

# COLOMBIA ROUND 2021



El futuro  
es de todos

Minenergía

# STRATIGRAPHY AND PALEOENVIRONMENTS OF COLOMBIAN CARIBBEAN AND EASTERN CORDILLERA BASINS, BASED ON ANH WELLS

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Fabian Gallego B.  
Sergio Celis H.

Universidad de Caldas, Instituto de Investigaciones en Estratigrafía



# CALDAS UNIVERSITY LABS-INSTITUTO DE INVESTIGACIONES EN ESTRATIGRAFÍA-IIES (2013-2021)



- Micropaleontology (palynology, foraminífera, calcareous nanofossils, diatoms, ostracods, mollusks)
- Sedimentology, provenance
- Ichnology
- Basin analysis (seismic interpretation)
- Geochronology-Thermochronology.



## IIES TECHNICAL STAFF



### Palynology

Andrés Pardo Ph.D.  
Ángelo Plata M.Sc. C. Ph.D.  
Felipe Duque Ph.D.  
Andrés Díaz M.Sc.

### Foraminifera

Raúl Trejos M.Sc. C. Ph.D.  
Mónica Duque M.Sc.  
Darwin Garzón c. M.Sc.

### Calcareous nanofossils:

Felipe Vallejo M.Sc. C. Ph.D.  
Margarita Buitrago Ph.D.  
Esteban Osorio c. M.Sc.

### Ostracods:

Andrés Salazar M.Sc. C. Ph.D.

### Sedimentology

Carlos A. Guzmán Ph.D.  
Valentina Espinel Ph.D.  
Fabián Gallego M.Sc.  
Edward Osorio M.Sc.  
Sebastián Rosero M.Sc.  
Jaime Muñoz M.Sc.  
Valentina Vargas M.Sc.

### Ichology:

Sergio Celis M.Sc. C. Ph.D.  
Carlos Giraldo M.Sc.

### Geochronology- Thermochronology

Sebastián Echeverri Ph.D.  
Ángel Barbosa Ph.D.

### Seismic interpretation

Lina M. Rendón M.Sc.  
Alejandro Arenas M.Sc.

### Vulcanology

Hugo F. Murcia Ph.D.  
Susana Osorio Ph.D.  
Laura Sánchez M.Sc.



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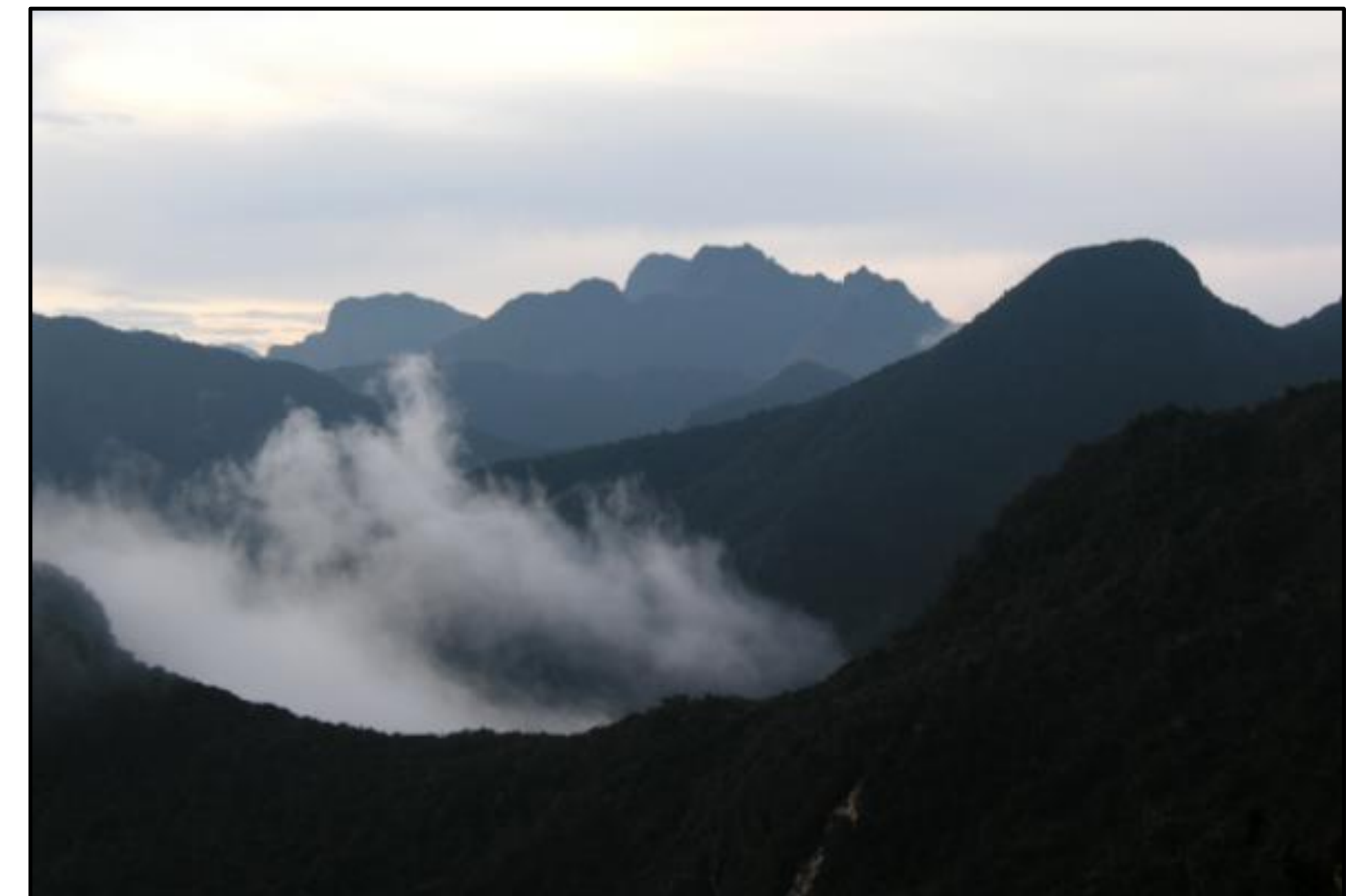


# SOME STUDIED AREAS



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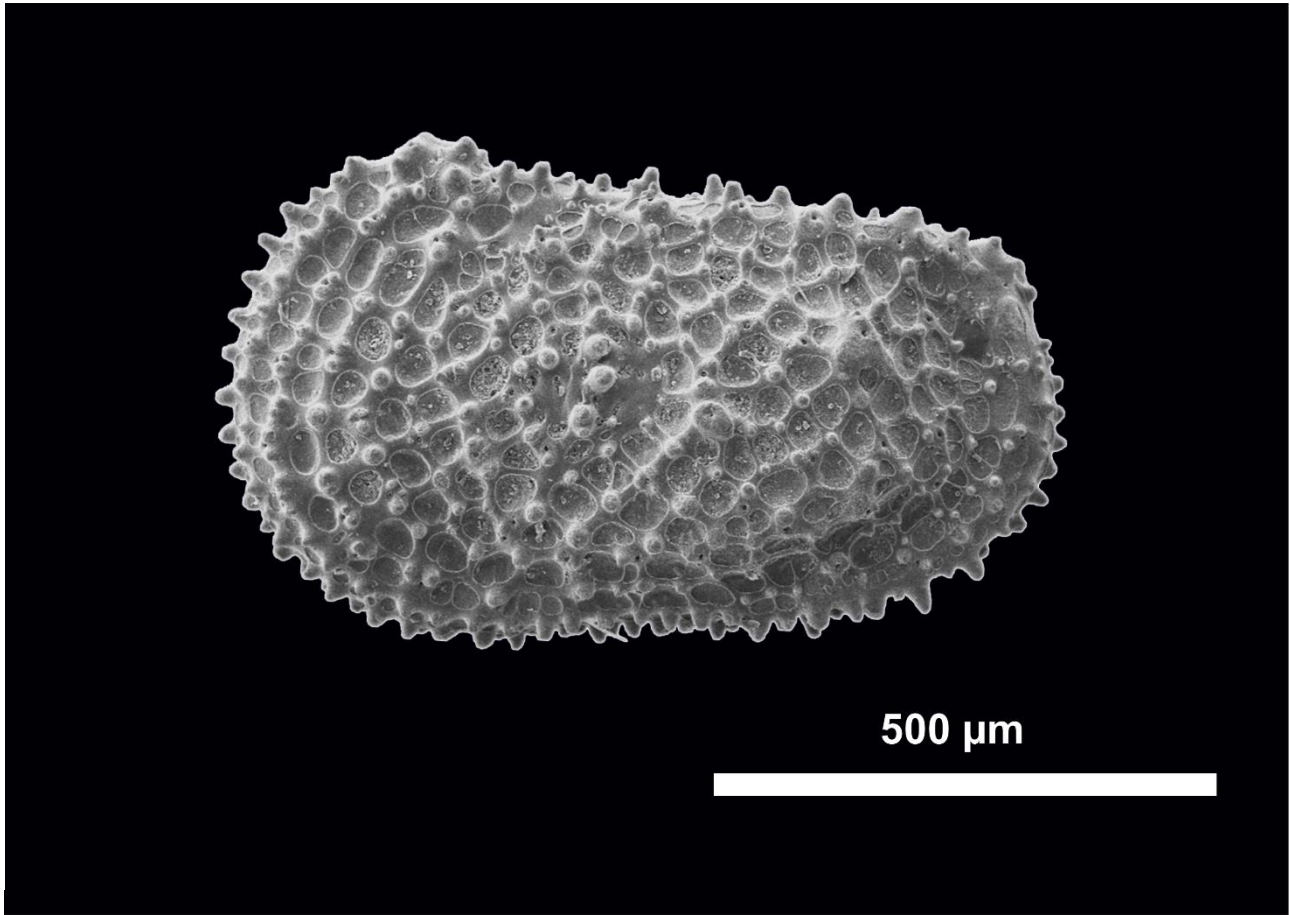




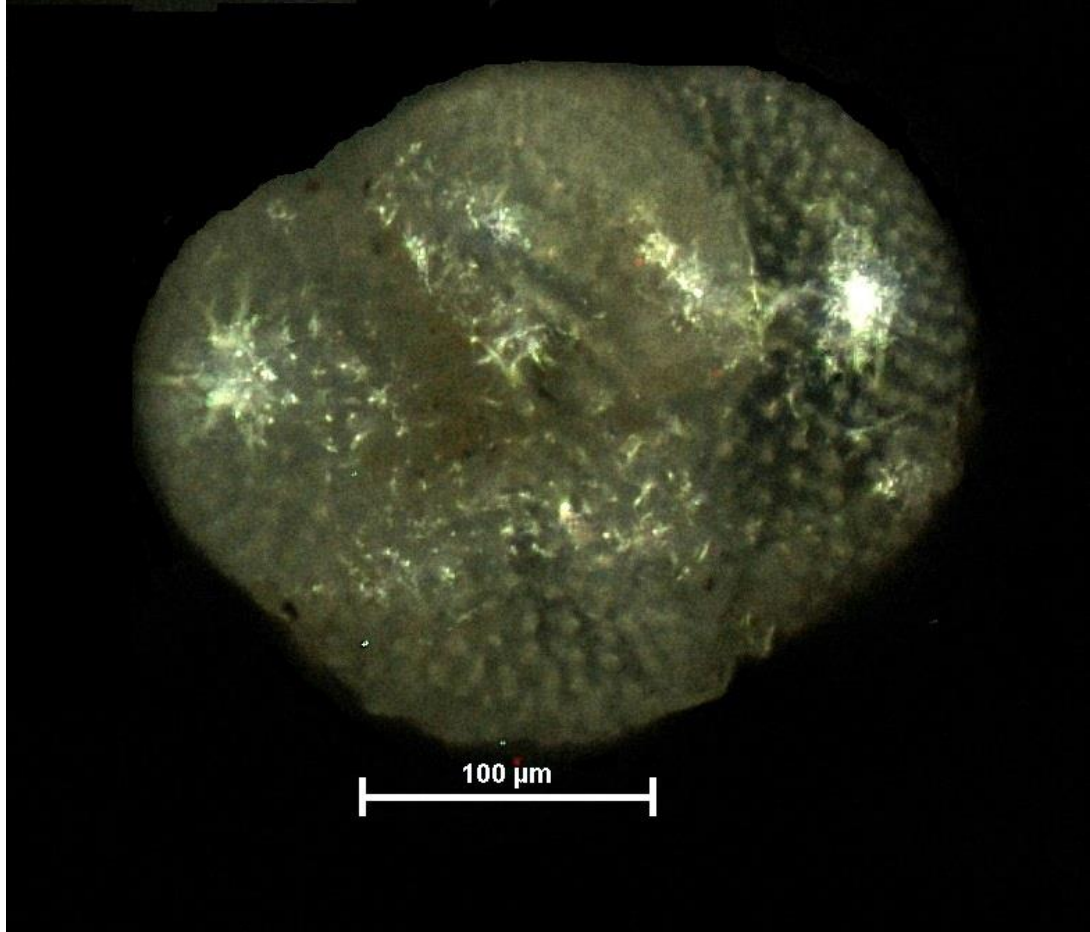
• Palynology



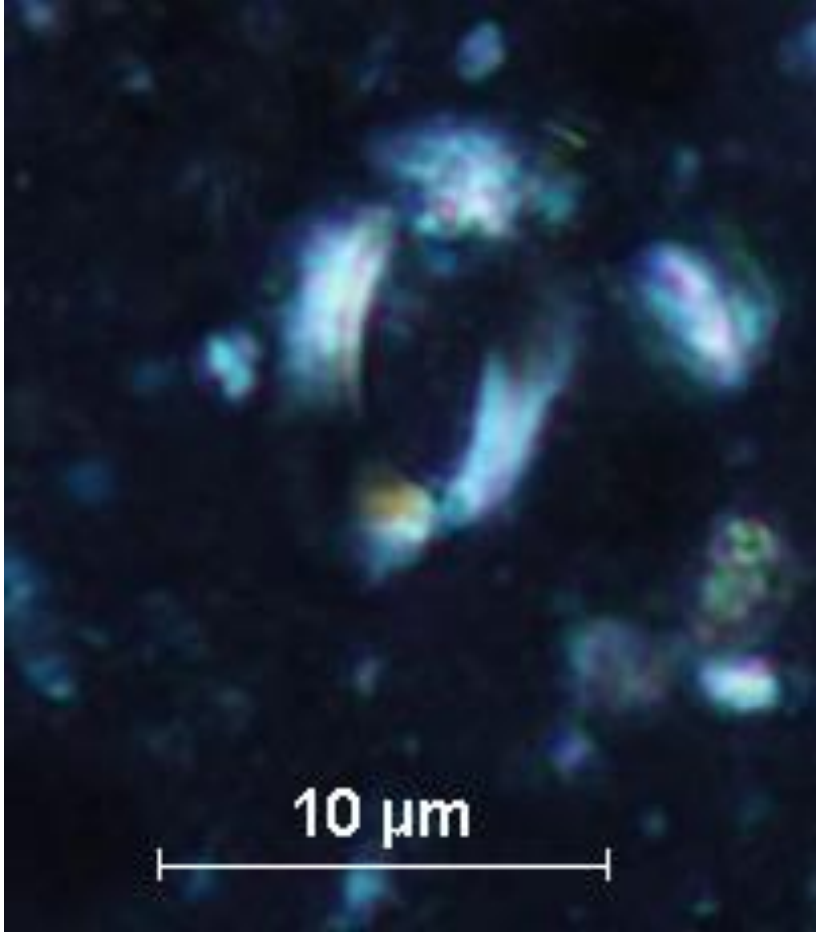
• Ostracods-mollusks



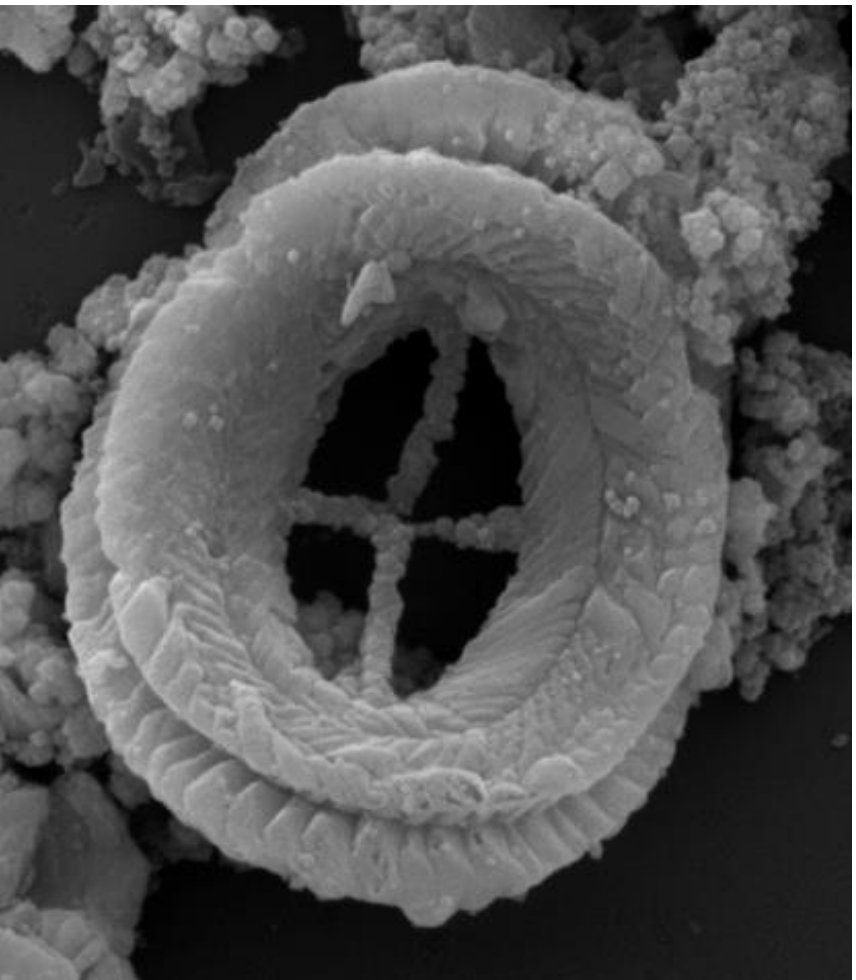
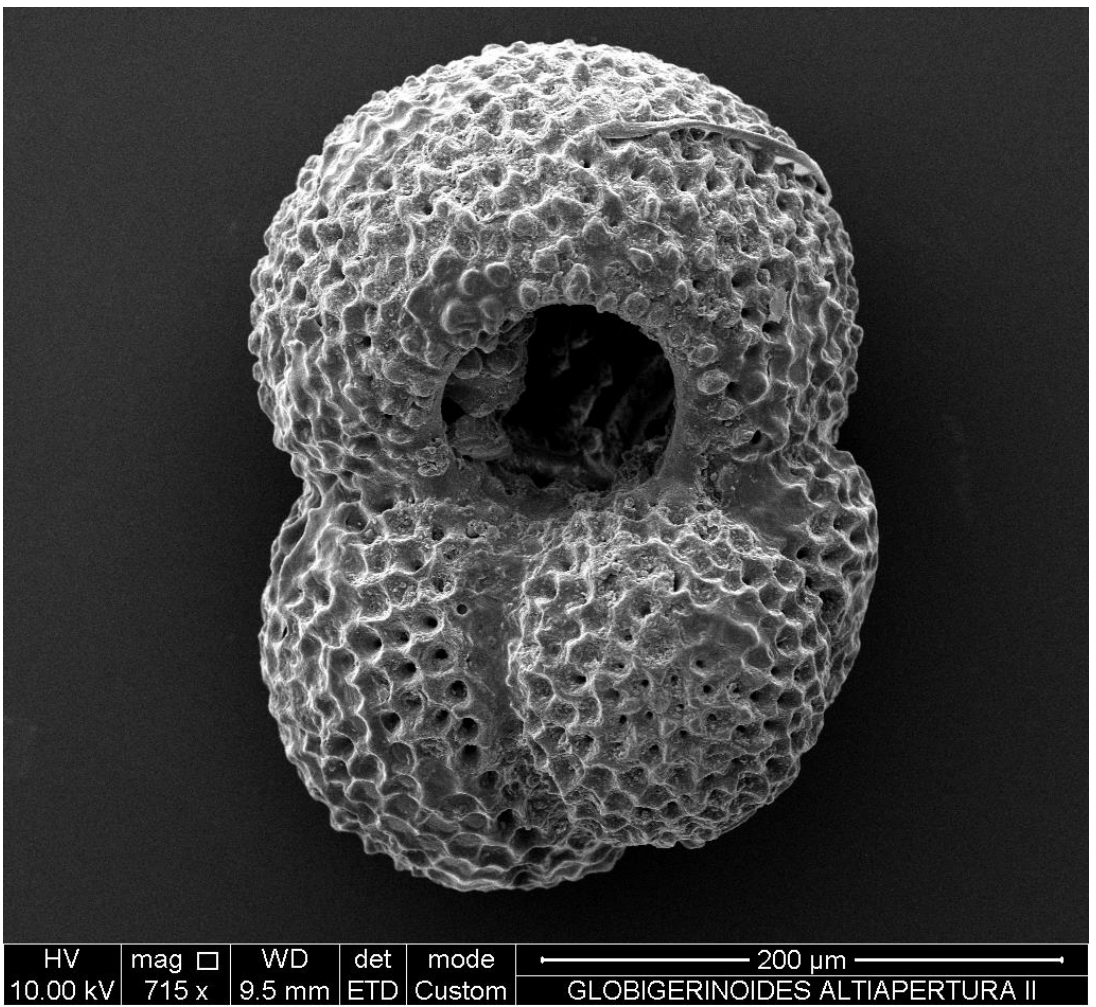
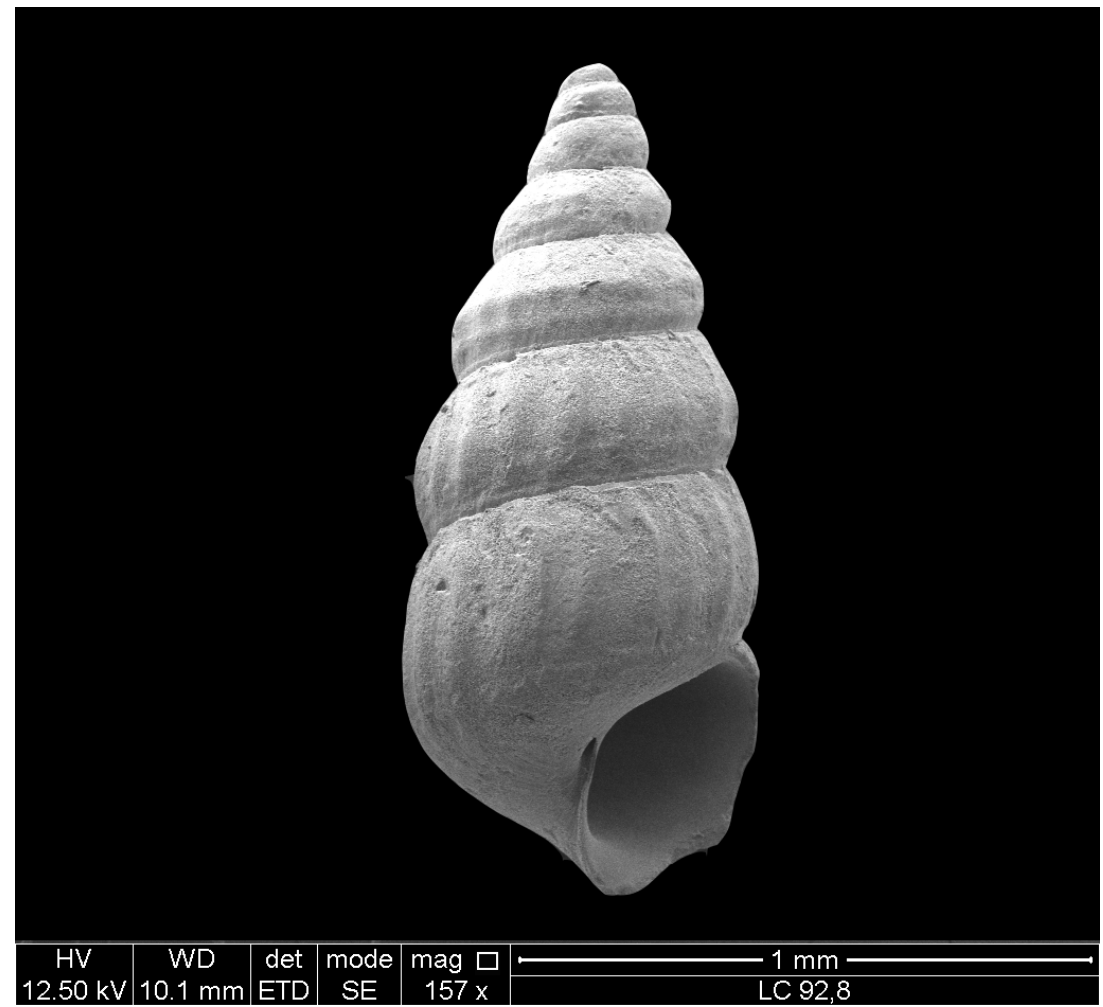
• Foraminifera



• Calcareous nanofossils

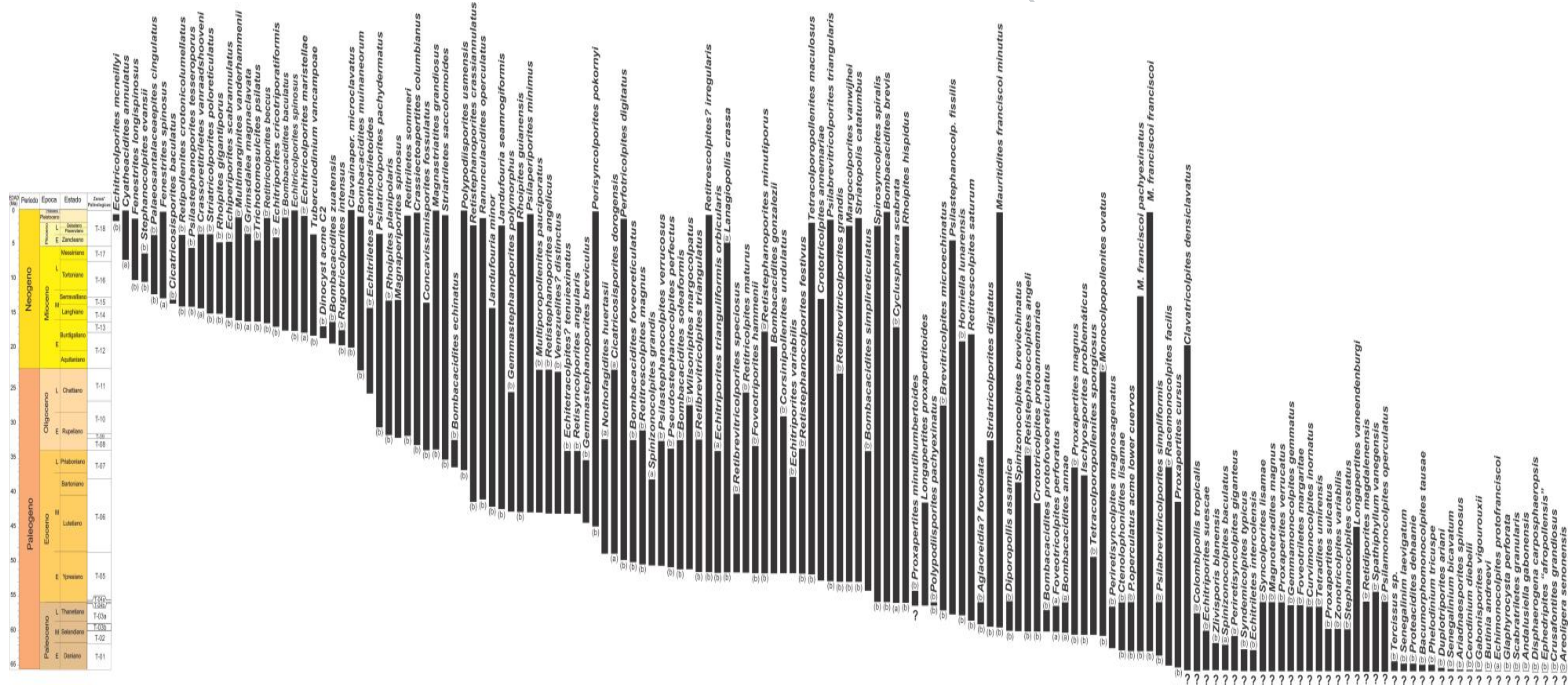


VNIVERSIDAD  
D SALAMANCA



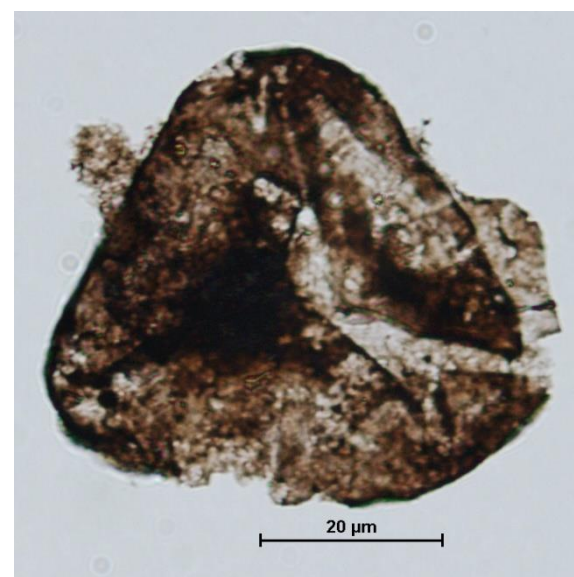
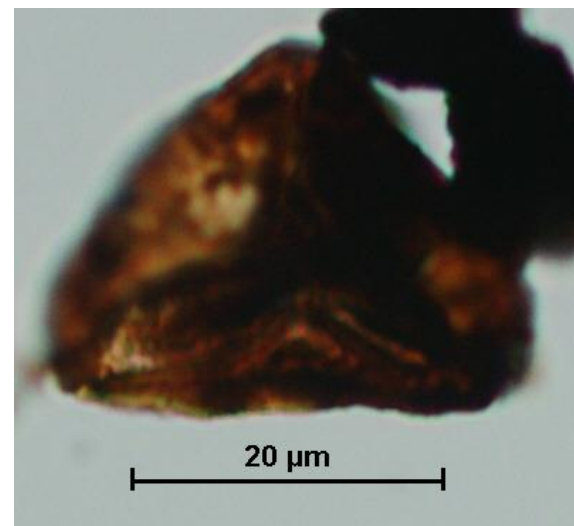
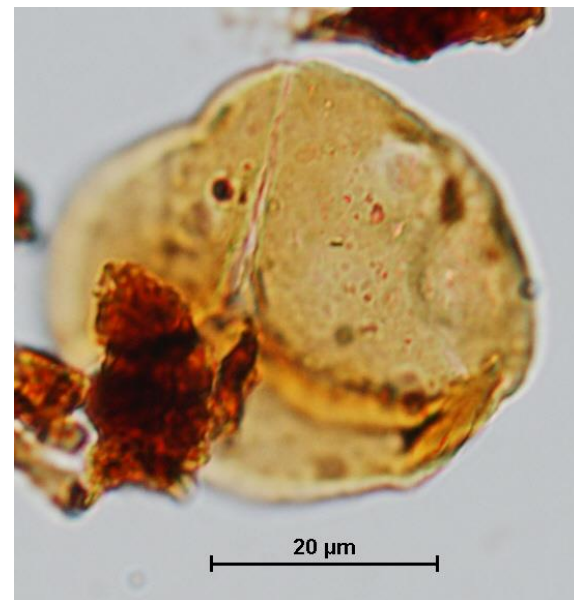


# PALINOLOGY-STRATIGRAPHIC FRAMEWORK

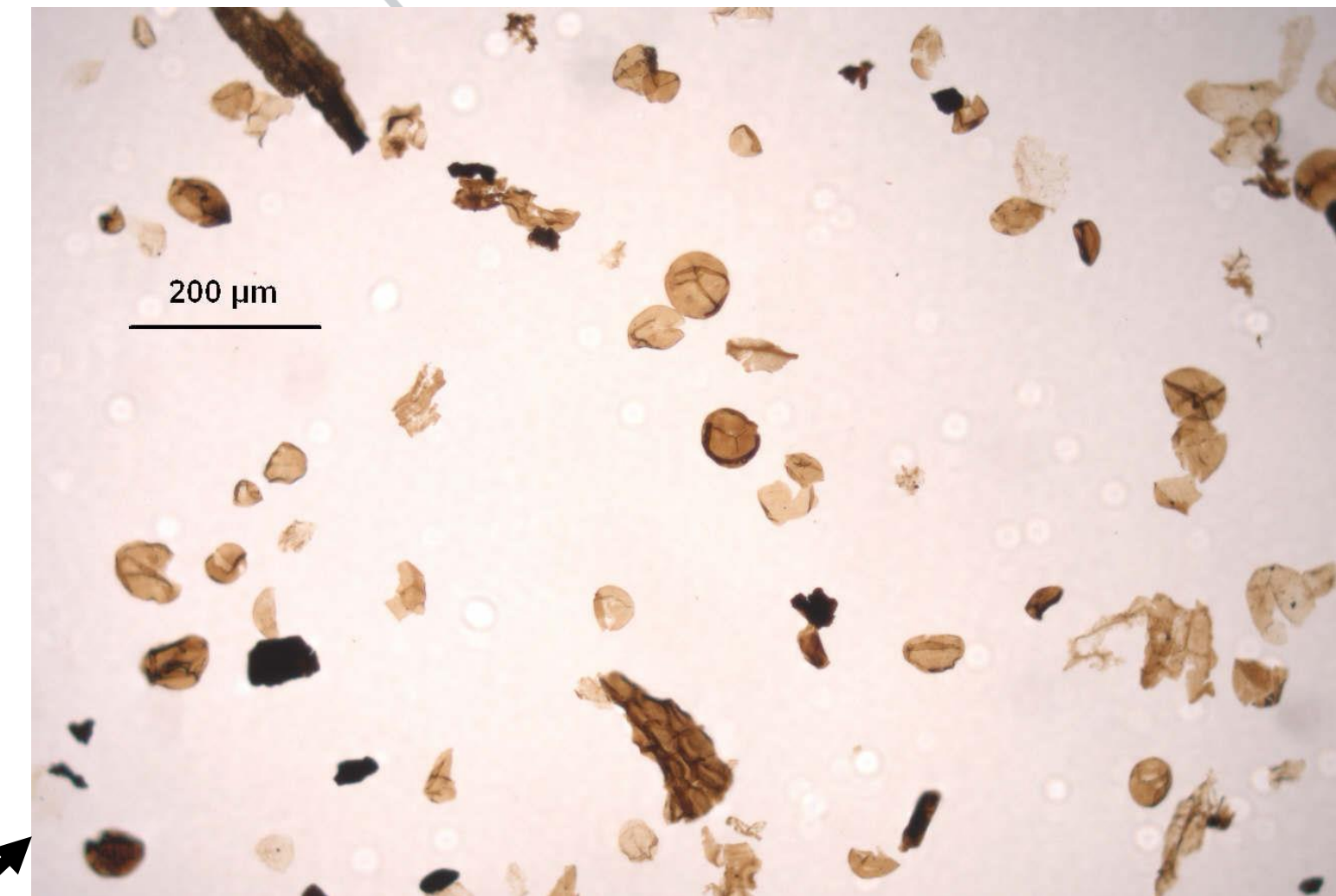




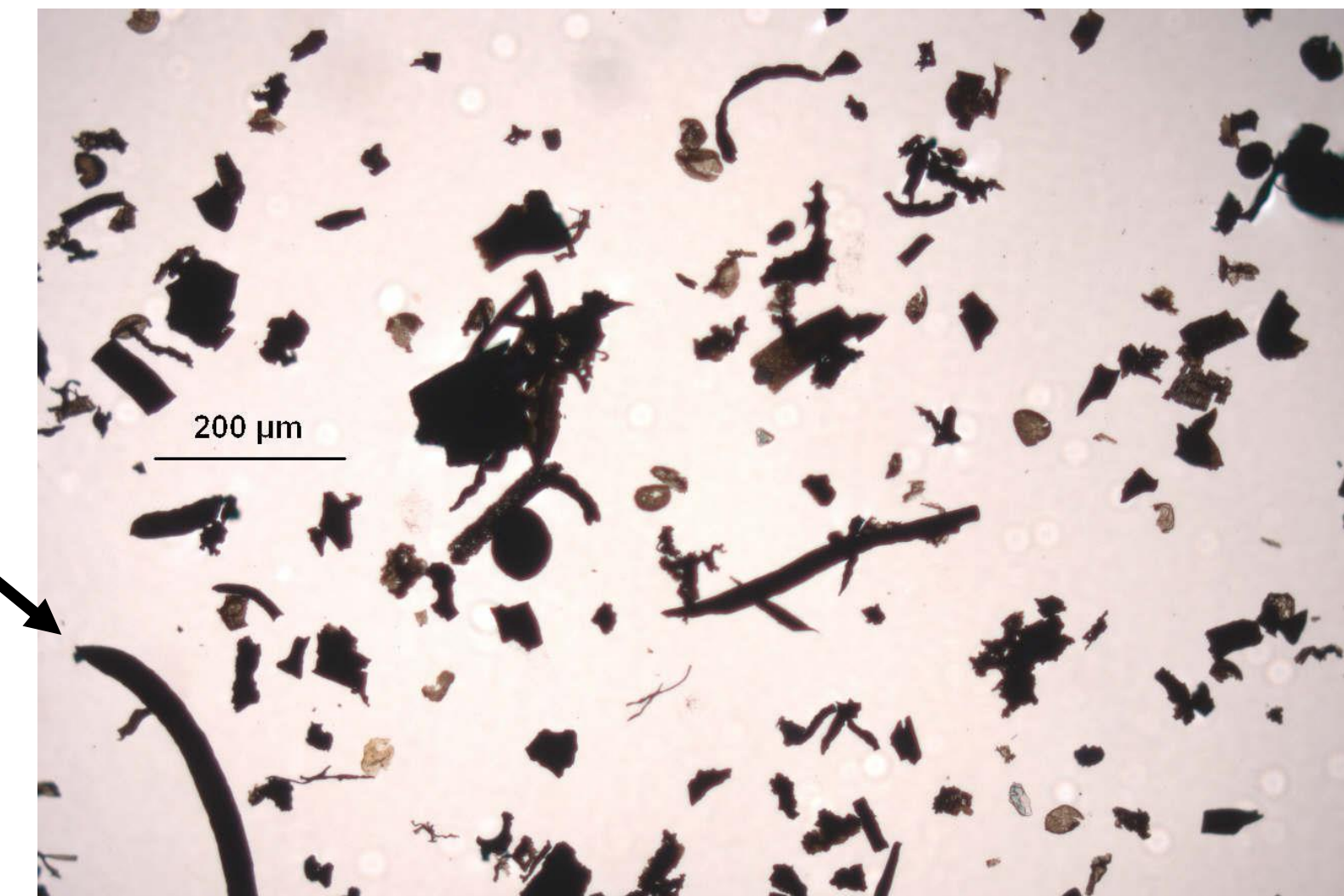
# PALYNOLOGY AND THERMAL ALTERATION INDEX



ORGANIC THERMAL MATURITY	COLOR OF FOSSIL SPORES/POLLEN	APPROXIMATE CORRELATION TO OTHER SCALES	
		TAI = 1-5	VITRINITE REFLECTANCE
IMMATURE	[Lightest yellow]	1	0.2%
	[Light yellow]	1+	0.3%
	[Yellow]	2-	
	[Yellow-orange]	2	
MATURE MAIN PHASE OF LIQUID PETROLEUM GENERATION	[Orange]	2+	0.5%
	[Orange-brown]	3-	.9%
	[Brown]	3	
	[Dark brown]	3+	1.3%
DRY GAS OR BARREN	[Darkest brown]	4-	2.0%
	[Black]	4	2.5%
	[Black & Deformed]	(5)	



**Mature**



**Overmature**

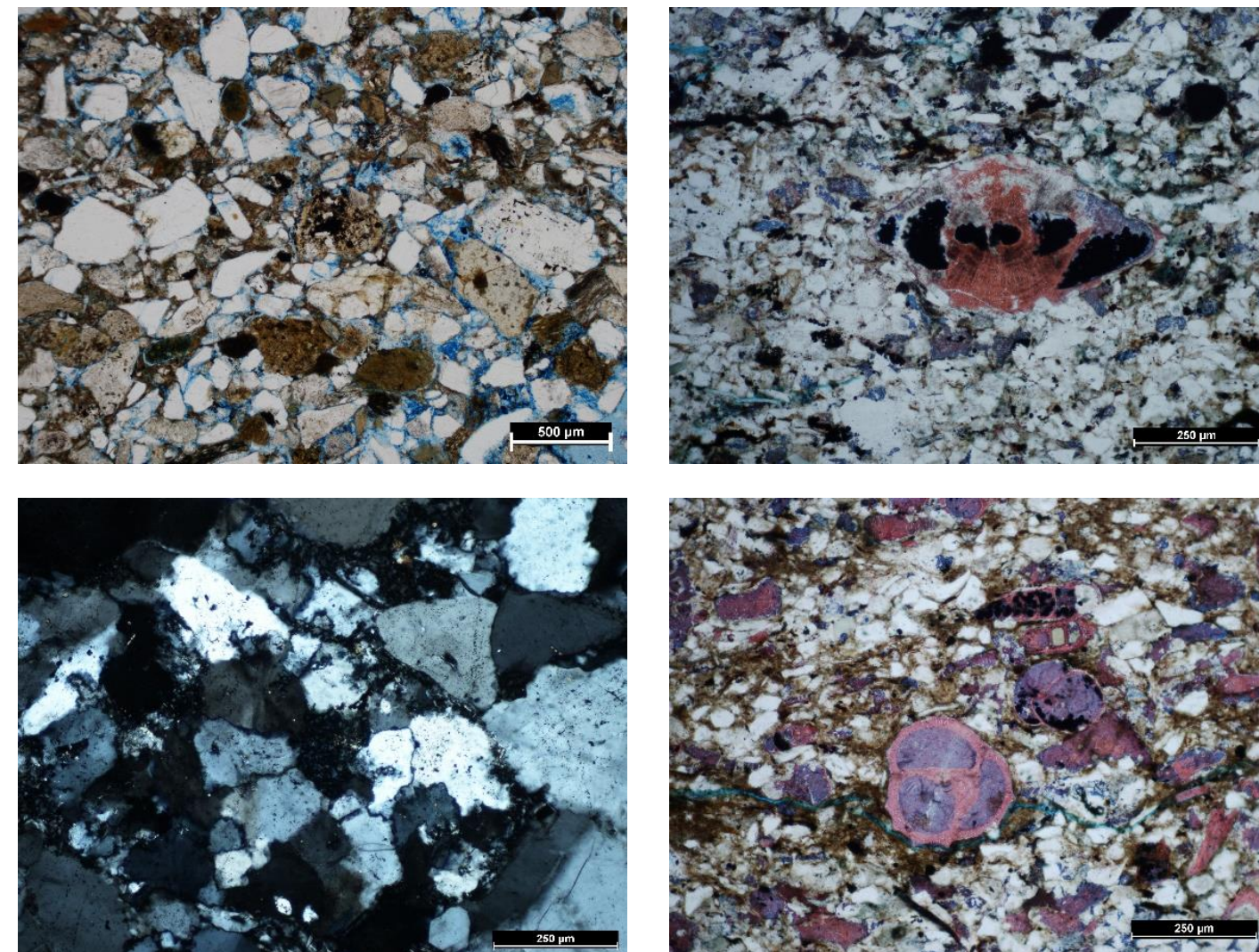


# PROVENANCE ANALYSES

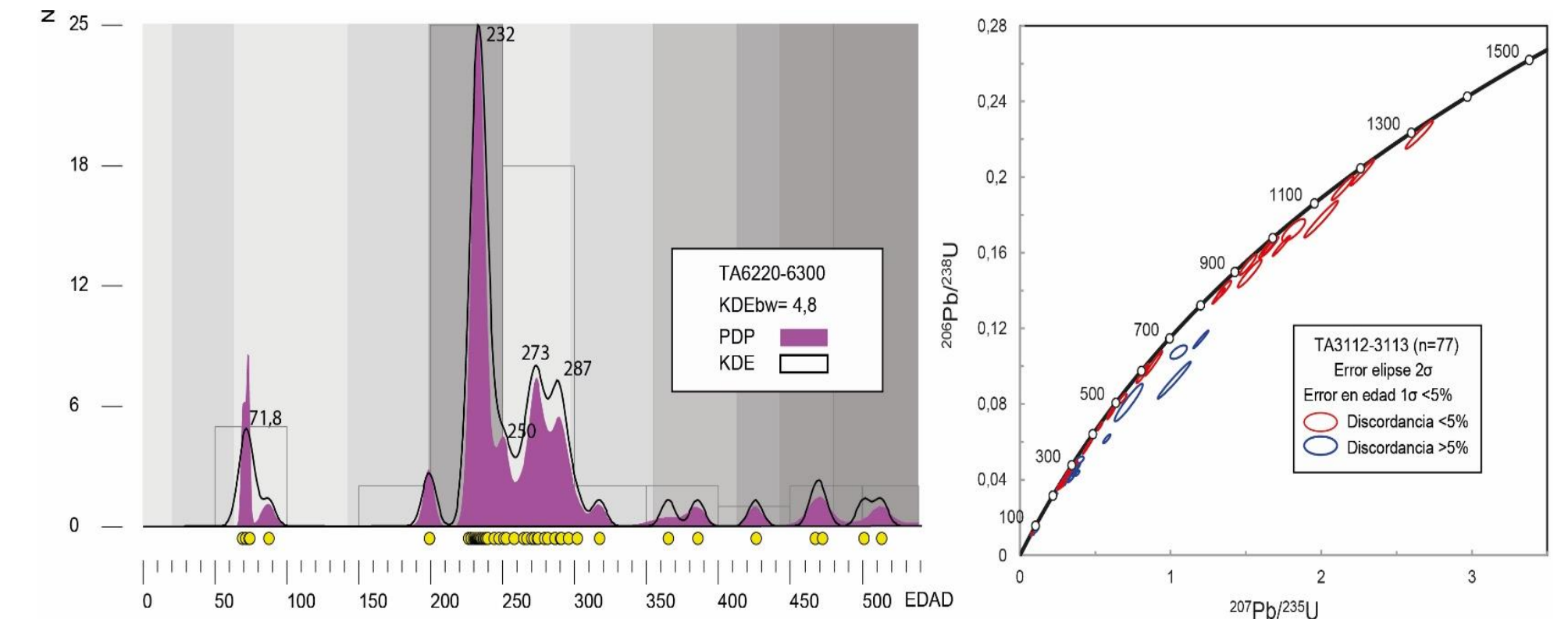
## Cores



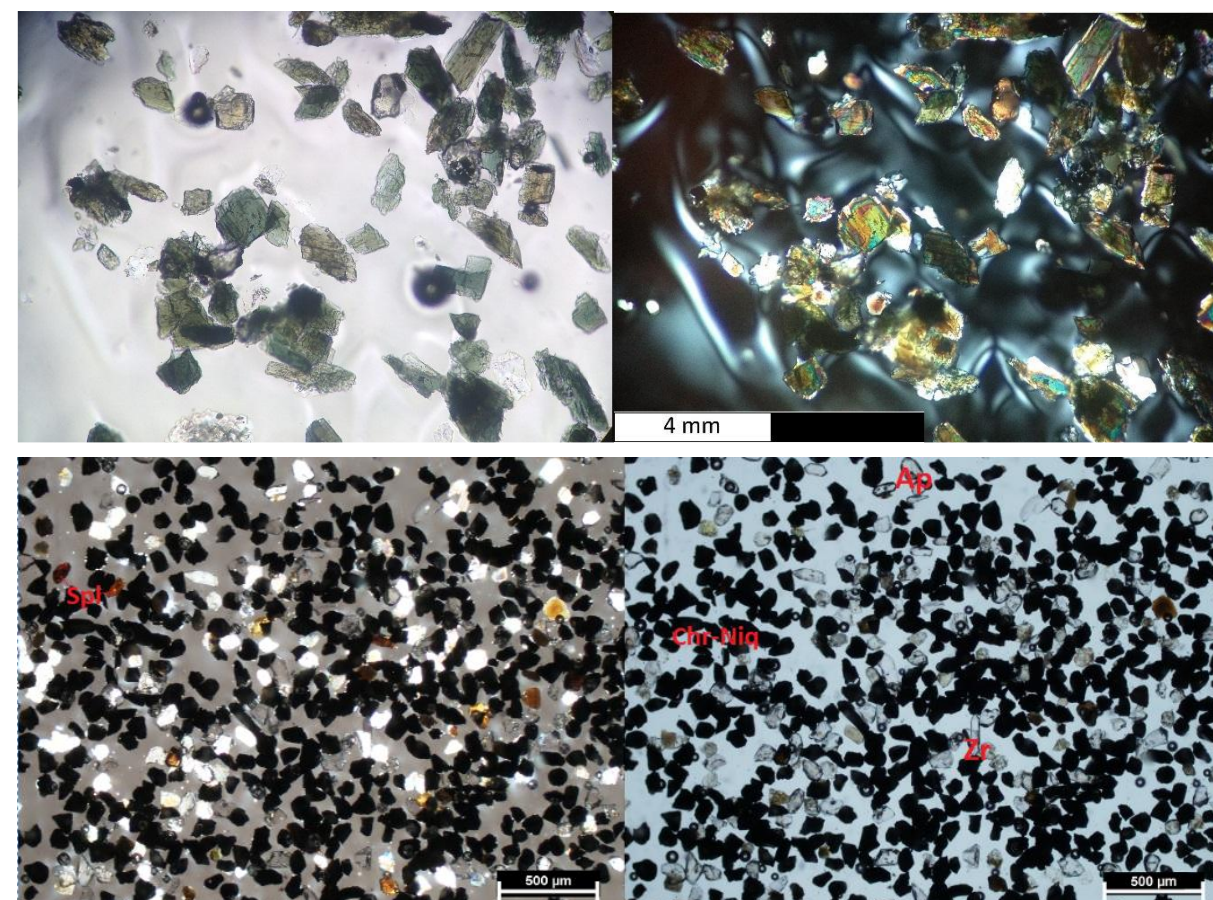
## Petrography



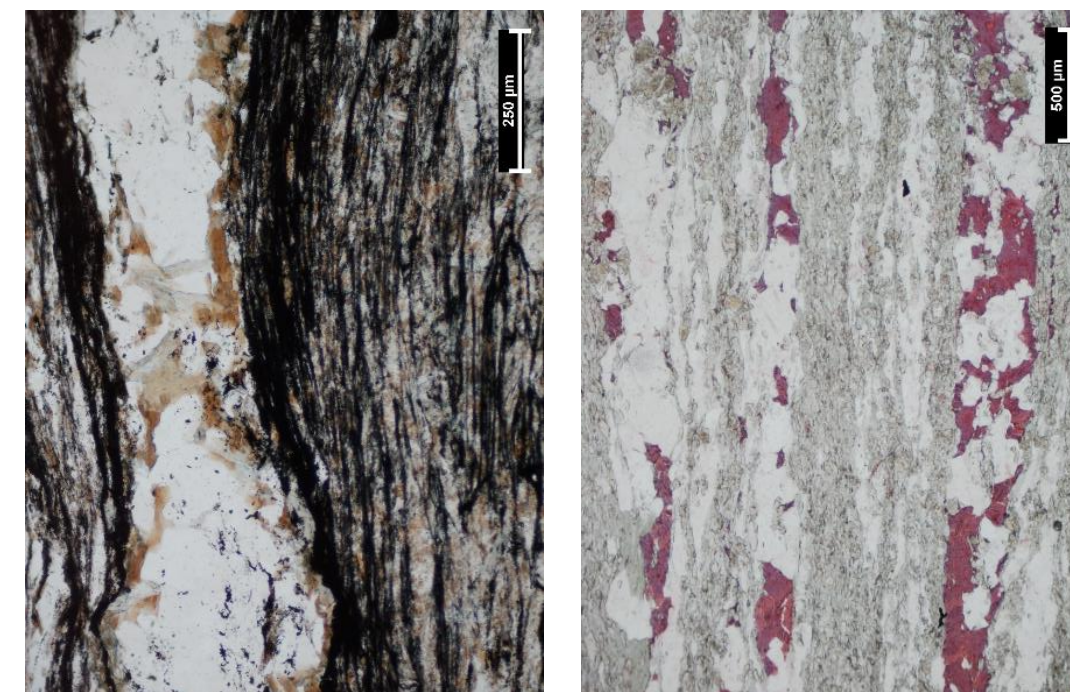
## U/Pb detrital geochronology



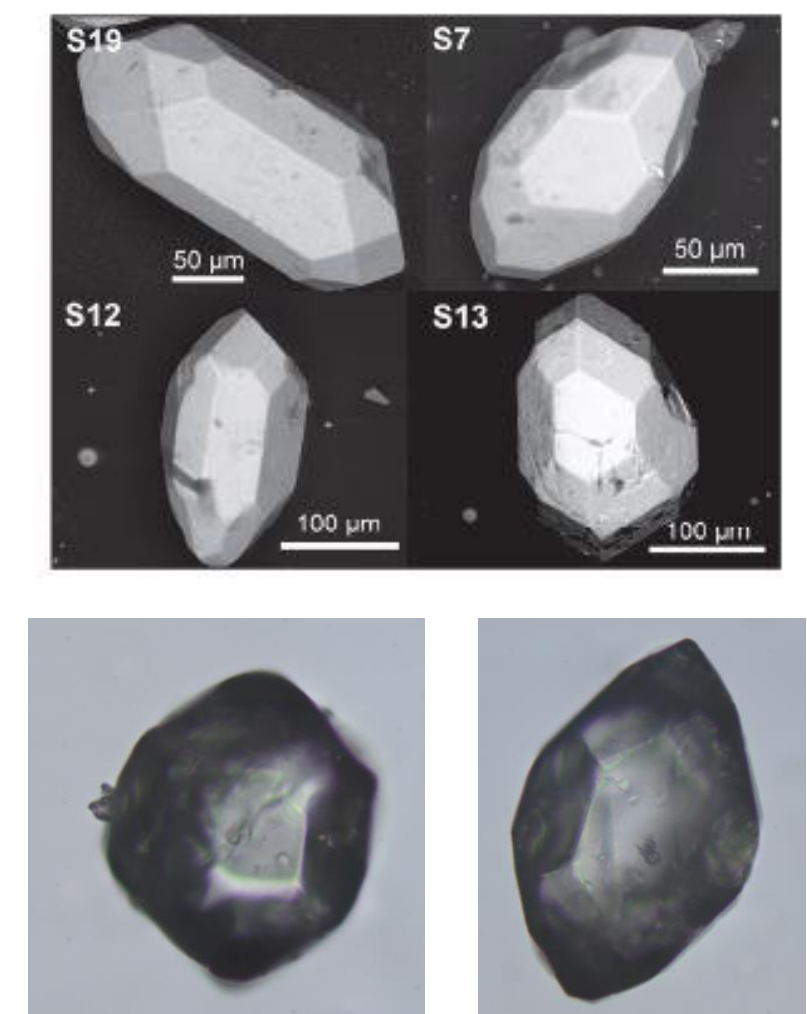
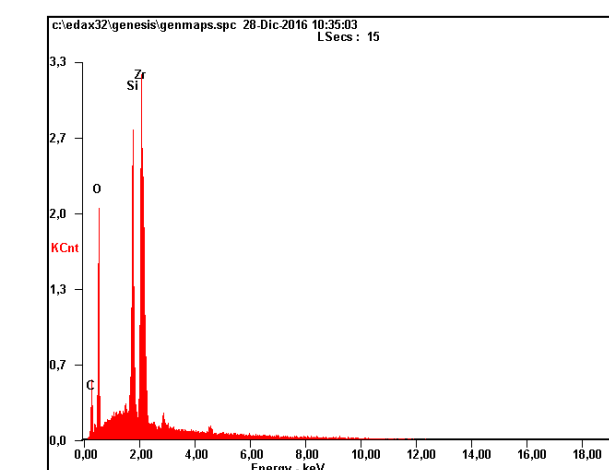
## Heavy minerals



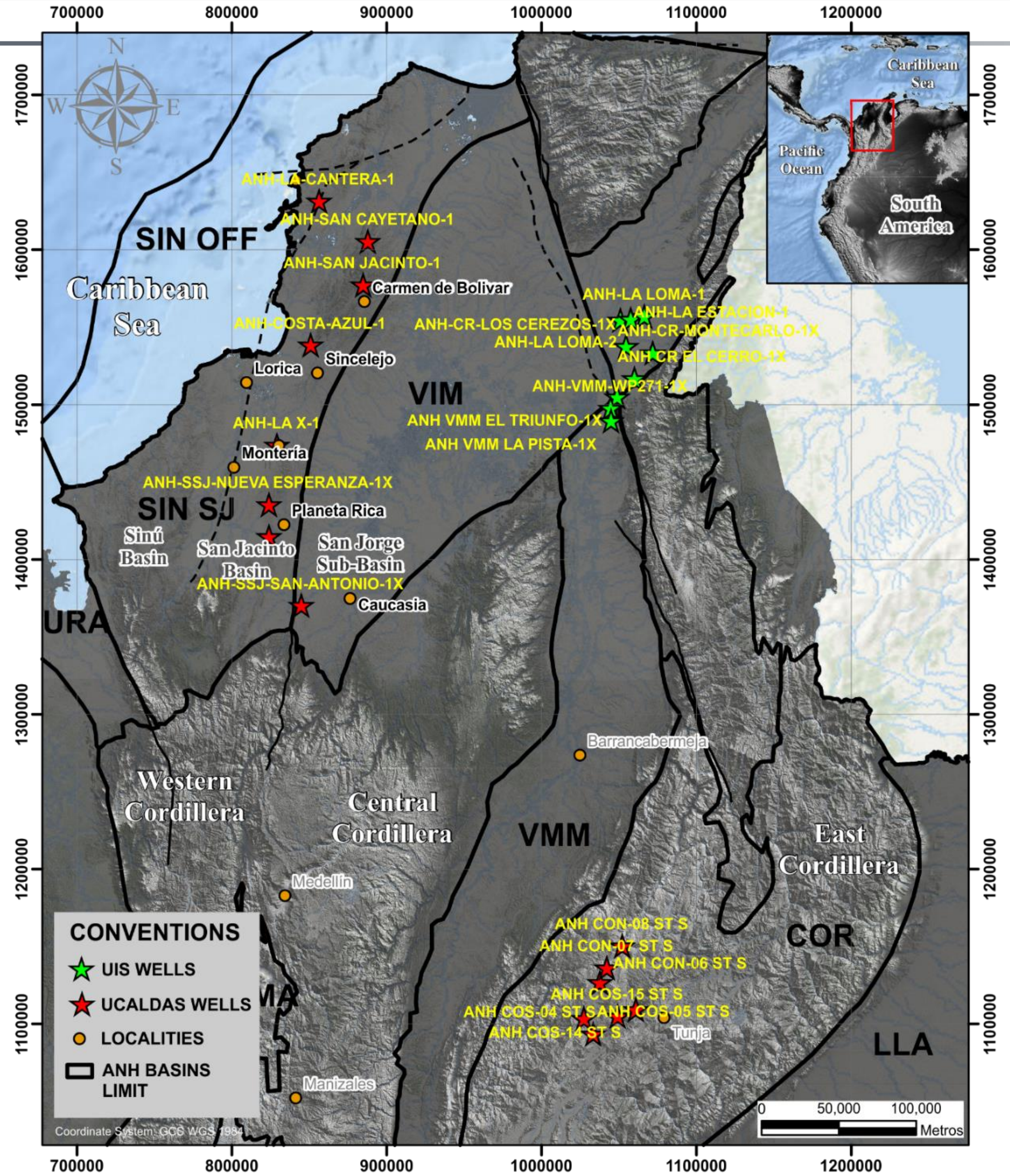
## Igneous-metamorphic petrology



## SEM-EDX







## ANH Wells in different basins

Increase the geologic knowledge of the basins and their petroleum potential

## Location of the studied Wells

- San Jacinto Fold Belt (UCALDAS)
- VMM-Cesar-Ranchería (UIS)
- Eastern Cordillera (UCALDAS)

## Goals of the project

- Age and depositional environments of 50.000 ft (15. 000 m) of cores from different basins
- Improve the academic formation of professionals of the research group of Caldas University



# ANH PROJECT

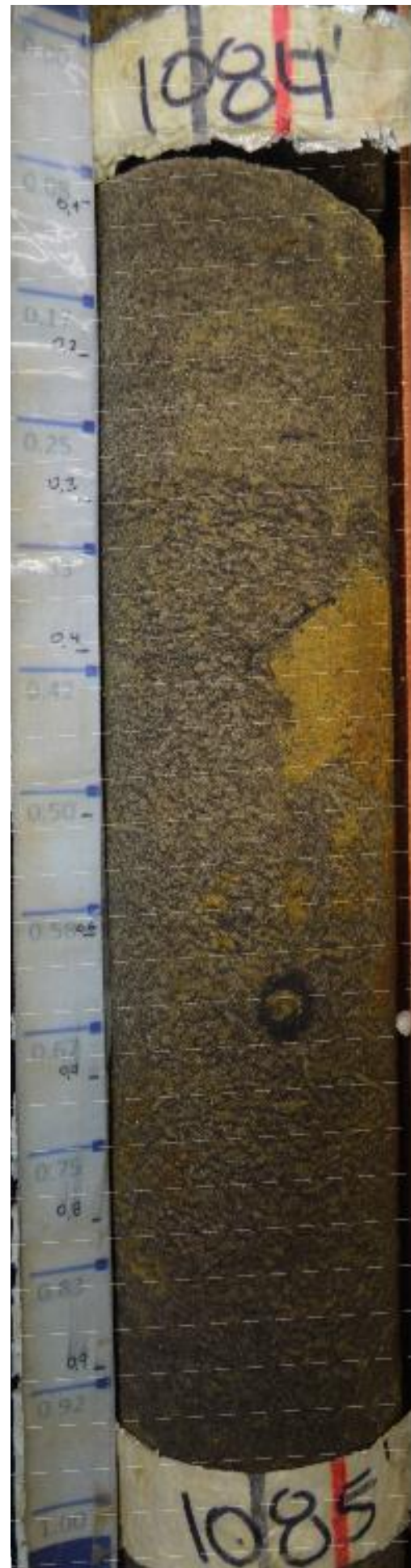


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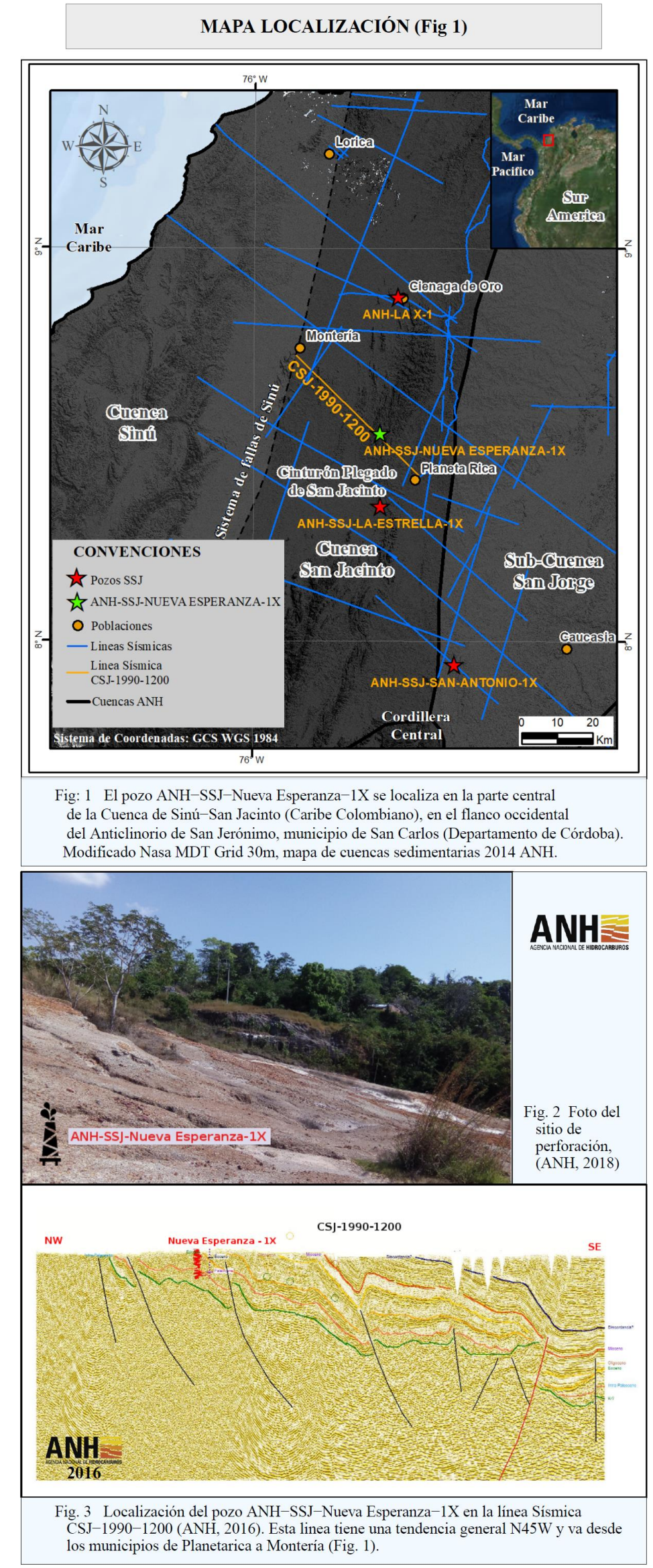








