

PETROLEUM GEOLOGY AND HYDROCARBON POTENTIAL OFFSHORE URUGUAY

E&P

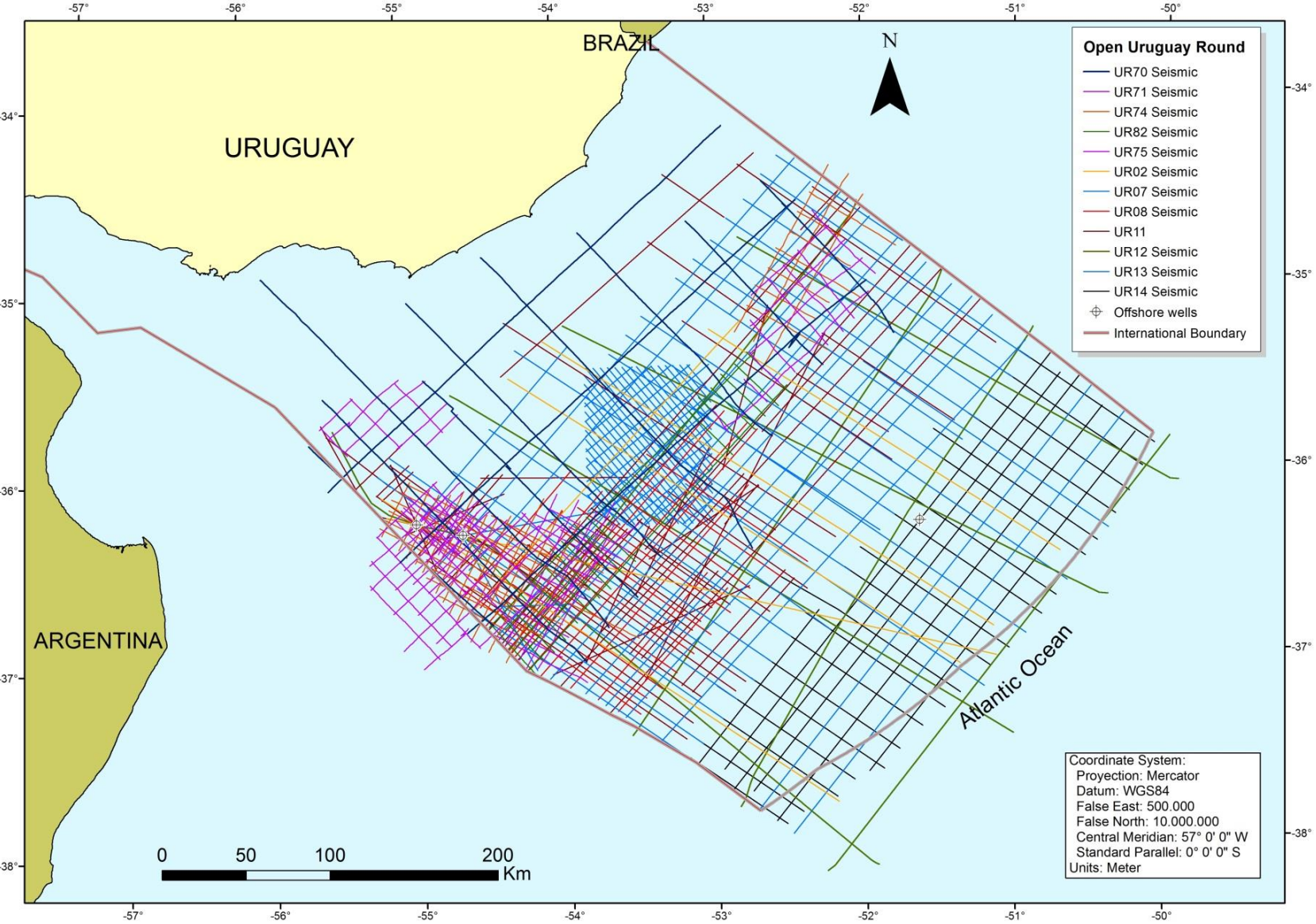
2020

CONTENT

- Database
- Offshore geology
- Petroleum systems and source rocks
- Plays and prospects
- Conclusions

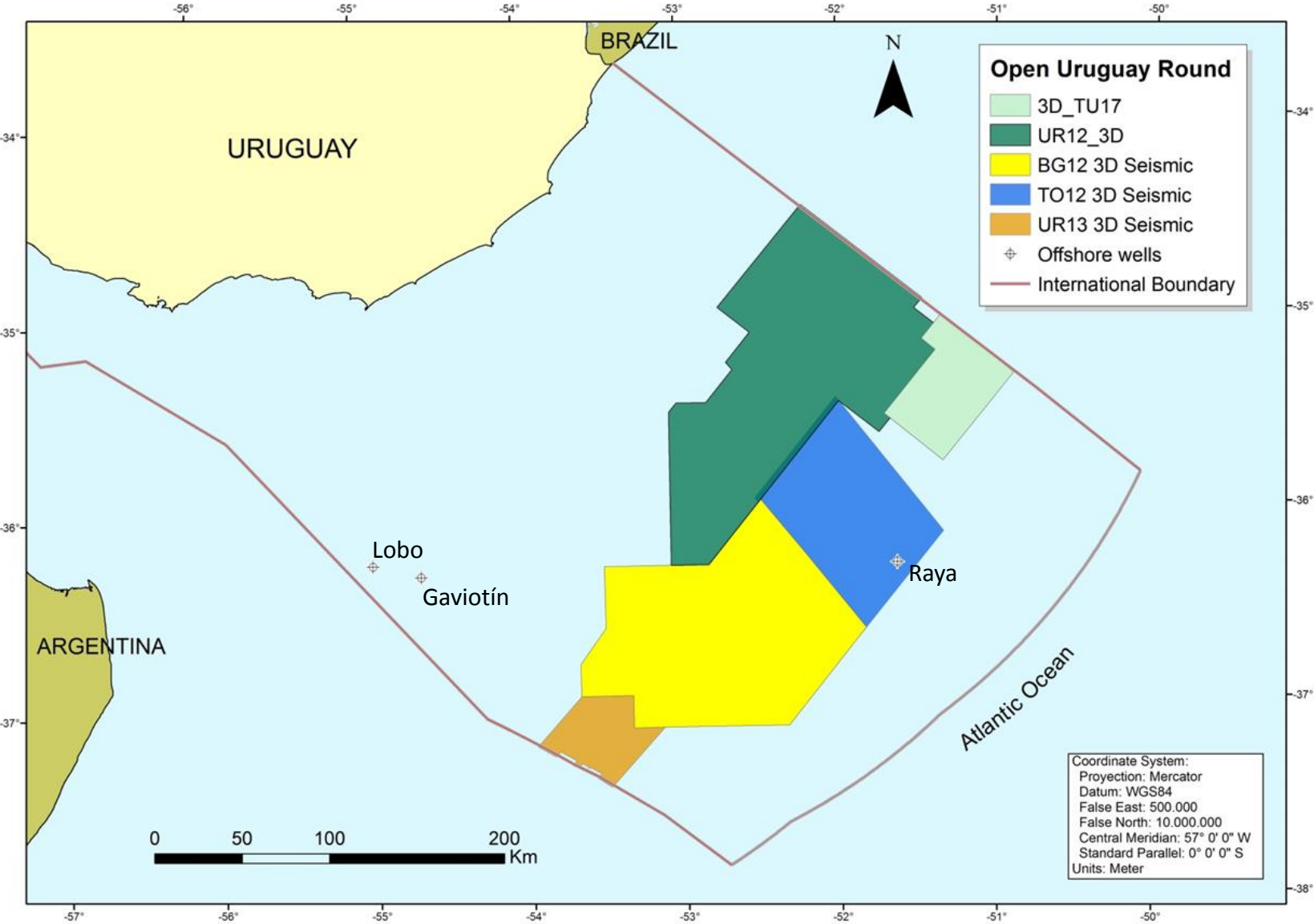
DATABASE

2D SEISMIC



All surveys: 41.000 km approx.

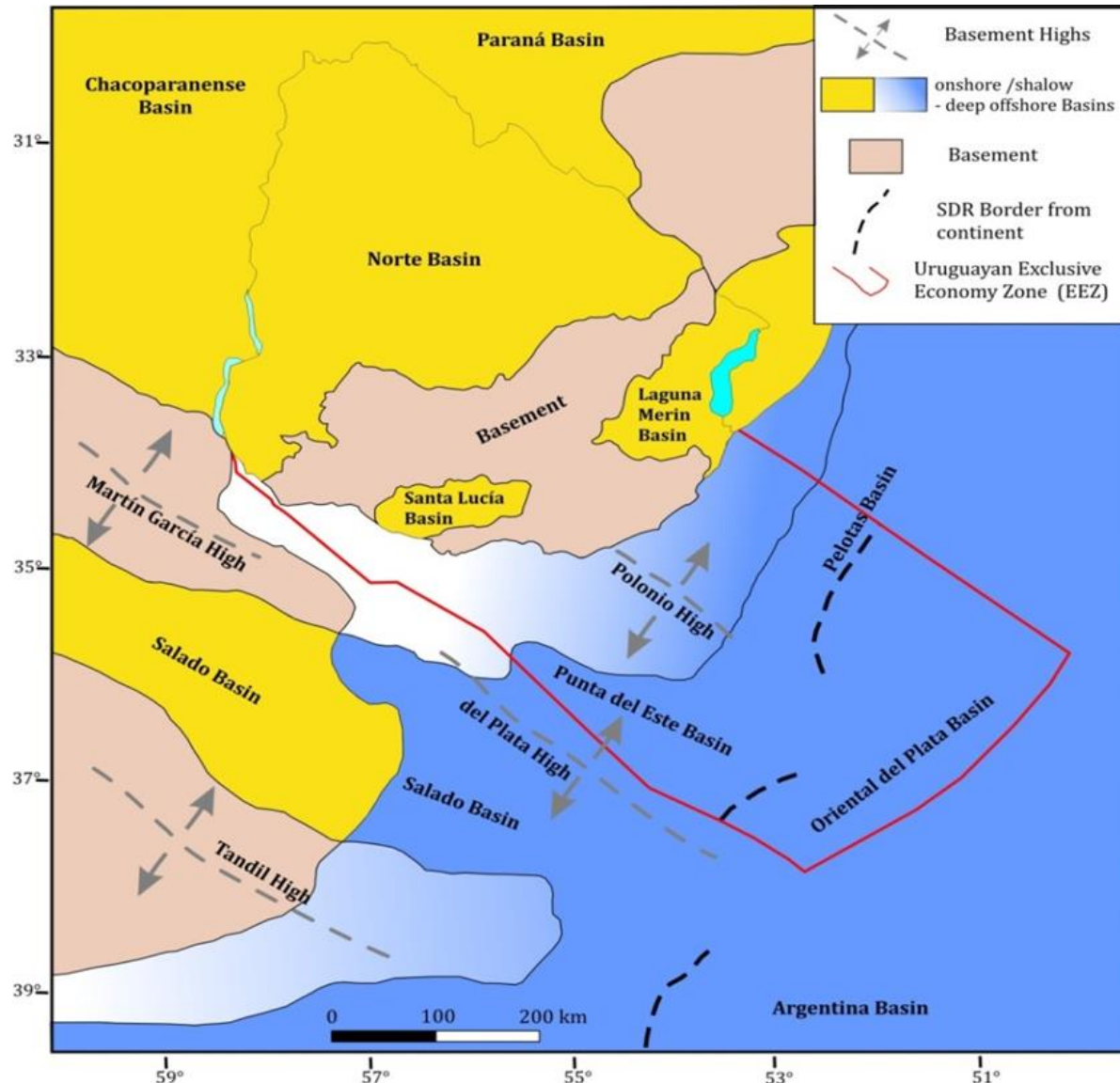
3D SEISMIC



All surveys: 43.500 km² approx.

OFFSHORE GEOLOGY

Tectonic and structural framework of the continental margin of Uruguay



Three basins are recognized offshore Uruguay:

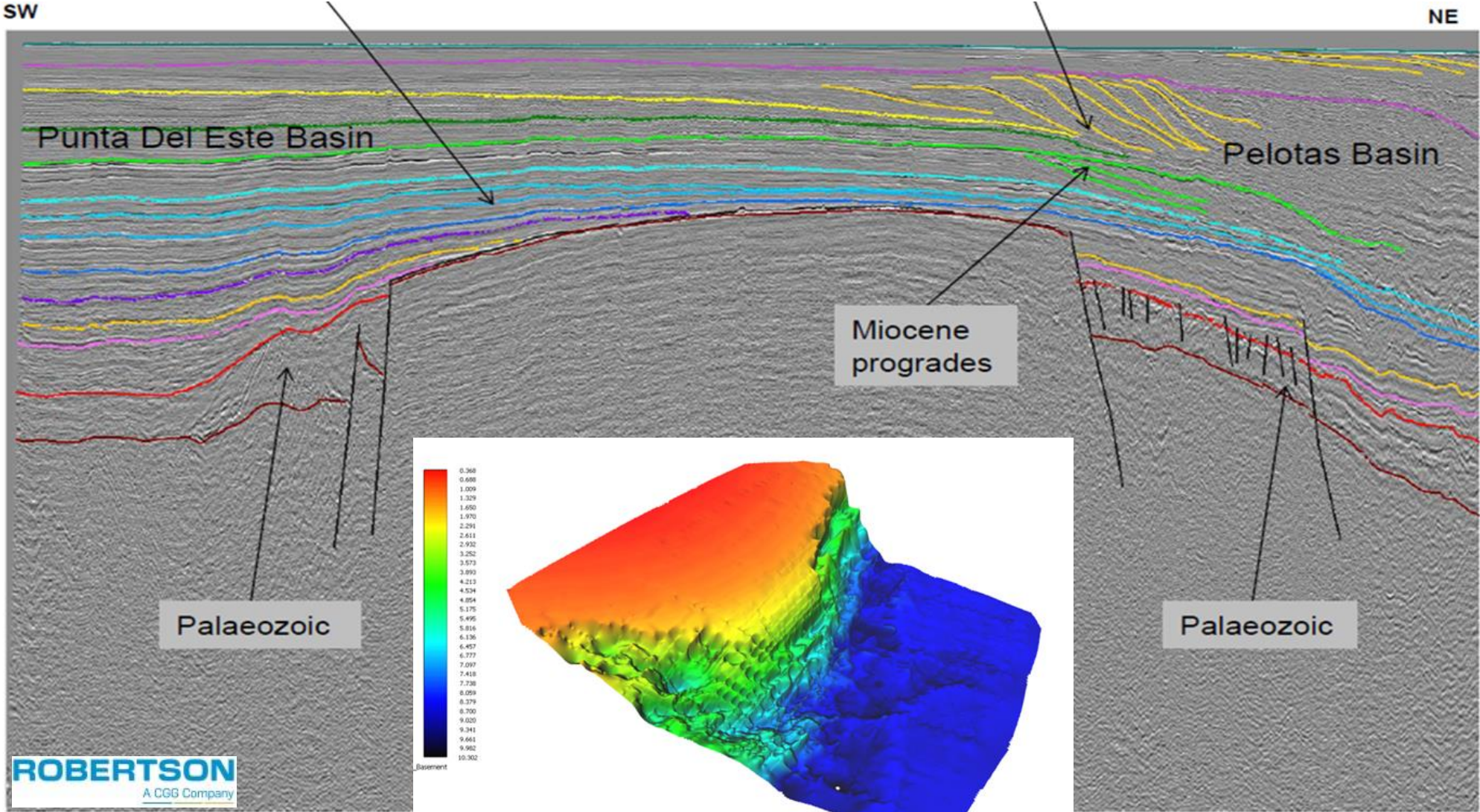
1. Punta del Este to the West
2. Pelotas Basin to the East
3. Oriental del Plata Basin in ultra-deep waters.

