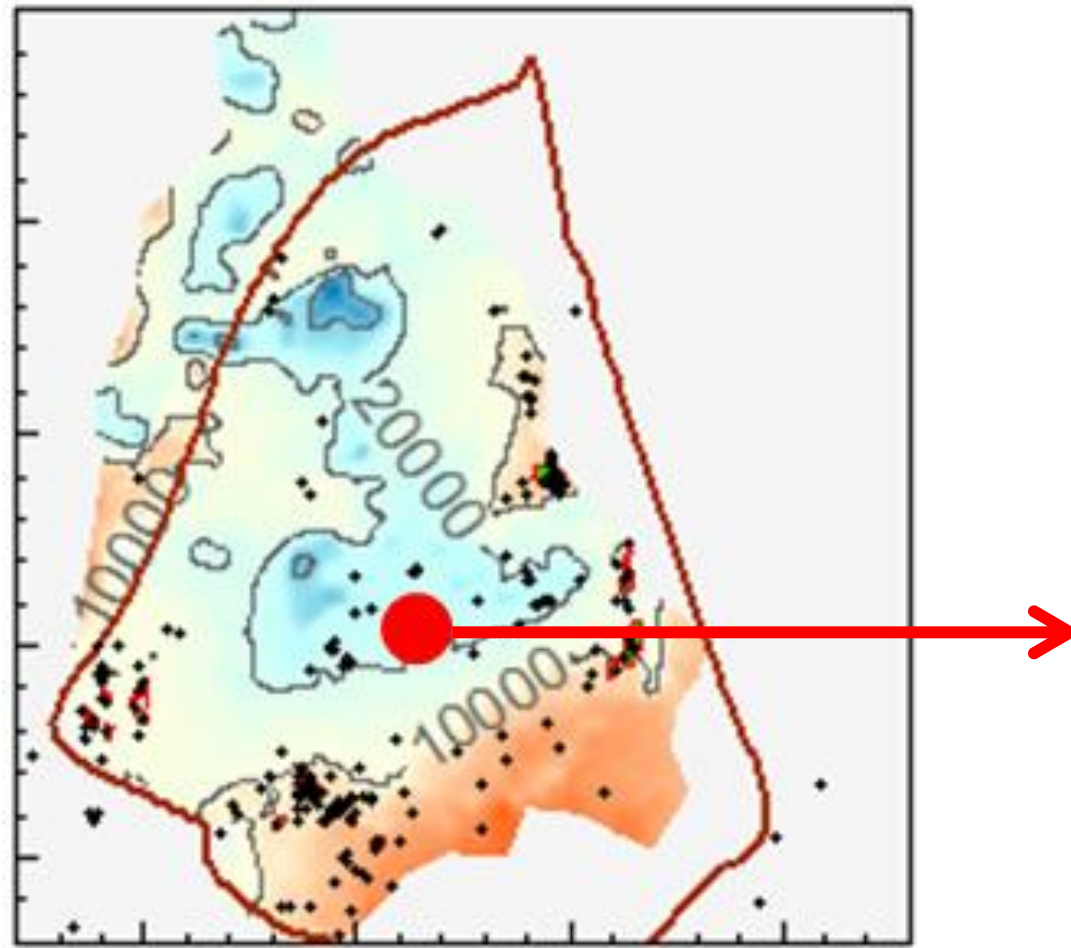
# PETROLEUM SYSTEM MODELING

## CHRONOSTRATIGRAPHIC FRAMEWORK - 1D MODELING



# PETROLEUM SYSTEM MODELING

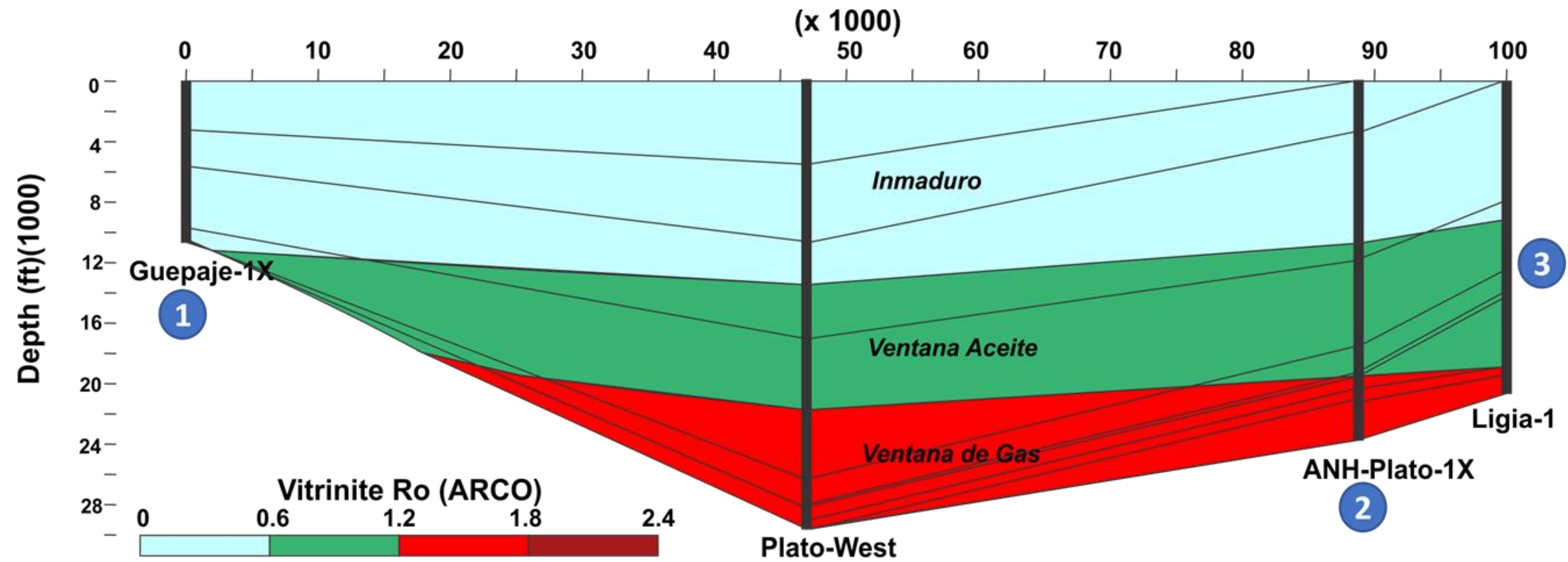
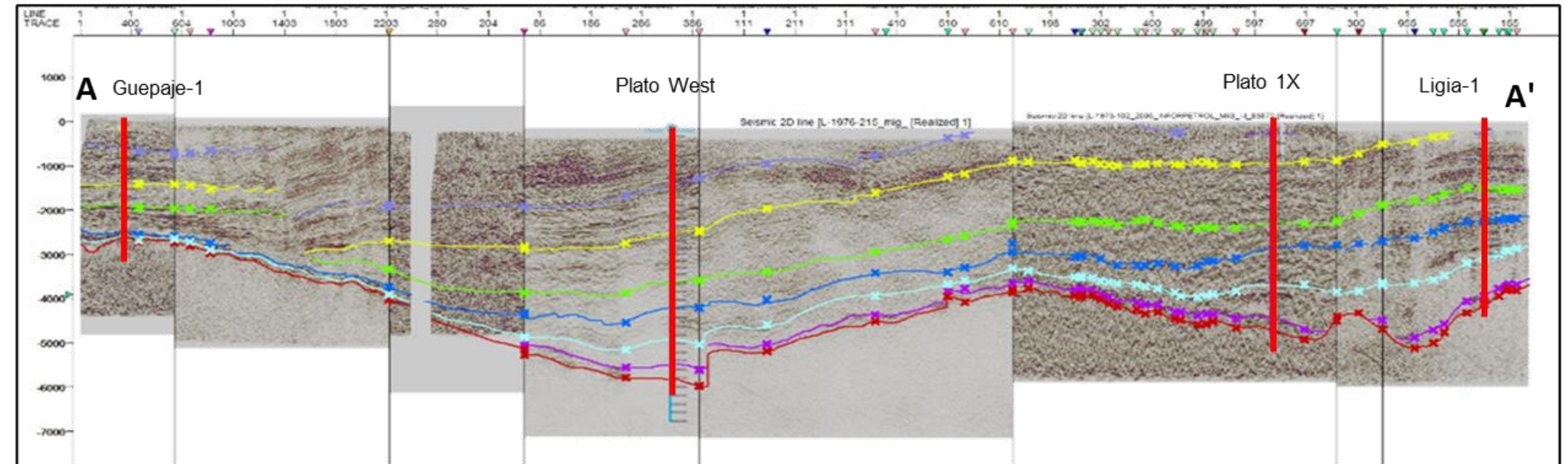
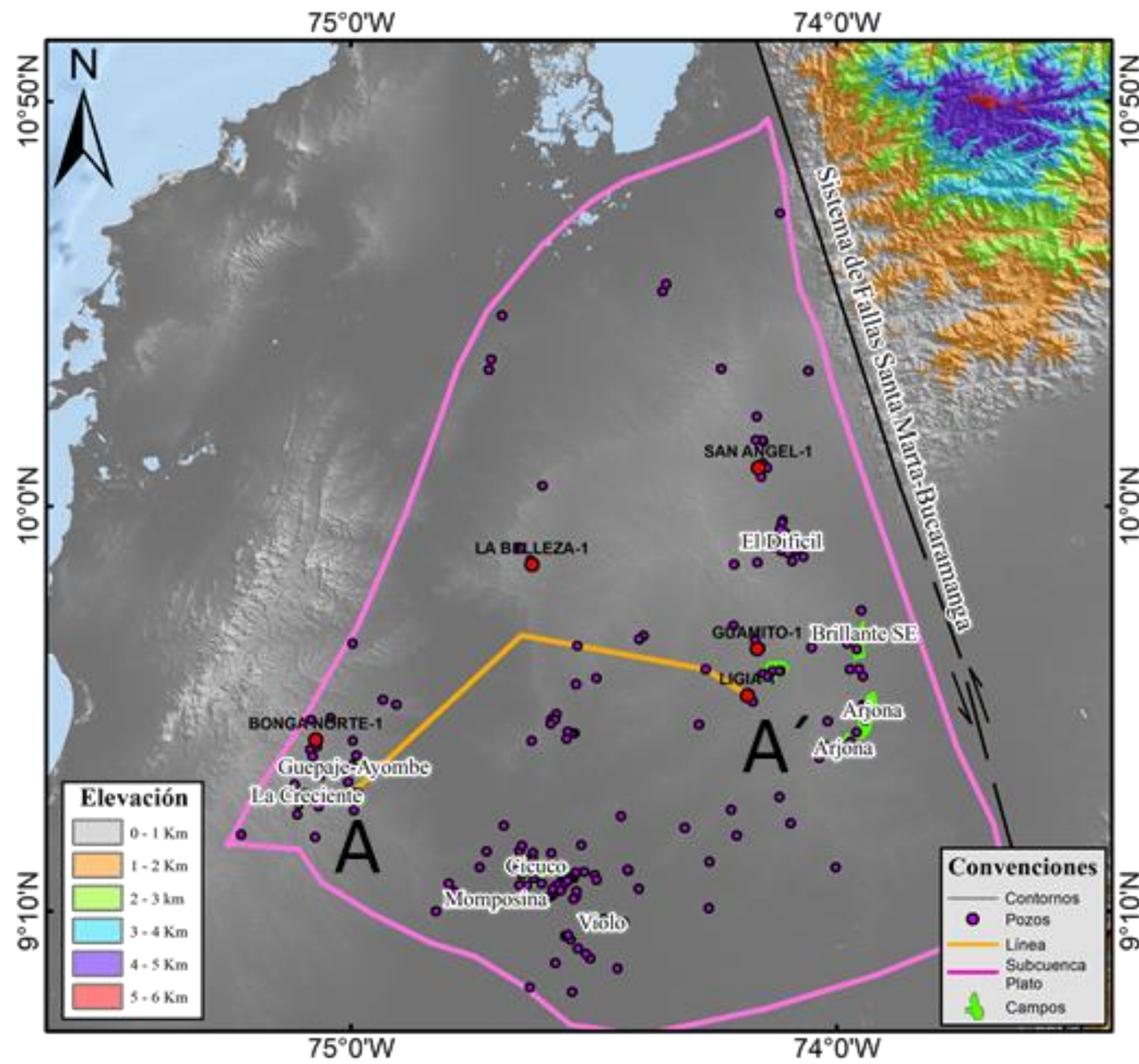
## 1D MODELING PLATO - 1X