# GRAPHIC REPRESENTATION OF THE WELLS









# CARIBBEAN SOME CONSIDERATIONS

-Geologically complex area (different hypothesis about its geologic evolution)

-It has a high potential for oil discoveries (oil seeps)

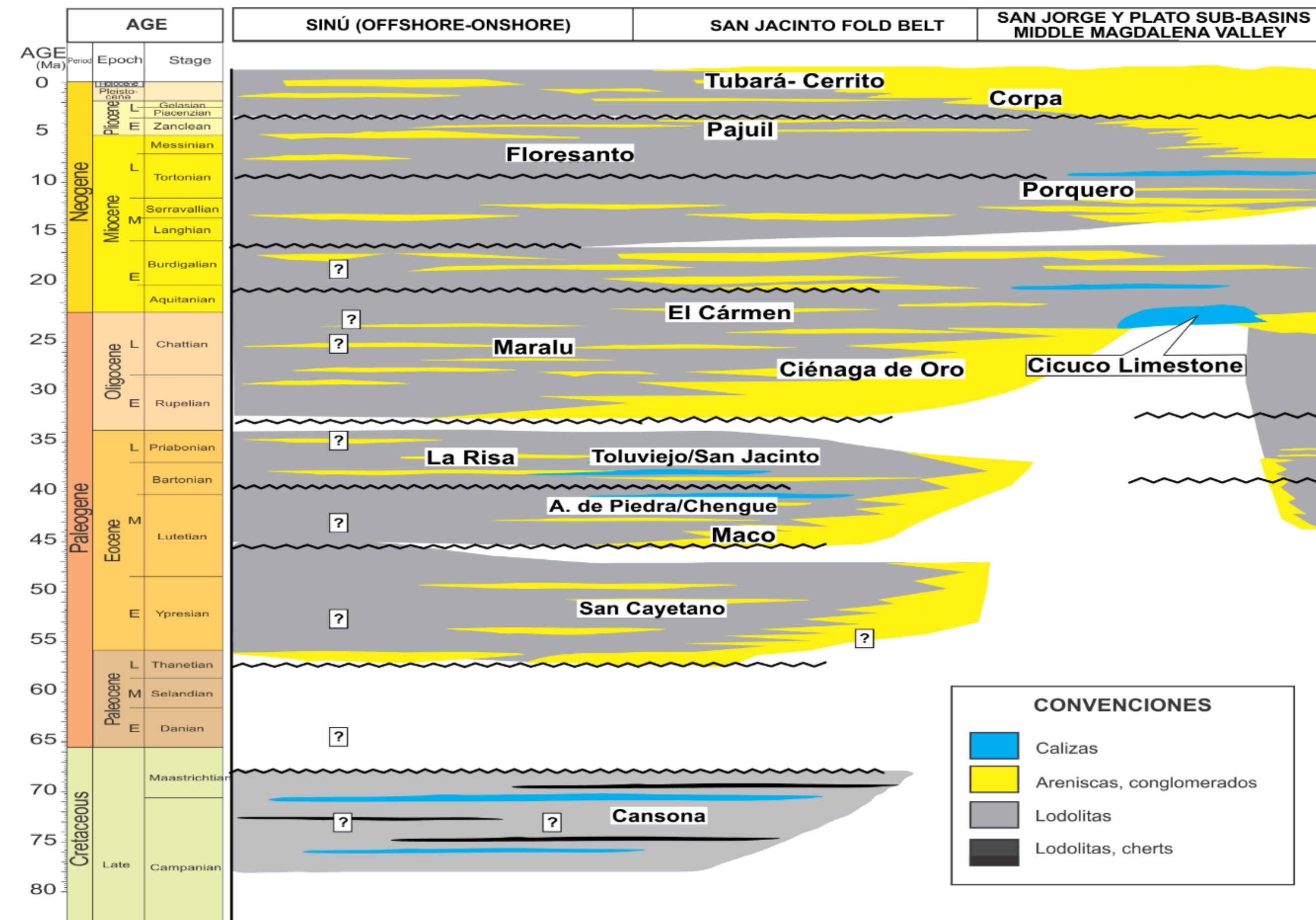
-Sedimentary record from Cretaceous-Recent

-Variations of facies in time and space

-Presence of regional unconformities

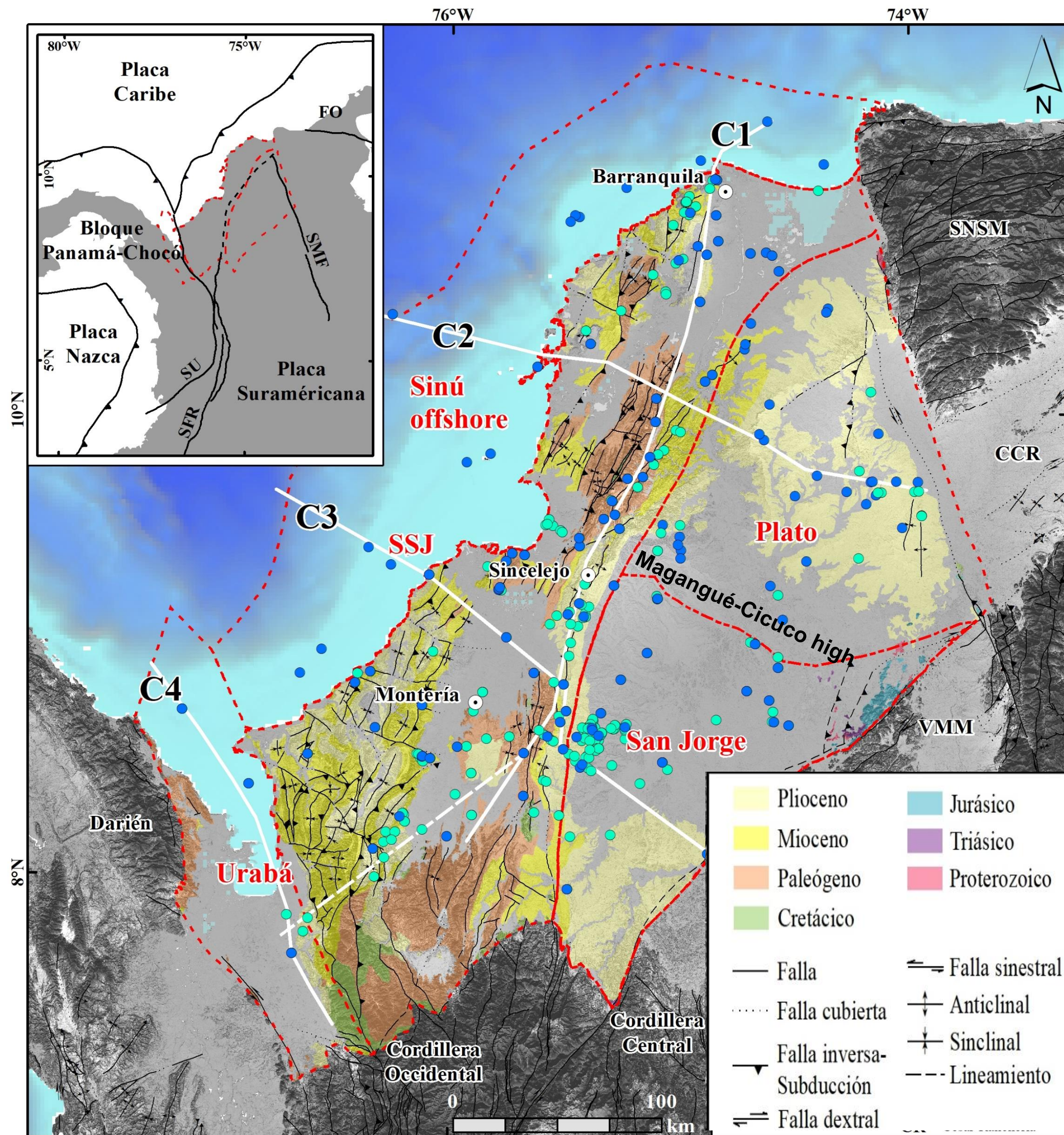
-Tectonic simultaneously with sedimentation

- Erosion of previously accumulated units





# CHRONO STRATIGRAPHIC CHARTS AND PALEOGEOGRAPHIC MAPS



## Regional Geology - Stratigraphy

**58 Wells (many new ANH Wells)  
Surface Geology (SGC)**

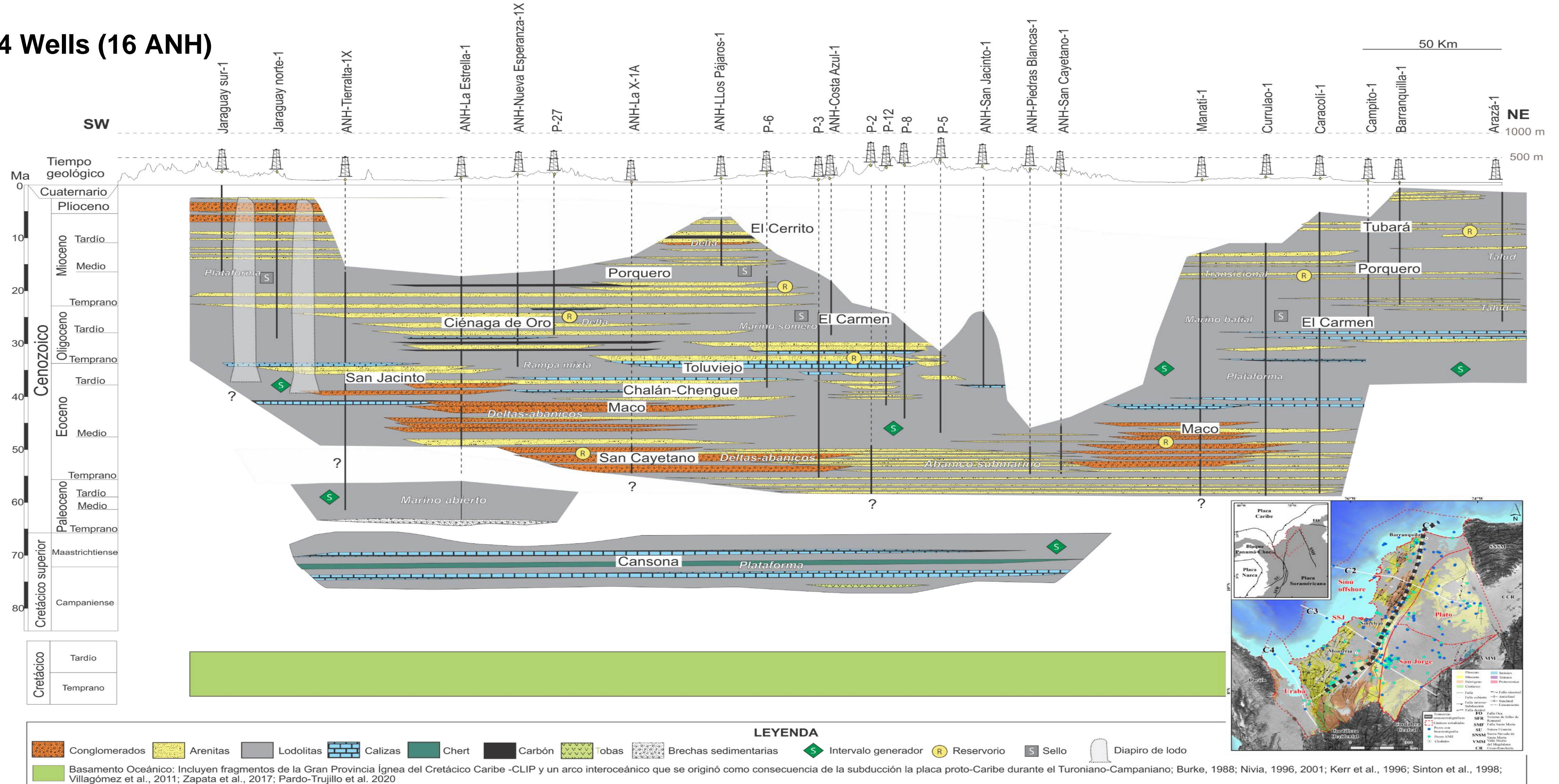
- 1 Strike section
- 3 Dip sections
- Lengths
  - T1: 498 km
  - T2: 282 km
  - T3: 323 km
  - T4: 204 km

**Total: 1 307 km**



# CHRONOSTRATIGRAPHIC CHART 1

## 24 Wells (16 ANH)

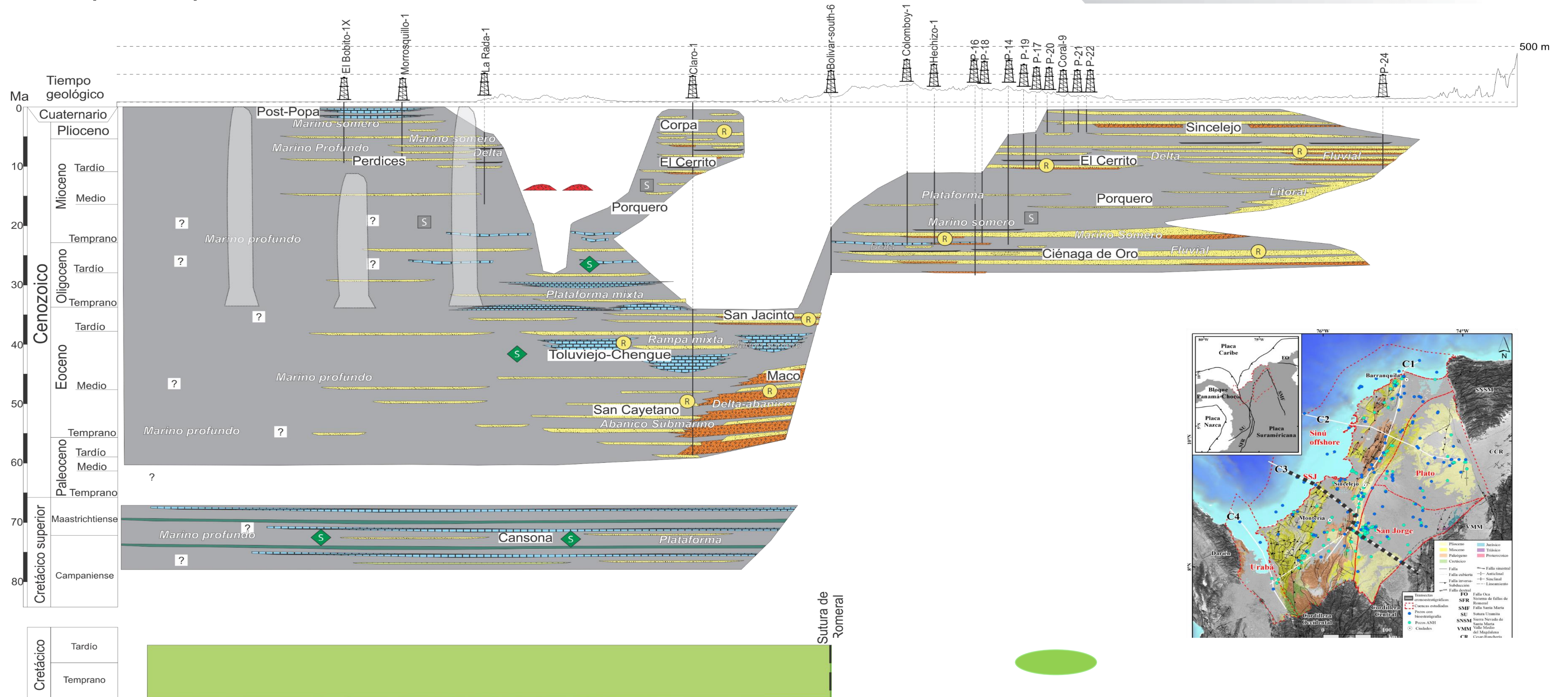




# CHRONOSTRATIGRAPHIC CHART 3



## 17 Wells (10 ANH)

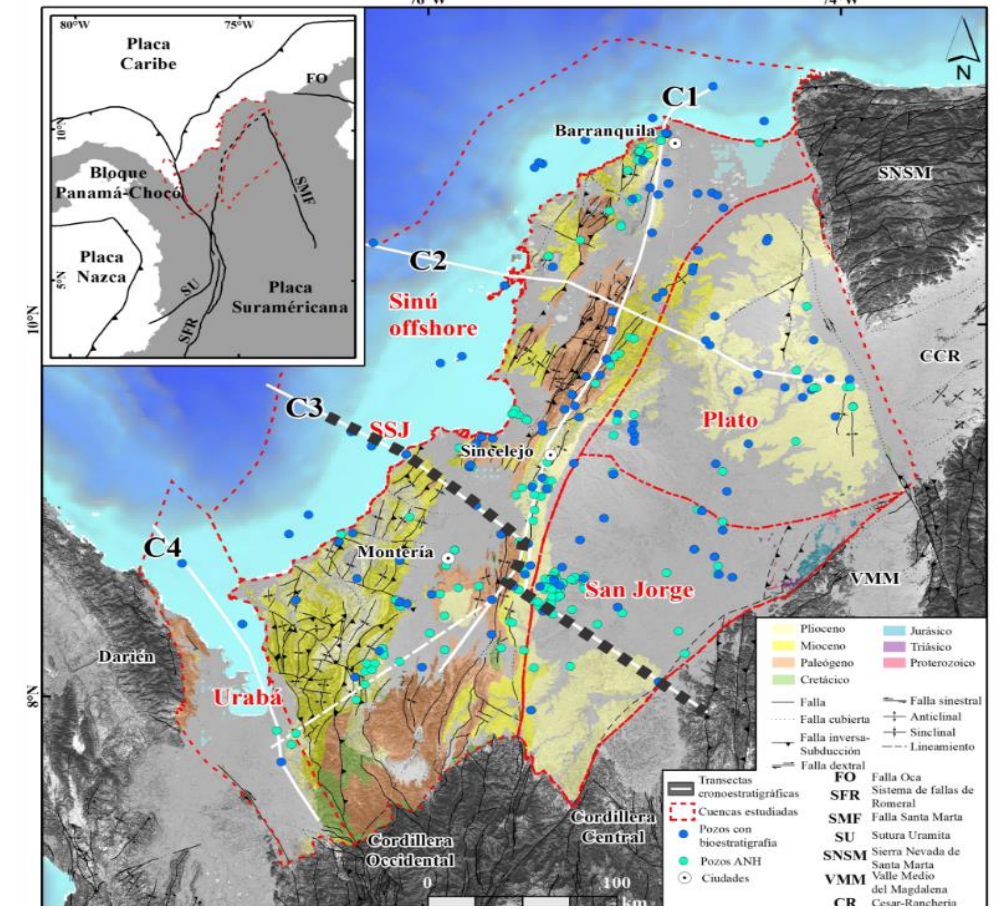


Cretácico	Tardío
	Temprano
Jurásico	
Pérmico-Triásico	

Sinú Offshore

Sinú-San Jacinto

San Jorge







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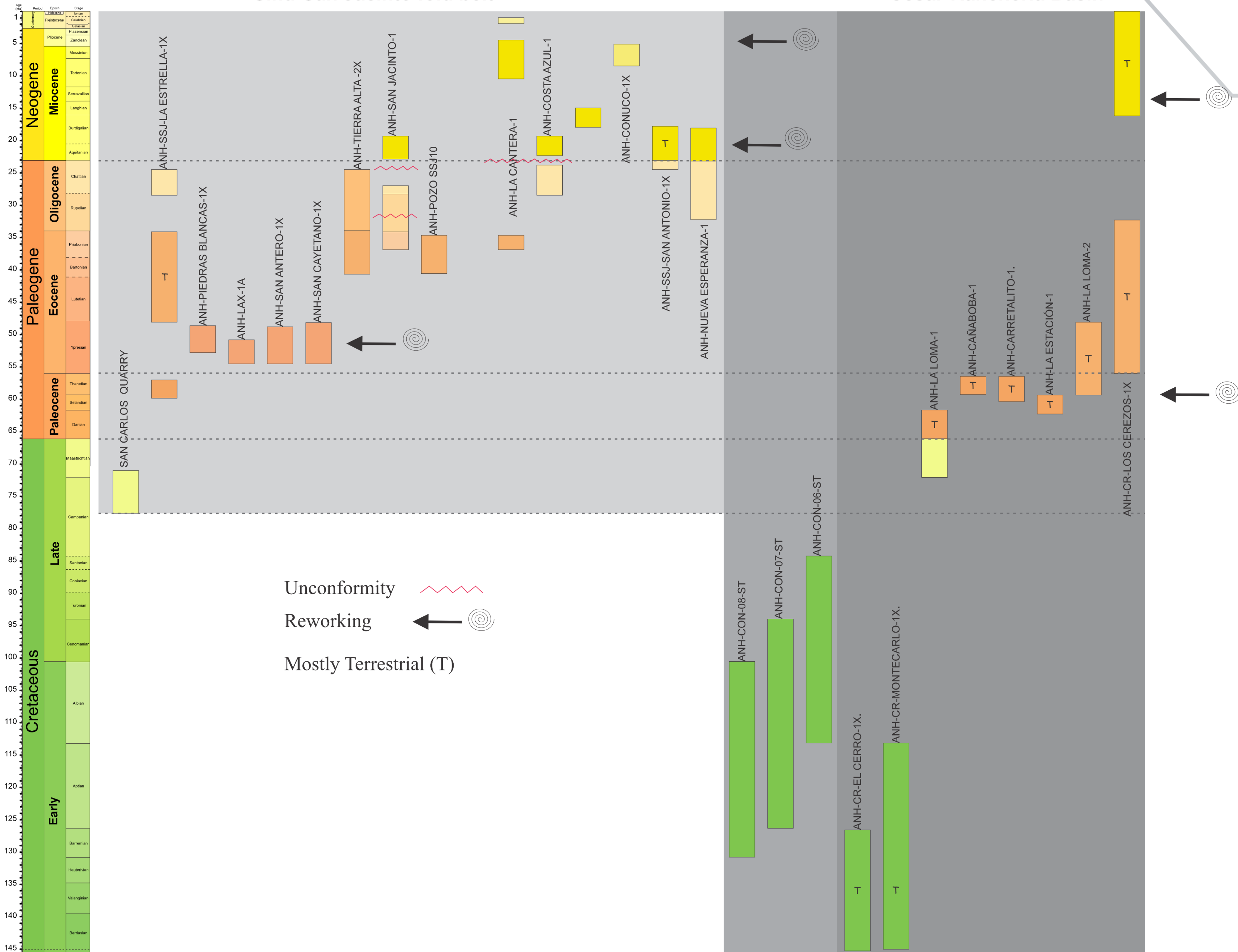
# Chronostratigraphic framework for Caribbean and Cesar Rancheria basins and Eastern Cordillera

Calcareous microfossil group  
Palynological group

**Sinu-San Jacinto fold belt**

**Eastern Cordillera**

**Cesar-Ranchería Basin**



Unconformity

Reworking

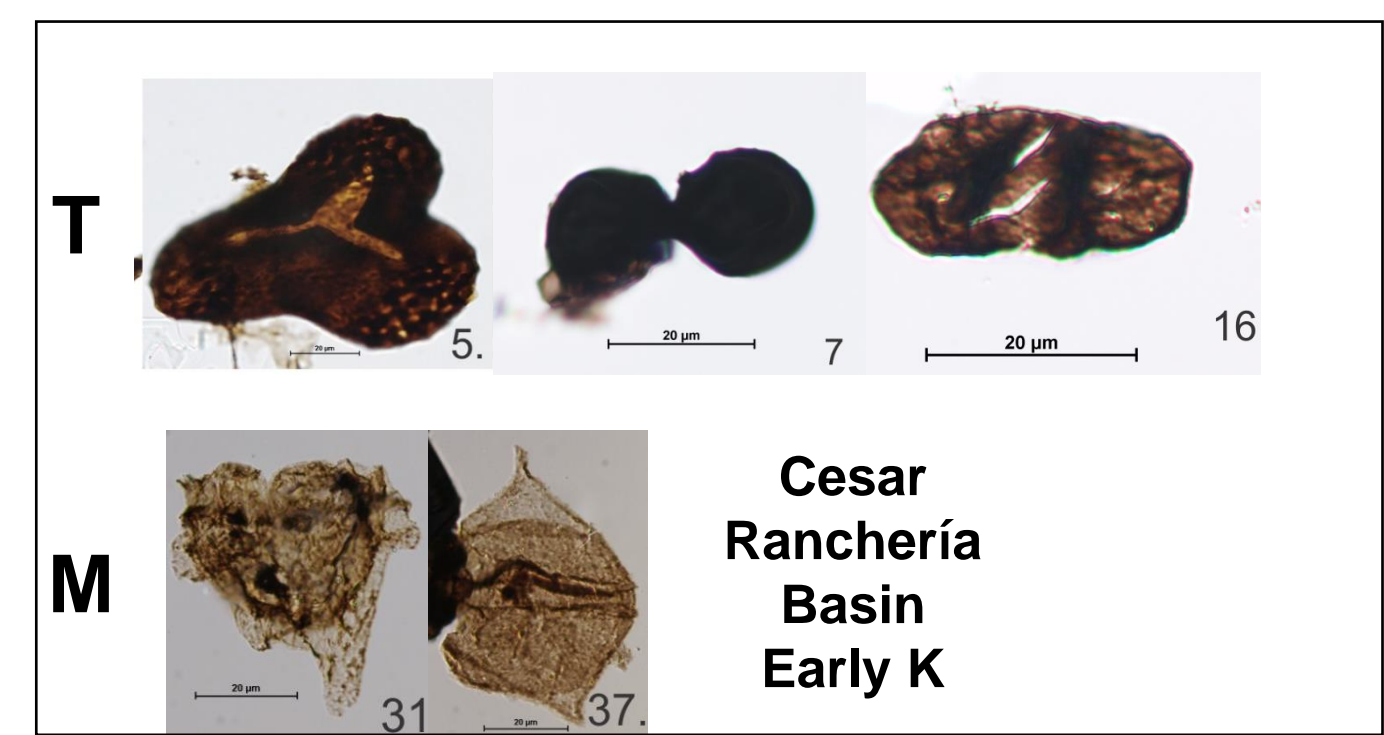
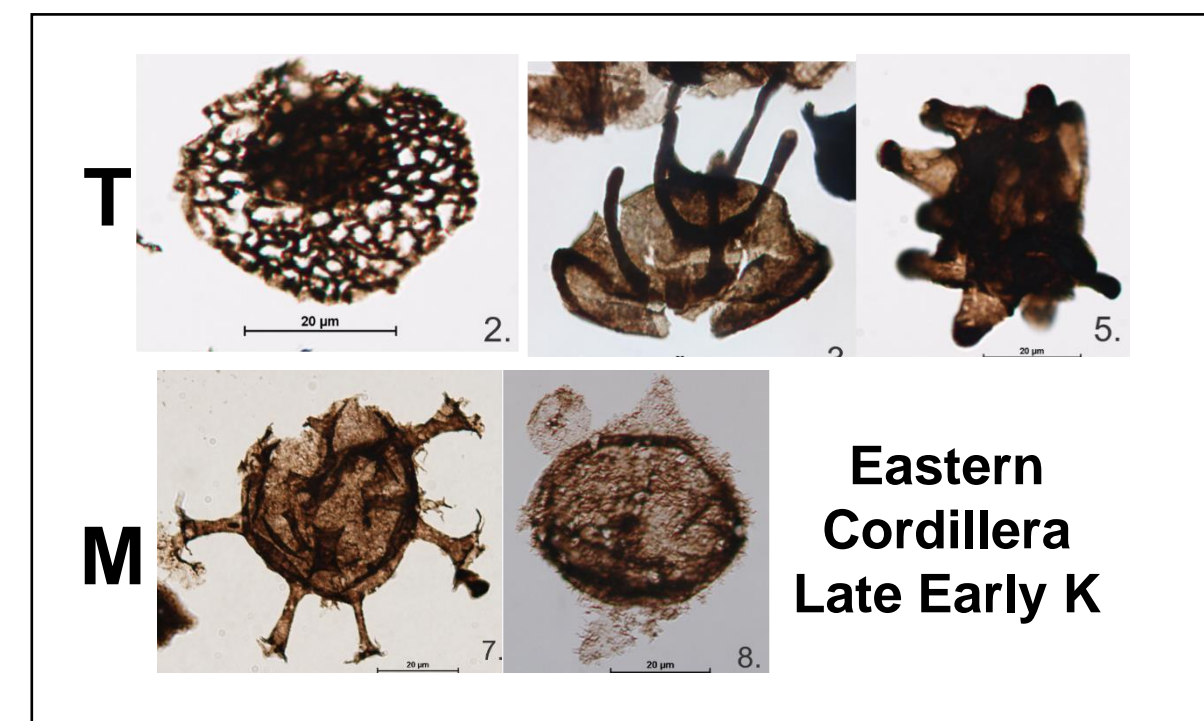
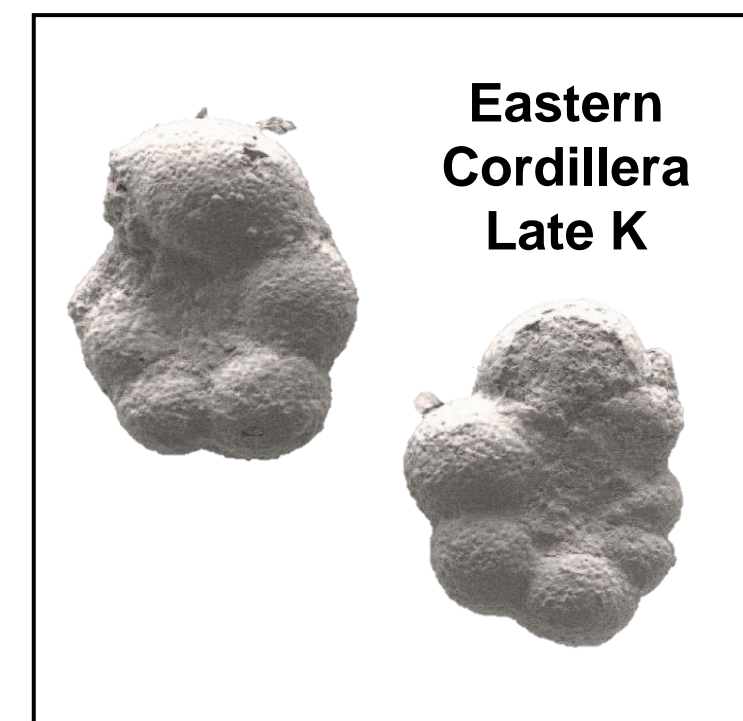
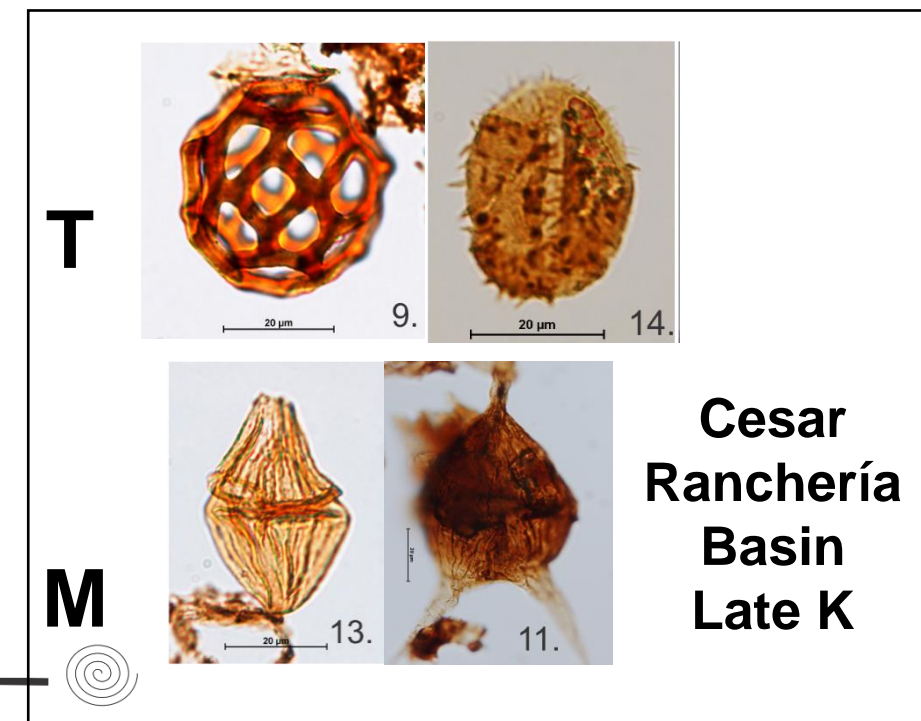
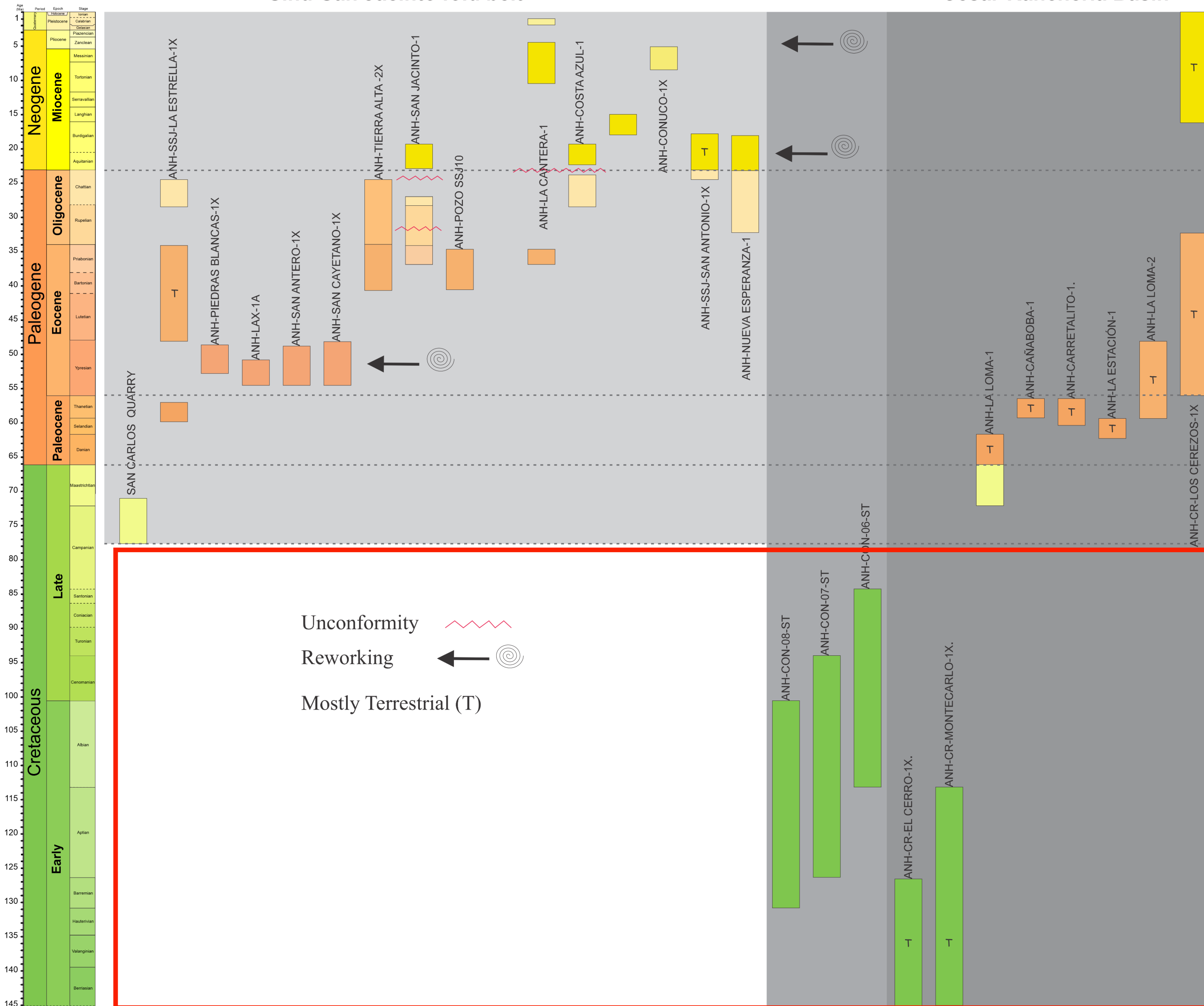
Mostly Terrestrial (T)

# Chronostratigraphic framework

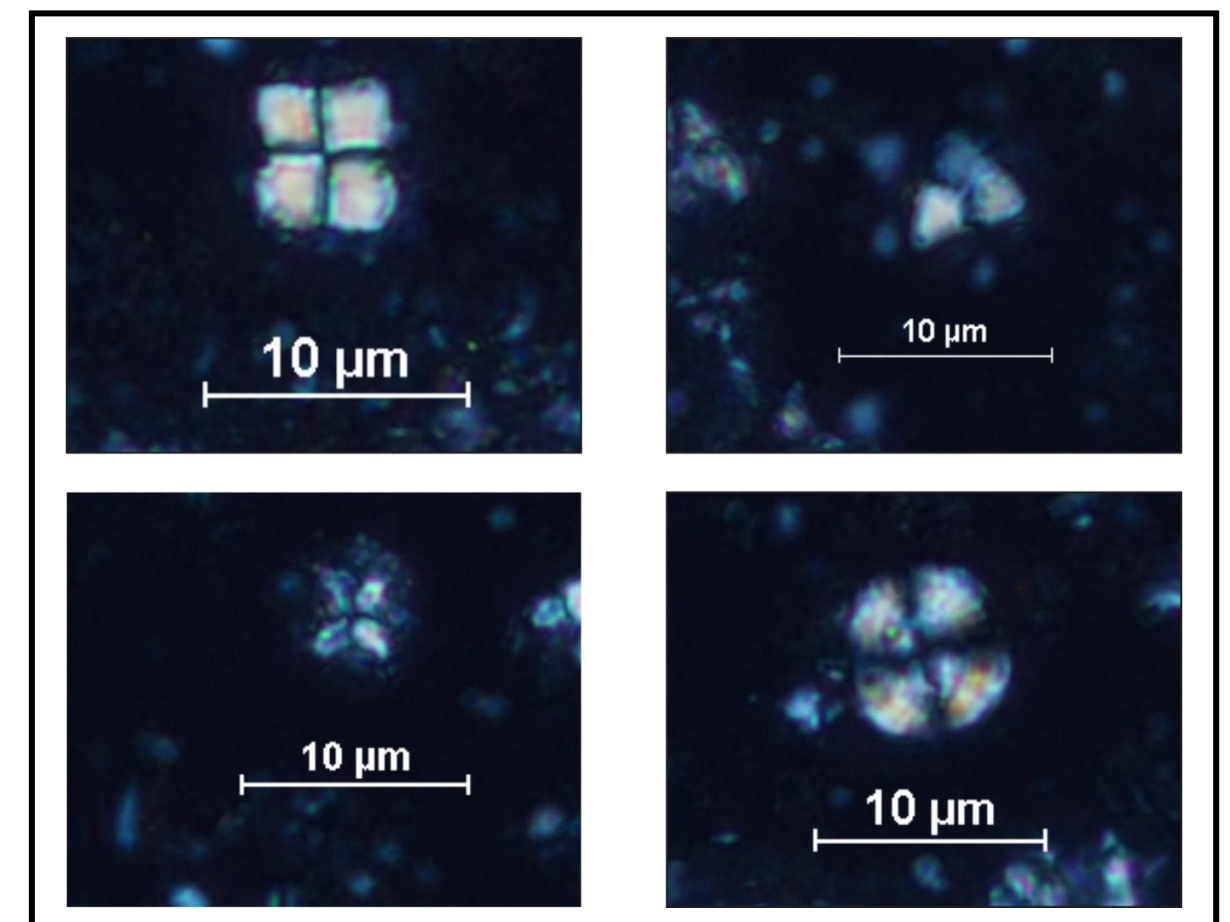
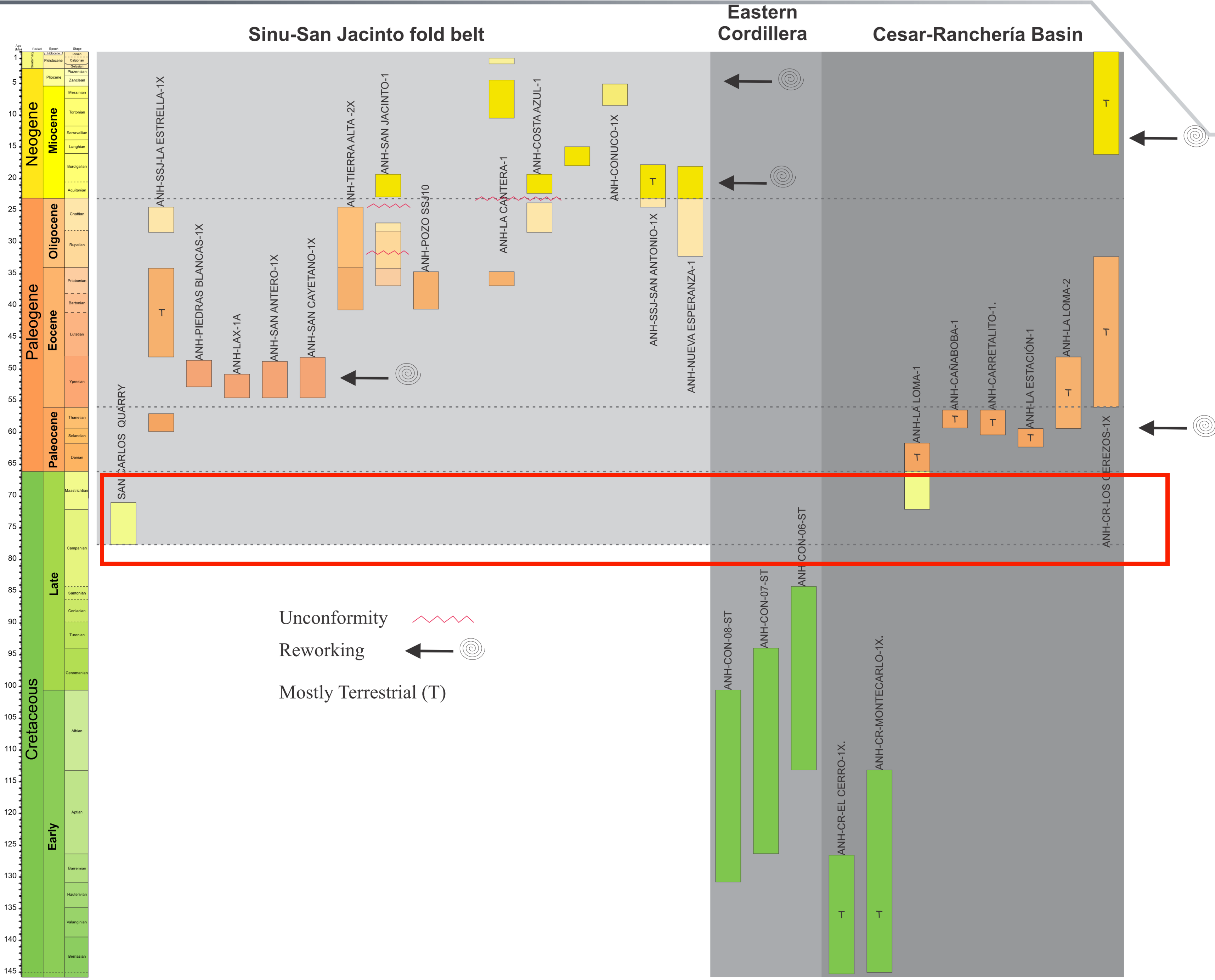
Sinu-San Jacinto fold belt

Eastern Cordillera

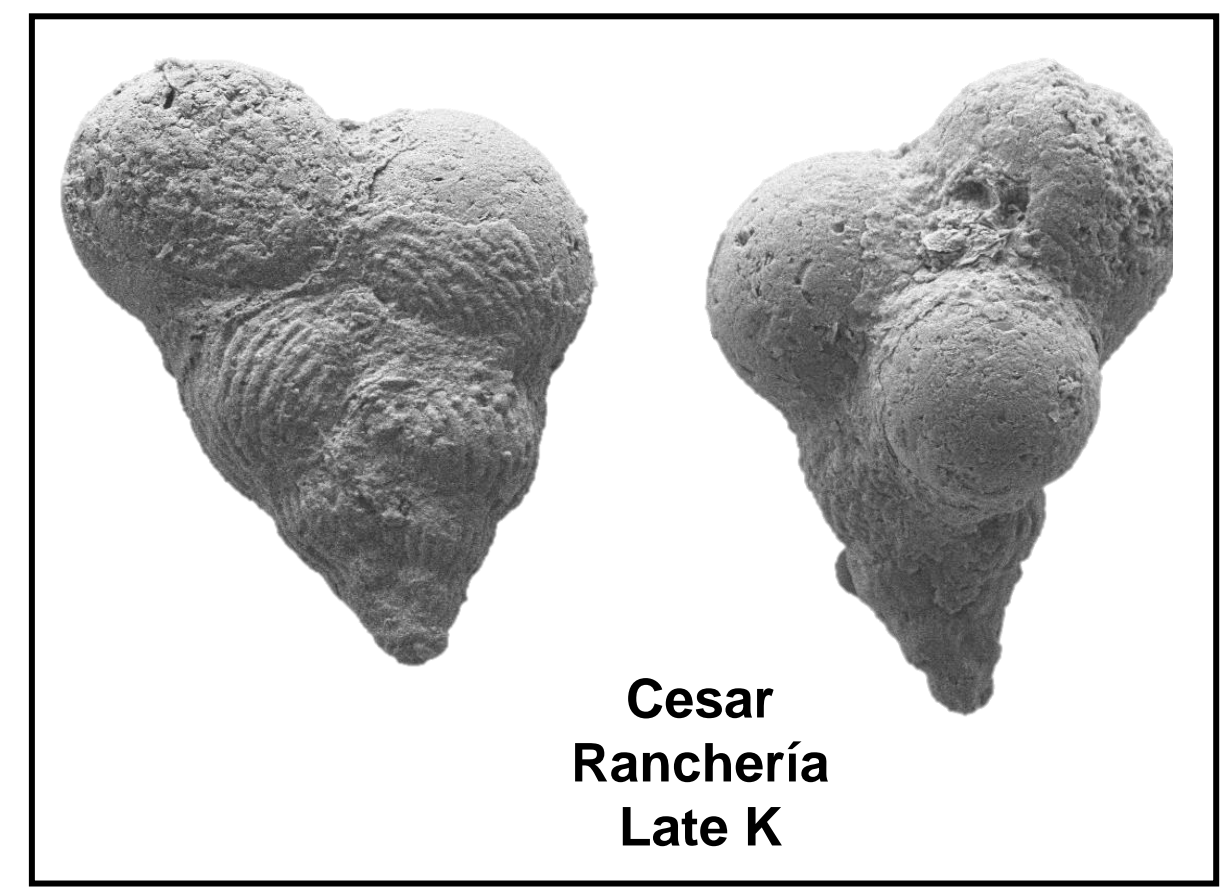
Cesar-Ranchería Basin







**SSJ  
Late K**

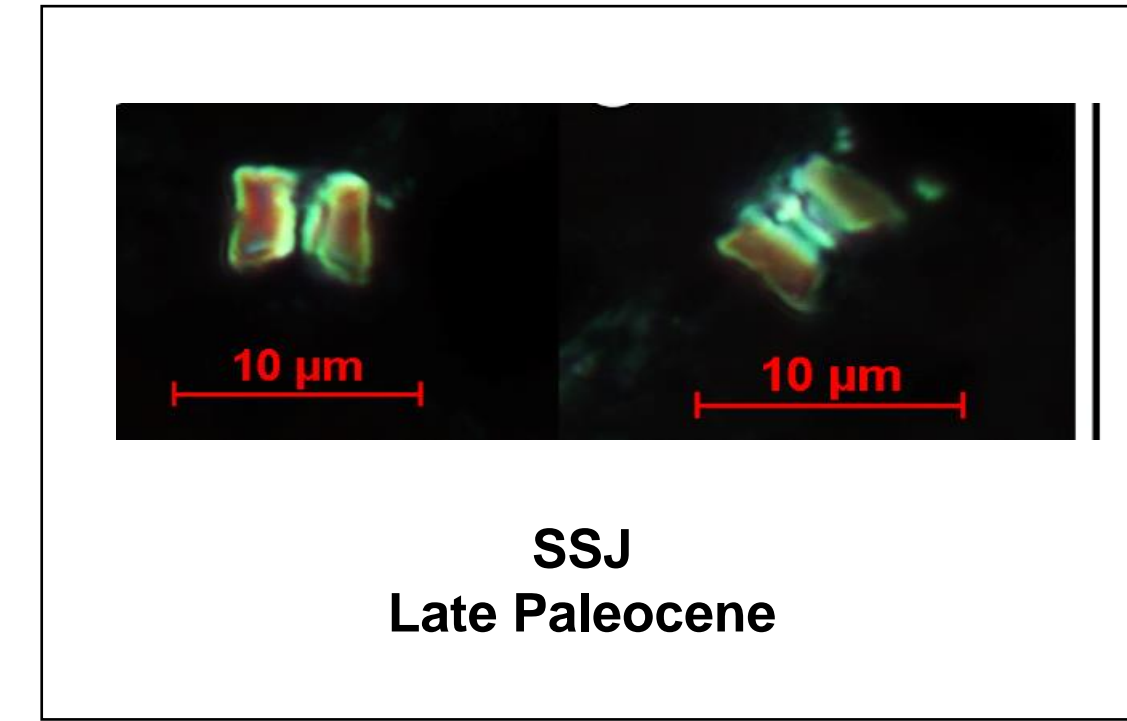
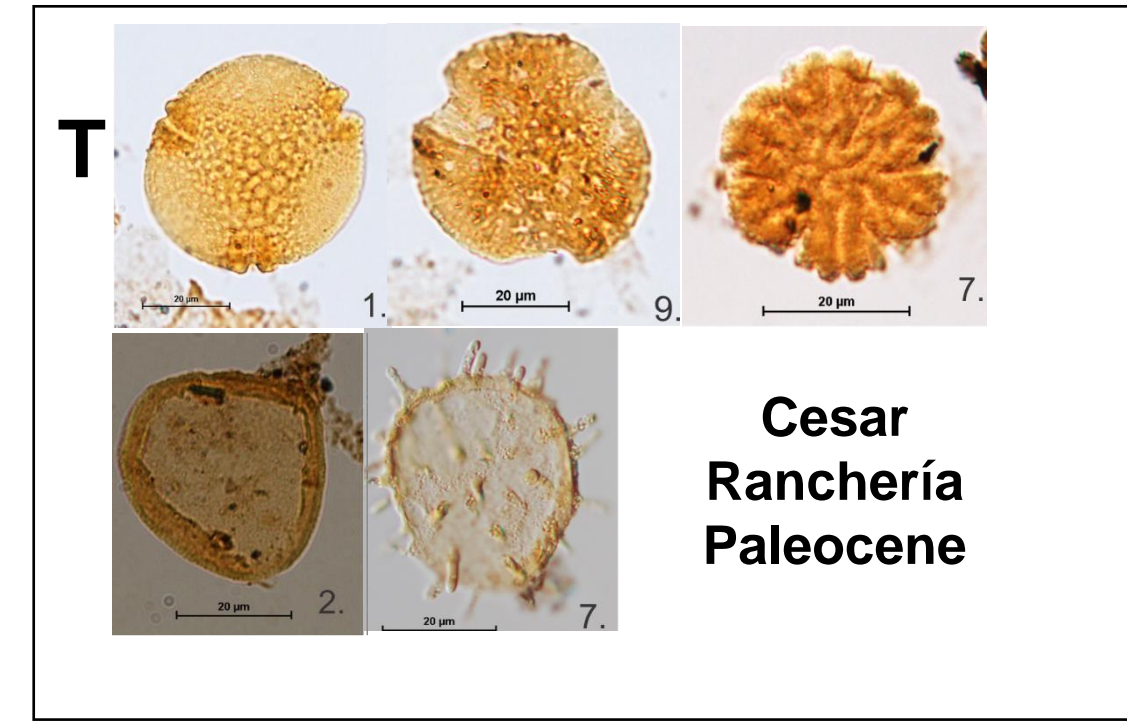
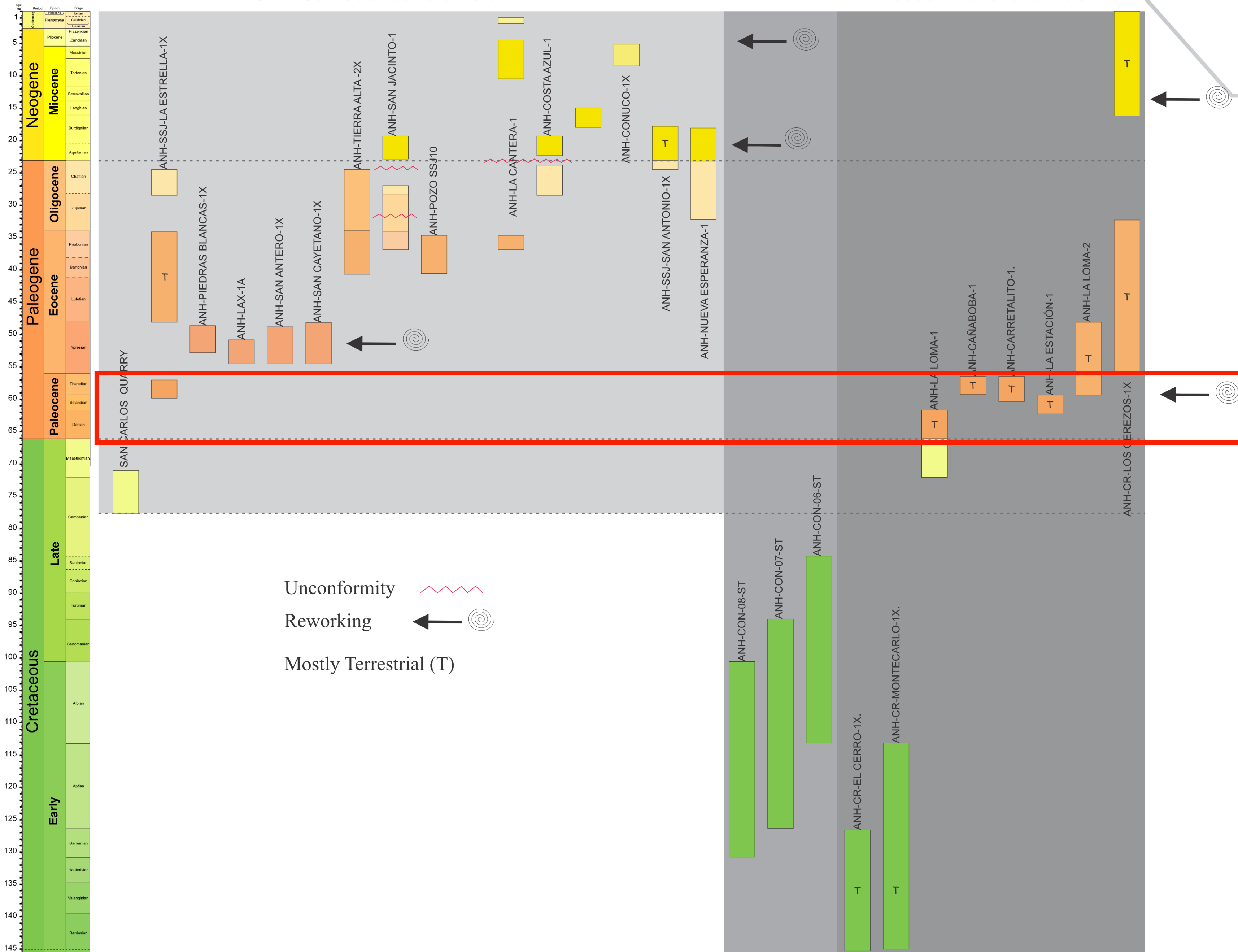


**Cesar  
Ranchería  
Late K**

**Sinu-San Jacinto fold belt**

**Eastern Cordillera**

**Cesar-Ranchería Basin**

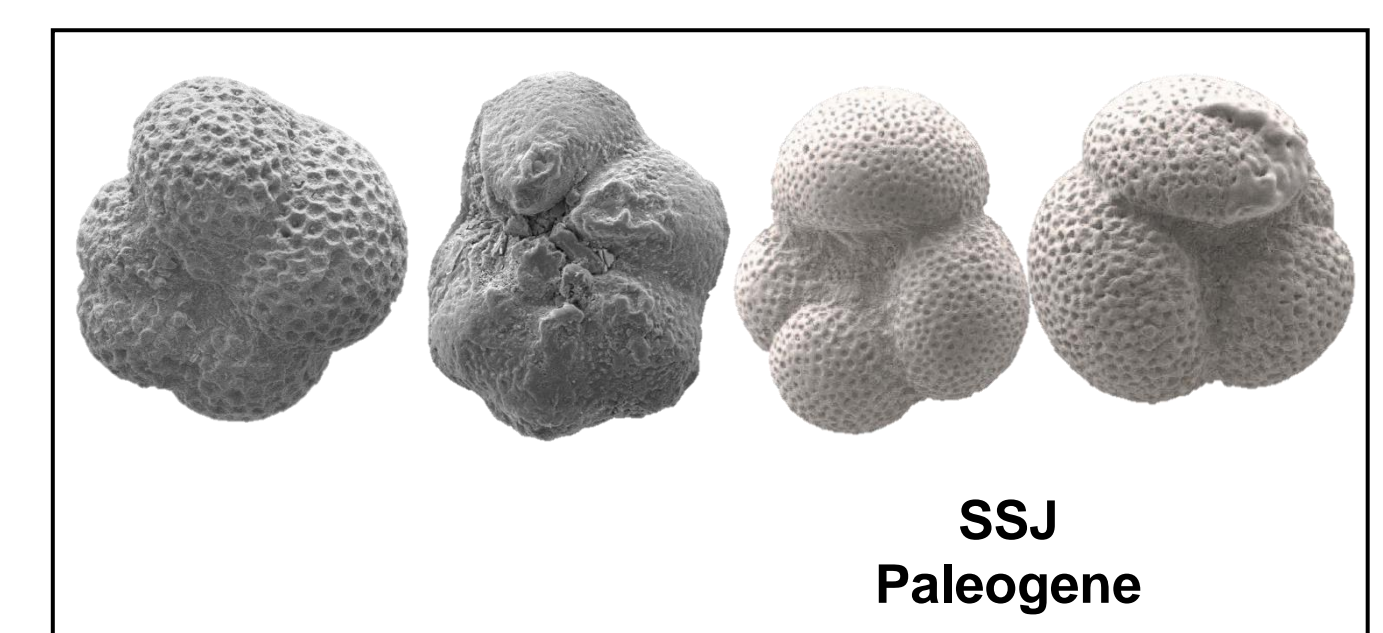
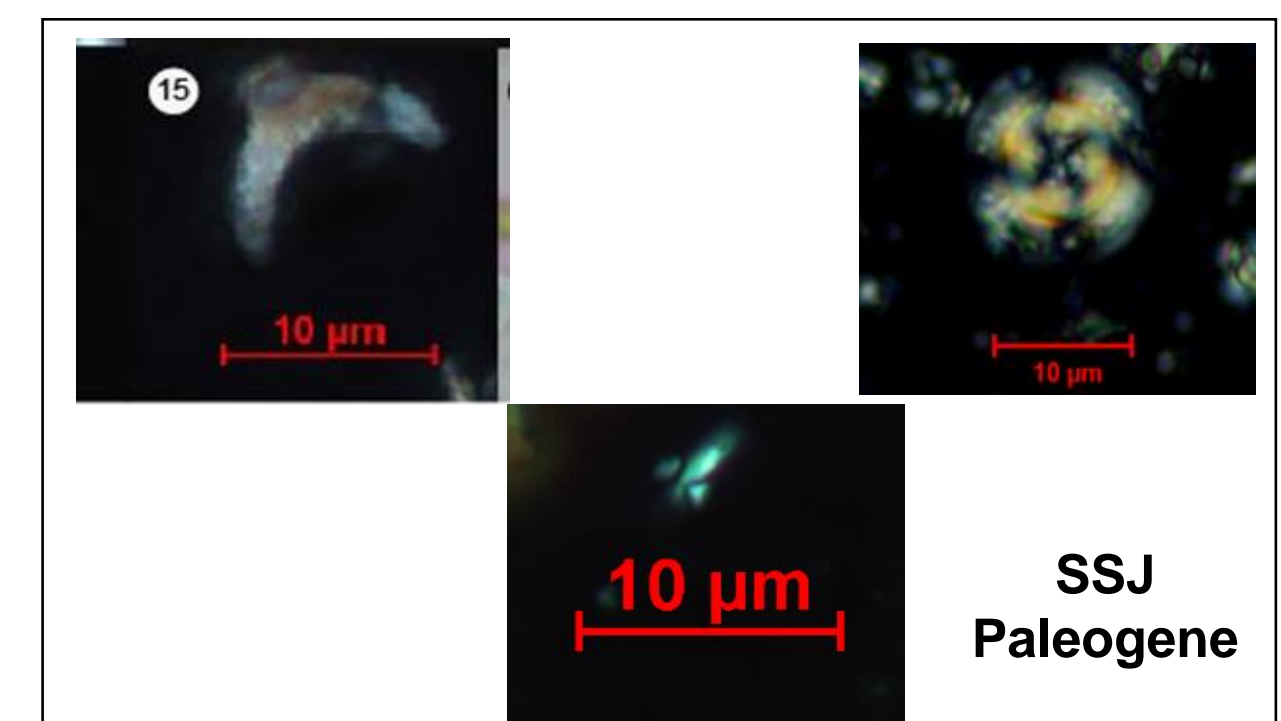
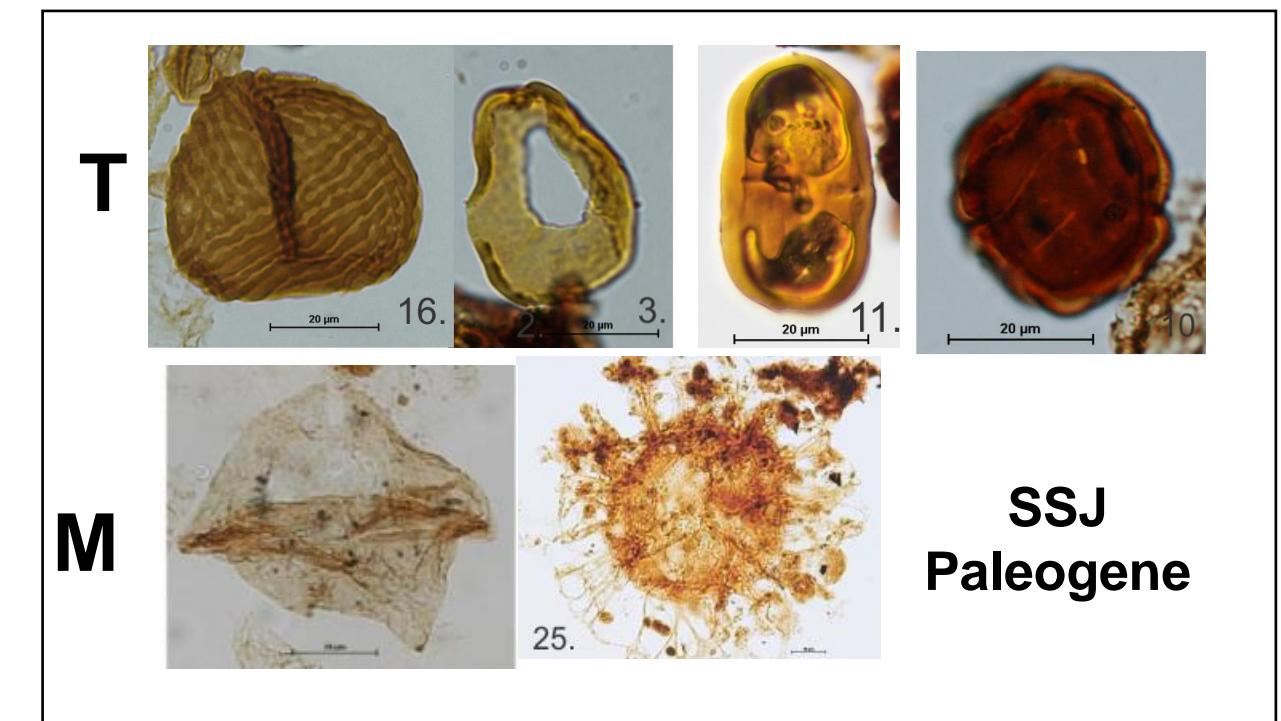
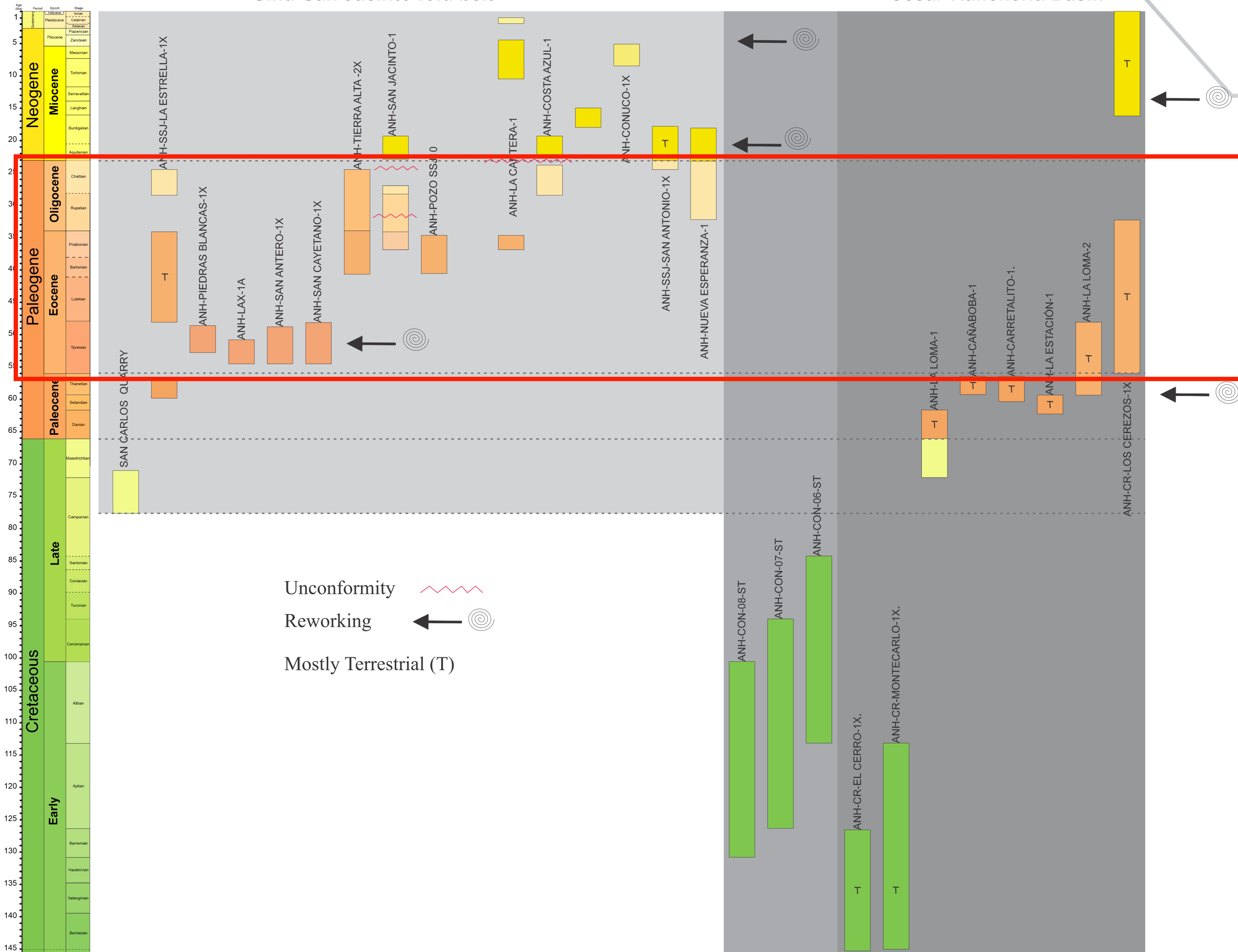




