Breaking Paradigms
Giant and Super-Giant discoveries in Brazil

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Brazil: General Information

Area: 8,514,877 km² (5th largest)
Population: 198 million
Coastline: 7,491 km
Borderline: 15,735 km (10 countries)
GDP/capita (2008): US$ 10,100
Petroleum Industry: 8% of GDP (2007) 12% (2009)
Brazil: Sedimentary Basins

- **ONSHORE**: 4,880,000 km²
- **OFFSHORE**: 1,550,000 km²
- **0 - 400m**: 770,000 km²
- **400 - 3000m**: 780,000 km²
- **TOTAL**: 6,430,000 km²

- 20 onshore basins
- 15 offshore basins’
1953: only one producing basin

Strongly dependent on imported oil

Consumption: 137,000 bopd
Production: 2,700 bopd
Proved reserves: 15 MM barrels

"Lacustrine graben"
1954: Petrobras is born

The main target: the “Bonanza Fields” in the huge Paleozoic basins

The mission: self-sufficiency
An exploratory “reality”: no oil fields in the Paleozoic basins

End of 1950’s

1958

National Production: 51,000 bopd
National Consumption: 220,000 bopd
The Exploration Training Process in the 50’s & 60’s

- Petrobras/University of Bahia Convenia
- Beginning of Geology graduation courses in Brazilian Universities
- Specialization courses in USA
1960’s  Breaking the paradigm: focus on onshore coastal basins

Carmópolis Field
the first giant
1963

Recôncavo Basin
Carmópolis
Sergipe/Alagoas Basin
Carmópolis
Petroleum scenario in the middle 60’s

No perspectives for self-sufficiency

National Production: 93,988 bopd
National Consumption: 331,000 bopd

Target: Exploration in onshore coastal basins
1968: breaking paradigm, toward the Brazilian seas

Confirmation of presence of salt domes

Target: Cretaceous/Tertiary reservoirs truncated by saline intrusion.

1967
- National Production: 147,000 bopd
- National Consumption: 355,000 bopd
1968

Toward the Brazilian seas

Exploring deltas

Guaricema Field (1-SES-1)
The first offshore discovery

São Francisco delta

Structural map
Base of Calumbi Fm.
Far from self-sufficiency

1973
National Production: 170,000 bopd
National Consumption: 760,000 bopd

The early 1970’s: the dawn of E&P offshore

Reserves

Production from small offshore fields: a learning process
After drilling more than 50 wells in the continental shelf, Petrobras has consolidated the knowledge of the continental margin geology concerning:

- Basin evolution within plate tectonics concept
- Sedimentology and stratigraphy
- Salt tectonics

- Creation of adhocratic exploratory groups with high synergy
- Training and capacitation, internal and abroad

NEW EXPLORATORY MODELS
Moving to Campos Basin - 1974 - Garoupa Field

The first discovery

Albian Carbonates
1975 - Breaking paradigms: Giant field in a marginal basin

Namorado Field:
The first giant in turbidite reservoirs

- 2D Seismic
- Amplitude anomaly
- Seismic inversion in the appraisal phase
1978 - Breaking paradigms: oil in the Paleozoic in compressional structures

Juruá Field
The marine Upper Cretaceous shales in Campos and Espírito Santo basins were immature.

Only the rift lacustrine shales were mature, in conditions to generate oil for the post-salt reservoirs.

The migration should be vertical through salt windows and faults.
Early 1980’s – Still far from self-sufficiency

1983

National Production: 340,000 bopd
National Consumption: 960,000 bopd

Campos Basin

Reserves

Onshore Phase

Shallow-water Phase
Early 1980’s - Preparing for deeper challenges

- Continuing internal training programs

- Agreements between Petrobras and Brazilian Universities
  
  Master and Ph.D. programs on Geophysics, Petrology, Sedimentology.