# PETROLEUM SYSTEM MODELING

## 1D MODELING PLATO – 1X / THERMAL MATURITY CORRELATION (%Ro)



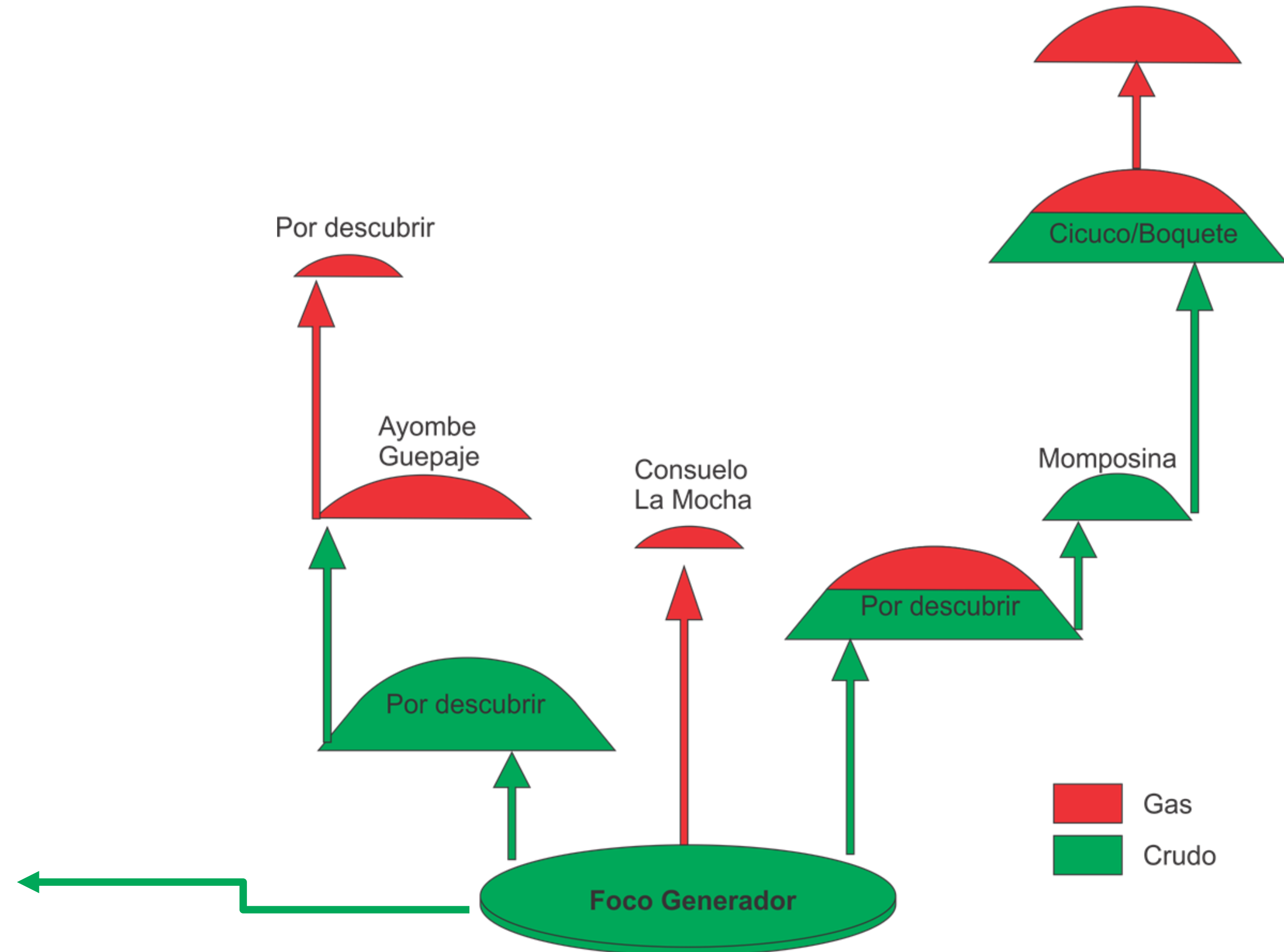
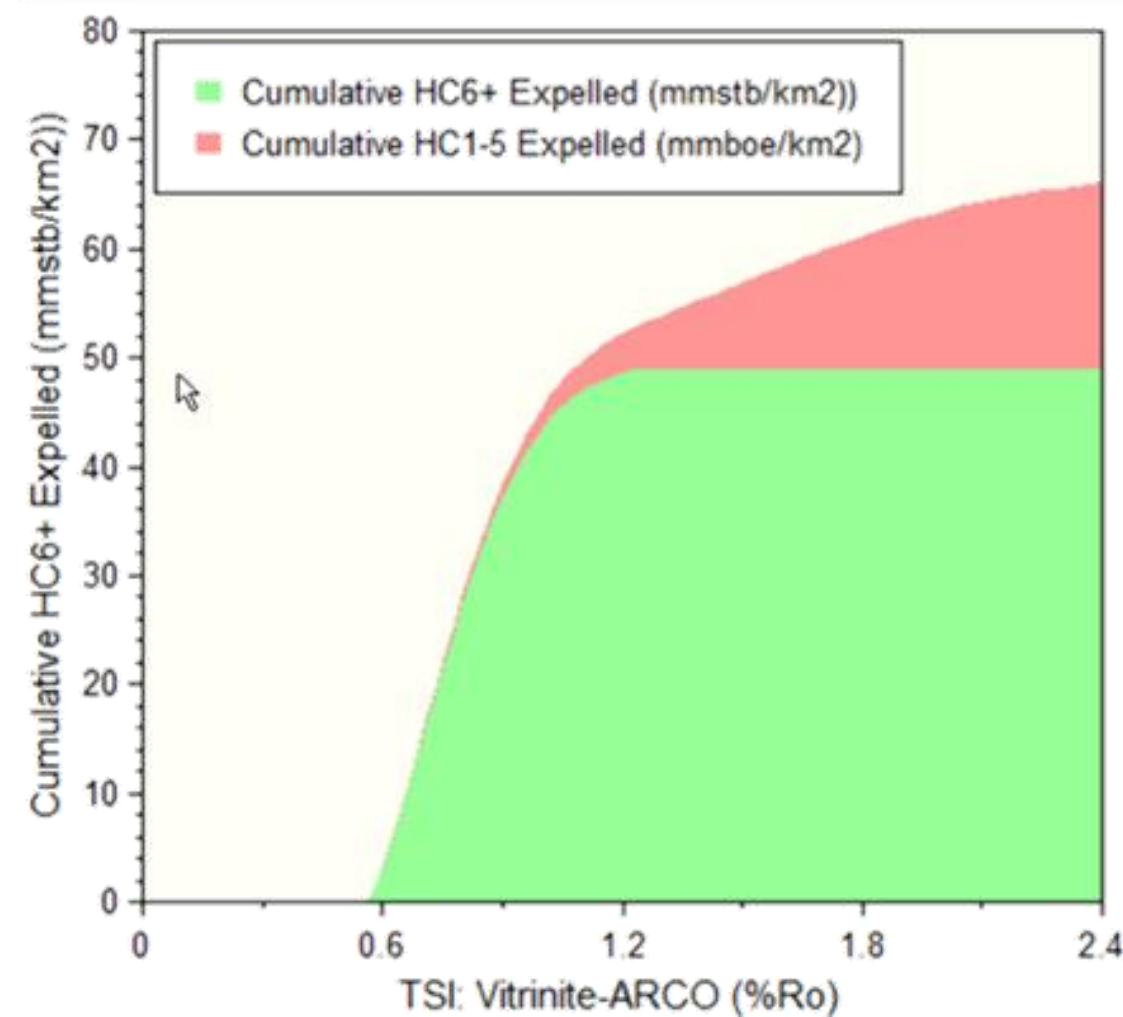
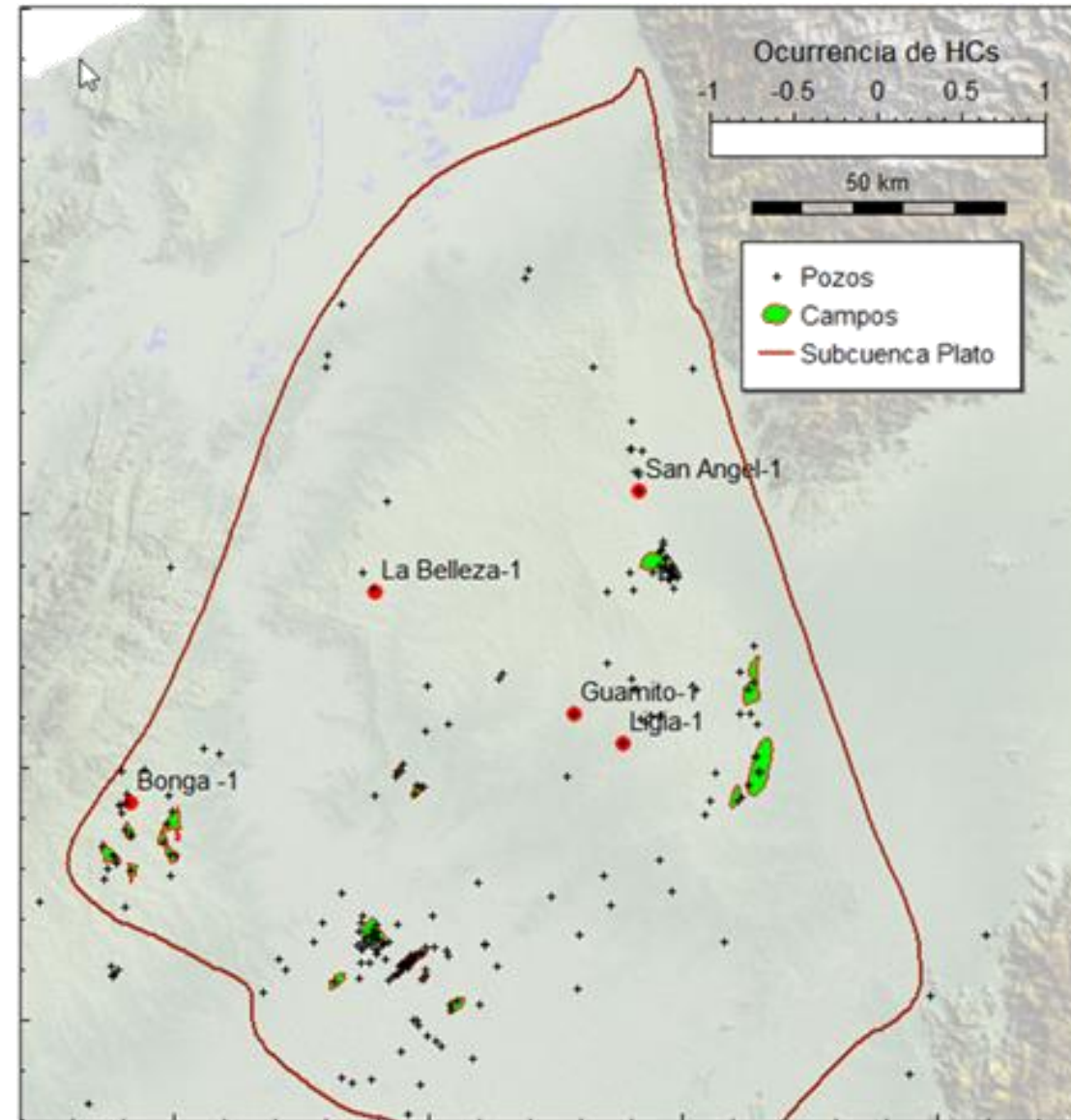
1. Dry gas (secondary cracking (%  
 $R_o > 1.4$ ))