In shallow waters Punta del Este and Pelotas basins are separated by the Polonio High (basement high).

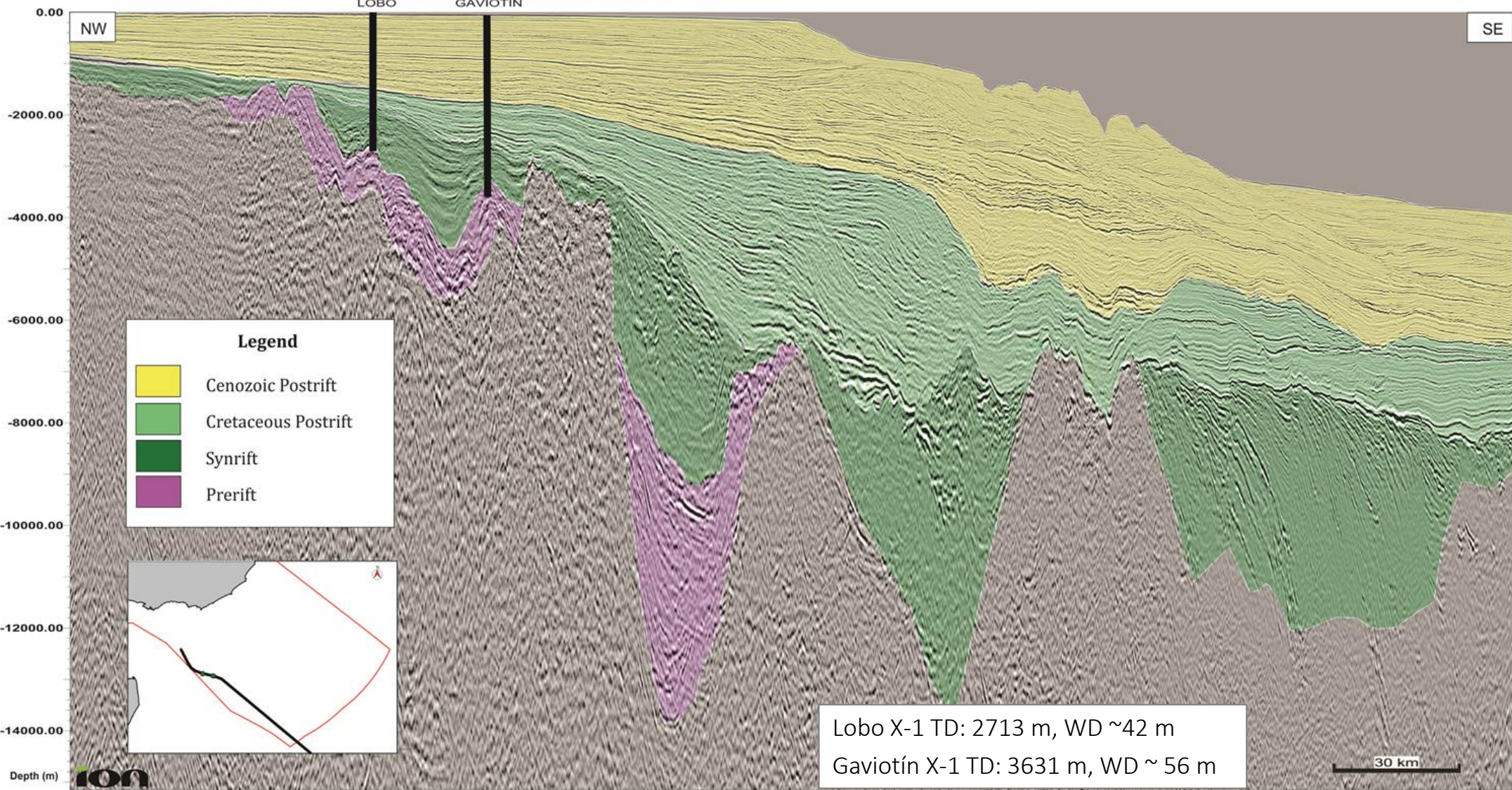
Polonio High

Onlap shows gradual drowning of Polonio High

Clinoforms indicate NE transport of sediment along the shelf, from Miocene to Recent

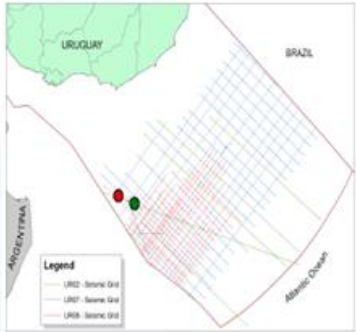


Punta del Este Basin (dip seismic line)



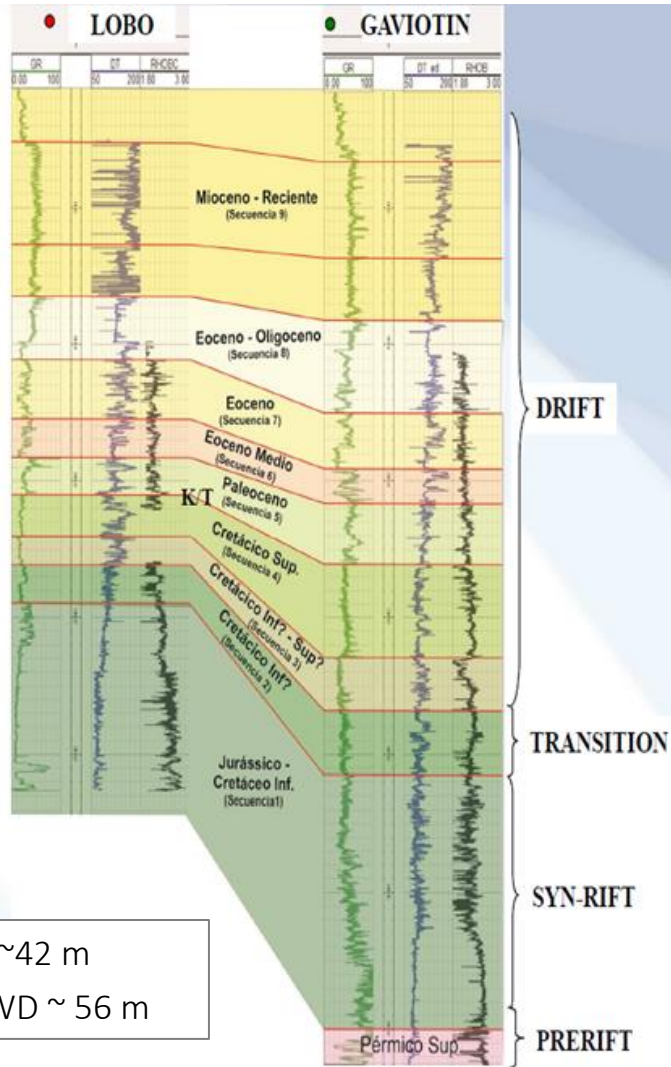
Lobo and Gaviotín wells

CORRELATION WELL TOPS



● LOBO
● GAVIOTÍN

Lobo X-1 TD: 2713 m, WD ~42 m
Gaviotín X-1 TD: 3631 m, WD ~ 56 m

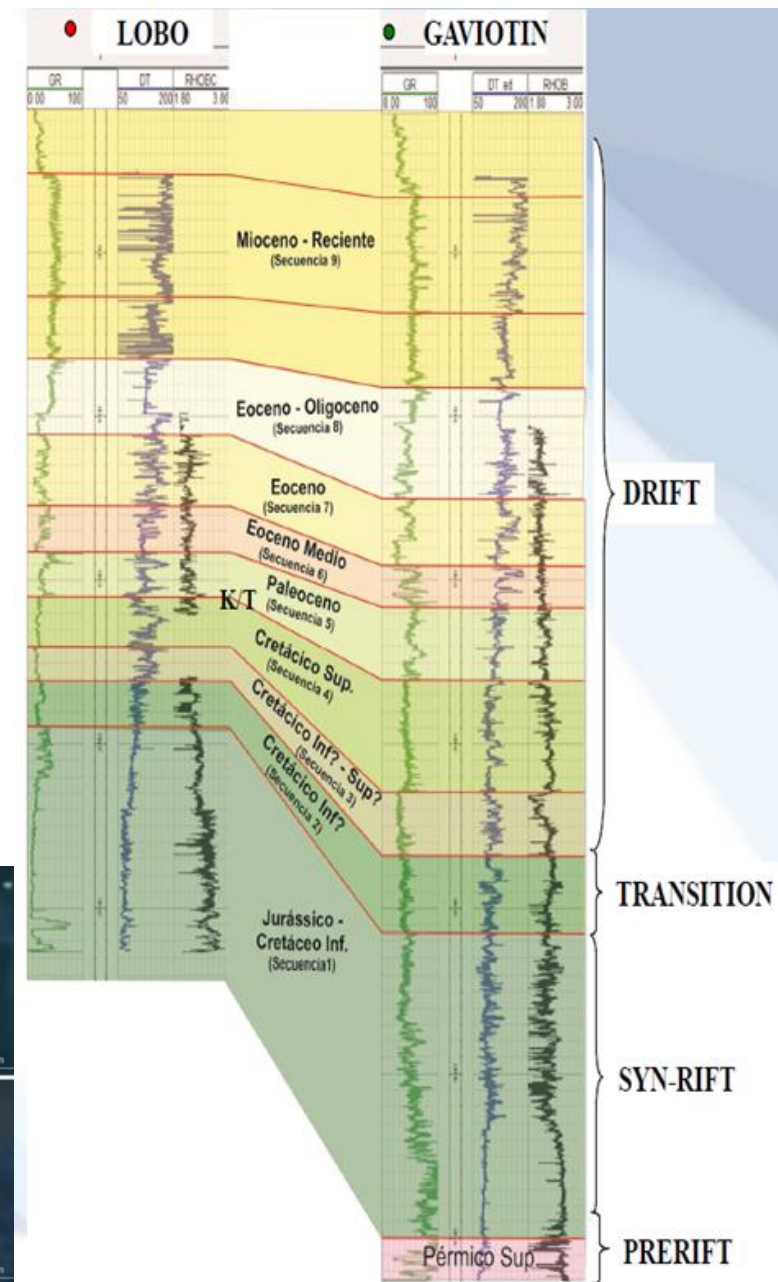
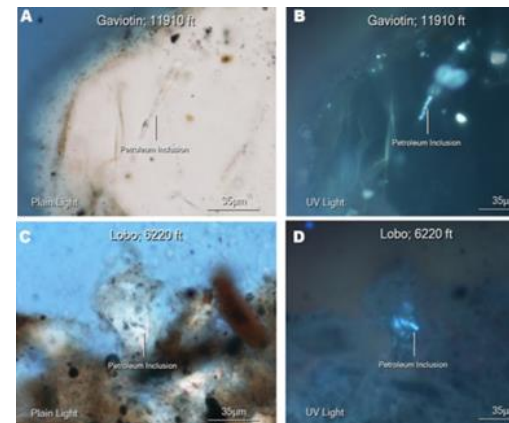


- Drilled by Chevron in 1976 in a very proximal segment of the basin
- Both declared dry wells
- Paleozoic sequence found in the last 139 m of Gaviotín well
- They did not find significant source rocks levels.
- An active petroleum system could not be proven.
- These results affected the exploration activity in the offshore of Uruguay for several years

Hydrocarbon evidences

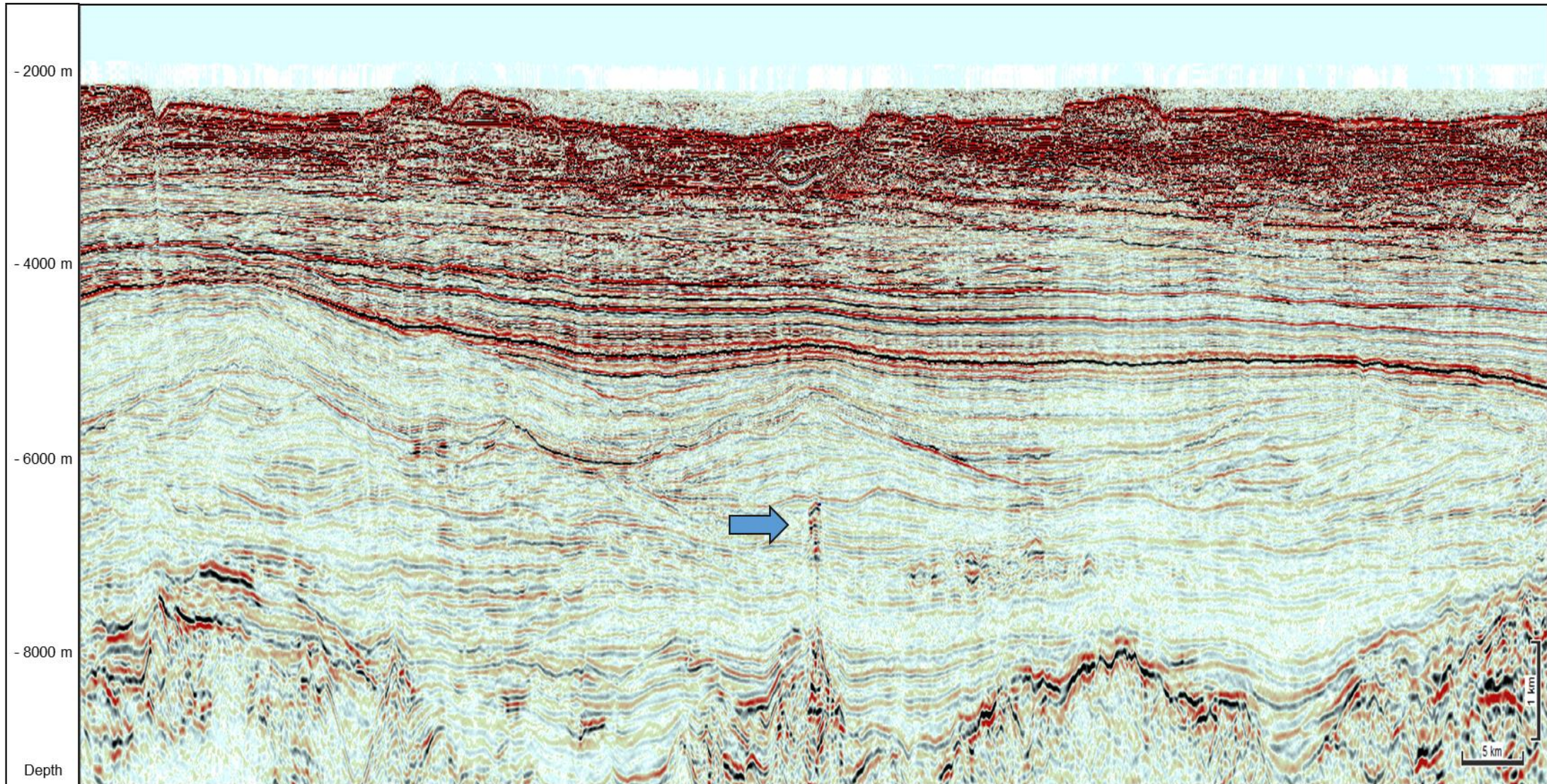
Fluid inclusions in Lobo and Gaviotin cuttings Study made by FIT in 2011