- Intensive training abroad:

  Advances on Stratigraphy and Seismic-Stratigraphy
  Capacitation in turbidites - Field courses
  Capacitation in carbonates
  Tectonics and basin modelling
1985 - Breaking paradigms: Marlim, a giant in deep waters

- Geological Models for deep water siliciclastic systems supported seismic acquisition in deep water
- Salt Tectonics
- AVO anomaly

2.7 Billions barrels of reserves
- 37 Floating Production Units
  - 18 FPSOs
  - 3 FSOs
  - 16 SSs
- 14 Fixed Platforms
- 564 Oil production wells
- 16 Non-associated gas wells

Campos Basin
Challenges of the 2000’s: exploring deeper

Back to the rocks !!
Early 2000’s - Expanding Frontiers: oil beyond Campos Basin

Map of Brazil showing the Campos Basin and surrounding areas.
2006 - Self-sufficiency comes true

Consumption

Production

Self-sufficiency
Santos Basin: existing challenges in the middle 1990’s

Was there a rift like Campos beneath the salt?
Late 90's: delineation of the rift

2D Seismic Line (twt): new acquisition and processing

Top K

Evaporites

Rift
Early 2000’s: the 3D acquisition

3D Seismic acquisition parameters

- Acquisition (bin size): 12.5 X 37.5m
- Direction: E-W
- Pre Stack Time Migration (Kirchoff)
- Final Processing (bin size): 18.5 X 25.0 m

World’s largest 3D survey 20,000 km²
**Santos Basin pre-salt ultra deep water petroleum system conception**

- Deeper water
- Thicker salt

**Diagram:**
- Internal High
- External High
- Structural Low
- Salt

[Santos Basin map and cross-section diagram]
“Seeing through the salt”: chasing the carbonates
Tupi: the first Brazilian Super Giant

Loc. TUPI

- w.d. = 2.140 m
- Top Salt
- Base salt
- t.d. = 6.000 m

2,0 km
Tupi Oil Field: the first Brazilian Super Giant
**Structural control of Tupi**

**General Information**
- First well (RJS-628A): Aug/2006
- Reserves: 5 to 8 BBO
- Thick salt: >2,000m
- Depth: >5,000m
- Carbonate reservoirs
- Oil: 28°API.

**Area:** ~ 1,150km²

**Iracema (NW) / Tupi (NE) structural complex**

**Base of Salt**
Pre-salt province – the dawn of a new era
Domestic investments in E&P

- Exploration
- Development of production

MM - US$ (Historical value)

Years: 1984, 86, 88, 90, 92, 94, 96, 98, 00, 02, 04, 06, 2009, 2012
Geologists and Geophysicists in Petrobras

Medium duration courses

Training
Total investments (US$)
2003/2008
Brazil: 120 MM
Abroad: 24 MM

Total of participant: 554
Proved Reserves 2008 (SPE)

Pre-salt not included

Onshore Phase

- Fluvial / Eolian 4.3%
- Carbonates 3.7%
- Alluvial / Deltaic Fans 2.2%
- Deltas 1.1%
- Turbidites 88.7%

Shallow-water Phase

- Parque das Baleias, Mexilhão, ...

Deep/Ultra-deep water Phase

- Roncador
- Marlim
- Carimópolis
- Guaricema
- Garuapa
- Namorado

14,092 BB boe
The successful history of petroleum exploration of Petrobras was marked by breaks in paradigms: hard work, determination, and competence are the key elements.

Breaking paradigms is facing risks. Definitely Petrobras is not a risk-aversion company.

The human mind, birthplace of creativity and knowledge and its continuous development are the most valuable assets of Petrobras exploratory process.
The geologic knowledge is the technical foundation for Petrobras exploratory investments.

It is based on the continuous evaluation of Brazilian sedimentary basins as a whole, not only blocks, supported by efficient training and technological development.

The commitment to Brazil and the Brazilian people is the foundation to Petrobras explorationists enthusiasm.
Petrobras commitment to Brazil continues: new challenges will appear, new paradigms will be broken.

The history has not finished...
Tupi extended production test design

1st Oil: May/2009

2 Well Production: 3-RJS-646 and P1
Expected Flow: 14,000 bpd
Test Duration: 15 months

FPSO BW Cidade de São Vicente

LDA 2,200m

Phase 1
Well 3-RJS-646
6 months

Phase 2
Well P1
6 months

Drill
Well P1

Phase 3
Well 3-RJS-646
3 months

Line relocation

6” Production
4” Service
EHU
Production Pilot

- 5 Producers
- 2 Water Injectors
- 1 Gas Injector
- Connected to a Spread Mooring FPSO

Tupi: Pilot Project Scope

Gas Pipeline
Water Pipeline
Oil Pipeline
Gas Injection
The first production in the pre-salt province

FPSO JK P-34

Linha de Produção de Óleo
Umbilical Eletrohidráulico
Cabo de Potência
Linha de Serviço

Ancoragem
Aliviador

7-JUB-04HP
7-JUB-06
3-ESS-110HPA
7-JUB-2HPA
1-ESS-103A

LDA 1,350m

7-JUB-04HP