

**New Stratus Energy Inc - Petrolia Ecuador**

*Colombia - VMM 18 Block*

*Corporate Technical Presentation*

***Tectonic Play - Middle Magdalena Basin (MMB)***

*Sept 2021*



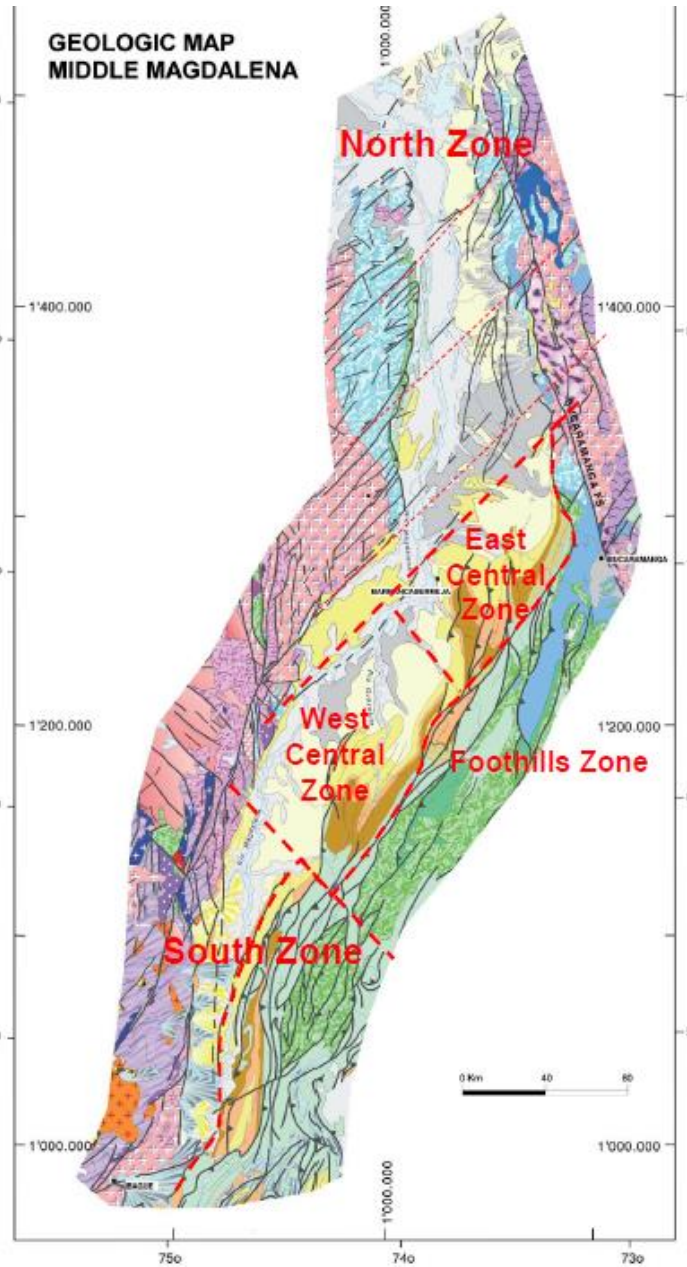
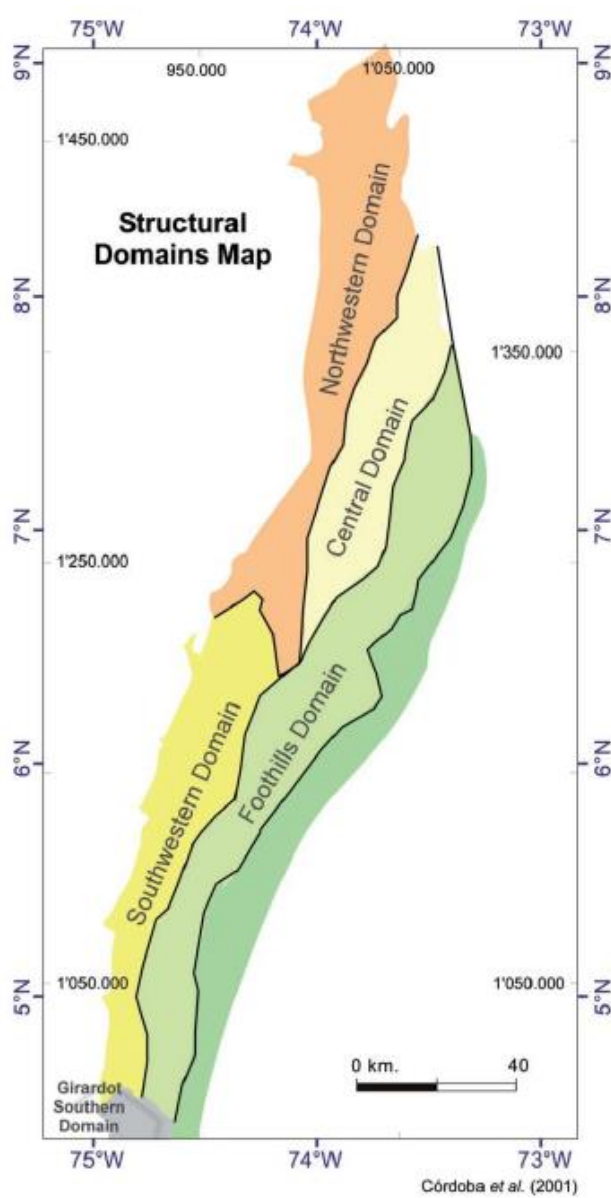
# Southern Middle Magdalena Basin (MMB) Play Concepts and Petroleum Systems

*L. Porras<sup>1,2</sup>, J.F. Arminio<sup>1</sup>, A. Lara<sup>1</sup> and M. Ostos<sup>1</sup>*

*(1) New Stratus Energy (1,2) New Stratus Energy and now Hocol S.A.*

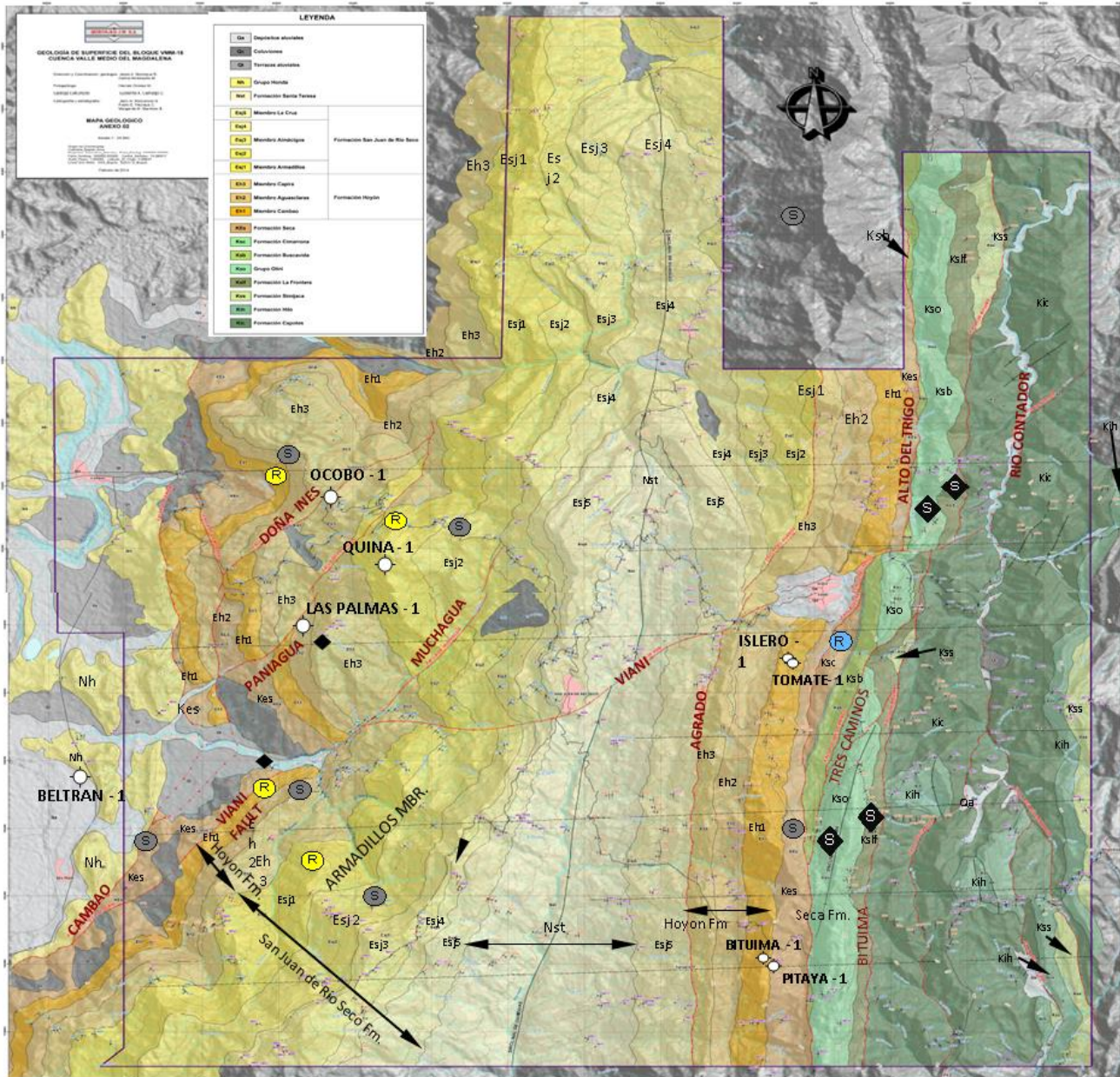
# **Tectonic Provinces of the Middle Magdalena Basin MMB**

*J.F. Arminio, L. Porras, A. Lara*



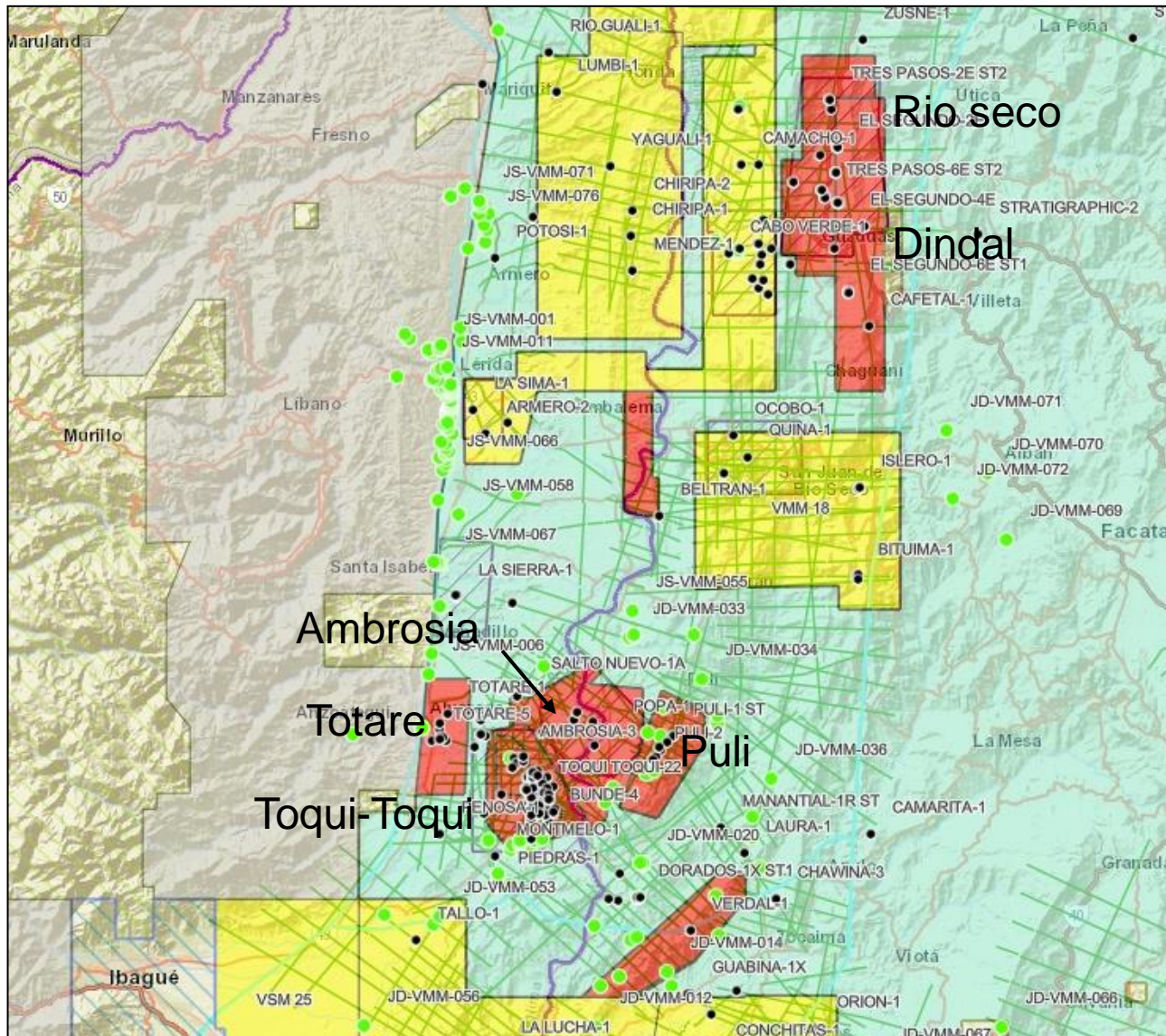
Source: ANH 2011 / 2021

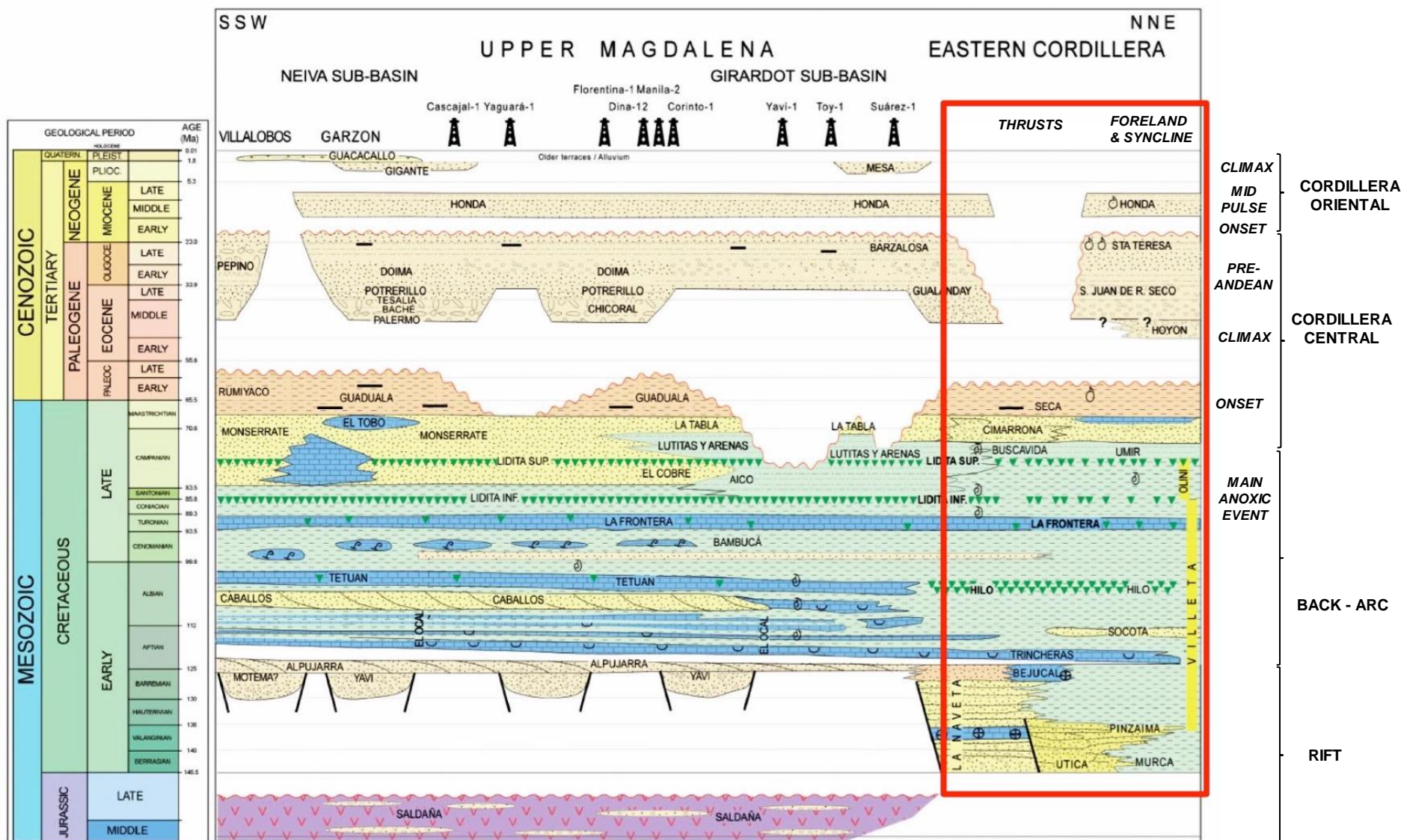
# **Stratigraphy and Surface Geology**



Modified from: Manrique, J., Amézquita, C. et al. (2014)

## Oil fields, Wells & Available Seismic Data





Source: Geotec (2000) and ANH (2012)



EDAD	UNIDAD	LITOLOGIA <small>Temario de grano</small>	MAIN LITHOLOGY	ENVIRONMENT	TECTONIC SETTING	PETROLEUM SYSTEM		
TERCIARIO	NEÓGENO	CUATERNARIO	CONGLOMERATES	ALLUVIAL PLAIN	MAIN ANDEAN UPLIFT			
		MIOCENO TEMPRANO A TARDÍO	CONGLOMERATES, SANDS AND CLAYS	ALLUVIAL PLAIN		Missing:		
	PALEÓGENO	Fm. Santa Teresa	OLIGOC. TARDÍO - MIOCENO TEMPRANO			Early - Mid Mio	O	
			Fm. San Juan de Rio-seco			EARLY ANDEAN UPLIFT		
		Eocene - Oligocene	Esg5					
			Esg4					
			Esg3					
		Fm. Hoyón	Esg2	CLAY, MUDS & SUBORD. SILTS	FLOODPLAIN			S
			Esg1	CONGLOMERATIC TO MEDIUM SANDS & CLAYS	FLUVIAL PLAIN: CHANNEL & OVERBANK			R
		Eocene - Oligocene	Fm. Hoyón	Eh3				O
				Eh2				S
				Eh1				R
	Fm. Seca	Kes	MUDSTONE, CLAY, SOME COALS & SILTS	COASTAL PLAIN	Missing: L. Paleocene Mid Eocene		S	
		Fm. Monserrate / Cimarrona	SANDSTONE (W) CARBONATES (E)	SHALLOW MARINE		CENTRAL UPLIFT	R R	
	CRETÁCICO SUPERIOR	Fm. Buscavida						
Gr. Olini							S	
							S	
Fm. La Frontera					BACK ARC BASIN			
CRETÁCICO INFERIOR	Fm. Simijaca							
	Fm. Hiló							

Almácigo Esg2 clay prone local member

Oligocene fluvial Doima sands equivalent to San Juan's Armadillos basal unit are effective reservoir in Toqui - Toqui

Hoyón's local Agua Clara mudstone member

Eocene fluvial Chicoral sands equivalent to basal Hoyón (Cambao) are effective reservoir in Toqui - Toqui

Seca fm. regional shale unit

Monserrate sand reservoir in Puli and Quintero fields  
Cimarrona carbonate reservoir in Guaduas

**PETROLEUM SYSTEM**

- OVERBURDEN
- SEAL
- RESERVOIR (Limestone)
- RESERVOIR (Sandstone)
- SOURCE

Modified from: Manrique, J., Amézquita, C. et al. (2014)

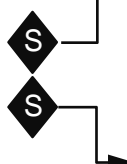
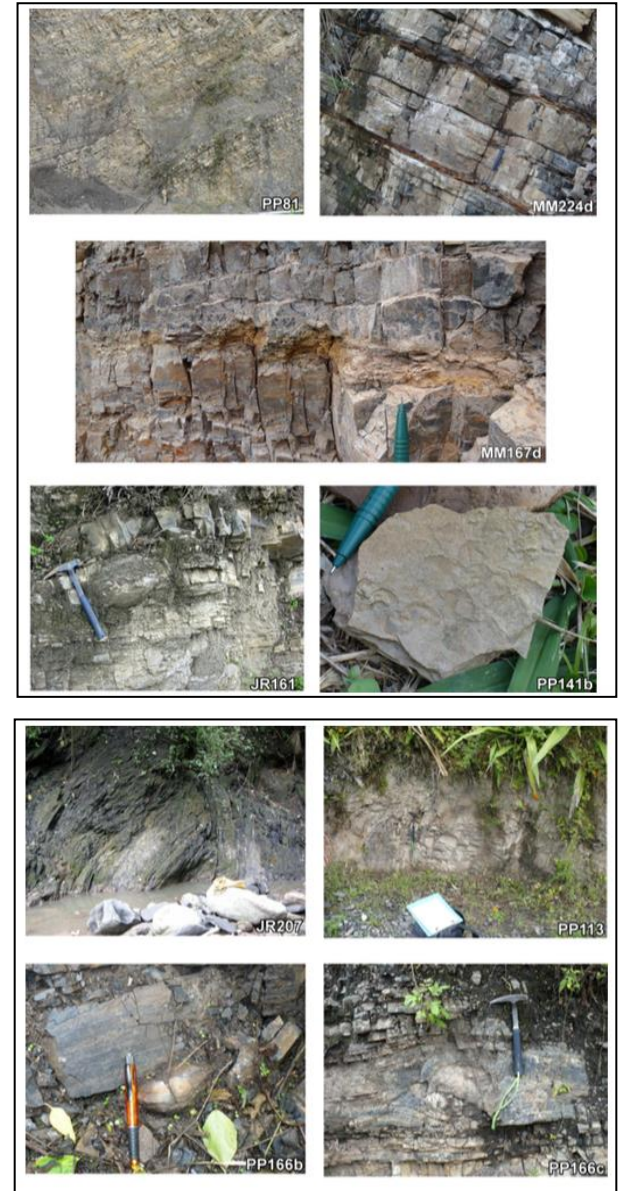
# **Petroleum System**