- The results of the new analysis indicate dry gas anomalies in each well in Jurassic, Cretaceous and Tertiary levels.
- Low, moderate and high gravity oil inclusions were found in 28 thin sections of sandstones and volcanic materials.
- Efficiency of the regional seal (deposited in the Maastrichtian-Paleocene transgression) is evident from the available data.
- The results demonstrate the generation of native hydrocarbons, migration pathways and the existence of paleo-hydrocarbon accumulations.



Hydrocarbon evidences

Several gas chimneys have been identified through seismic. Most of them connect the Aptian and synrift source rocks with Cretaceous reservoirs. They show amplitude and AVO anomalies

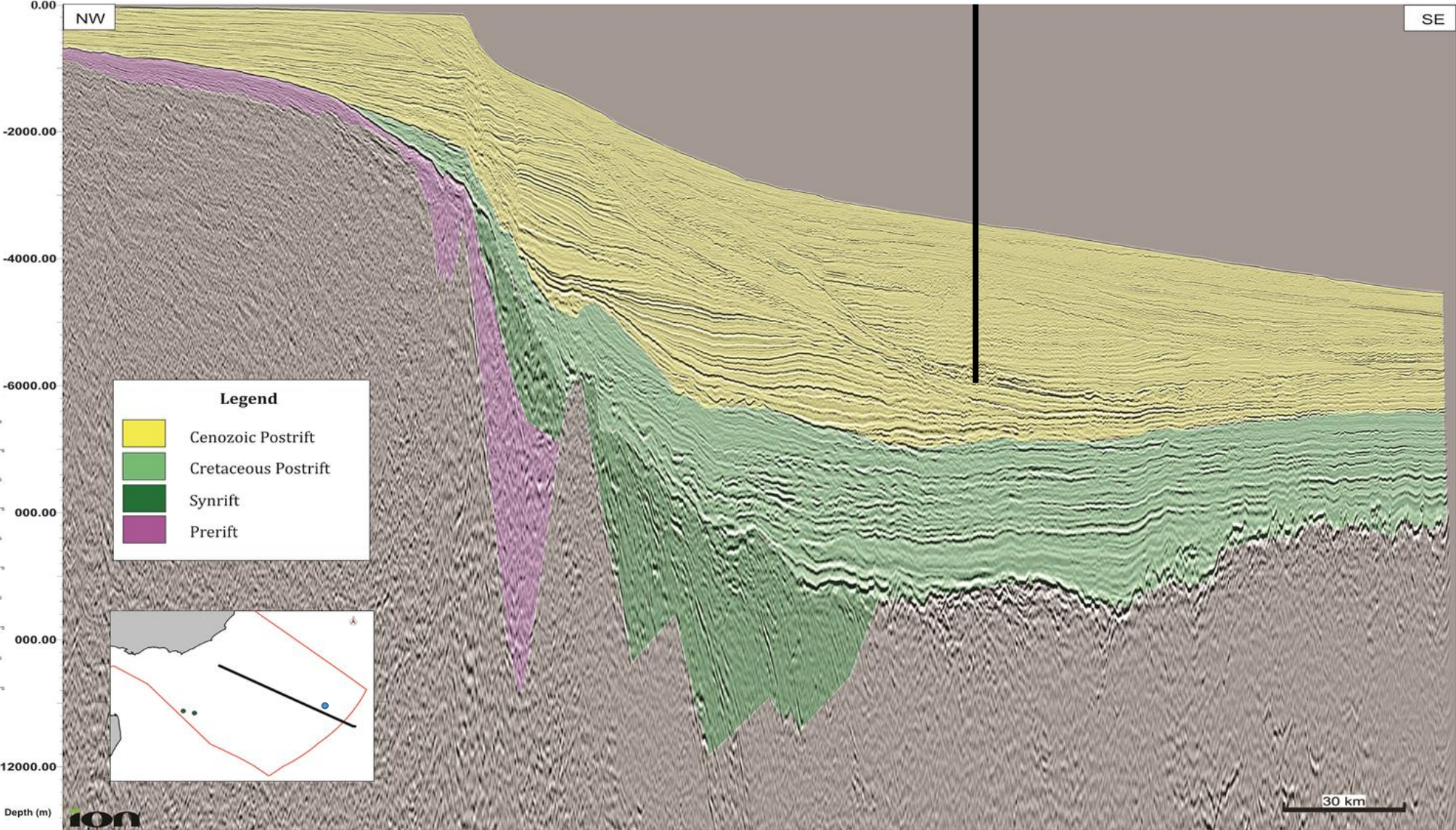
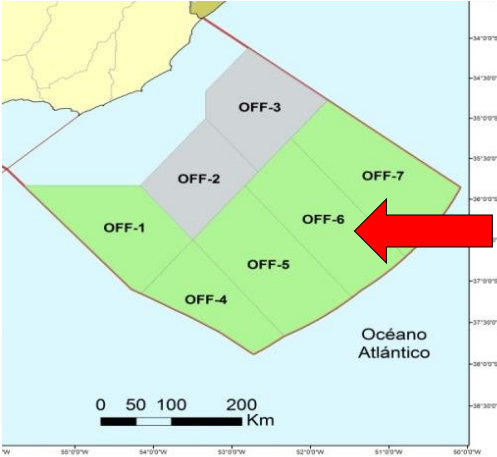


Pelotas Basin (dip seismic line)

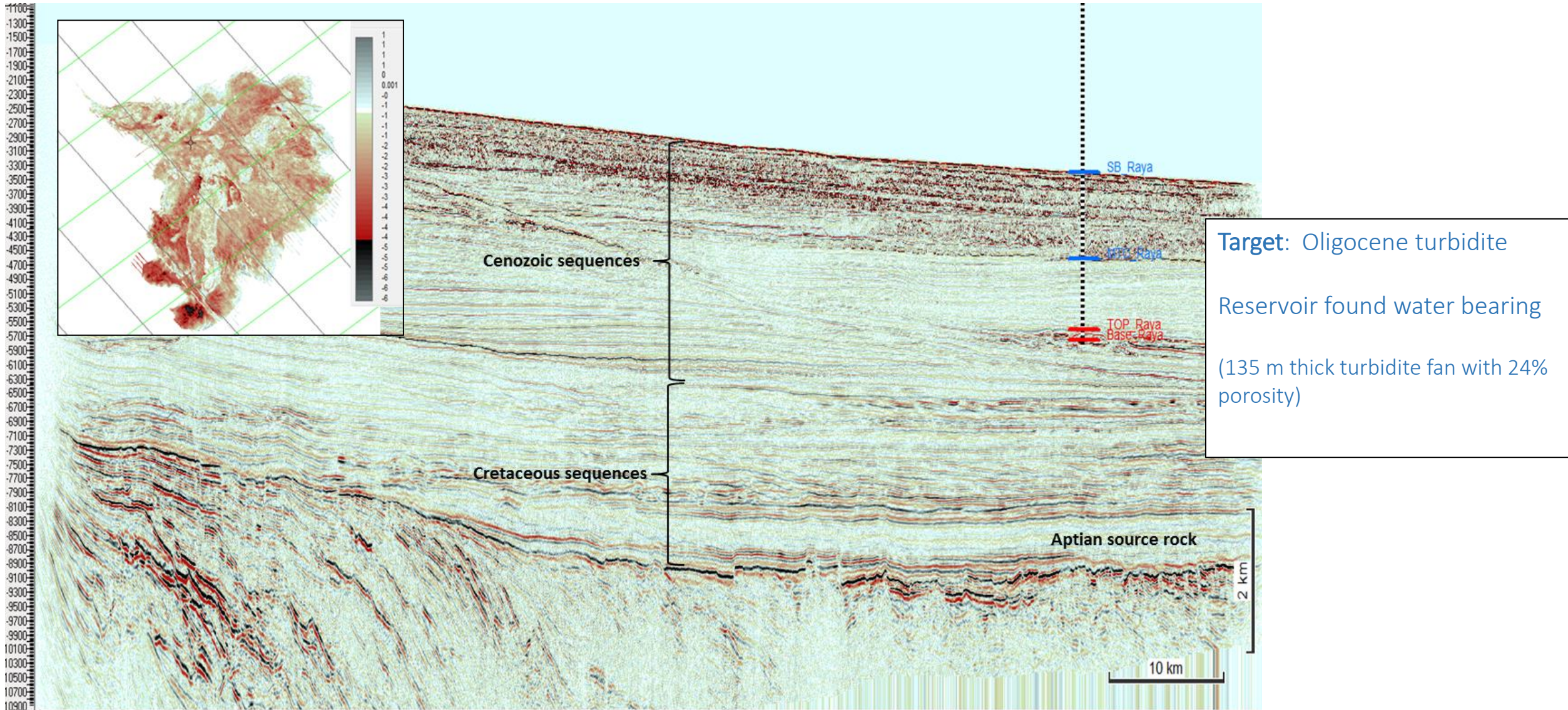
RAYA X-1 WELL

Raya X-1 well:

Water depth ~ 3,404 m
Sediment depth ~ 2452 m
Drilled by TOTAL

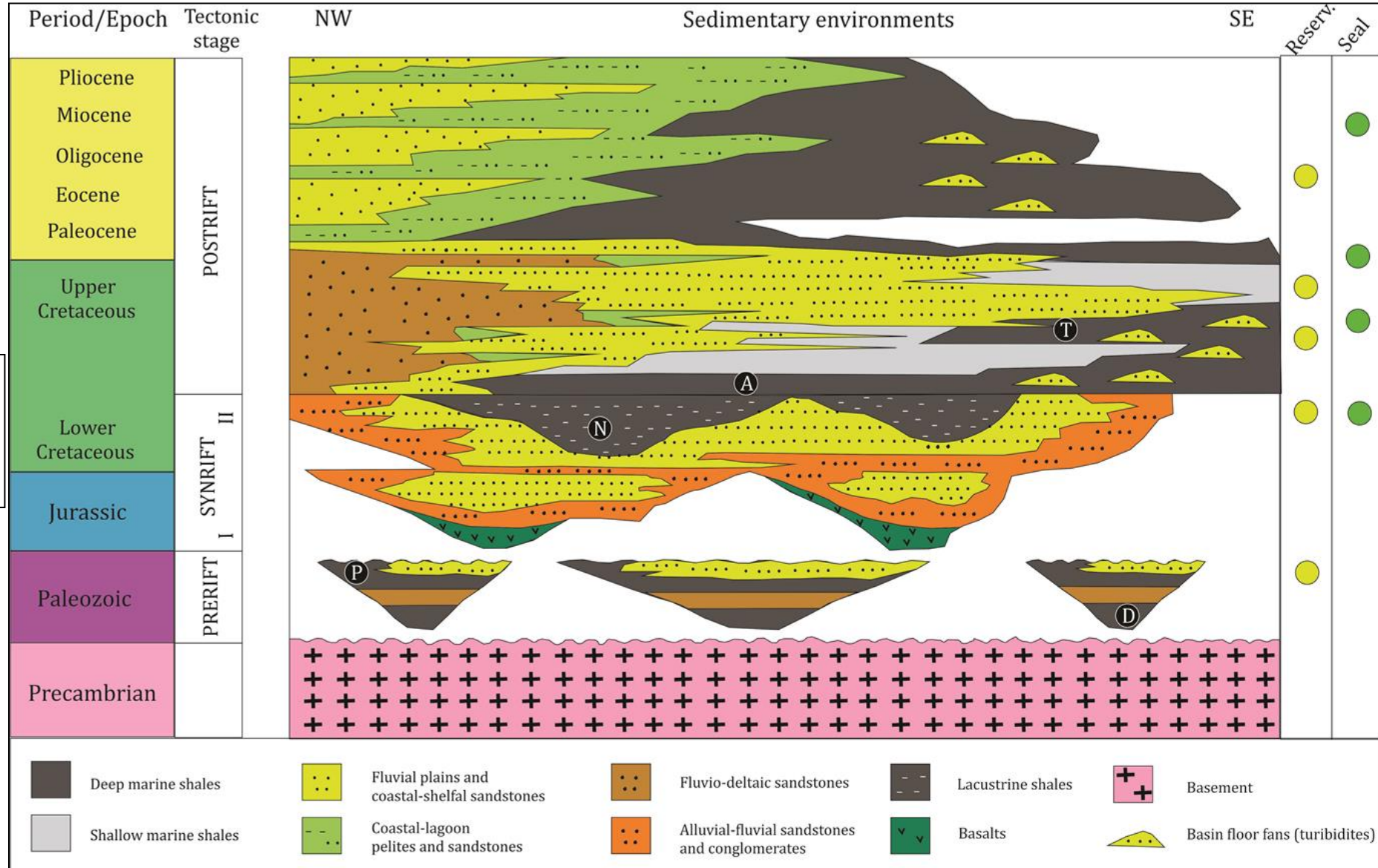


Raya well x-1



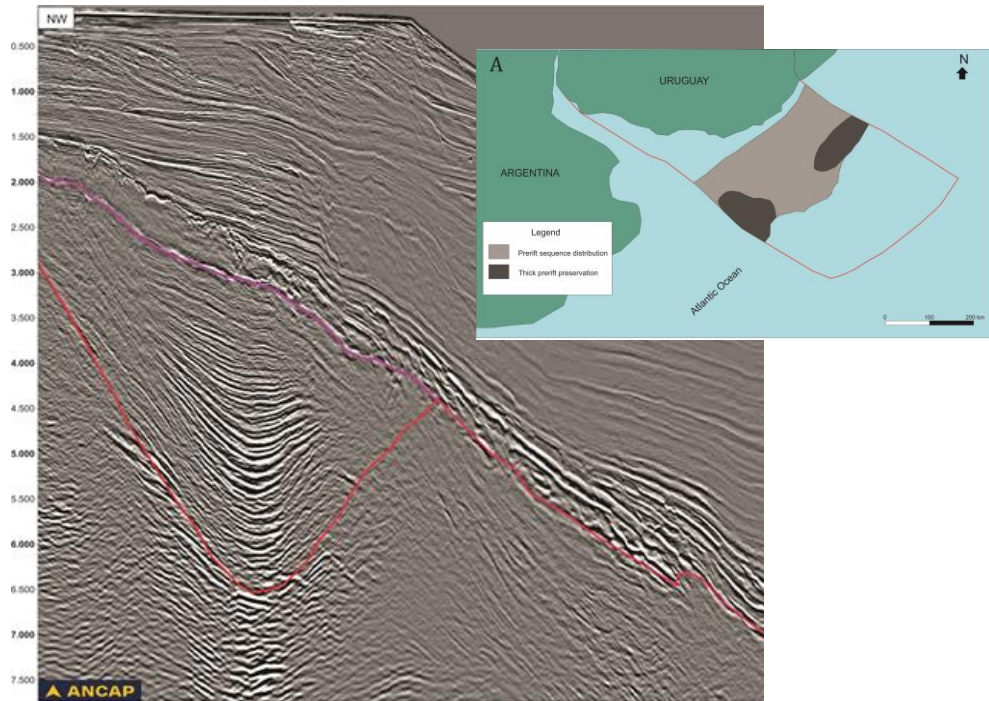
PETROLEUM SYSTEMS

Petroleum systems

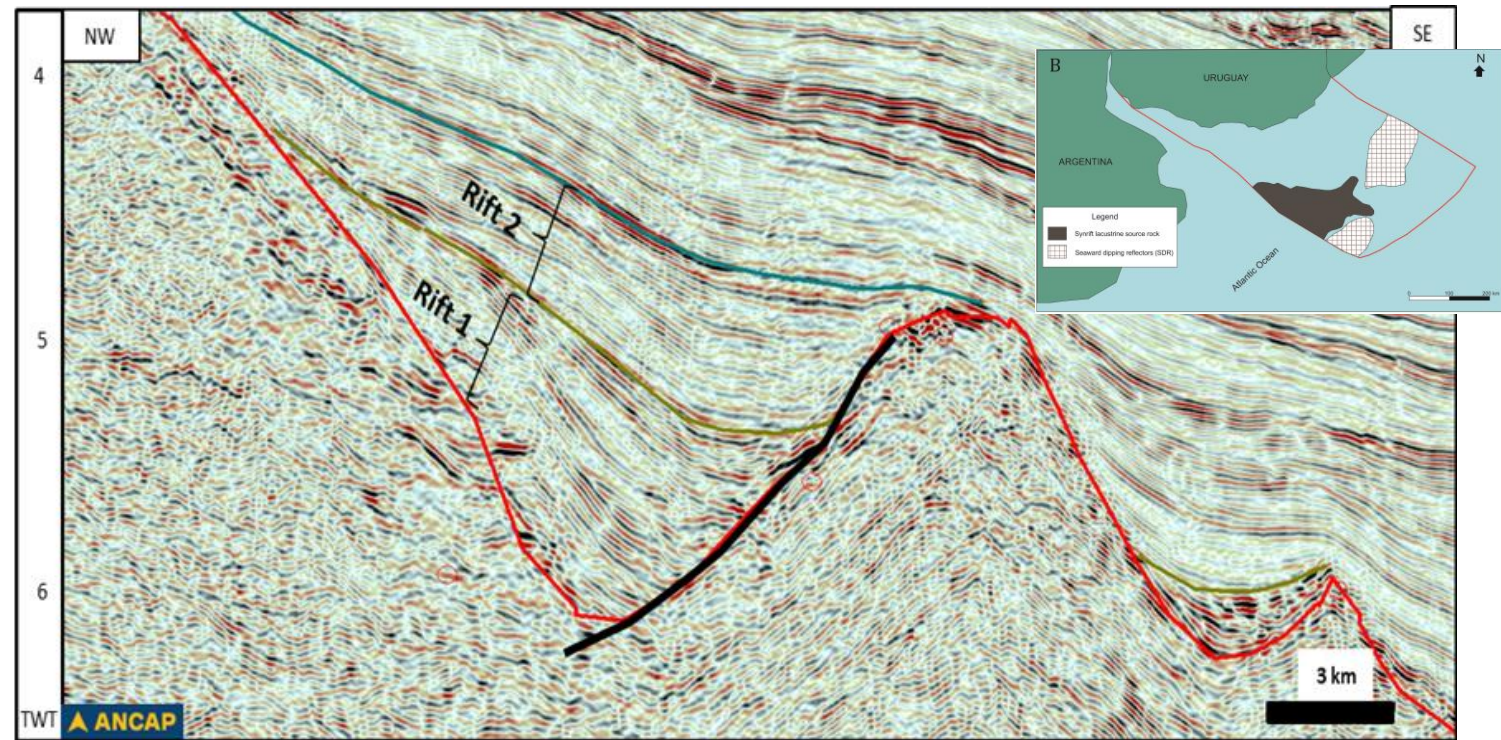


Source rocks distribution

PRERIFT: Devonian and Permian marine shales

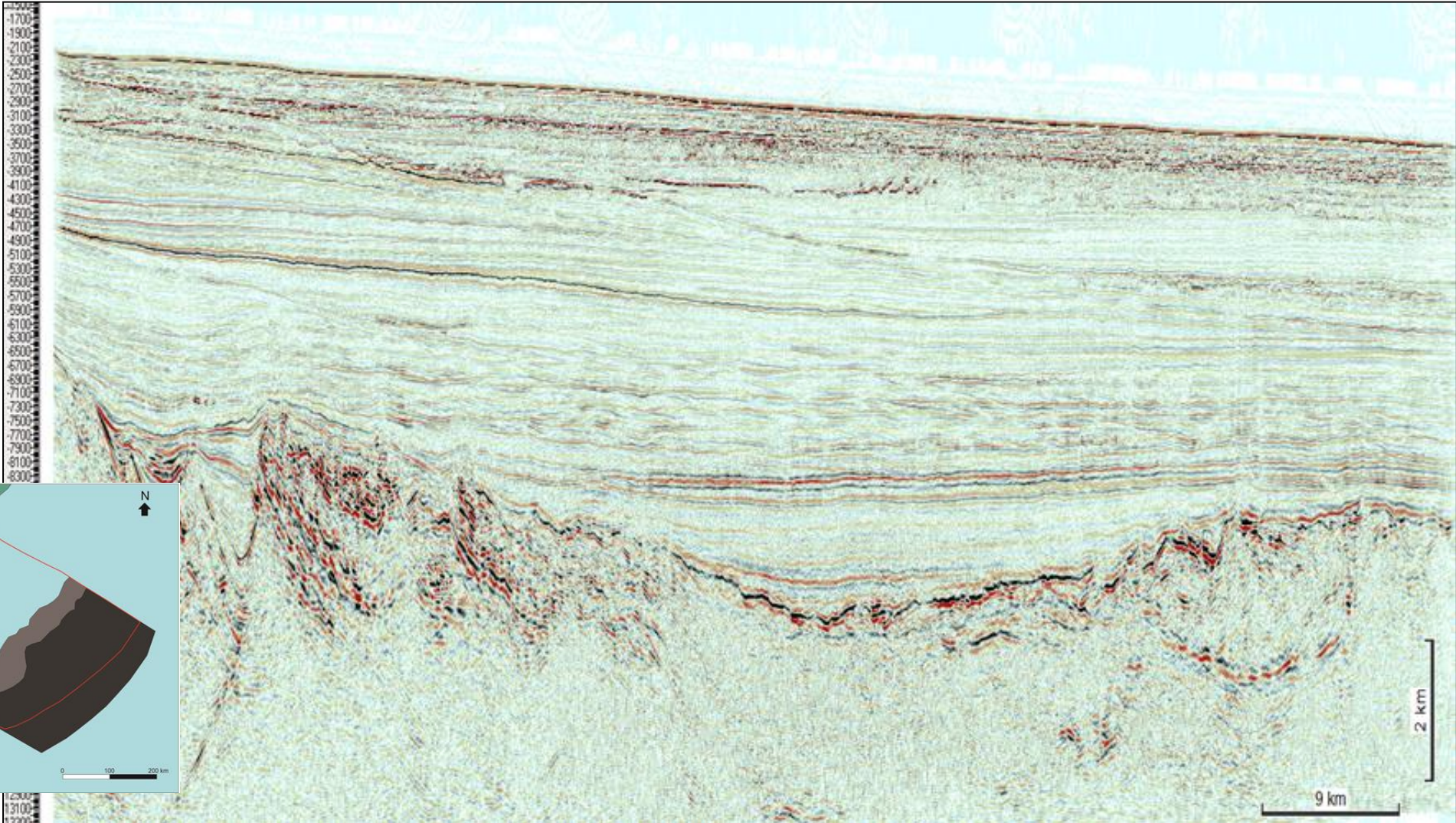


SYNRIFT: Early Cretaceous lacustrine shales



Source rocks distribution

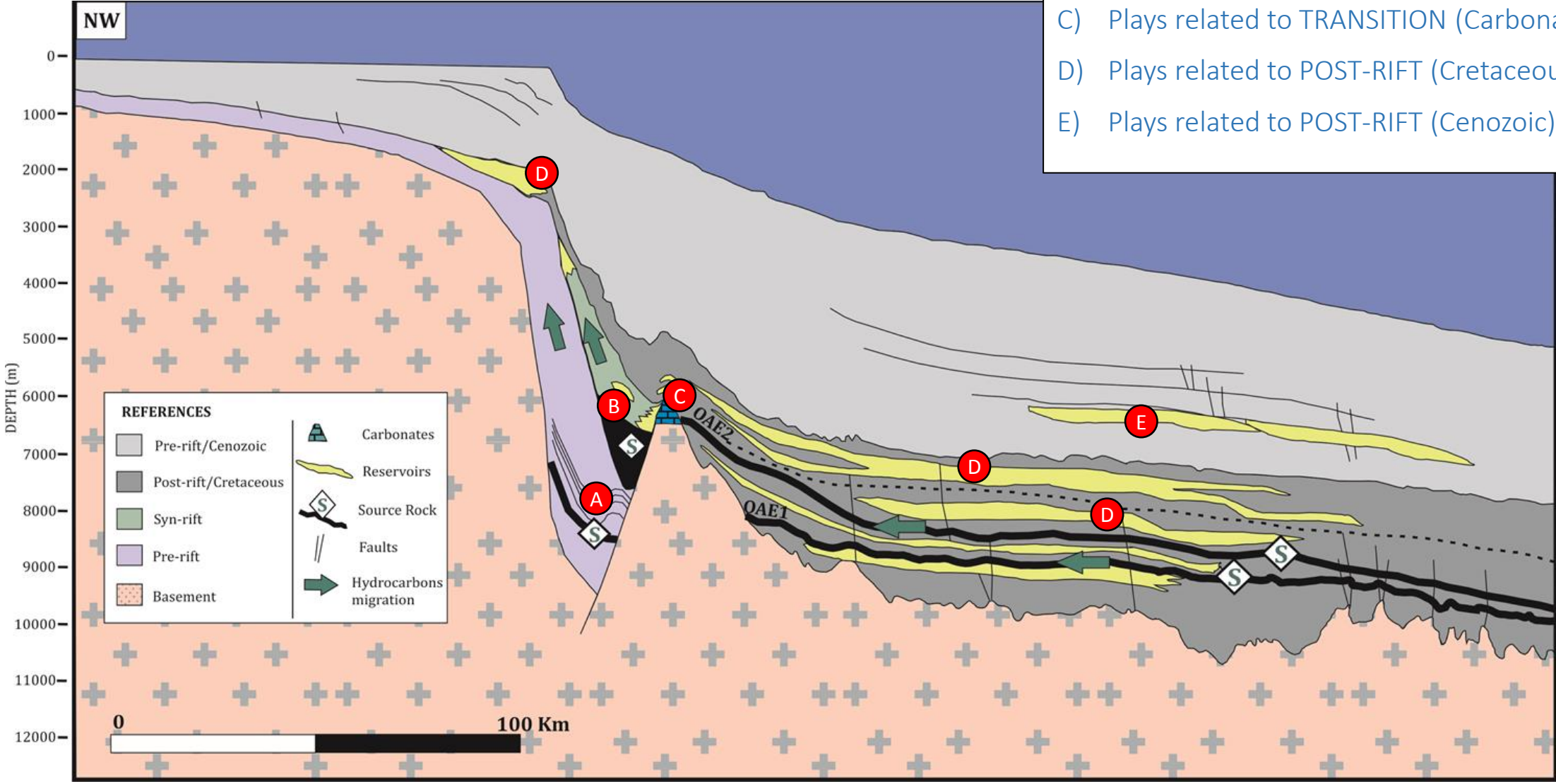
POSTRIFT: Aptian and Turonian marine shales