2. Gas and Condensate (%  $R_o \sim 1.2$ )

3. Light oil (%  $R_o \sim 1.0$ )

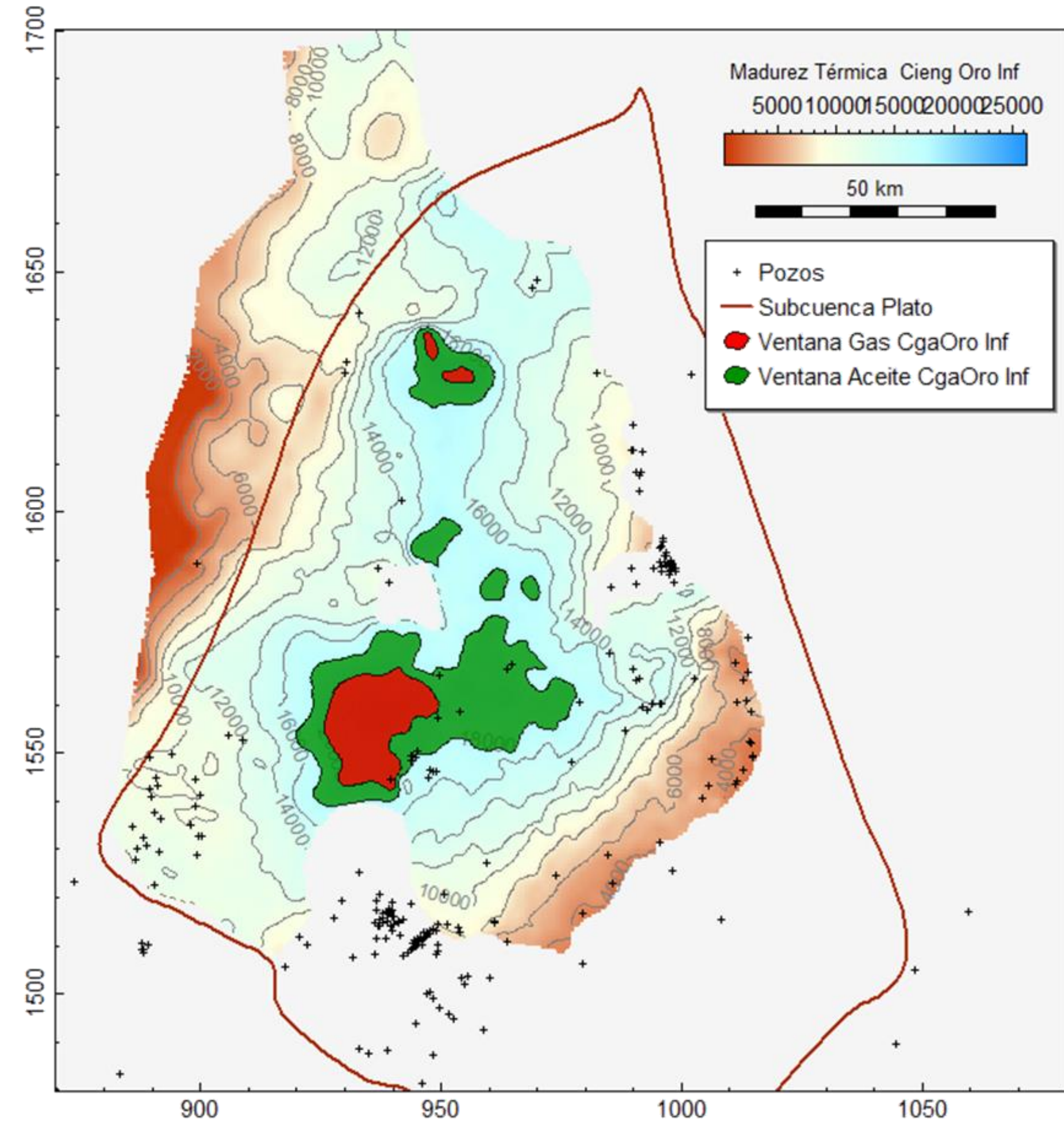
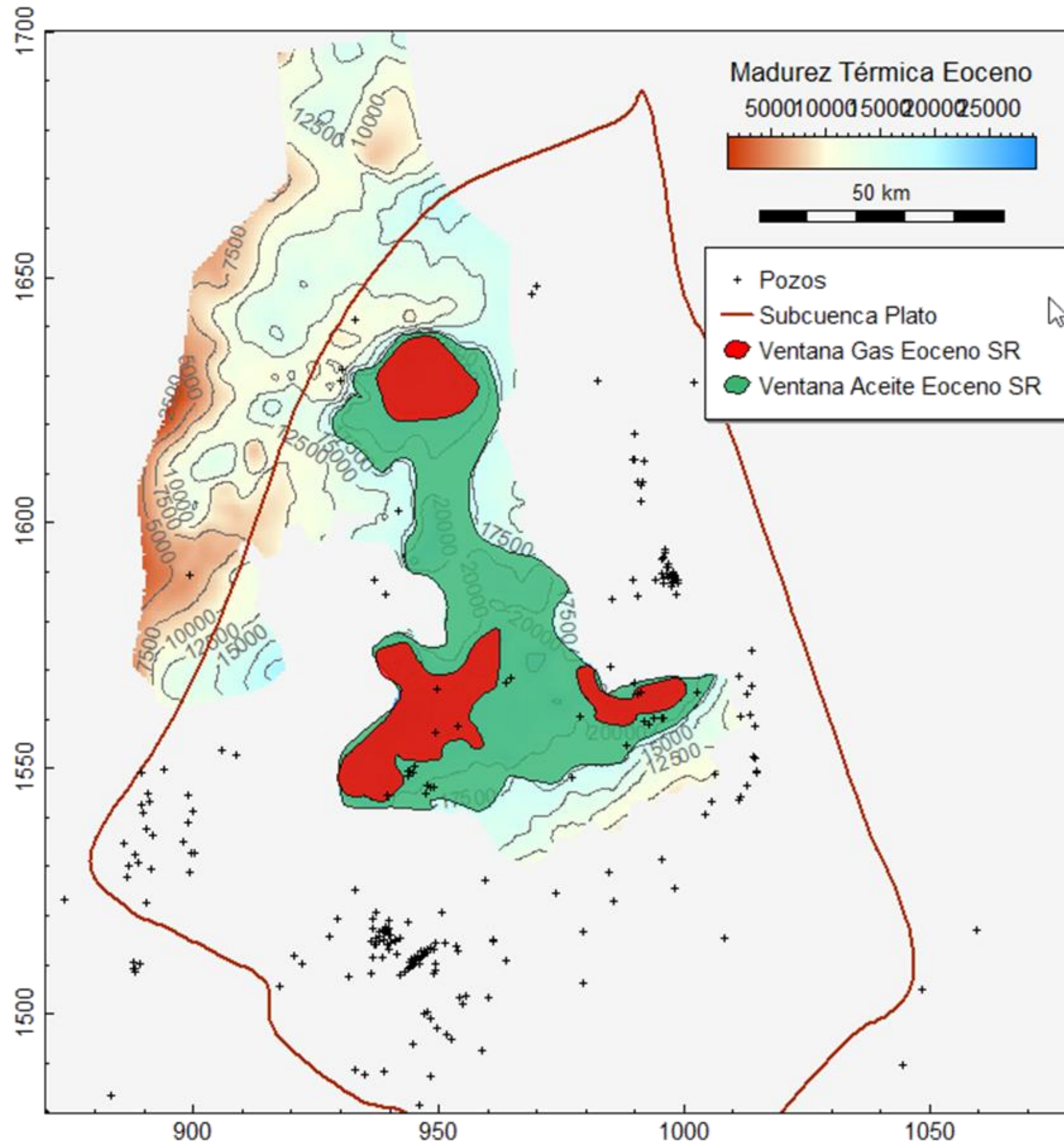
# PETROLEUM SYSTEM MODELING