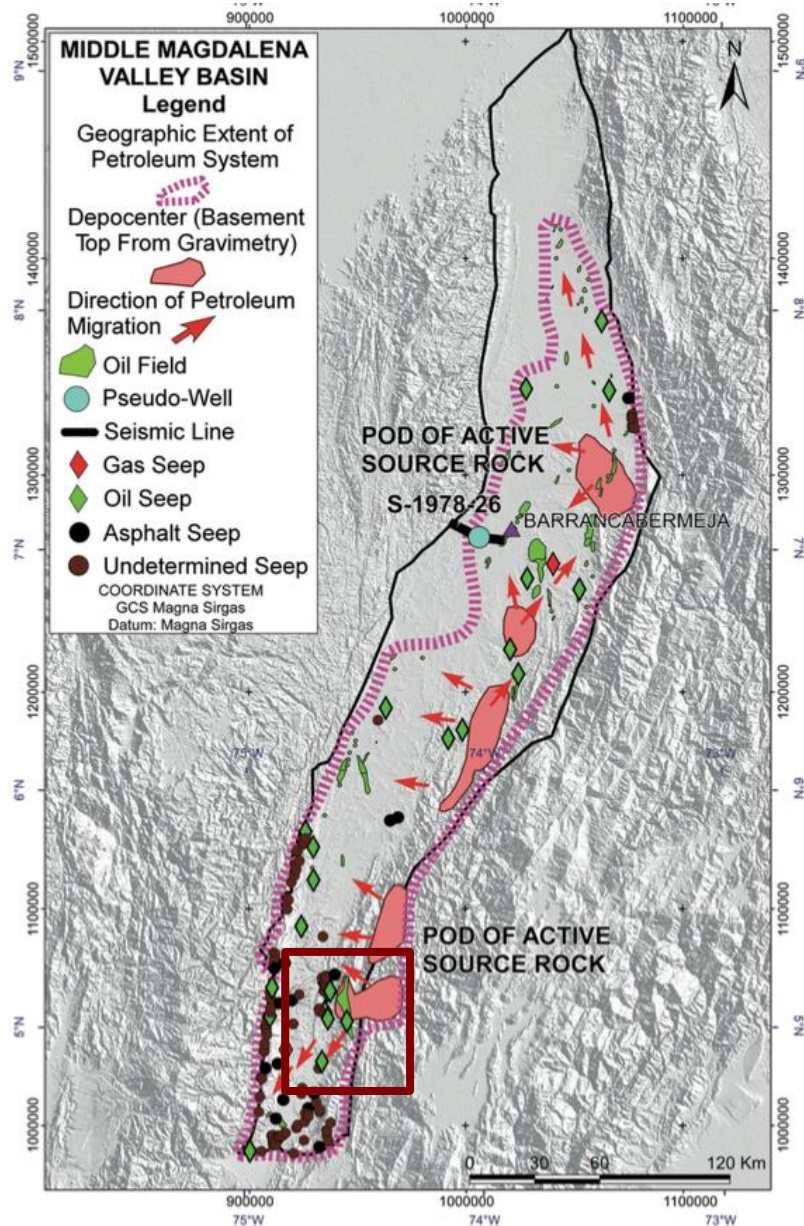
EDAD	UNIDAD	LITOLOGIA		ESPESOR (metros)	DESCRIPCIÓN	
		Tamaño de grano	Color			
TERCIARIO	NEÓGENO	Gr. Honda		< 50	Gravas, arenas y lodos, asociados a los drenajes y laterales	
		Fm. Santa Teresa		> 500	Interposiciones de lodolitas rojas y arenitas líticas Bancos de arenitas líticas, conglomeráticas, con estratificación en arenas, fósiles, tobosos, textura así y pimienta Conglomerados poligónicos, con guijos redondeados de cuarzo chert y líticas, estratificación en arenas, gradan a arenitas líticas	
	PALEÓGENO	OLIGOCE.	Fm. San Juan de Río-seco	Eaj5	400 - 450	Interposiciones de lodolitas silíceas, micáceas, grises, y limolitas arenosas, ligeramente calcáreas, con conchas delgadas de bivalvos y gasterópodos Arenitas cuarzosas/sublíticas, de grano fino a medio, separadas por niveles gruesos de lodolitas micáceas y varicoloreadas Leve impregnación de hidrocarburos al tope de la unidad
				Eaj4	225 - 325	Secuencias grandocrecientes de arenitas conglomeráticas, con laminación inclinada y lodolitas arenosas, macizas y micáceas
				Eaj3	175 - 275	Lodolitas y lodolitas arenosas, rojas, o varicoloreadas con delgadas interposiciones de arenitas micáceas finas
				Eaj2	350 - 450	Bancos gruesos de arenitas de grano medio, cementadas, con micas diseminadas, separadas por lodolitas moteadas Bancos potentes de arenitas sublíticas y cuarzosas, de grano medio a grueso, poco cementadas, se interponen cuerpos de lodolitas varicoloreadas, ligeramente calcáreas, madrigueras
				Eaj1	300 - 400	Succiones grandocrecientes de arenitas de grano grueso a conglomerático, guijos finos de cuarzo e intraditas lodosas
		EOCENO - OLIGOCE. TEMPR.	Fm. Hoyón	Eh3	350 - 450	Arenitas sublíticas de grano fino, cementadas, de color rojo, micáceas, en ocasiones con matriz calcárea
				Eh2	250 - 350	Espesa sucesión de bancos macizos de lodolitas silíceas, fíles, moteadas, micáceas, ocasionalmente calcáreas
				Eh1	350 - 450	Arenitas sublíticas de grano fino a grueso, inmaduras, en capas gruesas, con laminación inclinada difusa
				Eh3	250 - 350	Secuencias grandocrecientes, conglomerados clasto soportados, macizas o con laminación inclinada difusa, guijos de cuarzo y chert negro
				Eh2	200 - 300	Bancos muy potentes y canaliformes, de conglomerados clasto soportados, de guijos gruesos de cuarzo y chert negro, interposiciones de lodolitas arenosas macizas, rojas
	CRETÁCICO	SUPERIOR	Fm. Seca		500 - 600	Alternancia de lodolitas arenosas rojas con granos flotantes de cuarzo y chert, litarenitas lodosas de grano fino (wackas), y arenitas conglomeráticas, con guijos finos y redondeados Bancos potentes de lodolitas silíceas, grises, micáceas, fíles
			Fm. Monserrate/Cimarrón	Ksc	15 - 80	Secuencias grandocrecientes, bancos potentes y macizas de conglomerados clasto soportados, con guijos y guajeros, redondeados, poligenicos, cementados, con lentes de litarenitas conglomeráticas
			Fm. Buscavida		300 - 400	Lodolitas arenosas rojas, moteadas, con lentes de limolitas arenosas, con granulos y guijos flotantes de cuarzo y chert
Gr. Olini				200 - 300	Arcolitas y lodolitas silíceas, de tonalidades rojas y púrpura, con nódulos limosos y en ocasiones calcáreas	
Fm. La Frontera				150 - 250	Lodolitas y arcilolitas silíceas, grises, localmente con laminillas carbonosas y restos vegetales. Interposiciones de arenitas de grano fino y niveles de nódulos ferruginos	
INFERIOR		Fm. Simijaca		400 - 600	Arenitas conglomeráticas calcáreas, localmente glauconíticas, al tope gradan a calizas terrígenas, muy cementadas	
		Fm. Hiló		150 - 250	Limolitas arenosas calcáreas, grises oscuras, con contenido variable de foraminíferos berrónicos y fragmentos de conchas	
		Fm. Capotes		450 - 550	Lodolitas calcáreas, micáceas, nódulos calcáreos con piritas Arcilolitas y limolitas calcáreas grises oscuras, con restos de peces y foraminíferos	
				200 - 300	Capas delgadas de chert, limolitas silíceas calizas lodosas y chert, contienen foraminíferos, restos de peces y radiolarios	
				150 - 250	Lodolitas silíceas grises, en ocasiones ligeramente calcáreas Limolitas silíceas y chert, con moldes de bivalvos y ammonitas	

Modified from: Manrique, J., Amézquita, C. et al. (2014)

**OLINI**  
LA LUNA & VILLETA EQ.  
Late Coniacian – Campanian  
200m – 300m (measured sections)  
reference: La Luna in Tachira, Ciniacian – Campanian; in Perija, Cenomanian – Campanian (De Romero, Truskowski, Odreman ; Galea 2003)

**LA FRONTERA**  
LA LUNA EQ.  
Turonian – Early Coniacian  
150 m – 250 m (maps) 65m (measured sections)





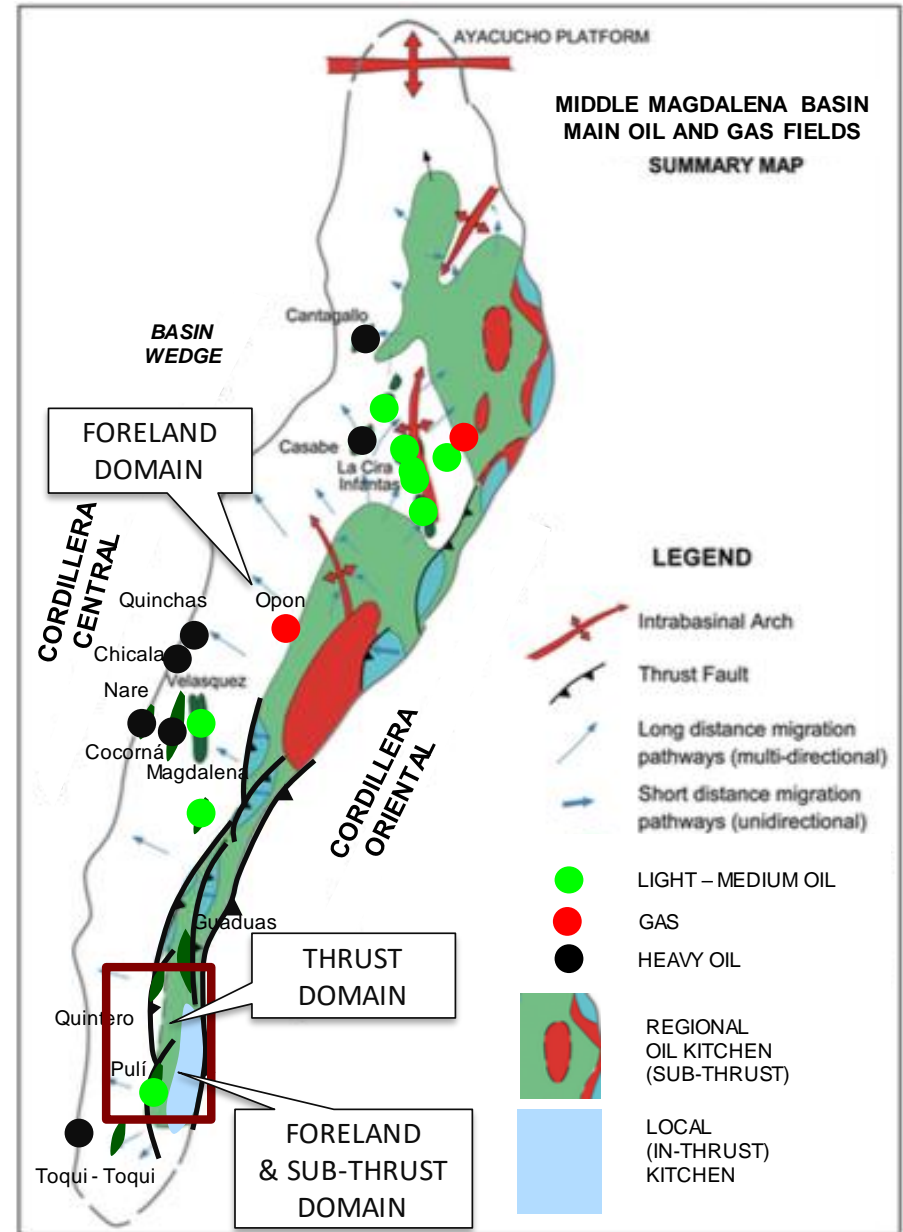
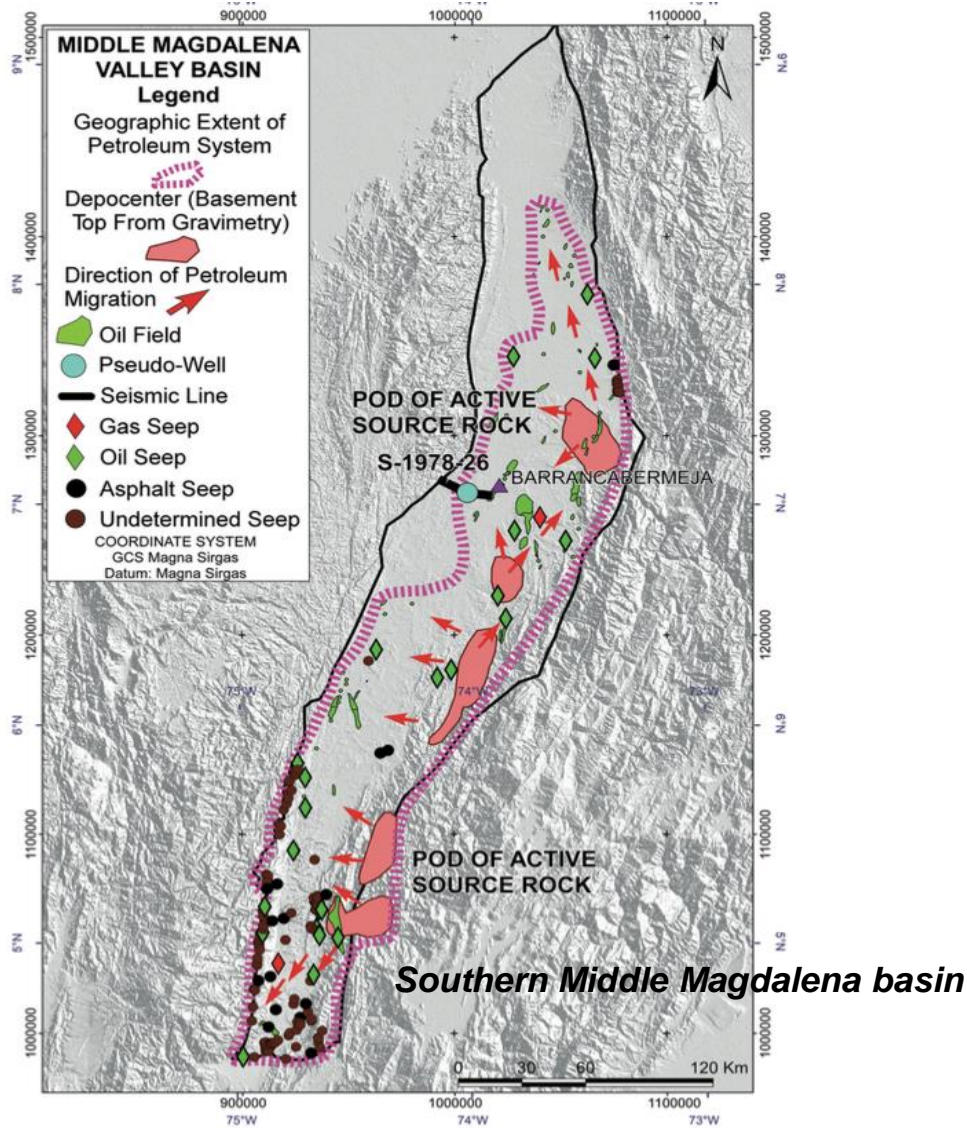
### Southern Middle Magdalena Basin:

- The petroleum system associated with Guaduas, Puli and Toqui-Toqui is supplied by Villeta –equivalent Olini and La Frontera
- Surface mapping and well data confirm that Olini – Frontera extend along the piedmont and pinch out east of BELTRAN – 1

**Figure 85.** Petroleum systems map of the Middle Magdalena Valley Basin. Note the location of the depocenter at the top of the basement, the hydrocarbon seeps, and the hypothetical areas of influence of the hydrocarbon systems.

From Sarmiento (2012)

## Petroleum System Map



- Olini – Frontera are late mature in outcrops

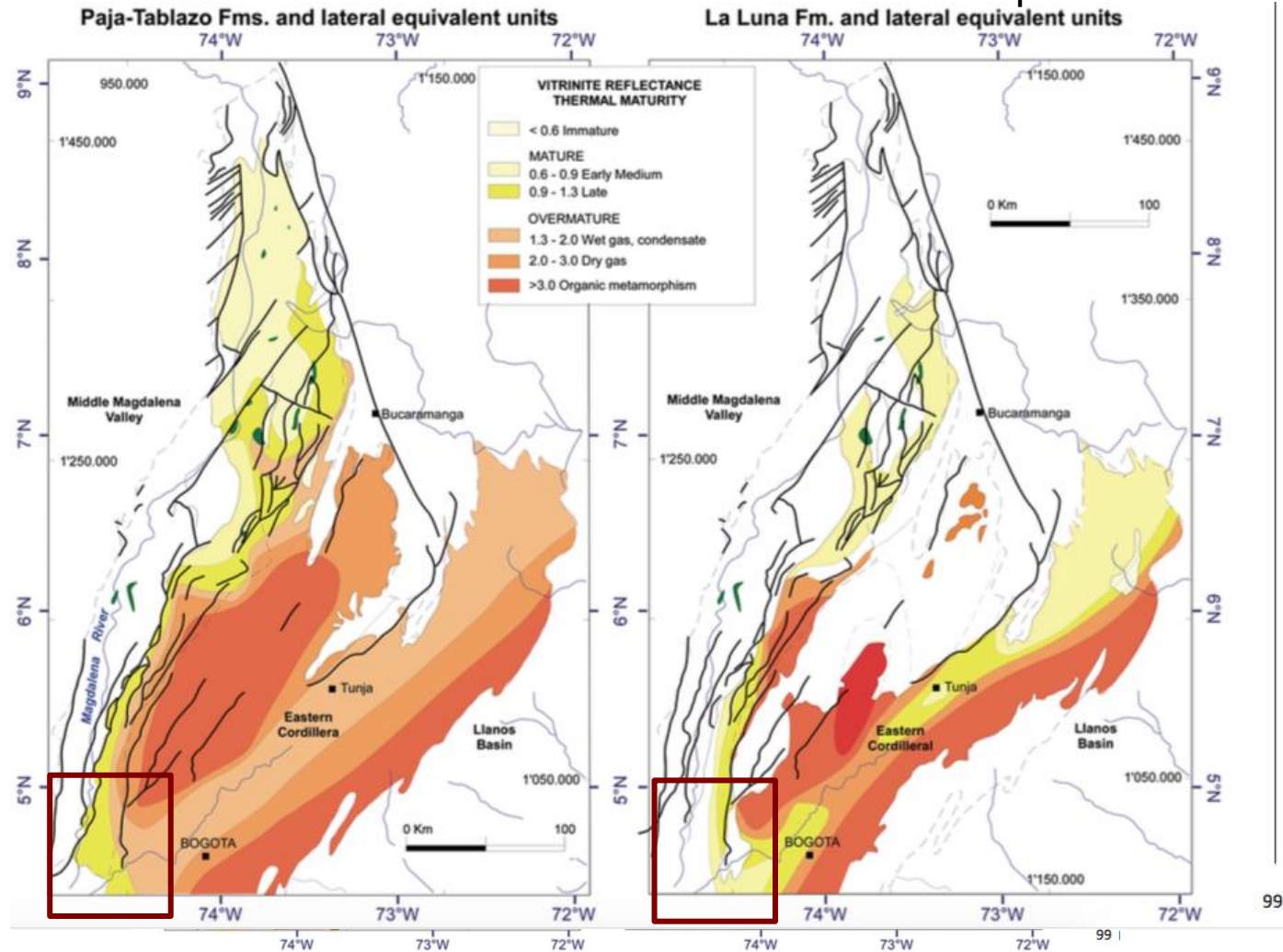
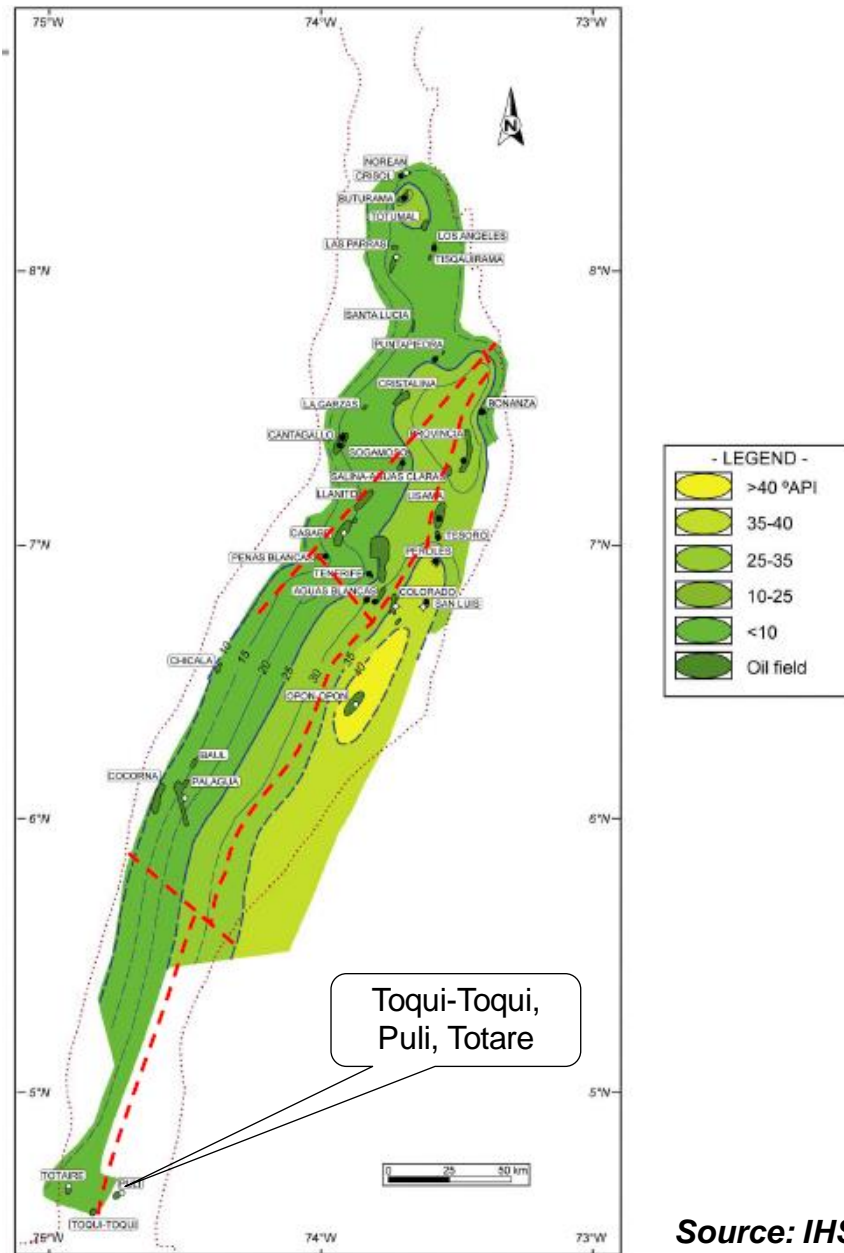
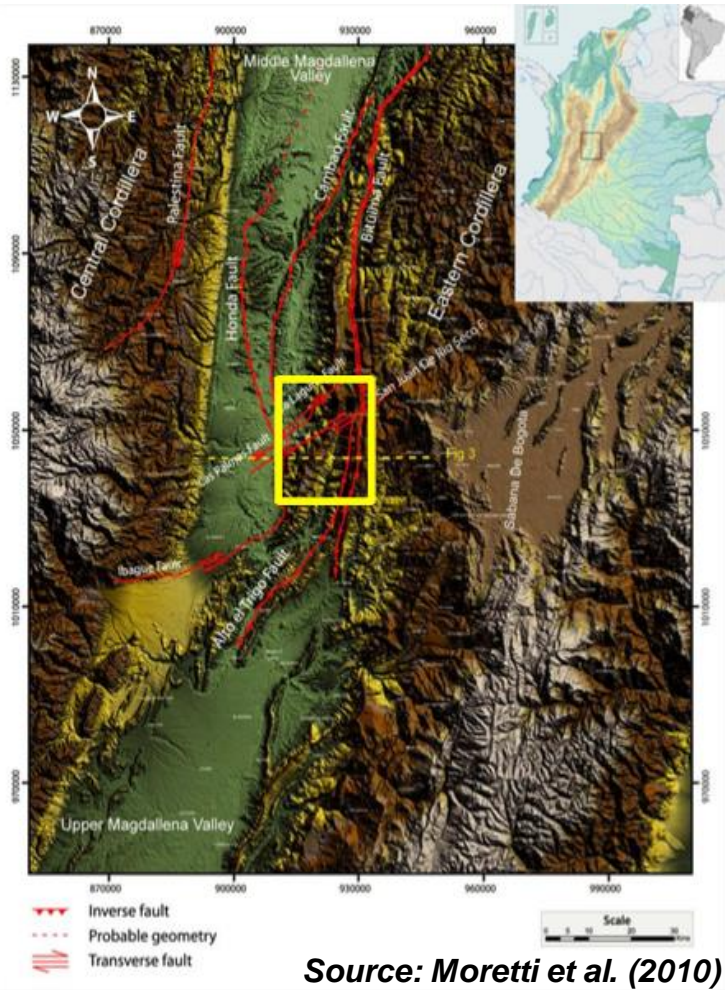