Sinu-San Jacinto fold belt

Eastern Cordillera

Cesar-Ranchería Basin

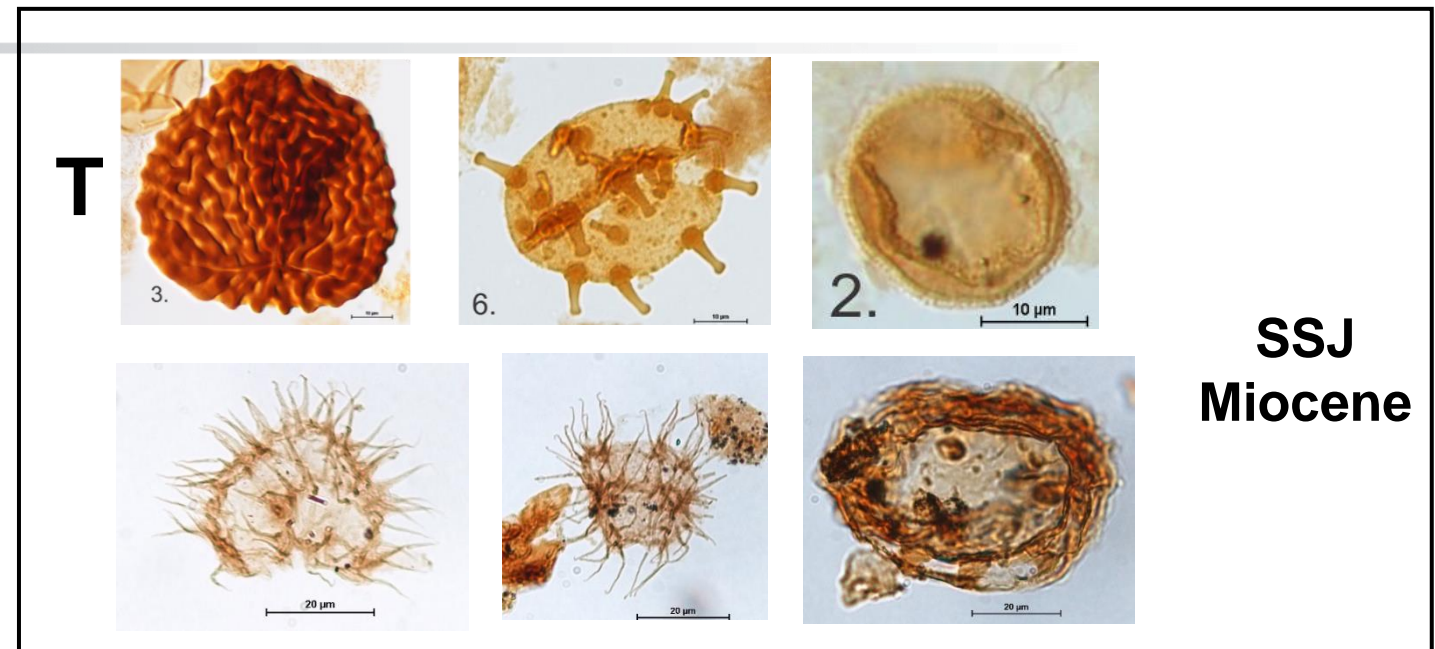
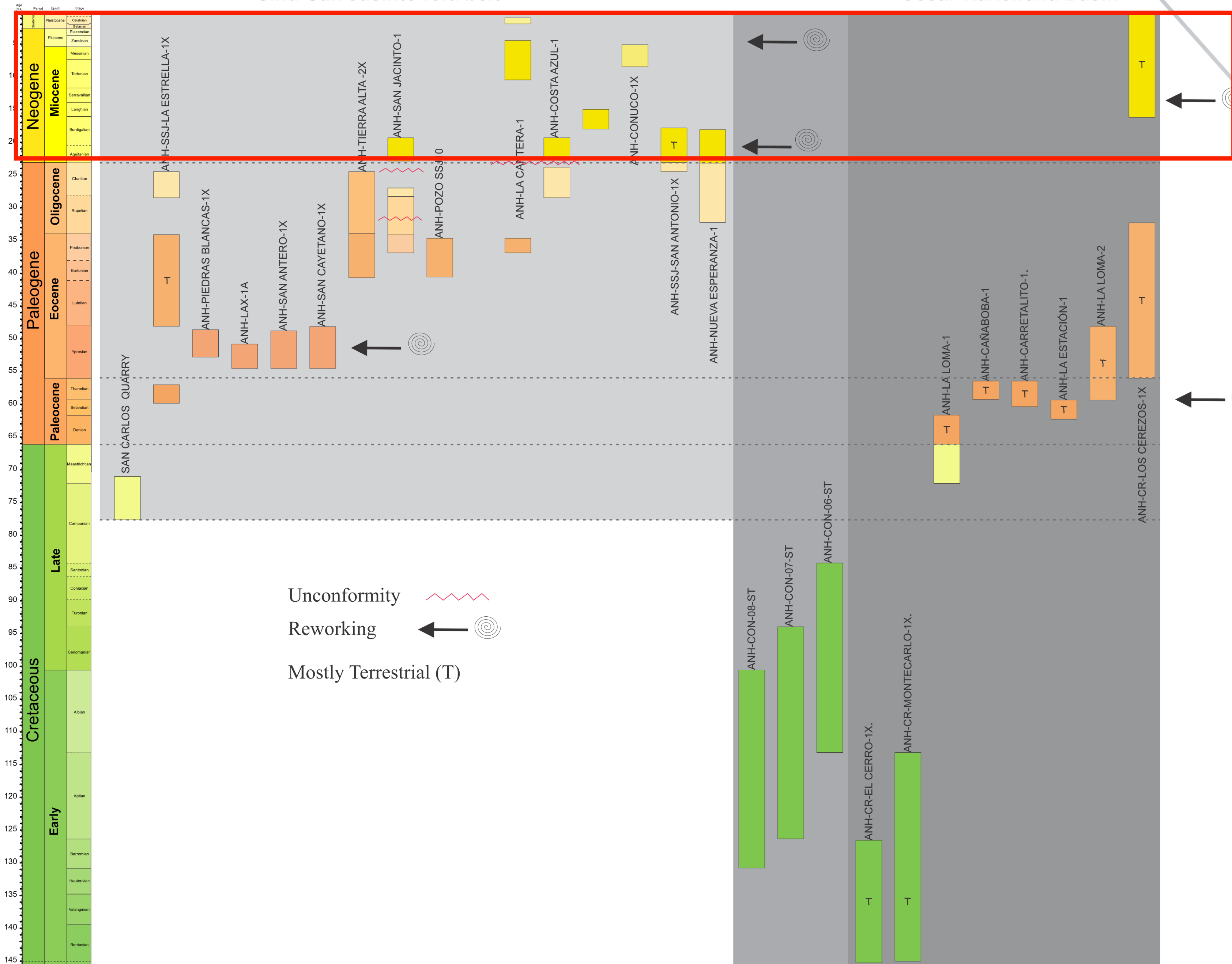




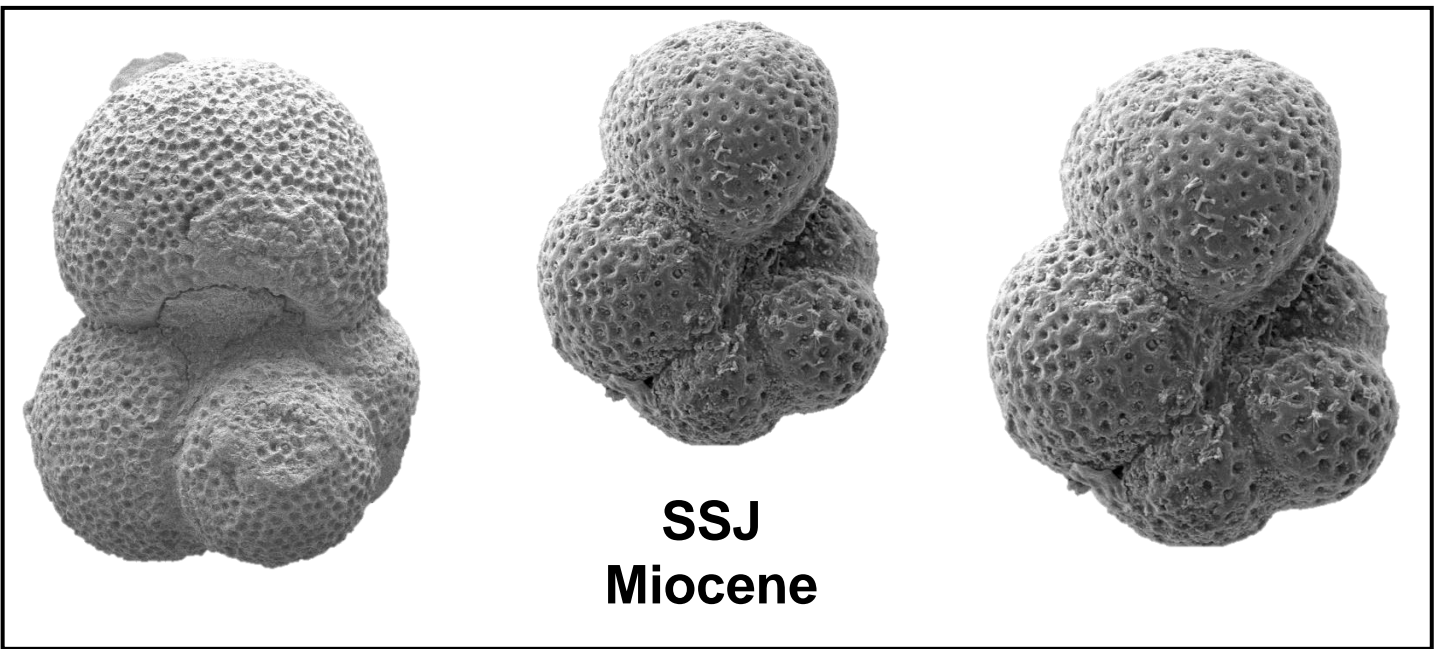
Sinu-San Jacinto fold belt

Eastern Cordillera

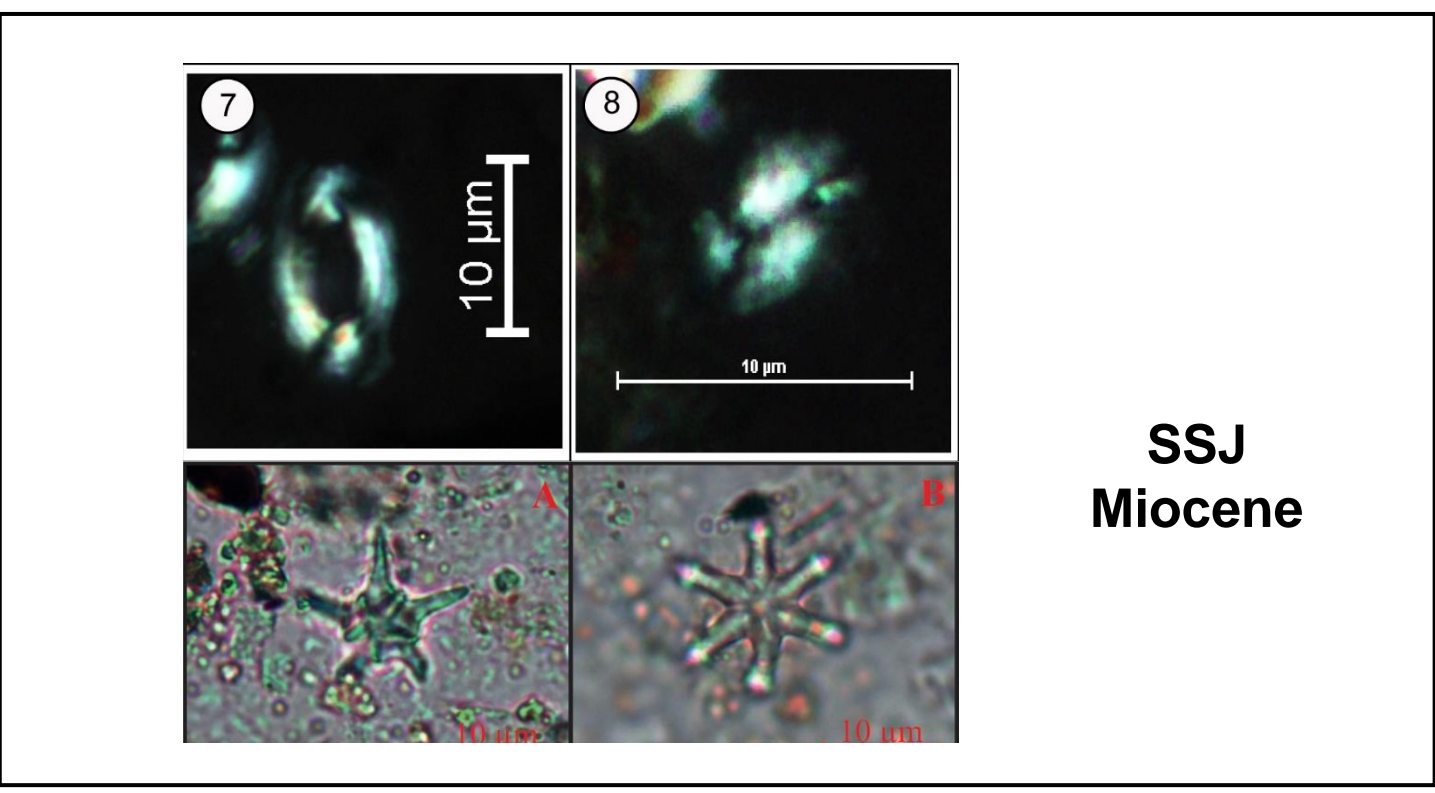
Cesar-Ranchería Basin



**SSJ Miocene**



**SSJ Miocene**



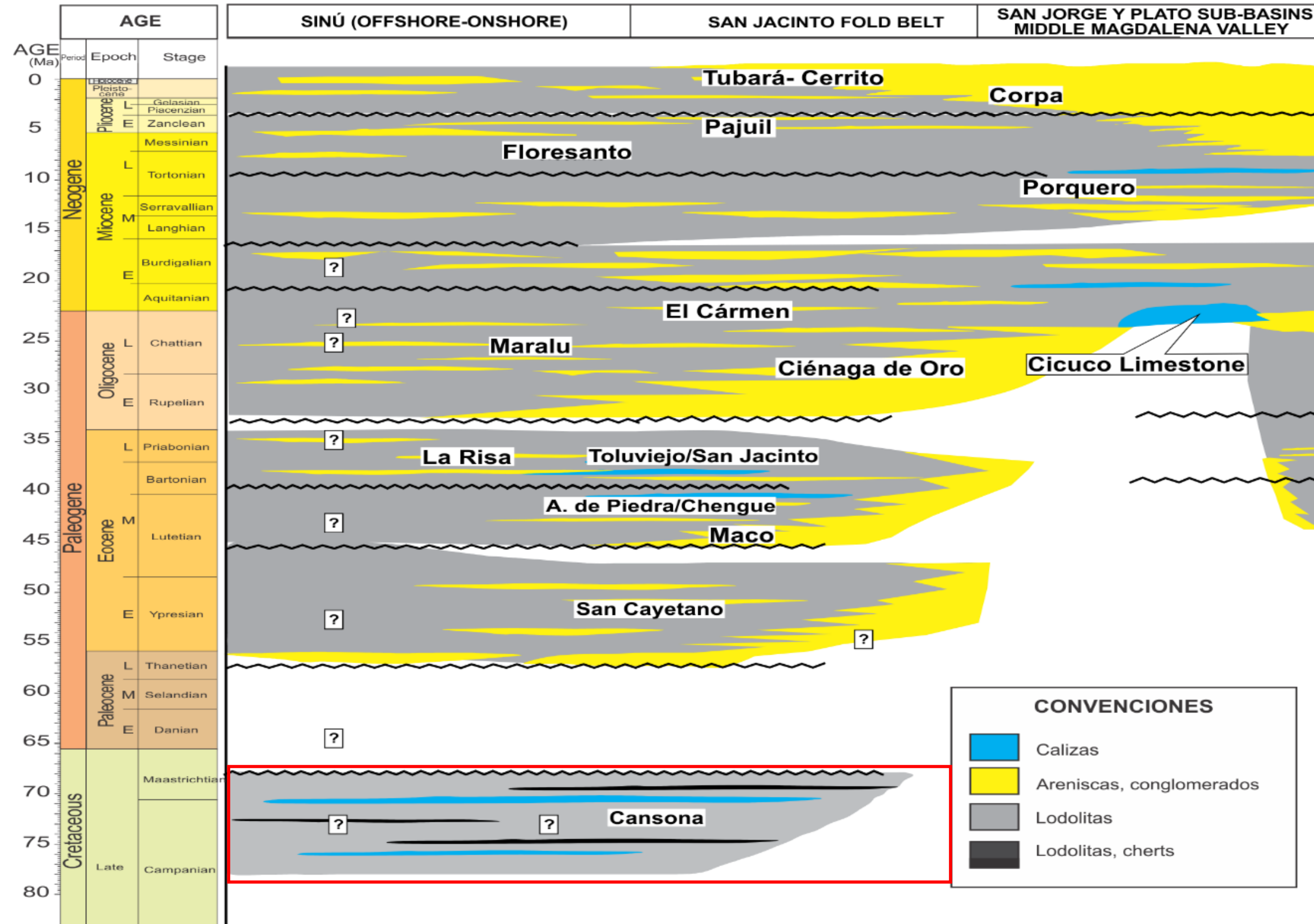
**SSJ Miocene**

Unconformity   
 Reworking   
 Mostly Terrestrial (T)



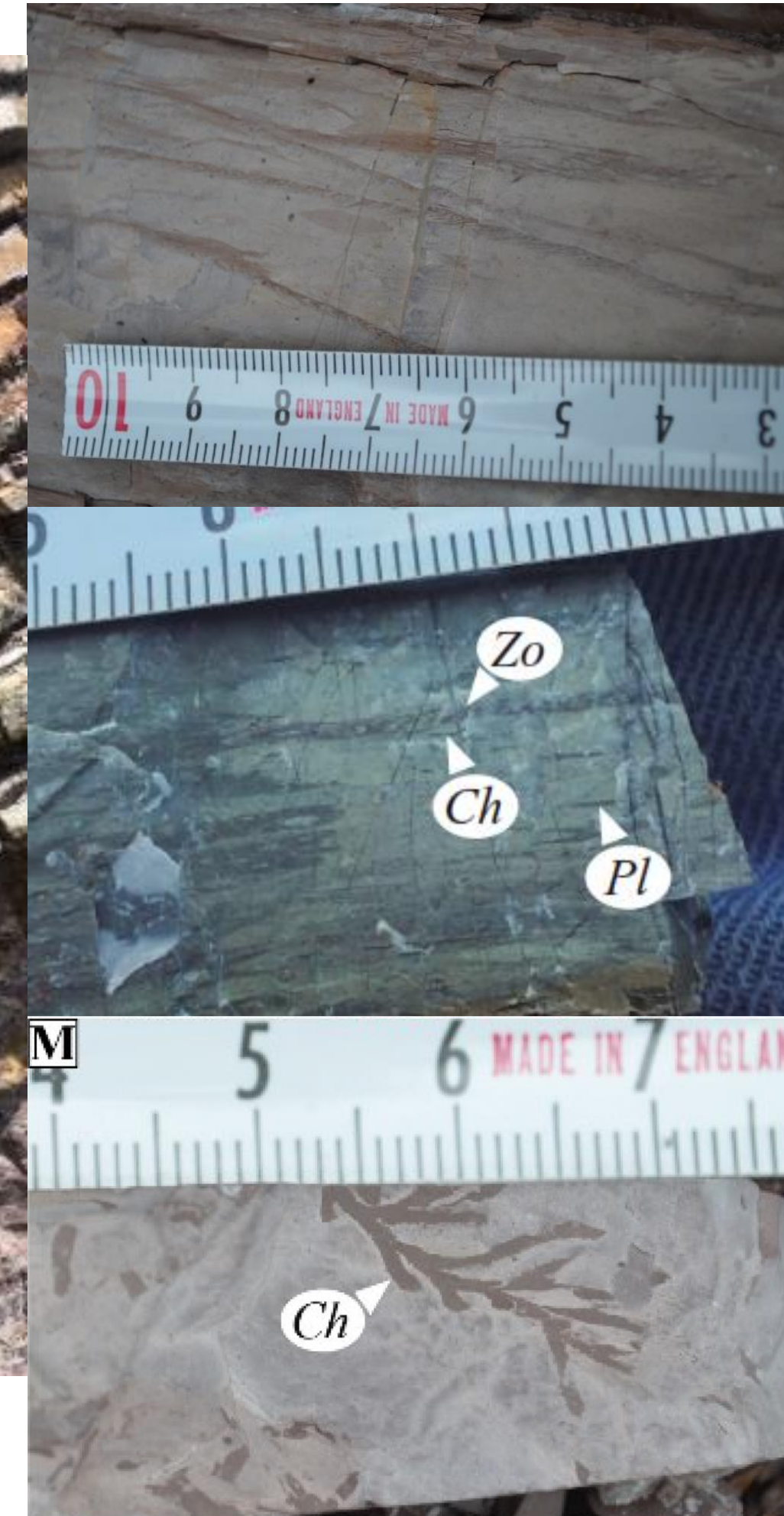
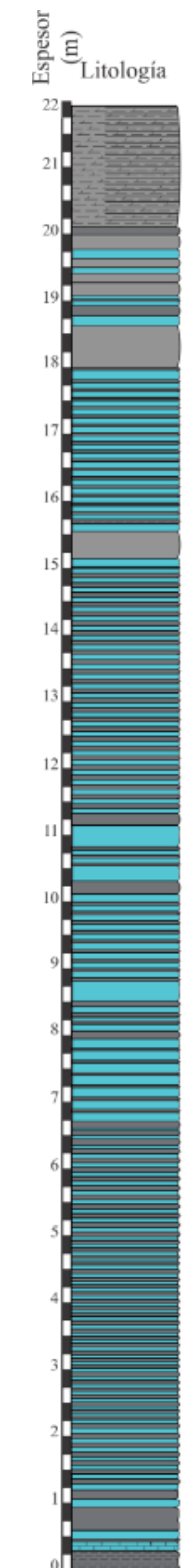
# STRATIGRAPHY AND PALEOENVIRONMENTS

- Late Cretaceous





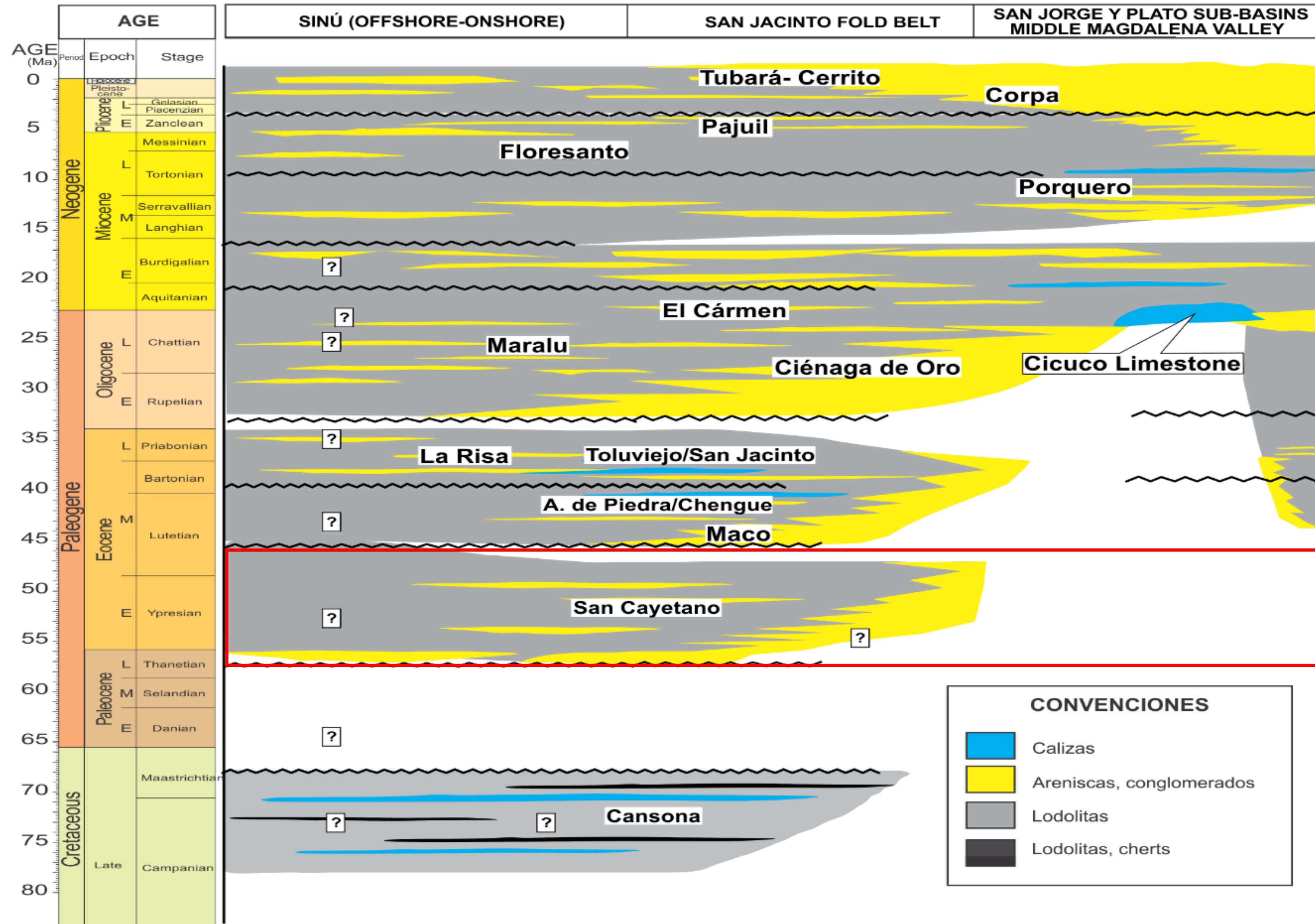
- Late Cretaceous Cansona Formation



- Giraldo et al., 2020



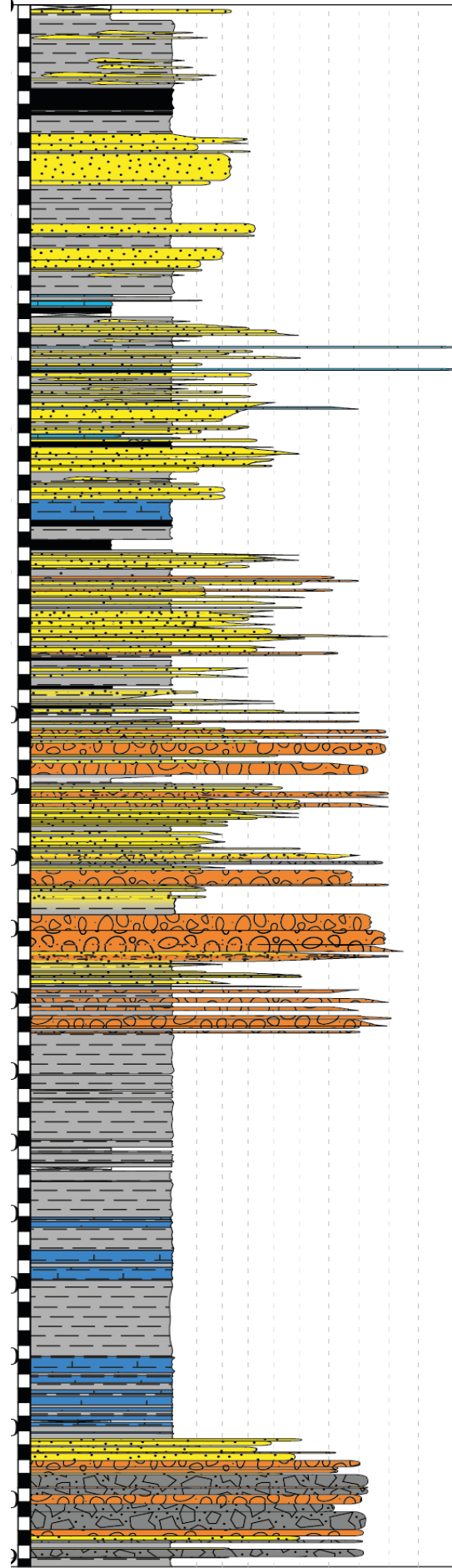
# STRATIGRAPHY AND PALEOENVIRONMENTS



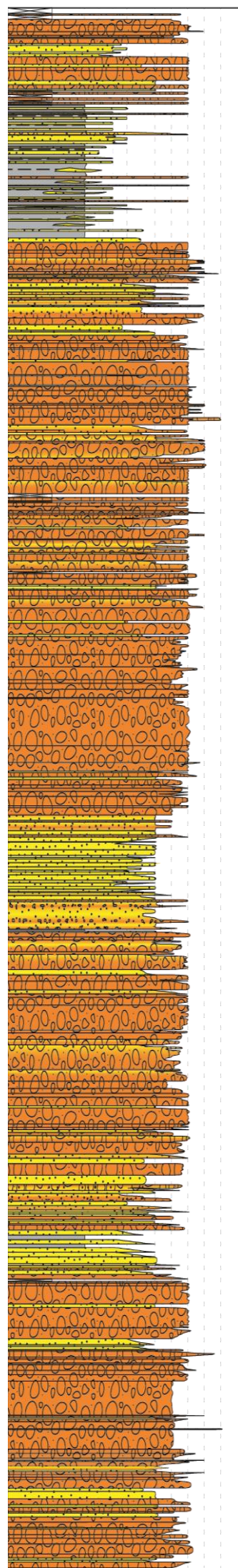


# Paleocene to Lower Eocene

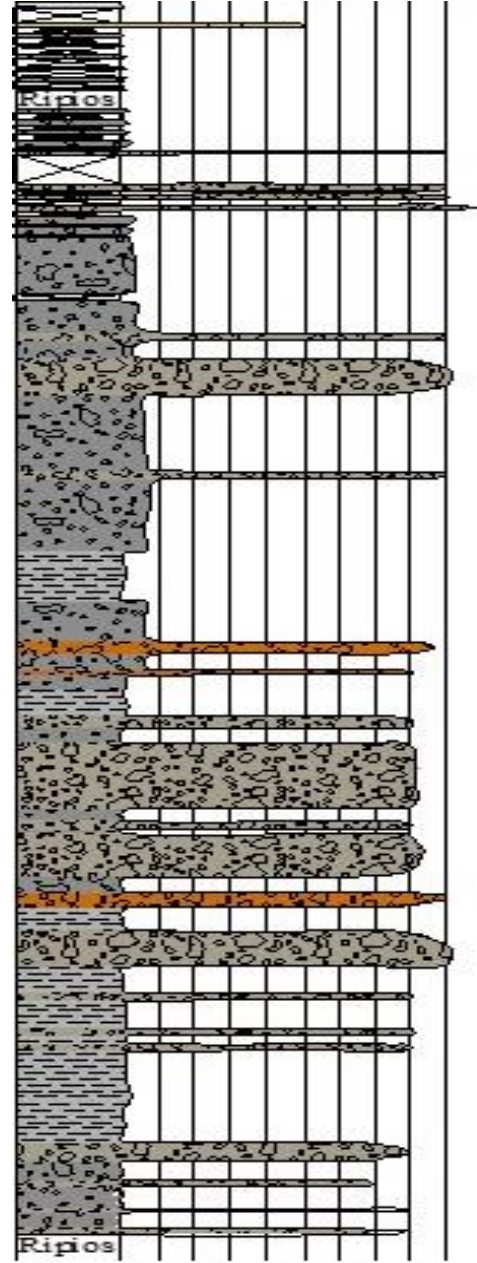
ANH-SSJ-LA ESTRELA-1X  
2190,9'



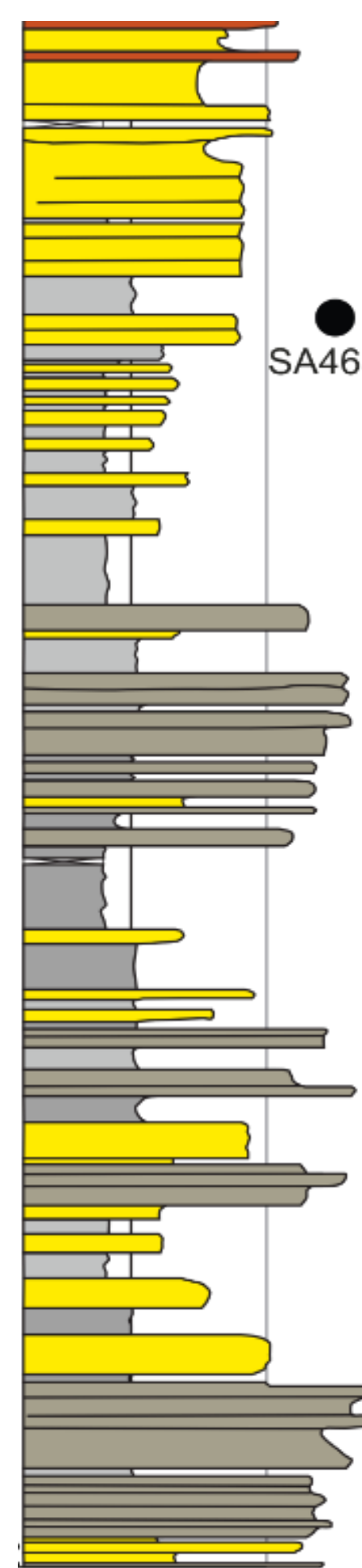
ANH-LA X-1ª  
4133'



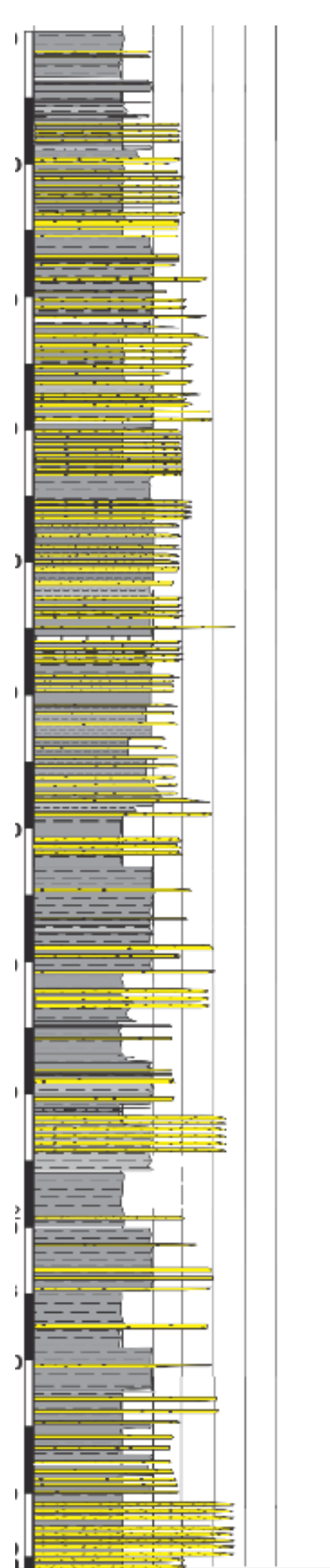
ANH-MOHAMBO  
1278'



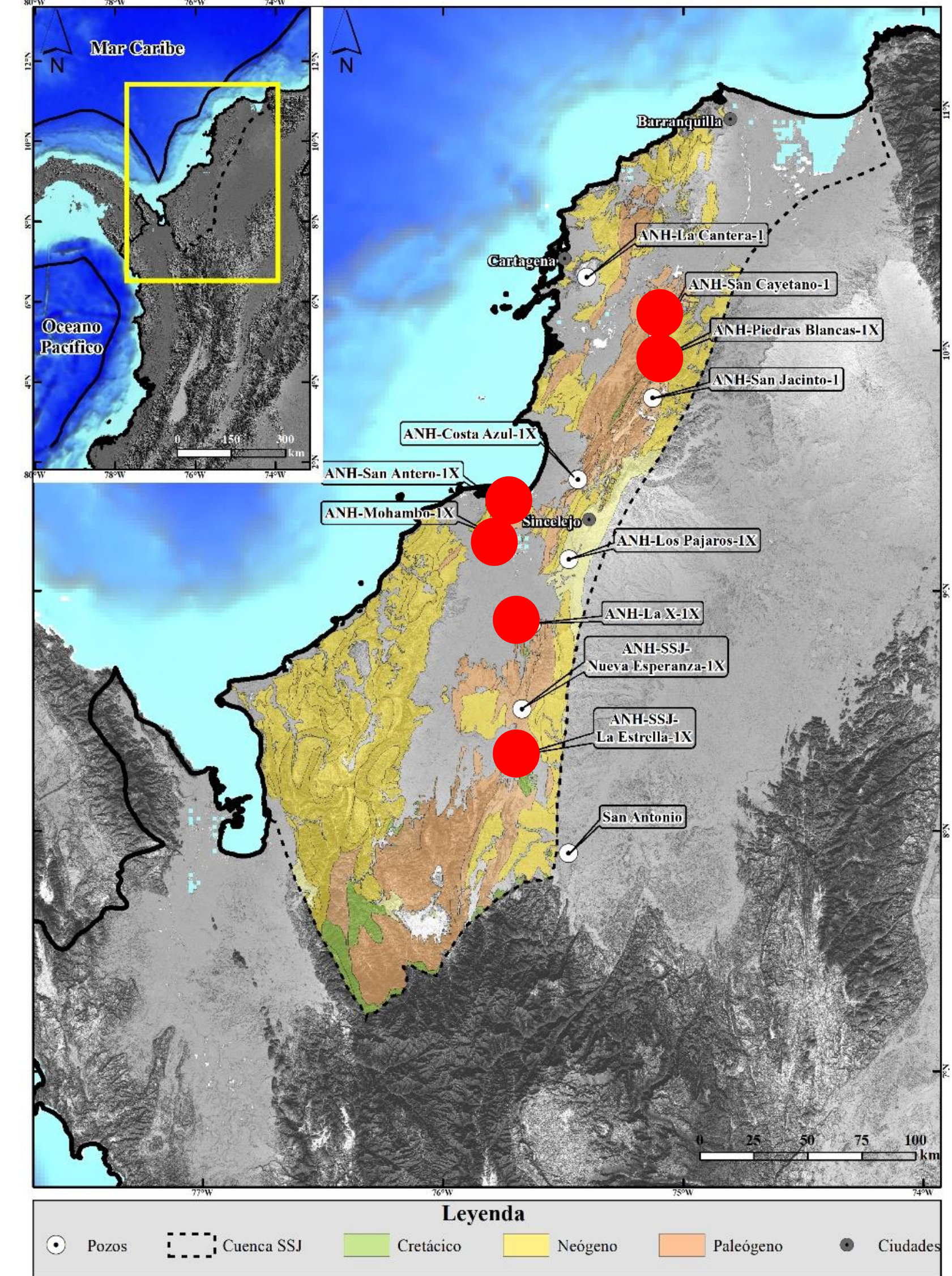
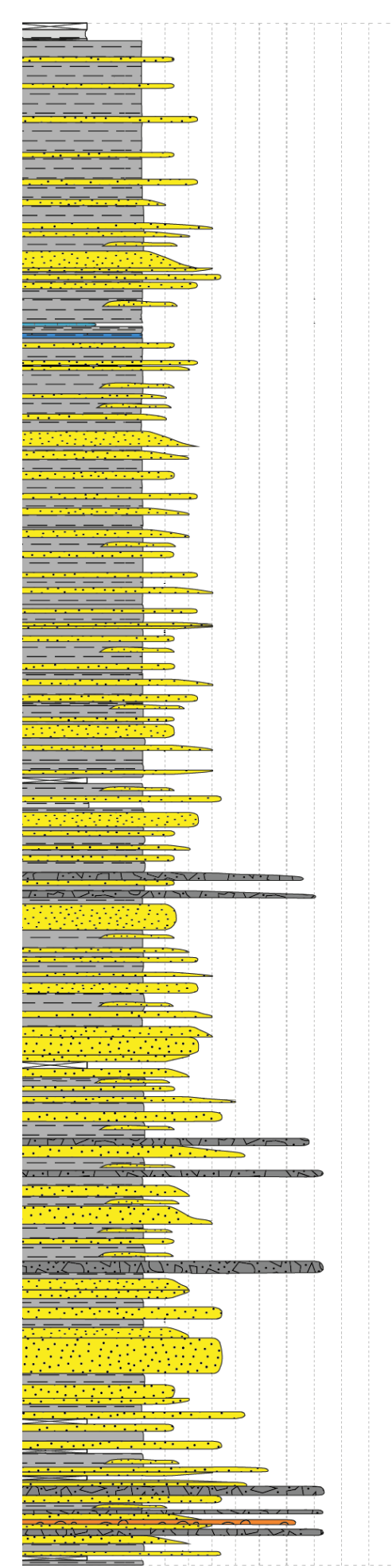
ANH-SAN ANTERO  
2169'



ANH-PIEDRABLANCA  
2477'



ANH-SAN CAYETANO-1  
2314'

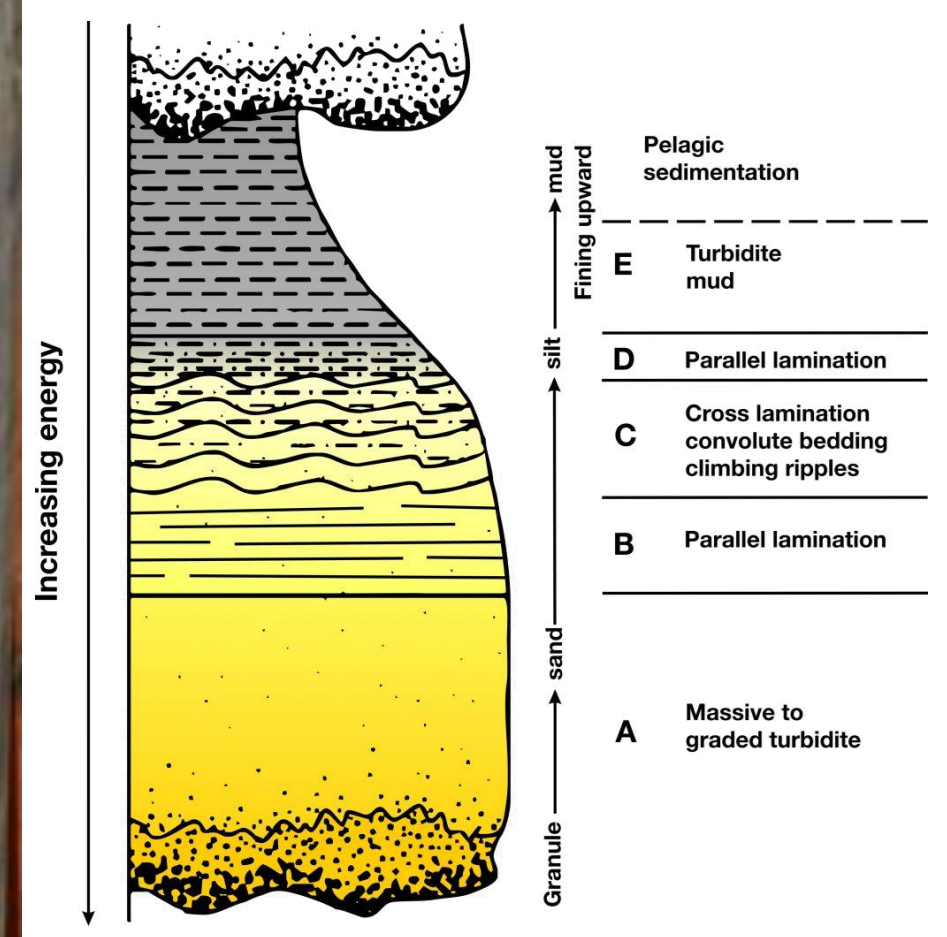




# Turbidite facies, ANH-PIEDRABLANCA and ANH-SANCAYETANO WELLS

## Zoophycos and Nereites Ichnofacies

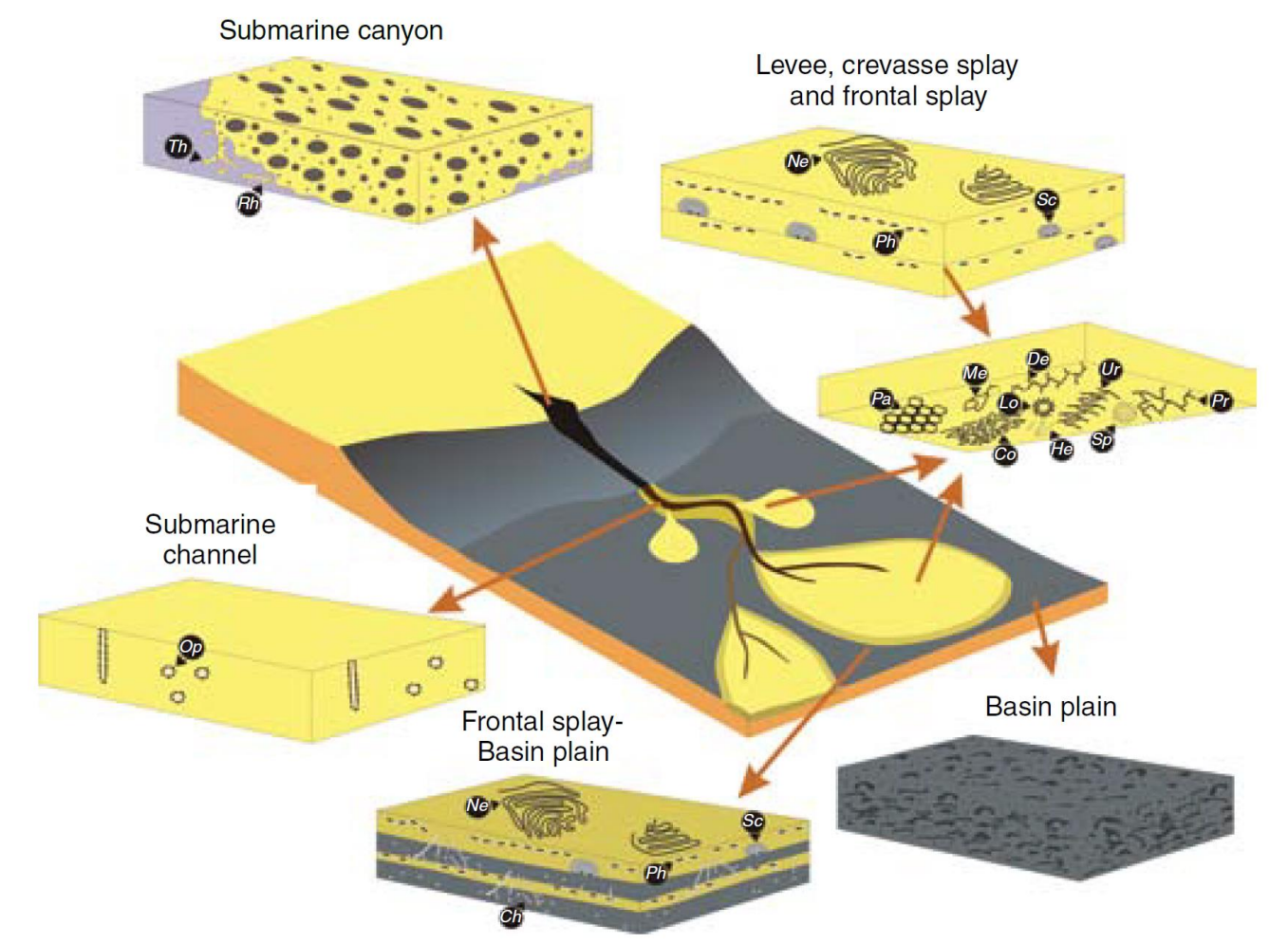
### Bouma sequence



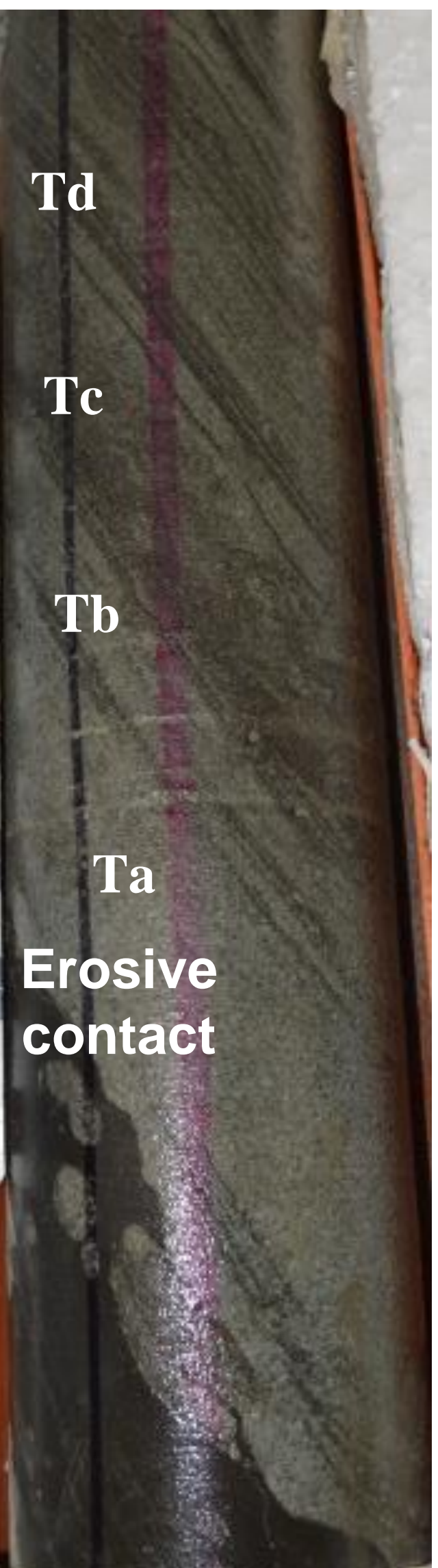
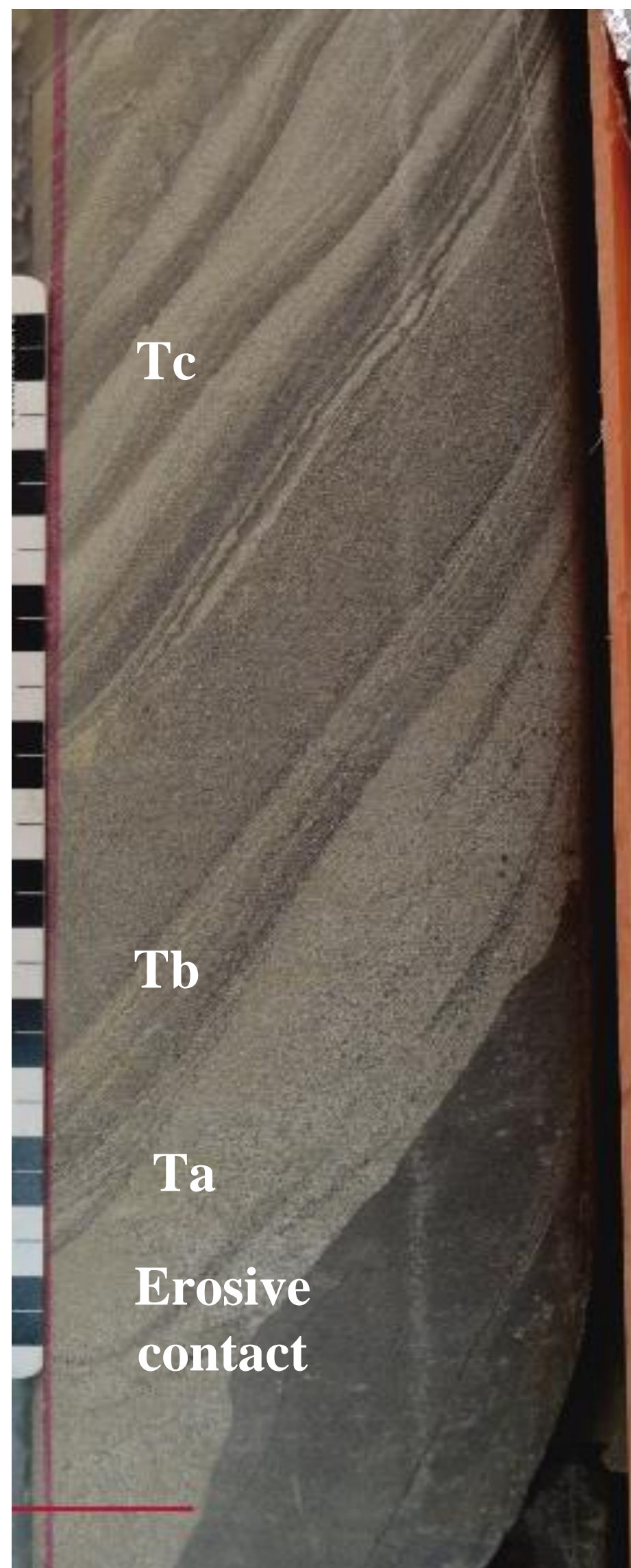
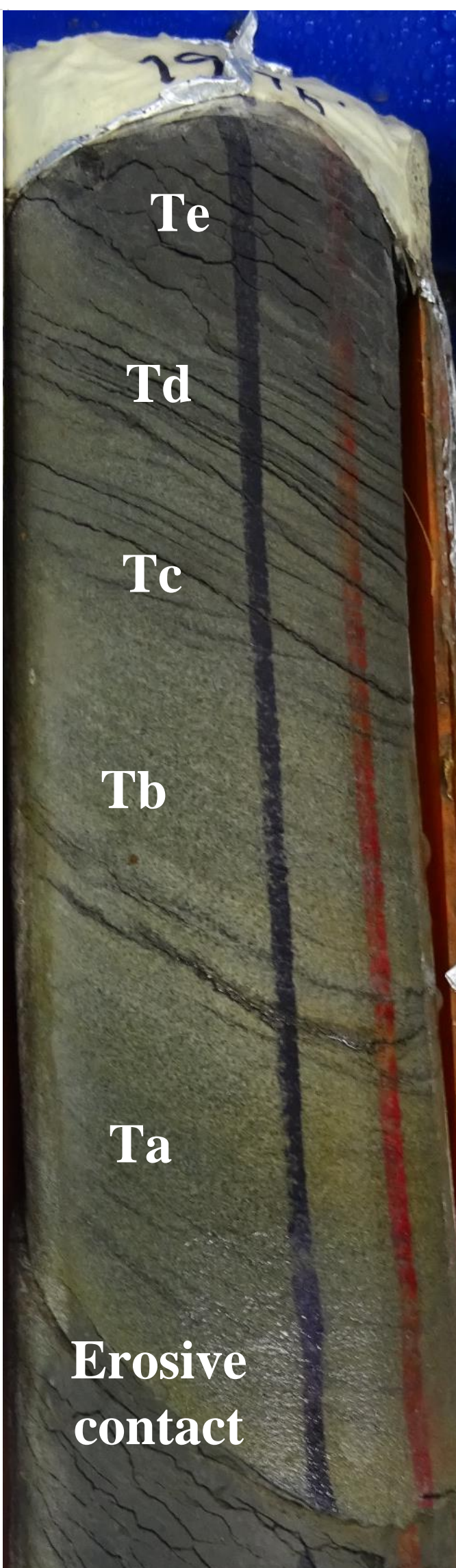
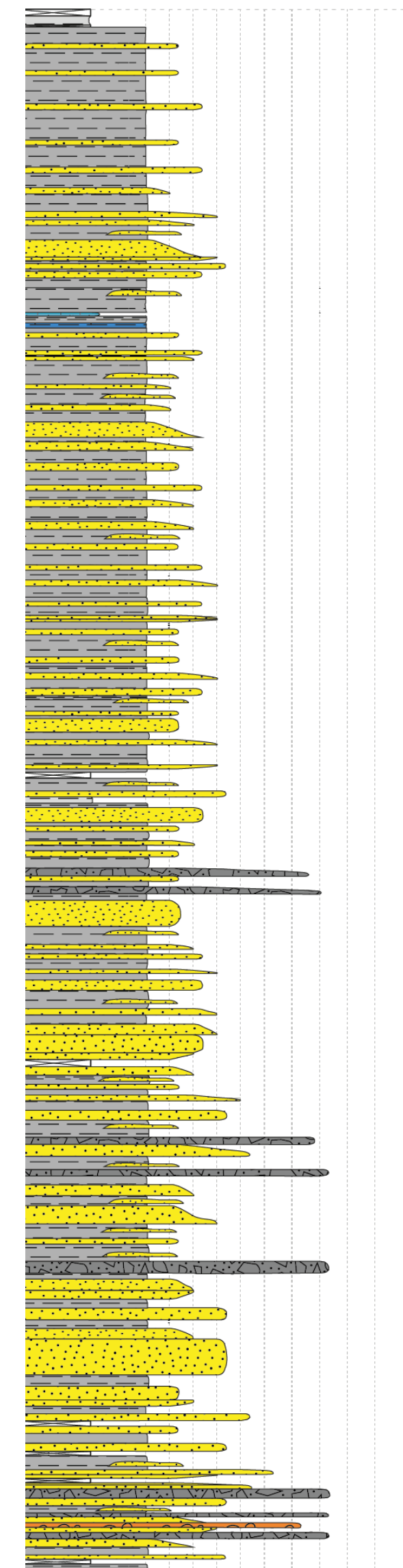
- Chondrites
- Ophiomorpha
- Palaeophycos
- Phycosiphon
- Planolites
- Schaubcylindrichmus
- Taenidium
- Teichichmus
- Thalassinoides
- Trazas sin diferenciar
- Zoophycos
- Nereites