PLAYS AND PROSPECTS

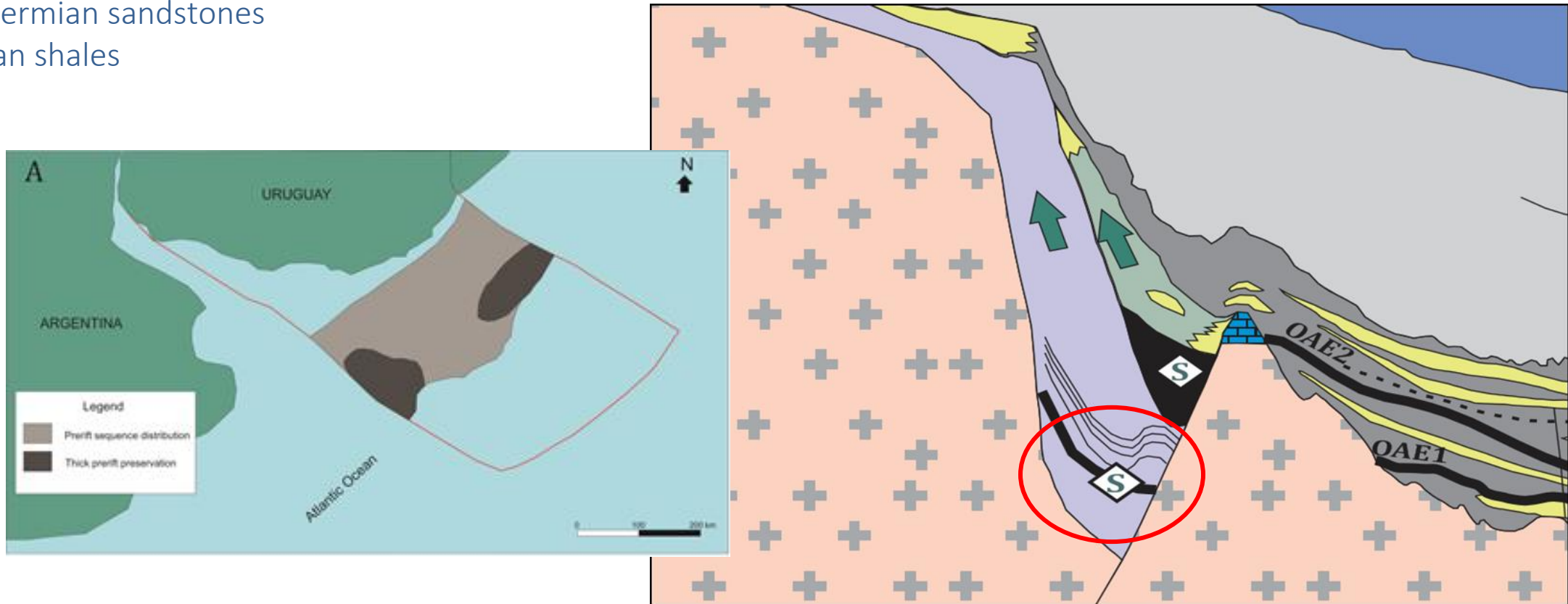
Geological model and plays

- A) Plays related to PRE-RIFT (Devonian and Permian)
- B) Plays related to SYN-RIFT (Barremian)
- C) Plays related to TRANSITION (Carbonate plays)
- D) Plays related to POST-RIFT (Cretaceous)
- E) Plays related to POST-RIFT (Cenozoic)



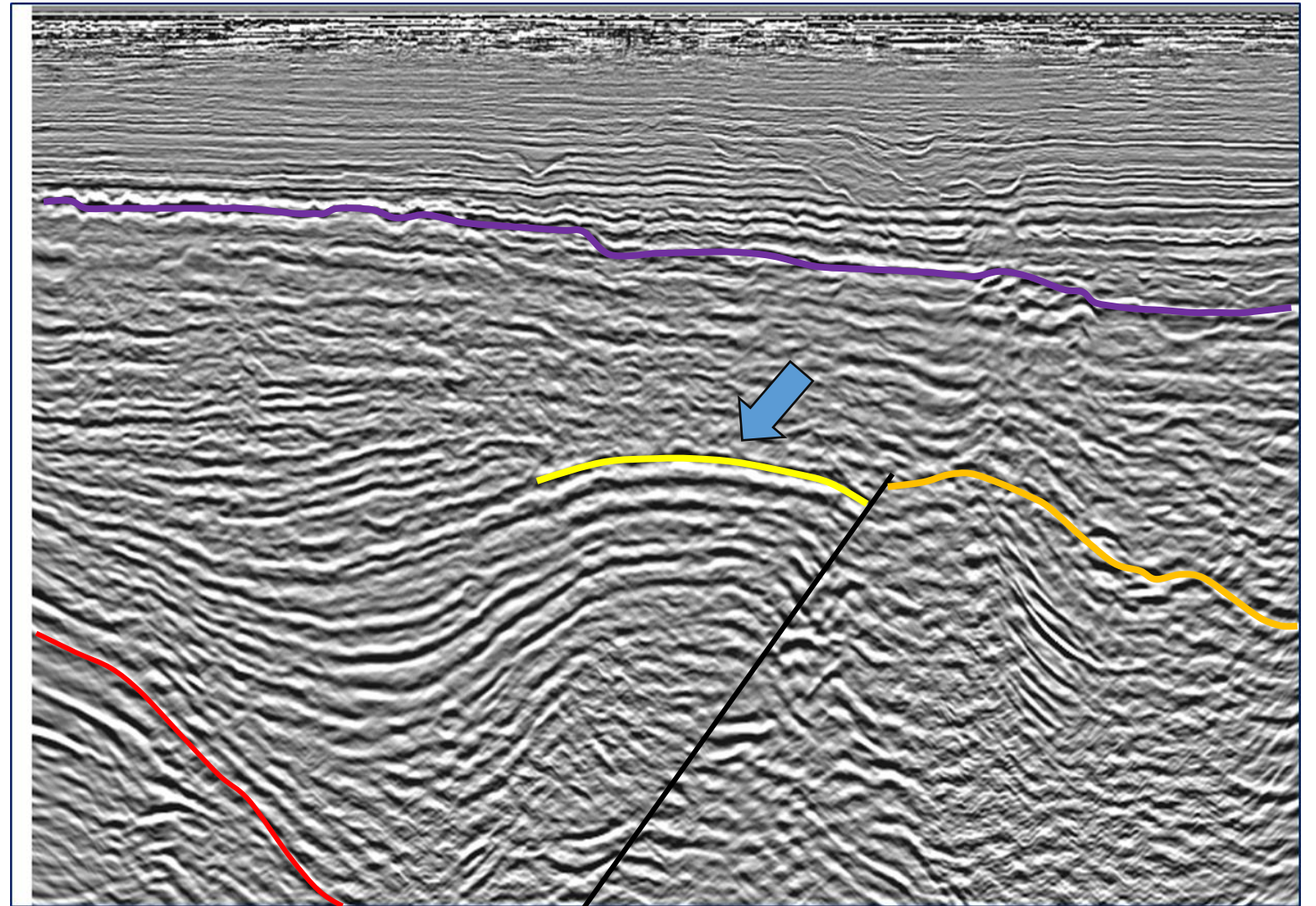
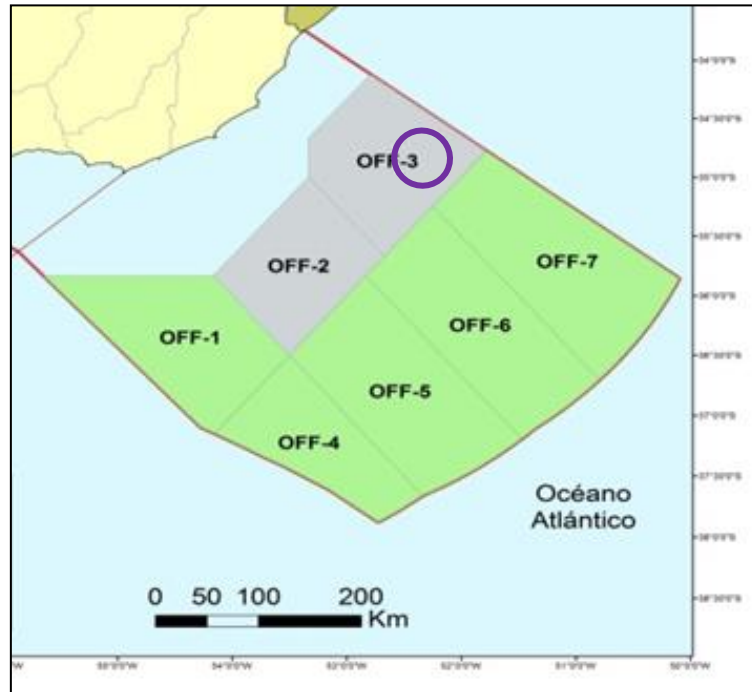
A) Plays related to Pre-Rift (Devonian and Permian)

- **Description:** Related to deep Paleozoic depocenters preserved from the pre-rift stage. The sequence in some areas is deformed, generating anticlines and rotated blocks.
- The pre-rift was drilled by the Gaviotin well in Punta del Este Basin (139 meters)
- **Source rock:** Permian and Devonian marine shales
- **Reservoir:** Permian sandstones
- **Seal:** Permian shales



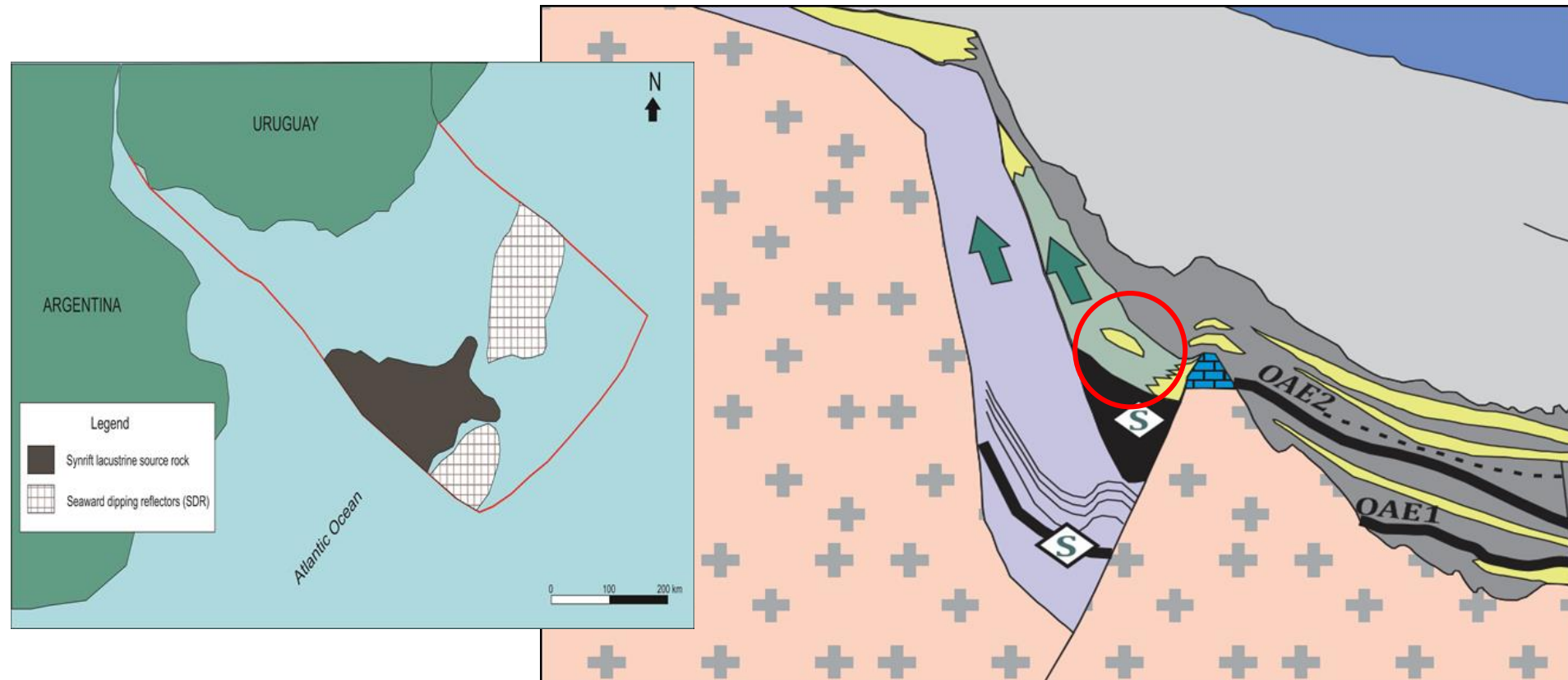
A) Plays related to Pre-Rift (Devonian and Permian)

Play type: 4 way closure anticline



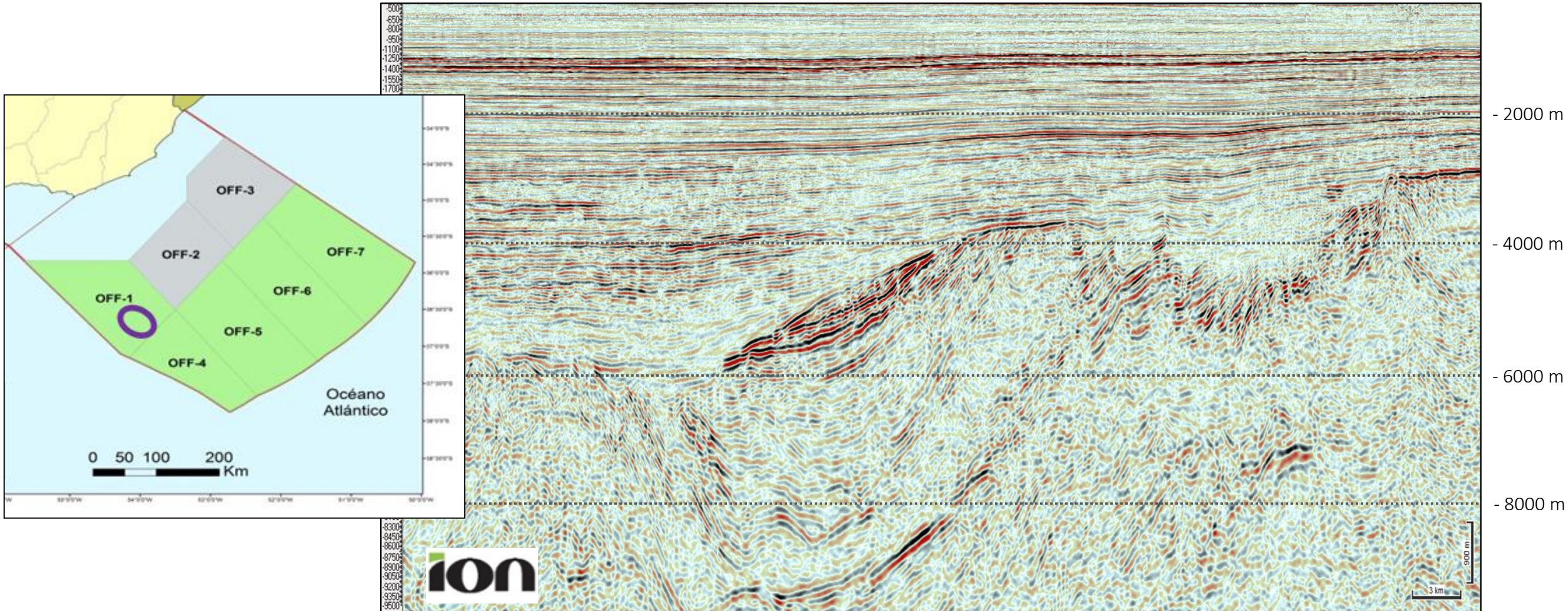
B) PLAYS RELATED TO SYN-RIFT (Barremian)