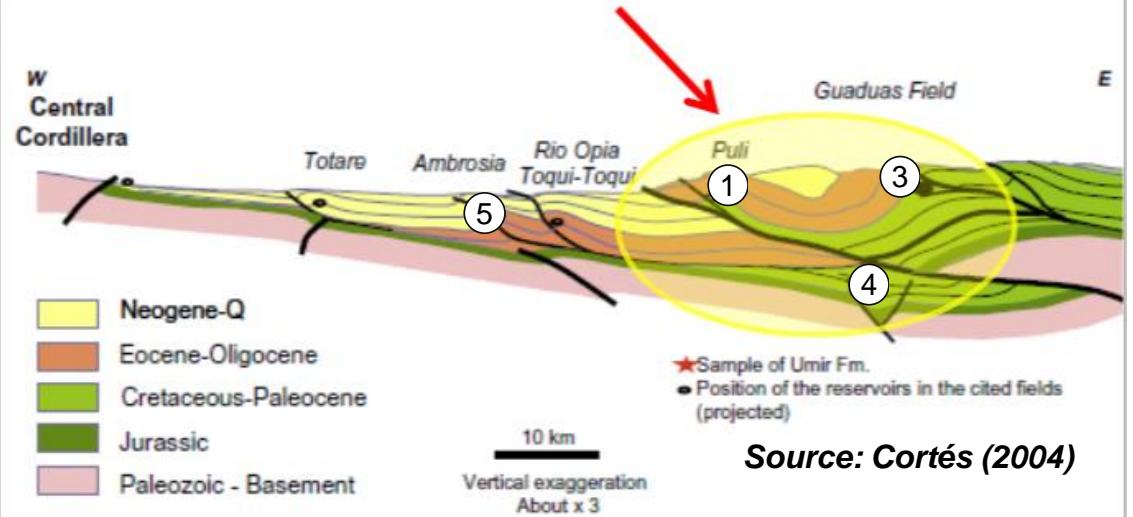
Figure 58. Present day thermal maturity maps for the two source rock stratigraphic intervals: the Aptian-Albian (Paja-Tablazo Fms. and lateral equivalents) and the Turonian-Coniacian (La Luna Fm. and lateral equivalents) of the ECB and MMB. From Garcia *et al.* (2003). Note that (1) maturity level of the Aptian-Albian source rock interval is greater than the maturity level of the Turonian-Coniacian source-rock, (2) In the ECB both stratigraphic intervals are over-mature except for the younger Turonian-Coniacian source rock in the Axial region of the ECB, (3) maximum maturity values approximately occur in the area of the maximum Cretaceous Cocuy, Tablazo and Cundinamarca depocenters in the eastern and western inverted structural domains of the ECB and the relative minimum values occur in the Sabana de Bogota, Tunja, Sogamoso axial region or depressional structural domain of the ECB. (4) Mature values occur in the Western foothills of the ECB and the ESE part of the MMB (enabling local generation and dominantly vertical migration). Source rocks are immature toward the WNW (requiring WNW lateral migration to fill traps in this part of the basin).

Source: Sarmiento, 2012

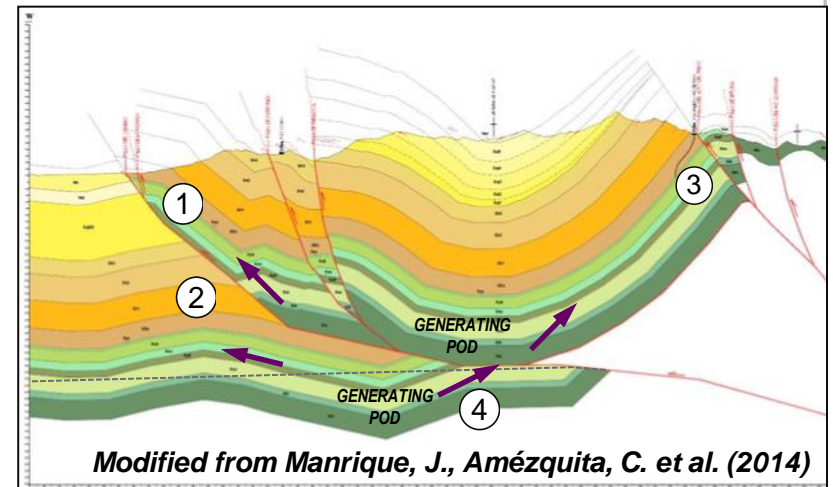




## FALLAS TRANSPRESIVAS (RUMBO) FALLAS INVERSAS CON VERGENCIA W



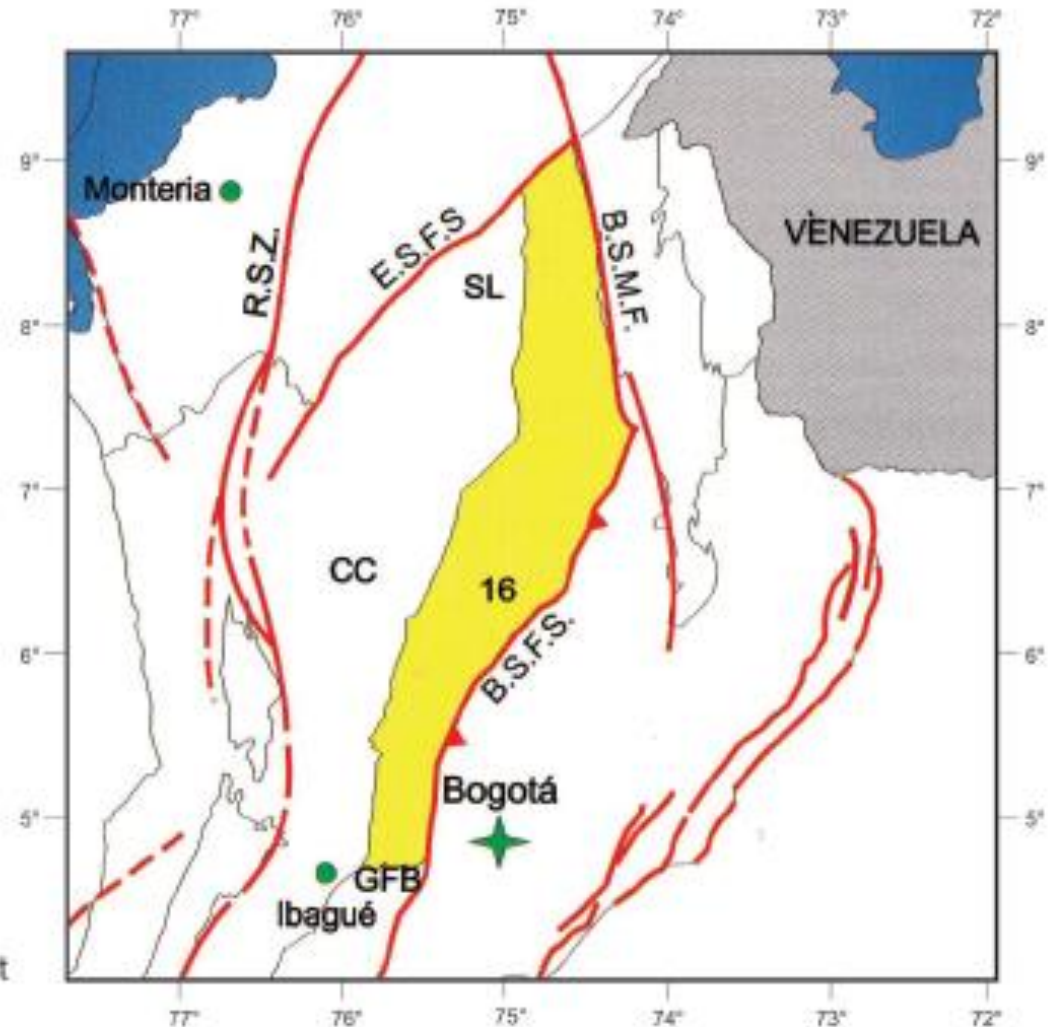
- ① Puli – type thrust play: light oil in Guadalupe sands
  - ② Sub thrust play: light / medium oil in Paleogene sands
  - ③ Guaduas - type heavy and light oil in Cimarrona carbonates and sands
  - ④ Cimarrona Deep sub-thrust play: light oil in imbricated cretaceous carbonates and sands
  - ⑤ Shallow thrust play: medium oil in Tertiary clastics
- MIGRATION PATH →







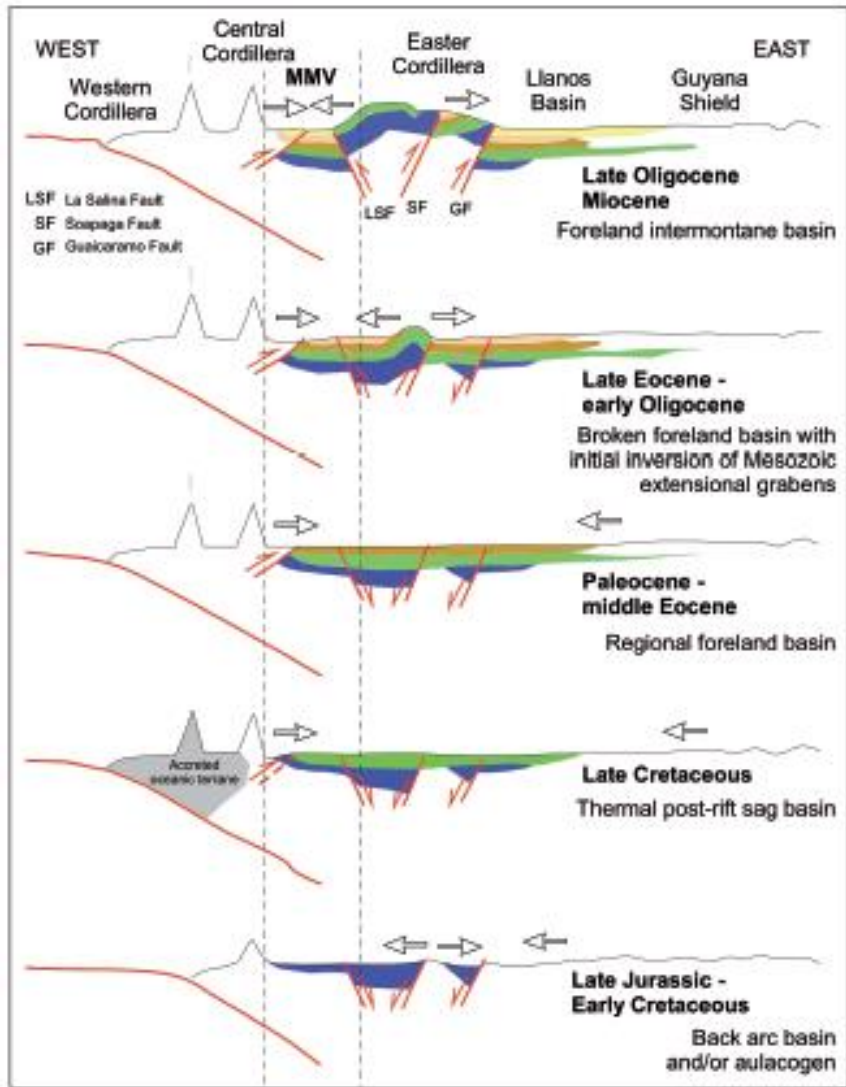
# **Tectonic Framework**



**BOUNDARIES**

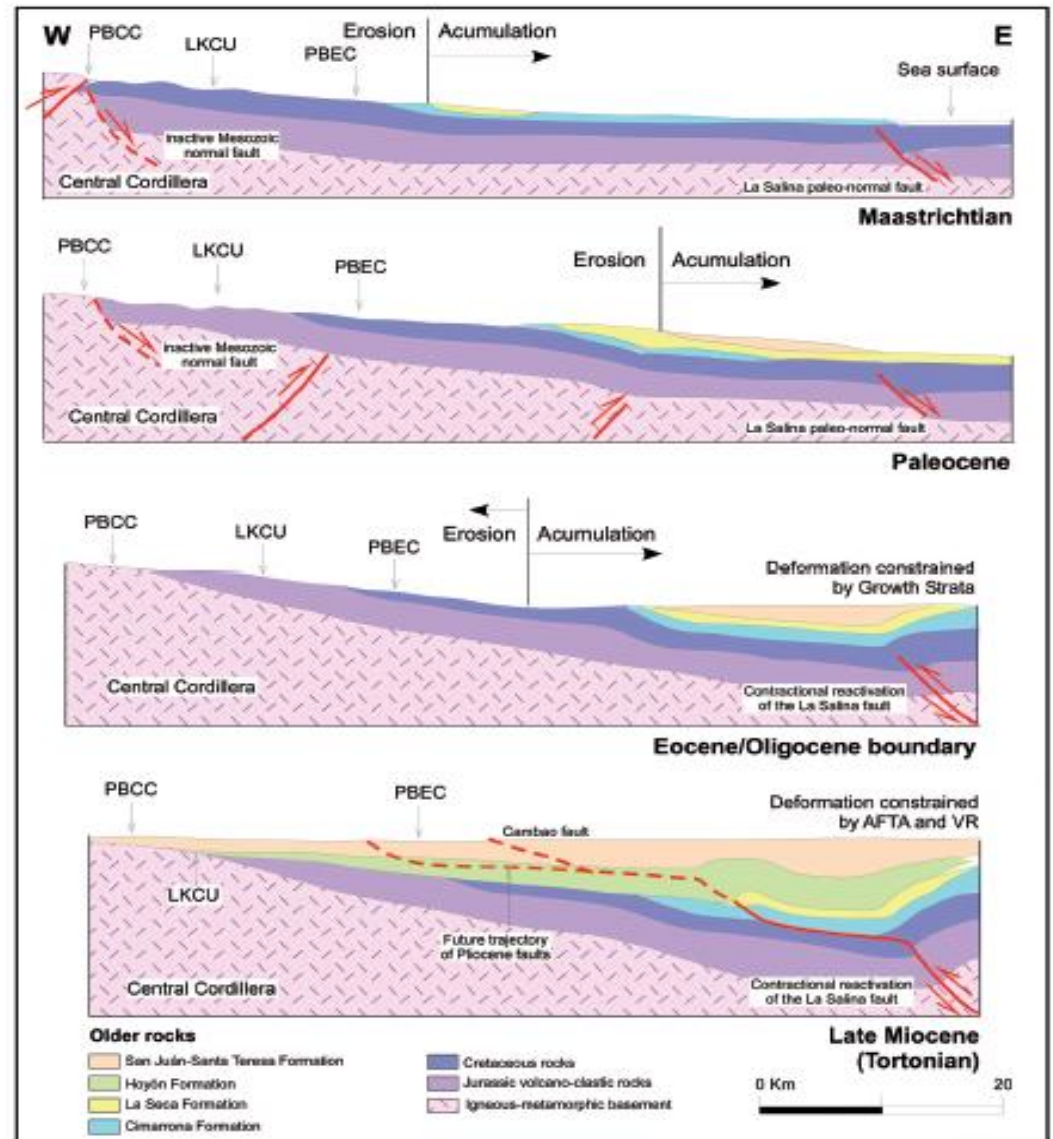
- Southeast: Bituima and La Salina fault systems (B.S.F.S.)
- North: Espiritú Santo fault system (E.S.F.S.)
- West: Onlap of Neogene sediments over the Serrania de San Lucas (SL) and Centrak Cordillera (CC) basement
- South: Girardot fold beld (GFB)
- Northeast: Bucaramanga-Santa Marta fault system (B.S.M.F.)

After ANH, Colombian Sedimentary Basins (2007)

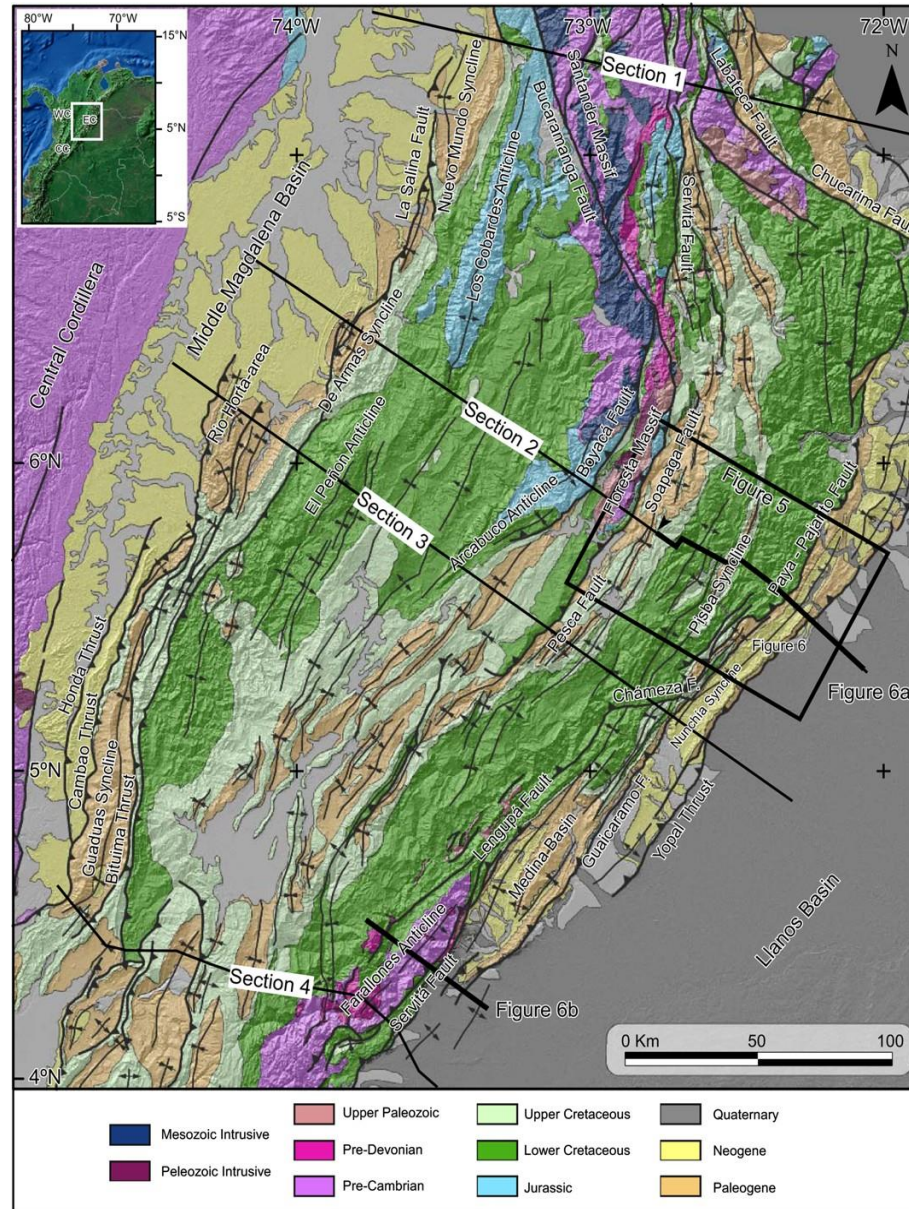


Modified from Horton et al. (2010)