Ichnology of deep-marine clastic environments

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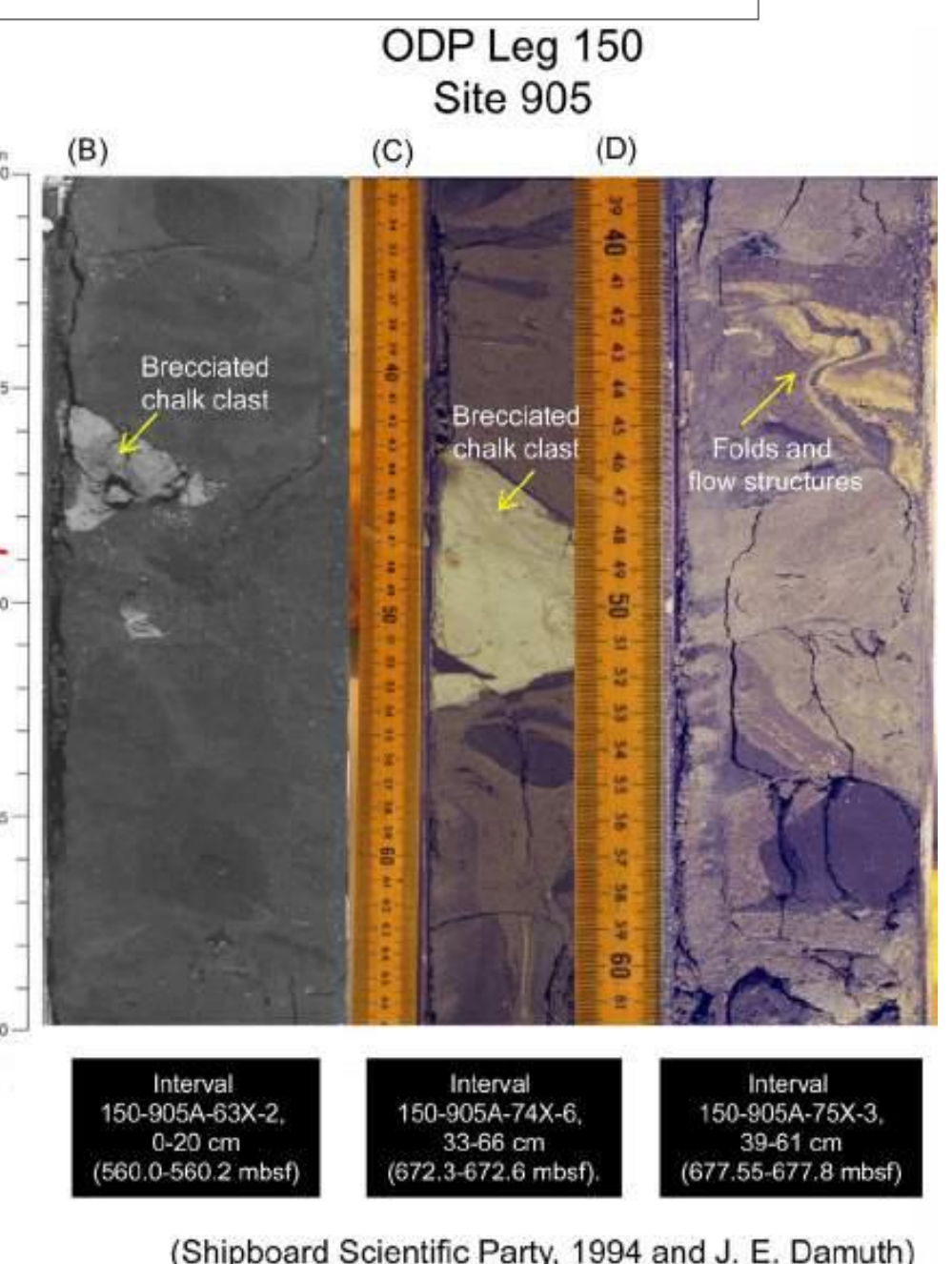
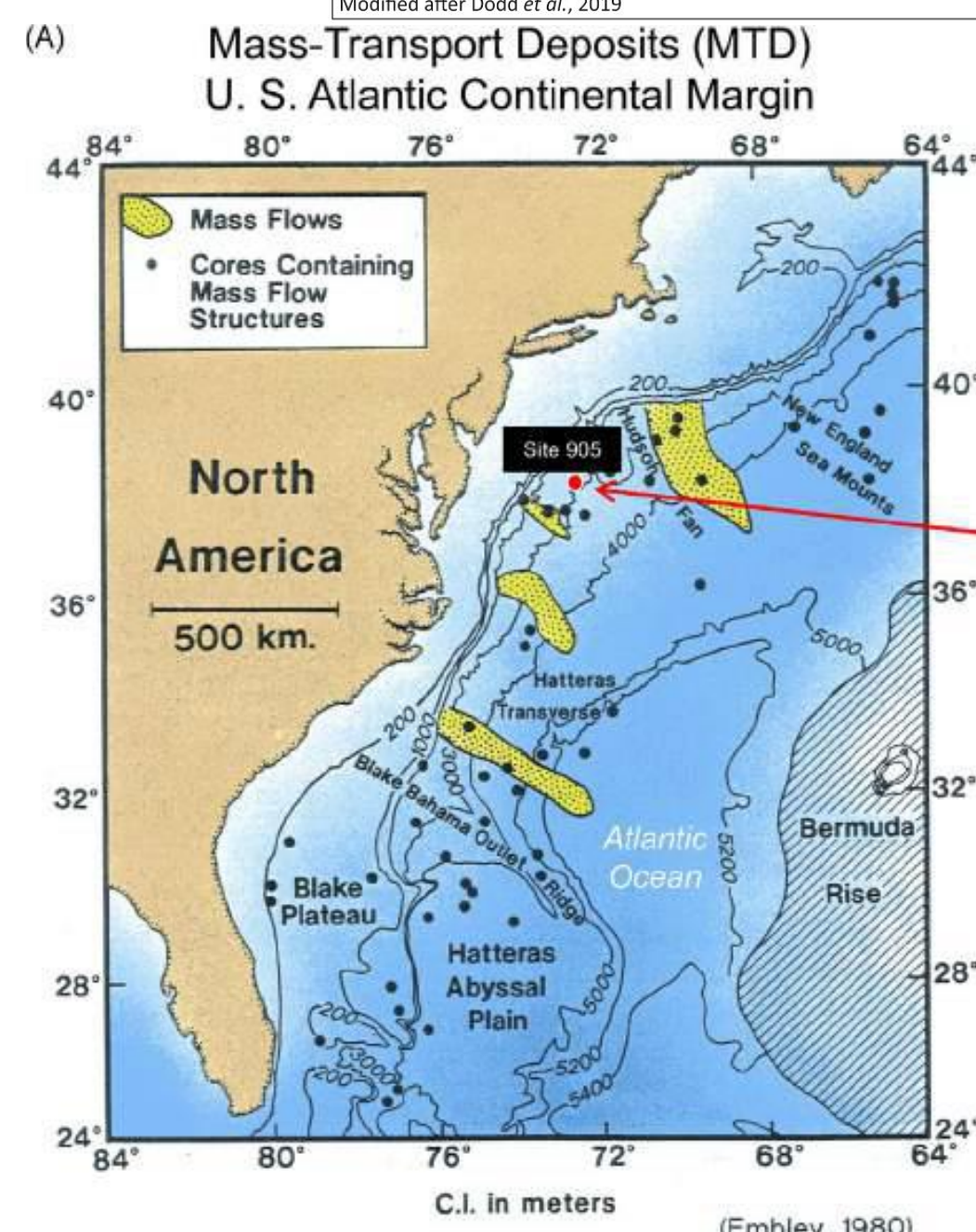
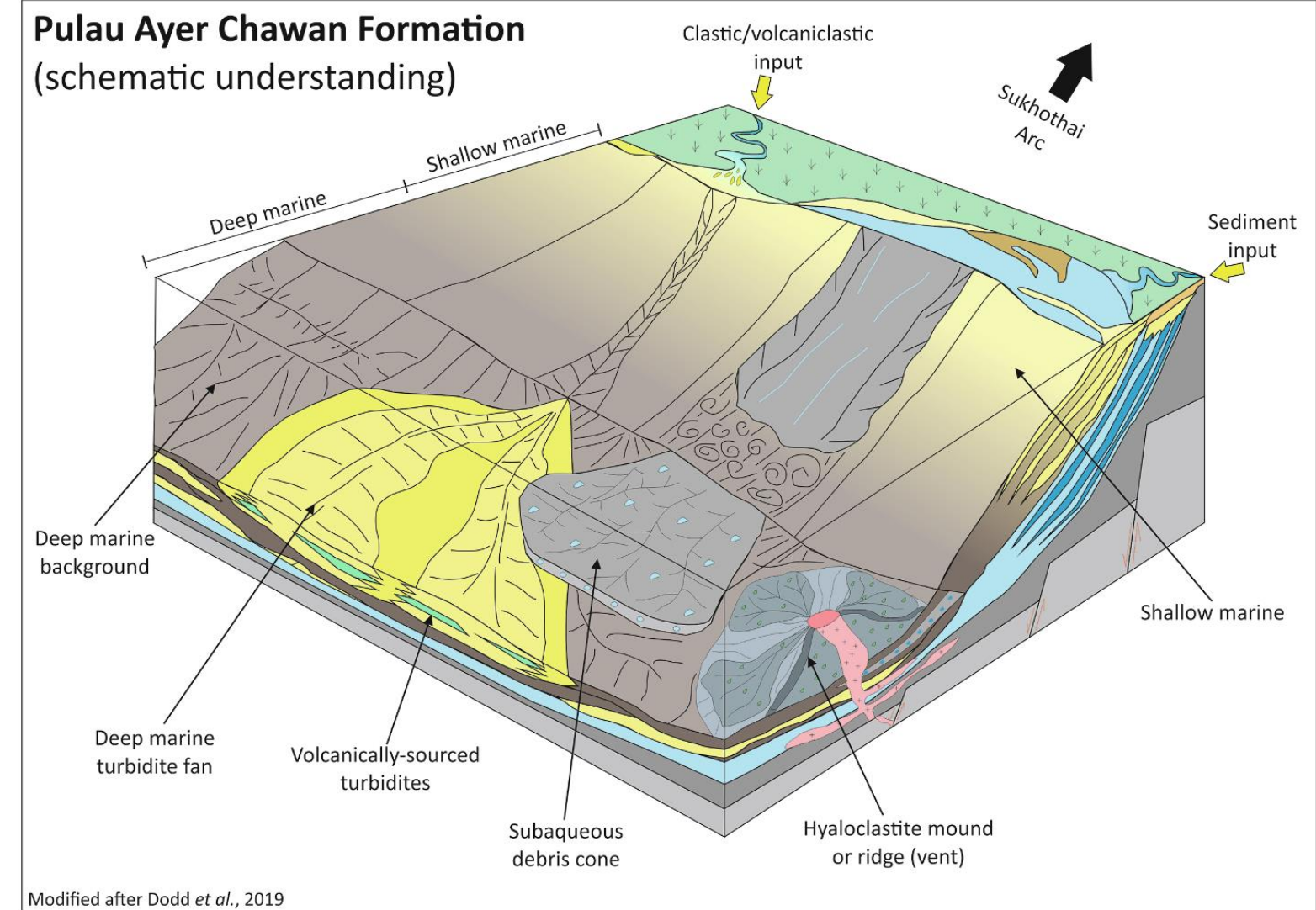
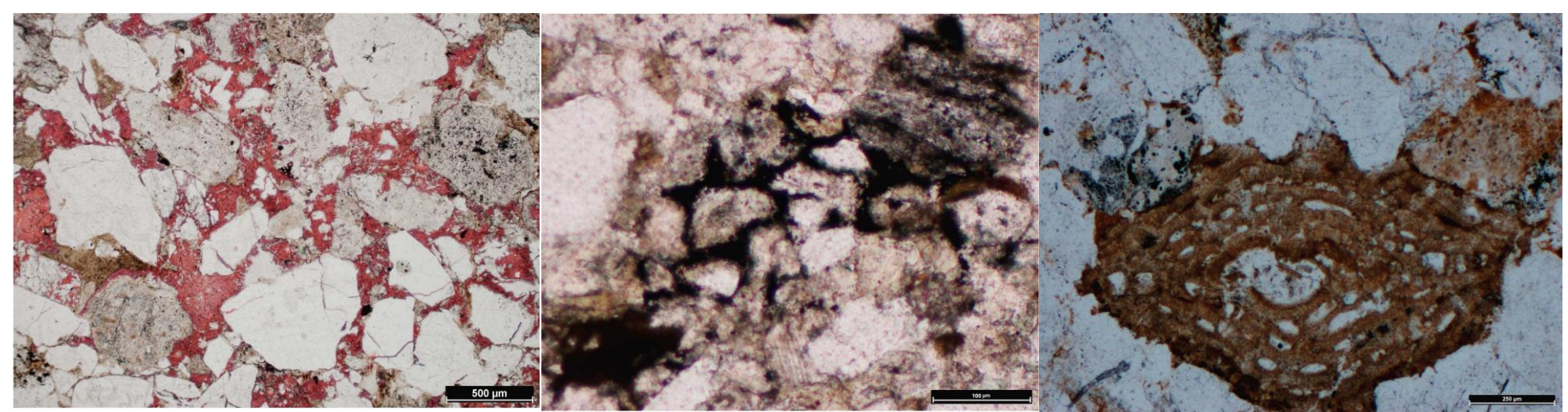
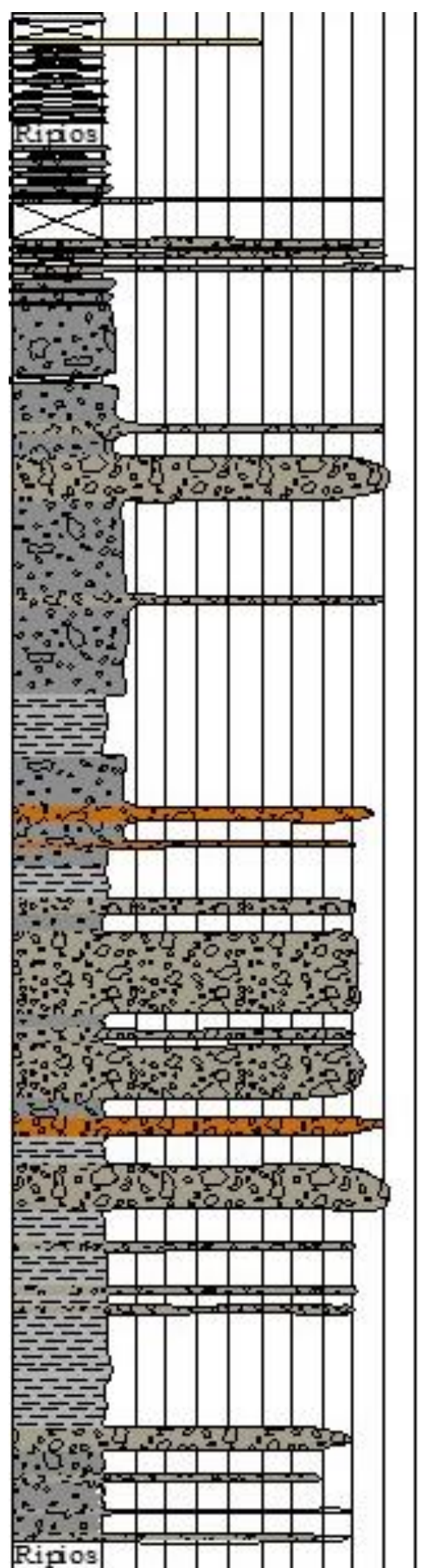


Buatois & Mángano (2011)





# Mass transport deposits (MTD) facies, ANH-MOHAMBO and ANH-SAN ANTERO WELLS





# Gilbert delta facies, ANH-LA X-1A WELL

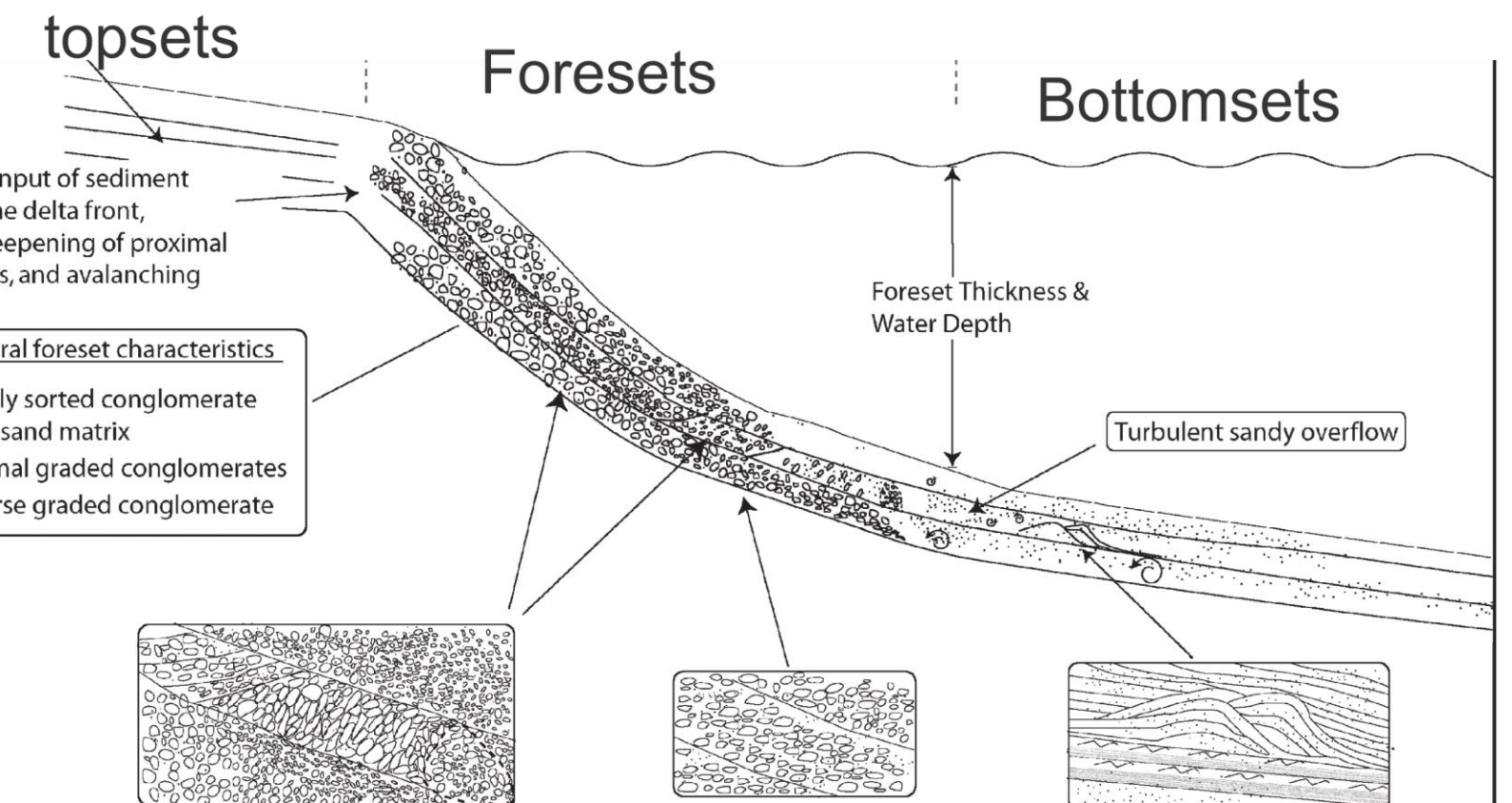
Topsets facies



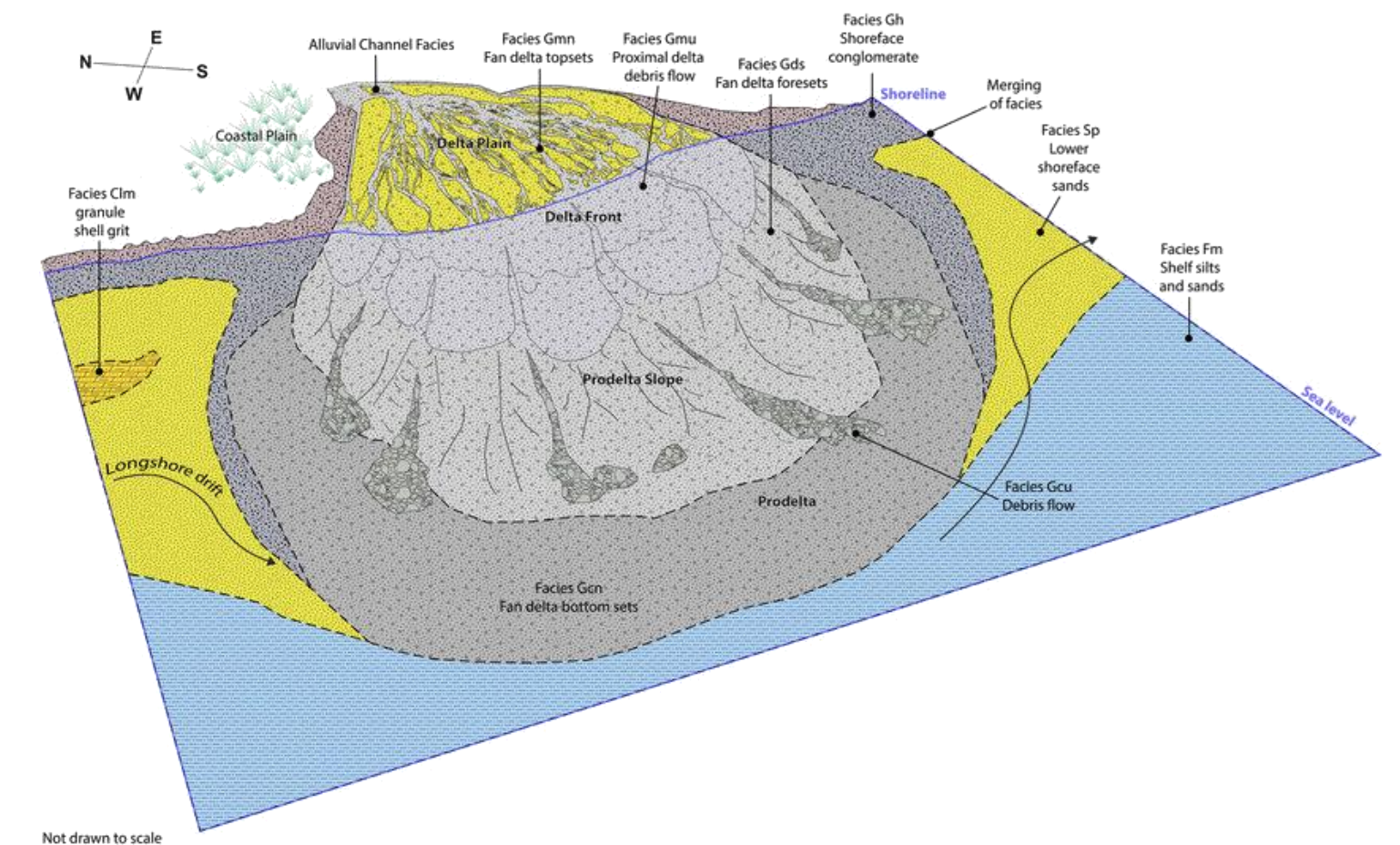
Foresets facies



Bottomsets facies

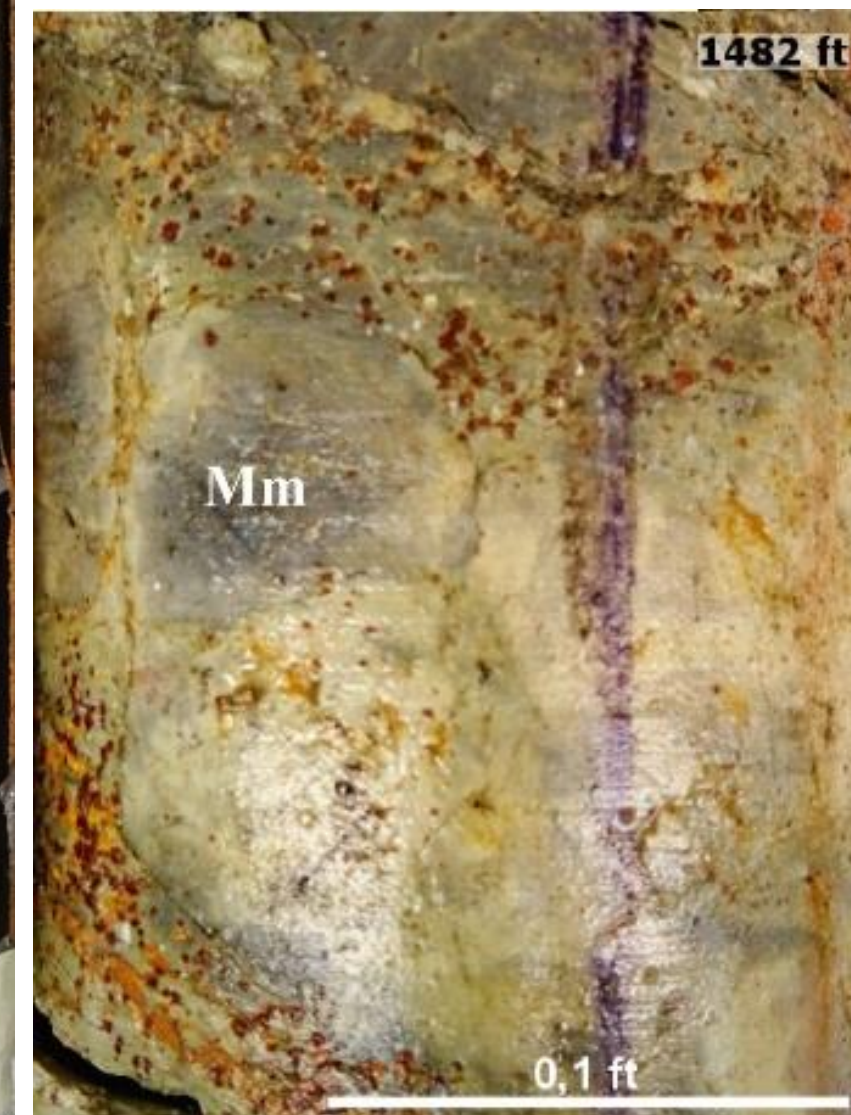
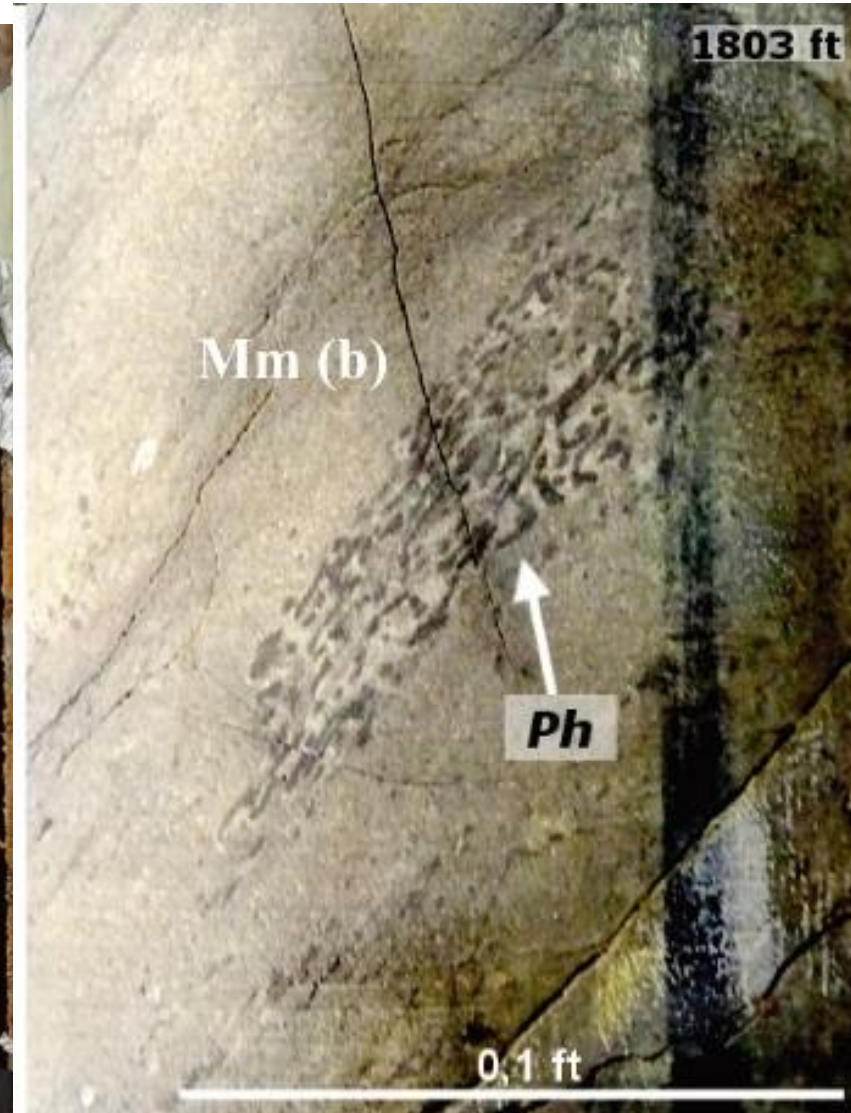
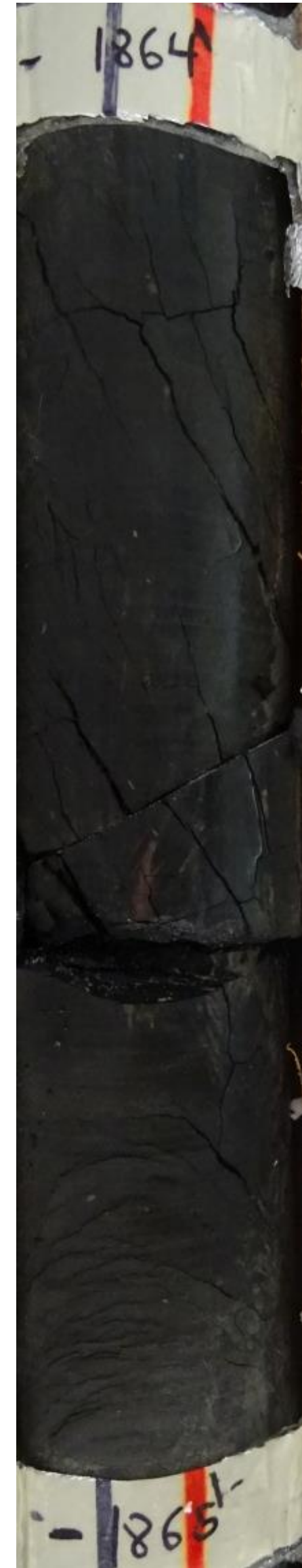
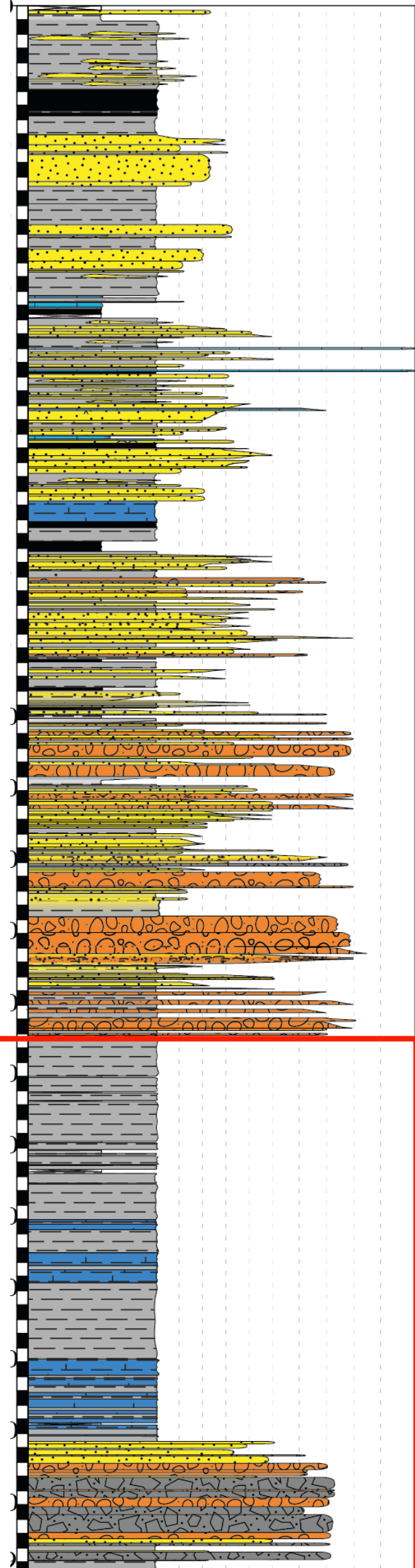


T.S. McConnico & Kari N. Bassett, 2006

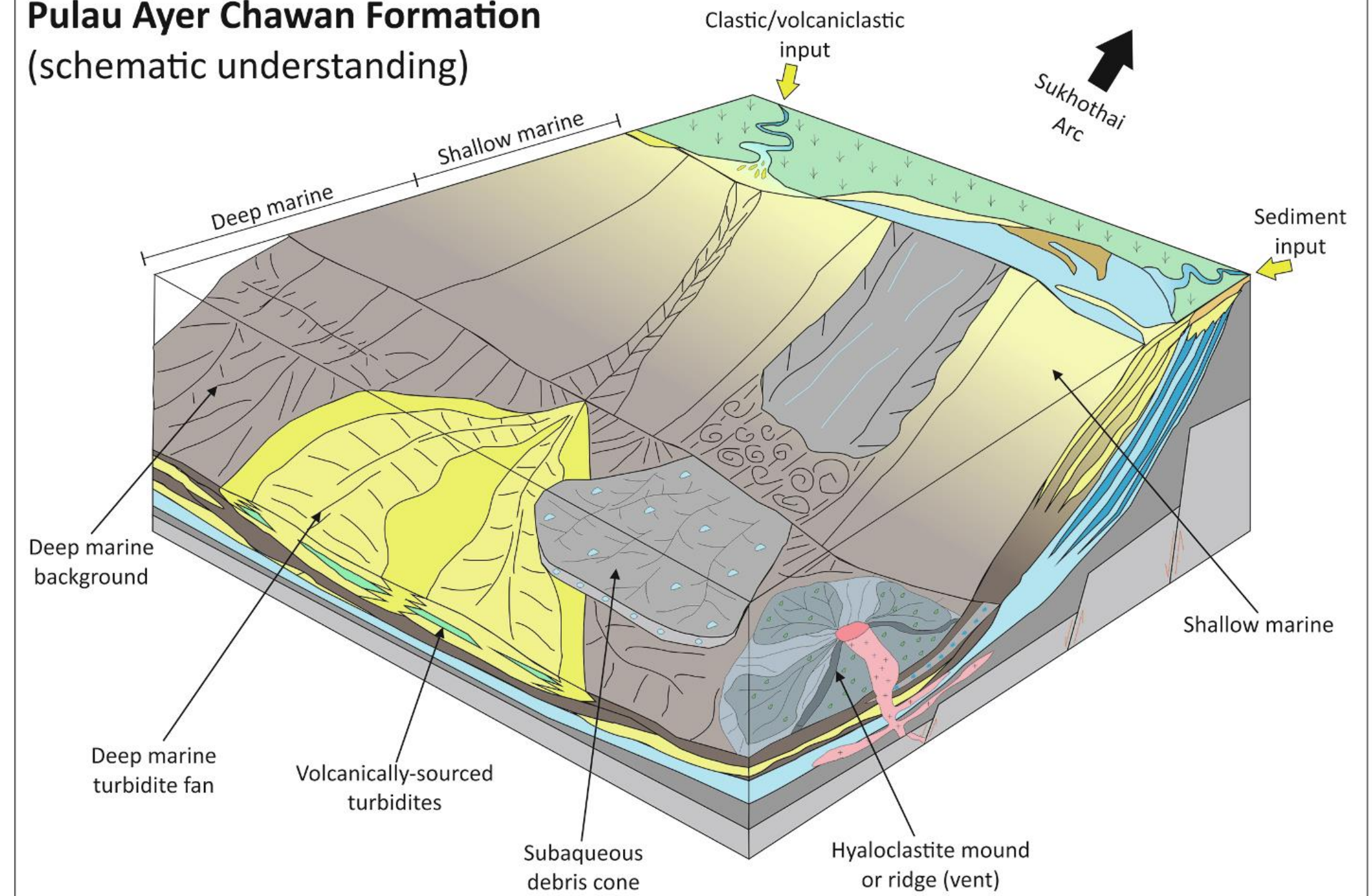




# Pelagic, Hemipelagic and MTD facies, ANH-SSJ-LA ESTRELA-1X WELL



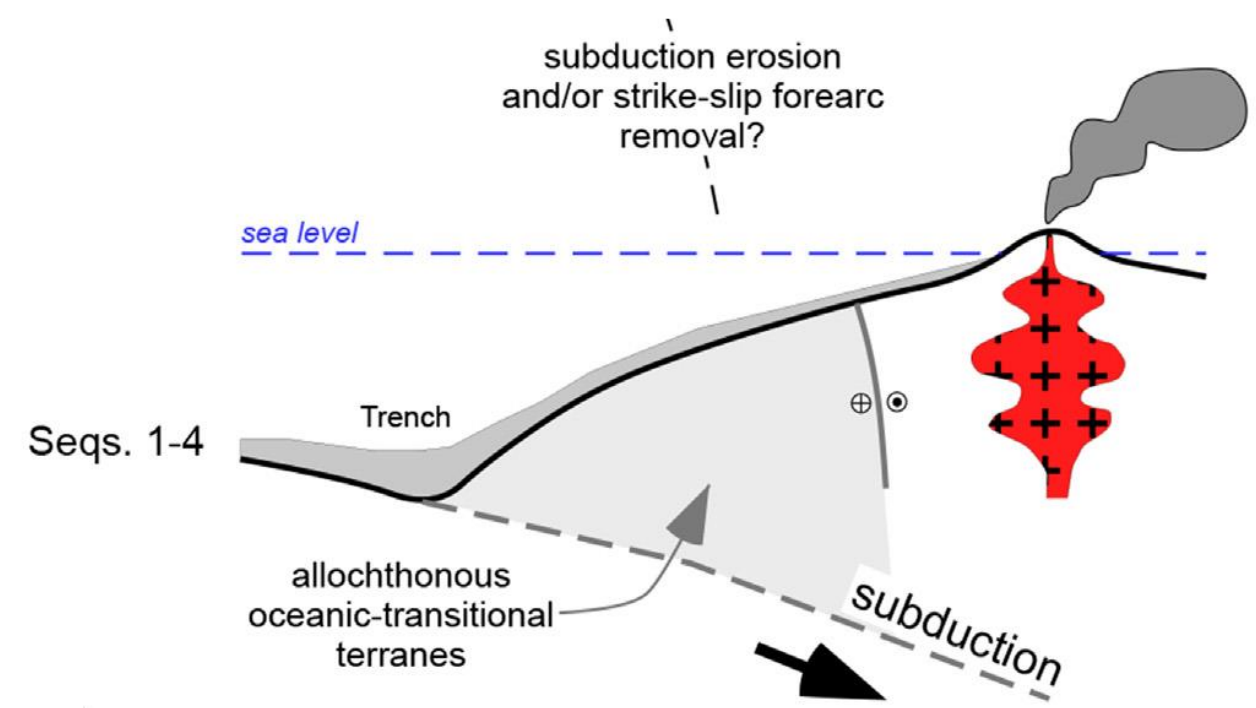
**Pulau Ayer Chawan Formation**  
(schematic understanding)



Modified after Dodd *et al.*, 2019

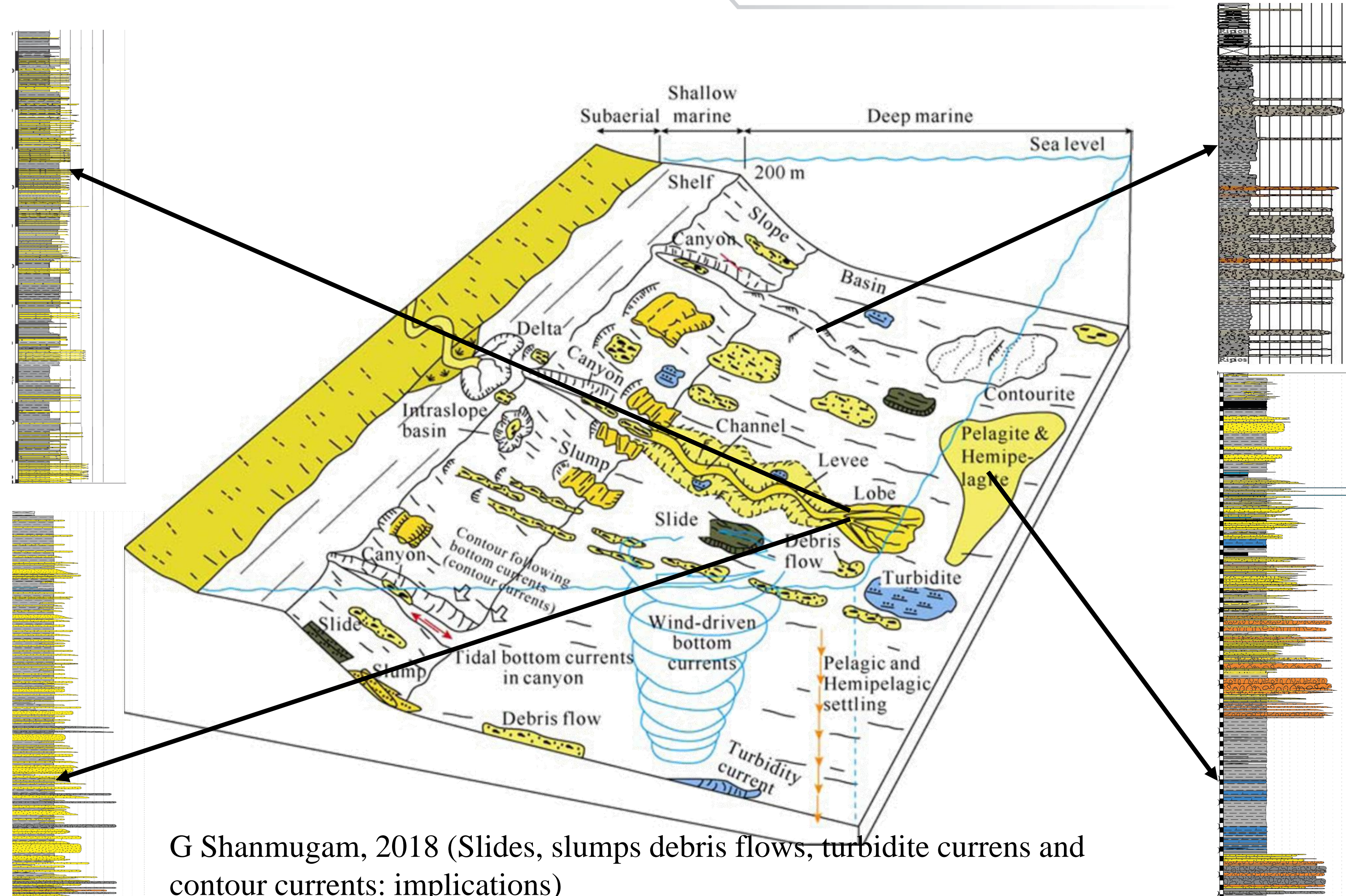


• Paleocene to Lower Eocene environments in SSJ



**Upper Cretaceous to lower Eocene:**  
San Jacinto underfilled (?),  
deep-marine, sloped forearc basin;  
subduction with active magmatic arc

Mora-Bohorquez et al., 2018

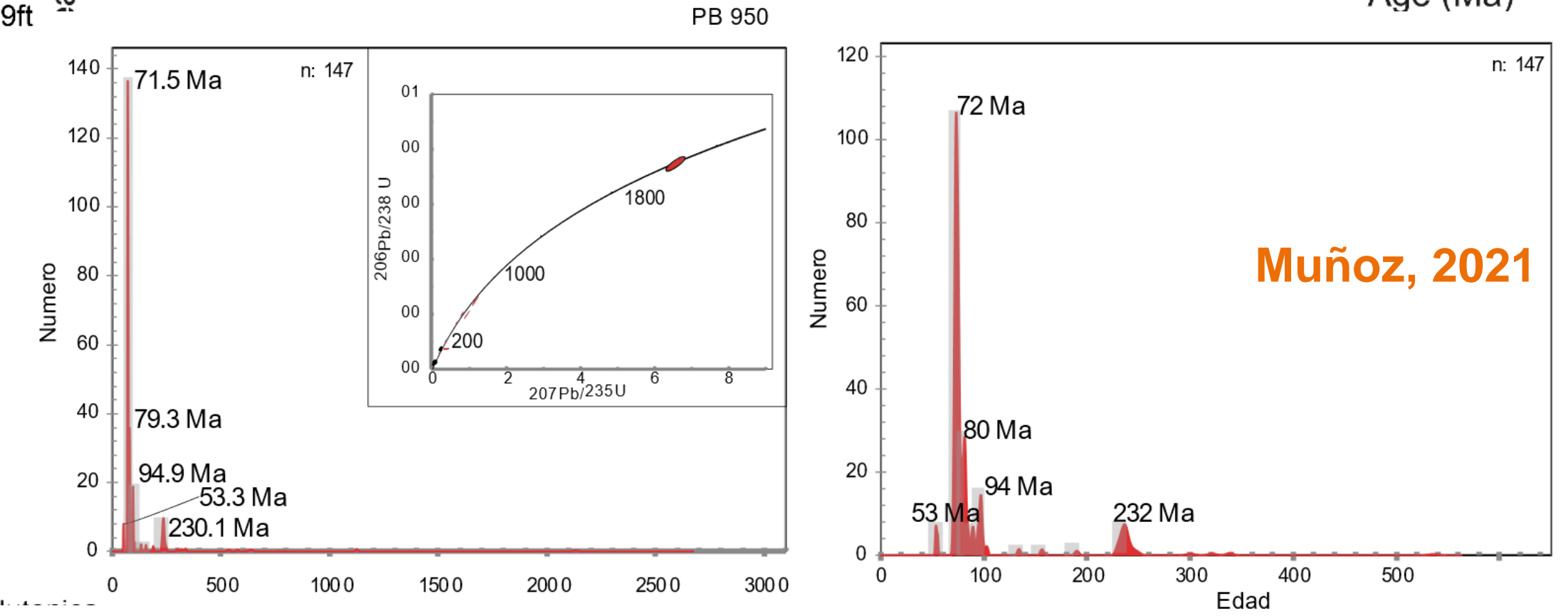
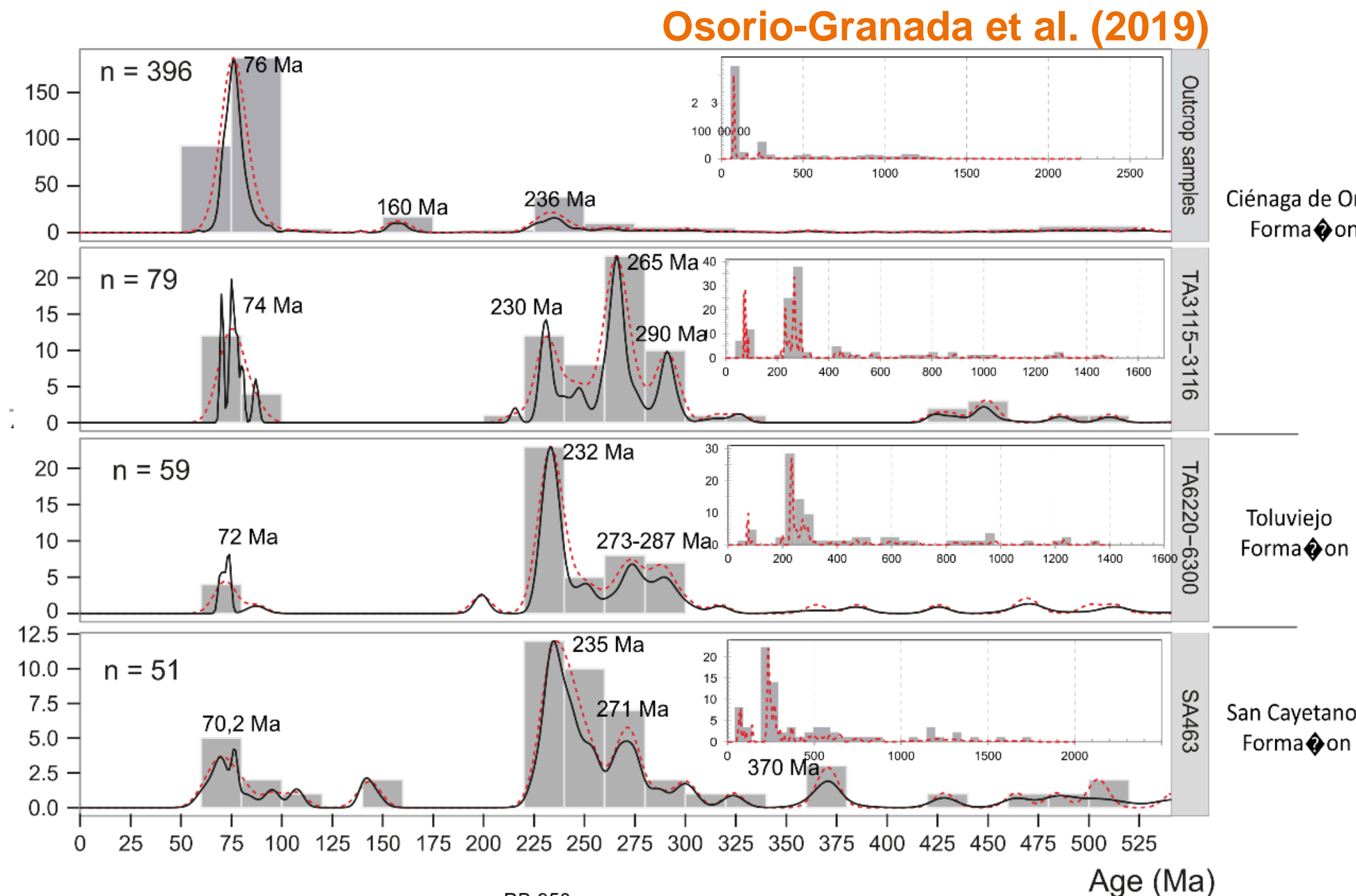
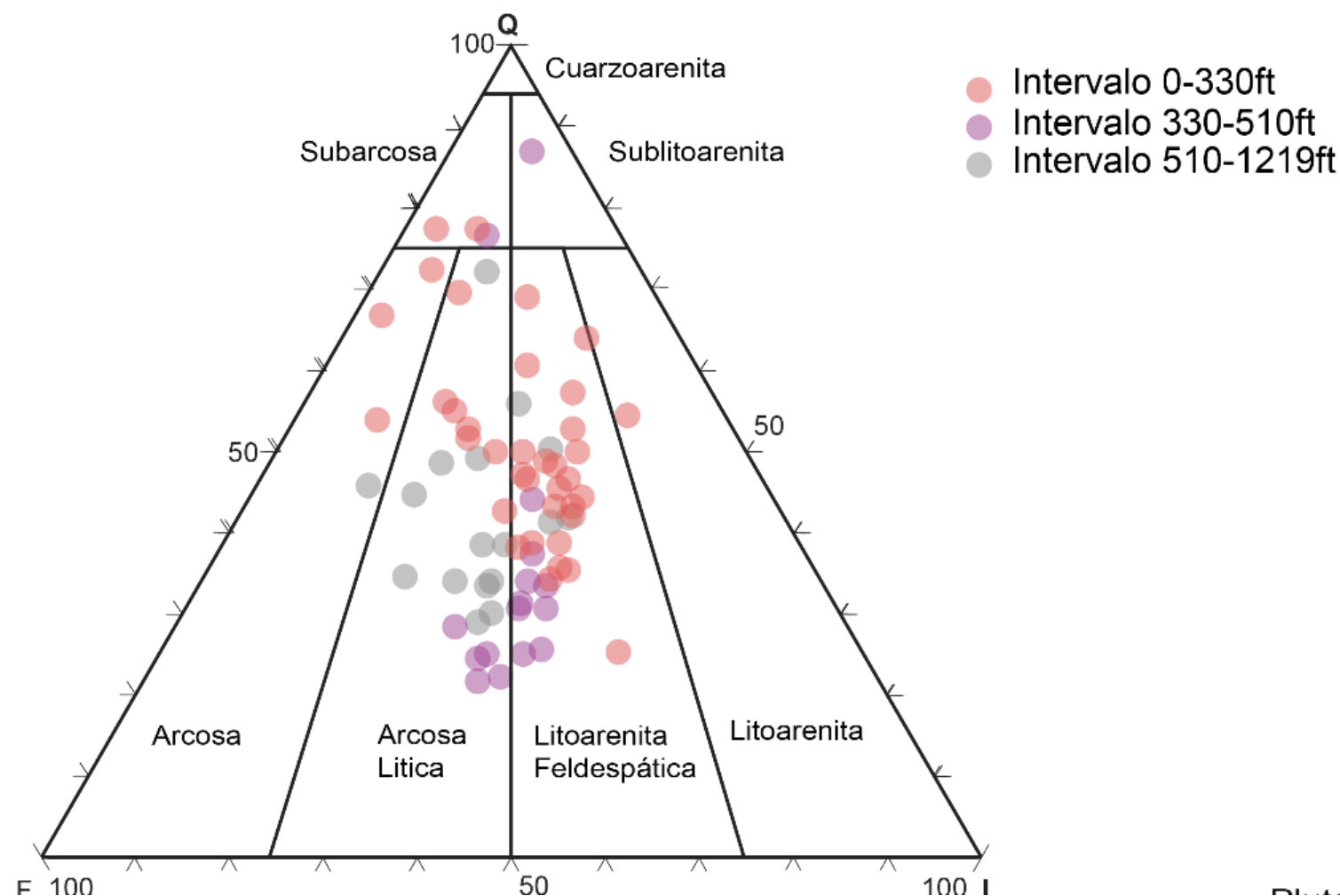
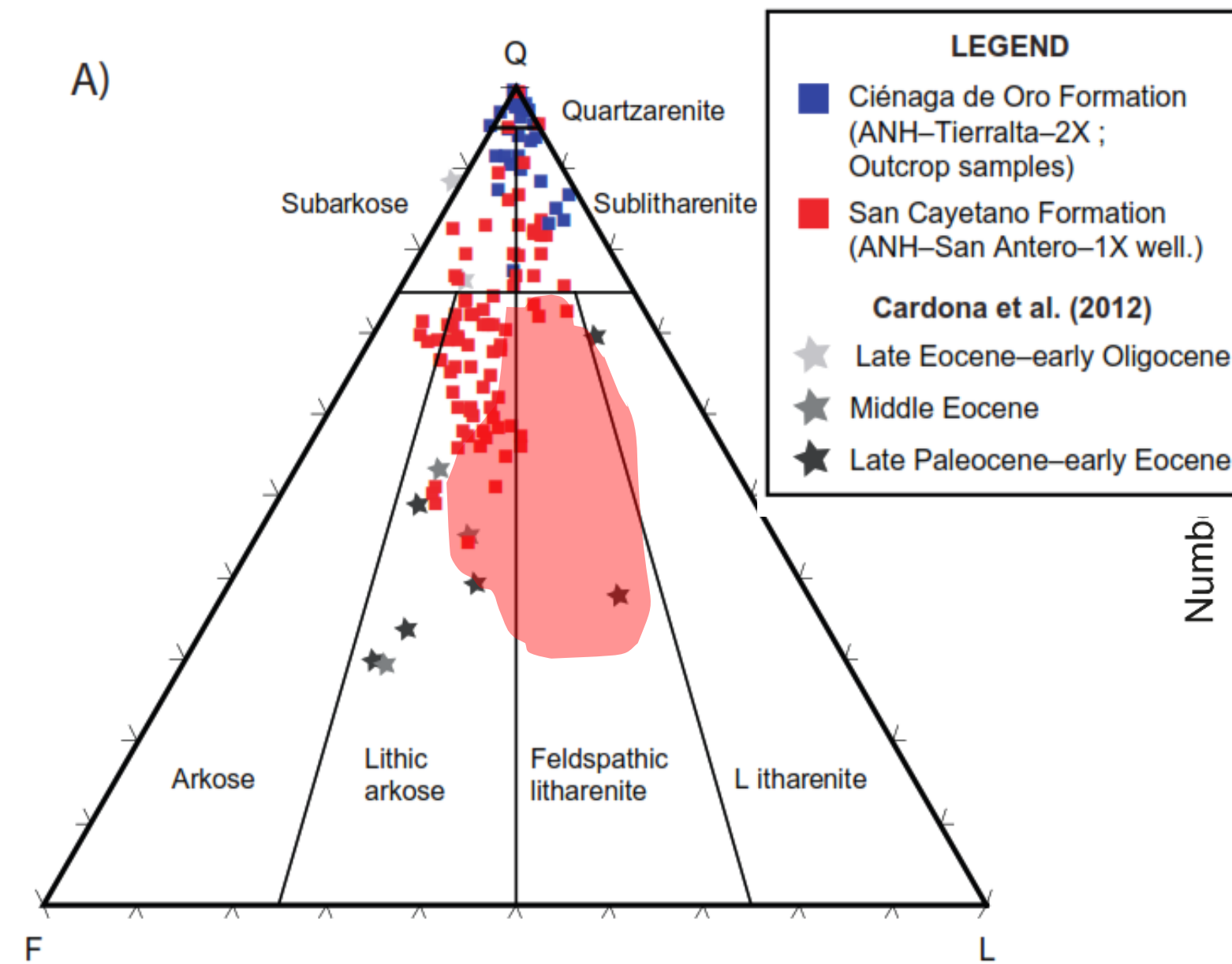


G Shanmugam, 2018 (Slides, slumps debris flows, turbidite currents and contour currents: implications)



# Provenance analysis for Early Eocene sandstones

petrographic evidence, such as the occurrence of feldspar, the content of apatite, and the presence of unstable mafic and ultramafic minerals, suggests that sediments for San Cayetano Formation came from igneous and metamorphic massifs located close to the depositional site.



Osorio-Granada et al. (2019)

Muñoz, 2021



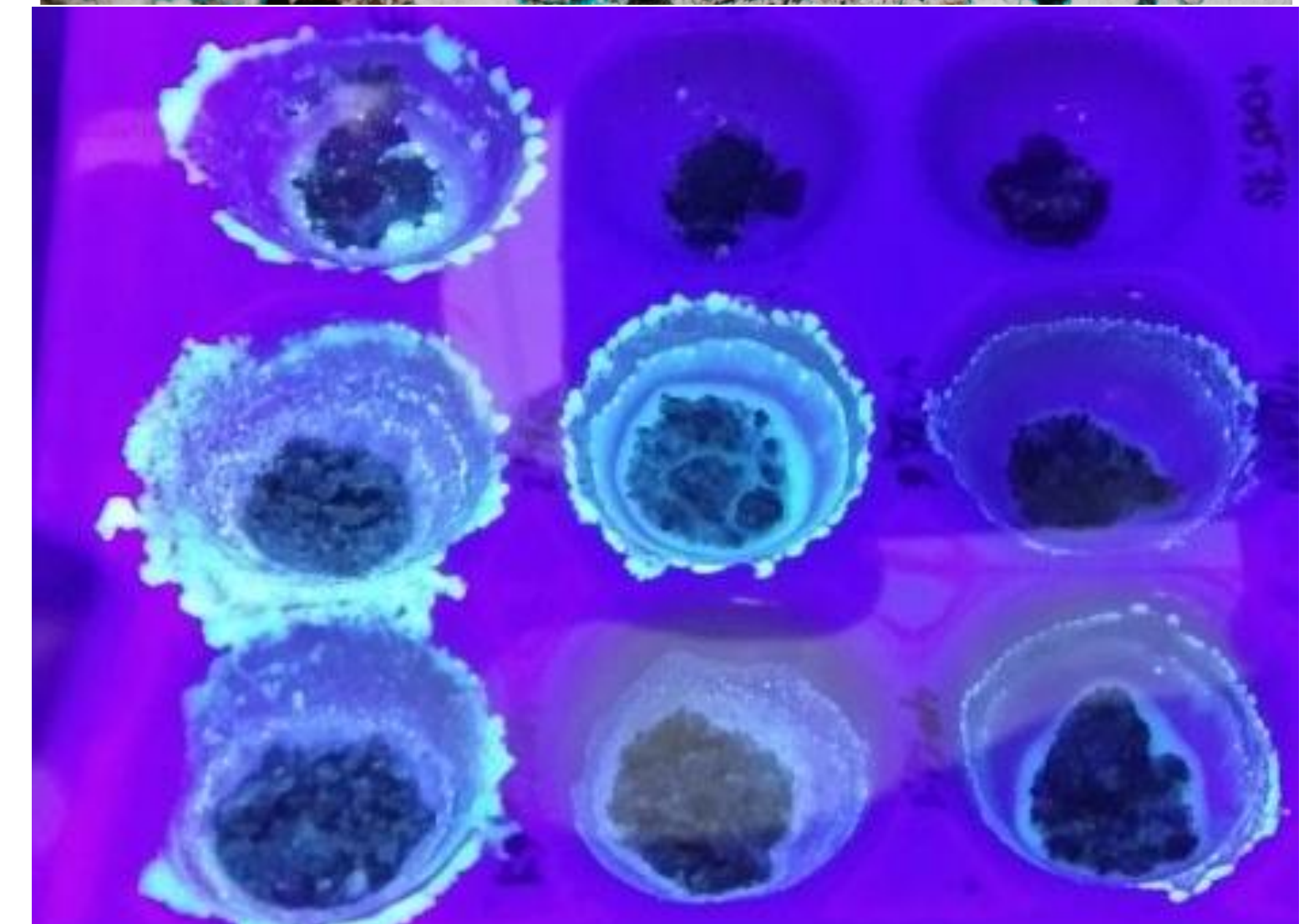
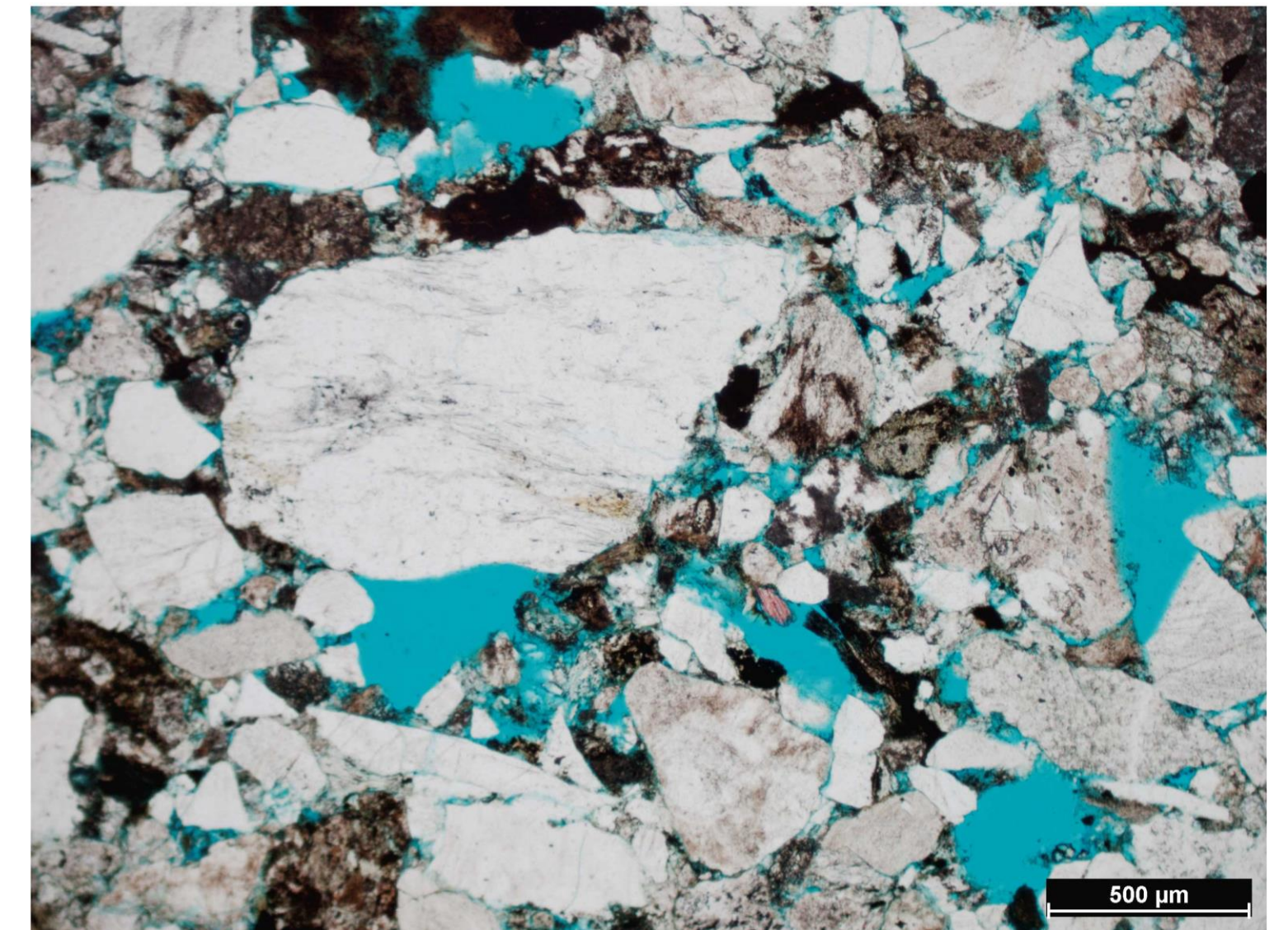
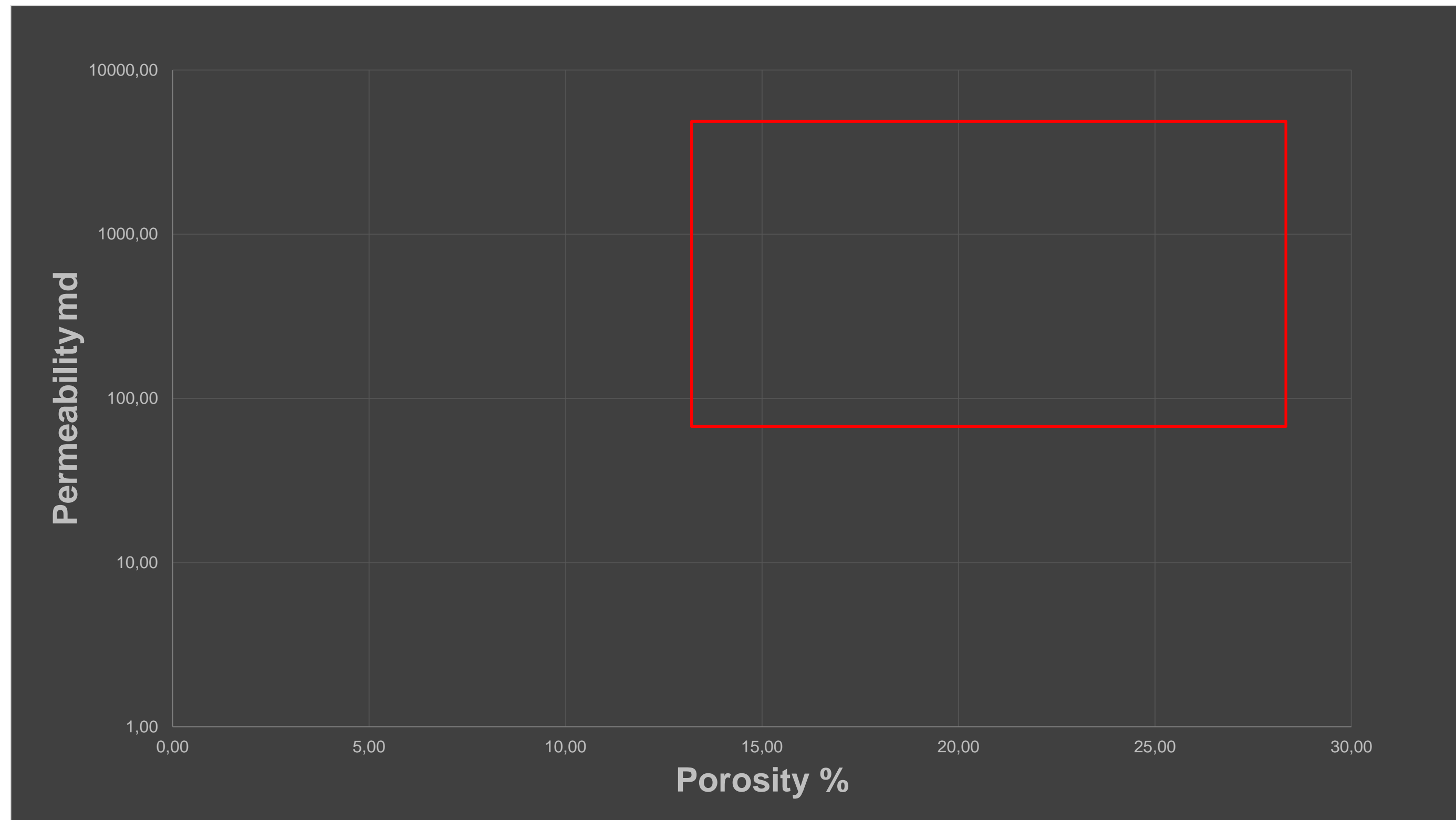
# Early Eocene sedimentary rocks can be an excellent reservoir

~500 test of porosity and permeability

Average porosity 12%, maximum 25%

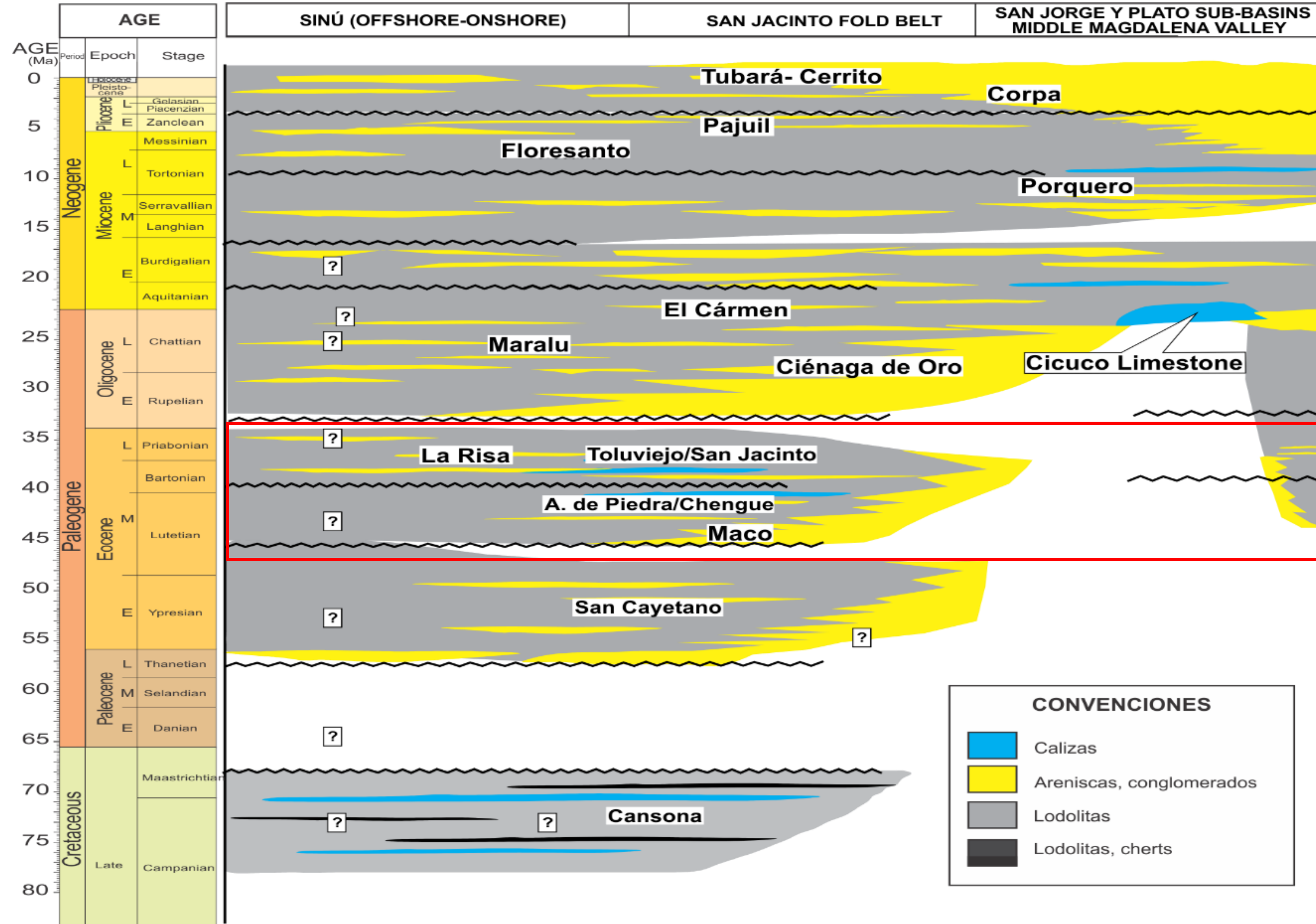
Average permeability 96 md in Gilbert delta, 5md in Turbidites.