- **Description:** Related to halfgrabens from the synrift stage (lacustrine fans, compaction syncline, pinchouts), particularly in Punta del Este Basin.
- Lobo and Gaviotin wells didn't drilled the halgraben infill (only the shoulders of halgrabens)
- **Source rock:** Lacustrine shales (Barremian)
- **Reservoir:** Barremian Sandstones (alluvial, lacustrine fans)
- **Seal:** Lacustrine shales



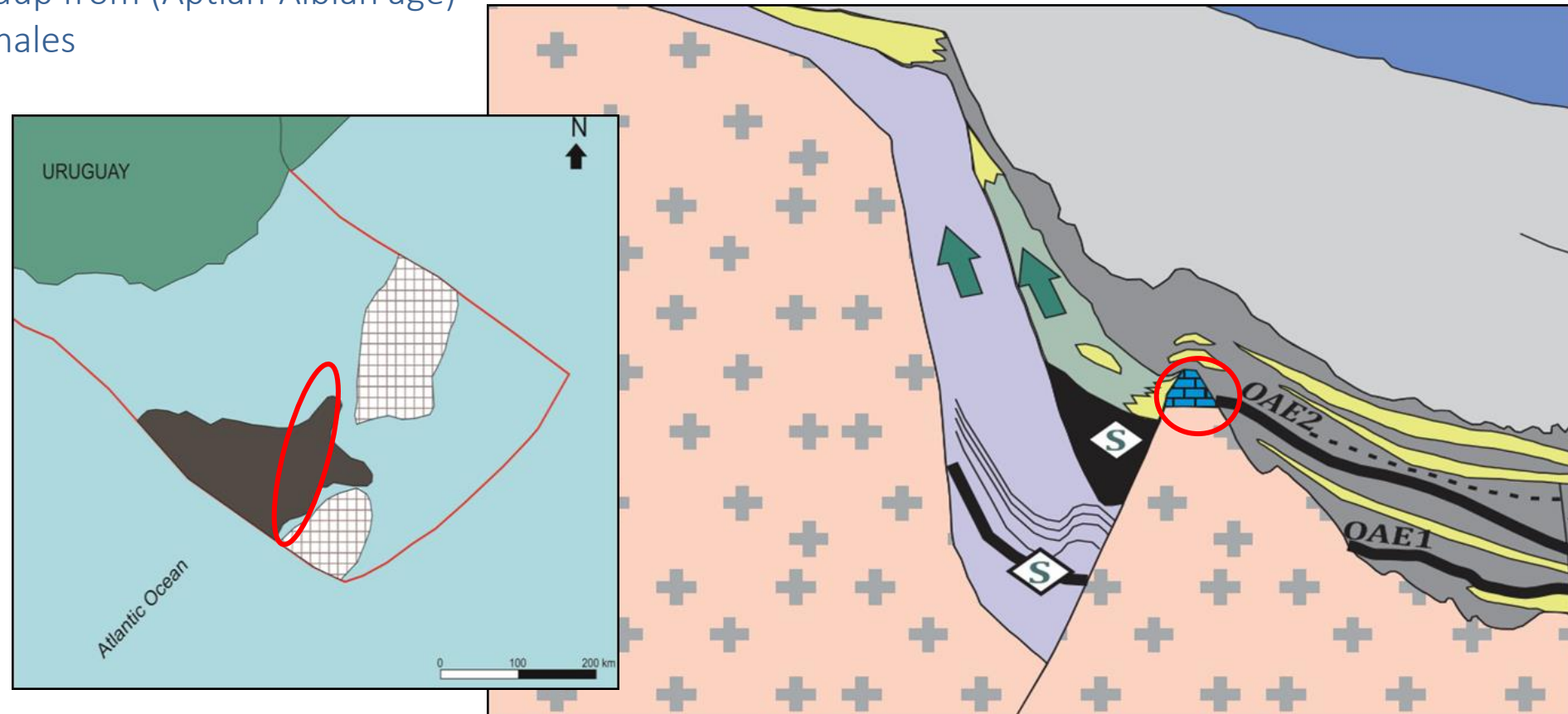
B) PLAYS RELATED TO SYN-RIFT (Barremian)

Play type: Lacustrine fan



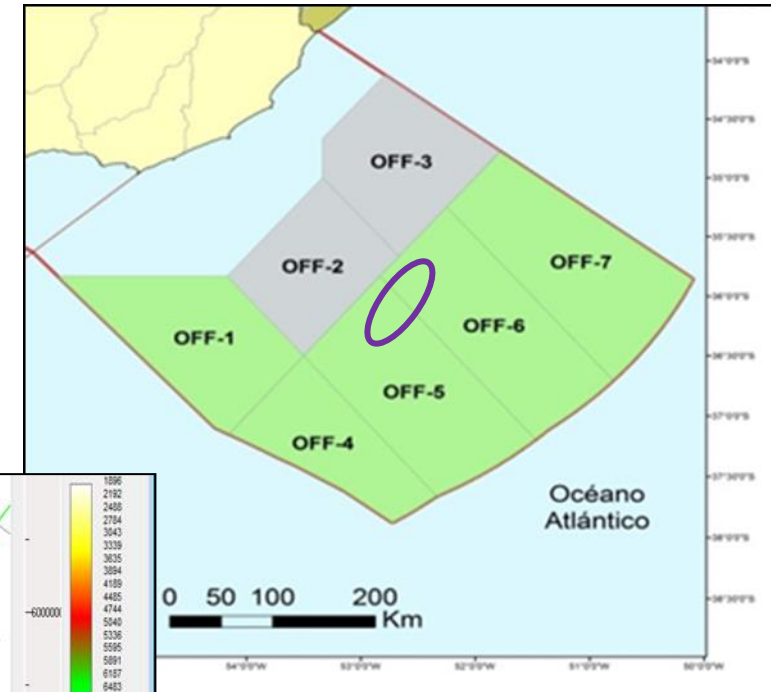
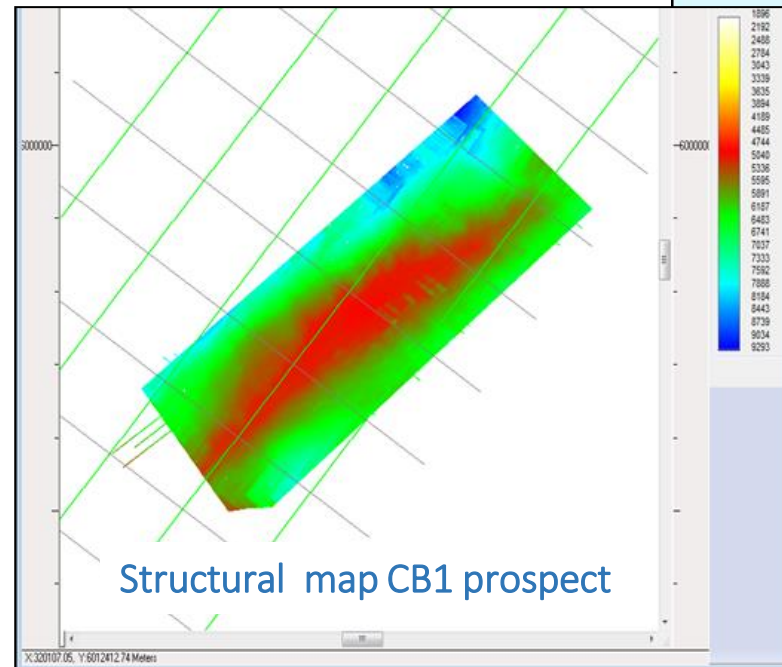
C) PLAYS RELATED TO TRANSITION (Albian) – Carbonatic plays

- Related to carbonate isolated buildups from the transition sequence stage (in basement highs or hanging walls)
- Lobo and Gaviotin wells didn't drilled the halgraben infill (only the shoulders of halgrabens)
- **Source rock:** Barremian lacustrine shales and Aptian marine shales
- **Reservoir:** Carbonatic buildup from (Aptian-Albian age)
- **Seal:** Cretaceous marine shales

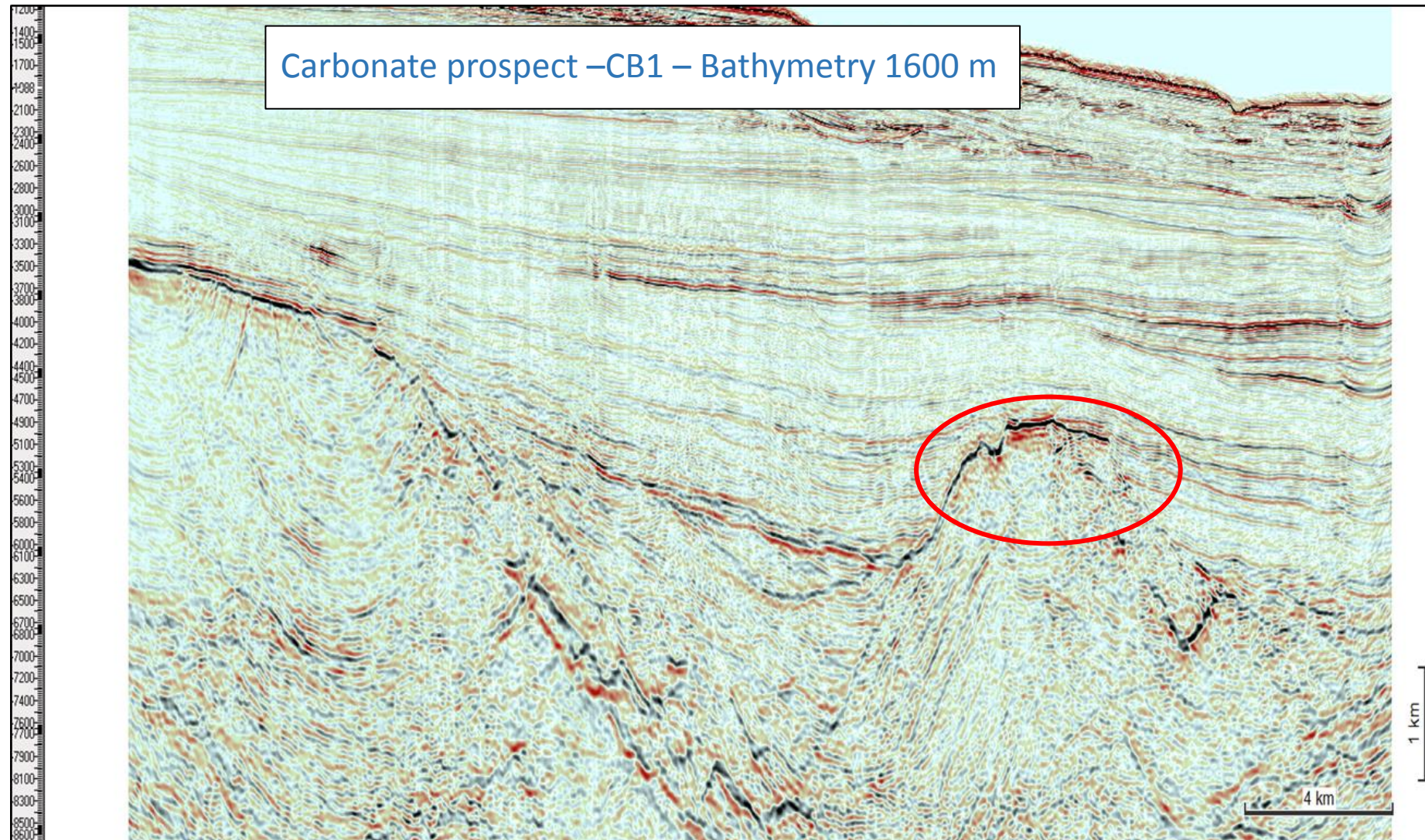
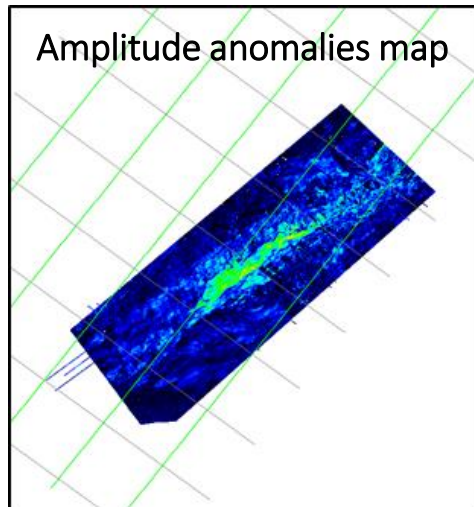
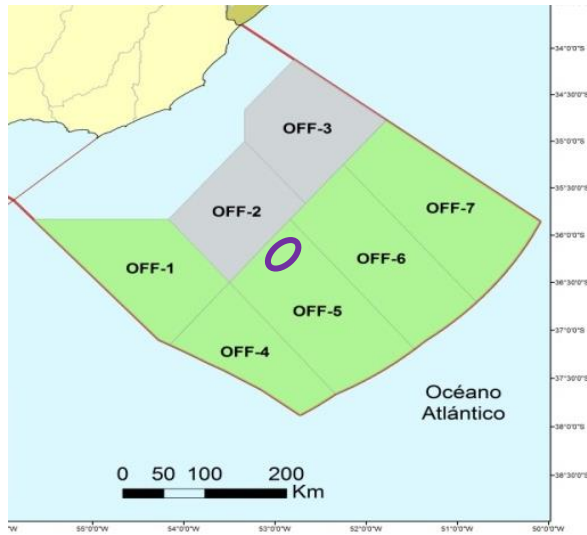


C) PLAYS RELATED TO TRANSITION (Albian) – Carbonatic plays

- Prospect code: CB1
 - Description: Carbonate construction over a basement High
 - Age: Albian
 - Type of trap: Carbonate
 - Reservoir: Carbonate
 - Seal: Upper Cretaceous shales
 - Source rock: Lacustrine from the syn-rift sequence (Lower Cretaceous – Barremian)
 - Migration: Lateral
-
- P10: 641 MMstb
 - P90: 96 MMstb

