The State of the Art of the Brazilian Pre-Salt Exploration*

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Abstract

The giant pre-salt discoveries in Santos Basin deep waters have profoundly modified the exploration setting in Brazil for the last decade. These discoveries are among the most important in the world and place Brazil in a strategic position meeting the world’s demand for energy. The pre-salt oil province was discovered in 2006 and is characterized by large prospects of excellent quality light oil accumulated in carbonate reservoirs deposited between Barremian and Aptian. Currently the pre-salt responds for about 1.6 million BOE/D, corresponding to about 48% of the national oil production. In the last decade, no other country in the world has discovered such significant volumes of oil, suggesting that Brazil has the potential to become one of the major oil and oil-derivative producers of the world. The exact oil volume in the pre-salt play is yet unknown, however, preliminary evaluation suggests that the Brazilian oil reserves could double with the increment of the discovered volumes (Lula, Sapinhoa, Buzios, Sepia, Lapa, Carcara, Libra, among others). The current Brazilian reserves are about 13 billion barrels of oil. In addition to the fields listed above, the prominent structure of Libra is currently under development. Libra is a structural high, with carbonate reservoirs (microbial and coquina), with recoverable resources of about 9 billion barrels of oil (IHS, 2016). Besides the structures located in granted area, many others were identified by ANP, such as the structures of Saturno, Peroba, Pau-Brasil and Uirapuru, among others with higher risk (Cabo Frio High region for example). Since its discovery, the Brazilian pre-salt play has become a world-class oil province; however, little was published about it. Therefore, this work is aimed at introducing the state of the art of the Brazilian pre-salt, presenting its historical setting and the current depositional model for the petroleum systems elements.

References Cited


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Salt Lake City, Utah
May 22nd, 2018
1. Brazil’s Current State
2. The Pre-Salt Play
3. 2017 to 2019 Pre-Salt Licensing Rounds: Giant Leads
4. Final Remarks
Outline

1. Brazil’s Current State
2. The Pre-Salt Play
3. 2017 to 2019 Pre-Salt Licensing Rounds: Giant Leads
4. Final Remarks
Brazil’s Current State

10th largest oil producer in the world and the largest in Latin America

Area under concession
~ 280,000 km²

335 Blocks
431 fields

Production
(Mar, 2018)
Oil 2.56 million barrels/d
Natural Gas 107 million m³/d

Proven Reserves
(Dez, 2017)
Oil 12.8 billion barrels
Natural Gas 367 billion m³

Sedimentary Area: 7.5 million km²
Oil Production in Brazil

1998
- Production (Dec, 1998)
  - 970 thousand bbl/d
  - 30 million m³/d

2018
- Production (Mar, 2018)
  - 2.56 million bbl/d
  - 107 million m³/d

Oil Export (2000)
- 18.68 bbl/d

Crude Oil Export (Feb, 2018)
- 0.9 million bbl/d
Brazil’s Prospectivity

**Pre-Salt**
- High quality **Carbonate Reservoirs** underneath the salt layer
- High **well productivity** more than 30,000 bpd in the beginning of production
- Potential for giant or supergiant field discoveries

**Conventional Offshore**
- **Eastern and Equatorial Margin**
  - Potential for oil discoveries from the Upper Cretaceous to Paleogene turbidite reservoirs

**Onshore**
- **Mature Basins**
  - (Remaining Potential)
- **New Frontier Basins**
  - Solimoes Basin: Potential for light oil accumulations
  - Paleozoic and Proterozoic basins: gas prone
Oil Production in Brazil

Million barrels of oil/day

- Total Oil
- Post-Salt
- Pre-Salt
- Onshore
Proven Reserves

December, 2017

Oil
12.8 Billion bbl

Gas
367 Billion m³

15 Billion boe

Oil Proven Reserves

- Pre-Salt: 5%
- Conventional Offshore: 56%
- Onshore: 39%

Gas Proven Reserves

- Pre-Salt: 18%
- Conventional Offshore: 53%
- Onshore: 29%

Pre-Salt: 56%
Conventional Offshore: 37%
Onshore: 7%
The Pre-Salt Play

Aptian

SINBPA/Petrobras
Scotese
The Pre-salt Play

Depositional Model

Buildup

Platforms


- Micritic limestone (mudstone - wakestone)
- Mud flat dolomite
- Argillaceous limestone & marl
- Siltstone
- Sandstone
- Conglomerate
- Lime packestone - grainstone with mollusk shells
- Transgressive limestone
- Basement