~500 test of conventional





# STRATIGRAPHY AND PALEOENVIRONMENTS



### CONVENCIONES

- Calizas
- Areniscas, conglomerados
- Lodolitas
- Lodolitas, cherts



• Middle to late Eocene

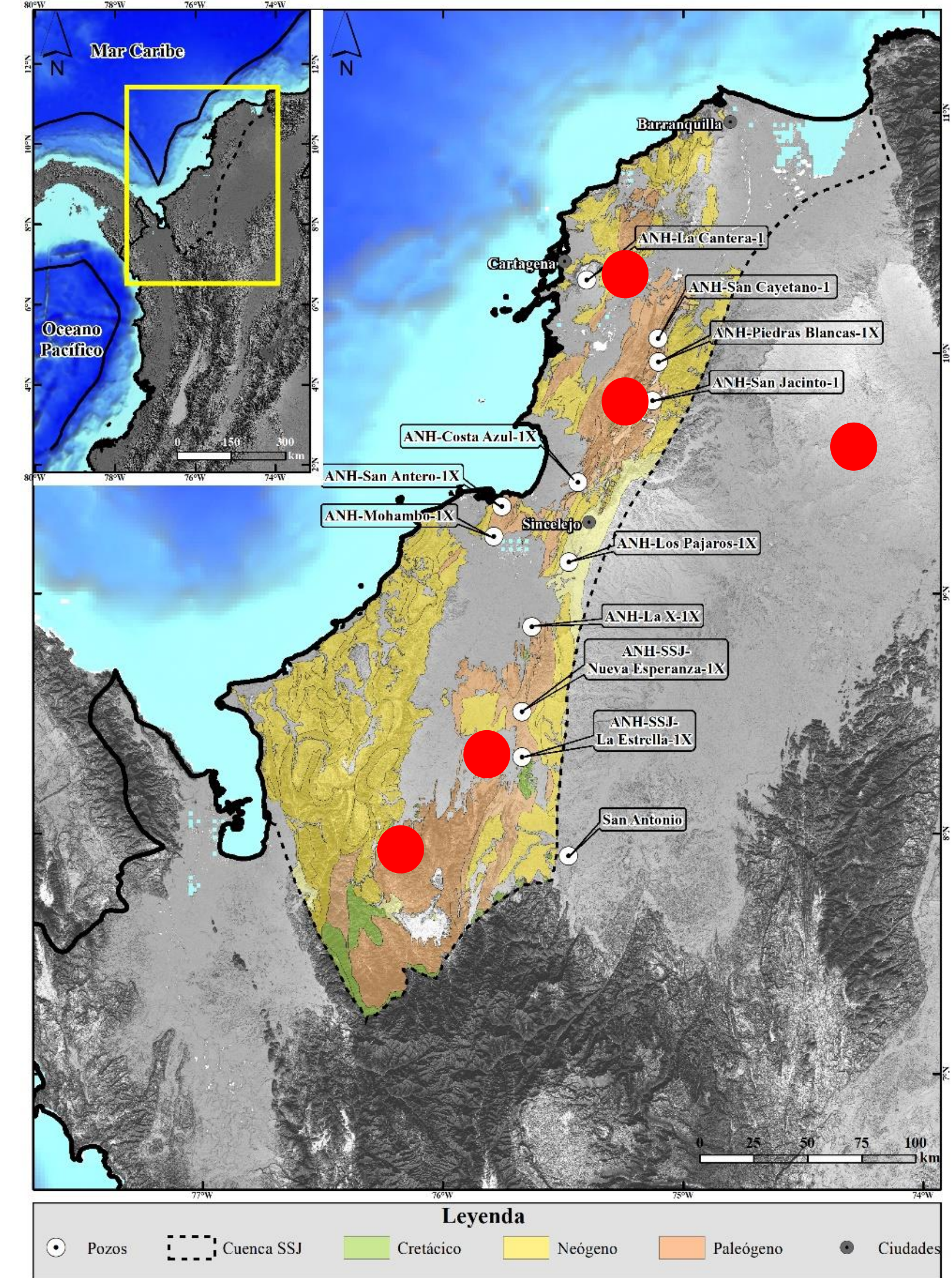
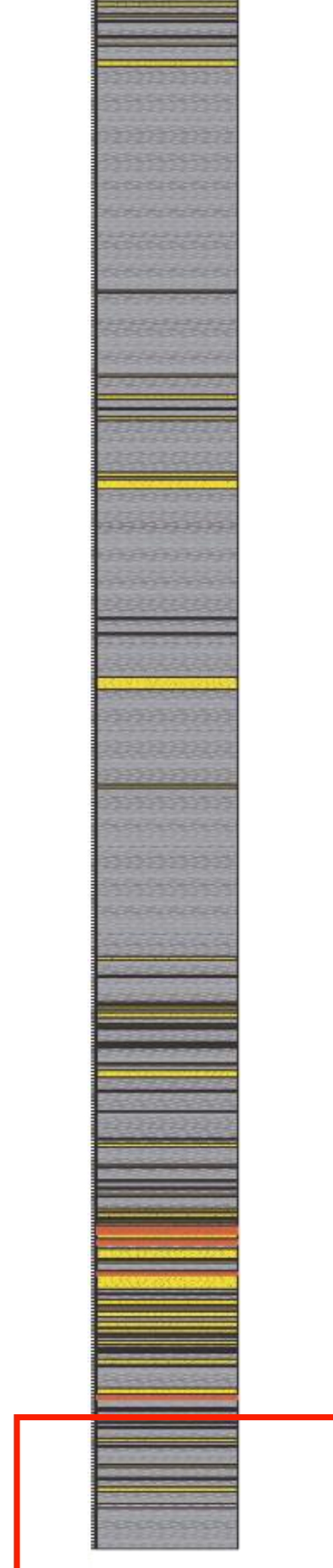
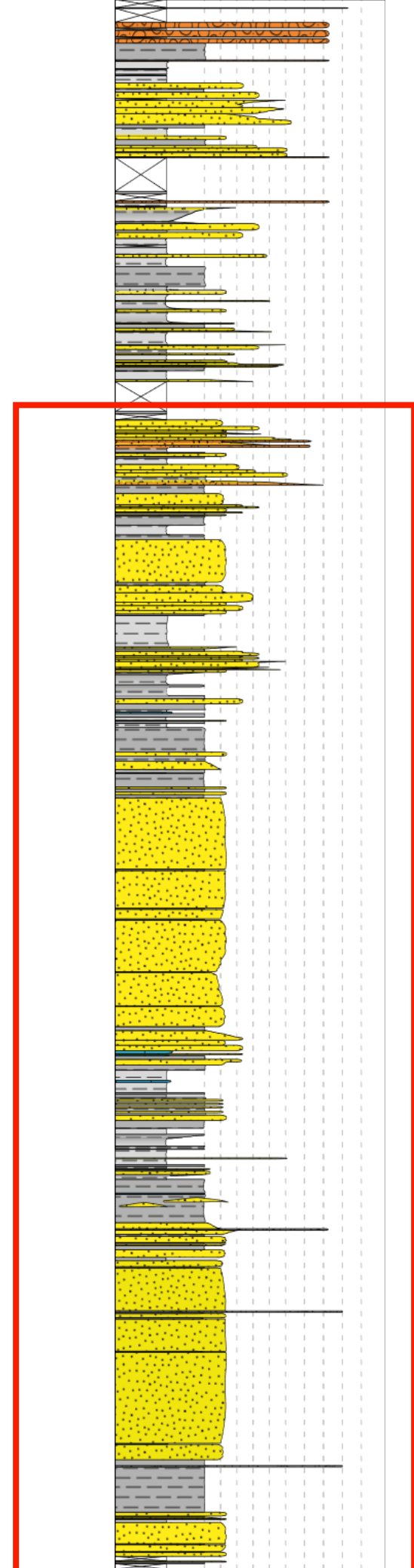
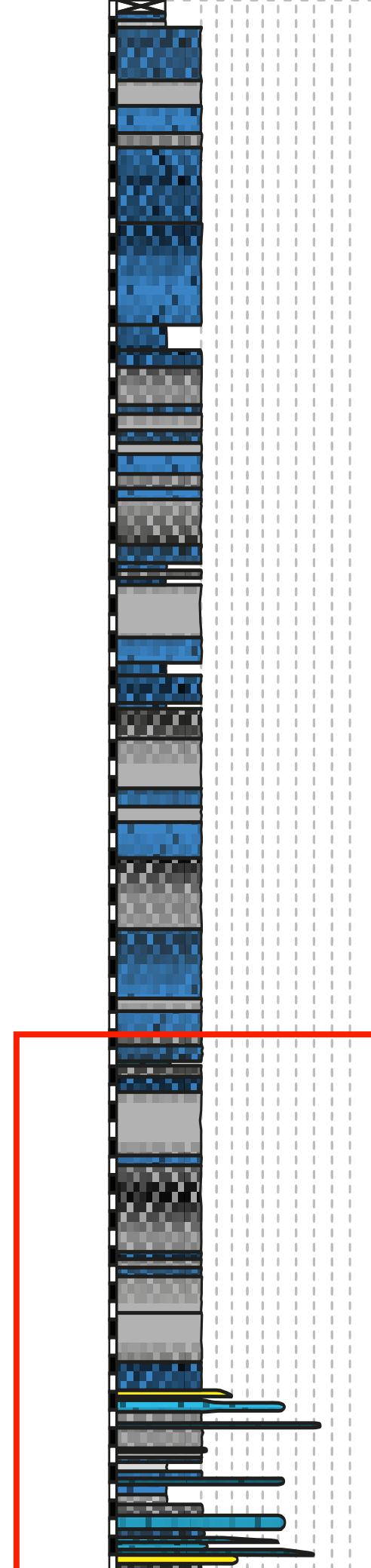
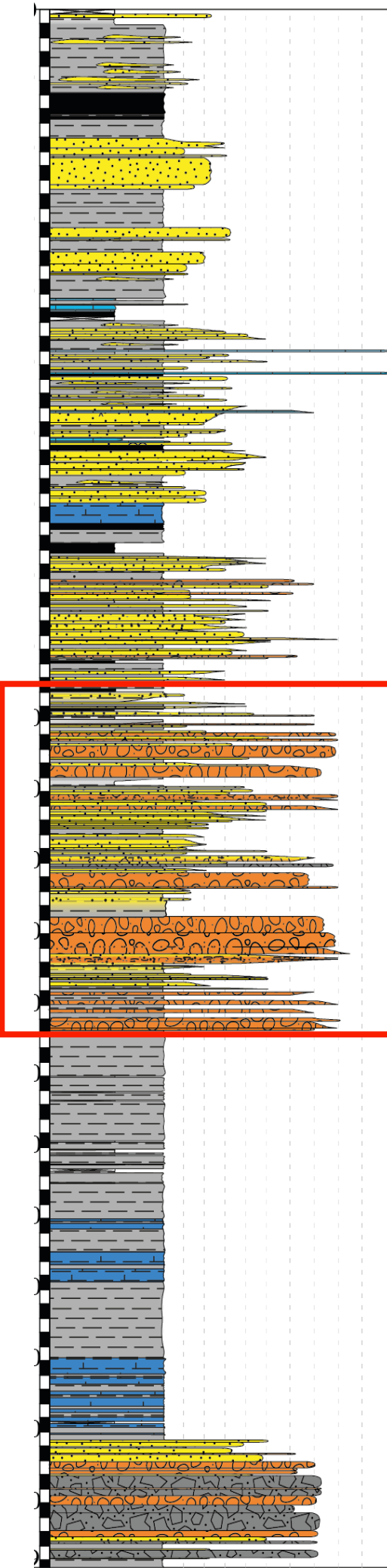
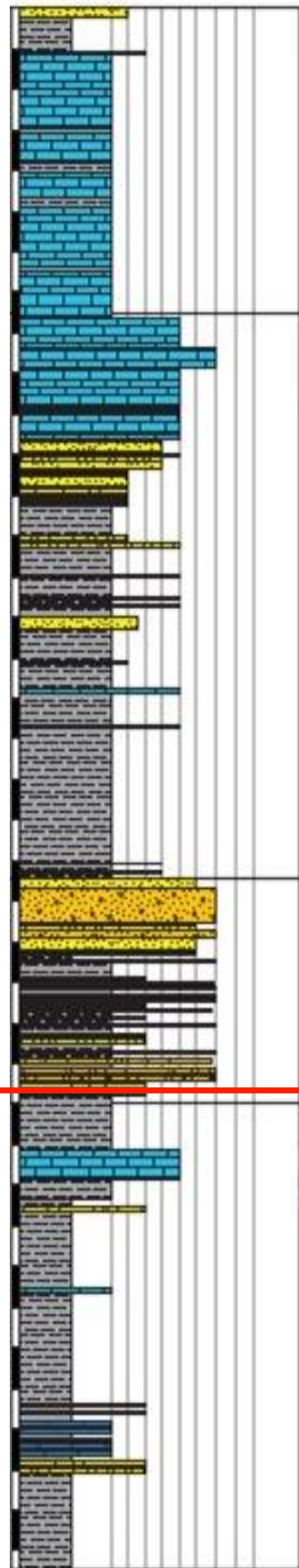
ANH-TIERRALTA-1X  
8800'

ANH-SSJ-LA ESTRELA-1X  
2190,9'

ANH-SAN JACINTO  
1725'

ANH-LA CANTERA  
1885,6''

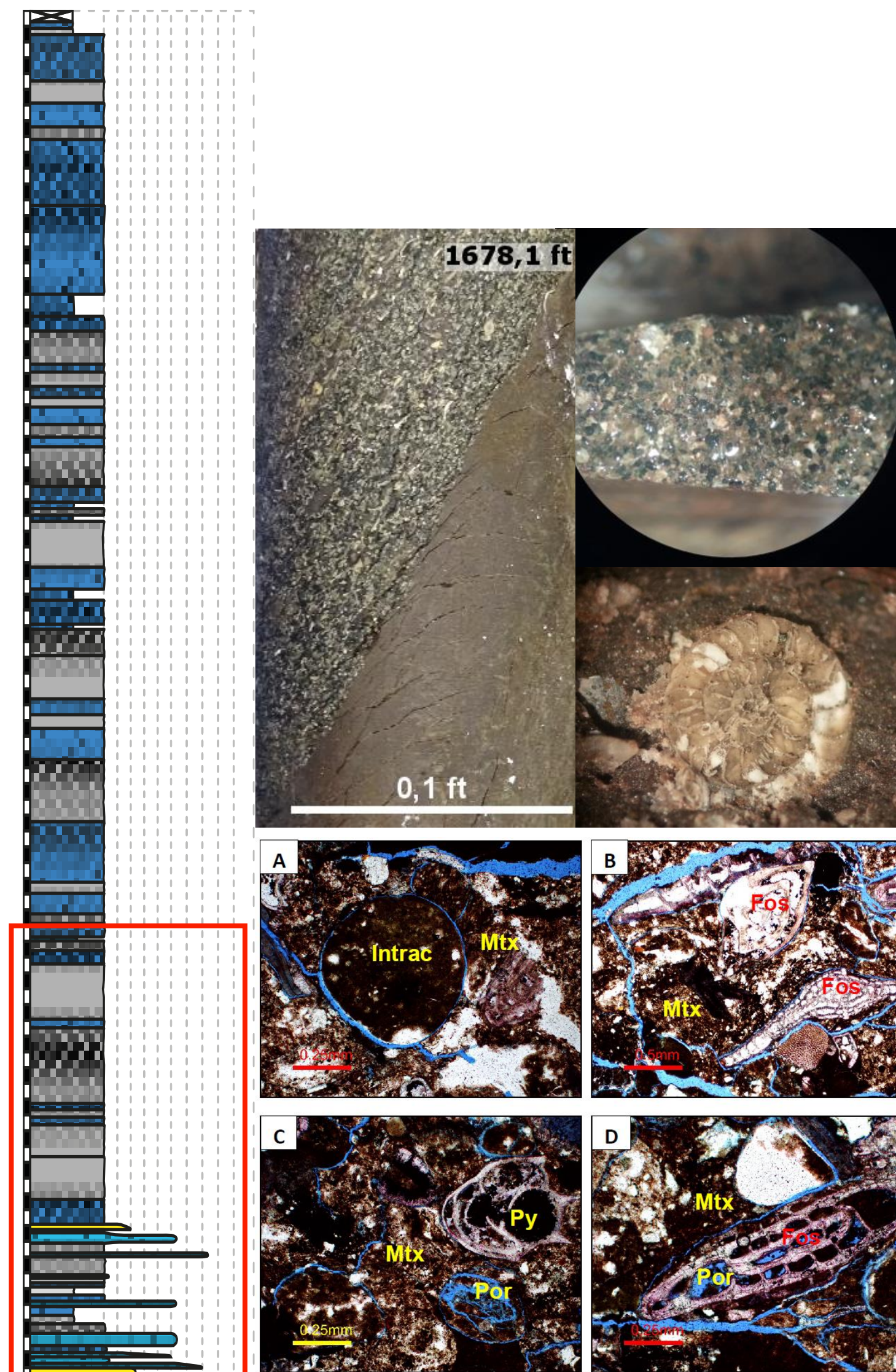
ANH-PLATO-1X  
21500'



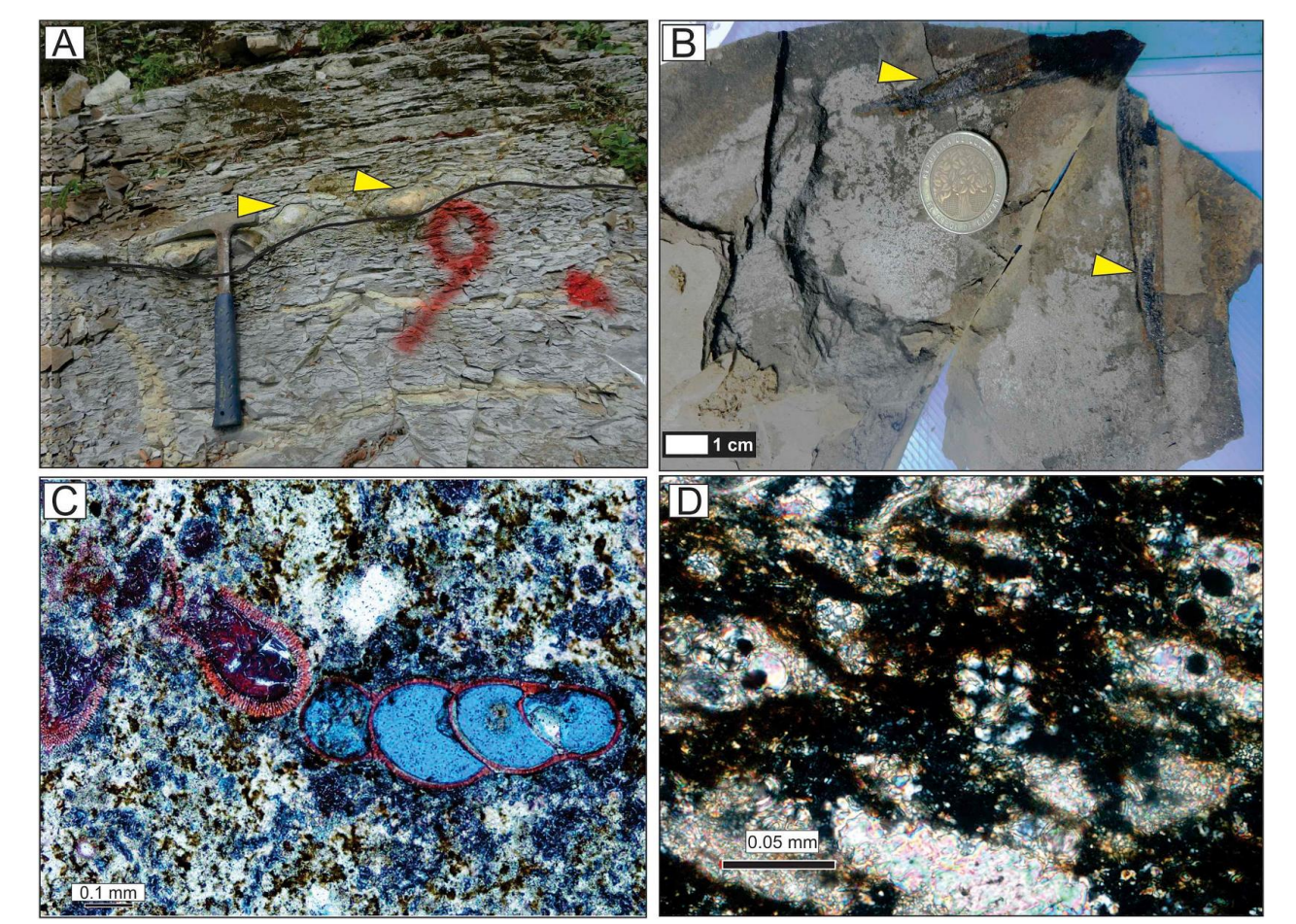
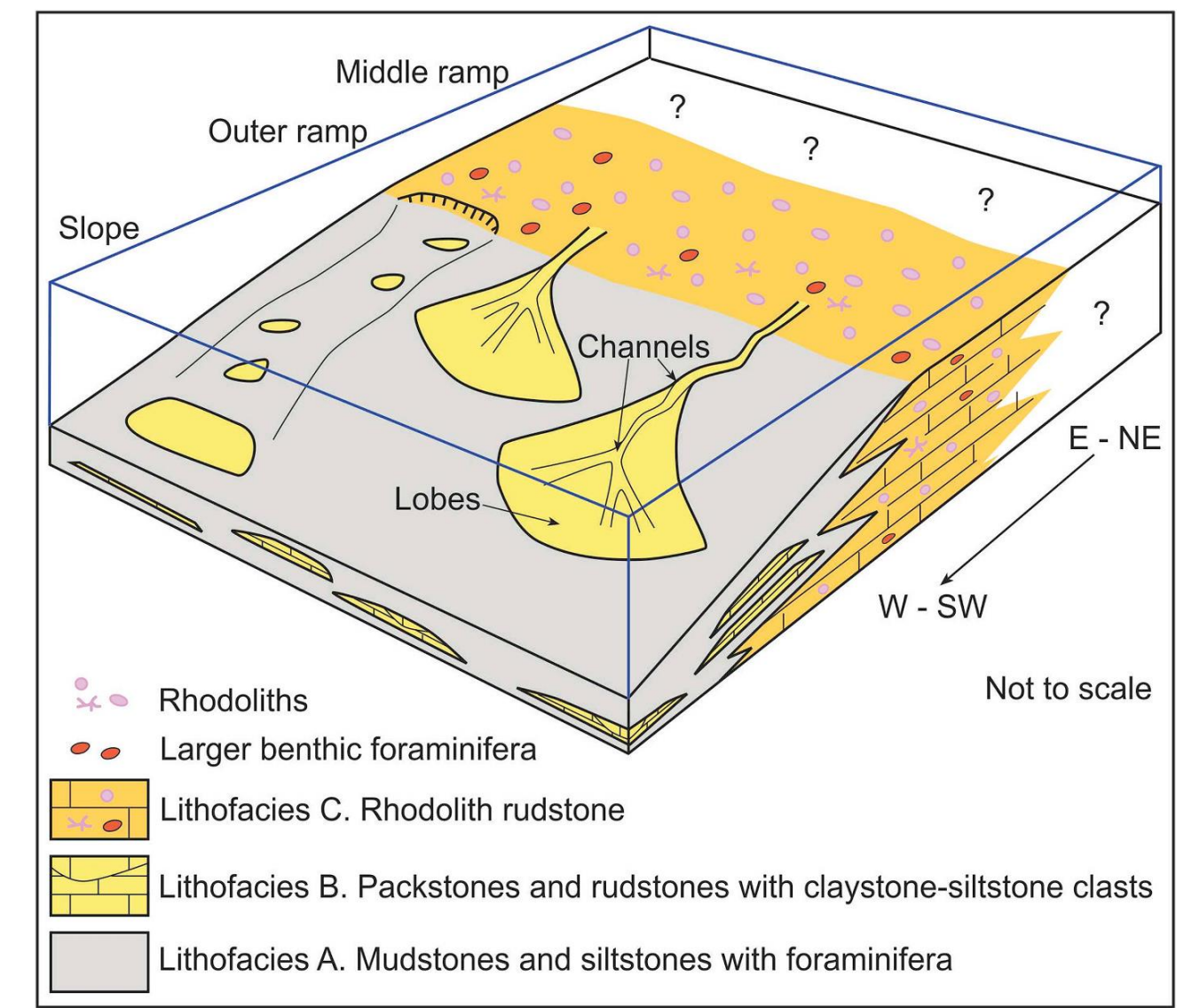
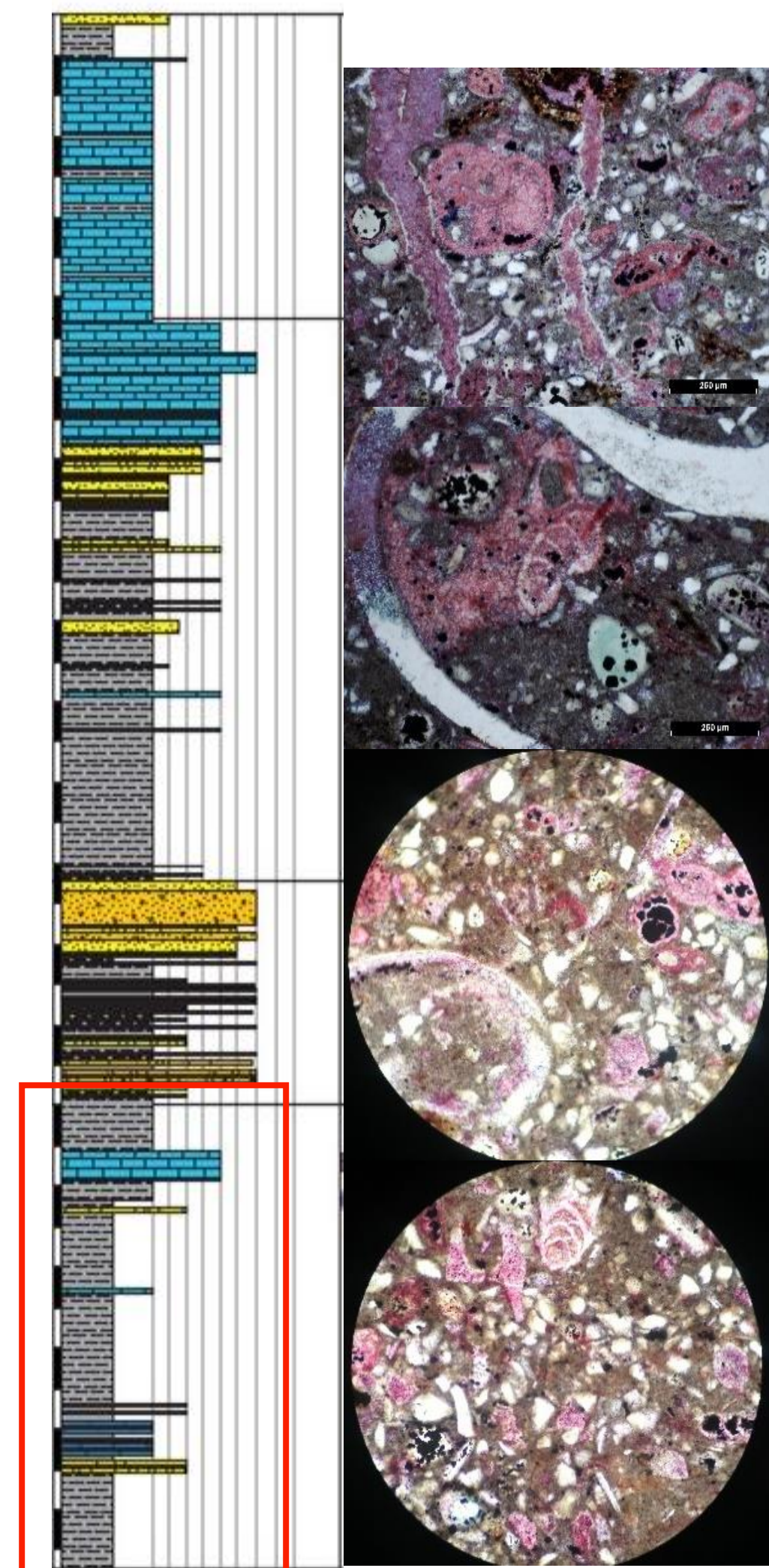


• Carbonate ramp and mixed ramp facies in the ANH-SAN JACINTO and ANH-TIERRALTA-1X wells

ANH-SAN JACINTO



ANH-TIERRALTA-1X

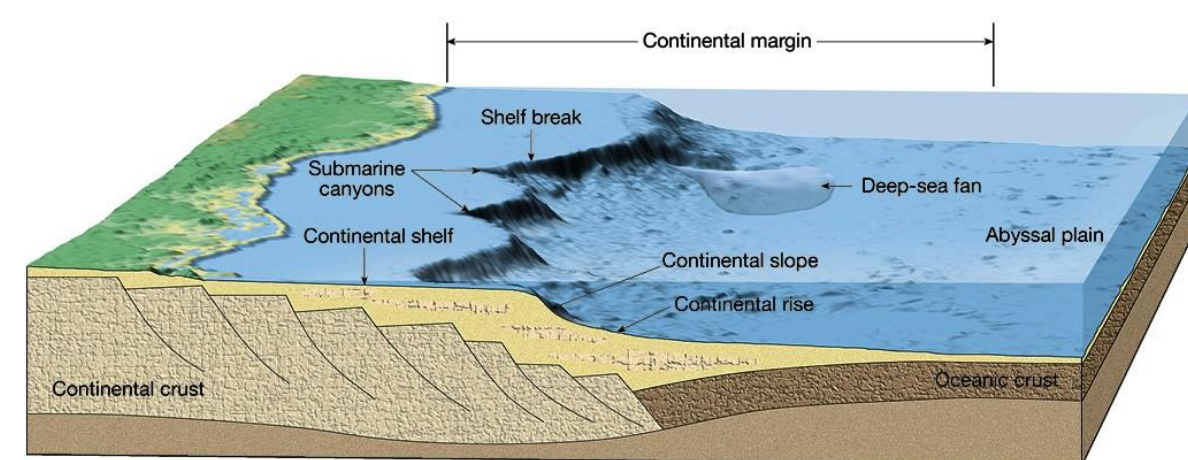
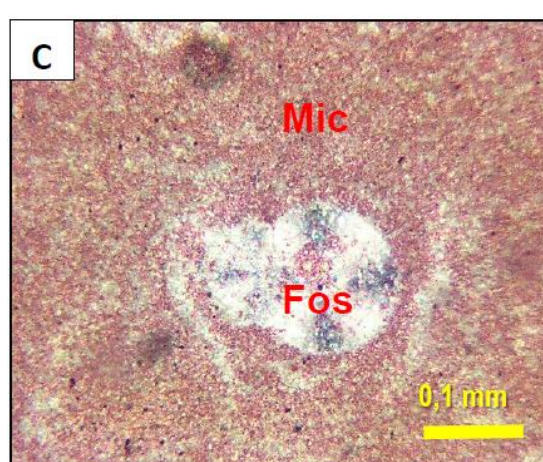
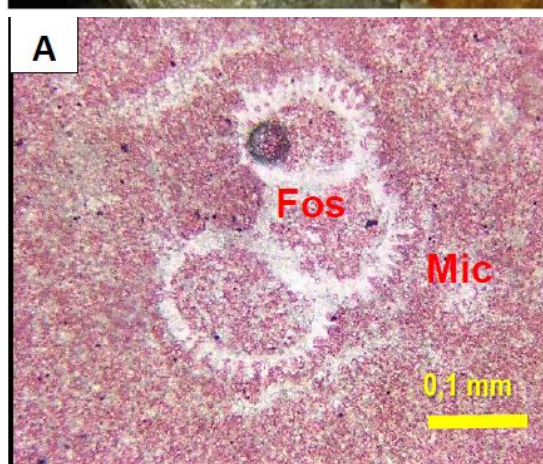
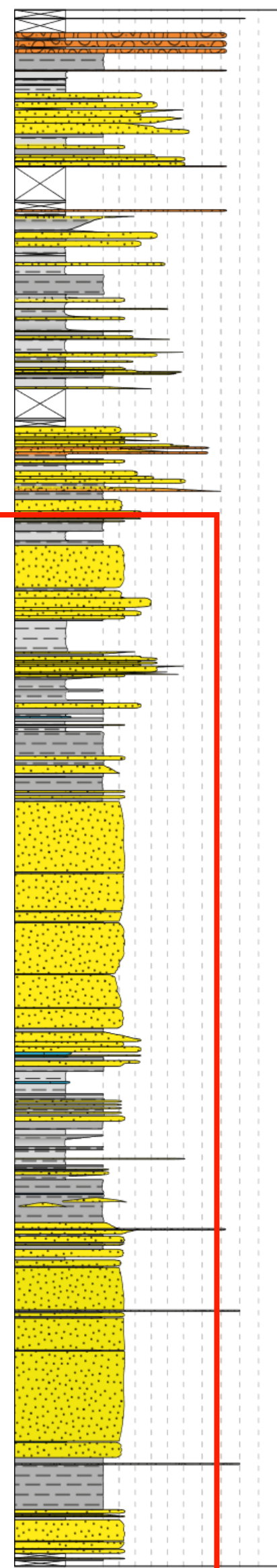


Salazar-Ortiz et al., 2020



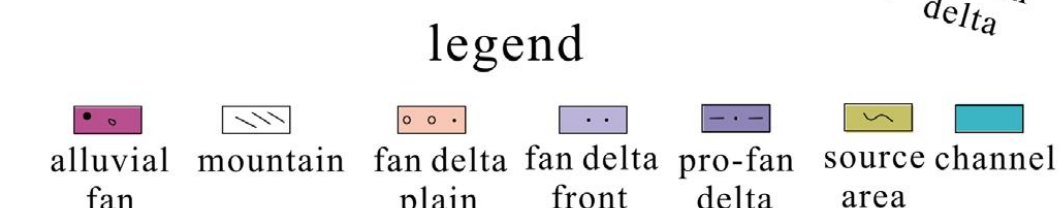
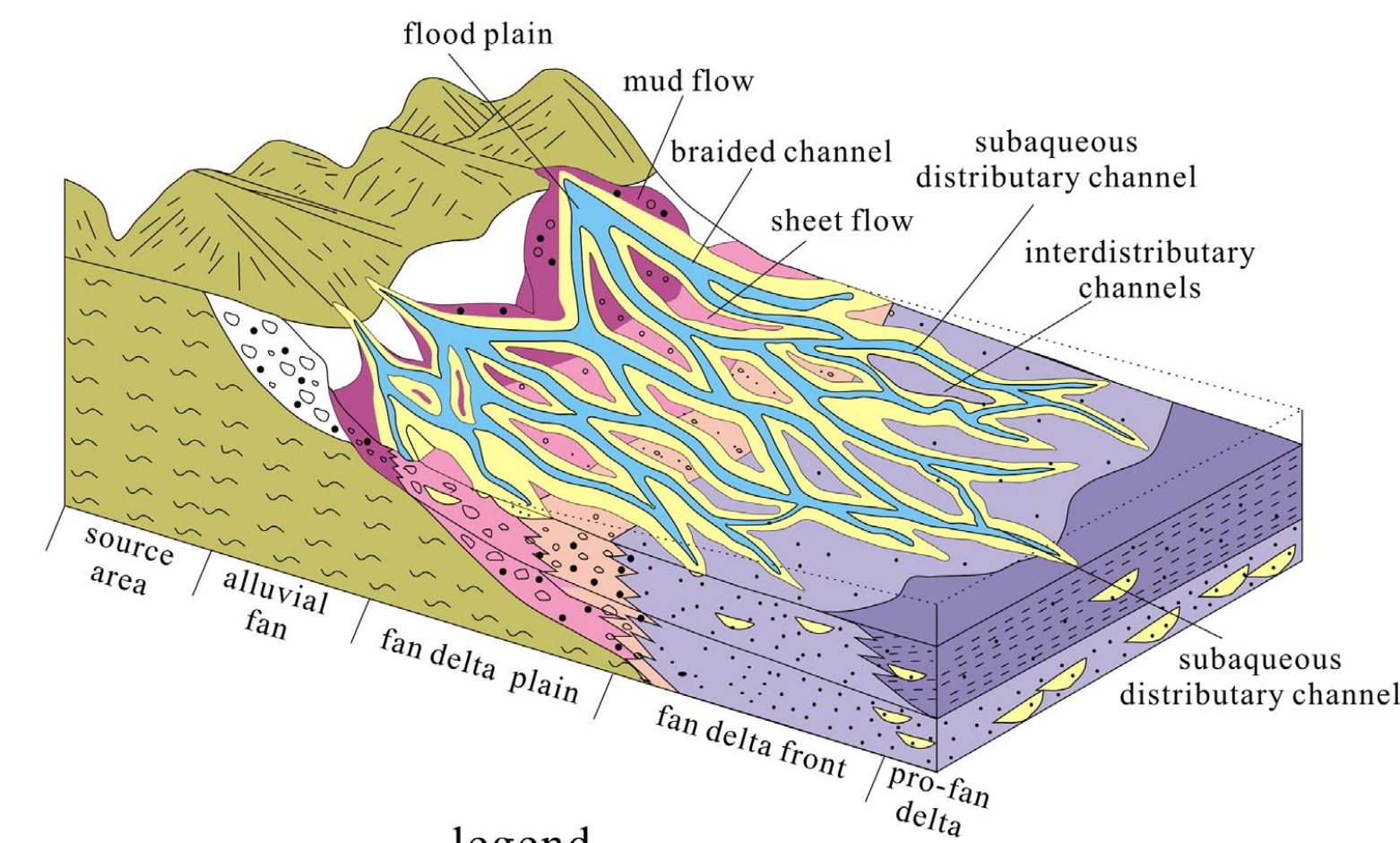
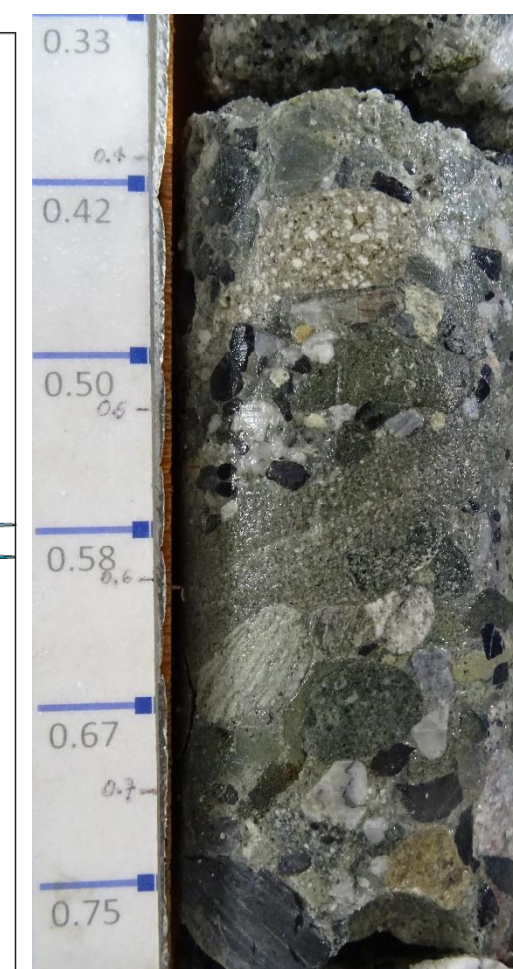
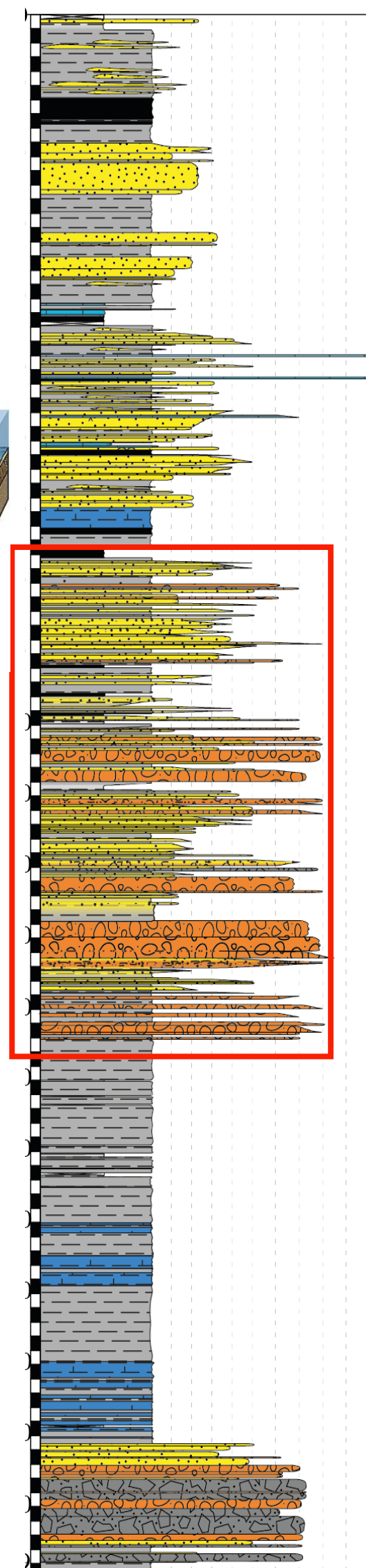
# Shallow marine and grain delta facies in the LA CANTERA and ANH-SSJ-LA ESTRELLA-1X wells

ANH-LA CANTERA



Toluviejo-Chengue Facies

ANH-SSJ-LA ESTRELLA-1X

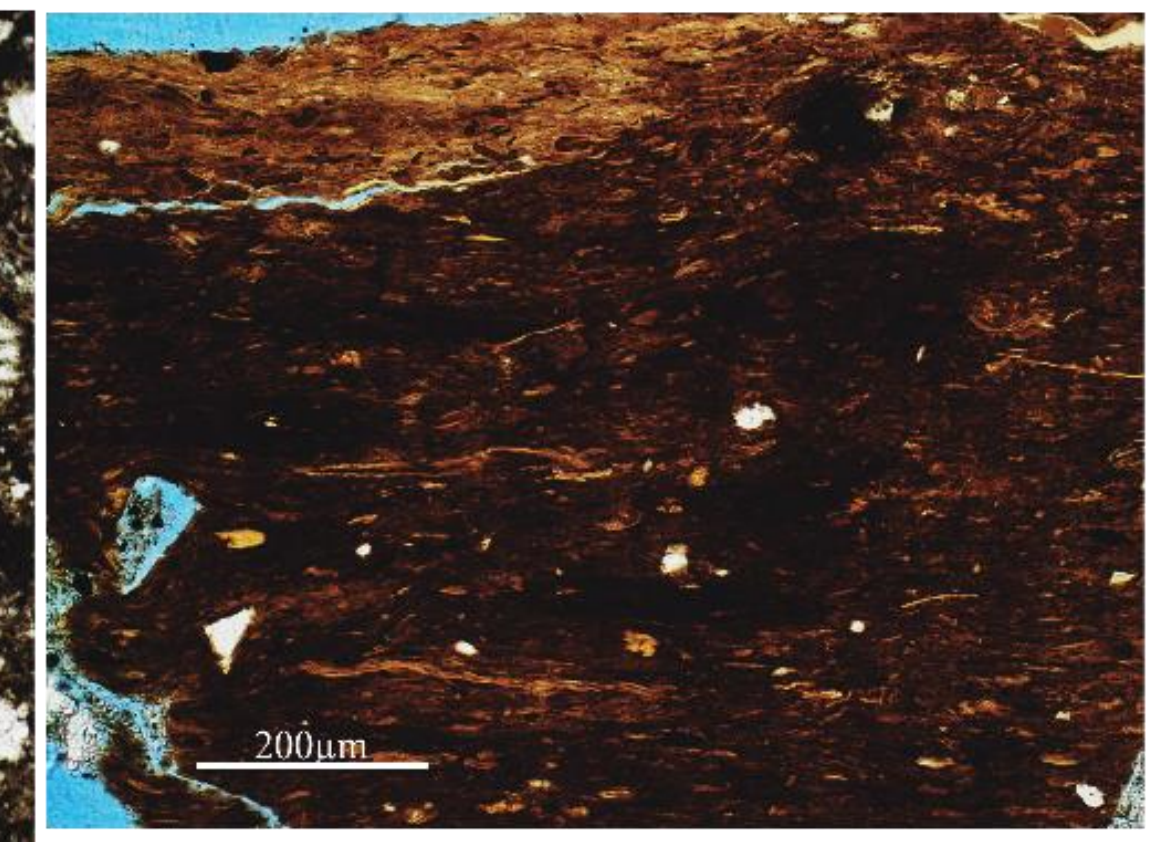
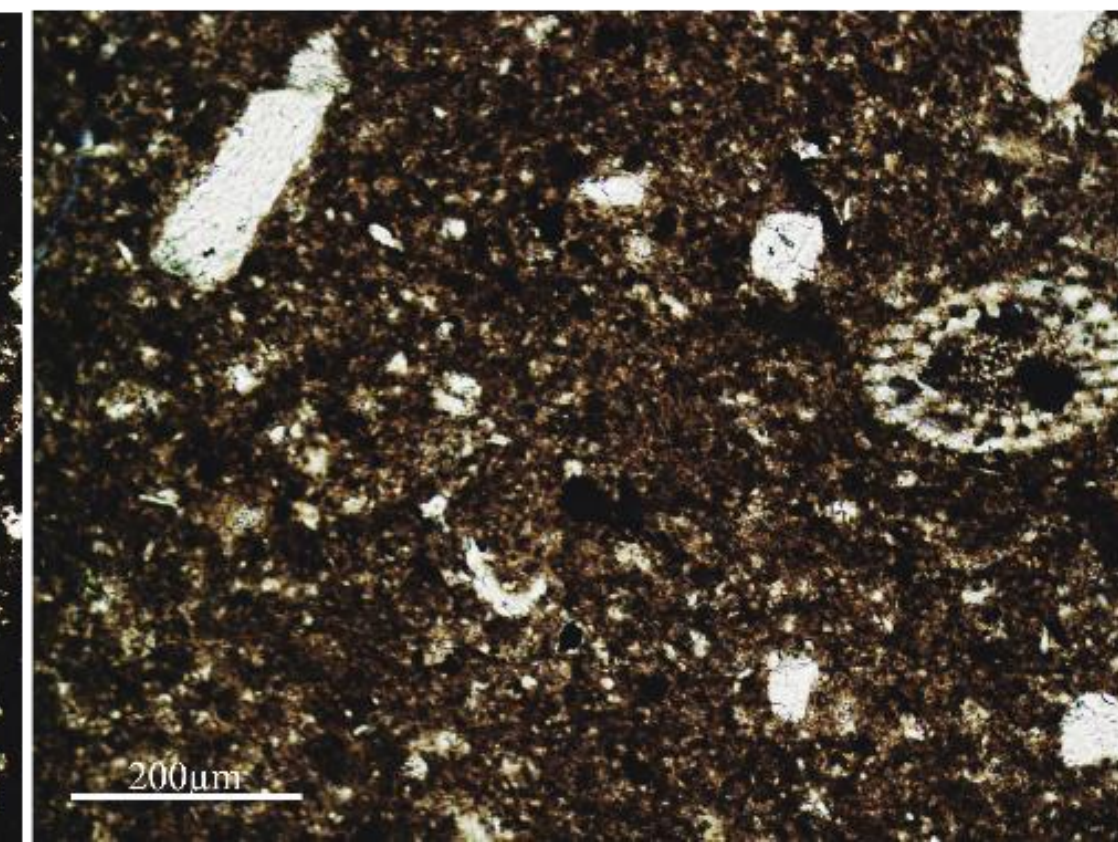
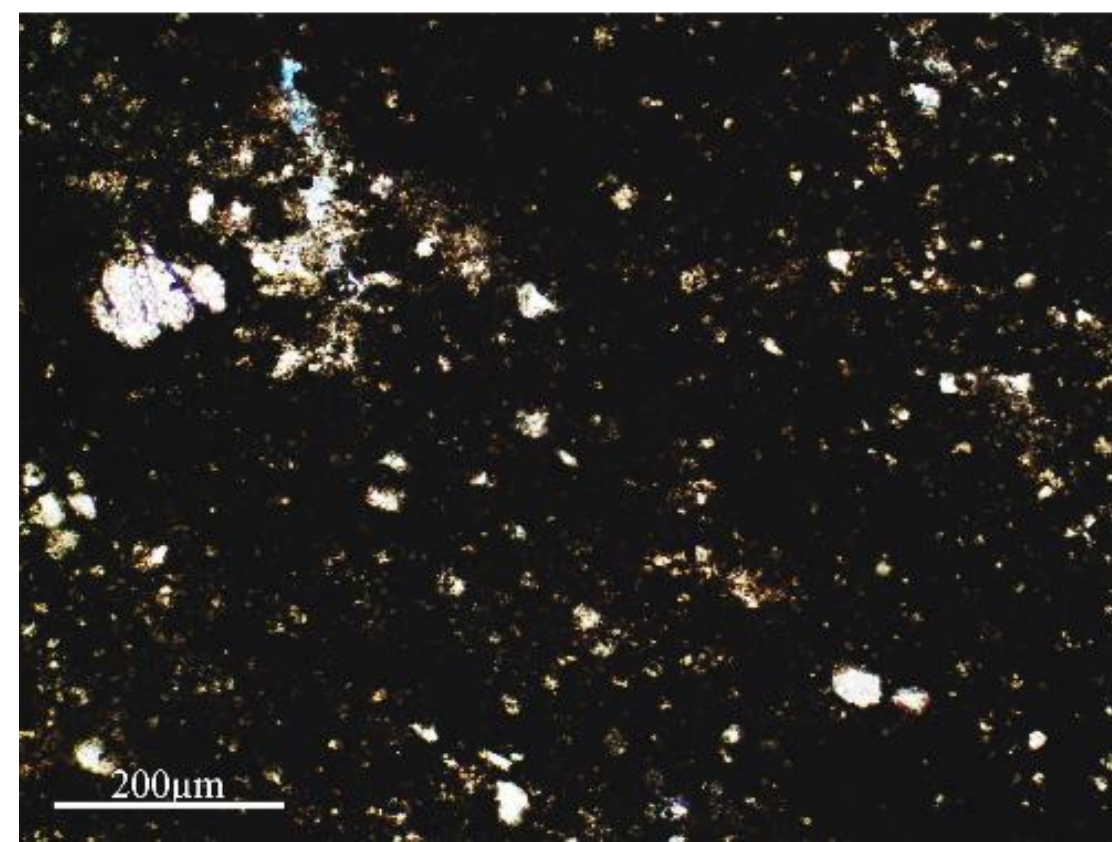
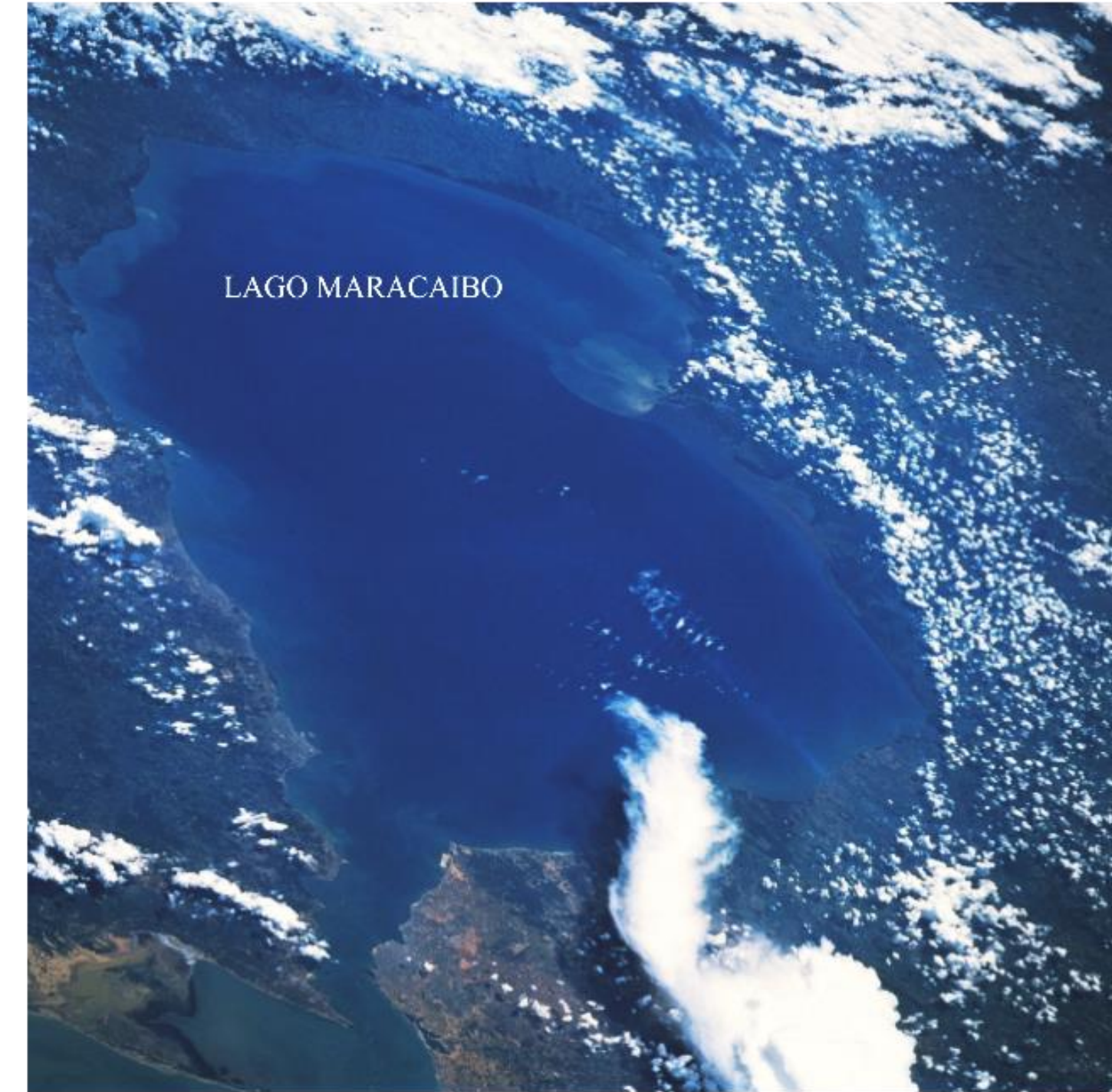
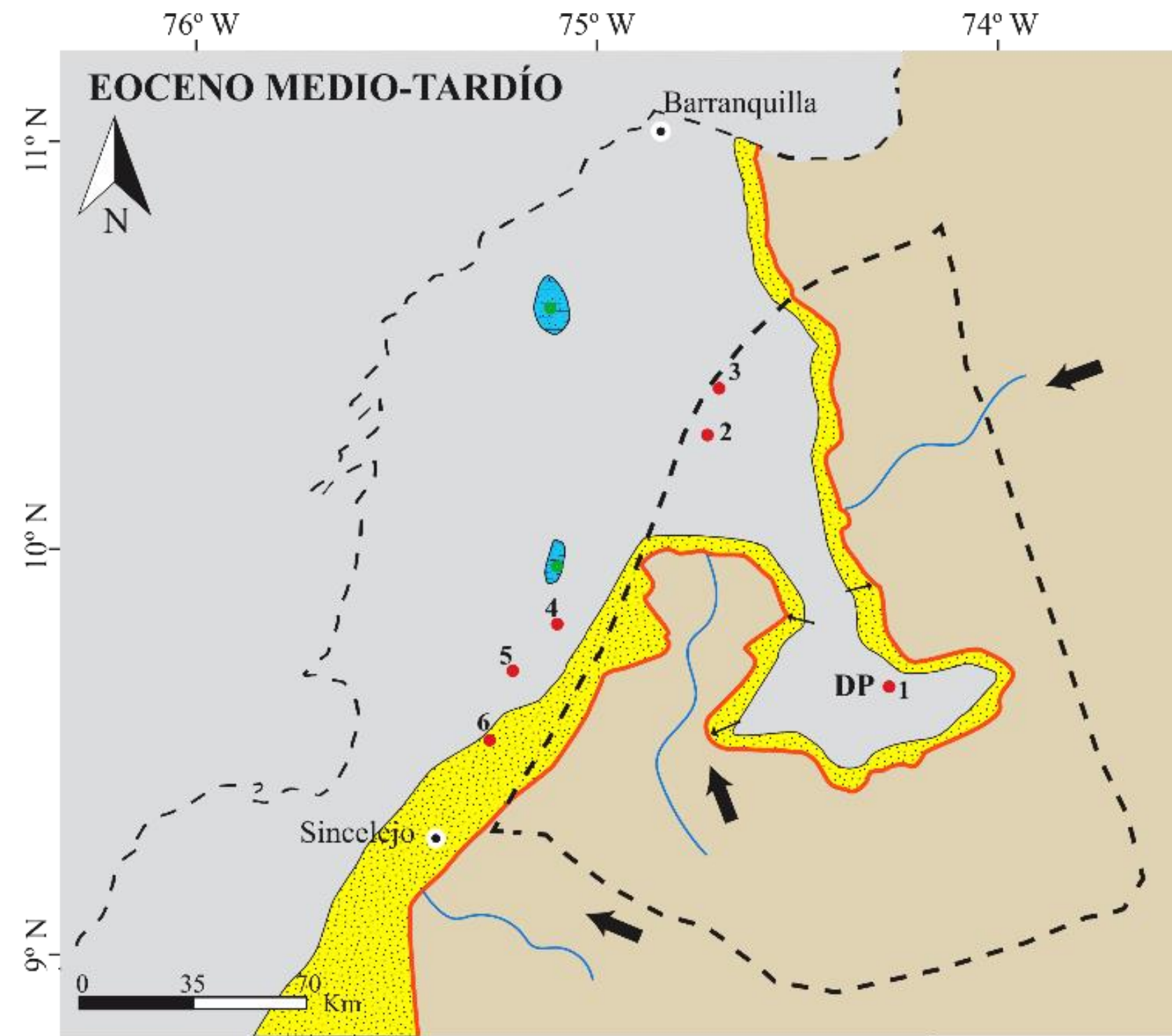
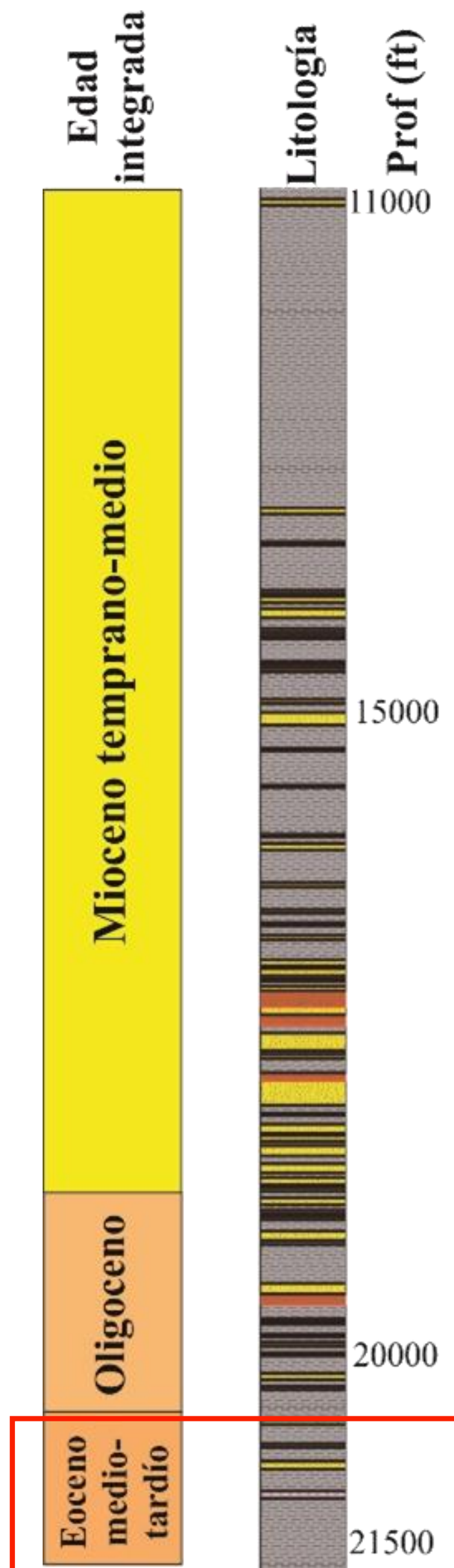


