URUGUAY ROUND 3
Offshore Petroleum Geology

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- Offshore basins.
- Play types and prospects.
- Final Remarks
Three offshore basins are recognized in Uruguay: Punta del Este Basin to the west, Pelotas Basin to the east, and Oriental del Plata Basin at ultra-deep waters. At shallow area, Punta del Este and Pelotas are separated by the Polonio high, and at deeper waters they are individualized by a NW-SE trending structure called the Rio de la Plata Transfer System.
Punta del Este basin
Pelotas basin
Play types

A) pre-Rift Plays (pre-Cretaceous)
B) Synrift Plays
C) Transition Carbonate Plays
D) Post-Rift Cretaceous Siliciclastic Plays
E) Post-Rift Cenozoic Siliciclastic Plays
A) Pre-Rift (pre-Cretaceous) Plays
1. Anticlines
2. Faulted and Rotated blocks

B) Syn-Rift Plays
3. Lacustrine fan
4. Pinch-out
5. Structures & compaction synclines

C) Transition Carbonate Plays
6. Carbonate buildup at half-graben hanging-wall
7. Carbonate buildup at basement high

D) Post-Rift Cretaceous Siliciclastic Plays
8. Turbidite
9. Anticline
10. Channel
11. Pinch-out (at Polonio High)

E) Post-Rift Cenozoic Siliciclastic Plays
12. Turbidite
13. Channel
A) Pre-Rift (pre-Cretaceous) Plays

- **Description**: Related to deep Paleozoic depo-centers preserved from the pre-Rift stage. This sequence shows deformation in certain regions, recognized as anticlines and rotated blocks at enhanced PSDM seismic. Pre-Rift in the offshore was drilled at Gaviotin well in Punta del Este Basin (200 meters).

- **Source rock**: Permian and Devonian marine shales (speculative offshore, outcrops onshore)

- **Reservoir**: Permian sandstones

- **Seal**: Permian shales
A) Pre-Rift (pre-Cretaceous) Plays

A.1: Anticline
A) Pre-Rift (pre-Cretaceous) Plays

A.1: Anticline

- Prerift
- Postrift
- Sea Level

Depth m

- 0
- 5,000
- 10,000
- 3 km
- 7 km
A) Pre-Rift (pre-Cretaceous) Plays

A.1: Anticline

Prospect: Morfeo

Features & Volumetric

Water depth: 180 m
Sediment depth: 7,125 m
EUR (dry gas): Mean 5.1 TCF
Paleozoic source rocks

- **NORTE (PARANA) BASIN**
  - Mangrullo Fm. (Permian)
  - TOC: up to 13.5%
  - HI: up to 1000 mg HC/g COT
  - Type I kerogen

- **San Gregorio Fm.** (Devonian)
  - TOC: up to 13%
  - IH: hasta 400 mg HC/g COT
  - Type II kerogen

- **Bacia Chaco-Parana**

- **Bacia do Paraná**

- **Paleozoic sequence preserved in offshore Uruguay may be part of the large onshore Paleozoic Paraná Basin.**
- **Parana Basin: 2 proven source rocks of Permian and Devonian Age (outcrops and subsurface).**
B) Syn-Rift Plays

- **Description**: Related to half-grabens at Syn-Rift stage (lacustrine fans, structures due to differential compaction, pinch-outs), particularly in Punta del Este Basin. Lobo and Gaviotín wells targeted the structural highs at proximal locations of the Punta del Este basin, hence did not drilled half-graben infill.
- **Source rock**: Lacustrine shales (Barremian)
- **Reservoir**: Barremian Sandstones (alluvial, lacustrine fans)
- **Seal**: Lacustrine shales
B) Syn-Rift Plays

B.3: Lacustrine Fan
B) Syn-Rift Plays

B.3: Lacustrine Fan
B) Syn-Rift Plays

B.3: Lacustrine Fan

Prospect: Lenteja

Features & Volumetric

Water depth: 80 – 110 m
Sediment depth: 4,350 m (avg.)
EUR (oil): Mean 1,914 MMbbls
EUR (assoc. gas): Mean 2.8 TCF
Lacustrine shales distribution
Lobo & Gaviotín wells drilled by Chevron in 1976.
Both declared dry wells
They did not find 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.
Fluid Inclusions

- Results (FIT, 2011): dry gas anomalies in Lobo and Gaviotín, at Jurassic, Cretaceous and Tertiary levels.
- Low, moderate and high gravity oil inclusions were found in 28 thin sections of sandstones and volcanic materials. Given the different gravities, different oil charges (more so in the Lobo well than in the Gaviotín well) can be assumed.
- Migration took place in Late Oligocene-Early Miocene. Efficiency of the regional seal (deposited in the Maastrichtian-Paleocene transgression) is evident from available data.
- The results demonstrate generation of native hydrocarbons, migration pathways and the existence of paleo-hydrocarbon accumulations.