## OIL vs GAS

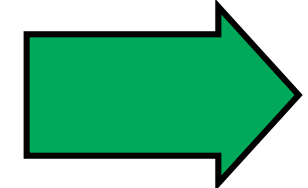


# PETROLEUM SYSTEM MODELING

## THERMAL MATURITY MAPS



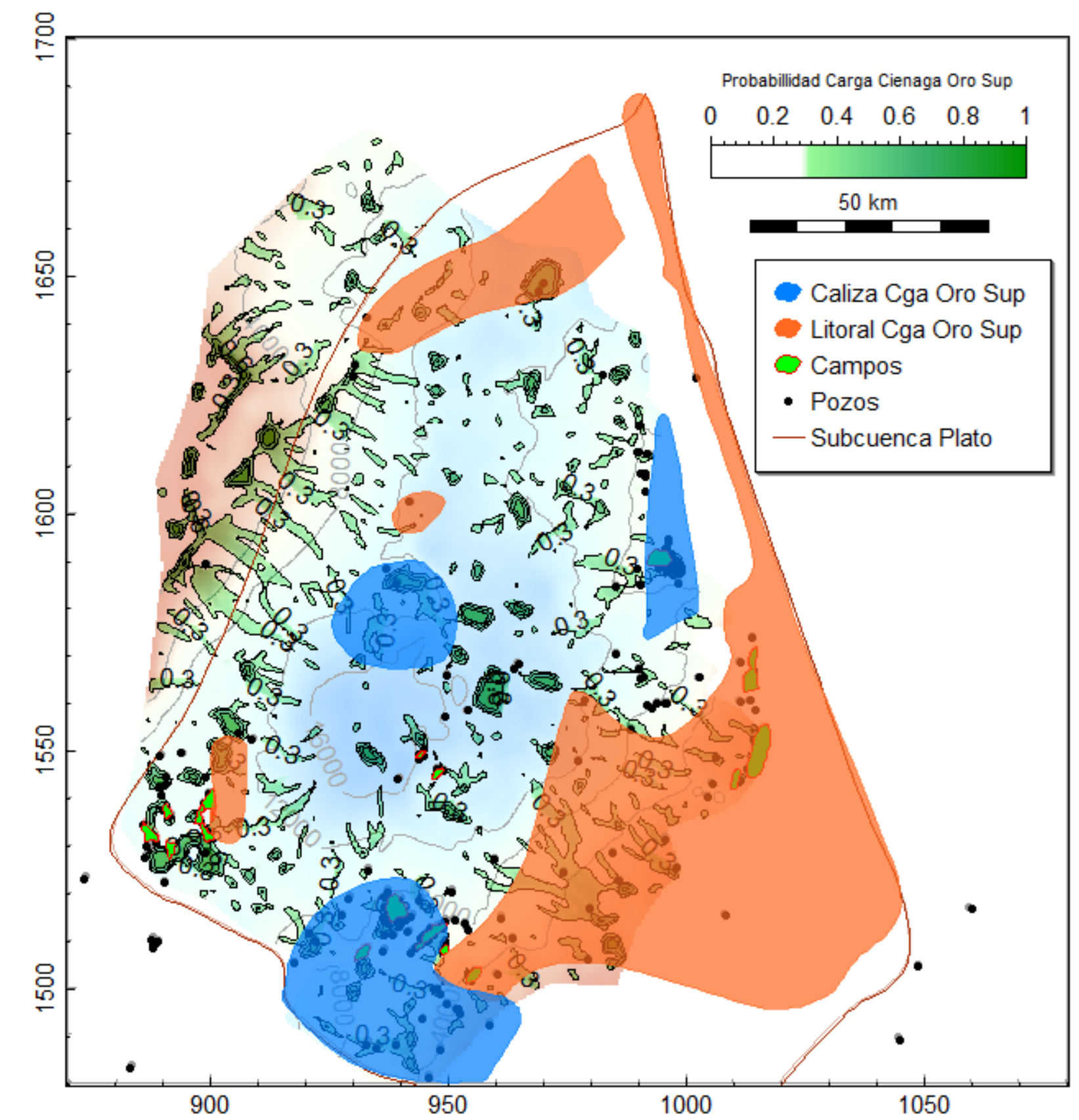
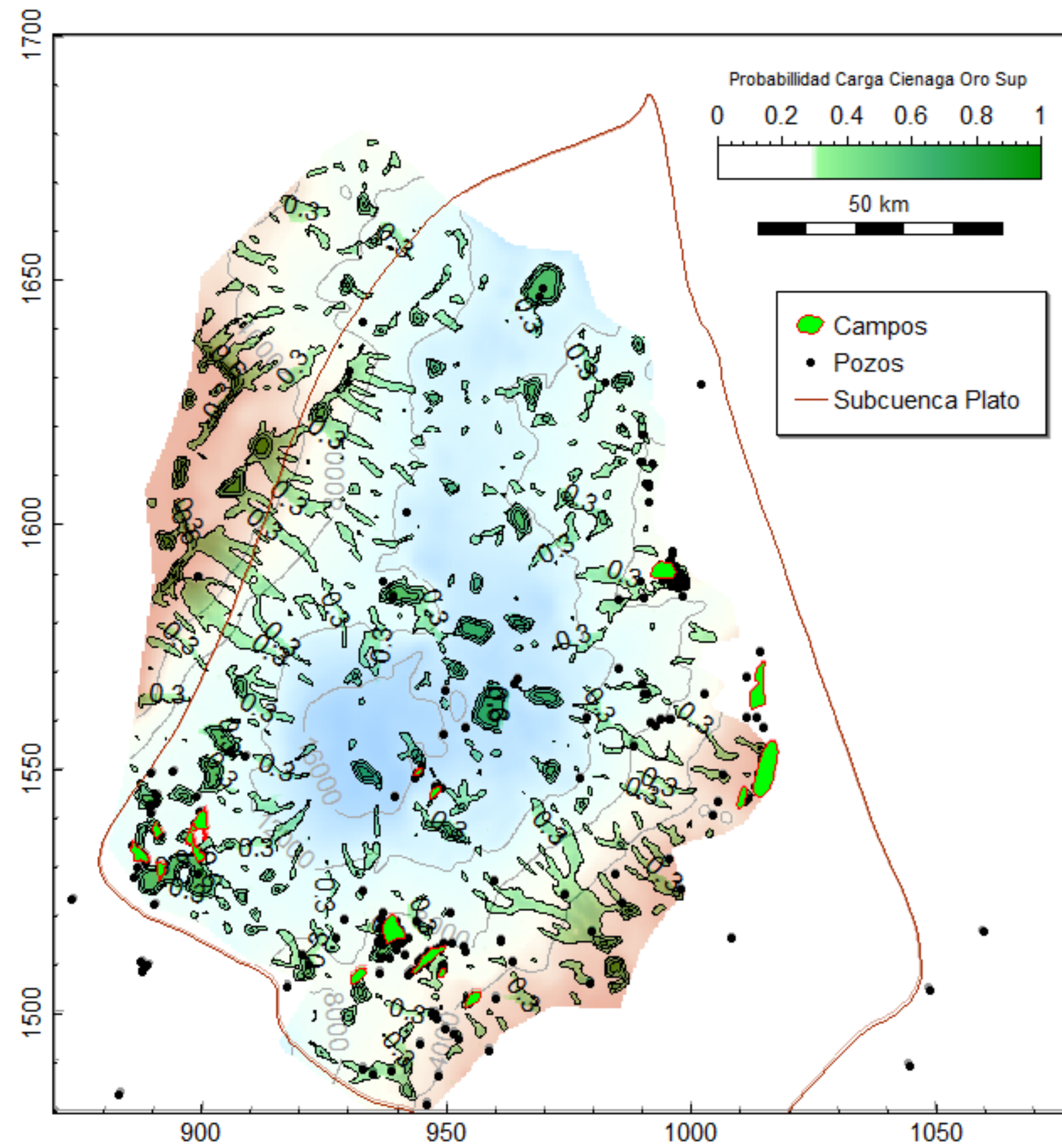
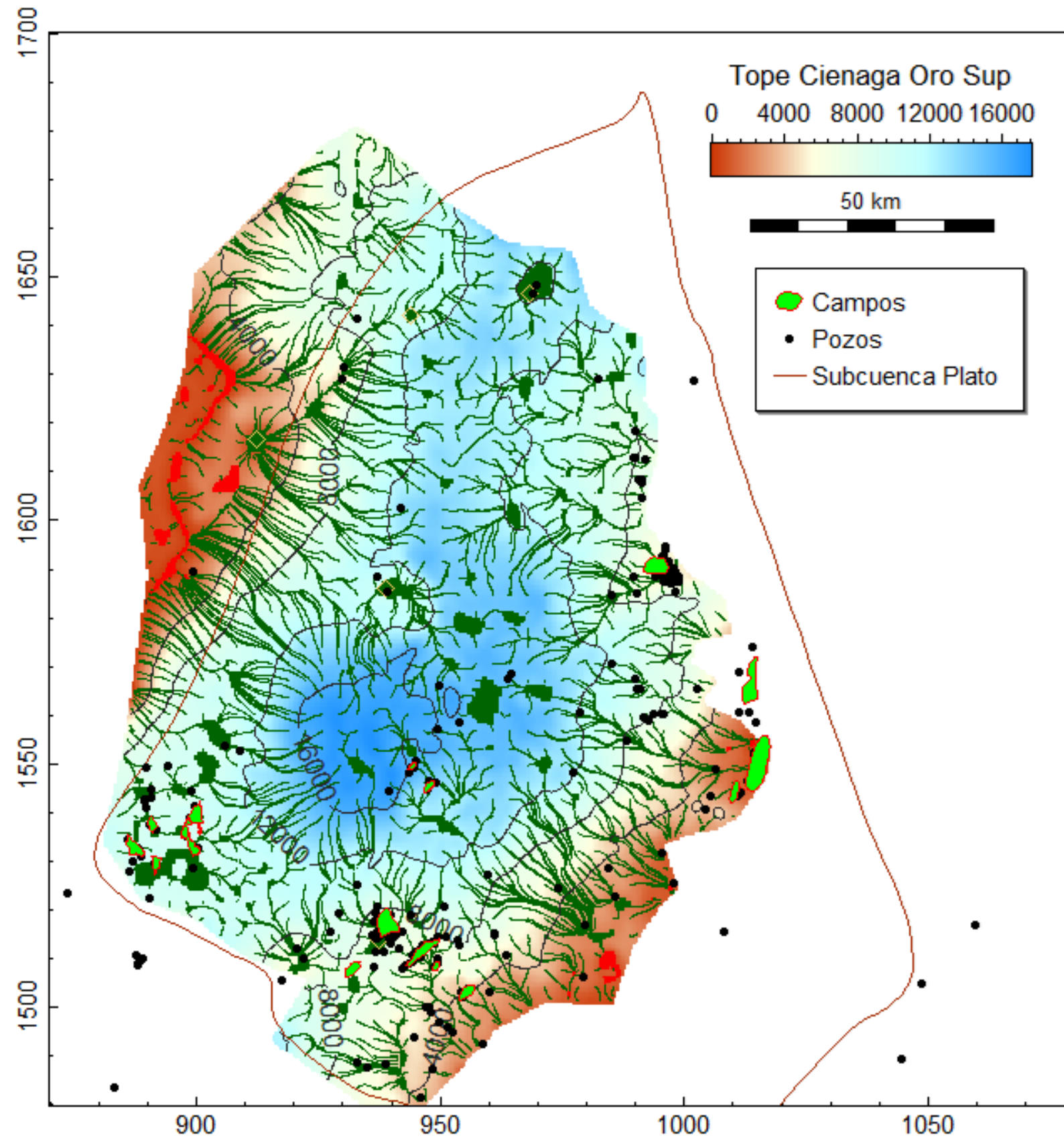
### Charge and migration modeling