Hongwei Kuang et al., 2017

San Jacinto Formation facies

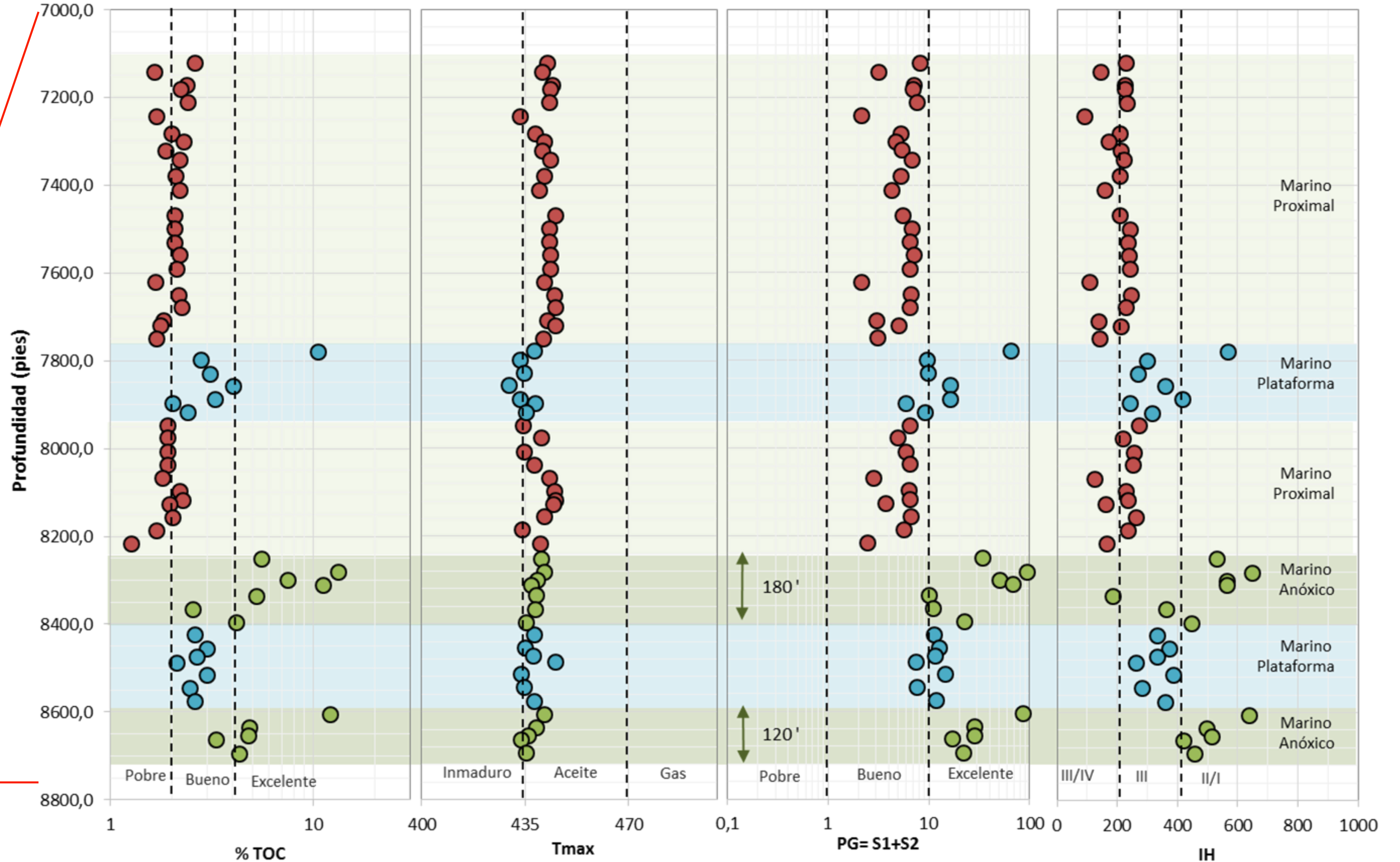
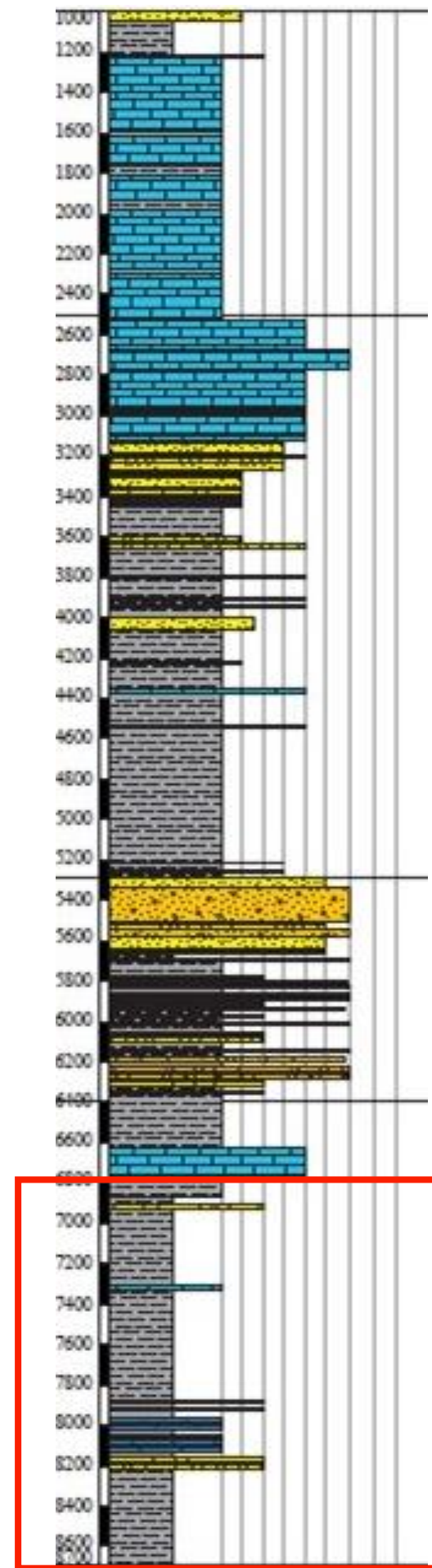


# Restricted bay in the Plato Sub-basin





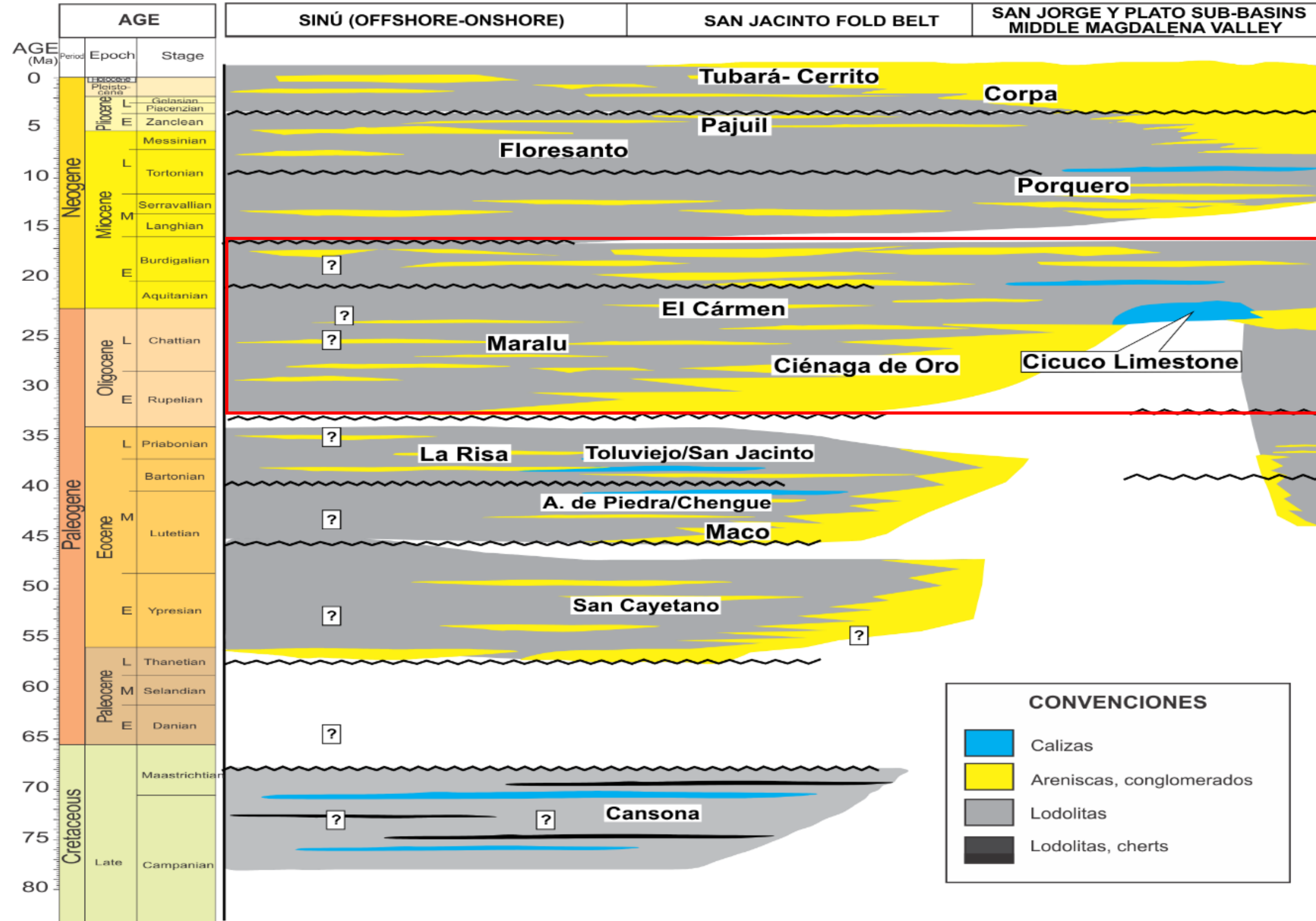
# Eocene? Source rock in ANH-TIERRALTA-1X



ANH-Tierralta-2-X-P



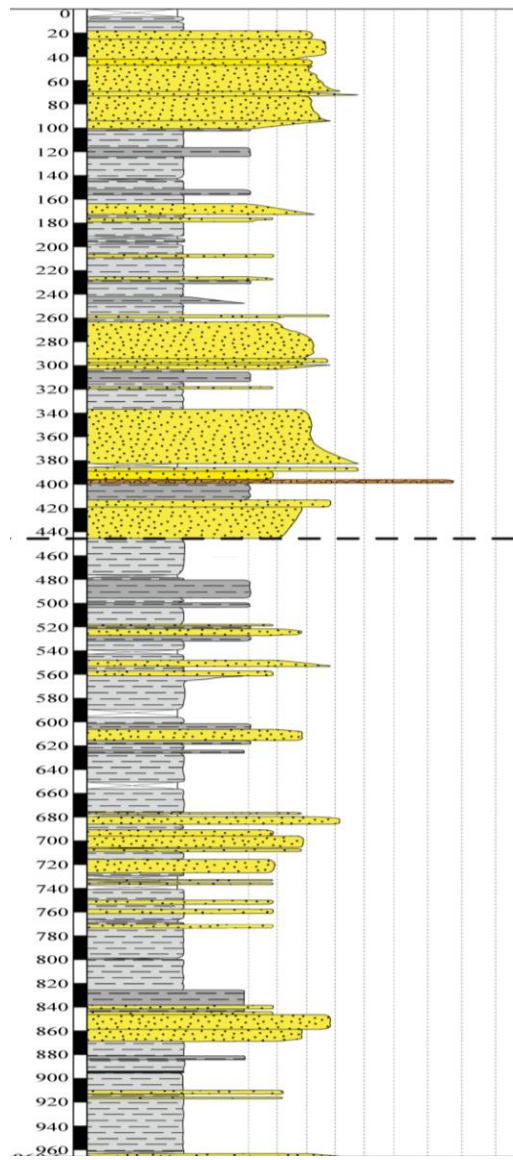
# STRATIGRAPHY AND PALEOENVIRONMENTS



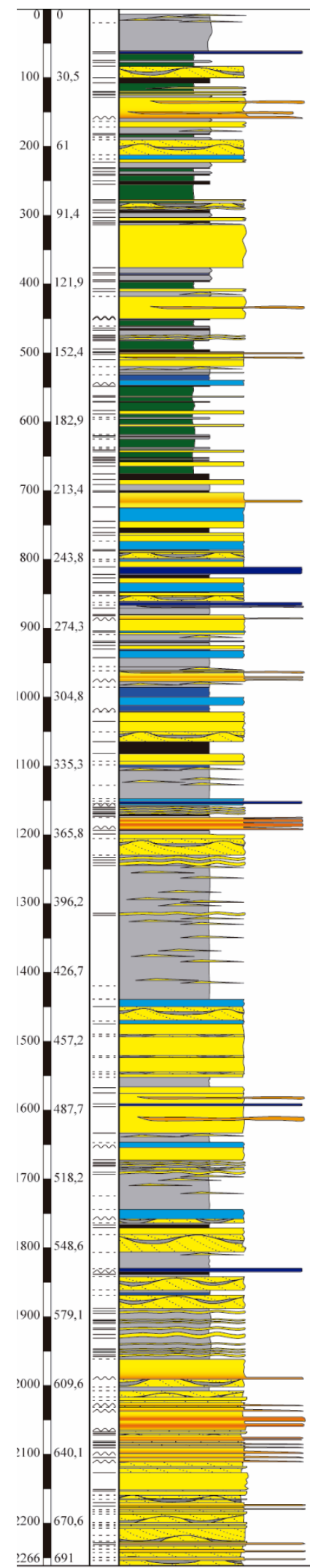


# STRATIGRAPHY AND PALEOENVIRONMENTS

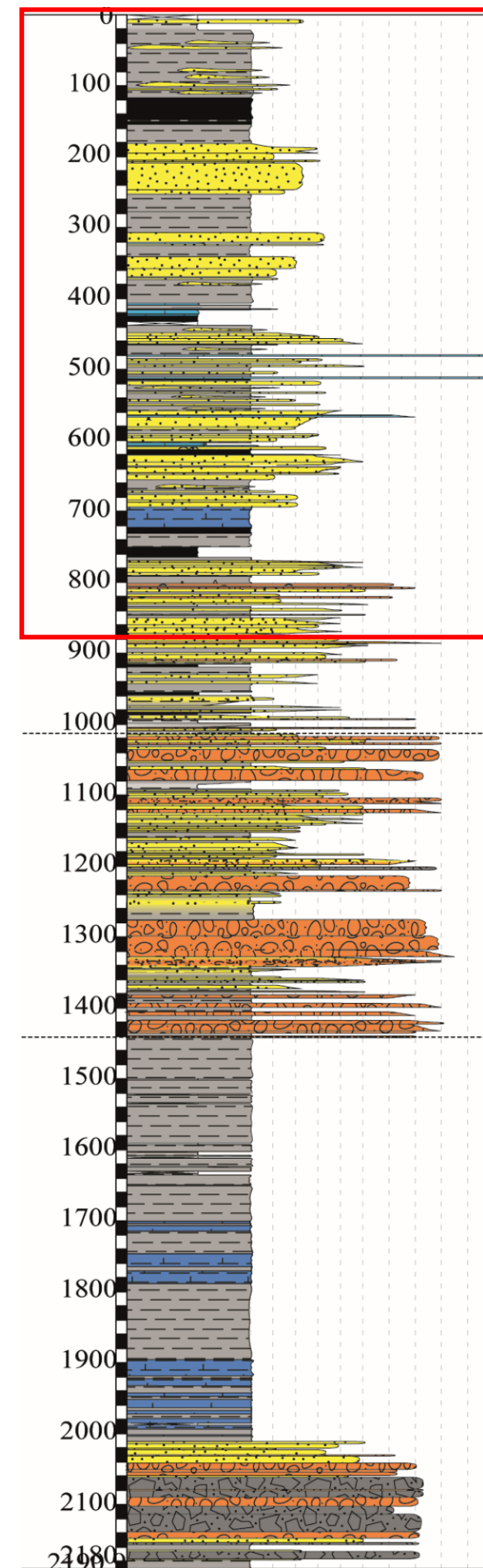
**ANH-SAN ANTONIO**  
960,6'



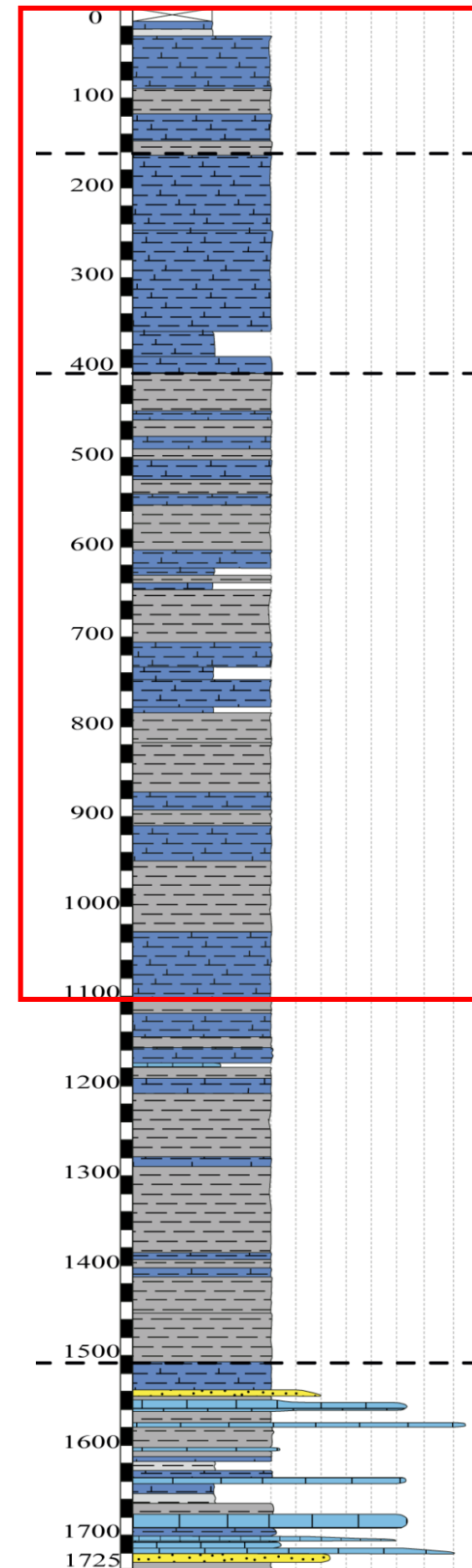
**ANH-SSJ-NUEVA ESPERANZA**  
2266'



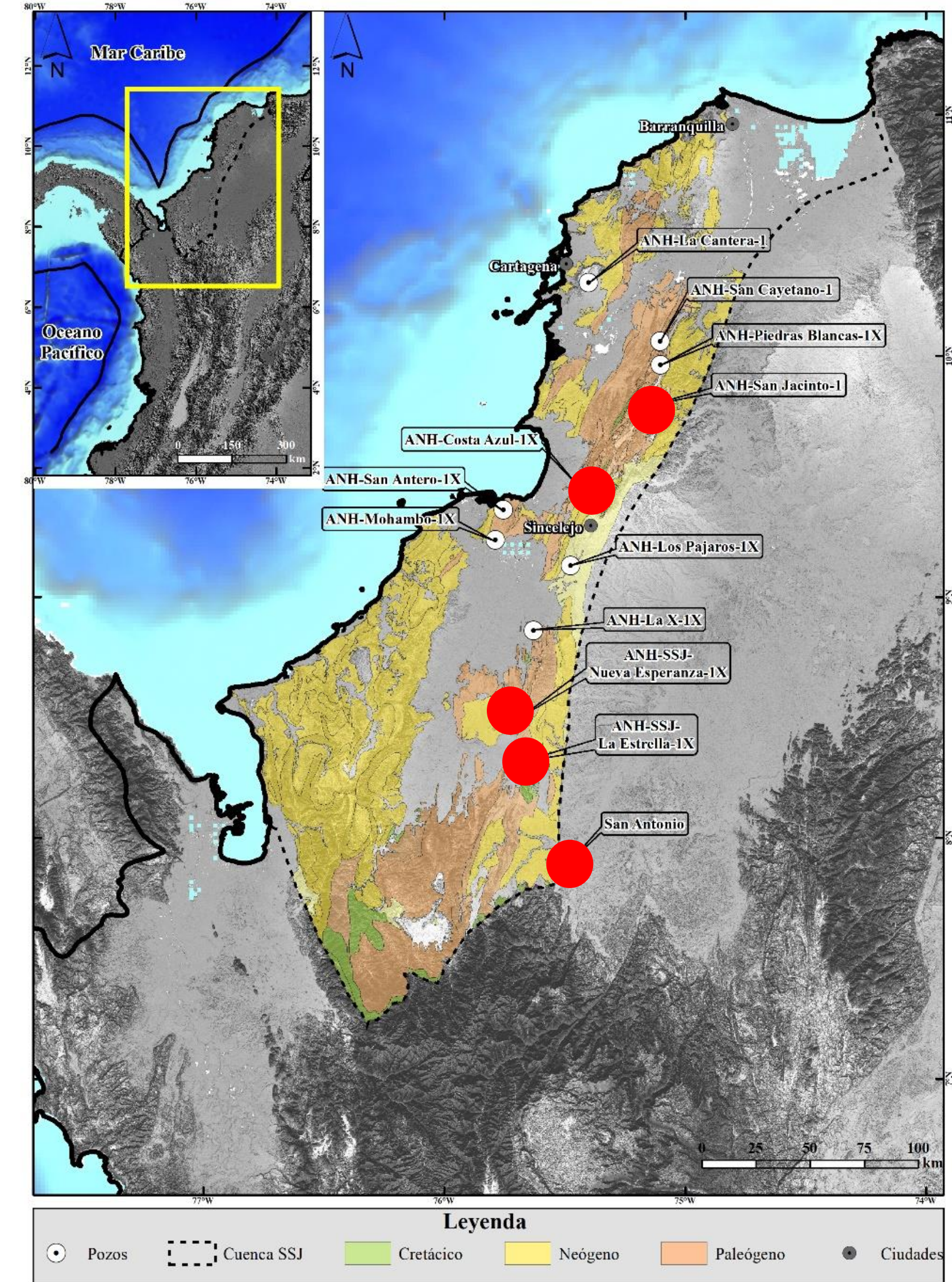
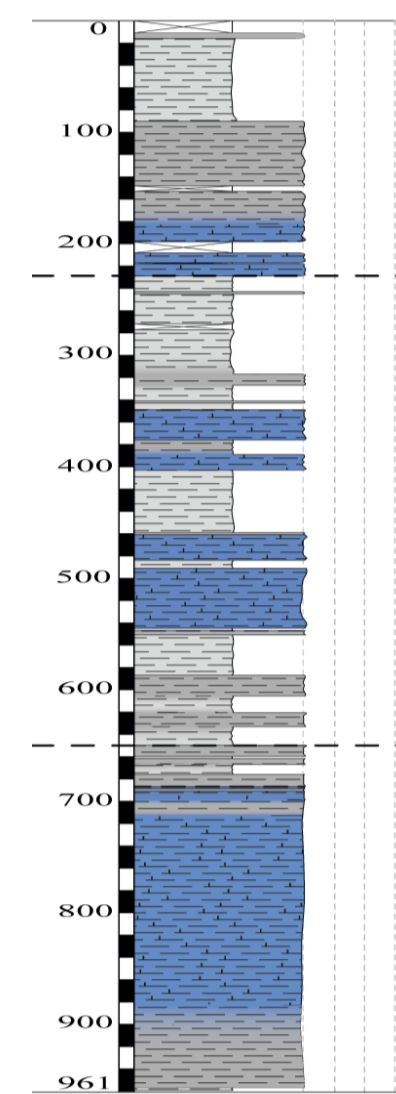
**ANH-SSJ-LA ESTRELA-1X**  
2190,9'



**ANH-SAN JACINTO**  
1725'

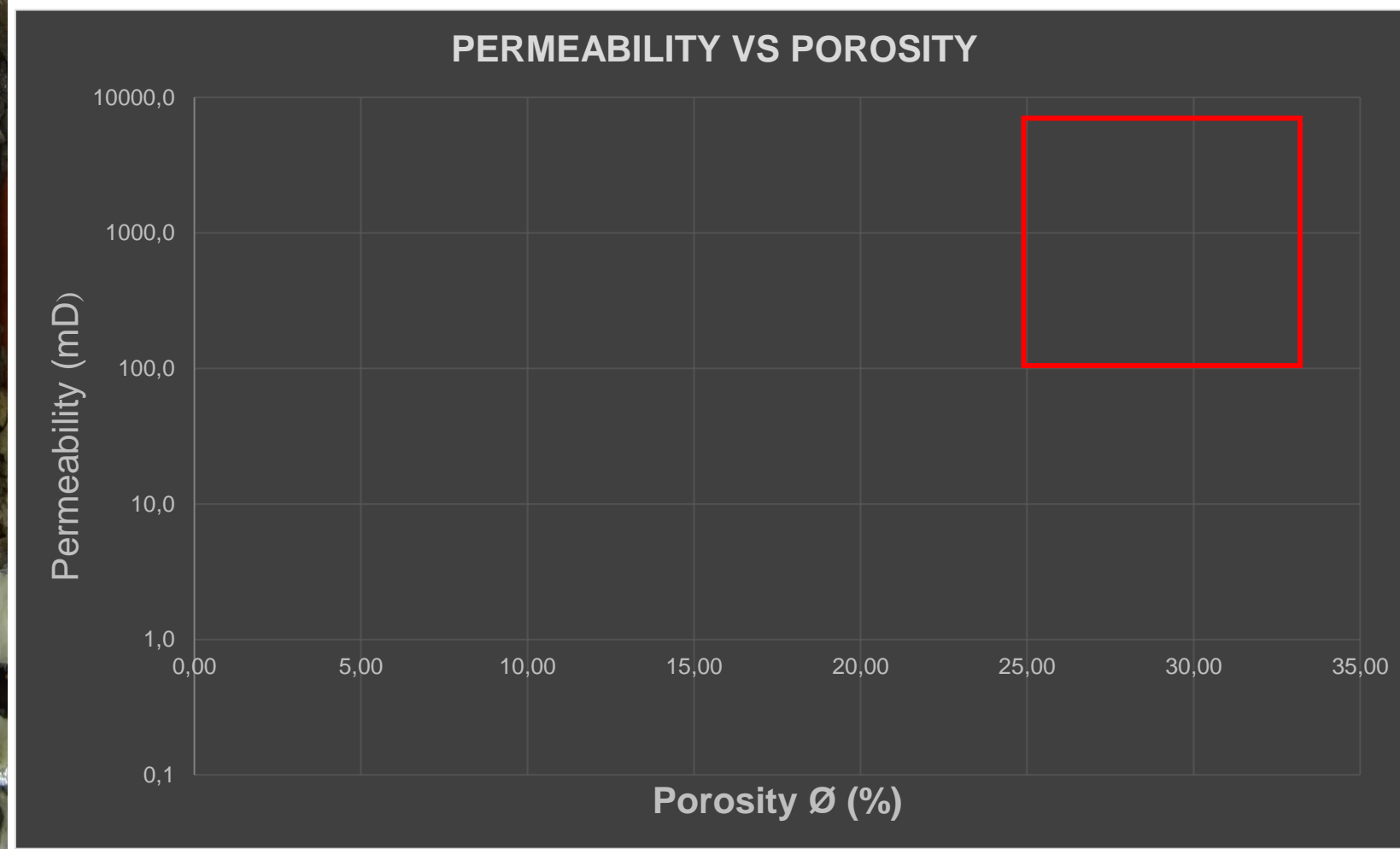
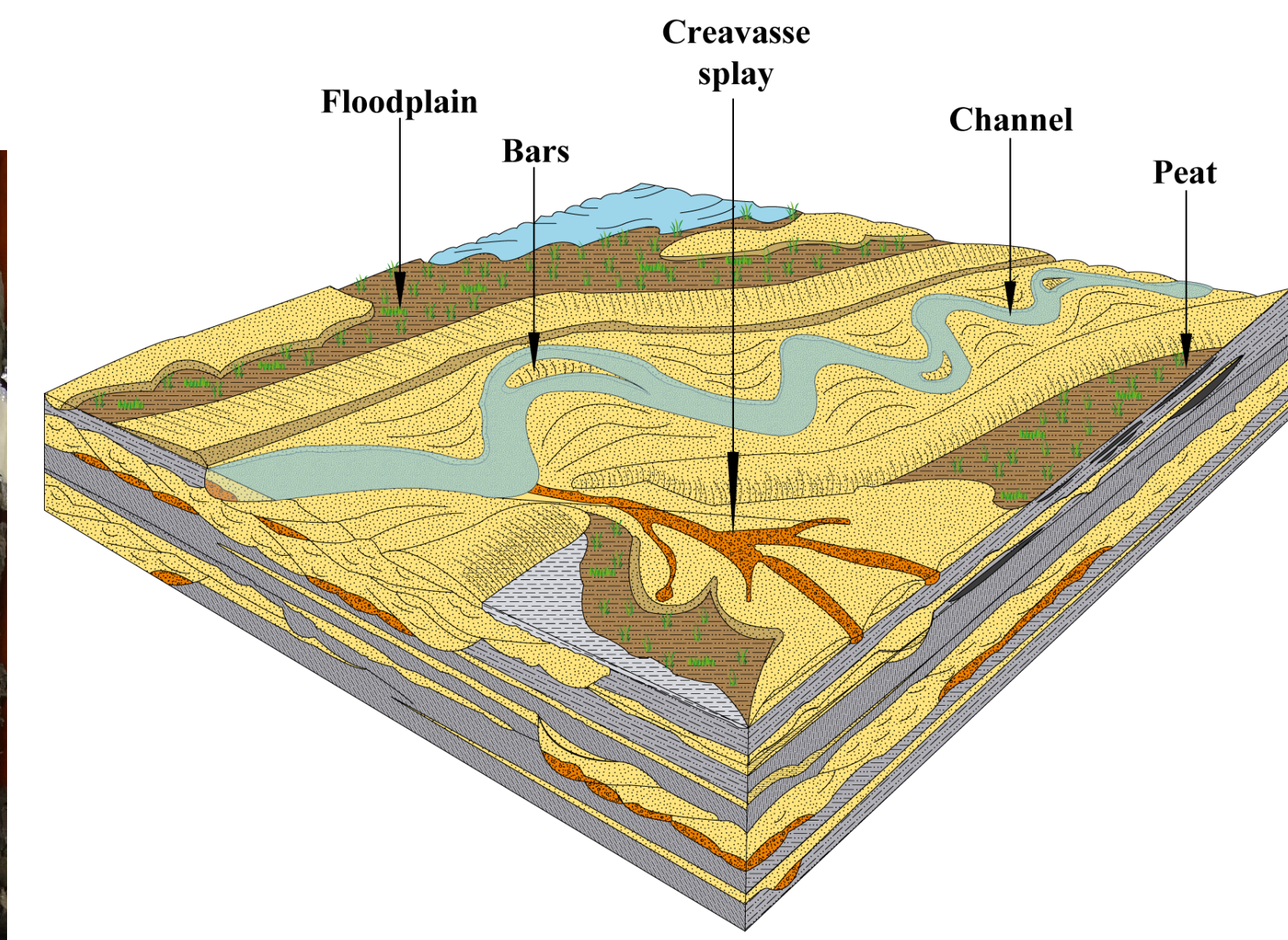
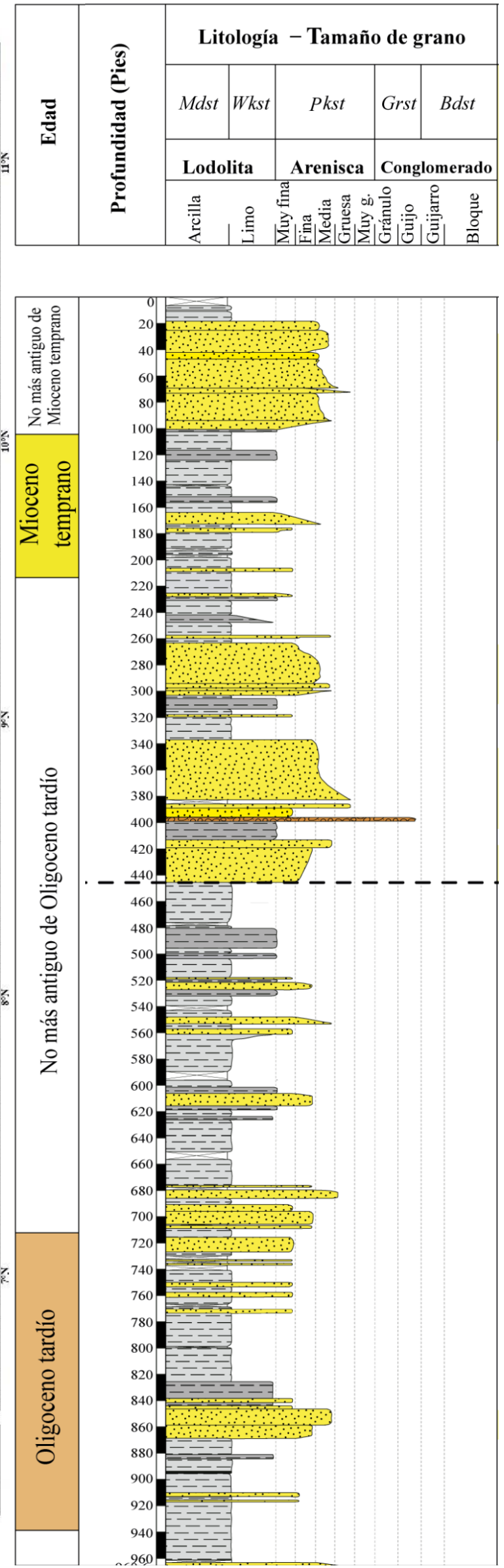
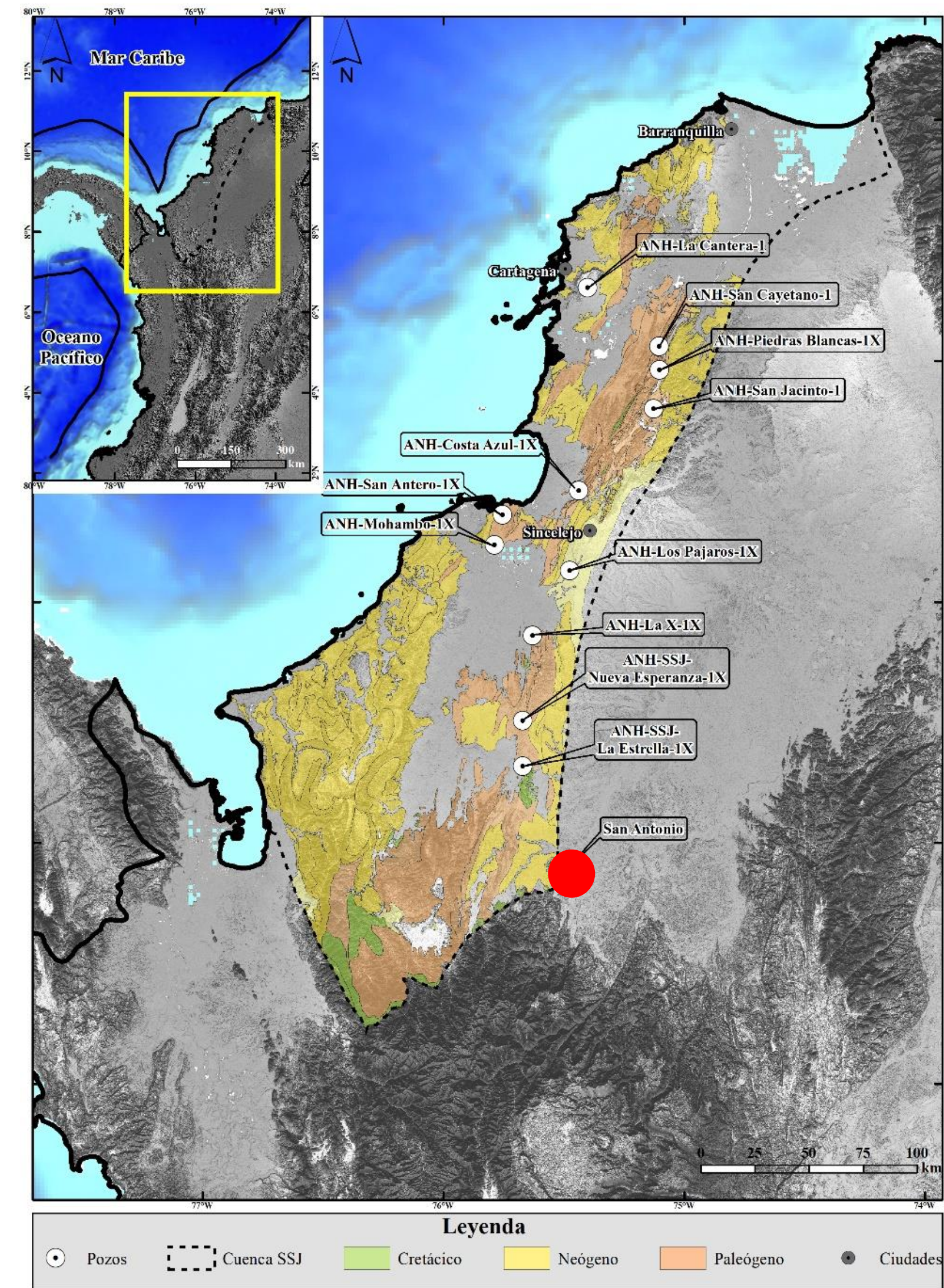


**ANH-COSTA AZUL**  
961'



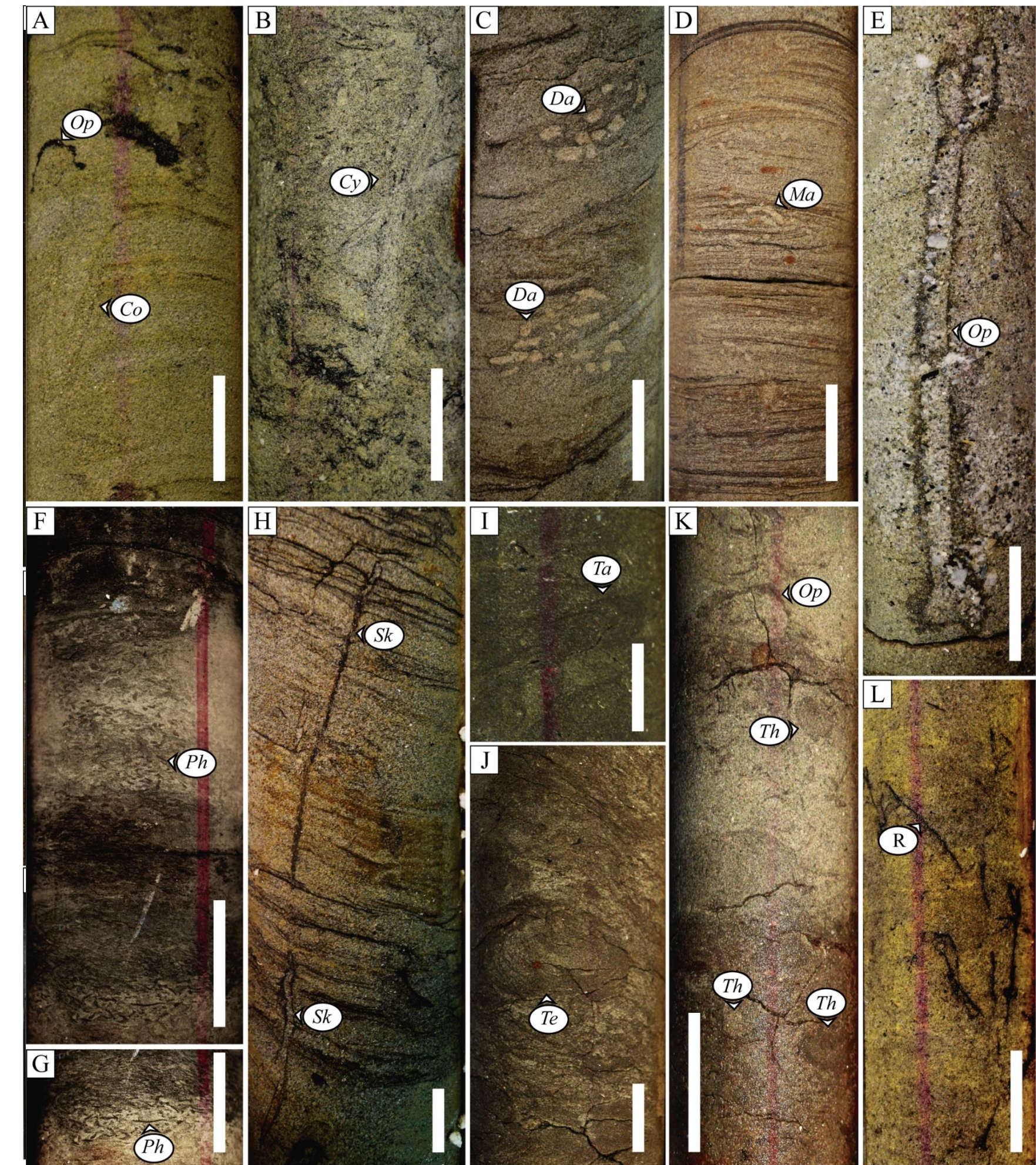
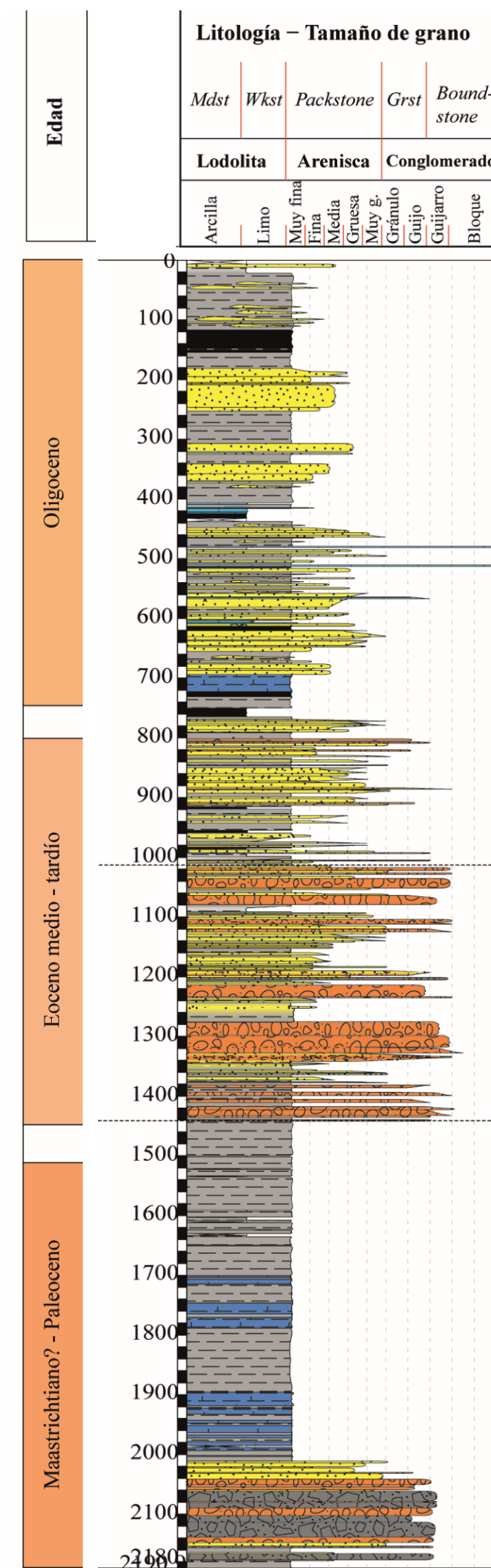
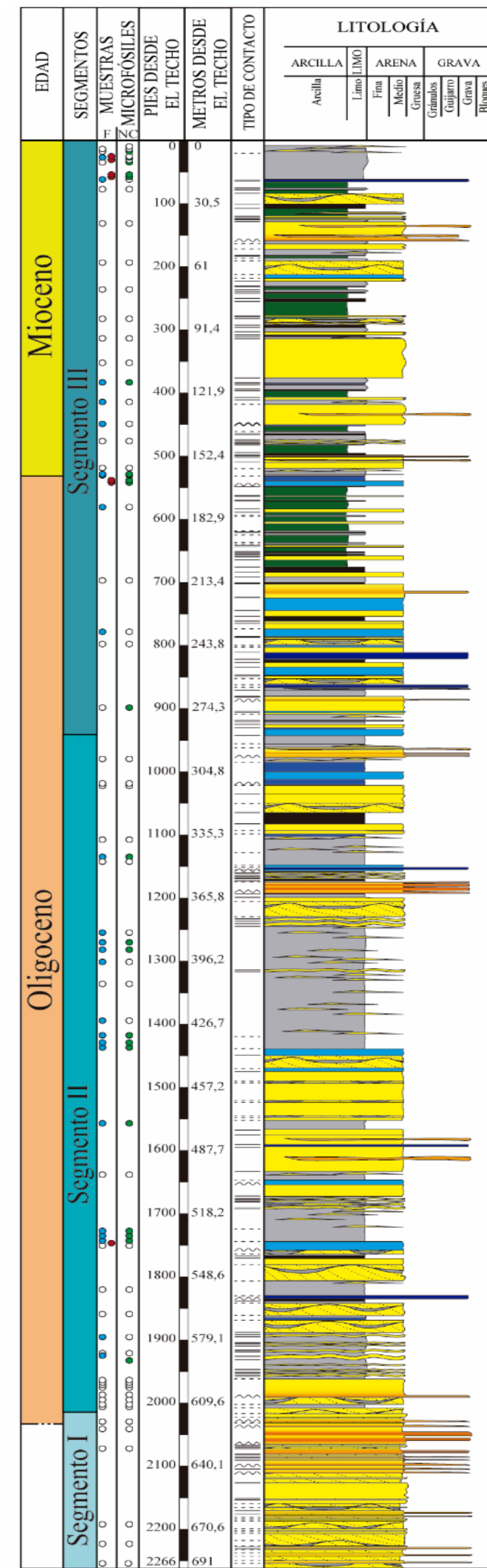
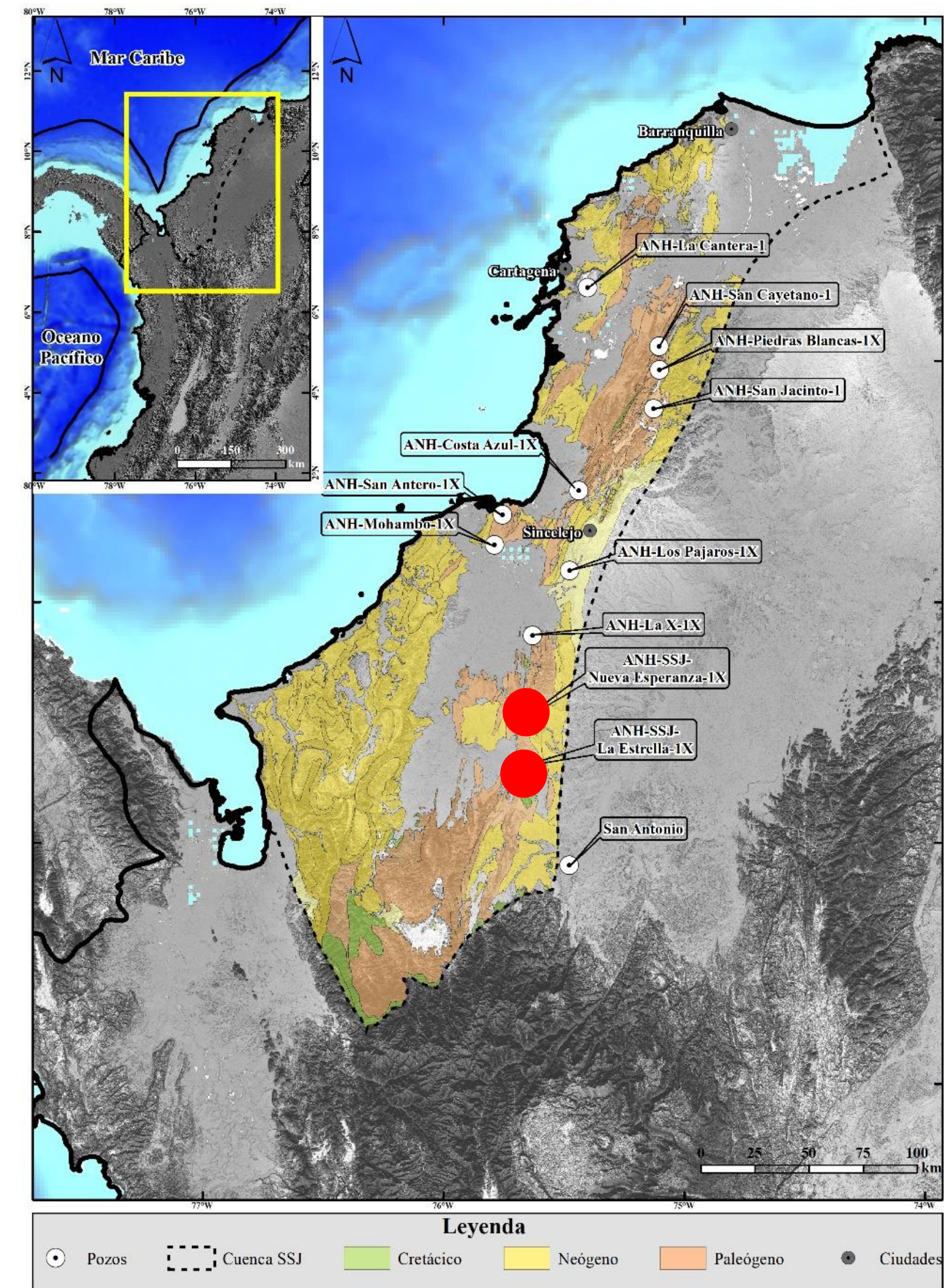


# STRATIGRAPHY AND PALEOENVIRONMENTS



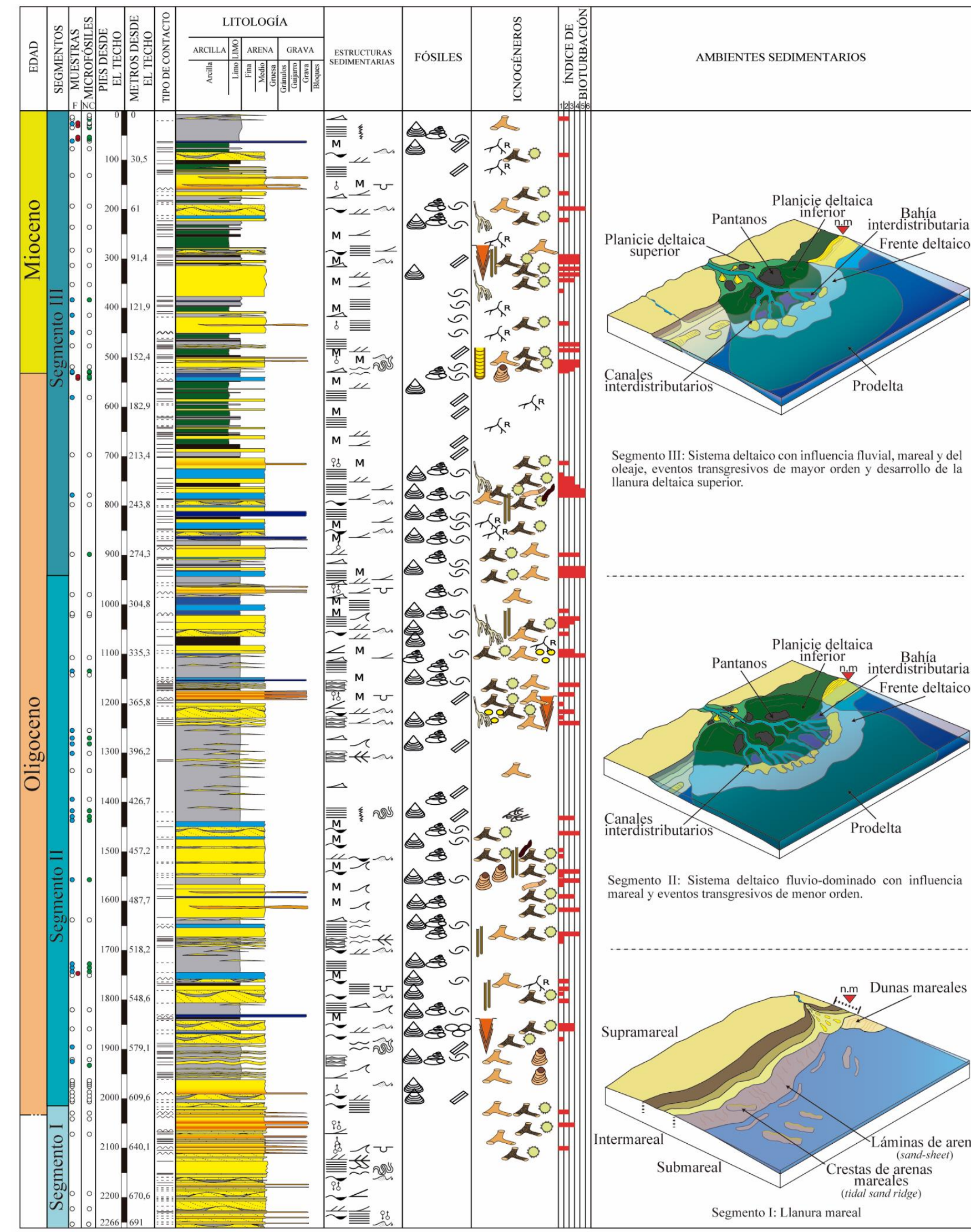
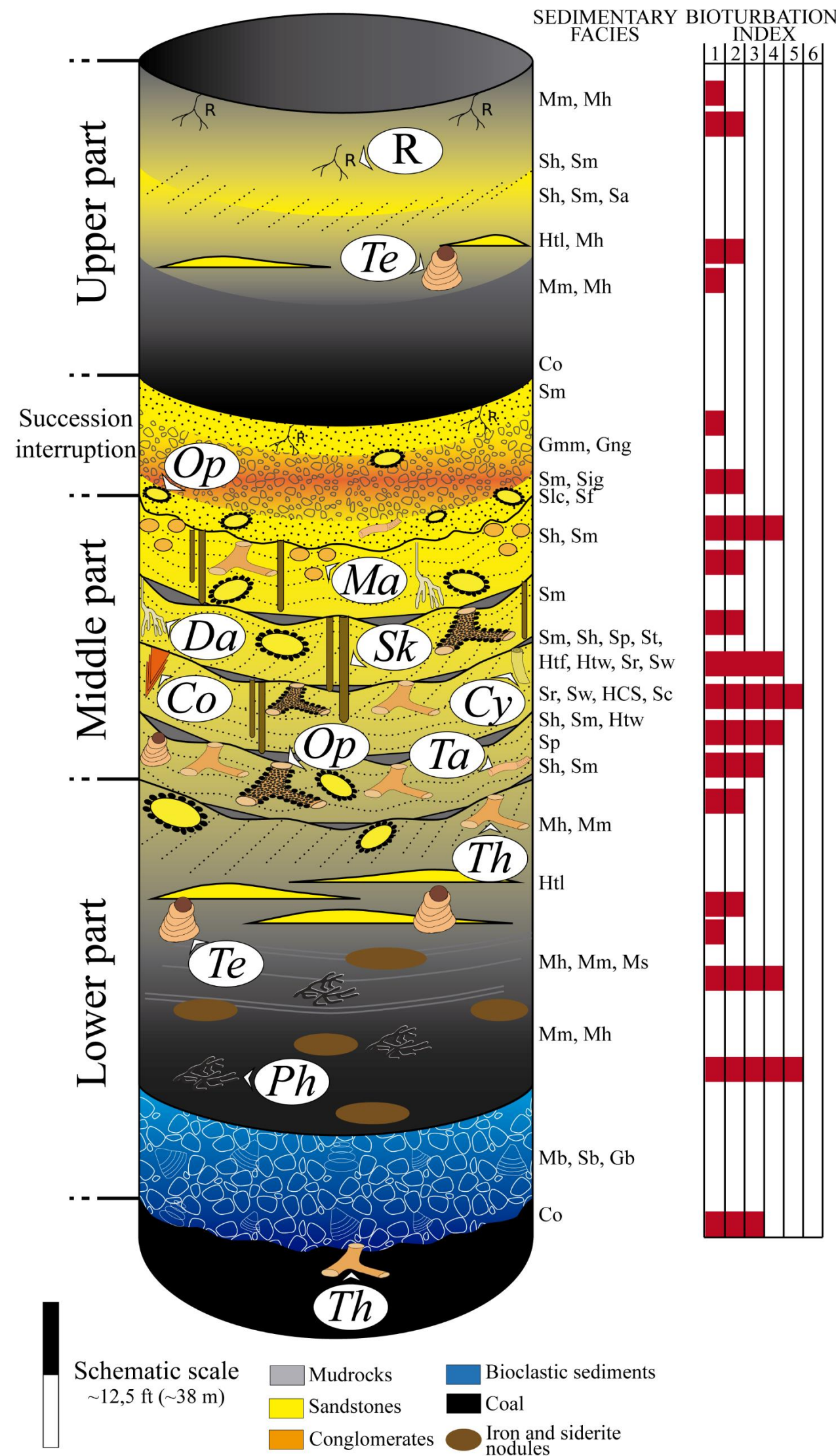


# STRATIGRAPHY AND PALEOENVIRONMENTS



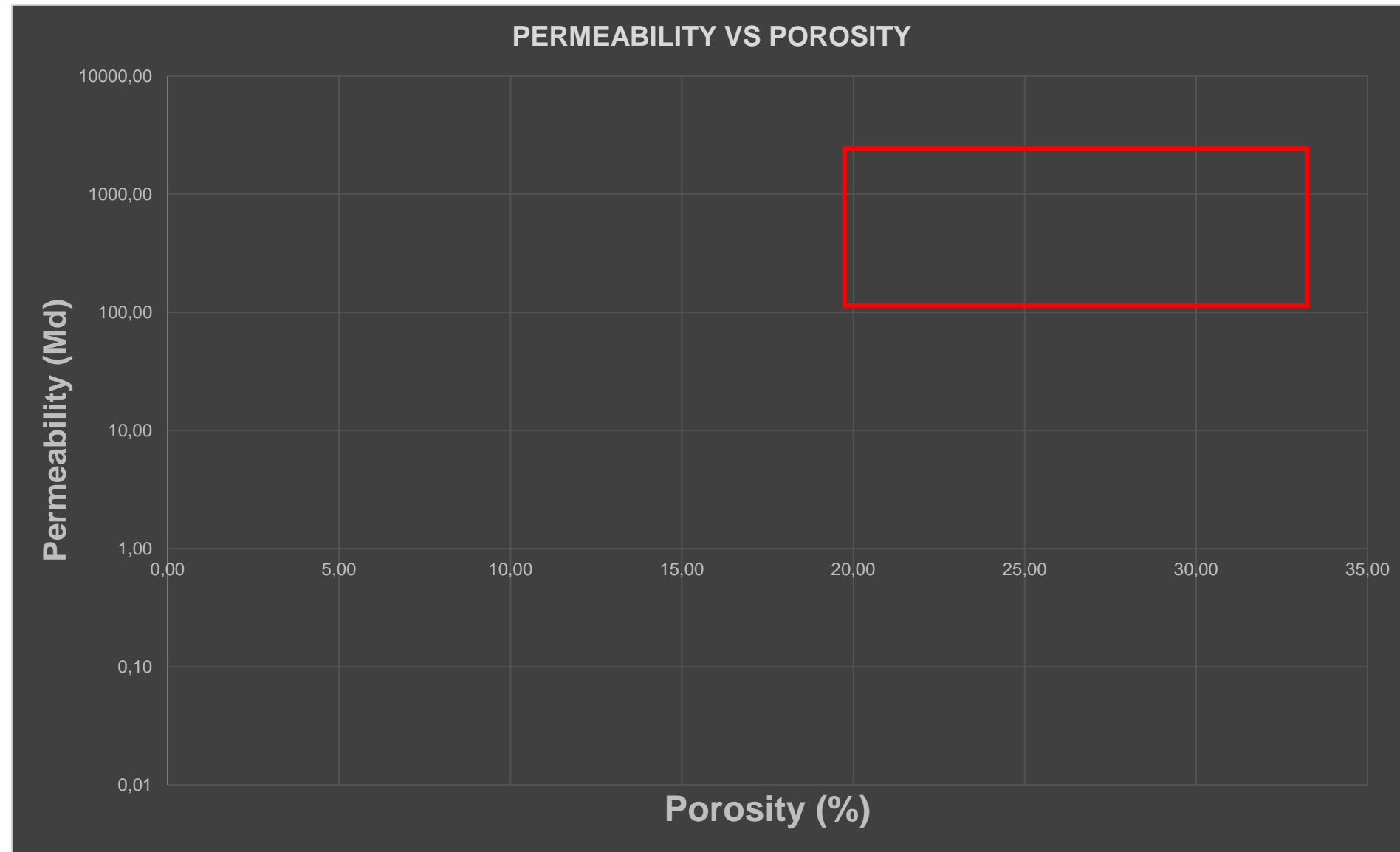


# STRATIGRAPHY AND PALEOENVIRONMENTS

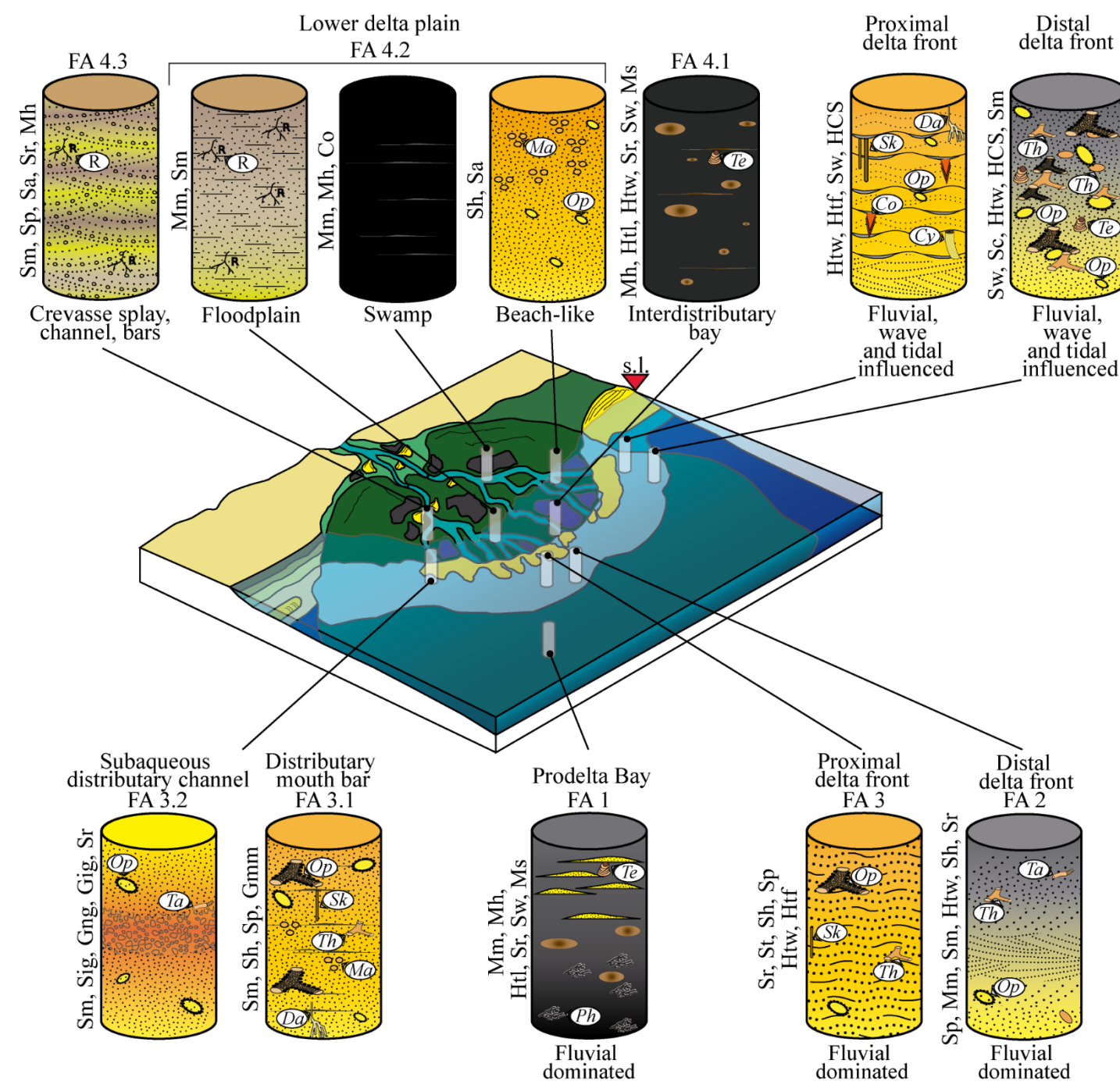
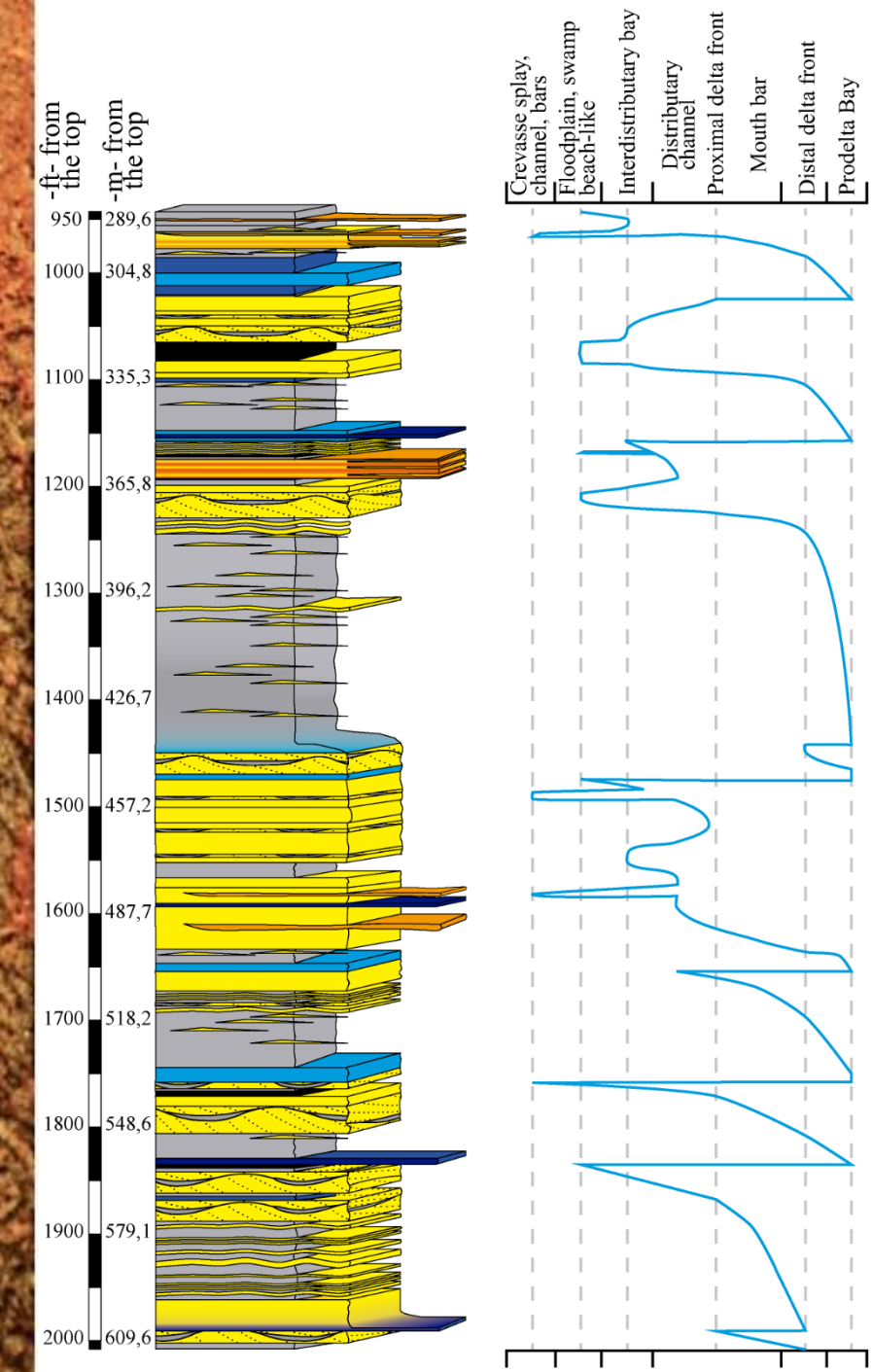