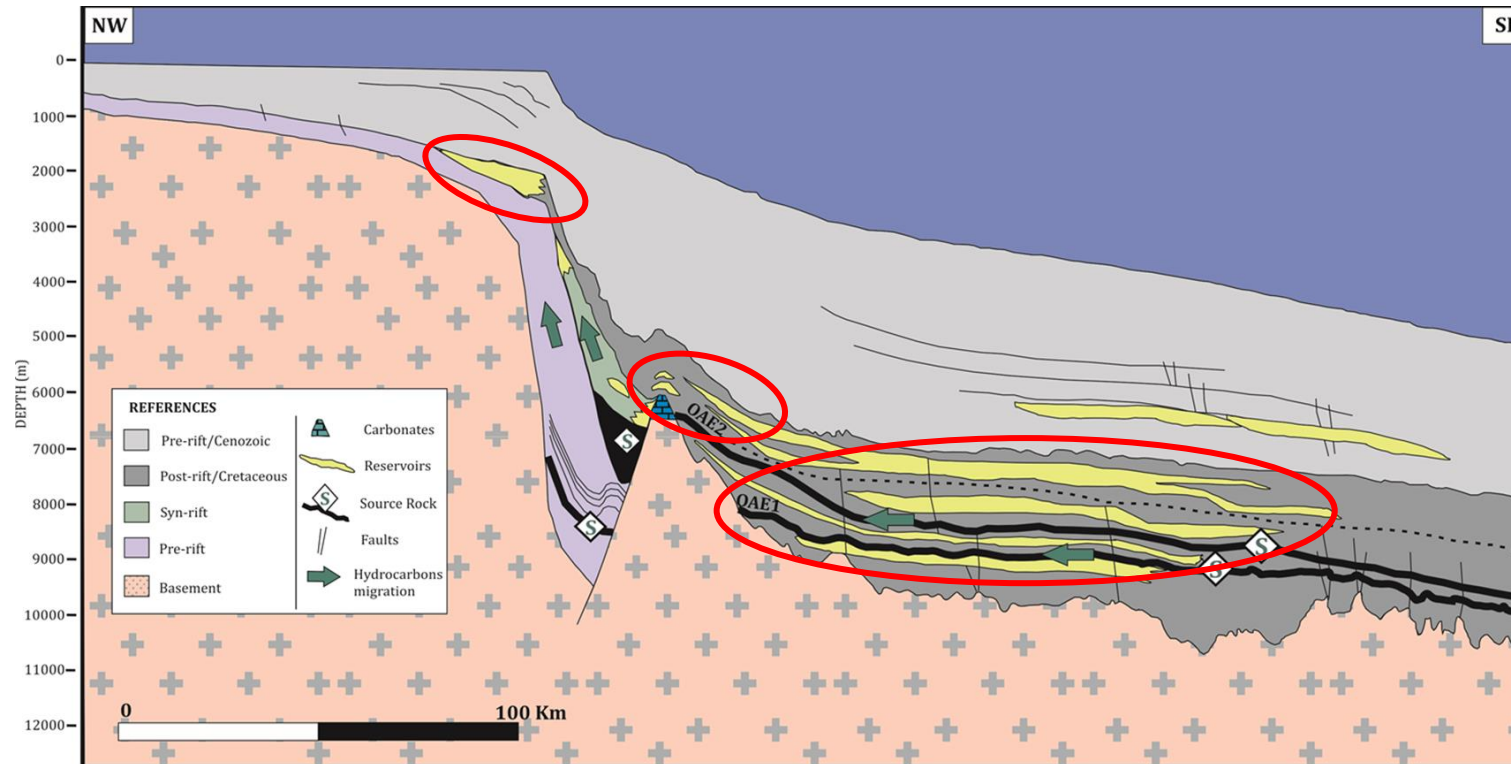


C) PLAYS RELATED TO TRANSITION (Albian) – Carbonatic plays

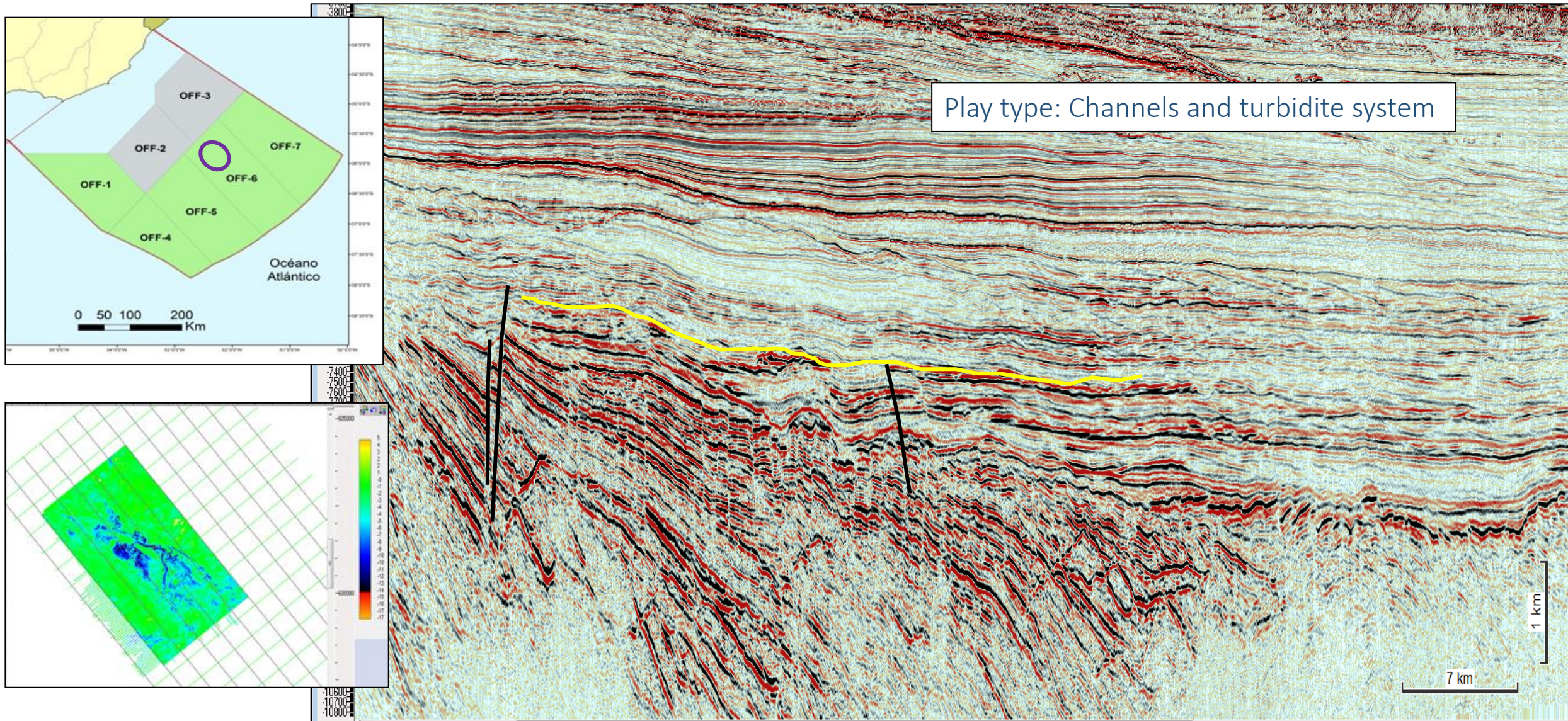


D) PLAYS RELATED TO POST-RIFT (Cretaceous)

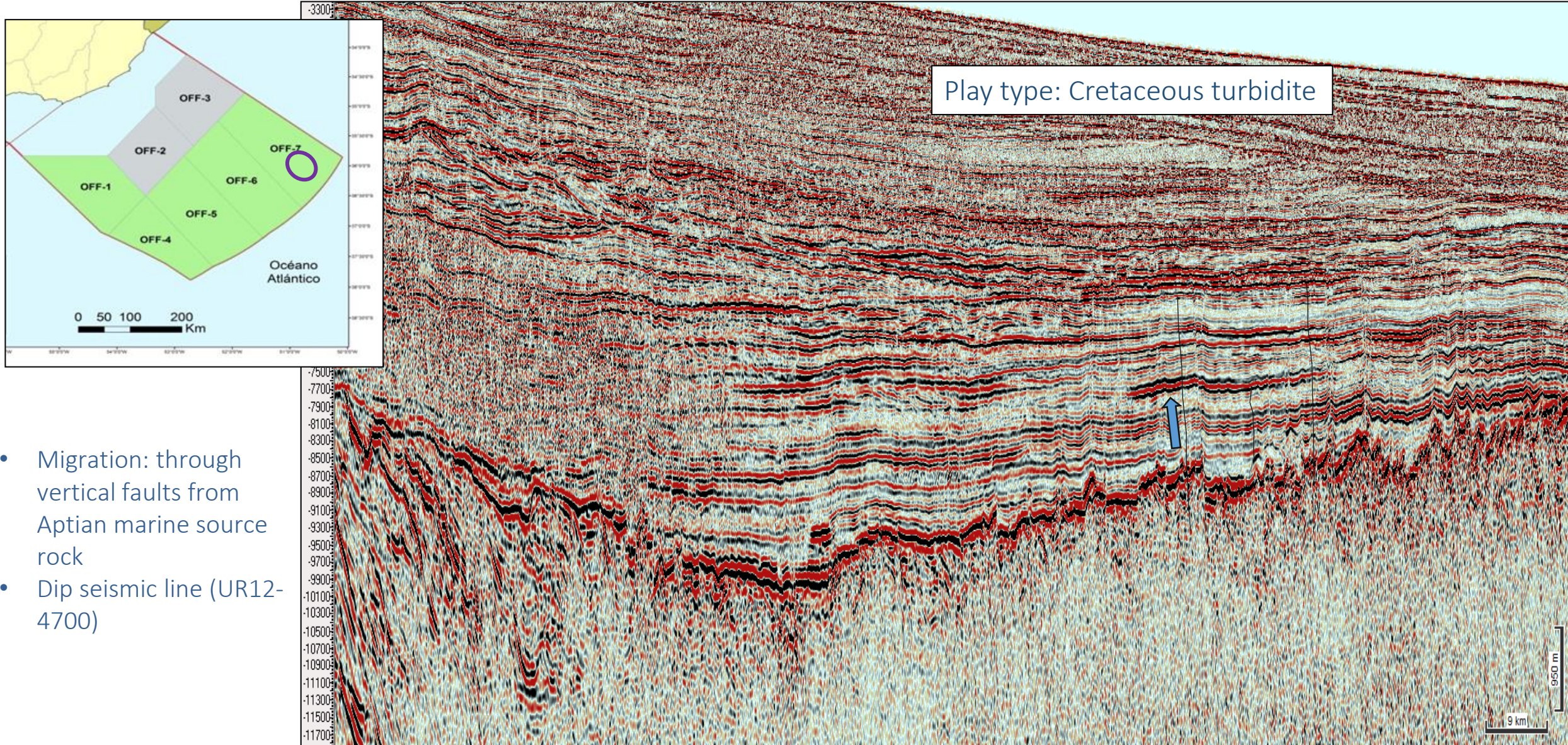
- **Description:** Siliciclastic Plays
 - Stratigraphic (channels, turbidites, pinch-outs, contourites)
 - Structural (gentle anticlines), traps are distributed throughout the Cretaceous Sequence.
- Not tested, yet
- **Source rock:** Marine Aptian and Turonian shales (First and Second oceanic anoxic event of the Cretaceous OAE1-OAE2)
- **Reservoir:** Conician, Santonian and Maastritichian sandstones
- **Seal:** Shales of the Paleocene transgression



D) PLAYS RELATED TO POST-RIFT (Cretaceous)

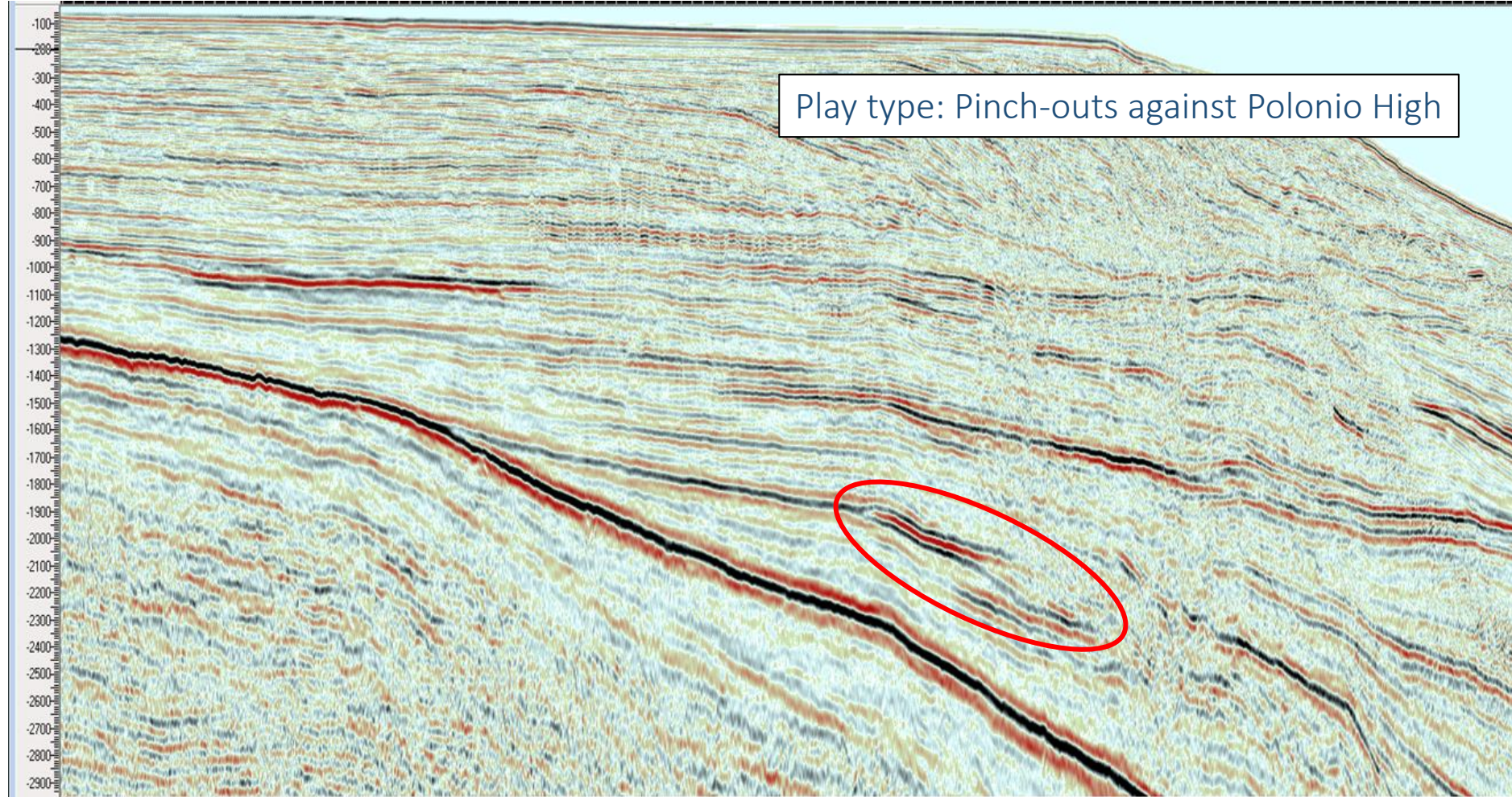
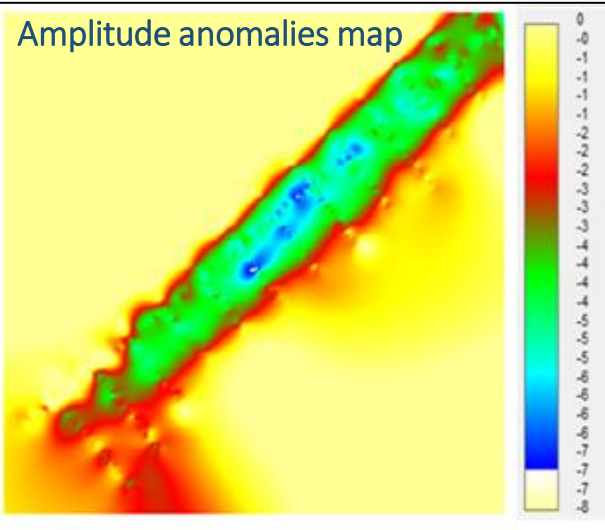
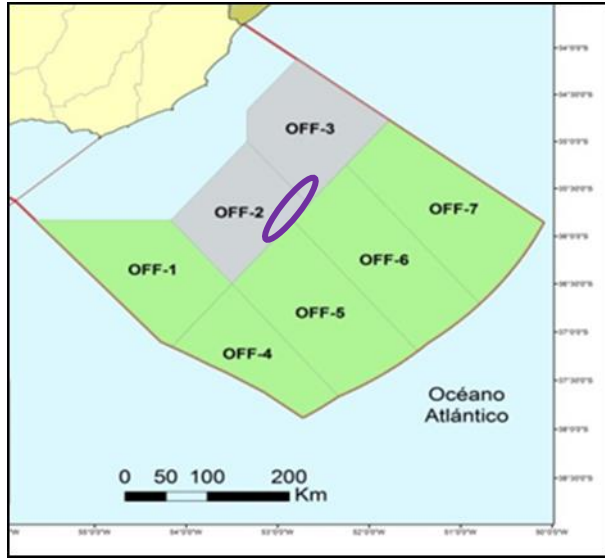