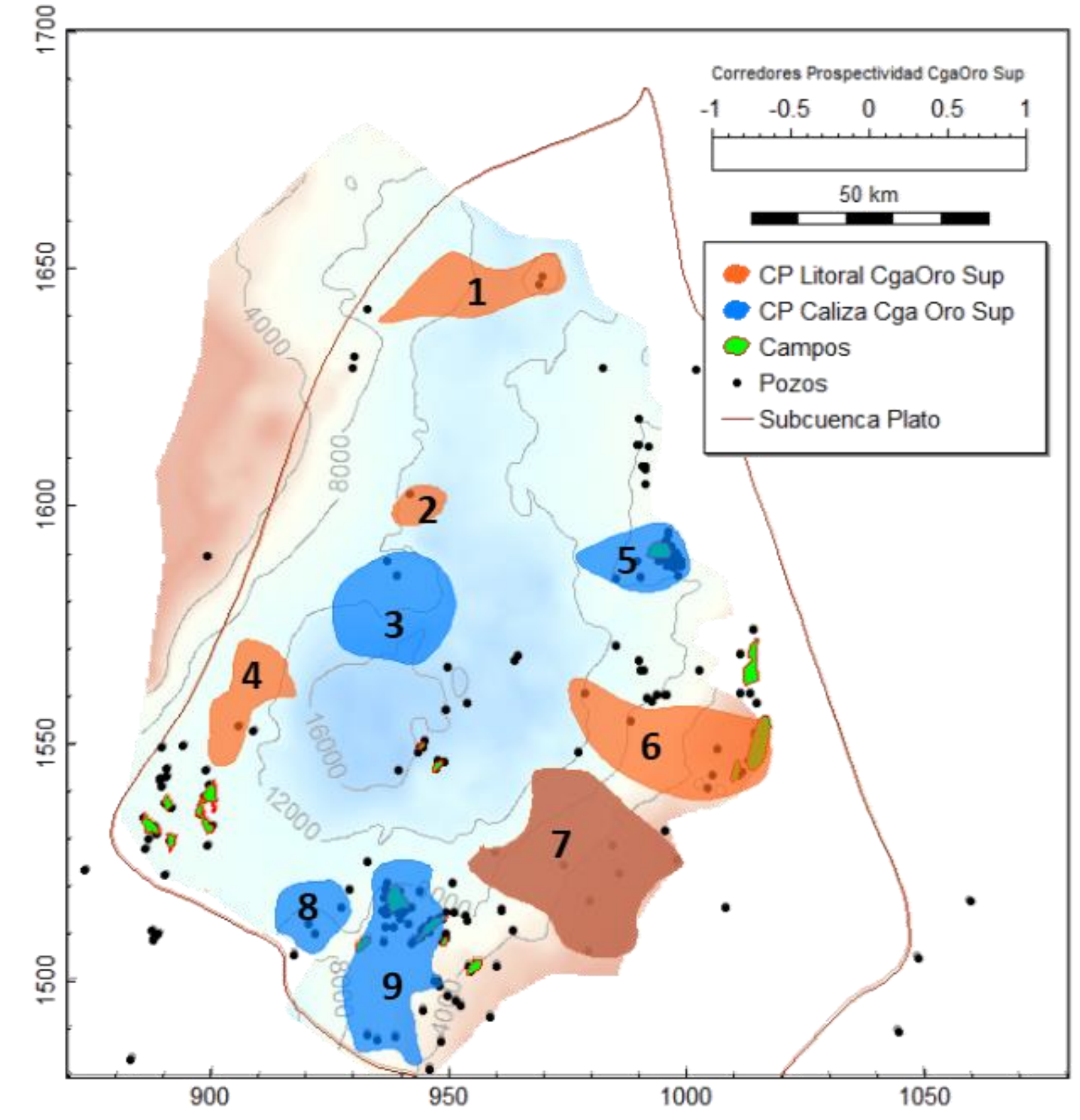
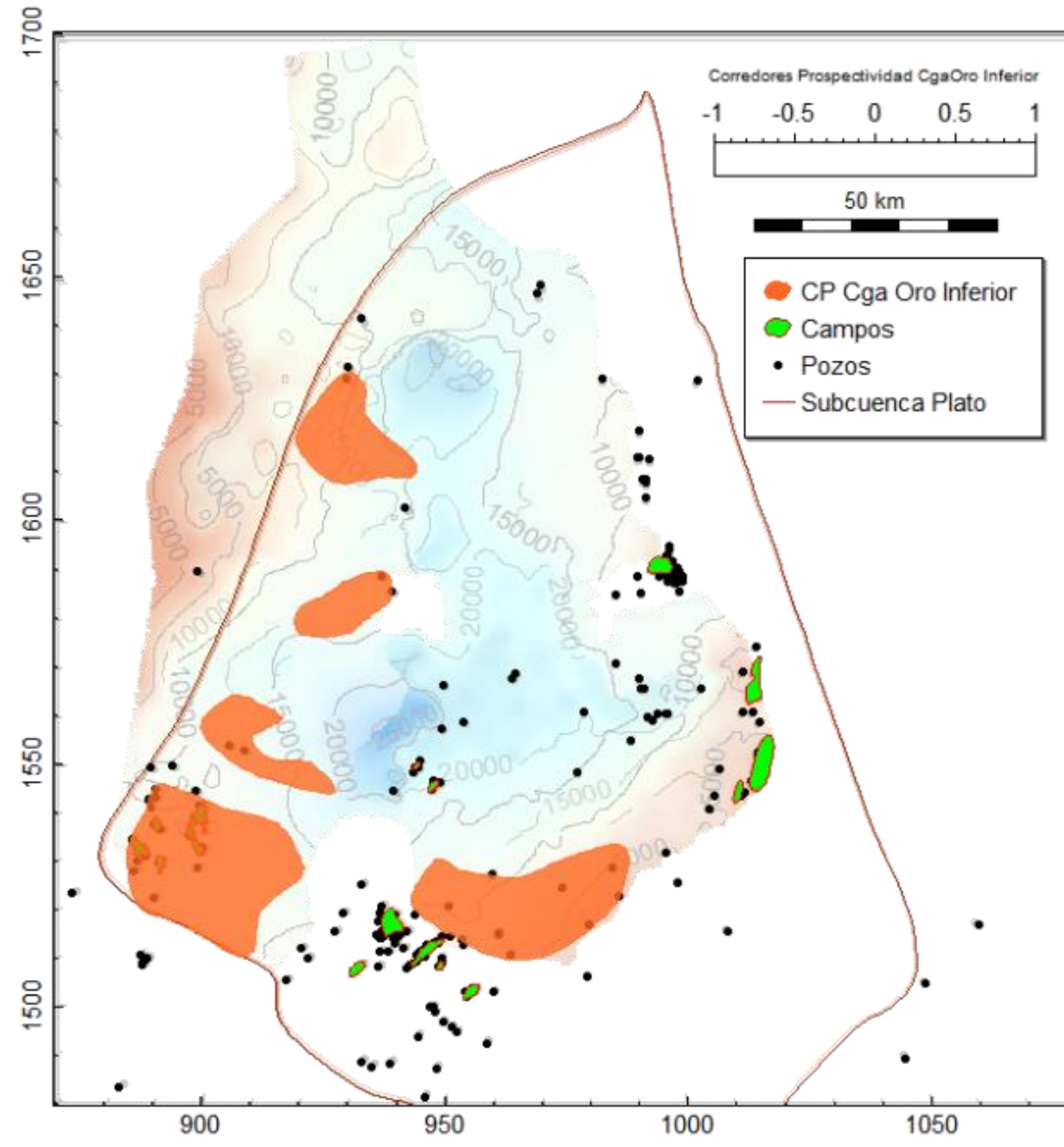
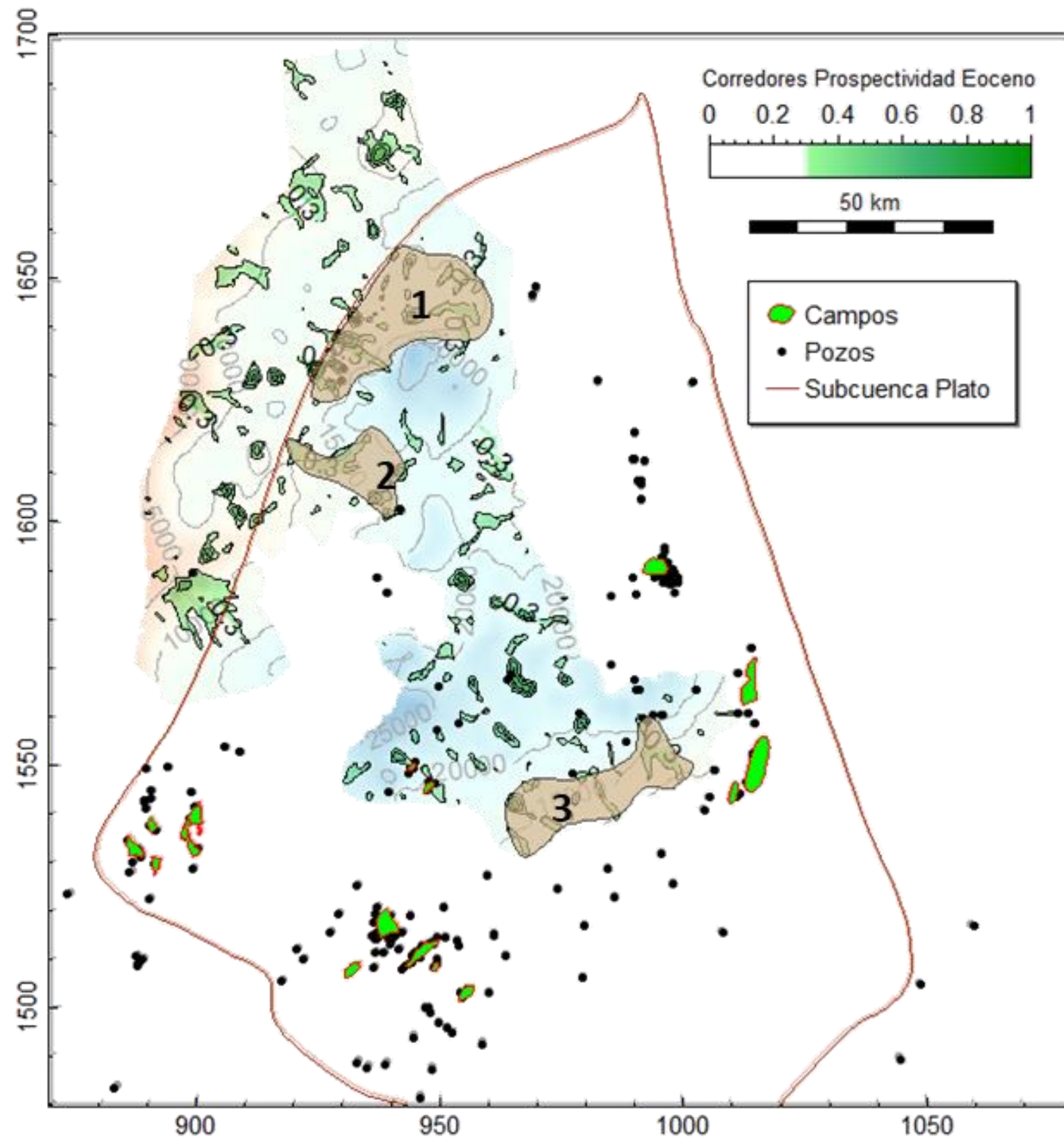
### Charge Probability