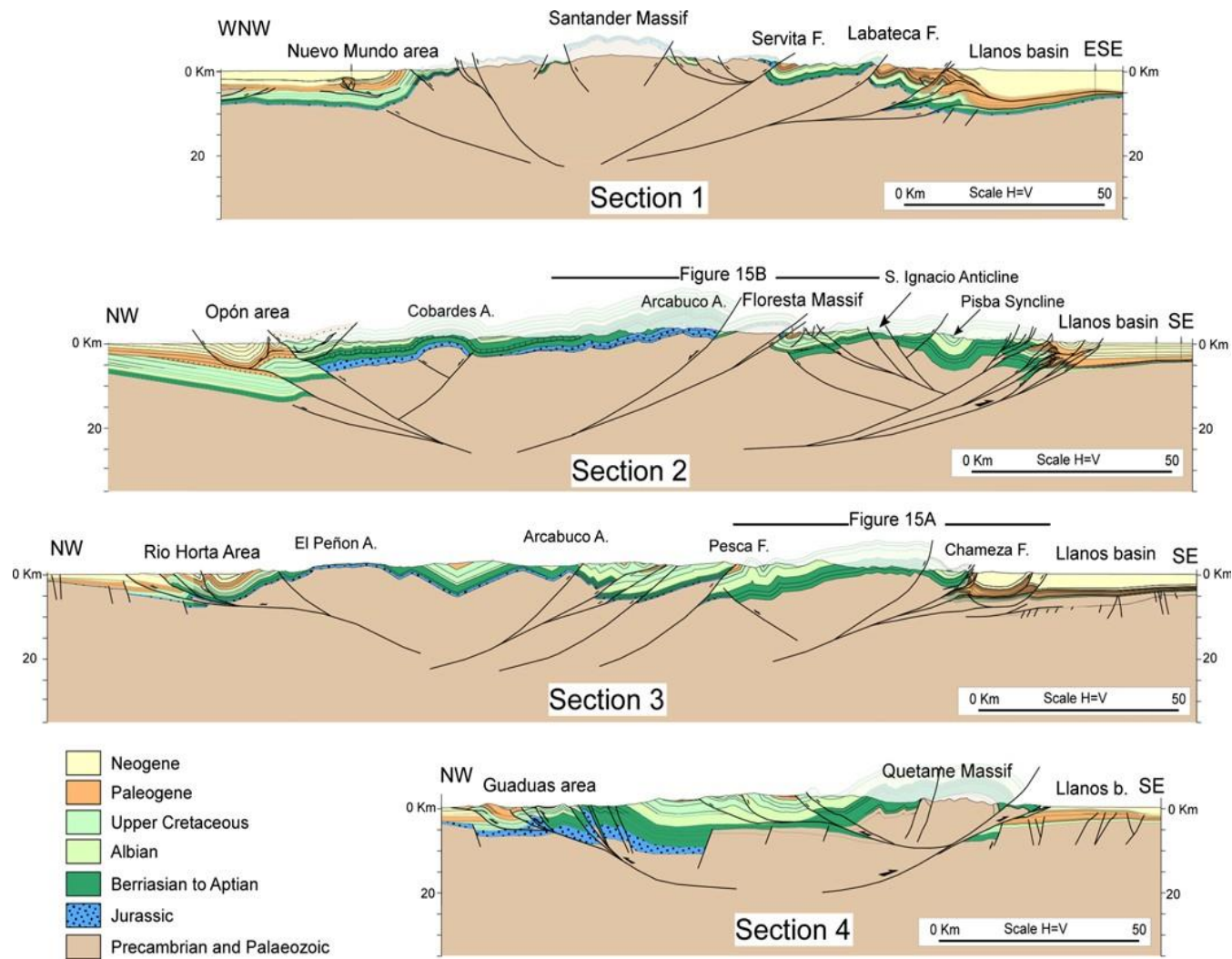
Figure 4. Schematic tectonic evolution of the MMB. After Horton et al. (2010a).



Gómez (2001)

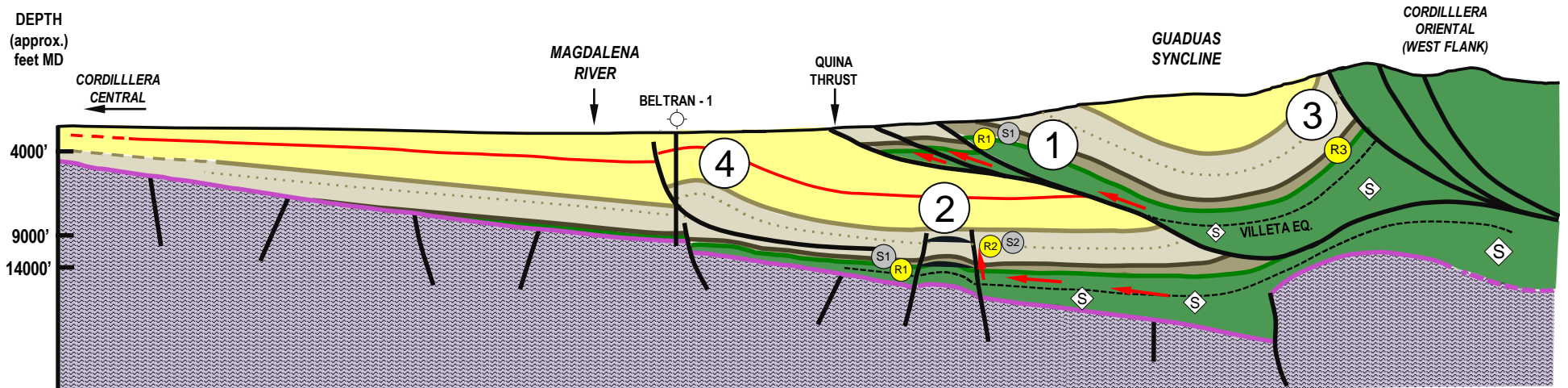


Source: Tesón et al. (2013)



Source: Tesón et al. (2013)

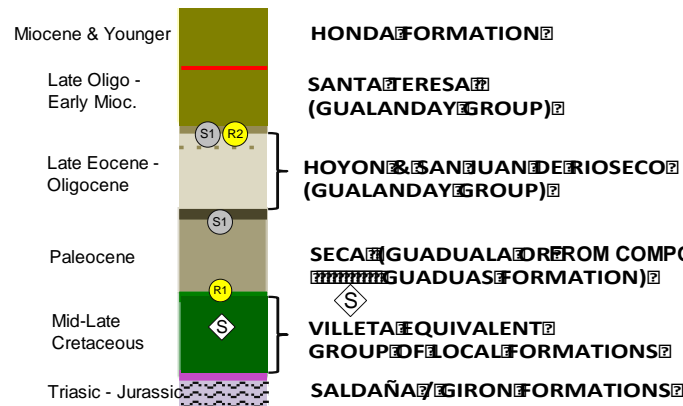
## Western Mountain Front of the Eastern Cordillera of Colombia



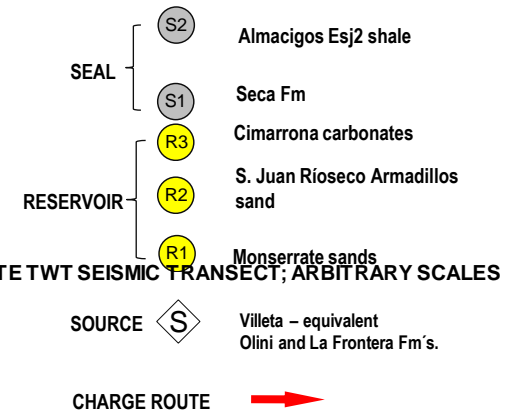
### EXPLORATORY PLAYS

- 1 Thrust play Puli - type: *light oil in Monserrate sands*
- 2 Sub-thrust play: *light / medium oil in Cretaceous and Monserrate sands*
- 3 Guaduas - type play: *heavy and light oil in Cimarrona carbonates*
- 4 Frontal thrust: *Toqui Toqui style Doima and Hoyon*

### STRATIGRAPHIC KEY

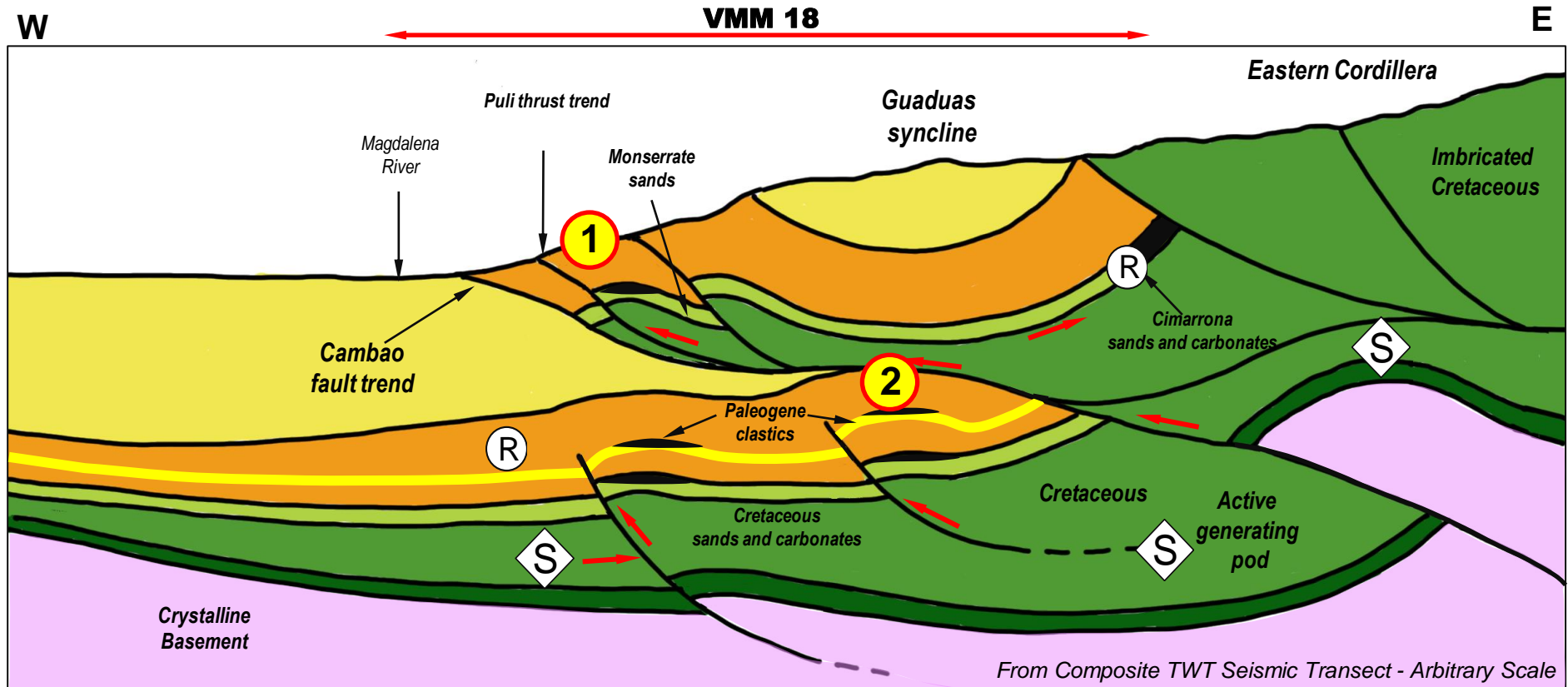


### PETROLEUM SYSTEM



Modified from Sarmiento (2012)

## Western Mountain Front of the Eastern Cordillera of Colombia



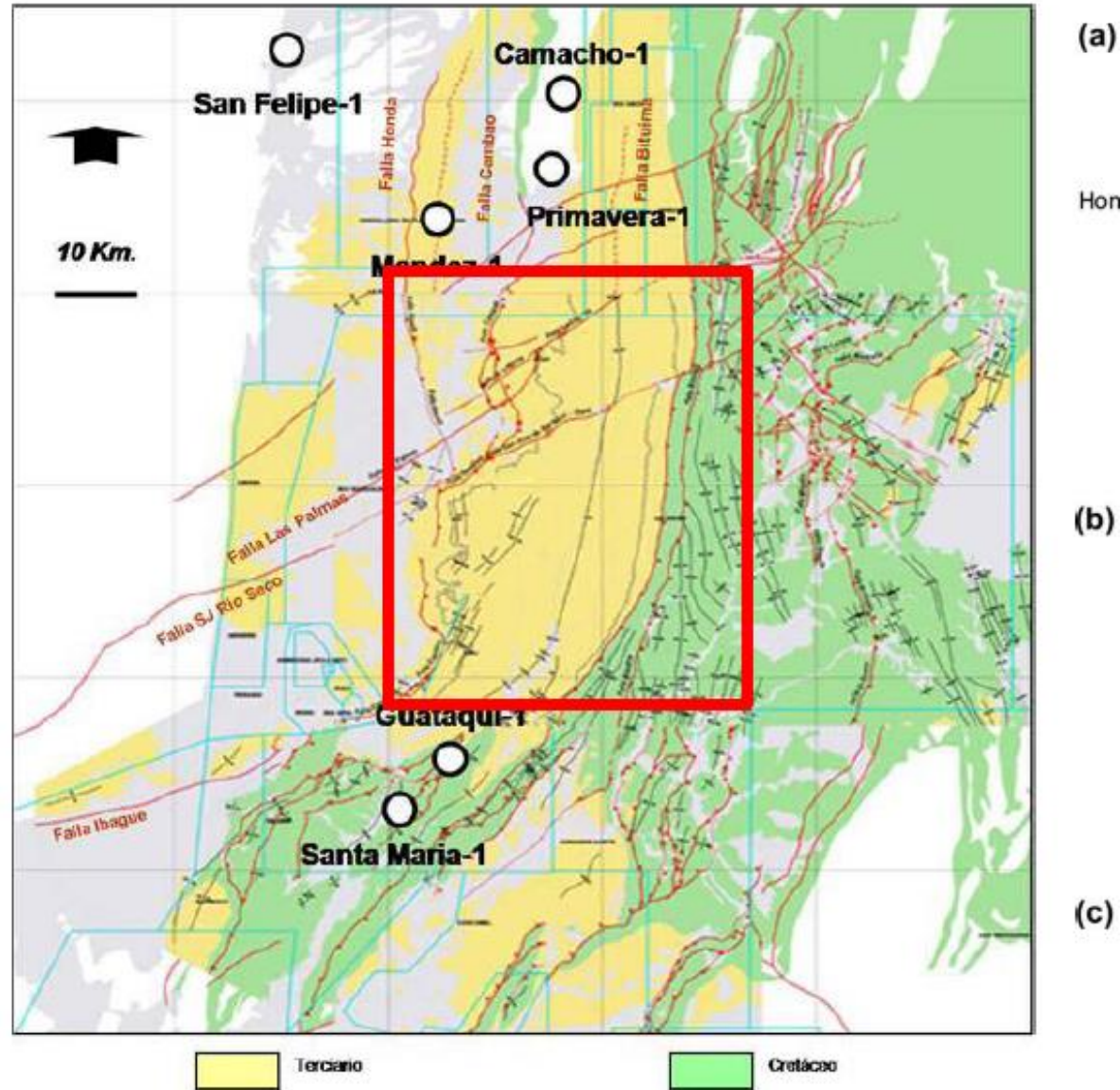
From Composite TWT Seismic Transect - Arbitrary Scale

Source: NSE, 2019

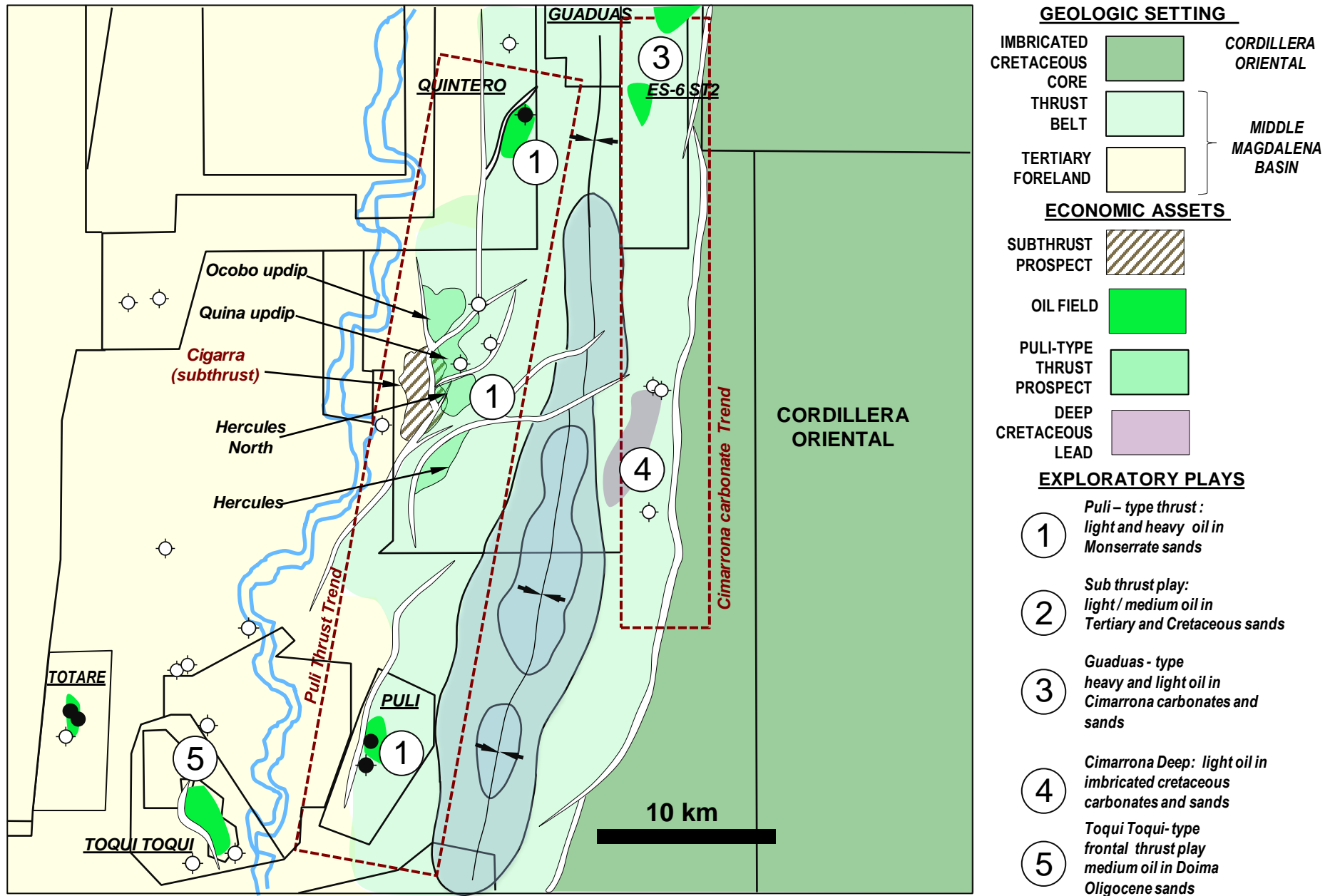
- ① Puli-type thrust play (light oil in Guadalupe sands) - Hercules & Hercules Norte Prospects
- ② Sub thrust play (light/medium oil in Paleogene sands) - Cigarra Prospect
- ◇ S Regional Cretaceous source: Villeta - equivalent, mature in surface
- ◇ R Regional Reservoirs: Cretaceous Cimarrona lmst & Monserrate ss / Eocene Hoyon & Chicoral ss

VMM18 Block is an attractive asset with three main prospects and leads located in the Puli and Dindal-Rio Seco (Guaduas Field) proven hydrocarbon trend of the MMB