C) Transition Carbonate Plays

- **Description**: Related to carbonate isolated buildups, within the Transition stage, at basement highs or hanging walls.
- **Source rock**: Barremian lacustrine shales and Aptian marine shales
- **Reservoir**: Carbonate buildup (Aptian-Albian)
- **Seal**: Cretaceous marine shales

![Diagram of carbonates in the Transition stage](image-url)
C) Transition Carbonate Plays

Analogy: Kwanza Basin, Angola
Schematic stratigraphic model for presalt in Kwanza Basin (Saller et al., 2016)
C) Transition Carbonate Plays

C.7: Carbonate buildup at basement high
C) Transition Carbonate Plays

C.7: Carbonate buildup at basement high

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**Basement**

**Synrift**

**Postrift**
C) Transition Carbonate Plays

C.7: Carbonate buildup at basement high

Prospect: Smith

Features & Volumetric

Water depth: 1,600 m (avg.)
Sediment depth: 3,300 m (avg.)
EUR (oil): Mean 331 MMbbls
EUR (assoc. gas): Mean 0.4 TCF
Marine shales distribution
Aptian & Turonian
D) Post-Rift Cretaceous Siliciclastic Plays

- **Description:** Stratigraphic (channels, turbidites, pinch-outs) and structural (anticlines) traps distributed throughout the Cretaceous sequence.
- **Source rock:** Marine Aptian and Turonian shales (1\textsuperscript{st} and 2\textsuperscript{nd} Oceanic Anoxic Event of the Cretaceous OAE1-OAE2).
- **Reservoir:** Conician, Santonian, Maastritchian sandstones.
- **Seal:** Shales of the Paleocene transgression.
D) Post-Rift Cretaceous Siliciclastic Plays

D.8: Turbidite
D) Post-Rift Cretaceous Siliciclastic Plays

D.8: Turbidite

Image description:
- NW: Northwest
- SE: Southeast
- Postrift
- Sea Level
- Turbidite
- Synrift
- Basement
- Depth in meters
- 2 km scale in the bottom right corner
D) Post-Rift Cretaceous Siliciclastic Plays

D.11: Pinch-out (at Polonio High)
D) Post-Rift Cretaceous Siliciclastic Plays

D.11: Pinch-out (at Polonio High)
E) Post-Rift Cenozoic Siliciclastic Plays

- **Description**: Deep marine deposits (channels and turbidites).
- **Source rock**: Marine Aptian and Turonian shales (1\textsuperscript{st} and 2\textsuperscript{nd} Oceanic Anoxic Event of the Cretaceous OAE1-OAE2).
- **Reservoir**: Paleocene, Eocene and Oligocene sandstones.
- **Seal**: Shales of the Paleocene and Miocene transgression.

K/T paleo-geography sketch
E) Post-Rift Cenozoic Siliciclastic Plays

E.12: Turbidite (lower Paleocene)
E) Post-Rift Cenozoic Siliciclastic Plays

E.12: Turbidite (lower Paleocene)
E) Post-Rift Cenozoic Siliciclastic Plays

E.12: Turbidite (lower Paleocene)

Prospect: Esmeralda

Features & Volumetric

Water depth: 1,350 m (avg.)
Sediment depth: 4,350 m (avg.)
EUR (oil): Mean 718 MMbbl
EUR (assoc. gas): Mean 0.9 TCF
E) Post-Rift Cenozoic Siliciclastic Plays

E.12: Turbidite (Oligocene)
E) Post-Rift Cenozoic Siliciclastic Plays

E.12: Turbidite (Oligocene)

- RAYA-1 (projected)
- Seabed
- K-T boundary
- Aptian source rock
- Basement
- SDRs
- NW-SE orientation

Depth (m)
Several play types recognized at 2D and 3D seismic data, from pre-Rift up to Cenozoic sequence, matured to leads and prospects, not yet tested.

Regional proved source rocks from Paleozoic to Cretaceous.

Reservoirs and traps (stratigraphic and structural) identified at 2D and 3D seismic, resembling analogies from recent discoveries in South Atlantic.

Further re-processing and quantitative interpretation of prospects, and 3D data acquisition at leads would help de-risk them (and identify much more prospect & leads).
Thank you for your kind attention!