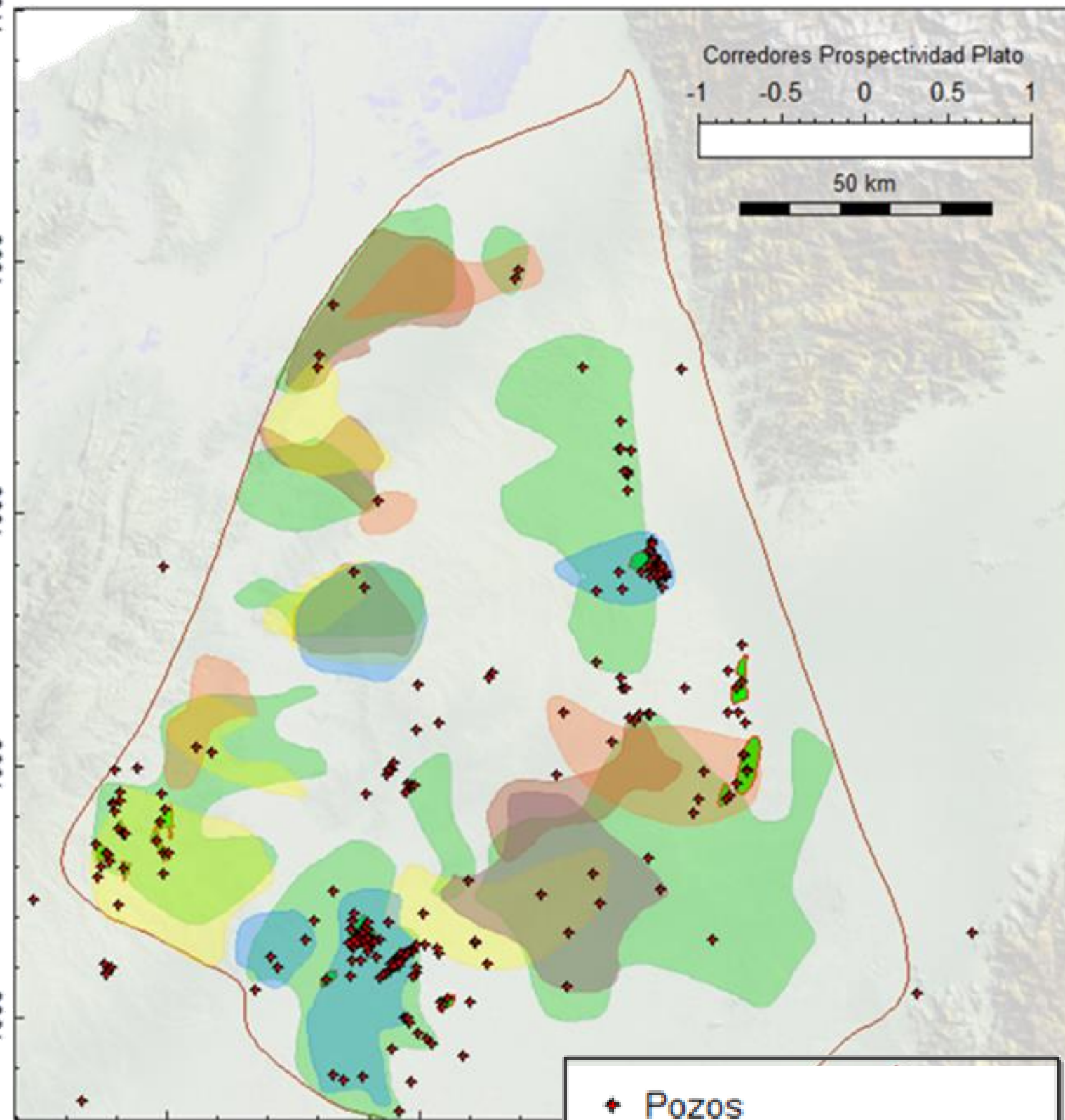
### Reservoir Probability



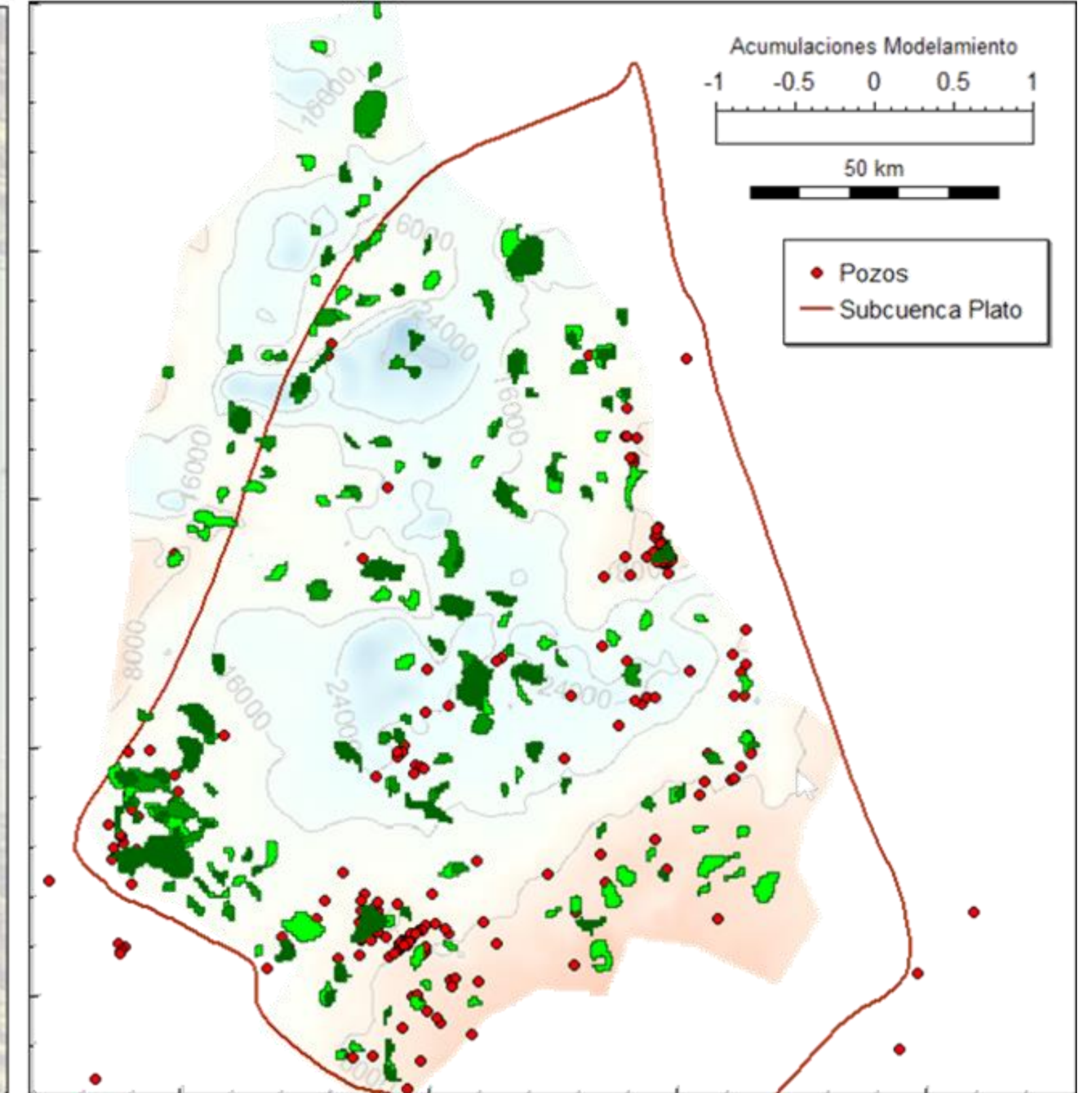
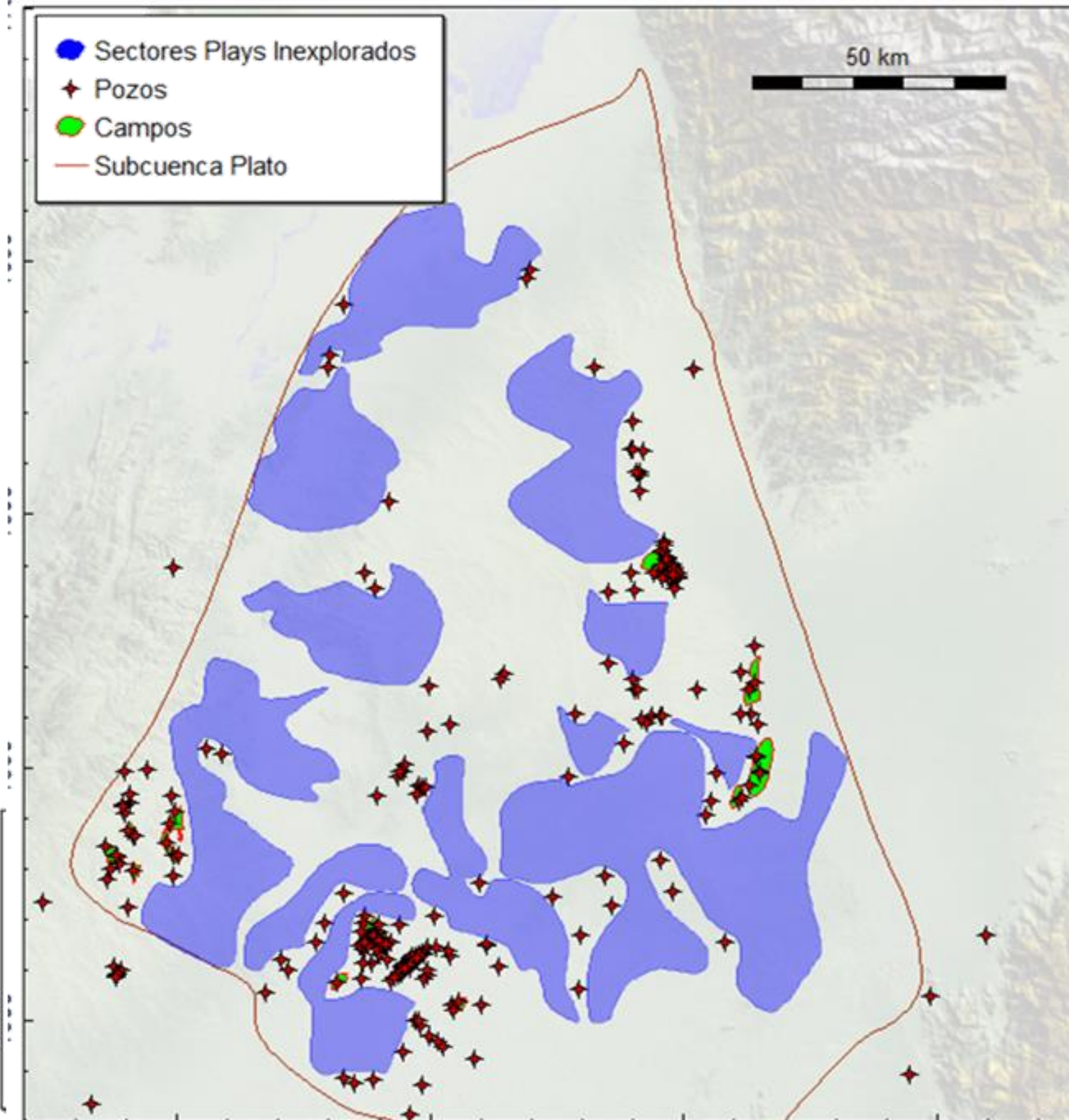
# PLAY FAIRWAY MAPS



# PLAY