- Domal to branching microbial (chert boundstone)
- Shrubby microbial boundstone
- Shale (commonly organic-rich)
The Pre-salt Play

Petroleum System

Itapema – Itapema/Barra Velha

Stratigraphic chart: Moreira et al., 2007
The Pre-salt Play

Buzios Field – Facies Example

2-ANP-0001-RJS

Core

Top of Coquina

Oil/water contact

Final Depth = 5,942.0 metros

8.85 meters

8.85 meters

371.0 meters (until O/W)

5435, 85...
The Pre-salt Play

Buzios Field – Facies Example

Schrubs

8.85 meters

2.0 cm

2.0 cm
The Pre-salt Play

Buzios Field – Facies Example

Spherulite

8.85 meters

CLU + estevensite? (ritimites)
Si
Sph
Sph + microlamination
Laminated CLU
Silica nodule
The Pre-salt Play

Buzios Field – Facies Example

8.85 meters

Laminated Calcilutite

Si

Si
The Pre-salt Play

Buzios Field – Facies Example

Calcarenite

8.85 meters
The Pre-salt Play

Mero Field – Facies Example

Core 1 = 5,548/5,566 m
Core 2 = 5,613/5,631 m

Final Depth = 6,029.3 metros
The Pre-salt Play

Mero Field – Facies Example

Core 1

Core 2

Calcarenite
The Pre-salt Play

Mero Field – Facies Example

Core 1

Core 2

Laminated calcilutite
The Pre-salt Play

Mero Field – Facies Example

Core 1

Core 2

Crenulated lamination calcilutite
The Pre-salt Play

Mero Field – Facies Example

Core 1

Core 2

Calcirudite
Pre-salt Prospectivity

The Pre-Salt comprises huge accumulations underneath the salt layers;

Light Oil with excellent quality accumulations and high commercial values;

1) Great prospectivity, potential for giant and supergiant oil fields;

2) High wells productivity related to high quality carbonate reservoirs and extensive and thick production zones.
Pre-salt Production

~1.4 million barrels of oil/day

The Pre-Salt production comes from 83 wells:

58 in Santos Basin
25 in Campos Basin
The Pre-salt Play Production

~1.4 million barrels of oil/day

Mar/2018
Outline

1. Brazil’s Current State
2. The Pre-Salt Play
3. 2017 to 2019 Pre-Salt Licensing Rounds: Giant Leads
4. Final Remarks
Bidding Rounds Schedule

- **4th PSC Bidding Round**
  - **2018**
  - (06.07.18)

- **5th PSC Bidding Round**
  - **2018**
  - (09.28.18)

- **2018 (Nov)**

- **2019 (1st S)**

- **6th PSC Bidding Round**
  - **2019**
  - (3rd Q)
4th Pre-salt Bidding Round

Public session for submission of bids:
Jun the 7th, 2018

4 blocks in Pre-Salt play

Potential for huge oil discoveries

Unrisked oil in place volume (P50)
~14 billion barrels
Unrisked in place oil volume (P50)
7.8 billion barrels
Unrisked in place oil volume (P50)
7.8 billion barrels
This auction will include 4 blocks: Saturno, Tita, Pau-Brasil and Sudoeste de Tartaruga Verde

Unrisked oil in place volume (P50) surpasses 17 billion barrels

Public session for submission of bids:
September the 28th, 2018
Base of Salt
Depth Structural Map

25 km
3 blocks in Pre-Salt play including giant leads
Aram Block

Prominent Basement High
Four-way Closure
Amplitude Anomalies

Area: 1,500 km²

Survey: R0014_BS_1_SOUTH_PSDM – Courtesy of PGS
6th Pre-salt Bidding Round

Aram Block

Survey: R0014_BS_1_SOUTH_PSDM – Courtesy of PGS

Prominent Basement High
Four-way Closure
Ampitude Anomalies

Area: 1,500 km²
Outline

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The Pre-salt play is comprised of highly productive Aptian carbonate reservoirs in structural traps sealed by thick salt layers; Currently, there are 12 fields producing from the Pre-salt layers in Brazil. The Pre-salt play is responsible for more than half of the Brazilian oil production; Estimated unrisked in place volume surpasses 30 billion barrels of oil for the 4th and 5th Pre-Salt Licensing Rounds.
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