# STRATIGRAPHY AND PALEOENVIRONMENTS



Macaronichnus



Celis et al. (2021)



# STRATIGRAPHY AND PALEOENVIRONMENTS

**Research Paper**

**GEOSPHERE**

GEOSPHERE, v. 16

<https://doi.org/10.1130/GES02059.1>

13 figures; 1 set of supplemental files

## Provenance of Eocene–Oligocene sediments in the San Jacinto Fold Belt: Paleogeographic and geodynamic implications for the northern Andes and the southern Caribbean

E. Osorio-Granada<sup>1</sup>, A. Pardo-Trujillo<sup>1</sup>, S.A. Restrepo-Moreno<sup>2,3</sup>, F. Gallego<sup>1</sup>, J. Muñoz<sup>1</sup>, A. Plata<sup>1</sup>, R. Trejos-Tamayo<sup>1</sup>, F. Vallejo<sup>1</sup>, A. Barbosa-Espitia<sup>1,3</sup>, F.J. Cardona-Sánchez<sup>1</sup>, D.A. Foster<sup>3</sup>, and G. Kamenov<sup>3</sup>

<sup>1</sup>Departamento de Ciencias Geológicas, Grupo de Investigaciones en Estratigrafía y Vulcanología (GIEV-Cumanday), Instituto de Investigaciones en Estratigrafía (IIES), Universidad de Caldas, Manizales 1700004, Colombia

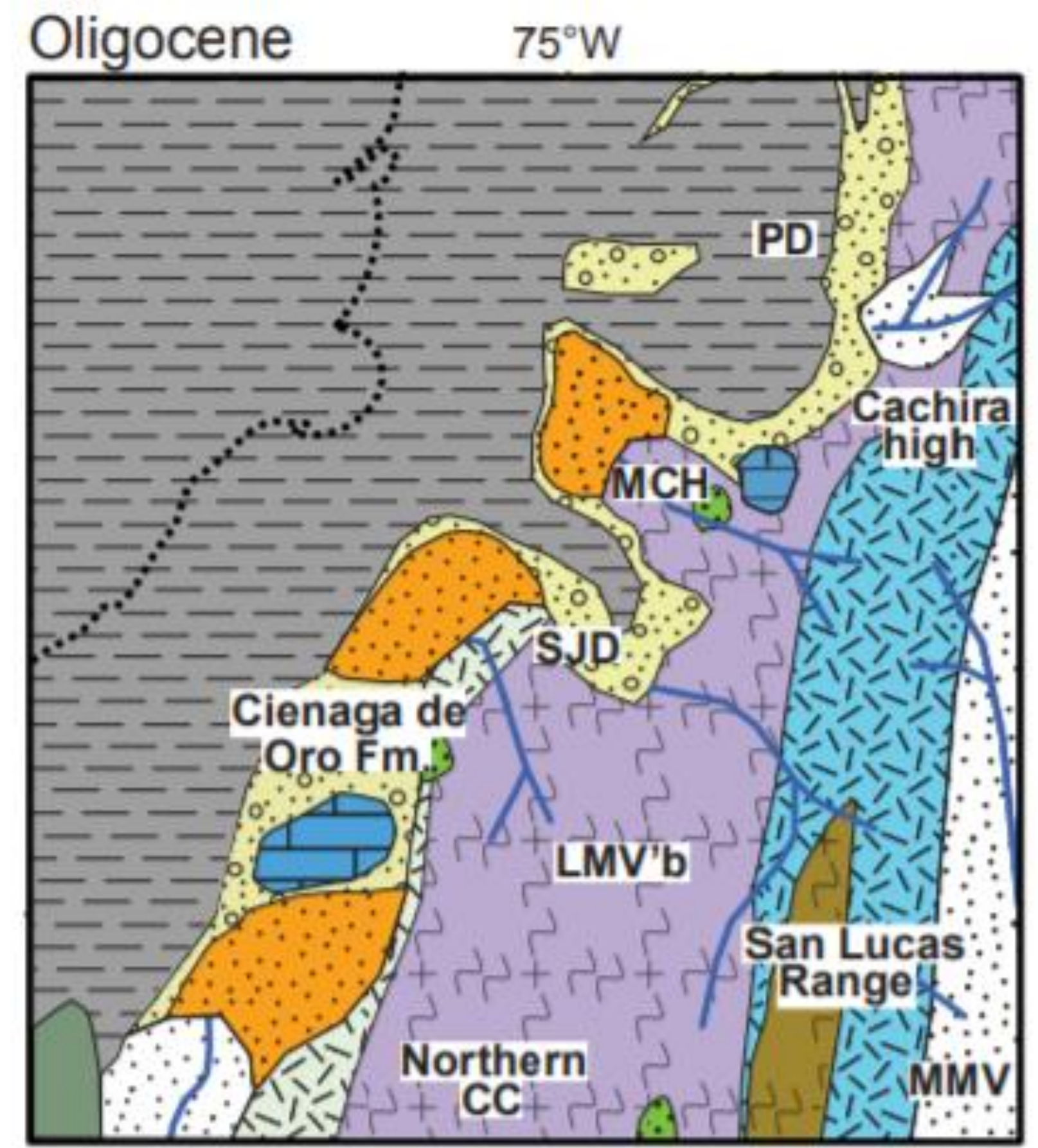
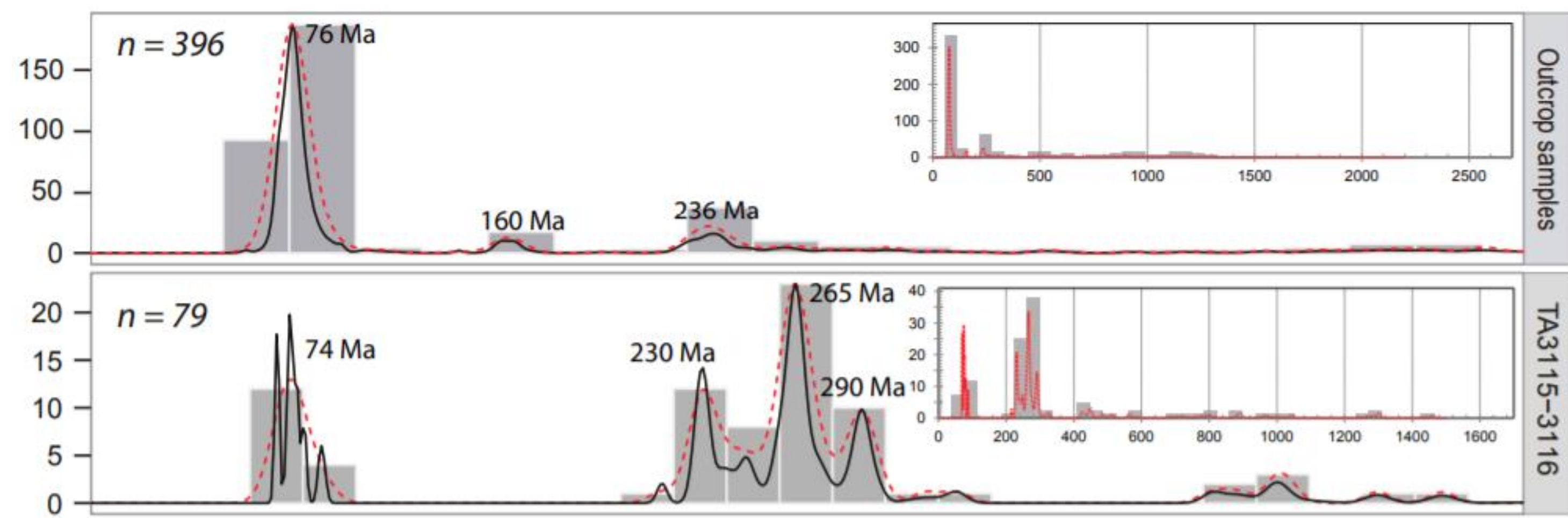


vol. 42, n.º 3, septiembre-diciembre de 2020  
ISSN impreso: 0120-0283 • ISSN en línea: 2145-8553



## Provenance of the Ciénaga de Oro Formation: unveiling the tectonic evolution of the Colombian Caribbean margin during the Oligocene - Early Miocene

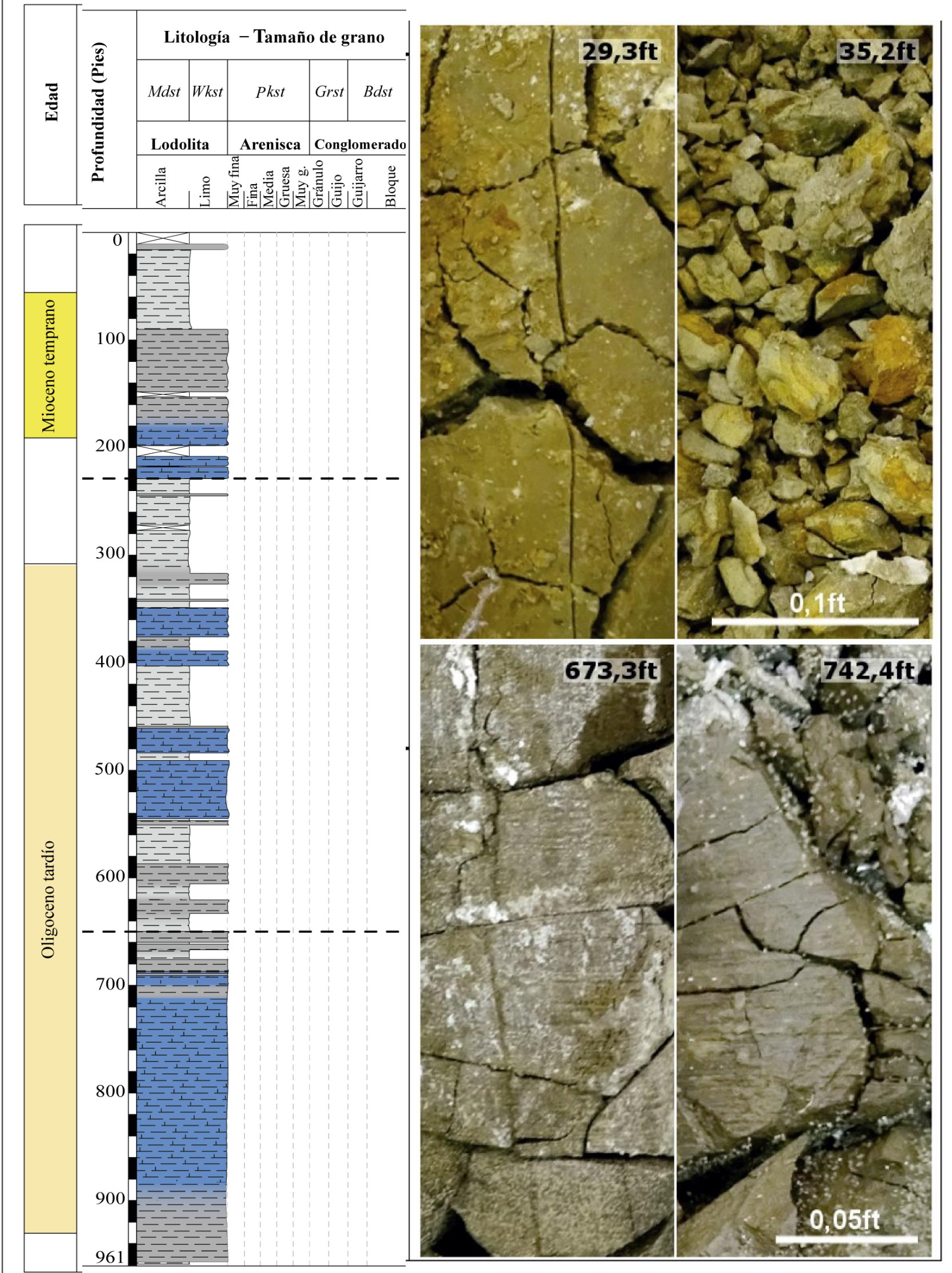
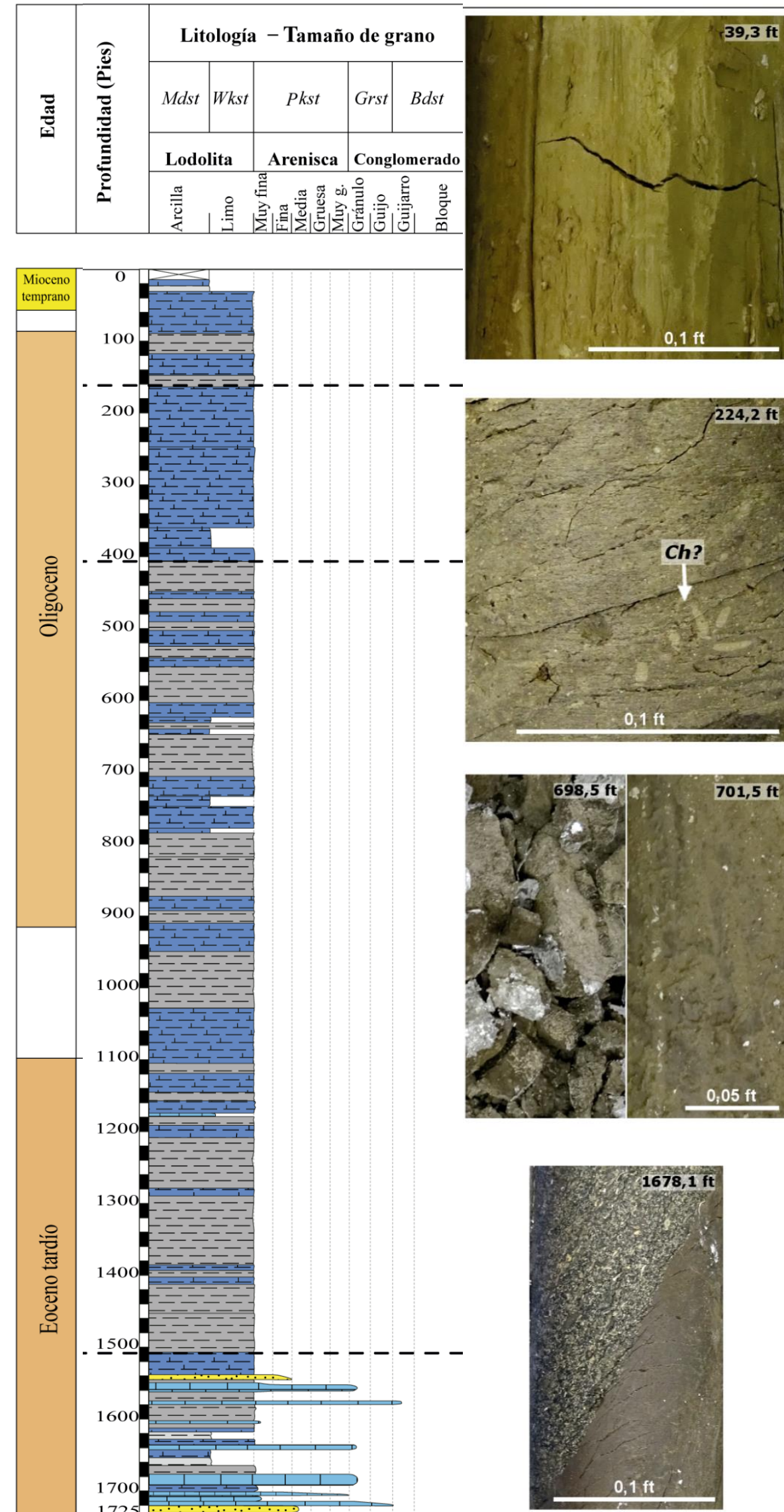
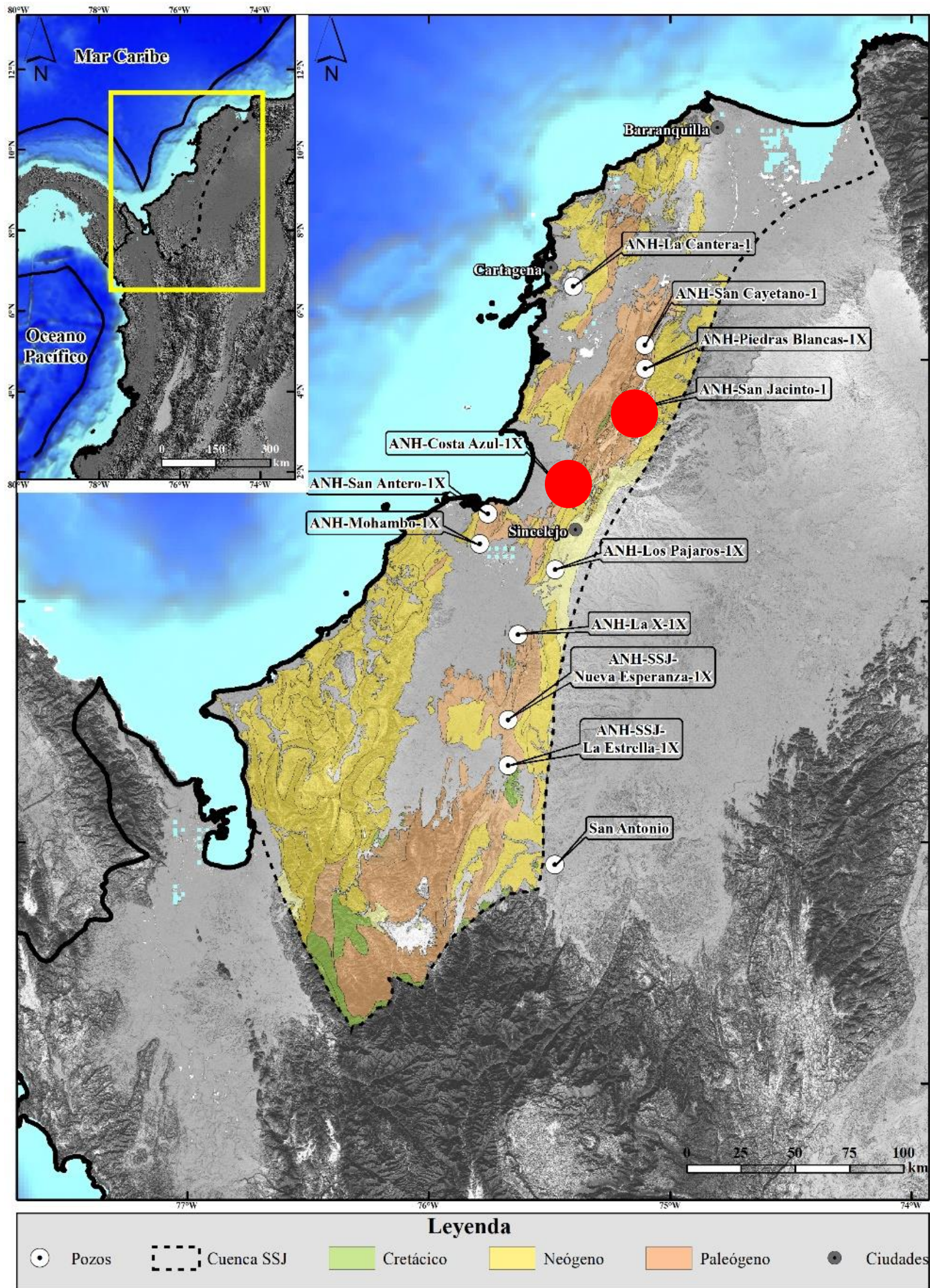
Alejandra Manco-Garcés<sup>1\*</sup> ; Maria Isabel Marín-Cerón<sup>1</sup> ; Carlos Javier Sánchez-Plazas<sup>2</sup> ; Luis Carlos Escobar-Arenas<sup>1</sup> ; Alejandro Beltrán-Triviño<sup>1</sup> ; Albrecht von Quadt<sup>3</sup>



Osorio-Granada et al. (2020)

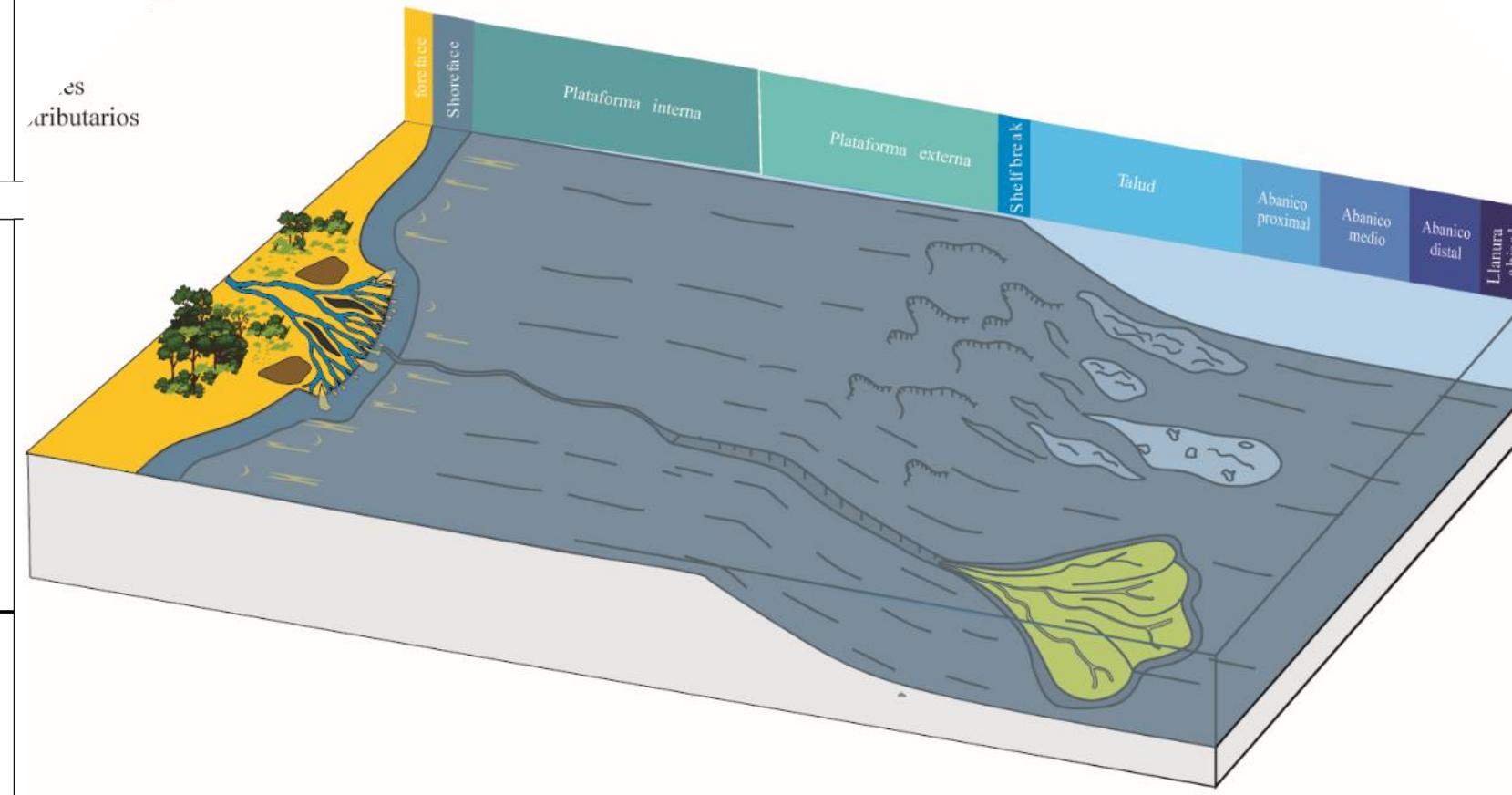
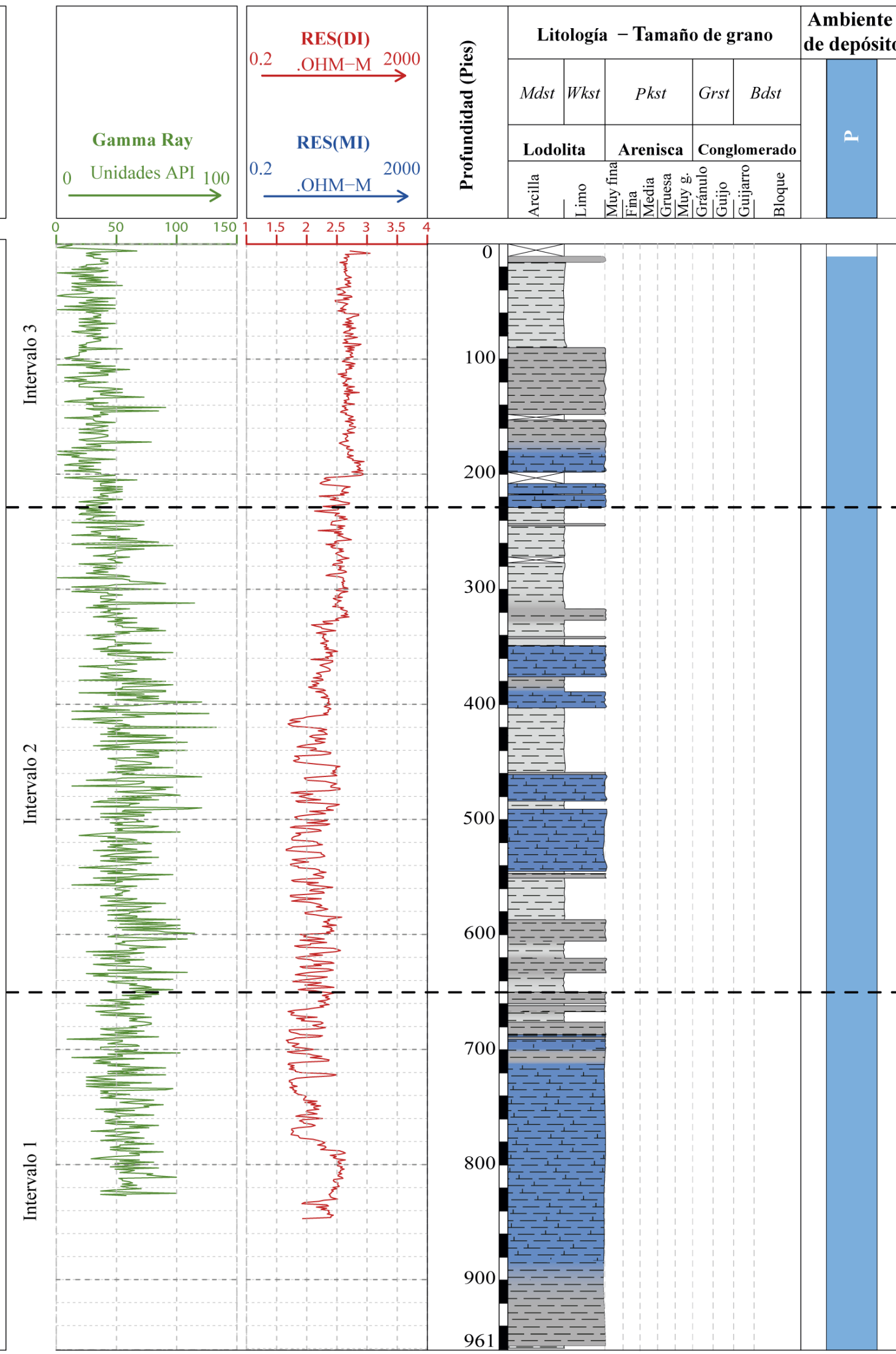
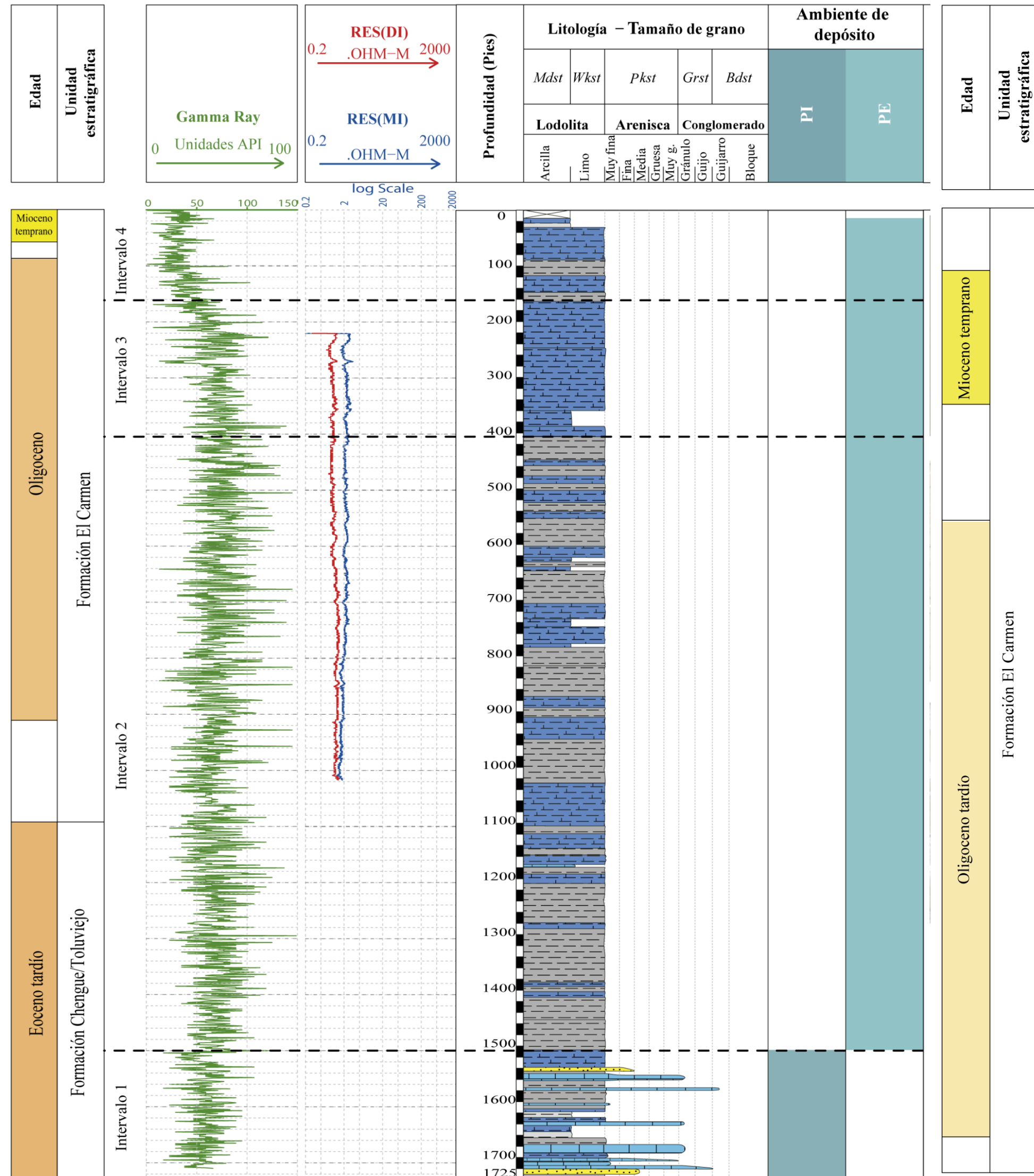


# STRATIGRAPHY AND PALEOENVIRONMENTS





# STRATIGRAPHY AND PALEOENVIRONMENTS



Marine and Petroleum Geology

Volume 65, August 2015, Pages 217-231

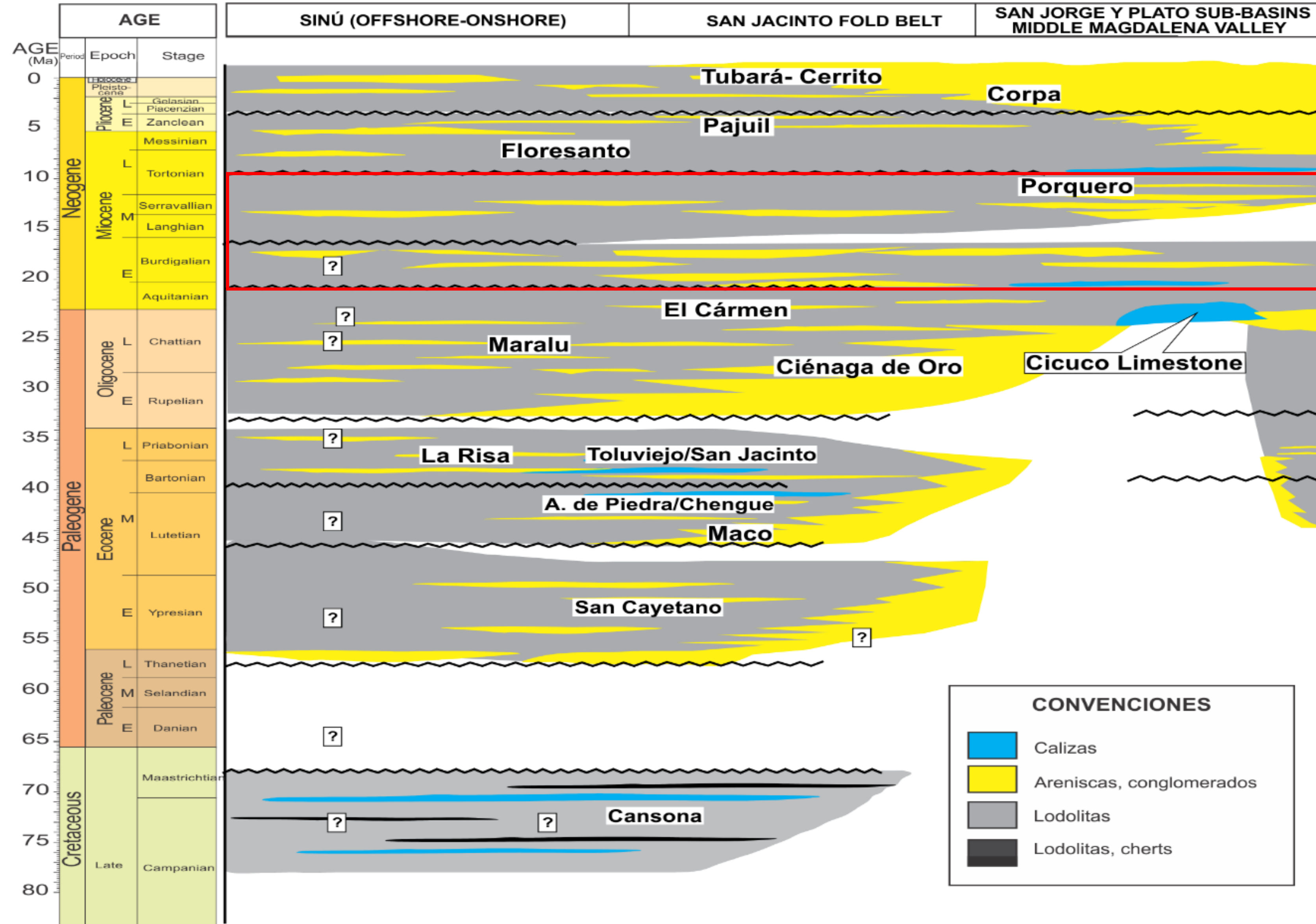
Research paper

## Geochemical assessment and petroleum systems in the Sinú-San Jacinto Basin, northwestern Colombia

José Osorno<sup>a</sup>, Antonio Rangel<sup>b</sup>



# STRATIGRAPHY AND PALEOENVIRONMENTS



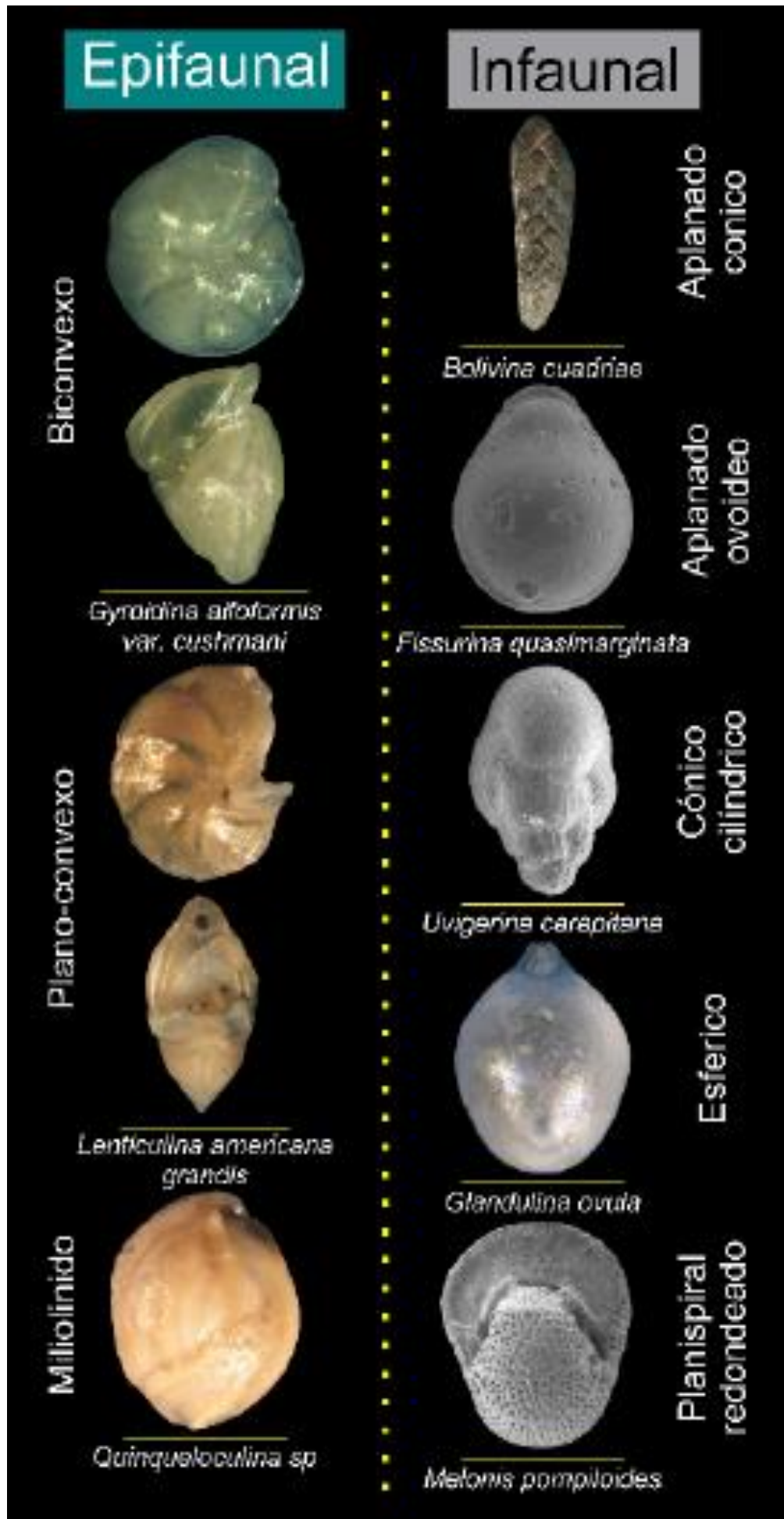
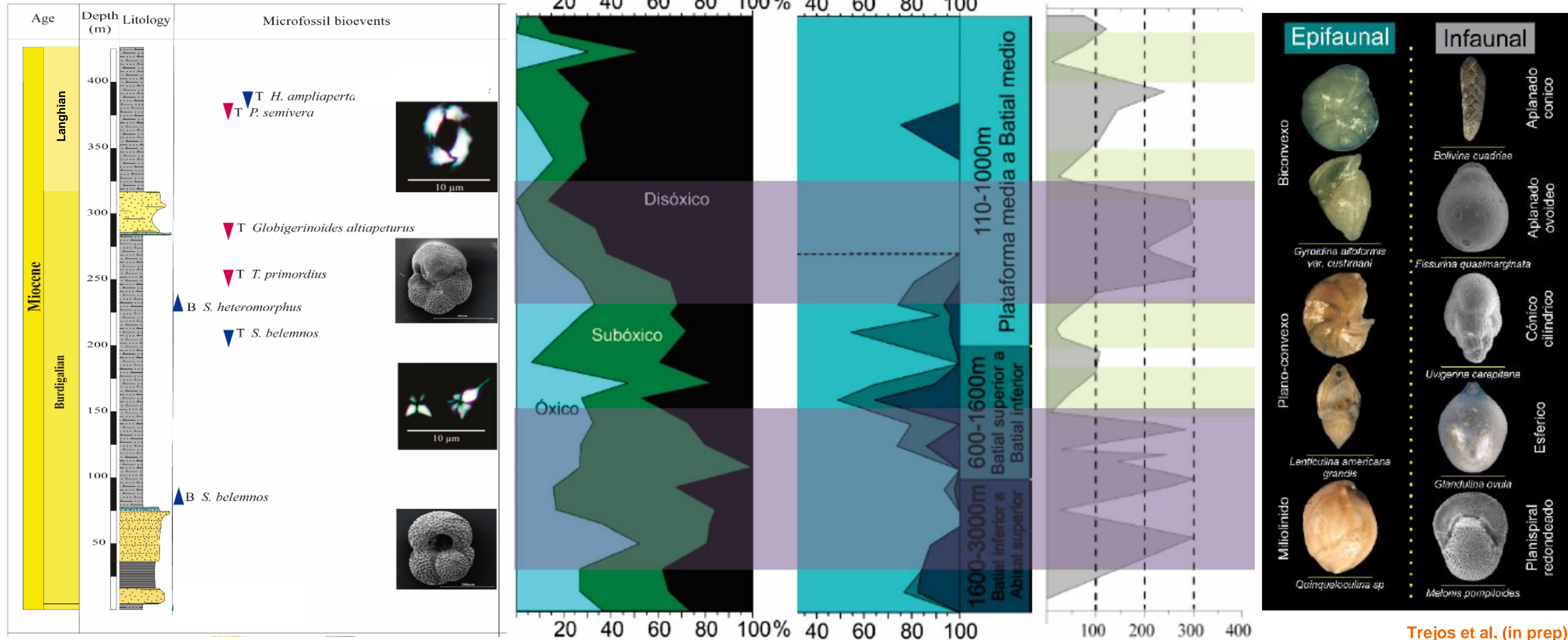
**CONVENCIONES**

- Calizas
- Areniscas, conglomerados
- Lodolitas
- Lodolitas, cherts



# STRATIGRAPHY AND PALEOENVIRONMENTS

P18

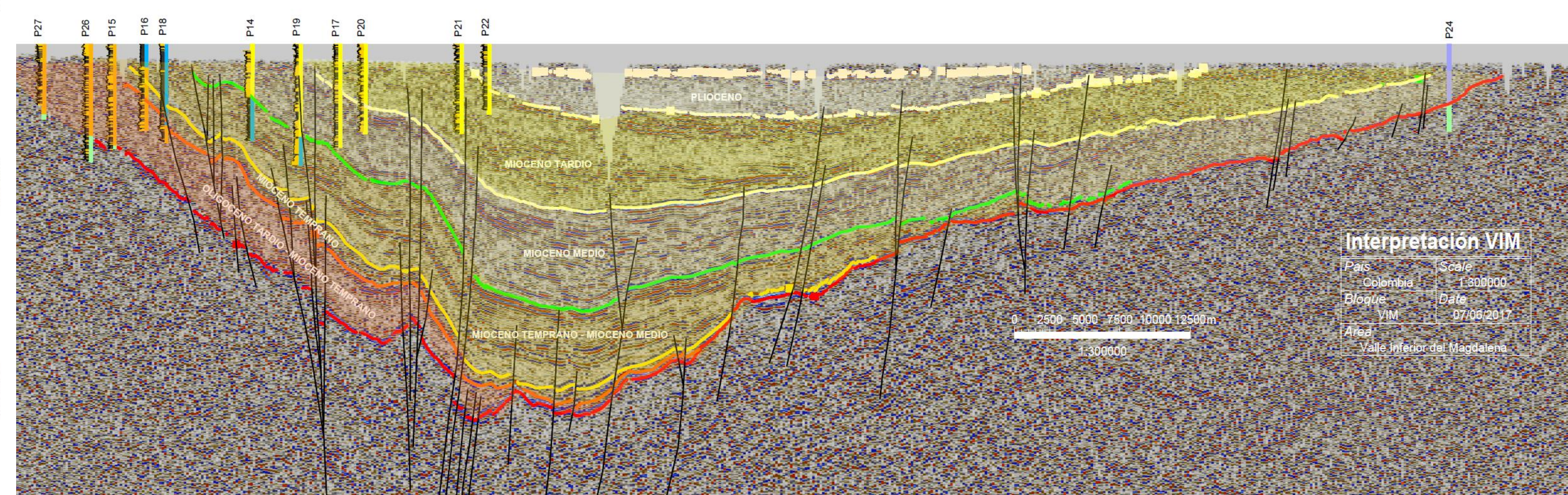
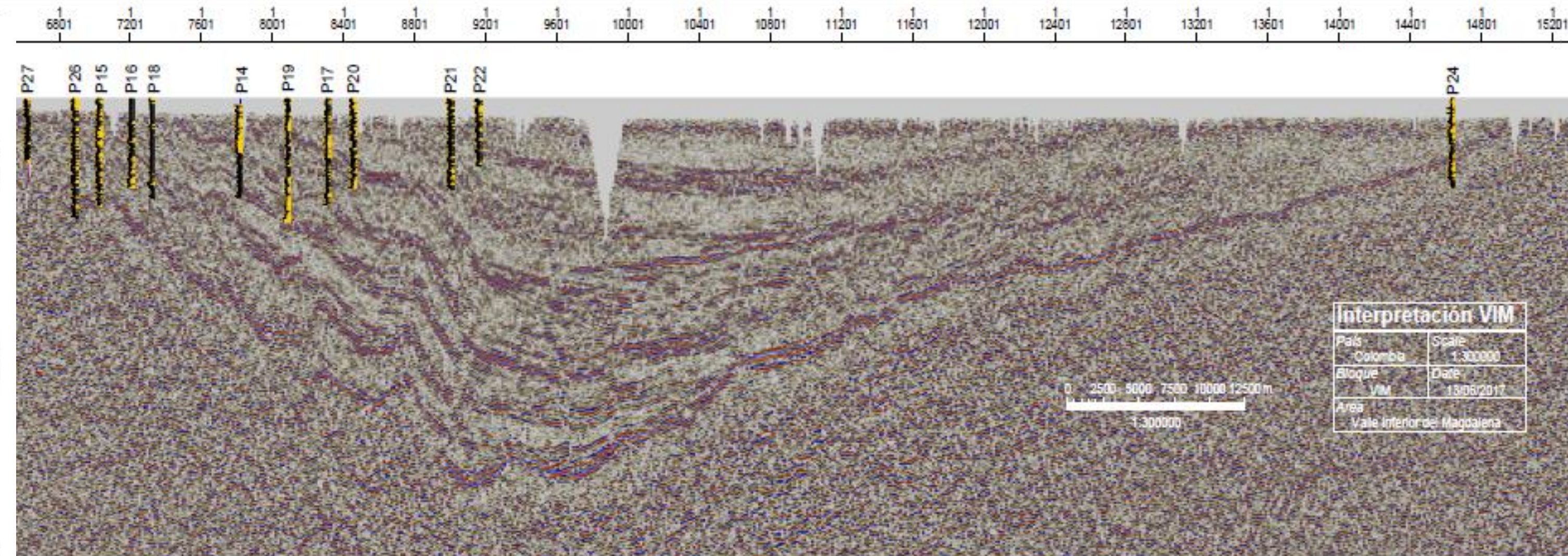
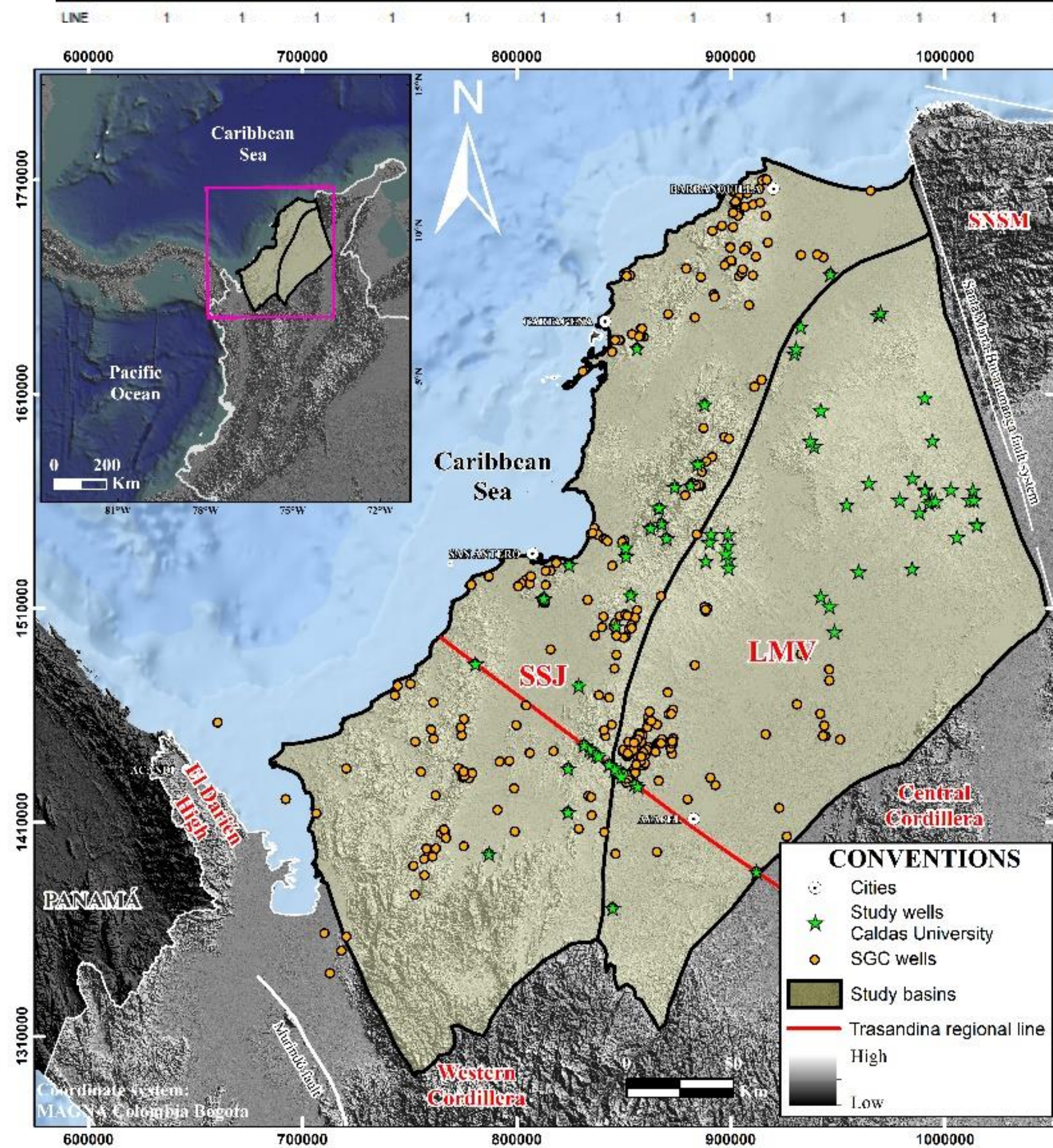




# STRATIGRAPHY AND PALEOENVIRONMENTS

## TRANS-ANDEAN SEISMIC LINE (ANH, 2008)- WELLS ASSOCIATED

Arenas (2017)





# STRATIGRAPHY AND PALEOENVIRONMENTS

## STRATIGRAPHIC CORRELATION OF THE WELLS

P27

P26

P16

P18

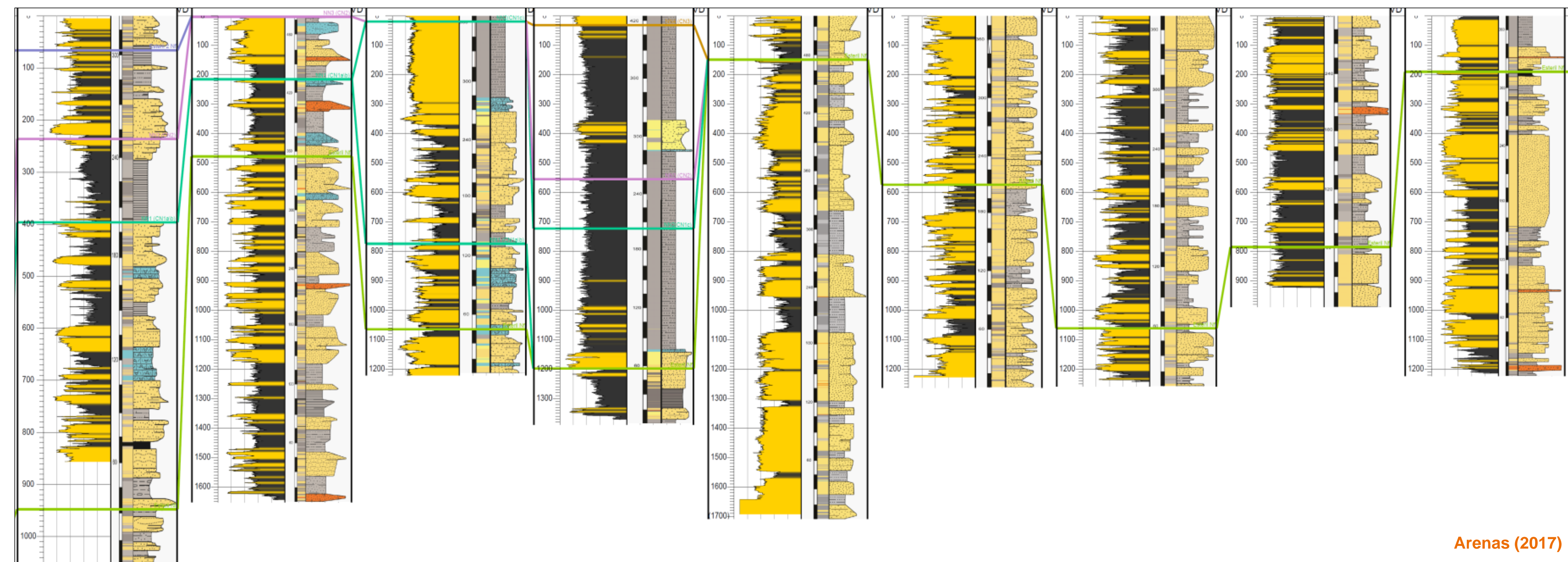
P19

P20

P21

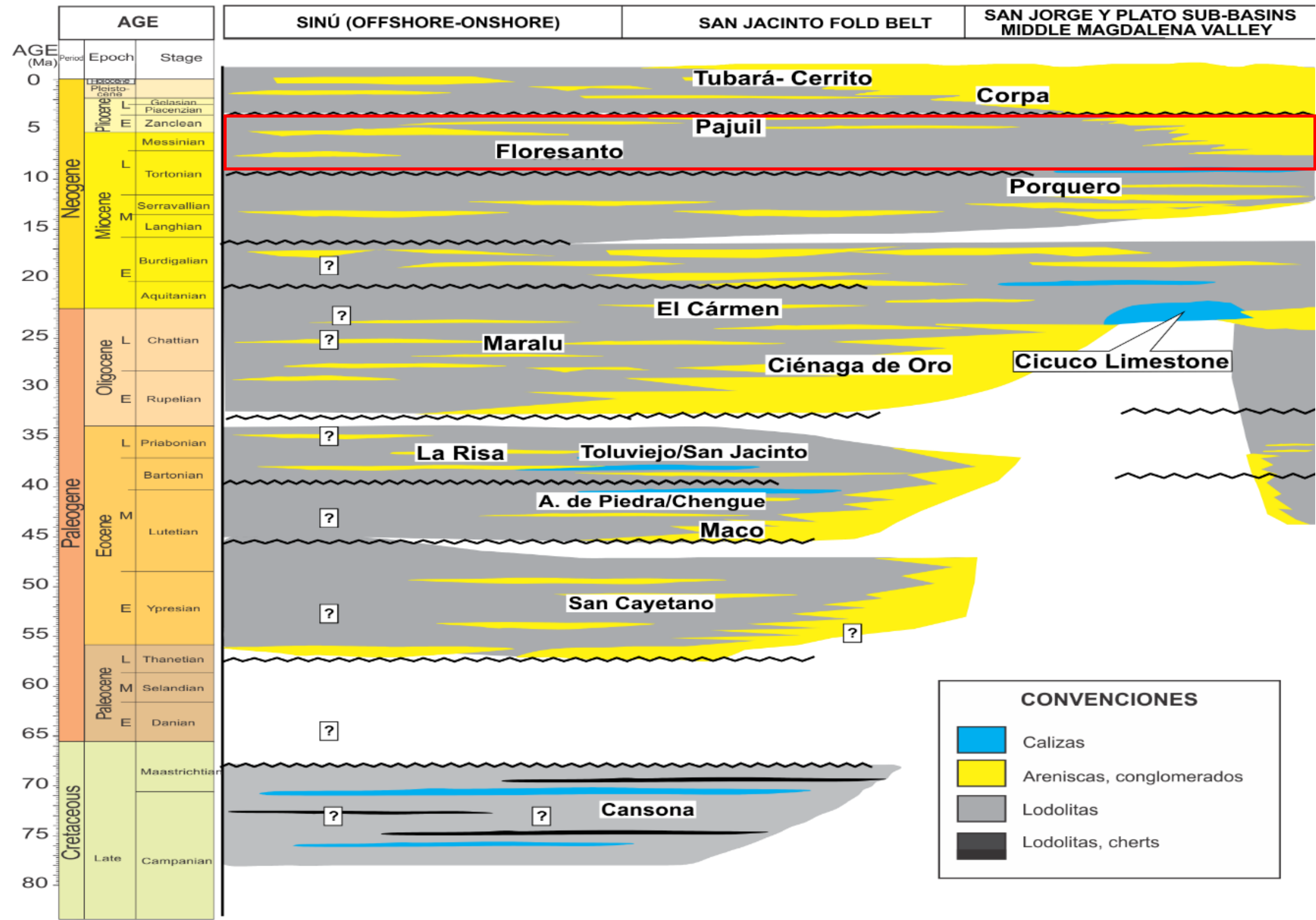
P22

P24





# STRATIGRAPHY AND PALEOENVIRONMENTS



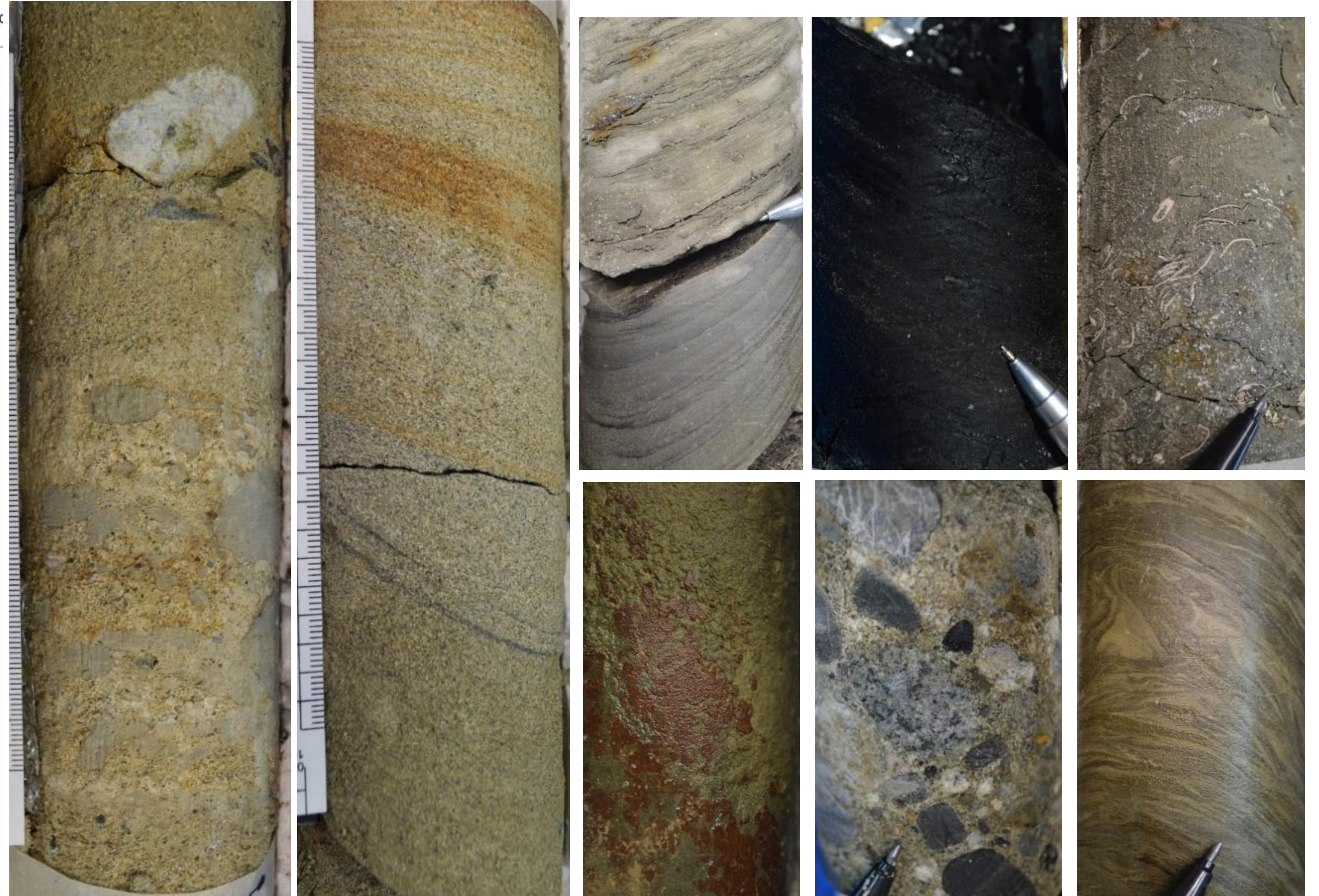
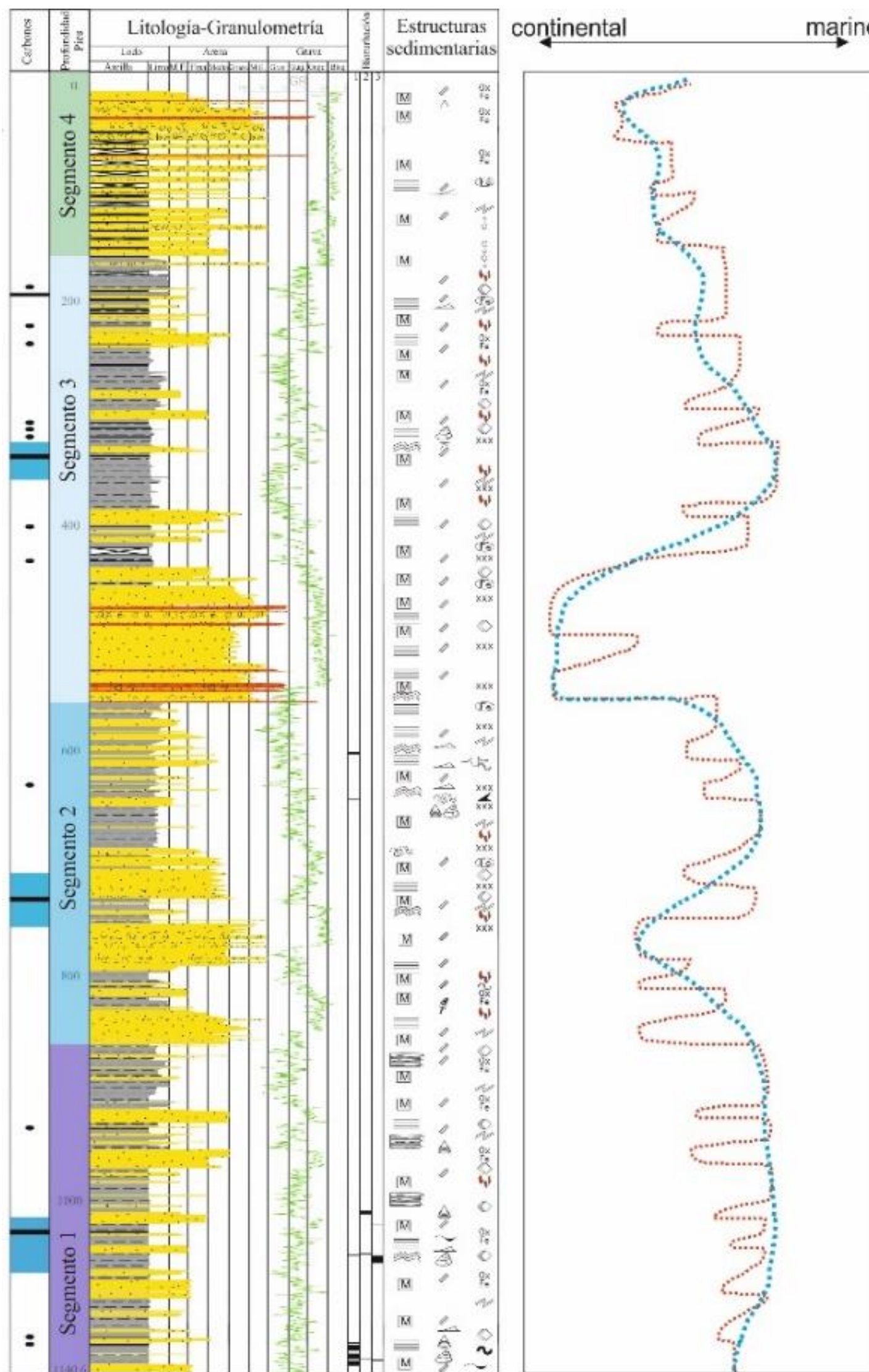
**CONVENCIONES**