FAIRWAY MAPS



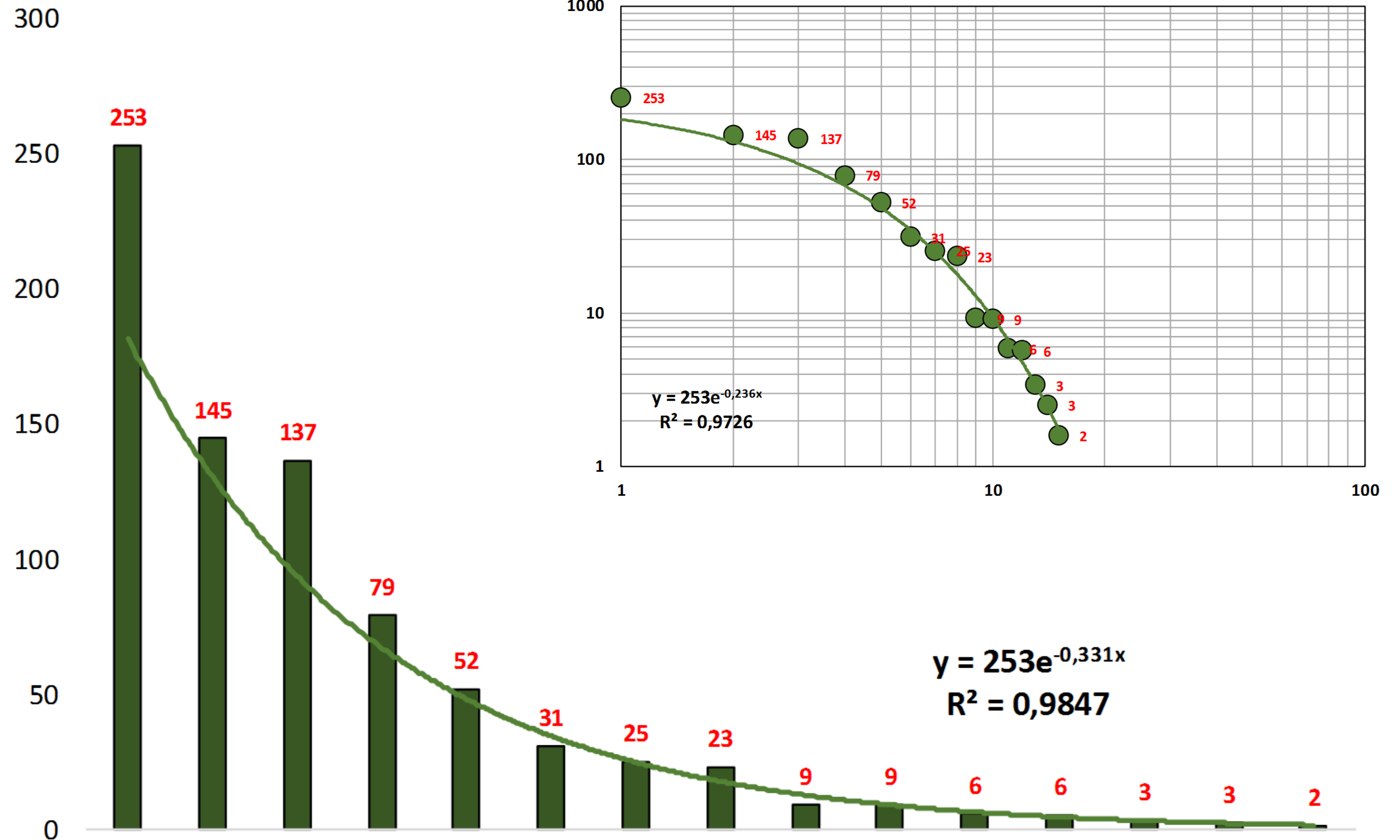
- ✦ Pozos
- CP Litoral CgaOro Sup
- CP Caliza Cga Oro Sup
- CP Cga Oro Inferior
- CP Basamento
- Campos
- Subcuenca Plato