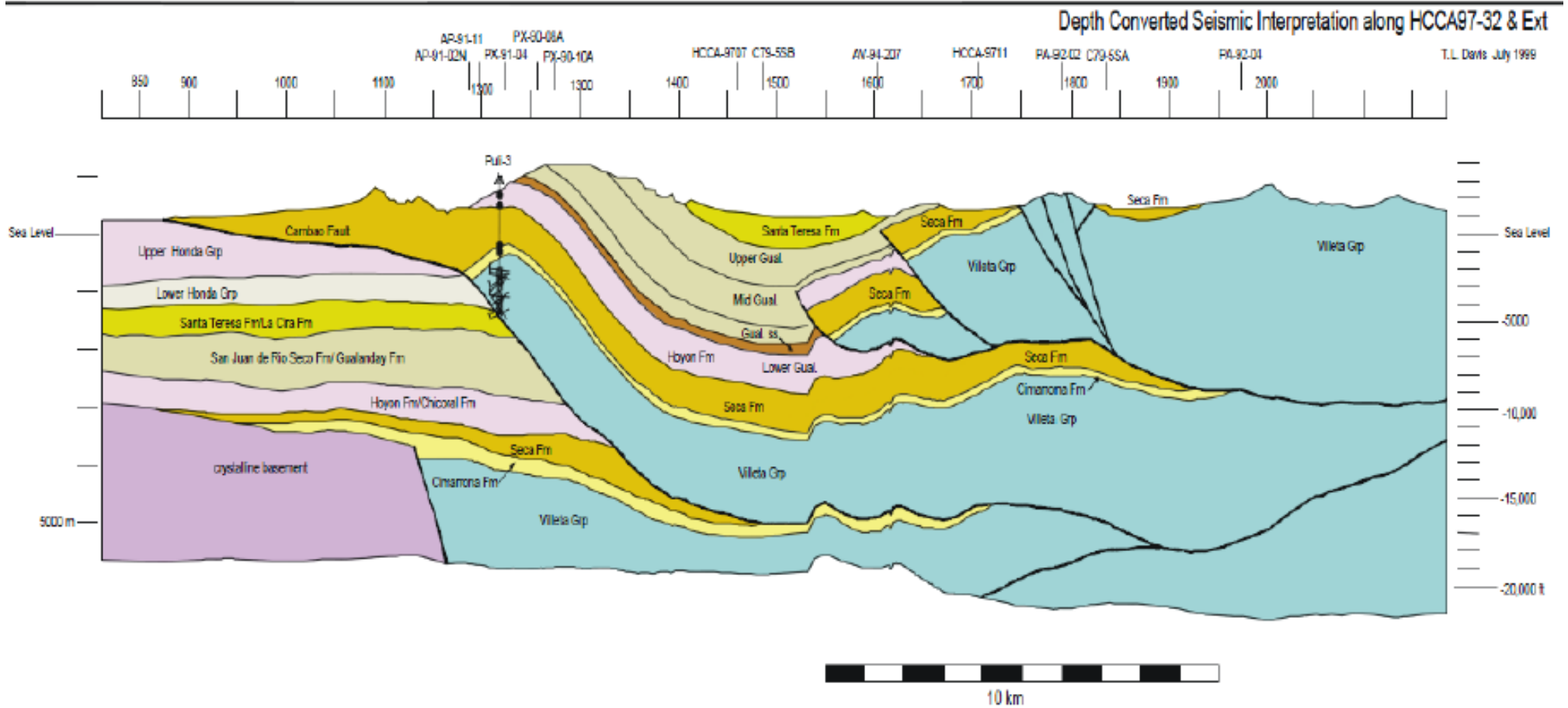




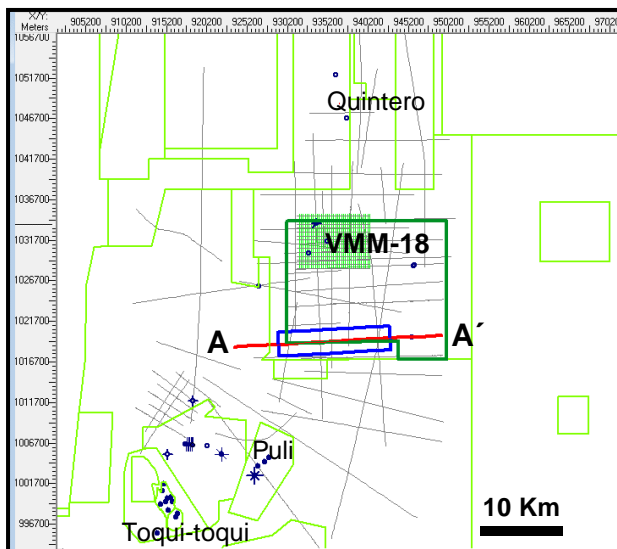
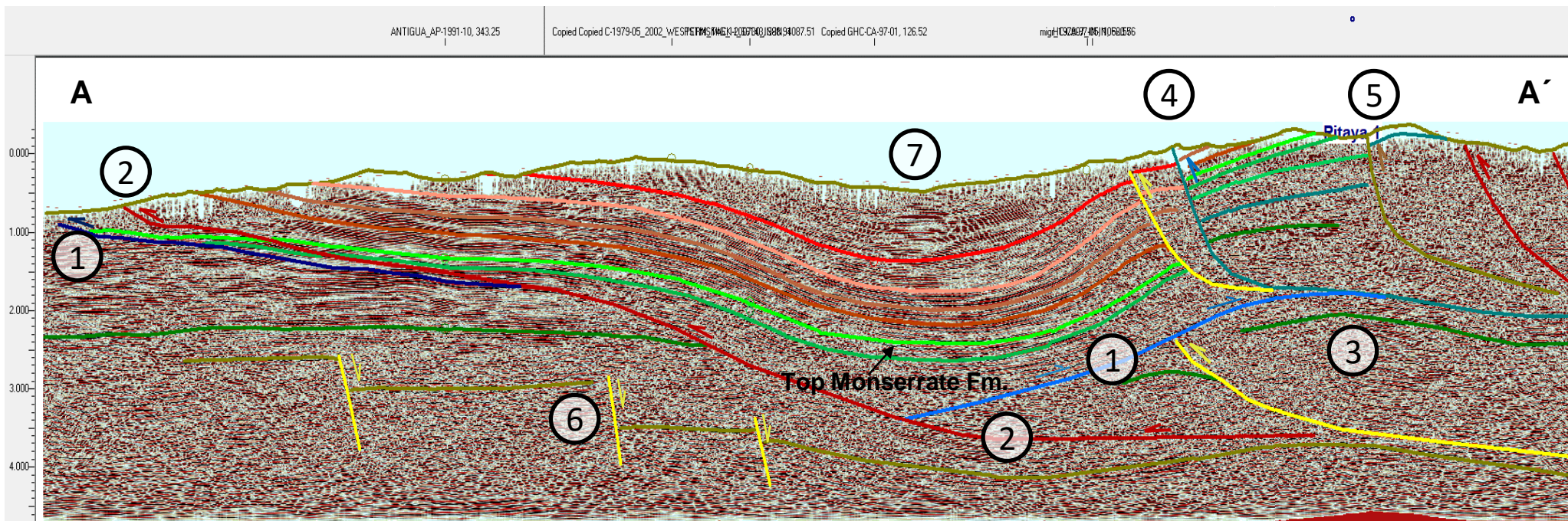
Source: Moretti Et al, Cortes 2004.



# **Regional Seismic Interpretation Thrust Play**



Source: Montajes JM (2016)



Seismic section across southern part of the block showing:

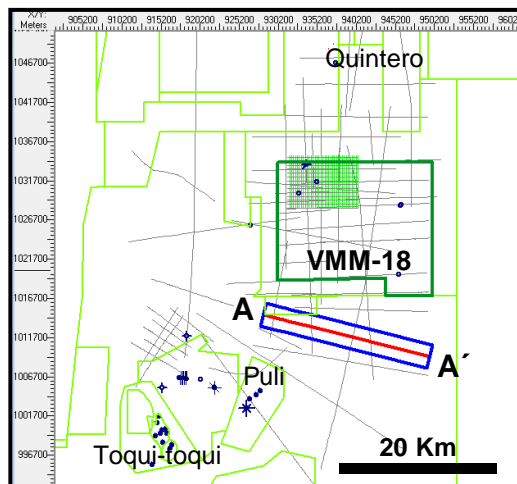
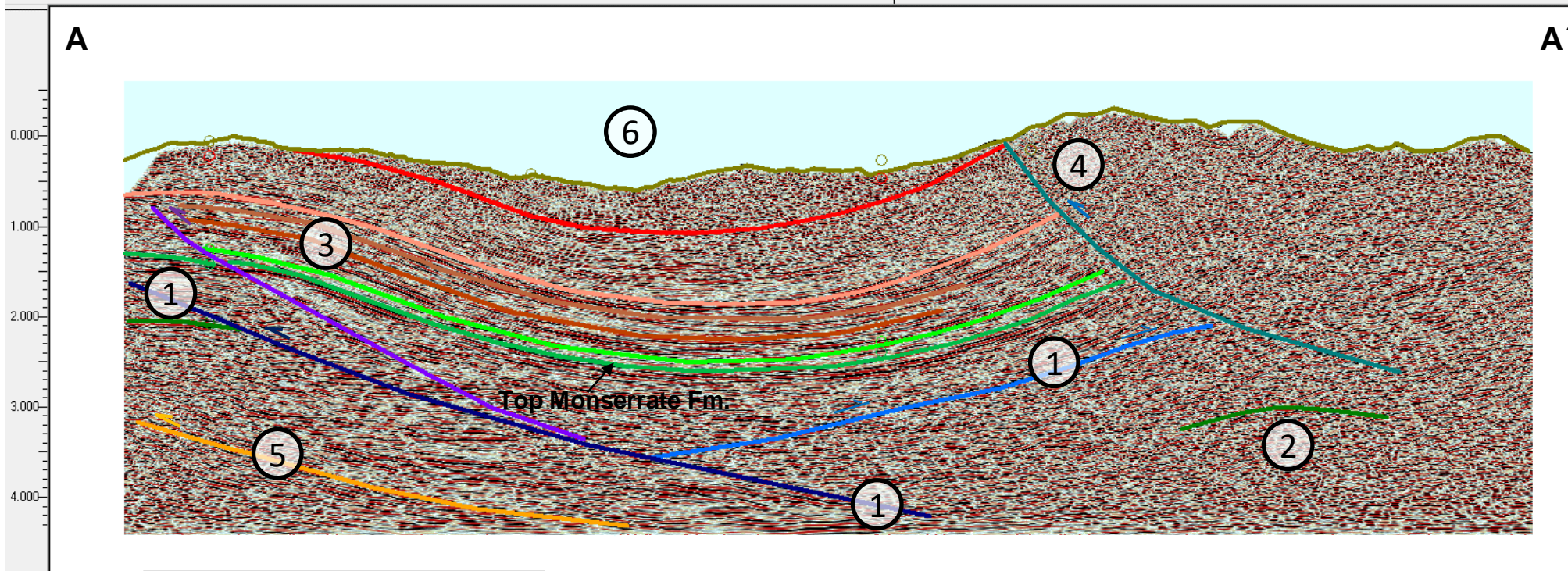
1. Cambao thrust and backthrust
2. Viani fault
3. Deep Cretaceous Cimarrona Play
4. Agrado fault emplacing Upper and Lower Cretaceous on top of the Deep Cretaceous structure
5. El Trigo fault
6. Pre-existing normal faults
7. Guaduas Syncline

ANTIGUA\_AP-1991-10, 184.58

Copied Copied C-1979-05\_2002\_WESTERN\_MIG\_IH\_66143, 271.45

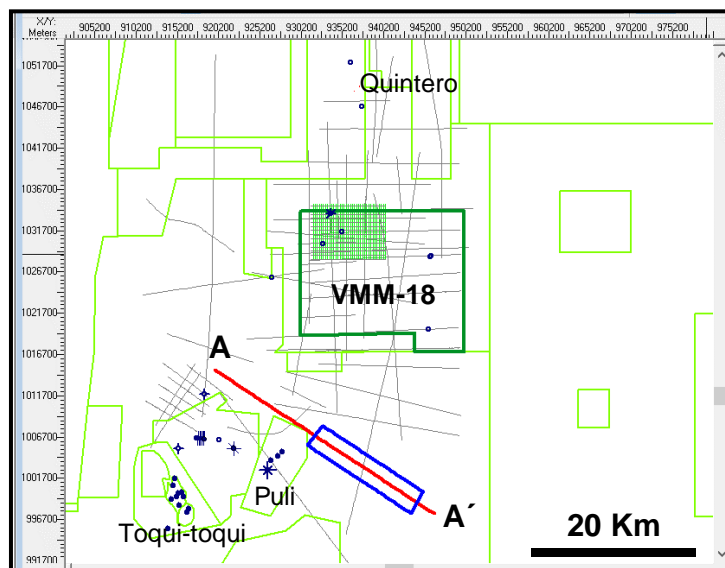
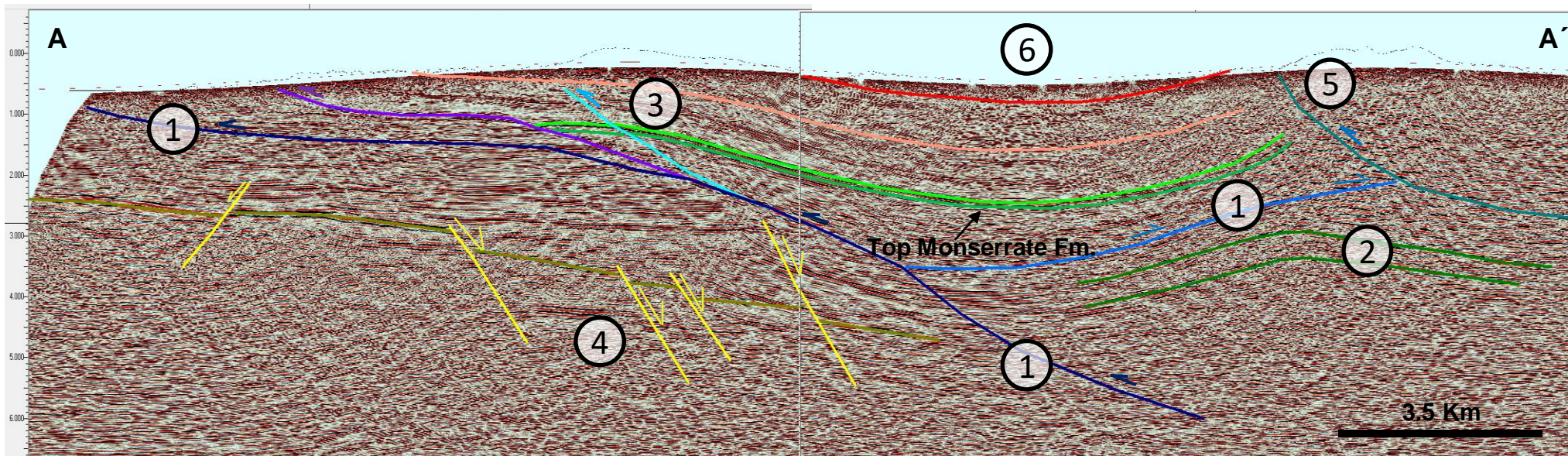
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migr\_197907\_IN-IN, 495.95



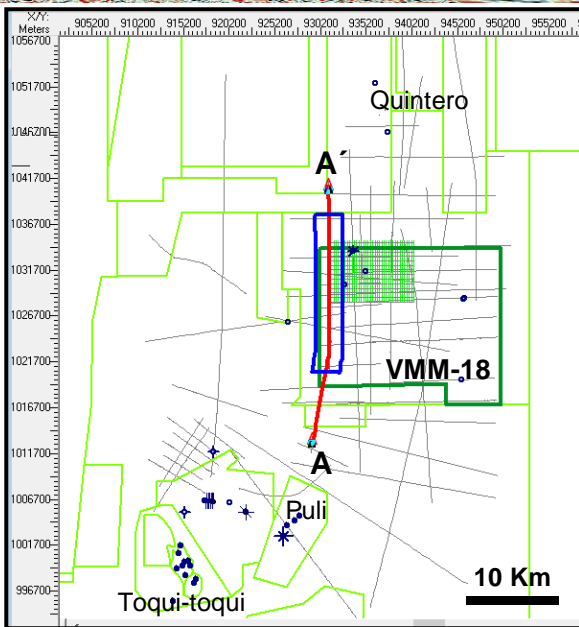
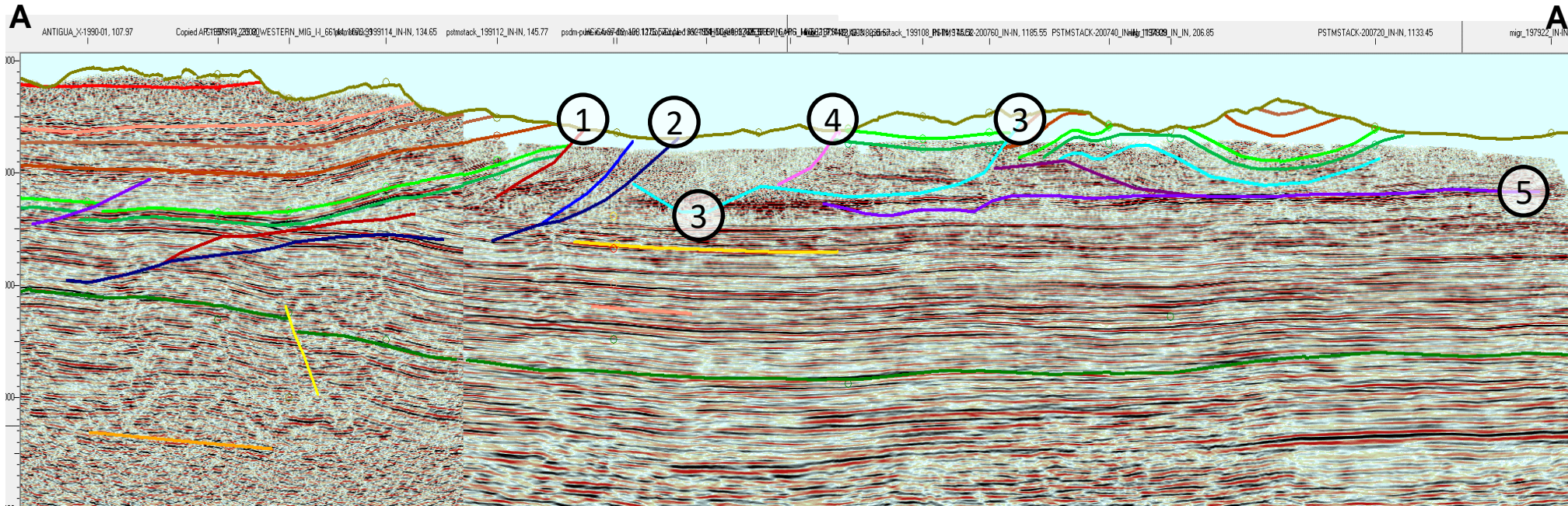
Seismic section showing:

1. Cambao thrust and backthrust
2. Deep Cretaceous Cimarrona Play
3. Hercules type structure
4. Agrado fault emplacing Upper and Lower Cretaceous on top of the Deep Cretaceous structure
5. Beltran thrust
6. Guaduas syncline



Regional seismic section showing:

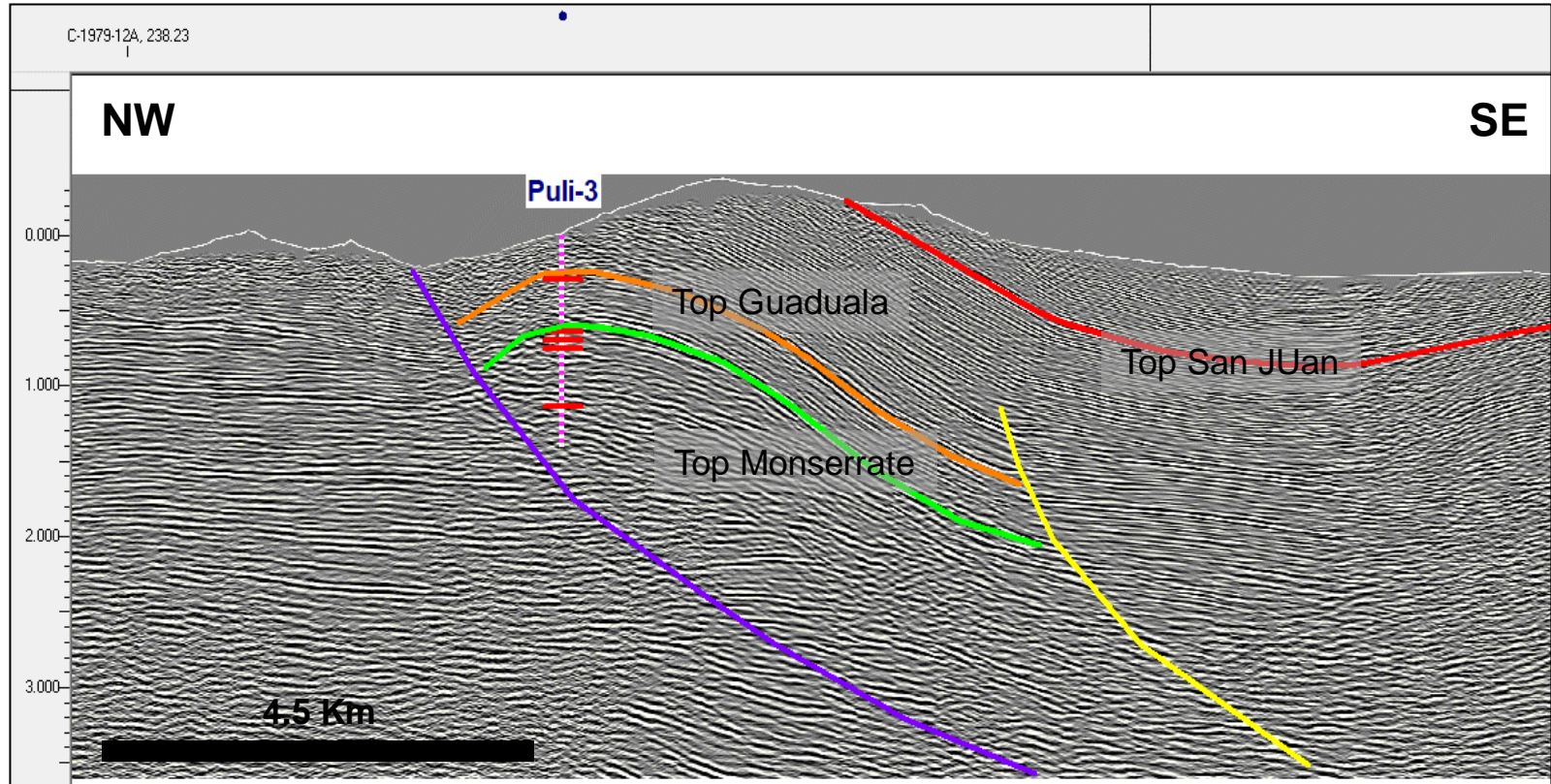
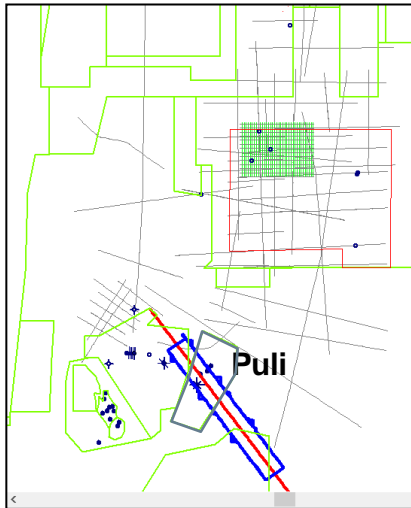
1. Cambao thrust and backthrust
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3. Hercules type structure
4. Pre-existing normal faults
5. Agrado fault emplacing Upper and Lower Cretaceous on top of the Deep Cretaceous structure
6. Guaduas syncline