D) PLAYS RELATED TO POST-RIFT (Cretaceous)



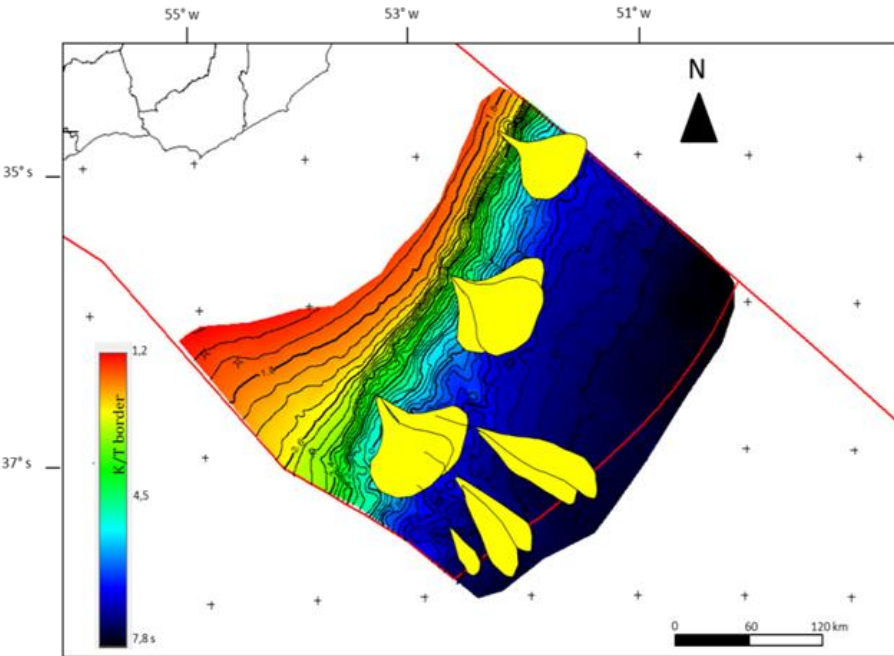
- Migration: through vertical faults from Aptian marine source rock
- Dip seismic line (UR12-4700)

D) PLAYS RELATED TO POST-RIFT (Cretaceous)

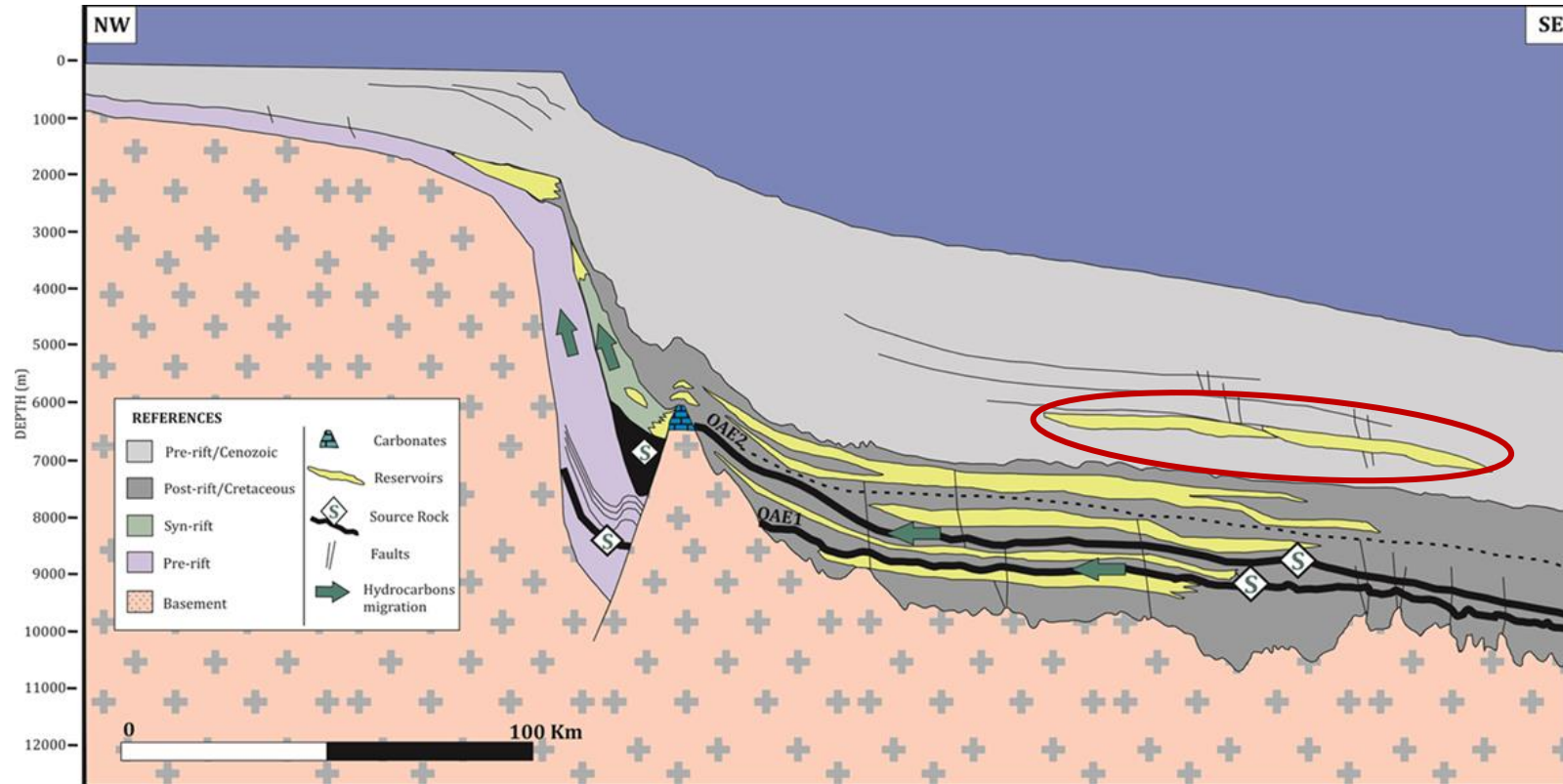


D) PLAYS RELATED TO POST-RIFT (Cenozoic)

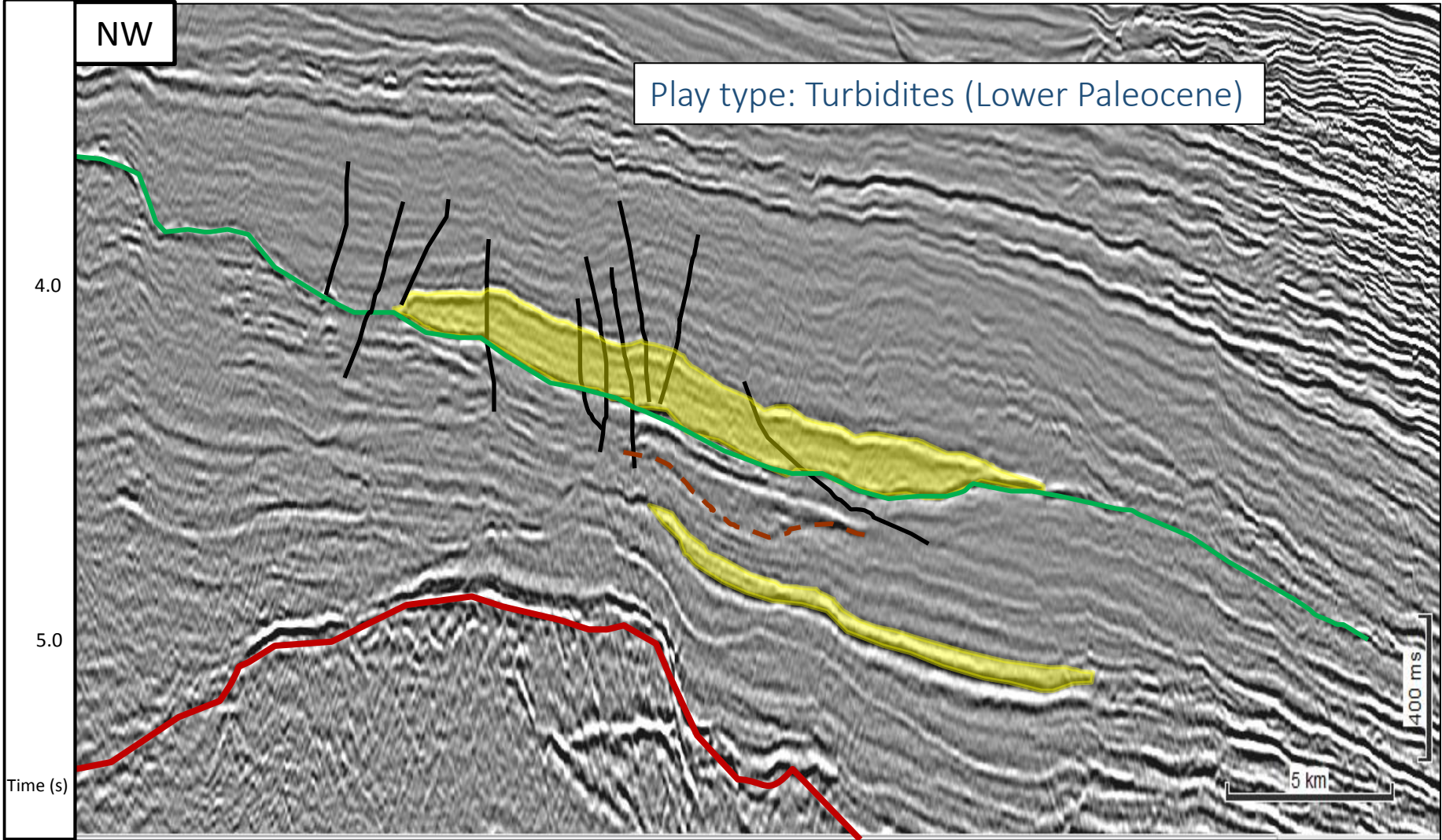
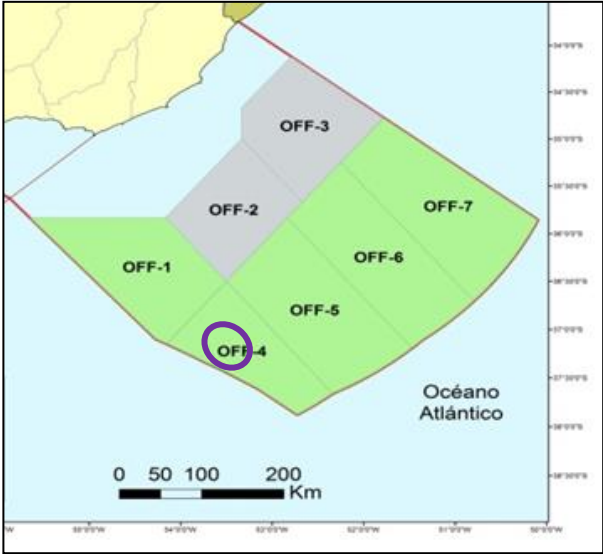
- **Description:** Stratigraphic (channels and turbidites).
- Tested by Raya well
- **Source rock:** Marine Aptian and Turonian shales (First and Second Oceanic Anoxic Event of the Cretaceous OAE1-OAE2)
- **Reservoir:** Paleocene, Eocene and Oligocene sandstones
- **Seal:** Shales of Paleocene and Miocene transgressions



K/T structural map



D) PLAYS RELATED TO POST-RIFT (Cenozoic)



FINAL REMARKS

- Only 3 exploratory wells drilled in an area of more than 120,000 km²
- Two wells located in the proximal segment of the basin (Lobo and Gaviotin) showed several evidences of an active petroleum system (fluid inclusions and gas crossovers)
- Raya well didn't reach the Cretaceous sequence (the most prospective)
- Presence of world class source rocks (Aptian-Turonian), good quality reservoirs
- Development of an effective regional seal (Paleocene), proven by well data, especially in the distal segment
- Many prospects identified through 2D and 3D seismic in shallow, deep and ultra-deep waters

Thank you for you attention!