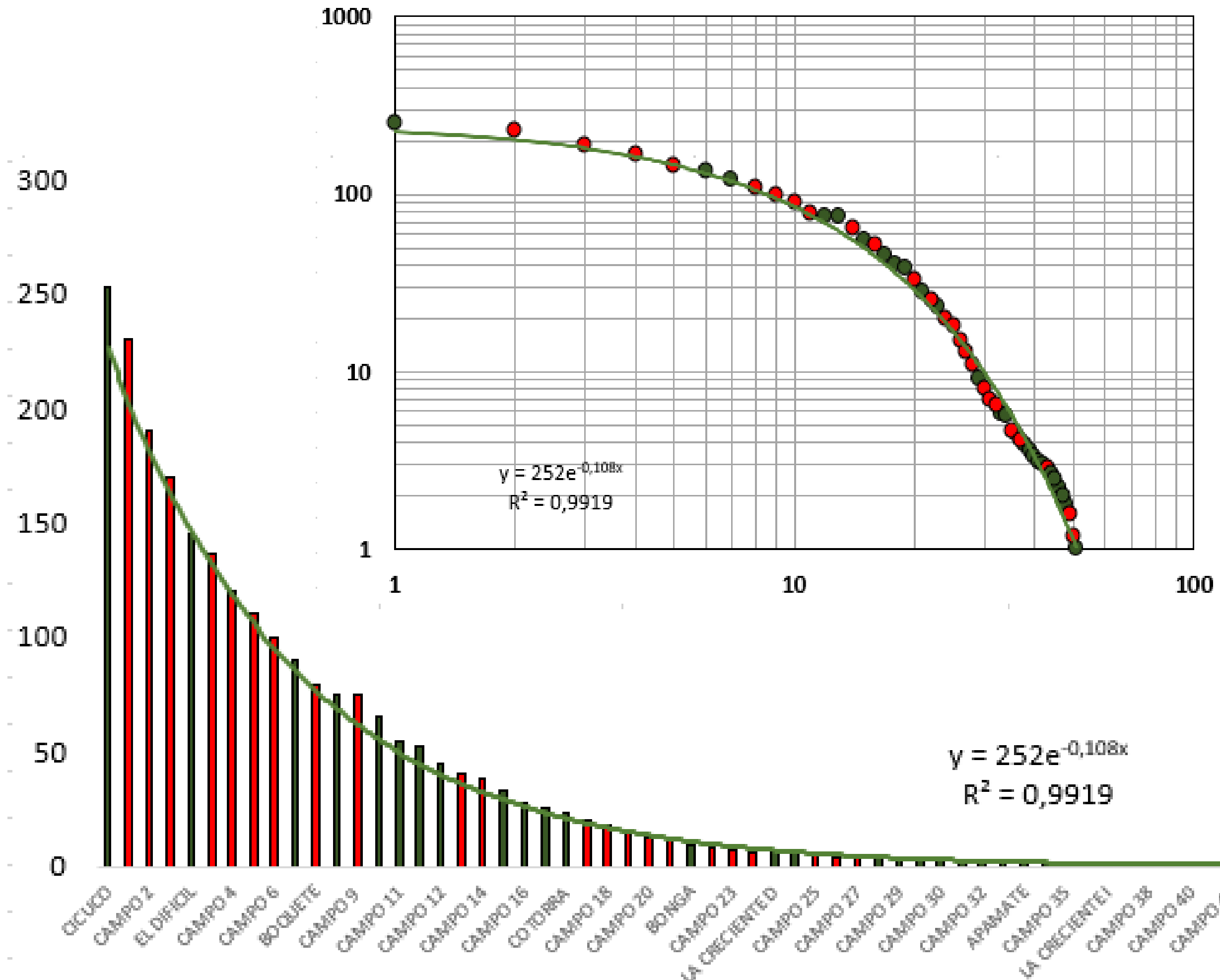
**PROSPECTIVE RESOURCES / FRACTAL ANALYSIS FORECAST**

Campo	OOIP (mbpe)
CICUCO	252,7
EL DIFICIL	144,7
CAPURE	136,5
BOQUETE	79,1
LA CRECIENTE A	51,9
PEDERNALITO	30,9
MAMEY	25,3
COTORRA	23,2
PALMER	9,2
BONGA	9,0
LA CRECIENTE D	5,8
TORONJA	5,6
ARJONA	3,4
APAMATE	2,5
LA CRECIENTE I	1,6
<b>TOTAL</b>	<b>781,4</b>

LEY DE PARETO	
No Actual Campos	15
OOIP 80%	625
No campos OOIP 80%	4
% Campos con el 80%	27%
Pareto Actual	73 / 27



Campo	OOIP (mbpe)	OOIP Acumulado (mbpe)	OOIP Pronóstico (mbpe)
CICUCO	252,7	252,7	
CAMPO 1	230,0	482,7	230,0
CAMPO 2	190,0	672,7	190,0
CAMPO 3	170,0	842,7	170,0
EL DIFICIL	144,7	987,3	
CAPURE	136,5	1123,9	
CAMPO 4	120,0	1243,9	120,0
CAMPO 5	110,0	1353,9	110,0
CAMPO 6	100,0	1453,9	100,0
CAMPO 7	90,0	1543,9	90,0
BOQUETE	79,1	1623,0	
CAMPO 8	75,0	1698,0	75,0
CAMPO 9	75,0	1773,0	75,0
CAMPO 10	65,0	1838,0	65,0
CAMPO 11	55,0	1893,0	55,0
LA CRECIENTE A	51,9	1944,9	
CAMPO 12	45,0	1989,9	45,0
CAMPO 13	40,0	2029,9	40,0
CAMPO 14	38,0	2067,9	38,0
CAMPO 15	33,0	2100,9	33,0
CAMPO 16	28,0	2128,9	28,0
MAMEY	25,3	2154,2	
COTORRA	23,2	2177,3	
CAMPO 17	20,0	2197,3	20,0
CAMPO 18	18,0	2215,3	18,0
CAMPO 19	15,0	2230,3	15,0
CAMPO 20	13,0	2243,3	13,0
CAMPO 21	11,0	2254,3	12,0
BONGA	9,0	2263,4	
CAMPO 22	8,0	2271,4	8,0
CAMPO 23	7,0	2278,4	7,0
CAMPO 24	6,5	2284,9	6,5
LA CRECIENTE D	5,8	2290,7	
TORONJA	5,6	2296,3	
CAMPO 25	4,6	2300,9	4,6
CAMPO 26	4,4	2305,3	4,4
CAMPO 27	4,1	2309,4	4,1
CAMPO 28	3,8	2313,2	3,8
CAMPO 29	3,6	2316,8	3,6
ARJONA	3,4	2320,2	
CAMPO 30	3,1	2323,3	3,1
CAMPO 31	3,0	2326,3	3,0
CAMPO 32	2,9	2329,2	2,9
CAMPO 33	2,7	2331,9	2,7
APAMATE	2,5	2334,4	
CAMPO 34	2,2	2336,6	2,2
CAMPO 35	2,0	2338,6	2,0
CAMPO 36	1,8	2340,4	1,8
LA CRECIENTE I	1,6	2342,0	
CAMPO 37	1,2	2343,2	1,2
CAMPO 38	1,0	2344,2	1,0
CAMPO 39	0,9	2345,1	
CAMPO 40	0,7	2345,8	0,7
CAMPO	0,5	2346,3	
CAMPO 41	0,4	2346,7	0,4
<b>TOTAL</b>	<b>2346,7</b>		<b>1605,0</b>



Tamaño OOIP (mbpe)	No de Campos Proyectados
entre 200-300	2
entre 150-200	2
entre 100-150	5
ENTRE 50-100	6
entre 20-50	8
menor de 20	32
<b>TOTAL</b>	<b>55</b>

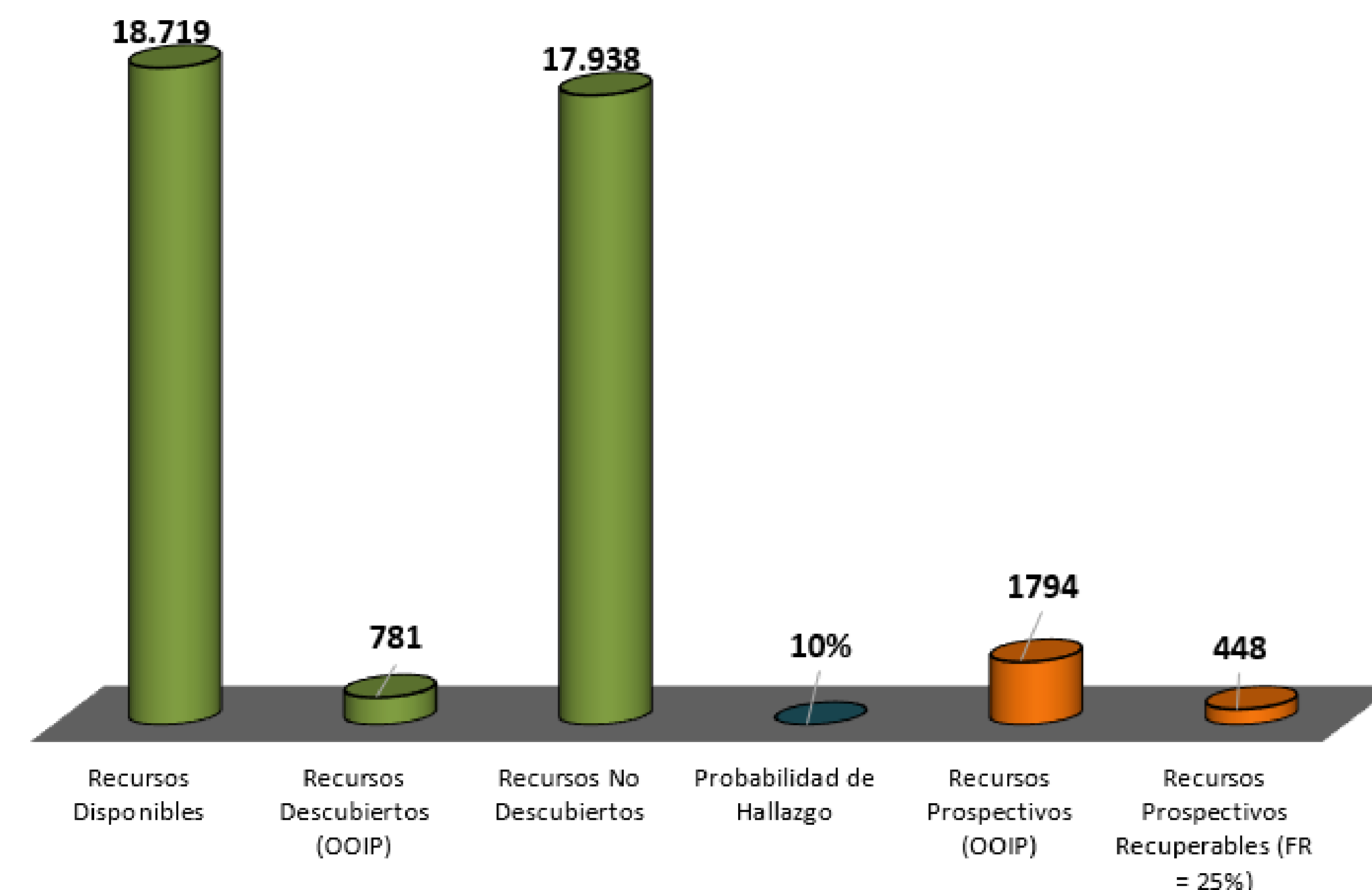
LEY DE PARETO	
No Proyectado Campos	55
No campos Incrementados	41
OOIP 80%	1877
No campos OOIP 80%	15
% Campos con el 80%	27%
Pareto Actual	73/27



PARÁMETROS	UNIDADES	SUBCUENCA PLATO (VIM)		TOTAL
		FG PLATO	FG ALGARROBO	
HC's Generados / Ciénaga Oro Inferior	mbpe	5.643	1.430	7.073
Hc's Disponibles /Ciénaga Oro Inferior	mbpe	592	172	764
HC's Generados / Eoceno	mbpe	151.056	16.628	167.684
Hc's Disponibles / Eoceno	mbpe	18.127	1.746	19.873
Total HC's Generados	mbpe	156.699	18.058	174.757
Recursos Disponibles	mbpe	18.719	1.918	20.637
Recursos Descubiertos (OOIP)	mbpe	781	0	781
Recursos No Descubiertos	mbpe	17.938	1.918	19.856
Probabilidad de Hallazgo	%	10%	10%	15%
<b>Recursos Prospectivos (OOIP)</b>	<b>mbpe</b>	<b>1794</b>	<b>192</b>	<b>1986</b>
<b>Recursos Prospectivos Recuperables (FR = 25%)</b>	<b>mbpe</b>	<b>448</b>	<b>48</b>	<b>496</b>

\*FG= Foco Generador

Balance Masas Subcuenca Plato (mbpe)



**REMAINING RESOURCES (OOIP)= 1,300 MMboe**  
**(OGIP)= 2.5 TCF**



Thank you  
[www.anh.gov.co](http://www.anh.gov.co)