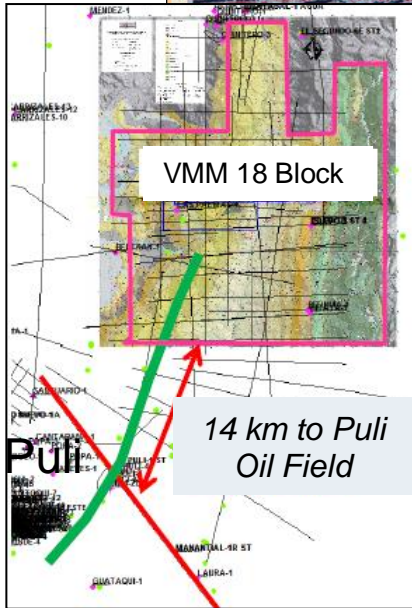
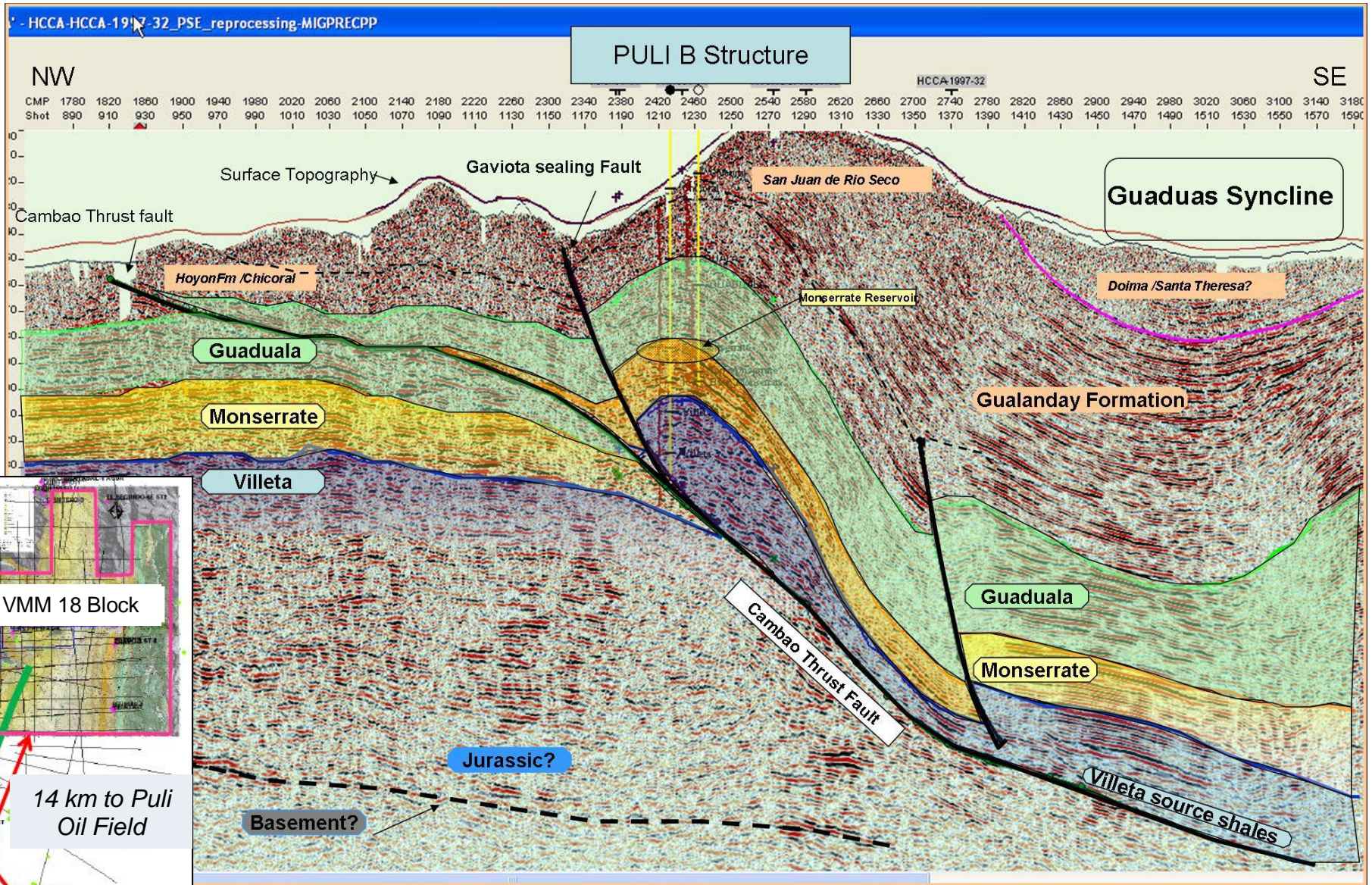


- Strike seismic section across block
1. Viani thrust
  2. Cambao thrust
  3. Doña Ines fault
  4. Paniagua fault
  5. Cambao North fault

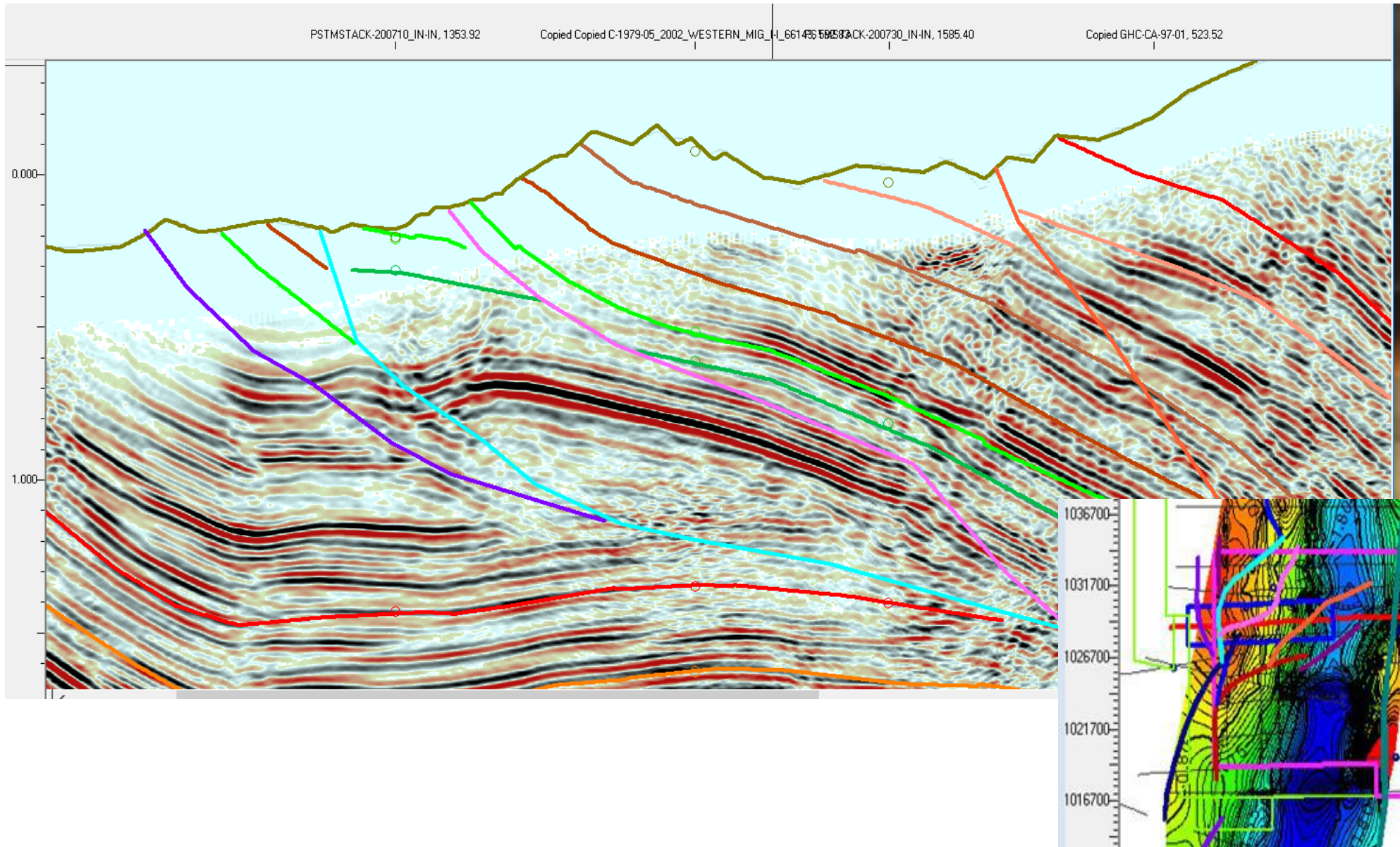


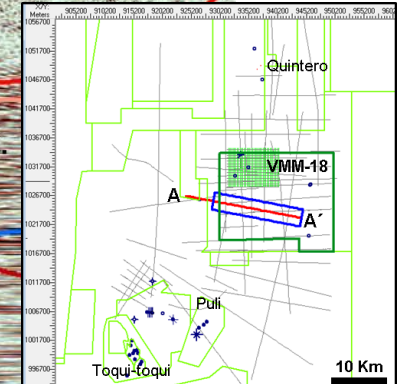
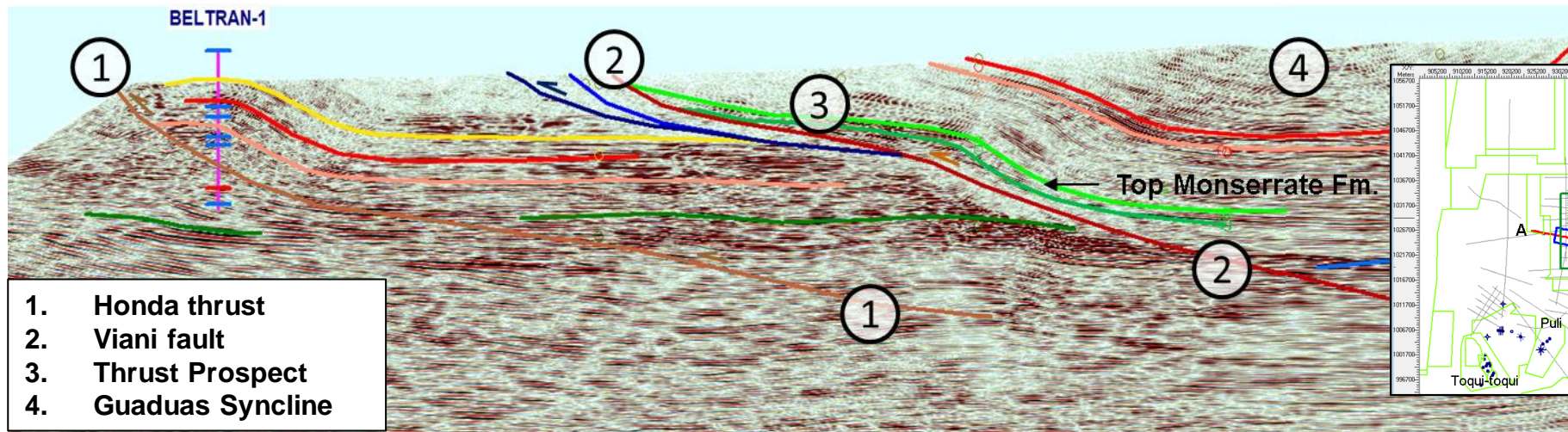
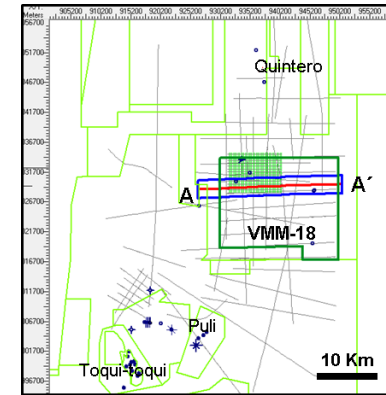
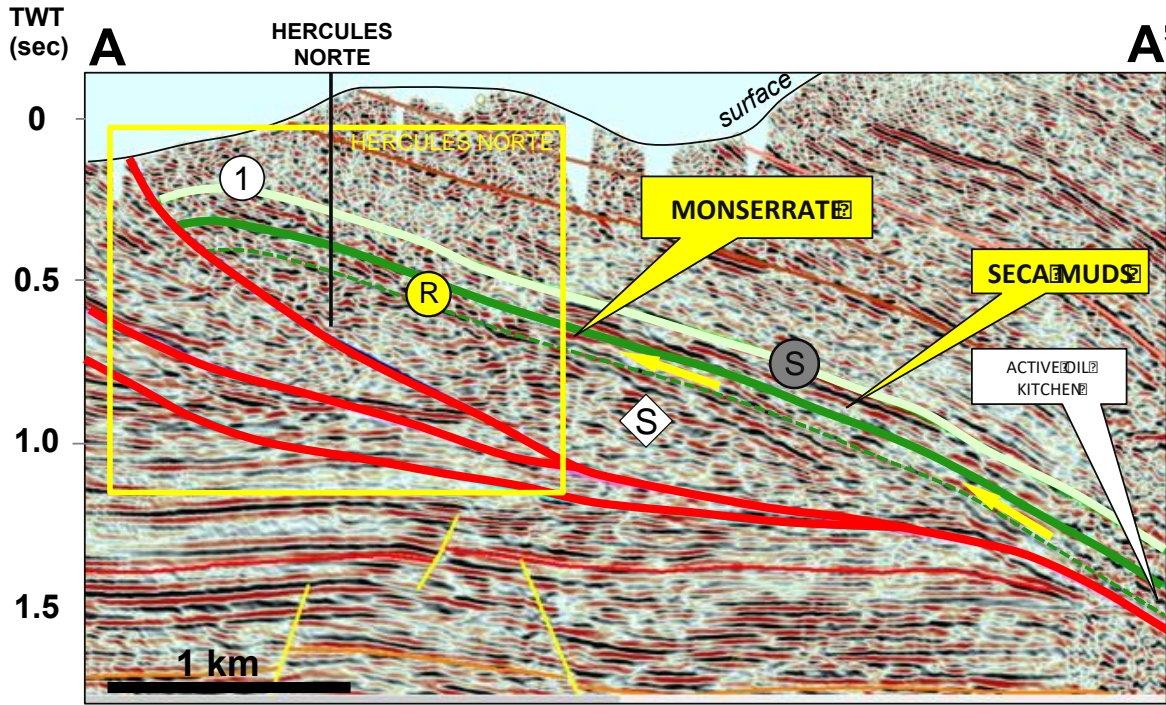
# Thrust Play





Source: Montajes JM (2016)





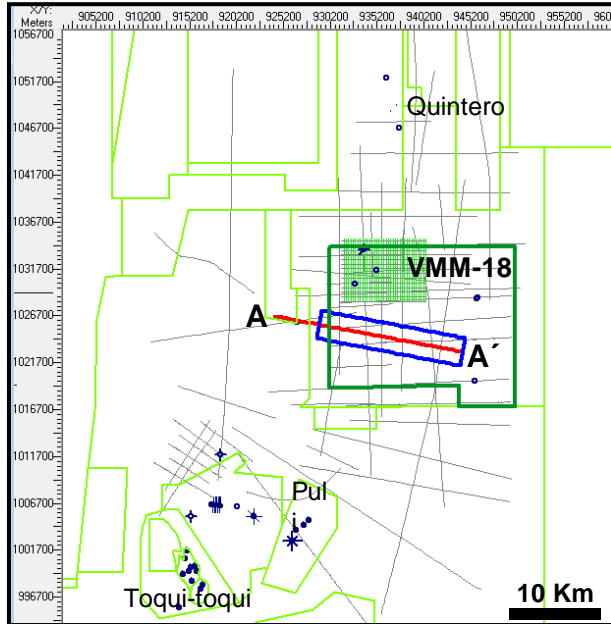
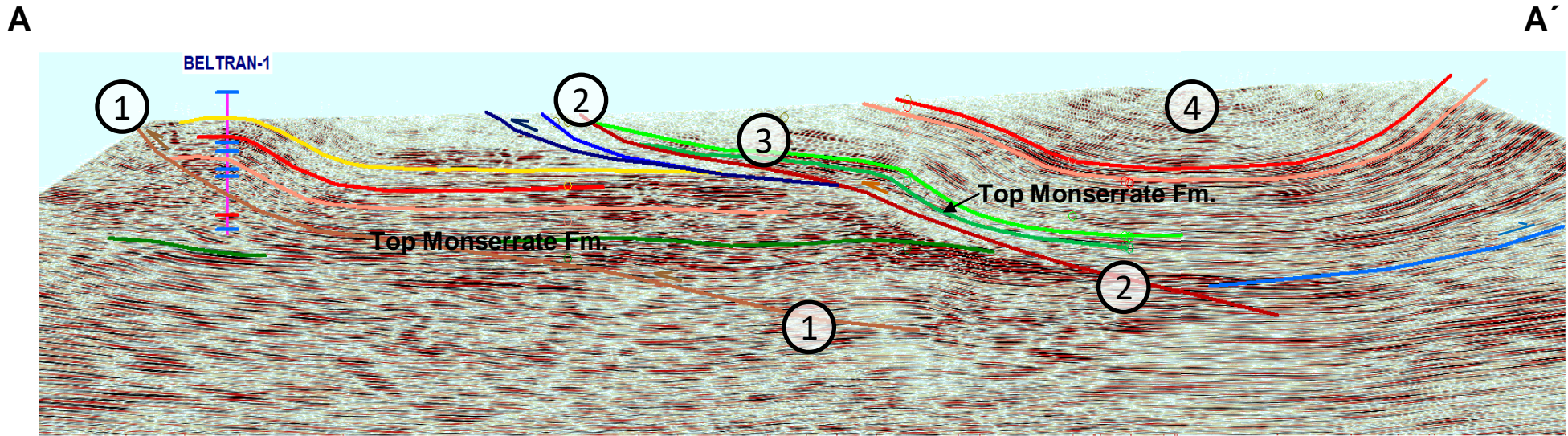
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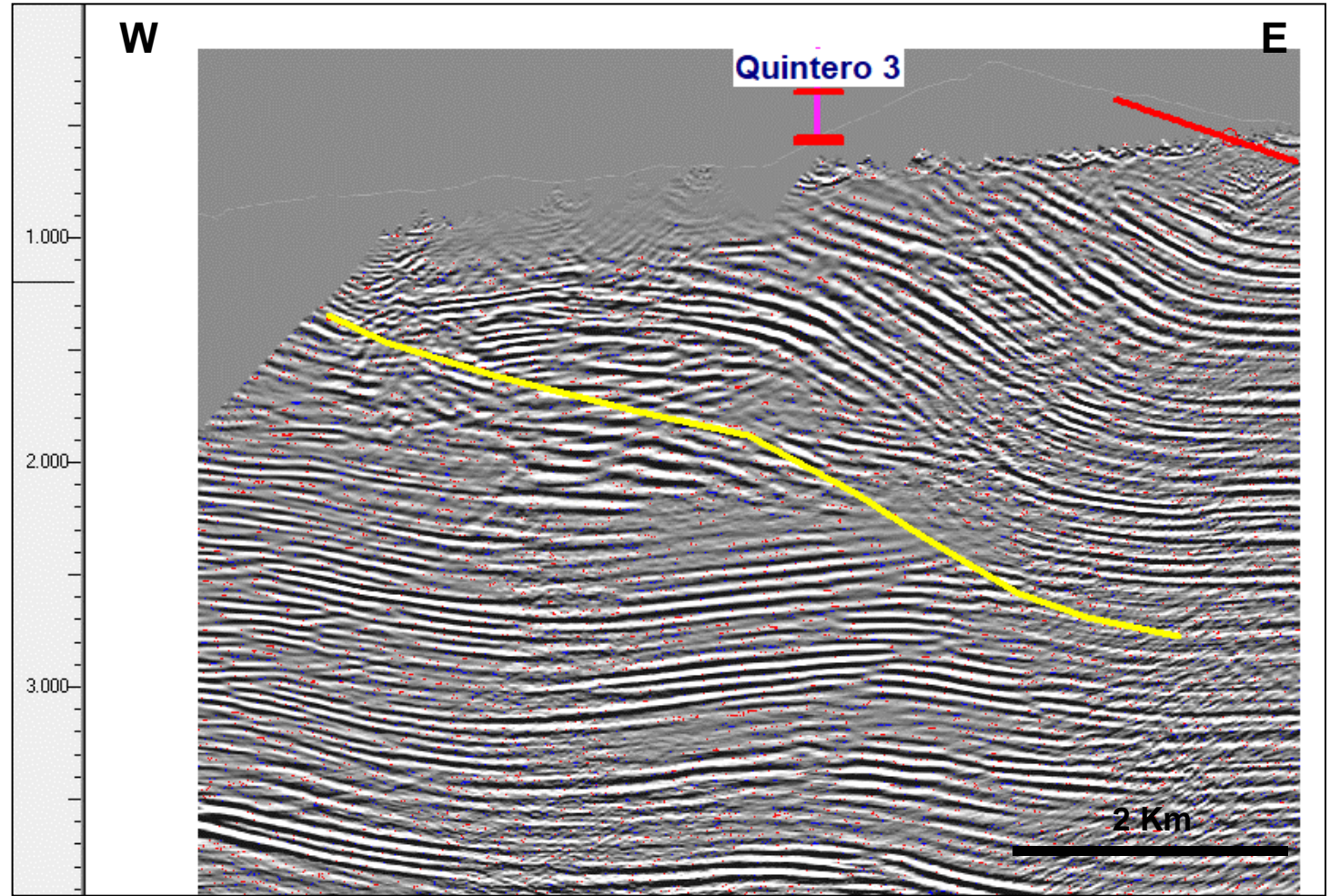
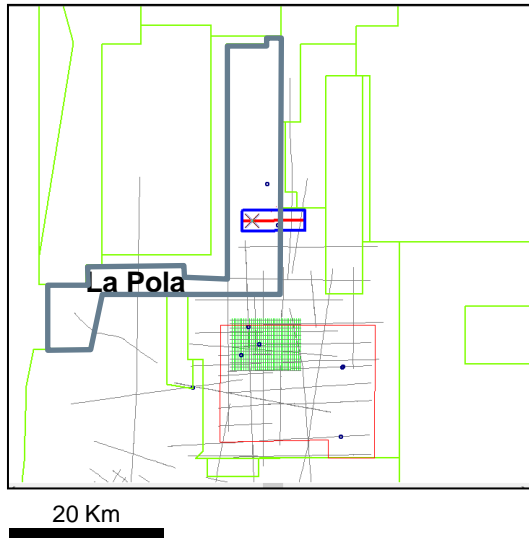
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Seismic section across Hercules Prospect