- Calizas
- Areniscas, conglomerados
- Lodolitas
- Lodolitas, cherts



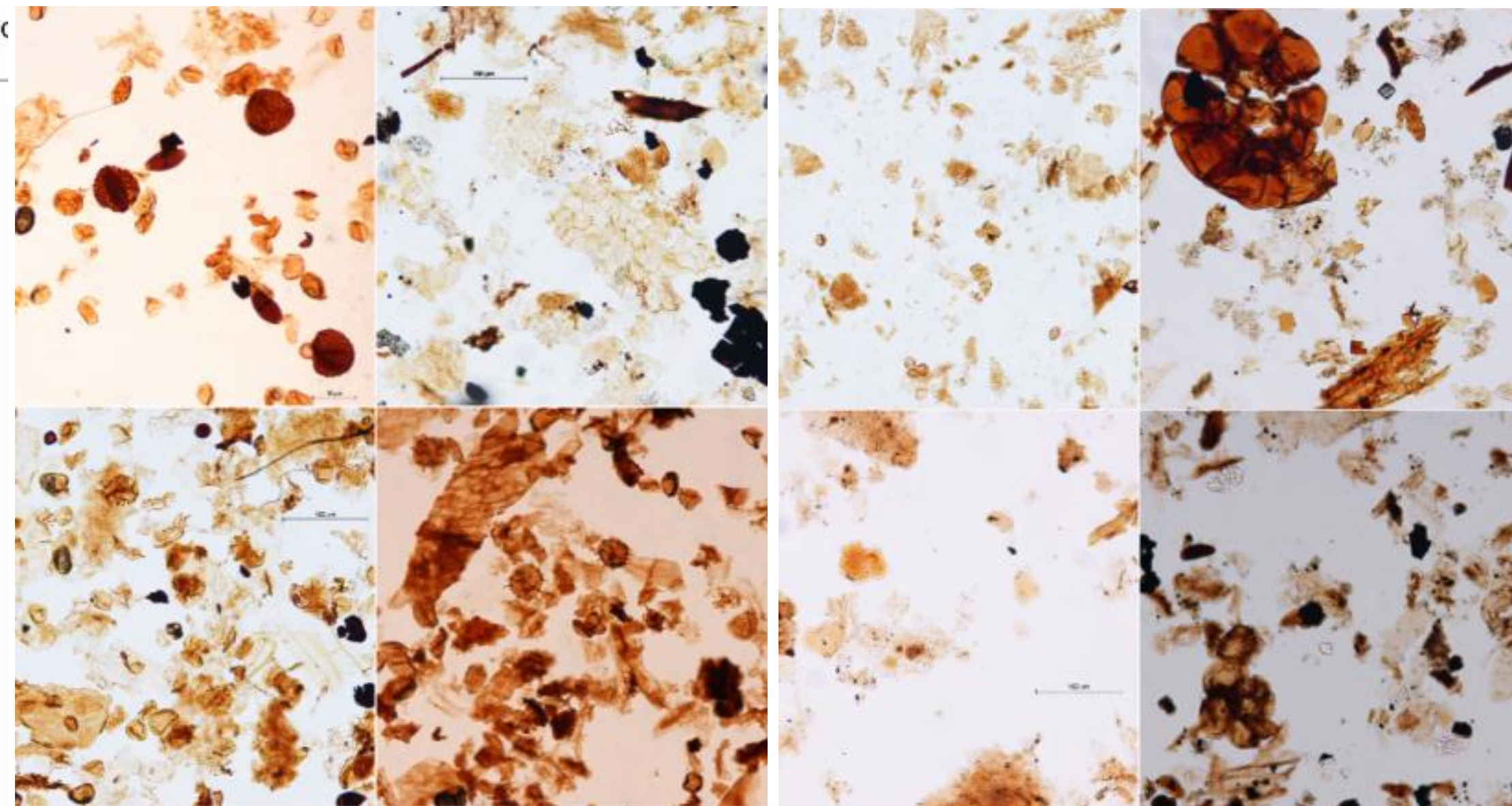
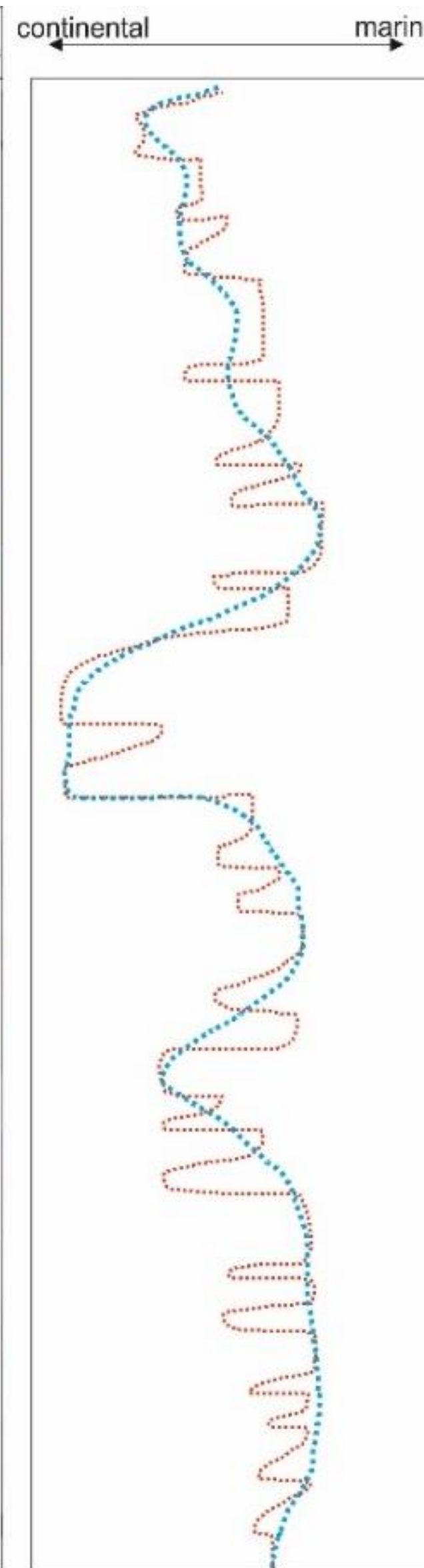
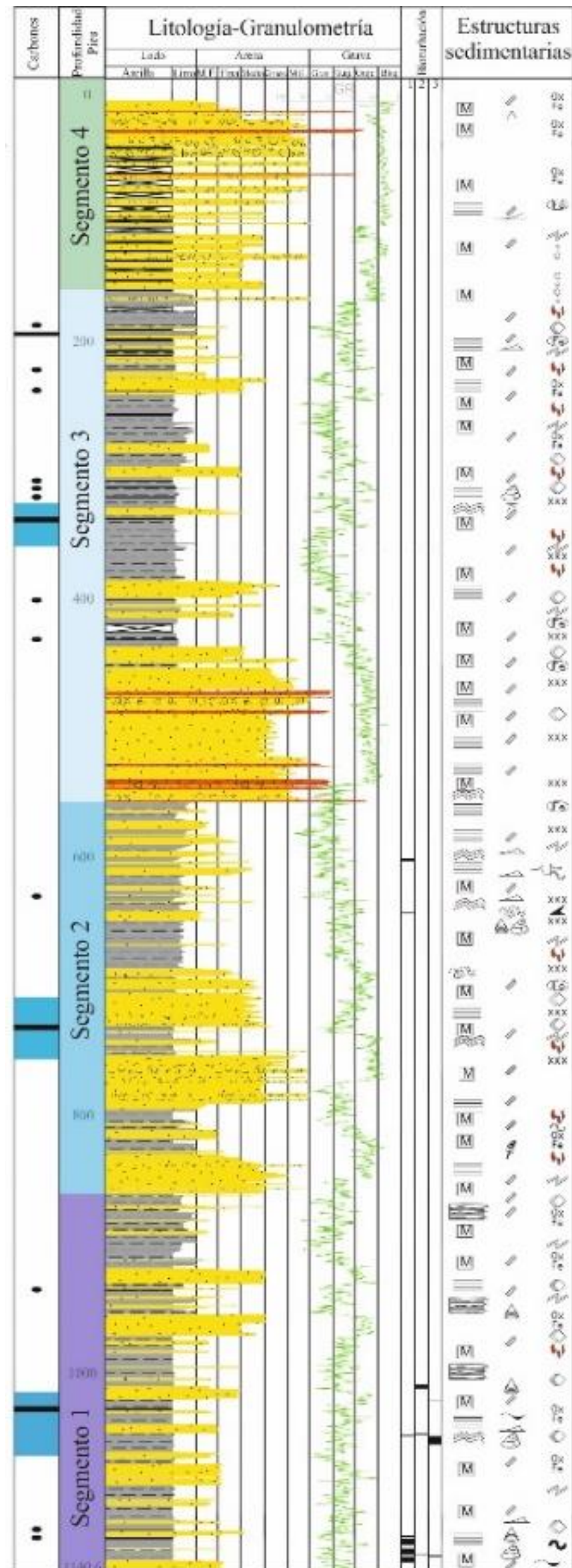
# STRATIGRAPHY AND PALEOENVIRONMENTS

## ANH-LOS PÁJAROS

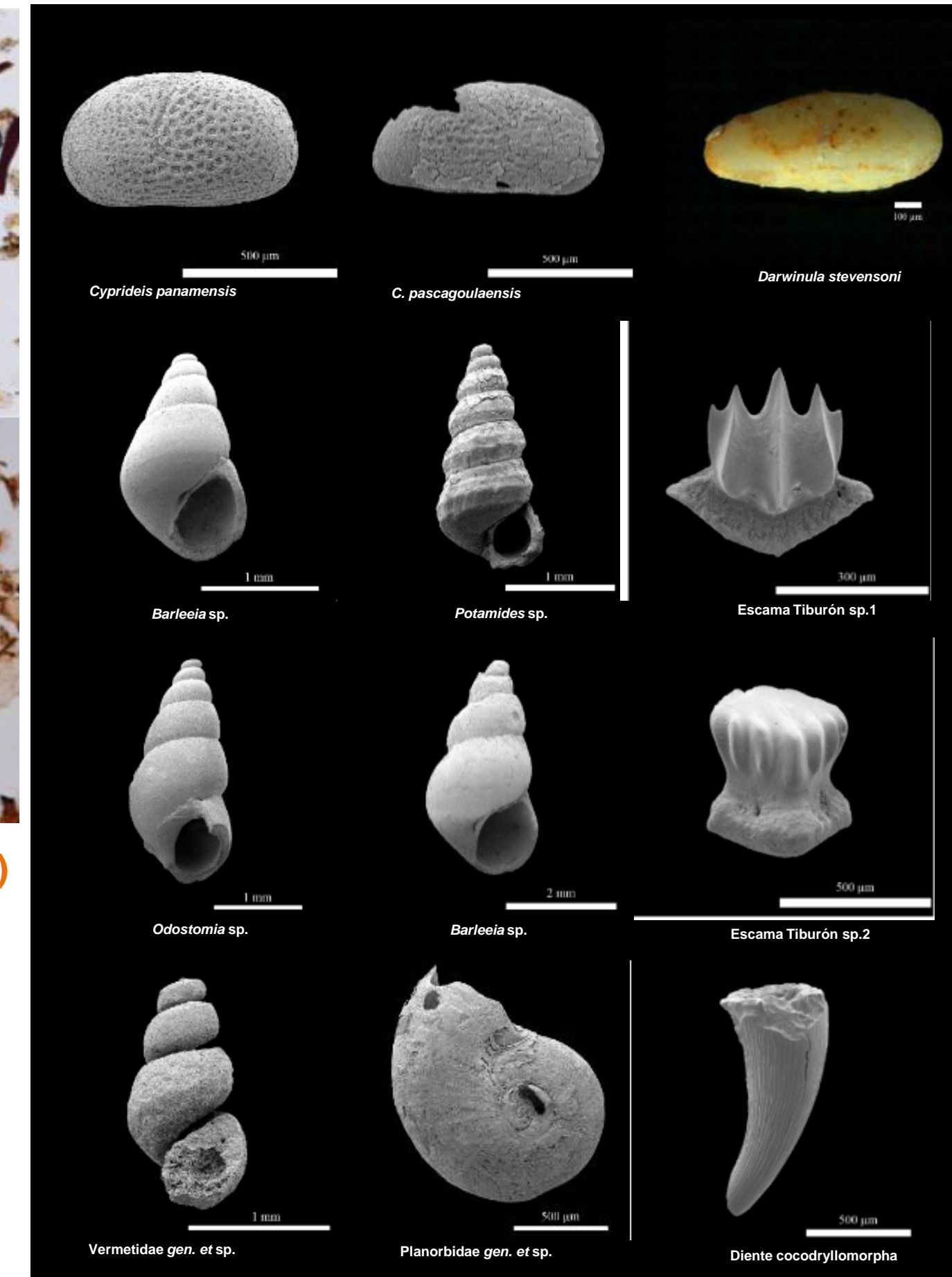
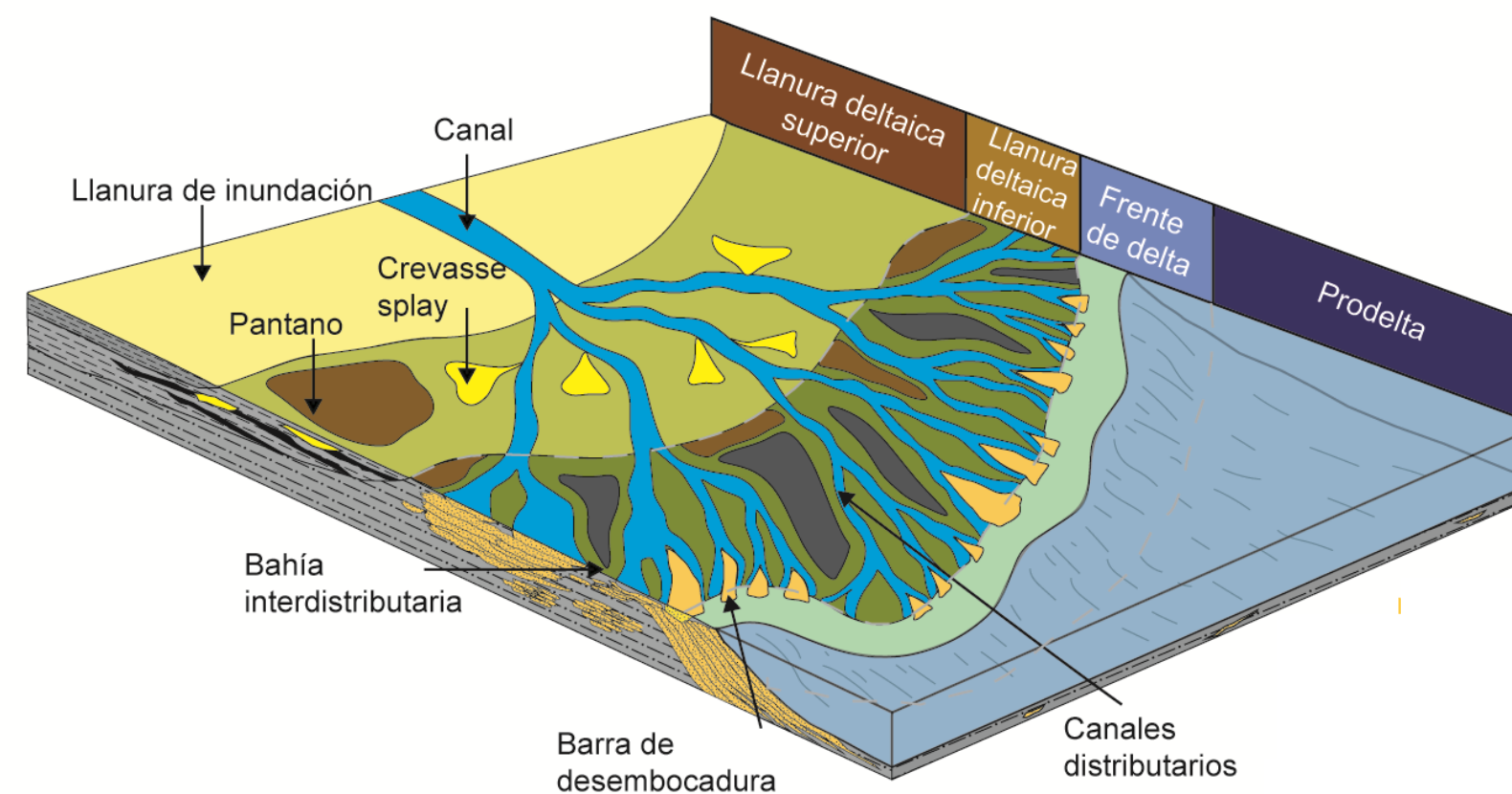




# STRATIGRAPHY AND PALEOENVIRONMENTS



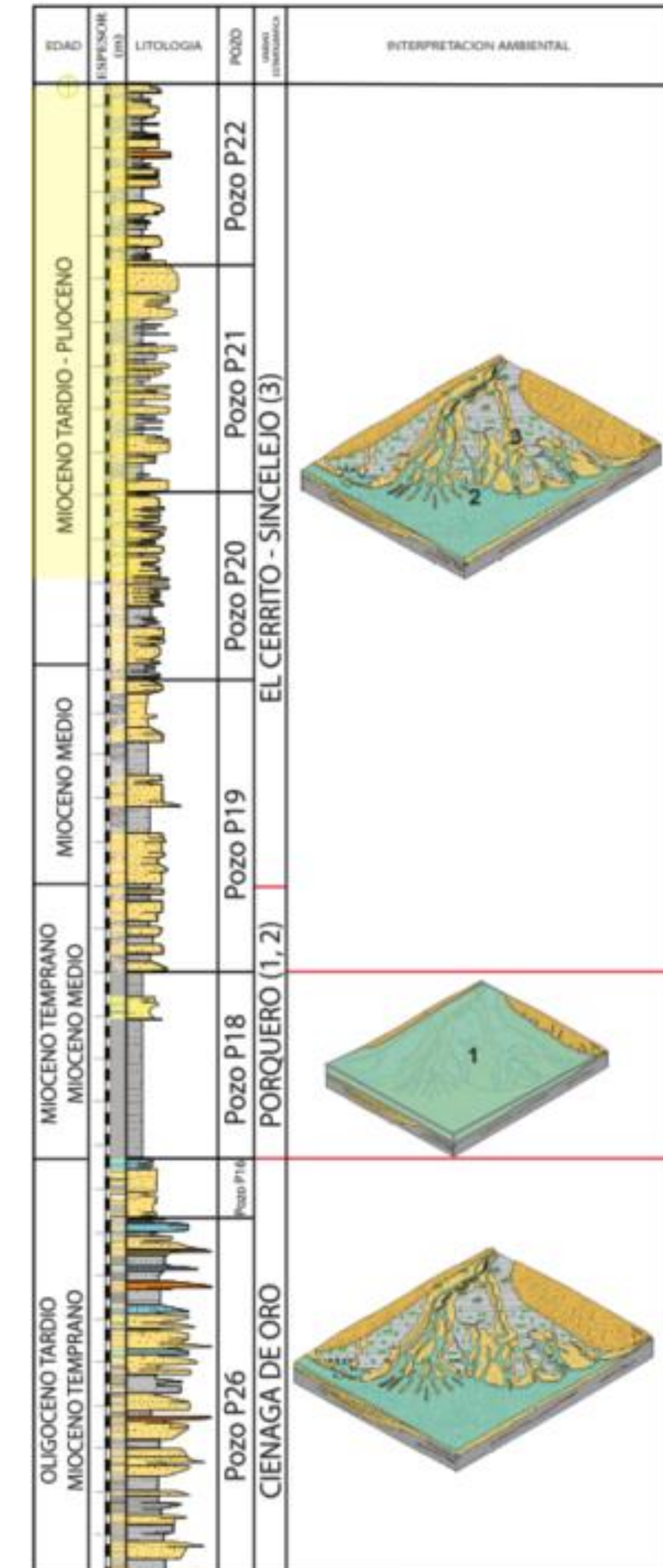
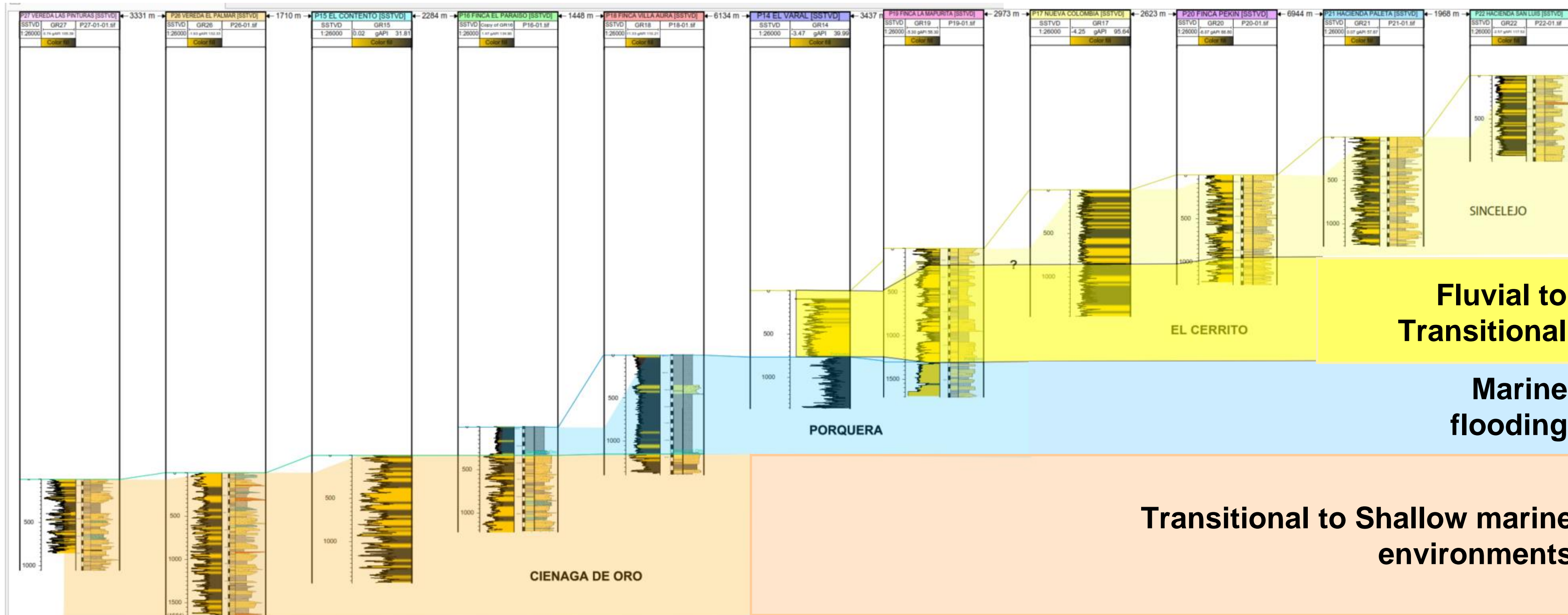
Díaz (2017)



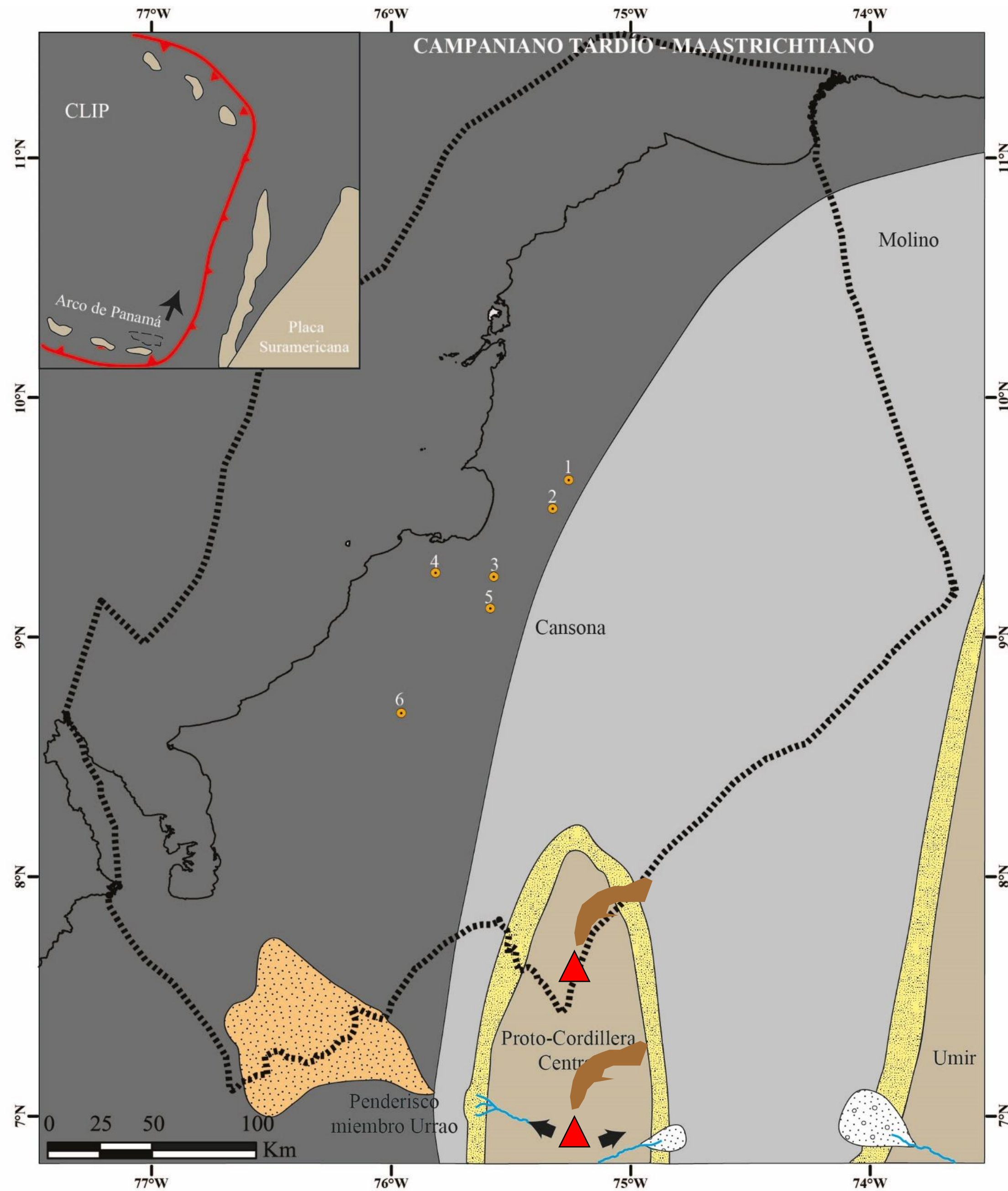
Salazar et al. (in prep)



# STRATIGRAPHY AND PALEOENVIRONMENTS







## Campanian-Maastrichtian

### LEYENDA

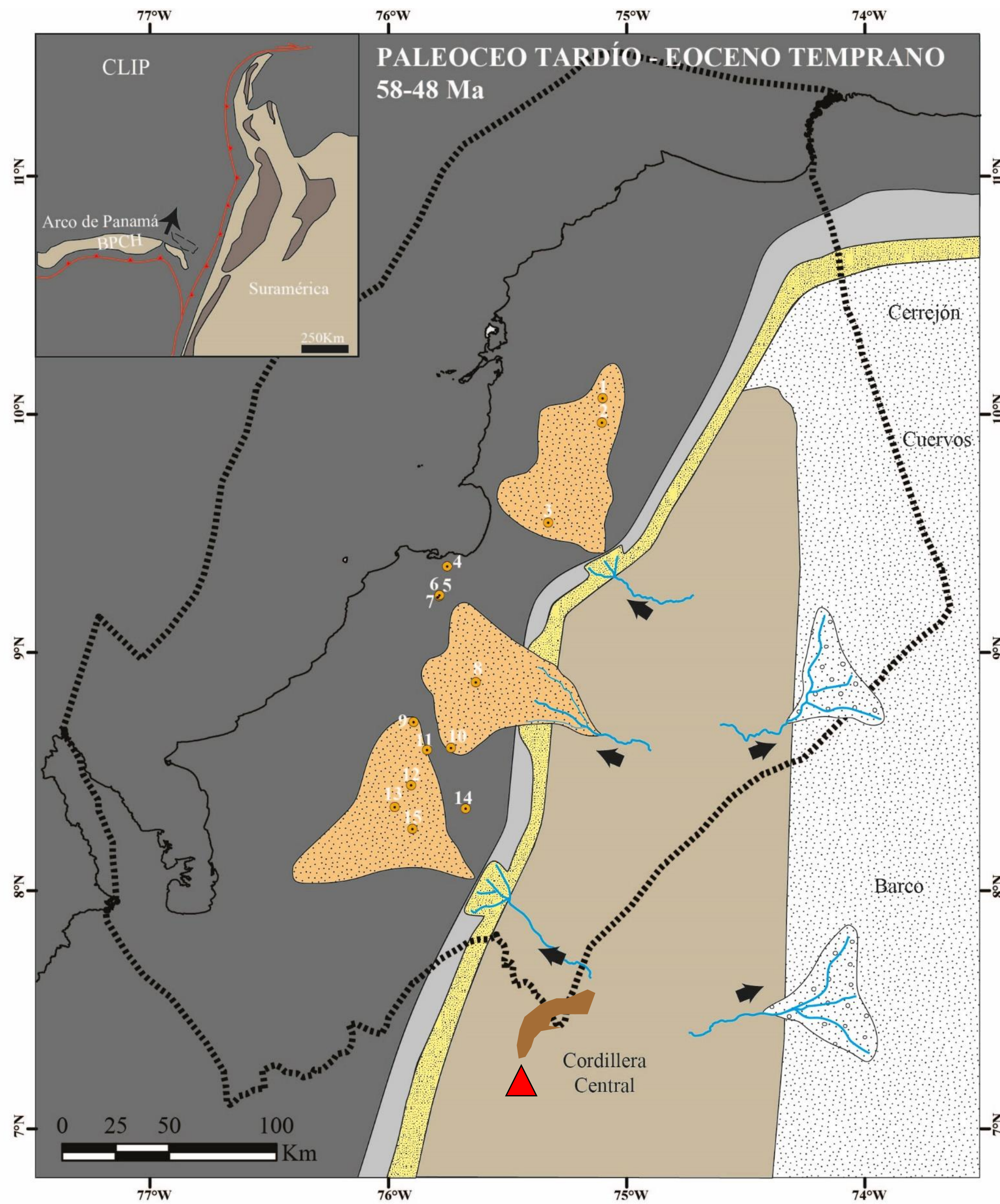
- Área emergida
- Ambiente transicional (delta, llanuras mareales, *foreshore* y *shoreface*)
- Ambiente marino somero (*offshore*-plataforma)
- Ambiente marino profundo (talud-llanura abisal)
- Abanicos deltaicos y submarinos
- Abanicos aluviales, depósitos fluviales
- Límite área de estudio
- Volcanism
- Dirección de aporte de sedimentos
- Drenajes

### SECCIONES ESTRATIGRÁFICAS

- 1 Cerro Cansona
- 2 Arroyo Peñitas
- 3 Sección San Carlos
- 4 San Carlos
- 5 Sección Chicoral
- 6 Purgatorio 2



## Late Paleocene – Early Eocene



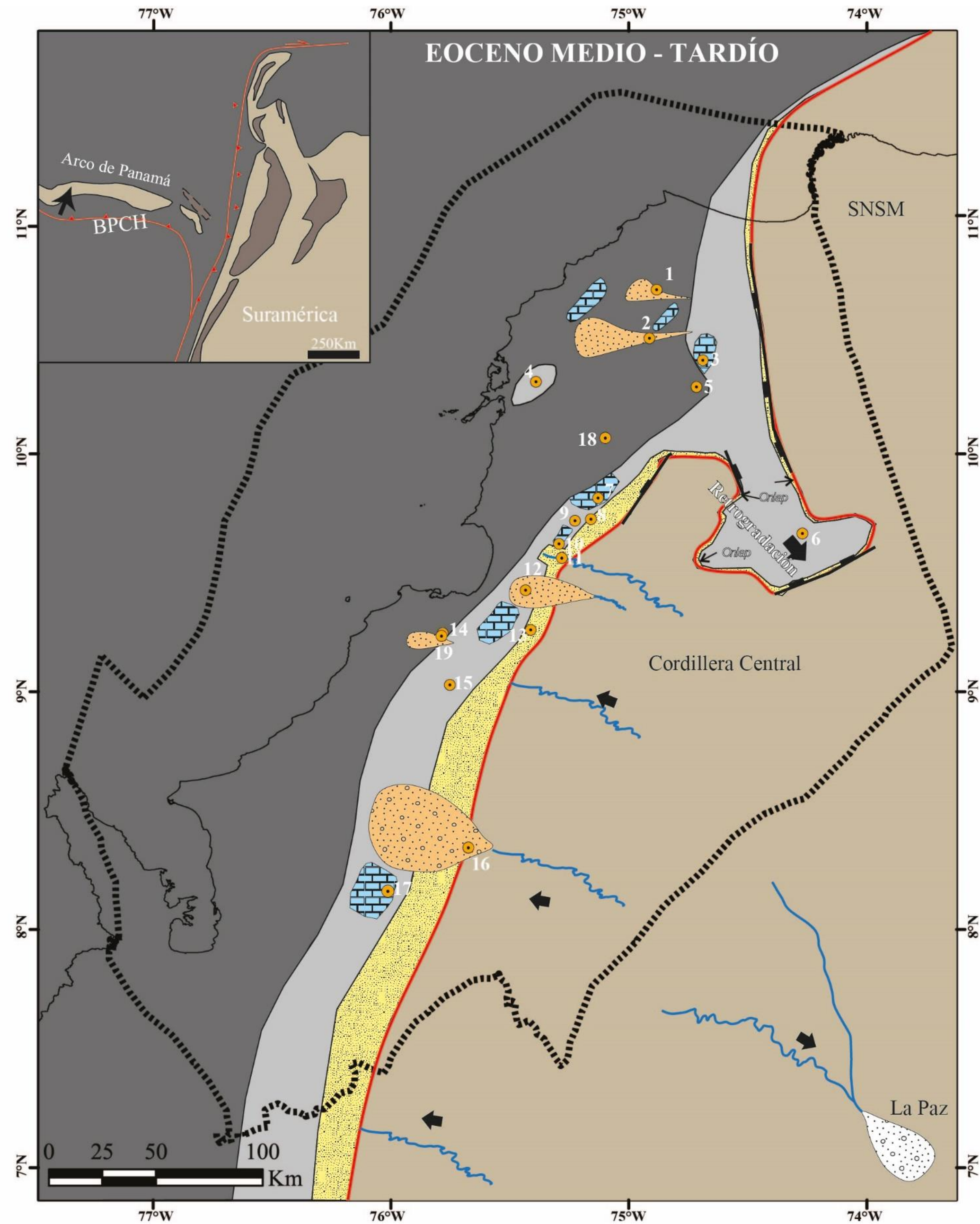
### LEYENDA

- Área emergida
- Ambiente transicional (delta, llanuras mareales, foreshore y shoreface)
- Ambiente marino somero (offshore-plataforma)
- Ambiente marino profundo (talud-llanura abisal)
- Abanicos deltaicos y submarinos
- Abanicos aluviales, depósitos fluviales
- Límite área de estudio
- Dirección de aporte de sedimentos
- Drenajes
- Volcanism

### POZOS

- |                       |                           |
|-----------------------|---------------------------|
| 1 ANH-San Cayetano-1  | 9 ANH-SSJ-015-STR-S       |
| 2 ANH-Piedra Blanca-1 | 10 ANH-SSJ-18-STR-S       |
| 3 P-2 Chalan          | 11 ANH-SSJ-17-STR-S       |
| 4 ANH-San Antero-1    | 12 ANH SSJ-4A ST R S      |
| 5 P-13 Nueva Estrella | 13 ANH SSJ-10 ST R S      |
| 6 P-11 San Sebastian  | 14 ANH-SSJ-La-Estrella-1X |
| 7 ANH-Moambo-1        | 15 ANH SSJ-8A ST R S      |
| 8 ANH-La X-1          |                           |





## Late - Middle Eocene

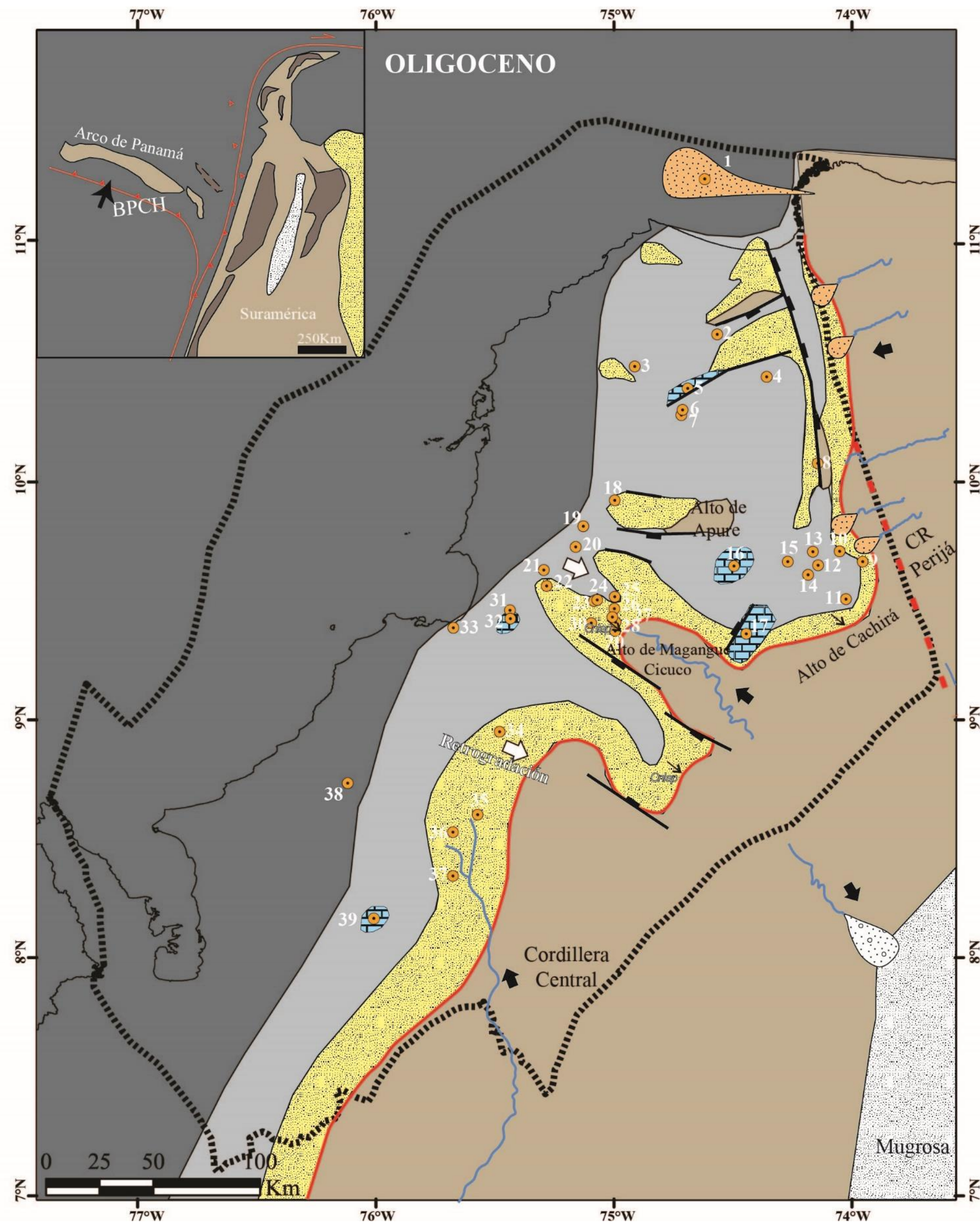
### LEYENDA

Área emergida	Carbonatos
Ambiente transicional (delta, llanuras mareales, foreshore y shoreface)	Ambiente marino somero ( <i>offshore</i> -plataforma)
Ambiente marino profundo (talud-llanura abisal)	Abanicos deltaicos y submarinos
Abanicos aluviales, depósitos fluviales	Límite área de estudio
Dirección de aporte de sedimentos	Falla normal
Drenajes	Patrones en <i>Onlap</i> a partir de sísmica

### POZOS

1 Currulao-1	10 P8(2)-Don Gabriel
2 Manati-1	11 P12-Almagra
3 Pivijay-1	12 P3-Toluviejo
4 ANH-L Cantera-1	13 P6(3)-Hacienda La Estancia
5 Balsamo-1	14 P13-Nueva Estrella
6 ANH-Plato 1-X-P	15 Claro-1
7 ANH-San Jacinto-1	16 ANH-SSJ-La Estrella 1-X
8 P7-Arroyo Arena	17 ANH-Tierra Alta 2X
9 P5-Caracolí	18 ANH-San Cayetano-1
	19 ANH-Moambo-1X





## Oligocene

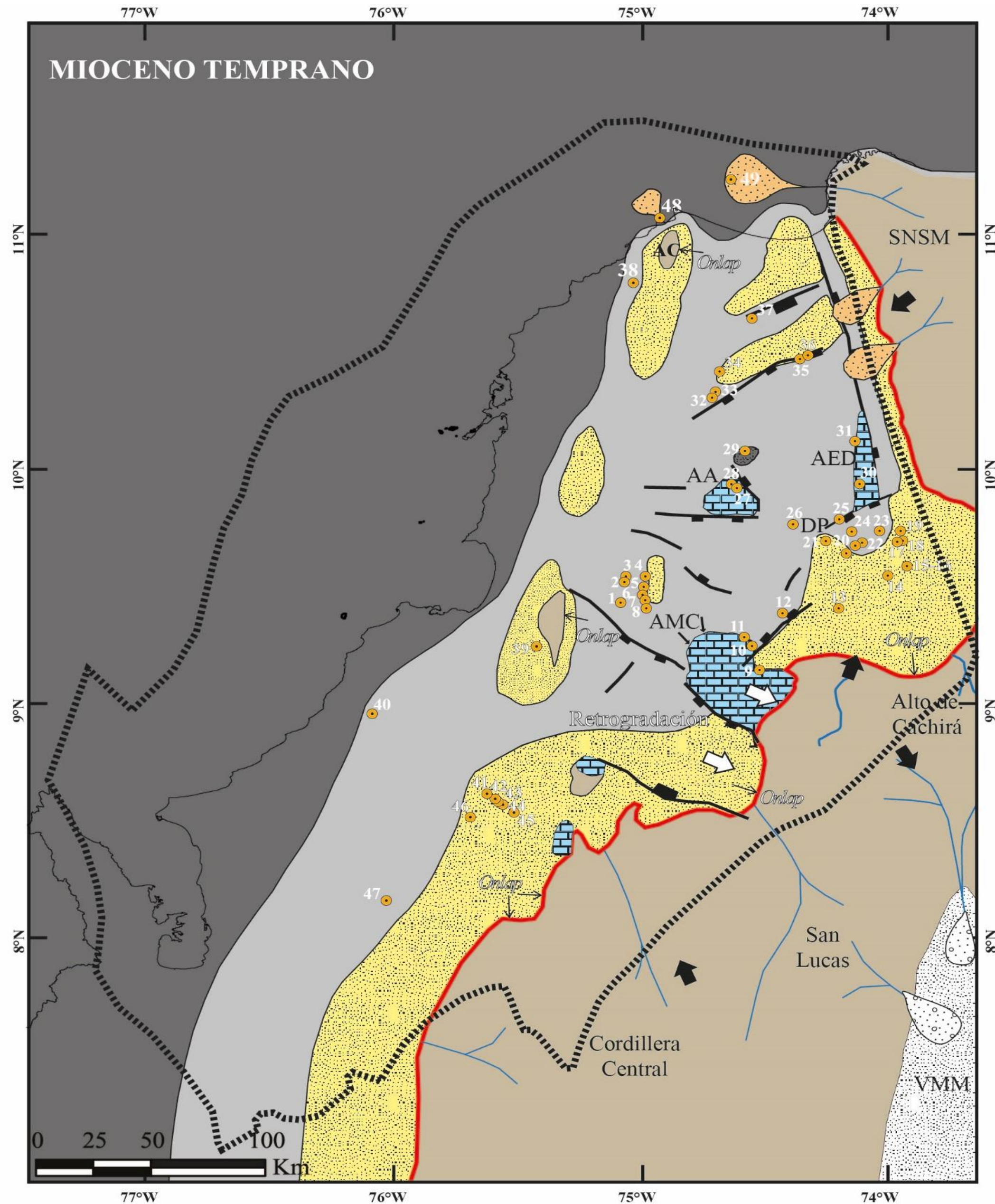
### LEYENDA

Área emergida	Carbonatos
Ambiente transicional (delta, llanuras mareales, foreshore y shoreface)	
Ambiente marino somero (offshore-plataforma)	
Ambiente marino profundo (talud-llanura abisal)	
Abanicos deltaicos y submarinos	
Abanicos aluviales, depósitos fluviales	
Límite área de estudio	Falla normal
Dirección de aporte de sedimentos	Patrones en Onlap a partir de sísmica
Drenajes	

### POZOS

● 1 Araza-1	● 16 Pinto-1	● 31 ANH-Costa Azul-1
● 2 Buena vista-1	● 17 Pijino-1	● 32 P3-Toluviejo
● 3 Manatí-1	● 18 Saman Est-1	● 33 P10-Torrente
● 4 Piñuela-1	● 19 ANH-San jacinto-1	● 34 Sahagun-1
● 5 Pivijay-1	● 20 P7-Arroyo Arena	● 35 P15-El Contenido
● 6 Danta-1	● 21 P8(2)-Don Gabriel	● 36 ANH-Nueva Esperanza-1
● 7 Balsamo-1	● 22 P12-Almagra	● 37 ANH-SSJ-La Estrella-1X
● 8 San Angel-6	● 23 Mamey-1	● 38 La Mora-1 ANH-Tierra
● 9 La Florida-1	● 24 Bonga-1	● 39 Alta-2X
● 10 El Castillo-1	● 25 Piragua-1	
● 11 El Retiro-1	● 26 Ayombe-1	
● 12 Cotorra-1X	● 27 Güepaje-2	
● 13 Guamito-1	● 28 Güepaje-1	
● 14 Ligia-1	● 29 Güepaje-3	
● 15 ANH-Plato 1X-P	● 30 La Creciente-1	





## Early Miocene

### LEYENDA

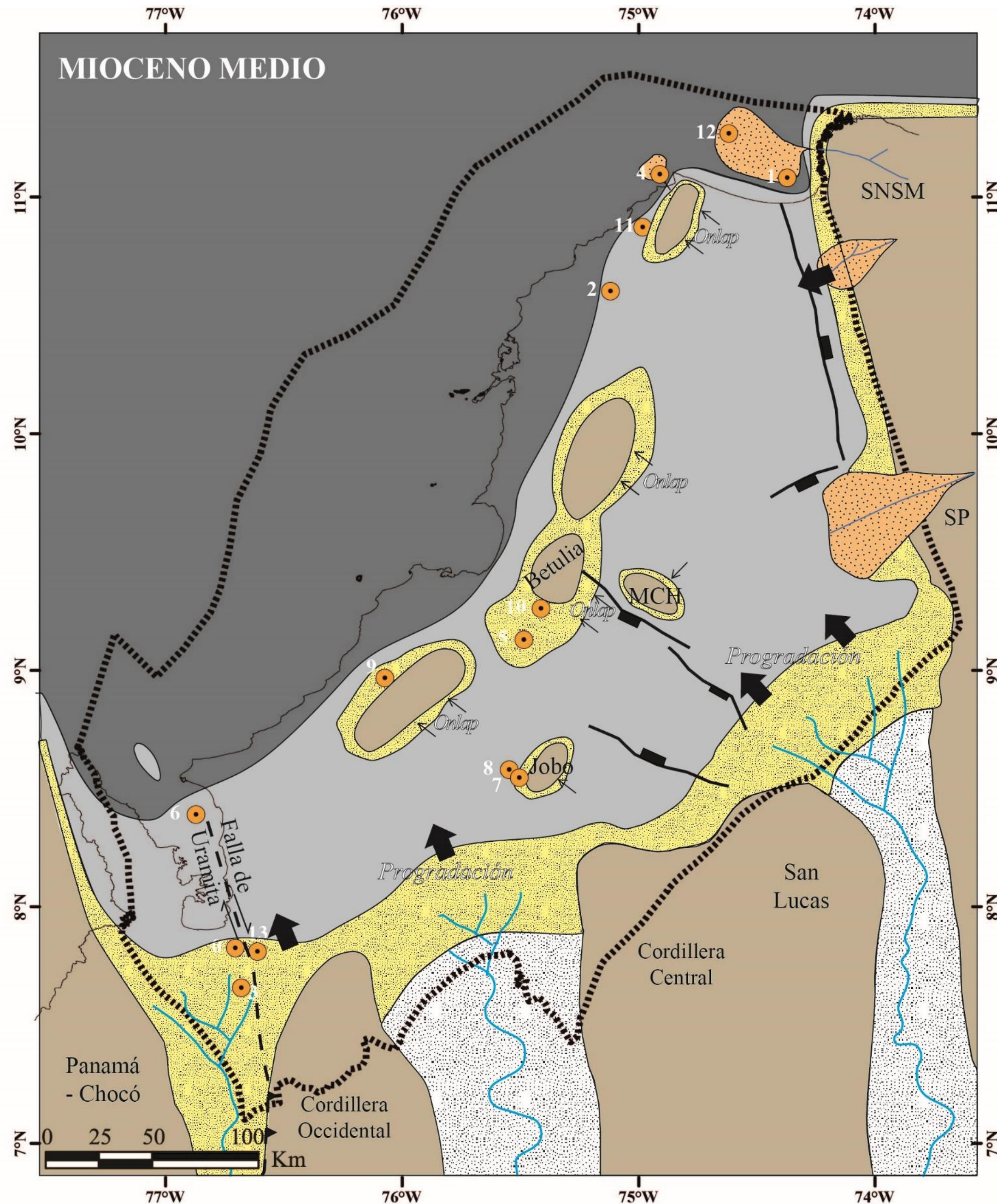
- |   |  |
|---|--|
| Área emergida   | Carbonatos                                   |
| Ambiente transicional (delta, llanuras mareales, foreshore y shoreface) |  |
| Ambiente marino somero ( <i>offshore</i> -plataforma)                   |  |
| Ambiente marino profundo (talud-llanura abisal)                         |  |
| Abanicos deltaicos y submarinos   |  |
| Abanicos aluviales, depósitos fluviales                                 |  |
| Límite área de estudio  | Falla normal                                 |
| Dirección de aporte de sedimentos                                       | Falla inversa                                |
| Drenajes  | Patrones en <i>Onlap</i> a partir de sísmica |

### POZOS

- |                    |                            |                               |
|--------------------|----------------------------|-------------------------------|
| ● 1 La Creciente-1 | ● 16 Arjona-6              | ● 31 San Angel-6              |
| ● 2 Mamey-2        | ● 17 Florida Oeste-1       | ● 32 Bálsamo                  |
| ● 3 Bonga Norte-1  | ● 18 La Florida-1          | ● 33 Danta-1                  |
| ● 4 Piragüa-1      | ● 19 Brillante SE-1X       | ● 34 Pivijay-1                |
| ● 5 Ayombe-1       | ● 20 Ligia-1               | ● 35 Piñuela-1                |
| ● 6 Guepajé-1      | ● 21 ANH-Plato-1-X-P       | ● 36 Caraballo-1              |
| ● 7 Guepajé-2      | ● 22 Capure-1X, Cotorra-1X | ● 37 Buenavista-1             |
| ● 8 Guepajé-3      | ● 23 El Castillo-1         | ● 38 ANH-Juan de Acosta-1     |
| ● 9 Boquilla-1     | ● 24 Guamito-1             | ● 39 P6-3S                    |
| ● 10 Boquete-2     | ● 25 Costa Rica-1          | ● 40 P-28                     |
| ● 11 Cicuco-22     | ● 26 Granate-1             | ● 41 P-27                     |
| ● 12 Pijiño-1      | ● 27 Apure-1               | ● 42 P-26                     |
| ● 13 Buena Fe-1    | ● 28 Apure-2               | ● 43 P-18 ● 48 Barranquilla-1 |
| ● 14 El Retiro-1   | ● 29 Tupale-1              | ● 44 P-15 ● 49 Arazá-1        |
| ● 15 Arjona-1      | ● 30 Alejandría-1          | ● 45 P-14                     |
|                    |                            | ● 46 ANH-Nueva Esperanza-1    |
|                    |                            | ● 47 ANH-Tierralta-2-X-P      |



## Middle Miocene



### LEYENDA

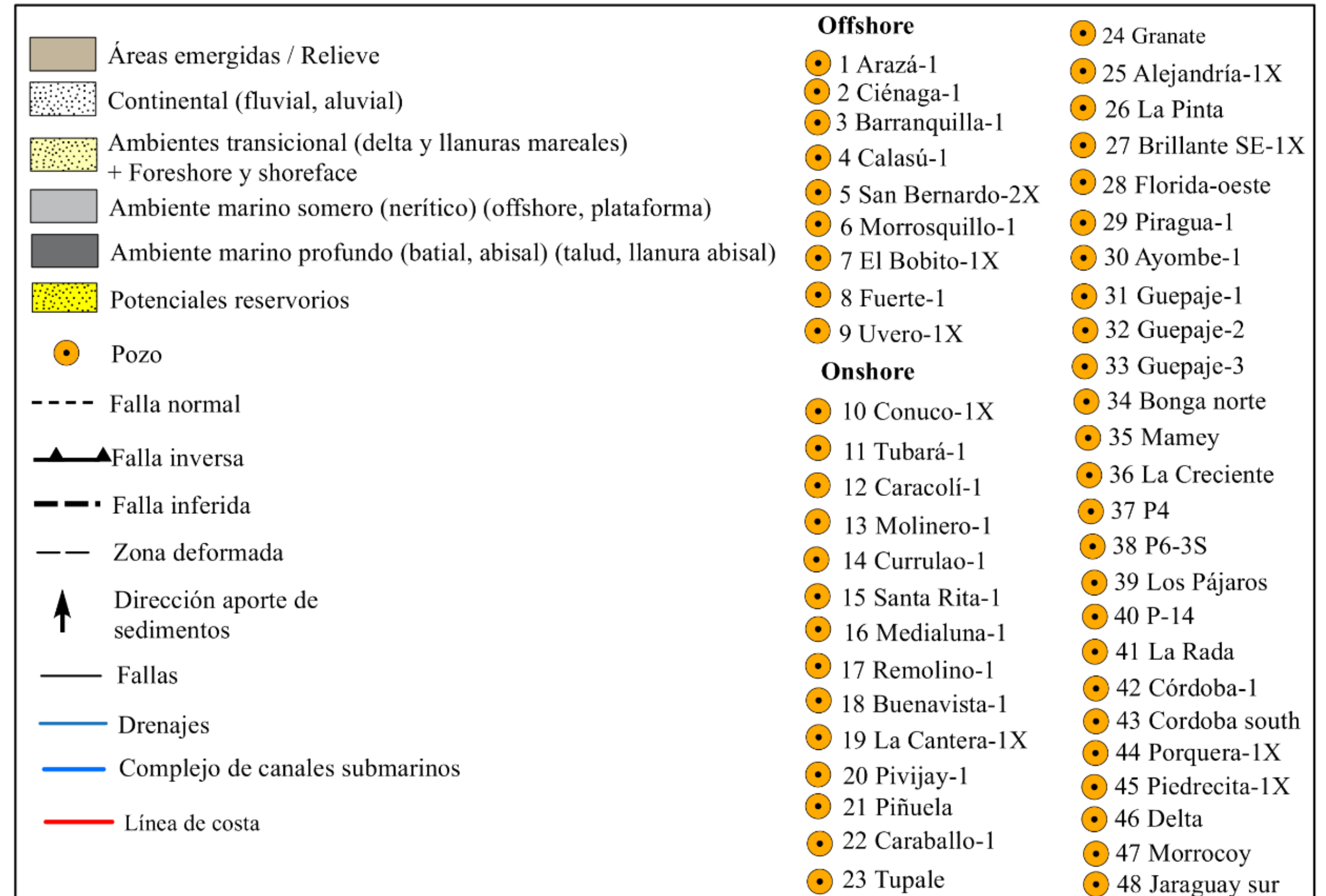
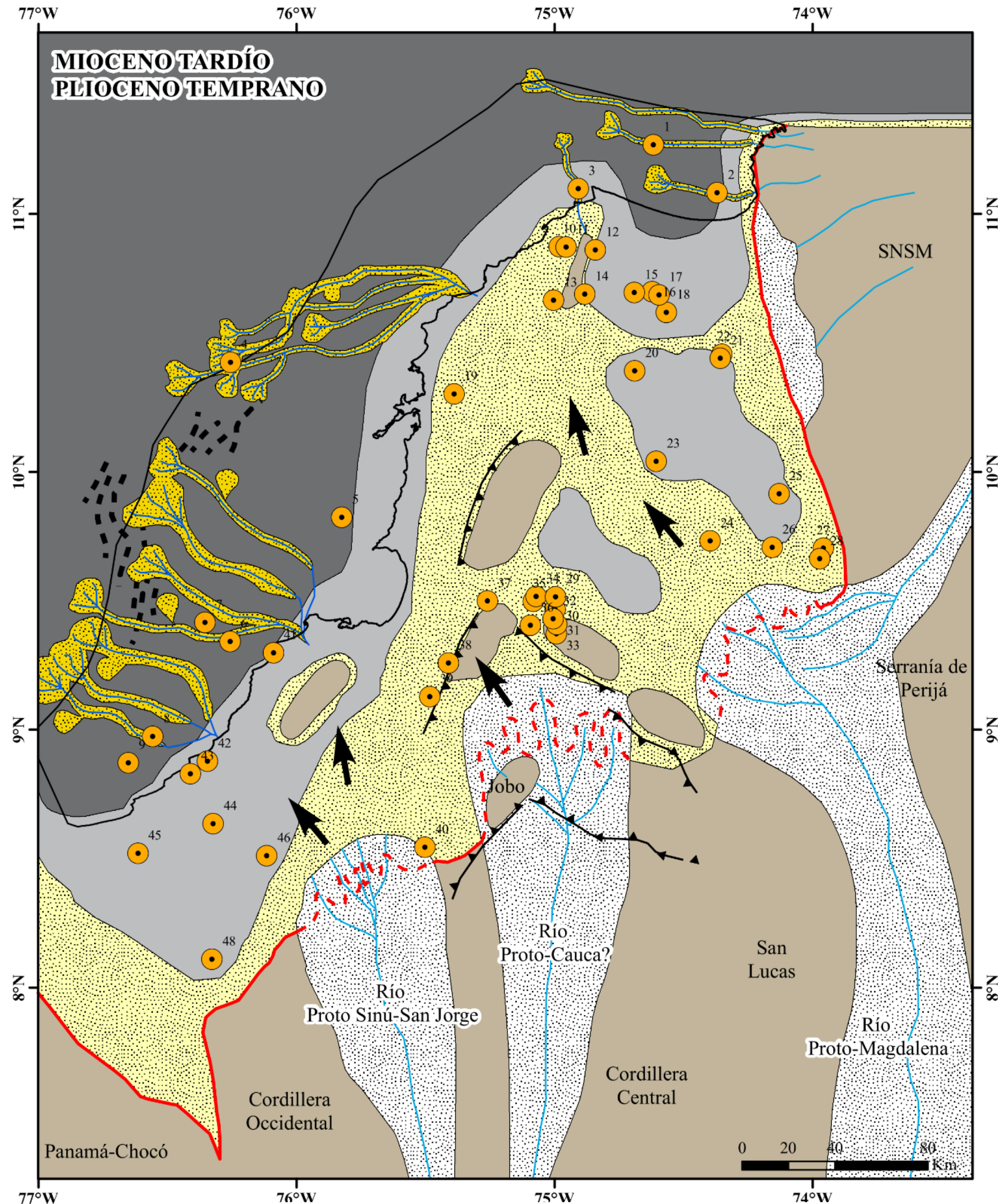
Área emergida	Carbonatos
Ambiente transicional (delta, llanuras mareales, foreshore y shelf)	
Ambiente marino somero ( <i>offshore</i> -plataforma)	
Ambiente marino profundo (talud-llanura abisal)	
Abanicos deltaicos y submarinos	
Abanicos aluviales, depósitos fluviales	
Límite área de estudio	Falla normal
Dirección de aporte de sedimentos	Falla inversa
Drenajes	Falla inferida
	Patrones en <i>Onlap</i> a partir de sísmica

### POZOS

0 Apartadó-1	7 P-14 El Varal
1 Ciénaga-1	8 P-18 Finca Villa Laura
2 ANH El Pabilo-1	9 P-28 Finca Villa Hermosa
3 Urabá-1	10 P6-3S Hacienda La Estancia
4 Barranquilla-1	11 ANH Conuco-1
5 ANH Los Pájaros-1	12 Arazá-1
6 Urabá 1629-1X	13 Turbo-1



## Late Miocene – Early Pliocene







El futuro  
es de todos

Minenergía

# Thanks

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



DATE