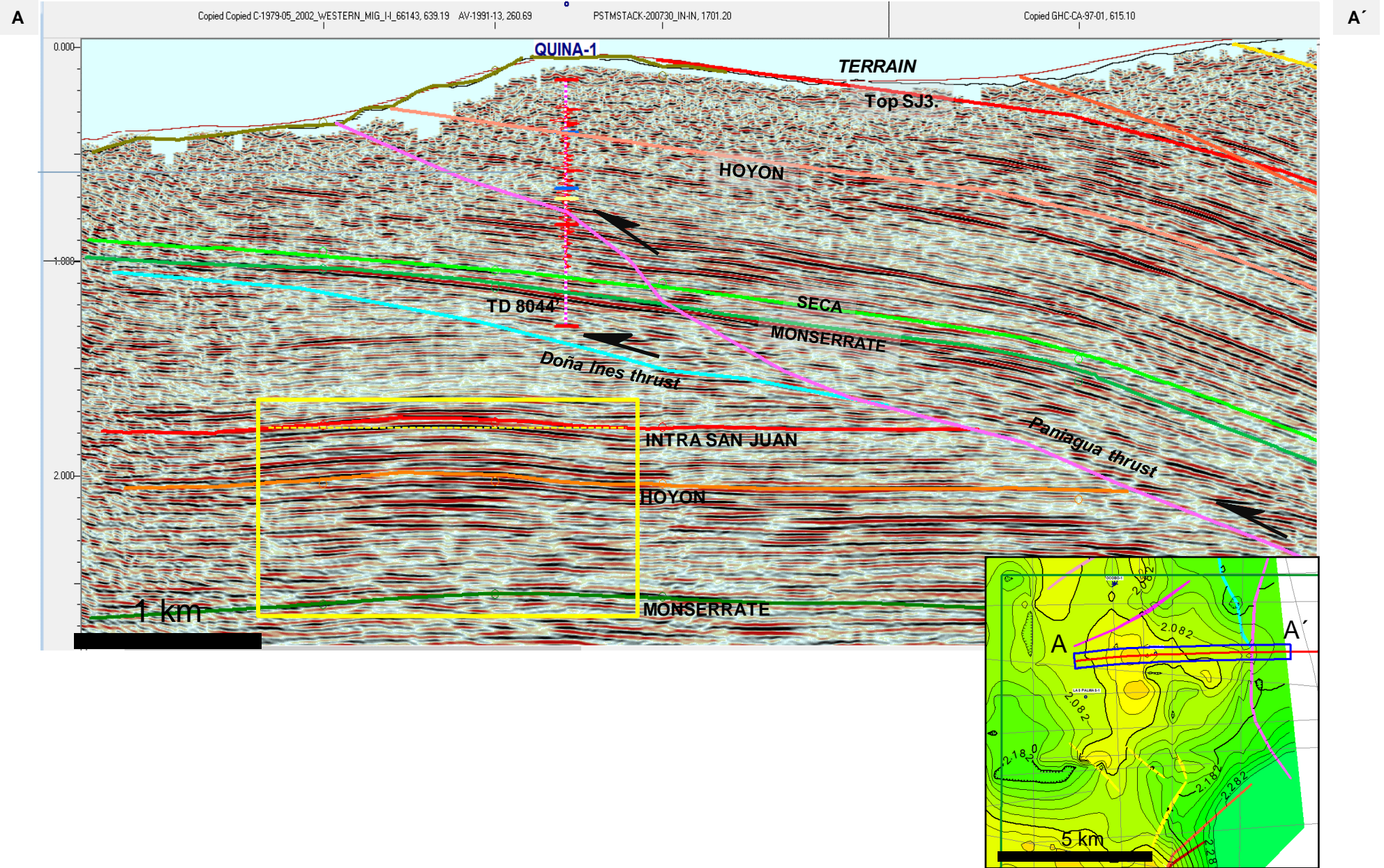
1. Honda thrust
2. Viani fault
3. Hercules Prospect
4. Guaduas Syncline

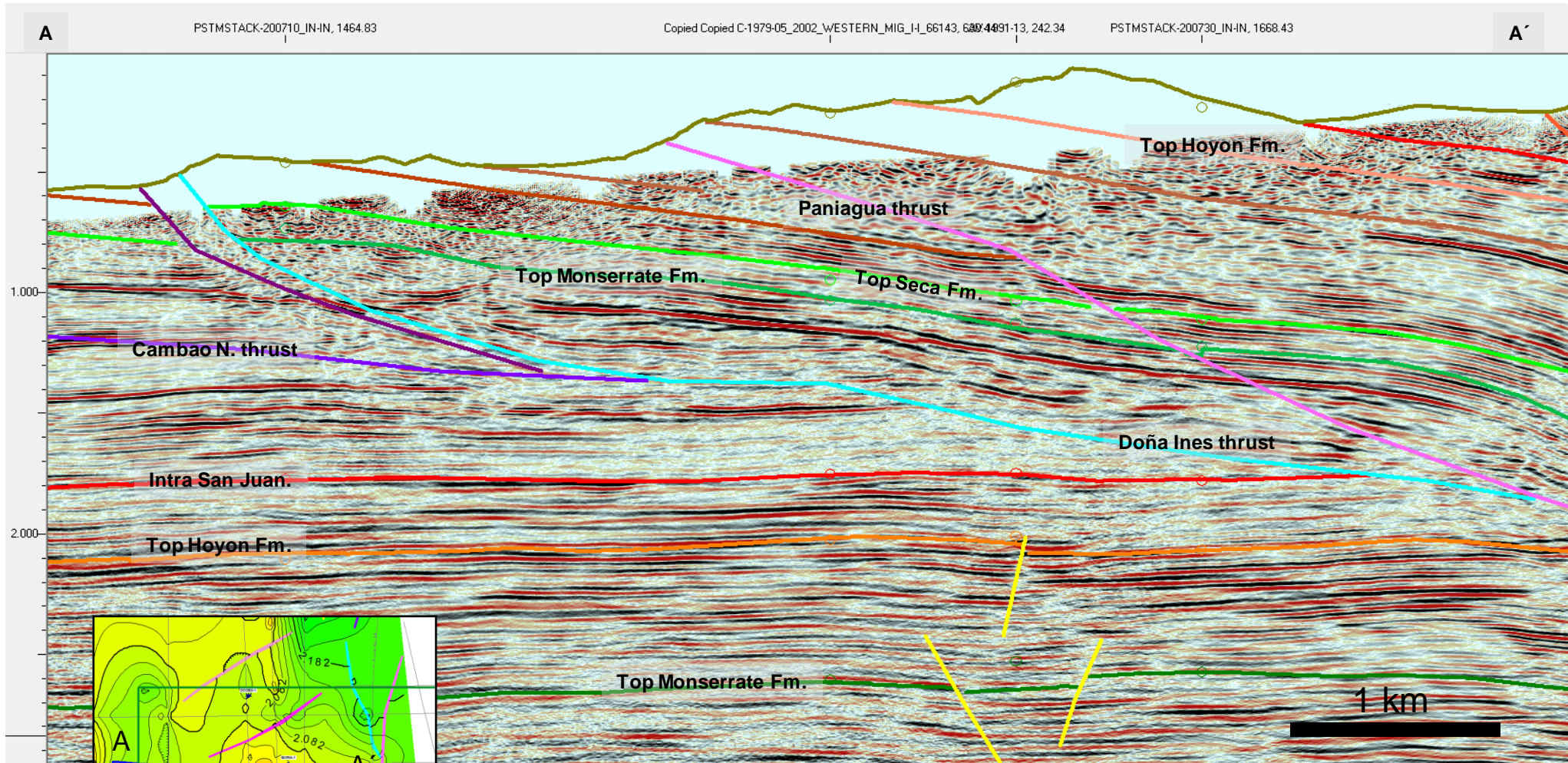
- Seca Fm.
- Monserrate Fm.



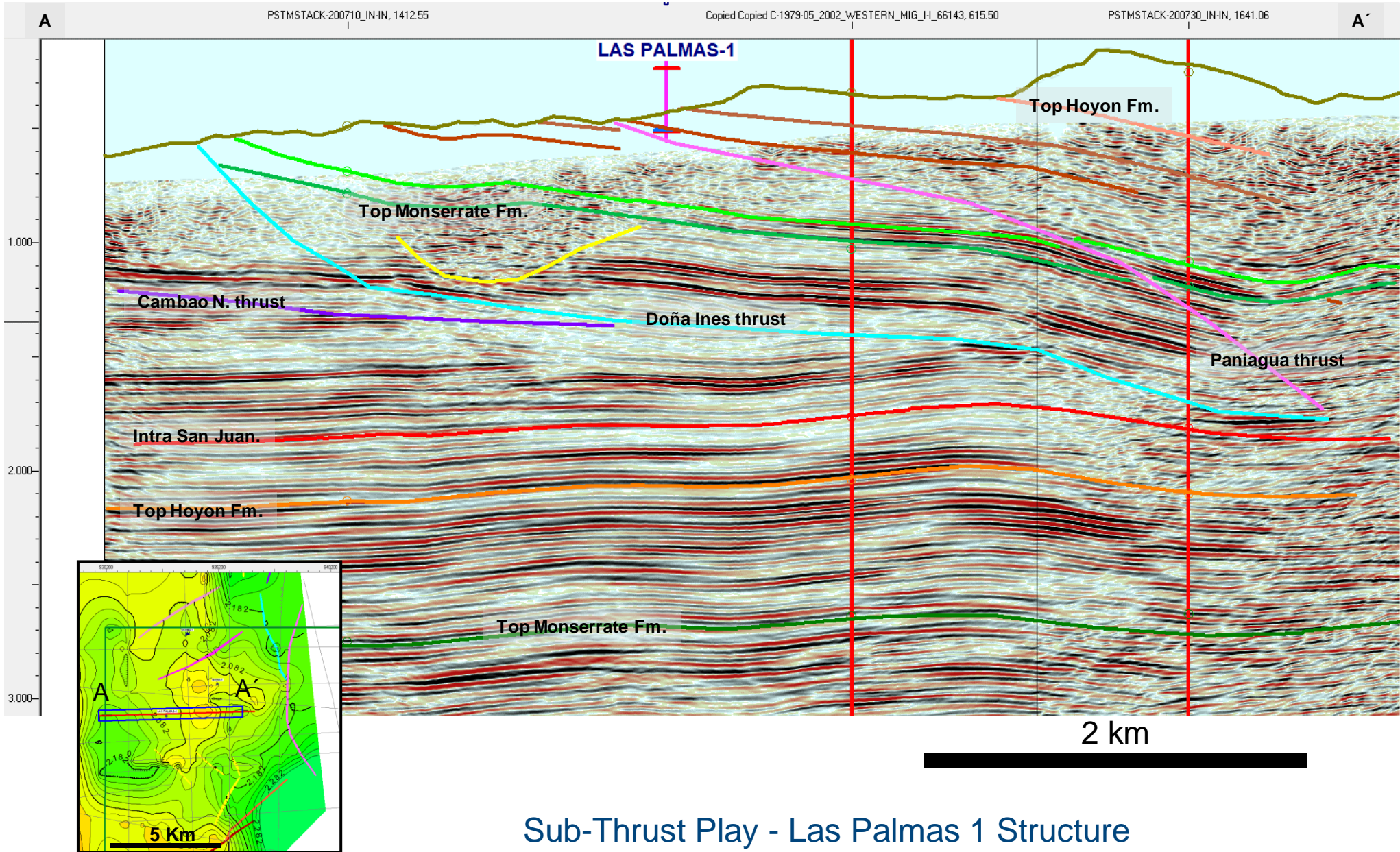
# Sub-Thrust Play



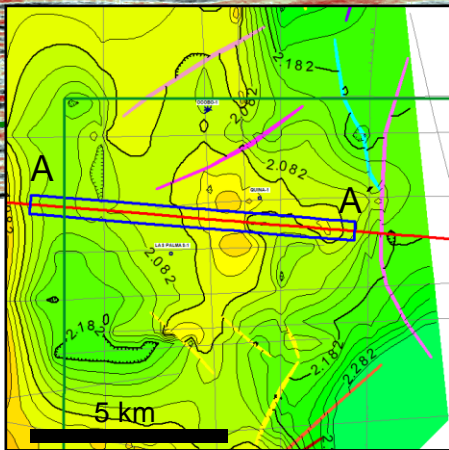
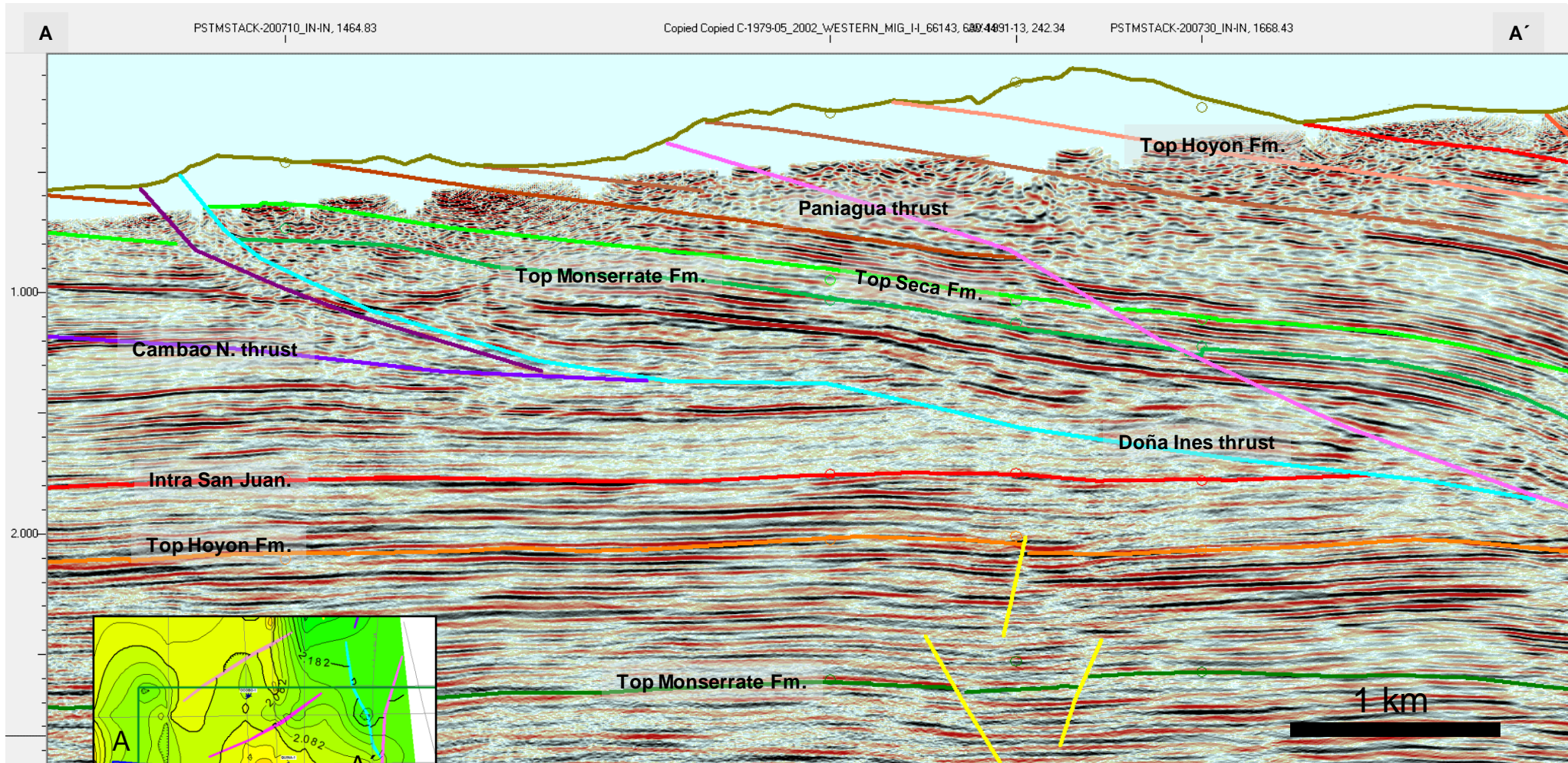




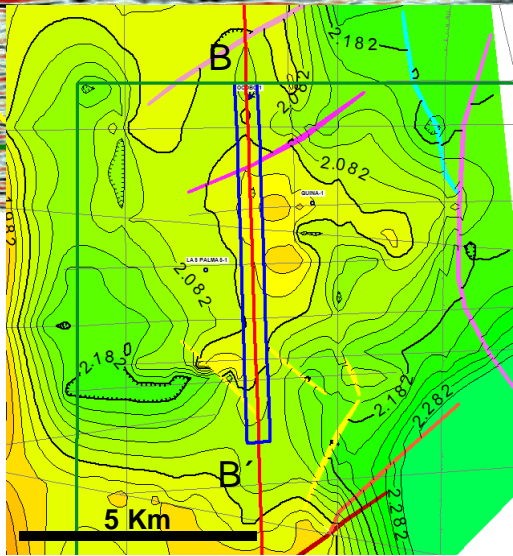
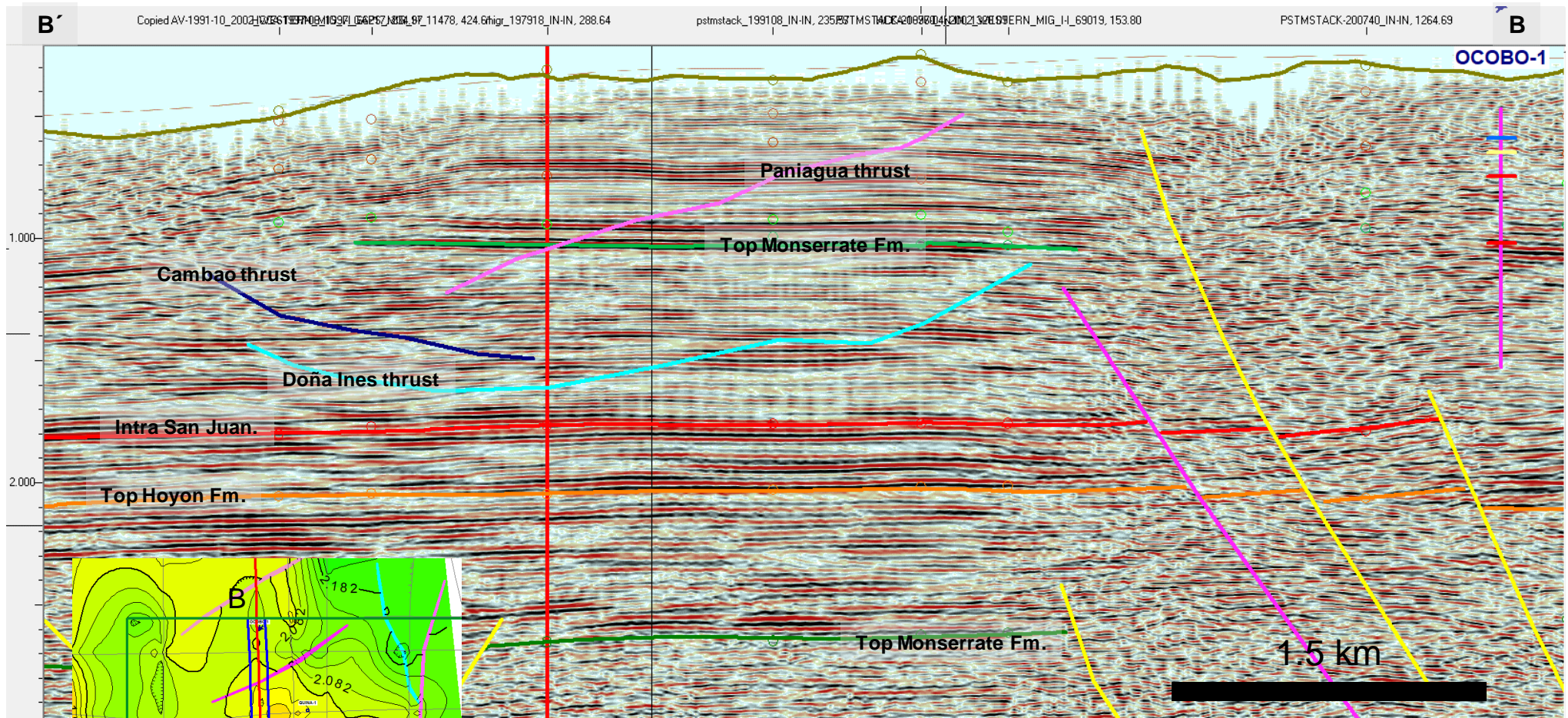
Sub-Thrust play with relics of an early Tertiary extensional event



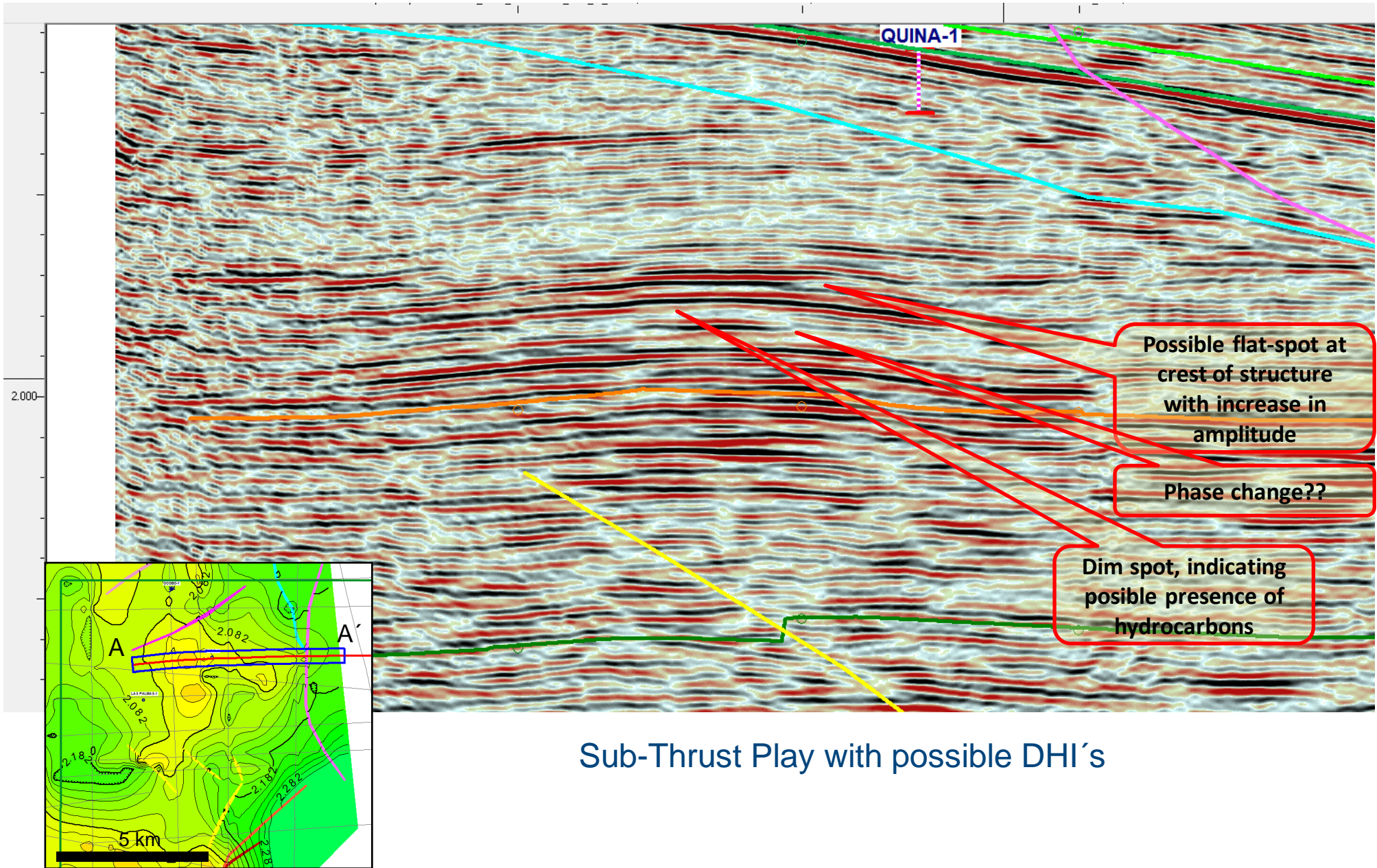
Sub-Thrust Play - Las Palmas 1 Structure



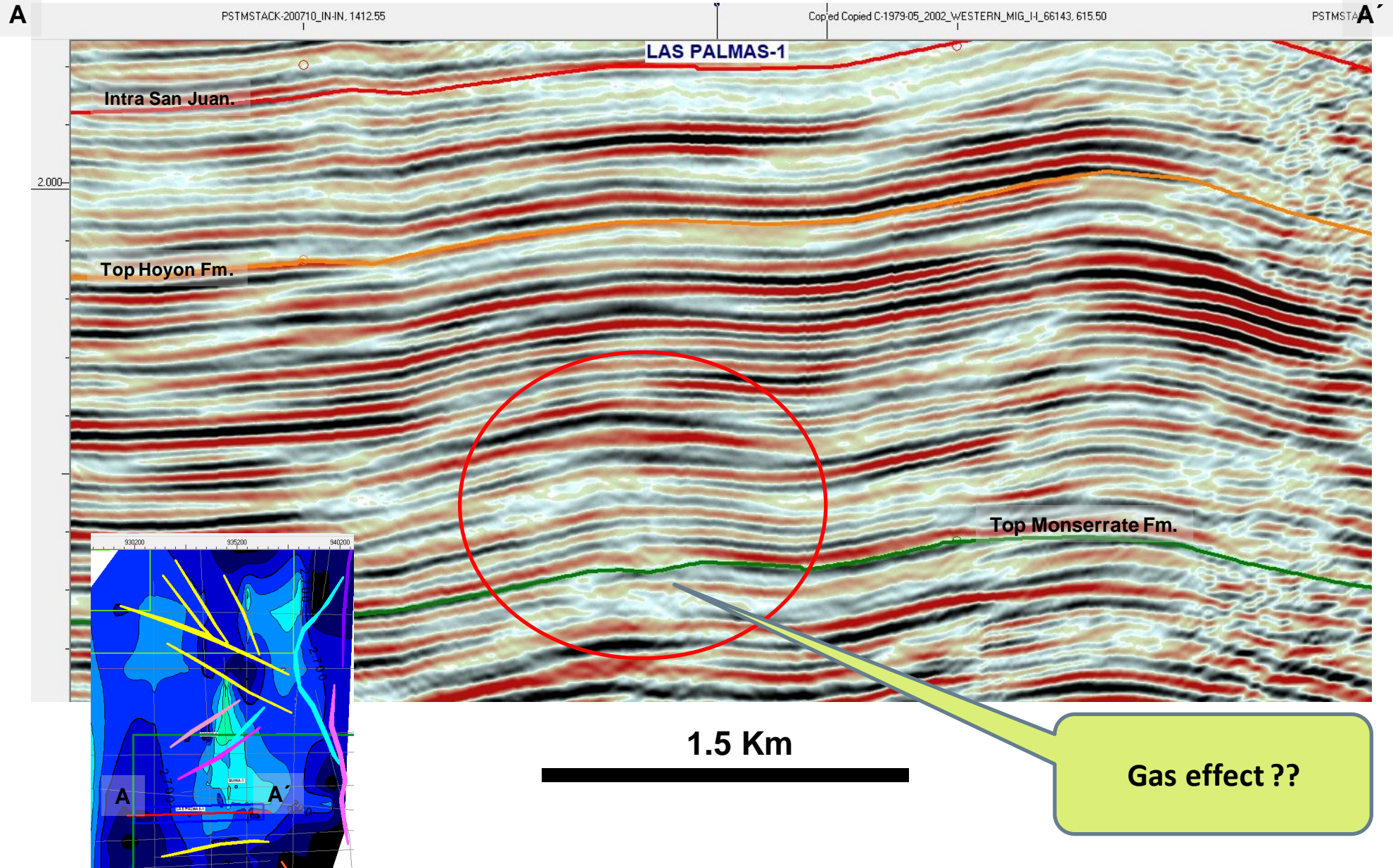
Sub-Thrust play with relics of an early Tertiary extensional event



2D seismic strike line across sub-thrust play



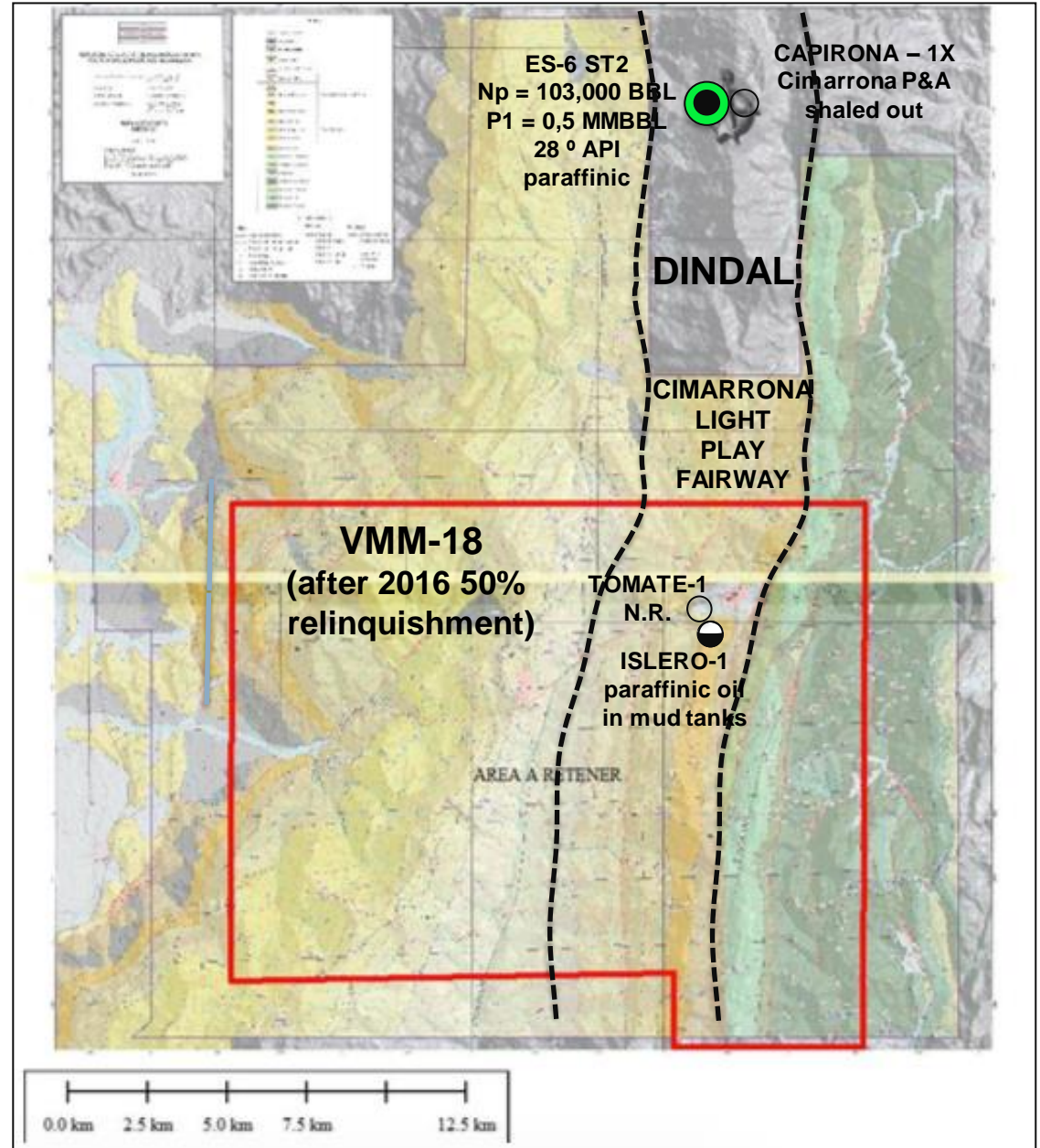
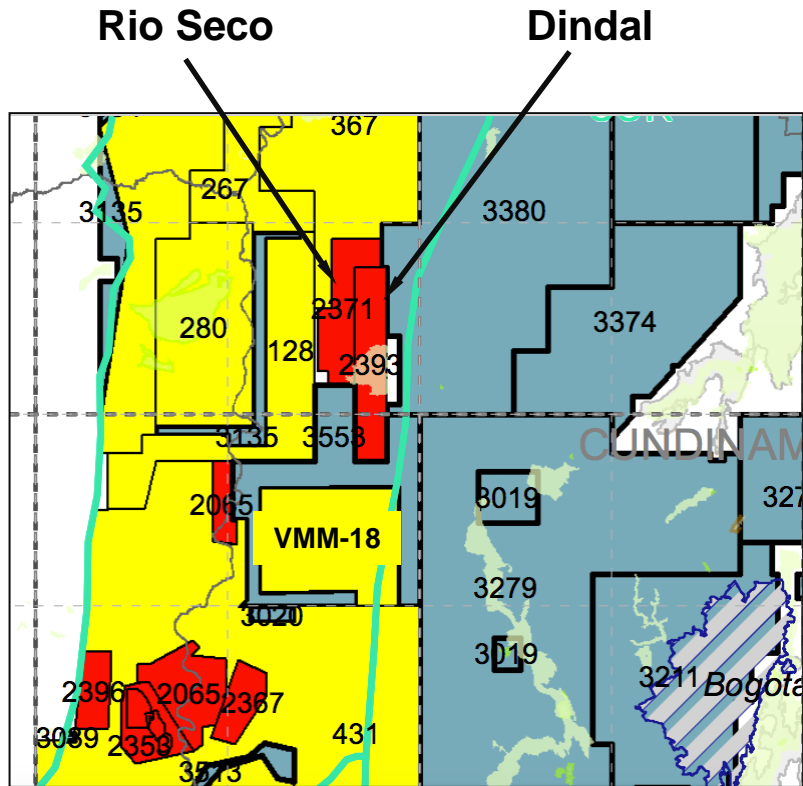
Sub-Thrust Play with possible DHI's



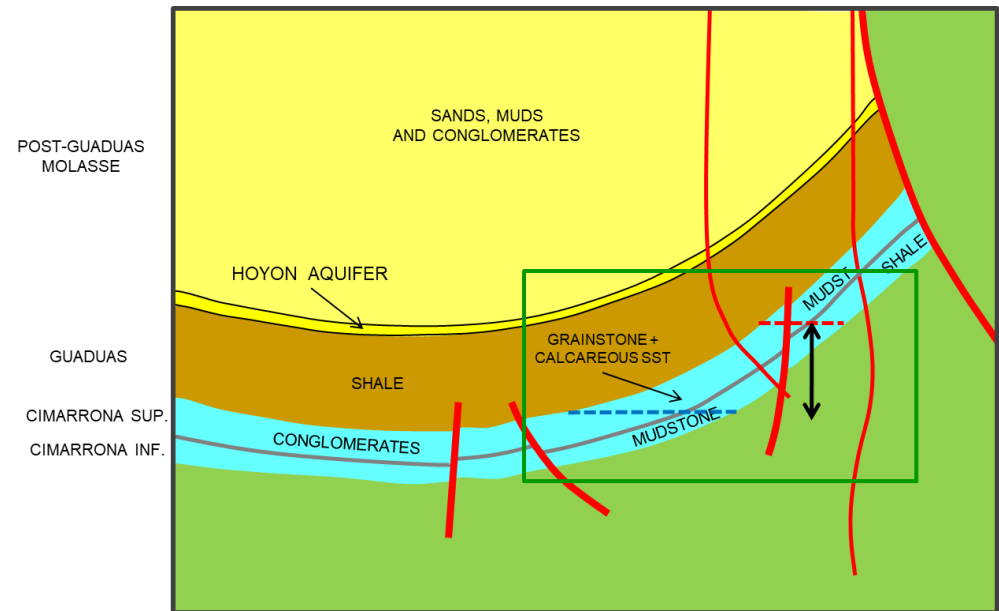
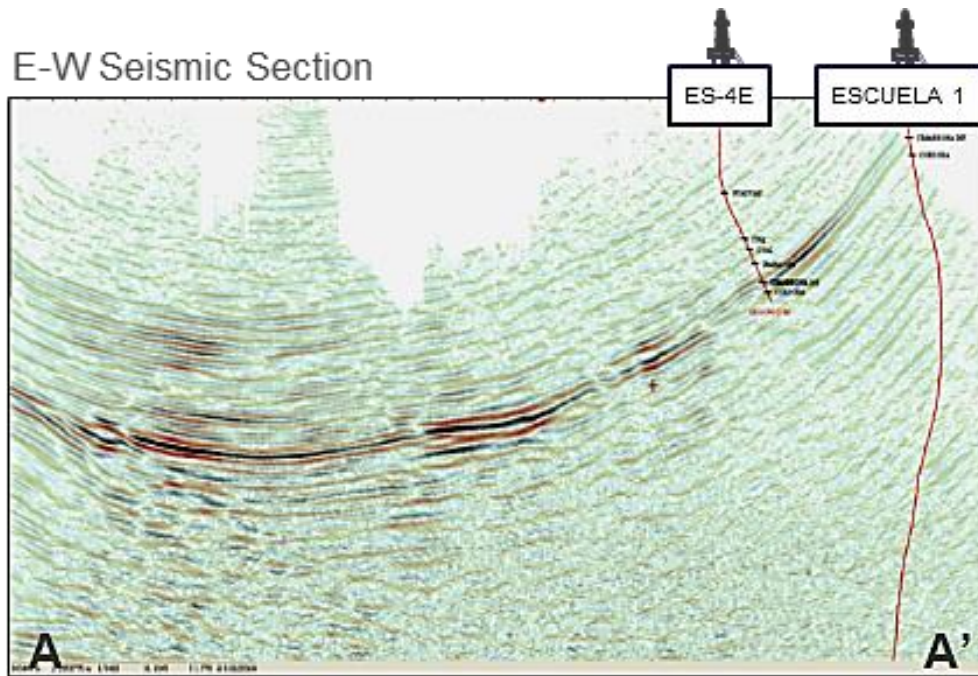
# **Guaduas Syncline Play**

# **Cimarrona Deep Sub-Thrust Play**



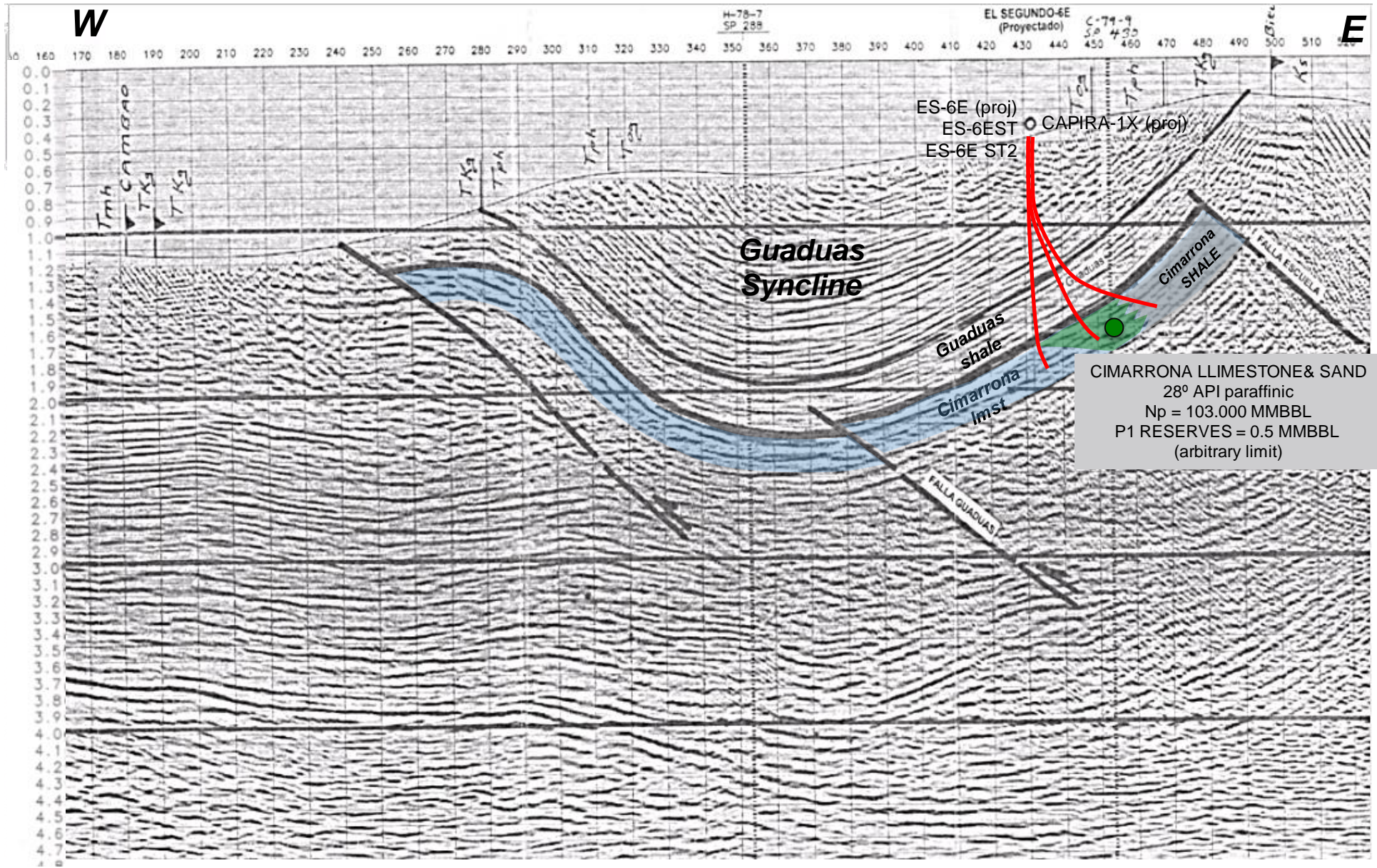


E-W Seismic Section



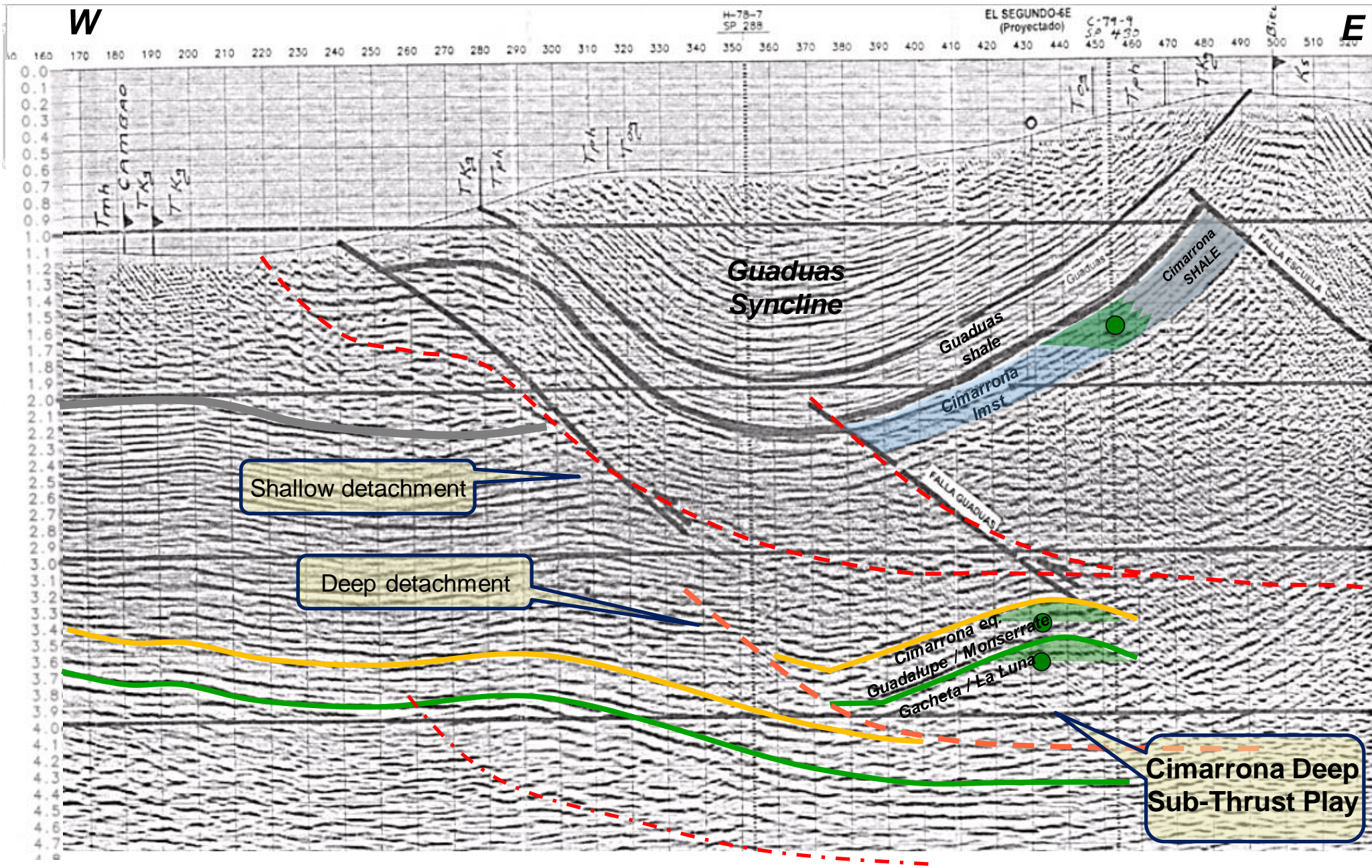
Source: Presentation PRE, 2010

# Guaduas Syncline Play (2)



CIMARRONA LIMESTONE & SAND  
 28° API paraffinic  
 N<sub>p</sub> = 103.000 MMBBL  
 P1 RESERVES = 0.5 MMBBL  
 (arbitrary limit)

# **Cimarrona Deep Sub-Thrust Play**



**END**

*L. Porrás<sup>1,2</sup>, J.F. Arminio<sup>1</sup>, A. Lara<sup>1</sup> and M. Ostos<sup>1</sup>*  
*1) New Stratus Energy (1,2) New Stratus Energy and now Hocol S.A.*