

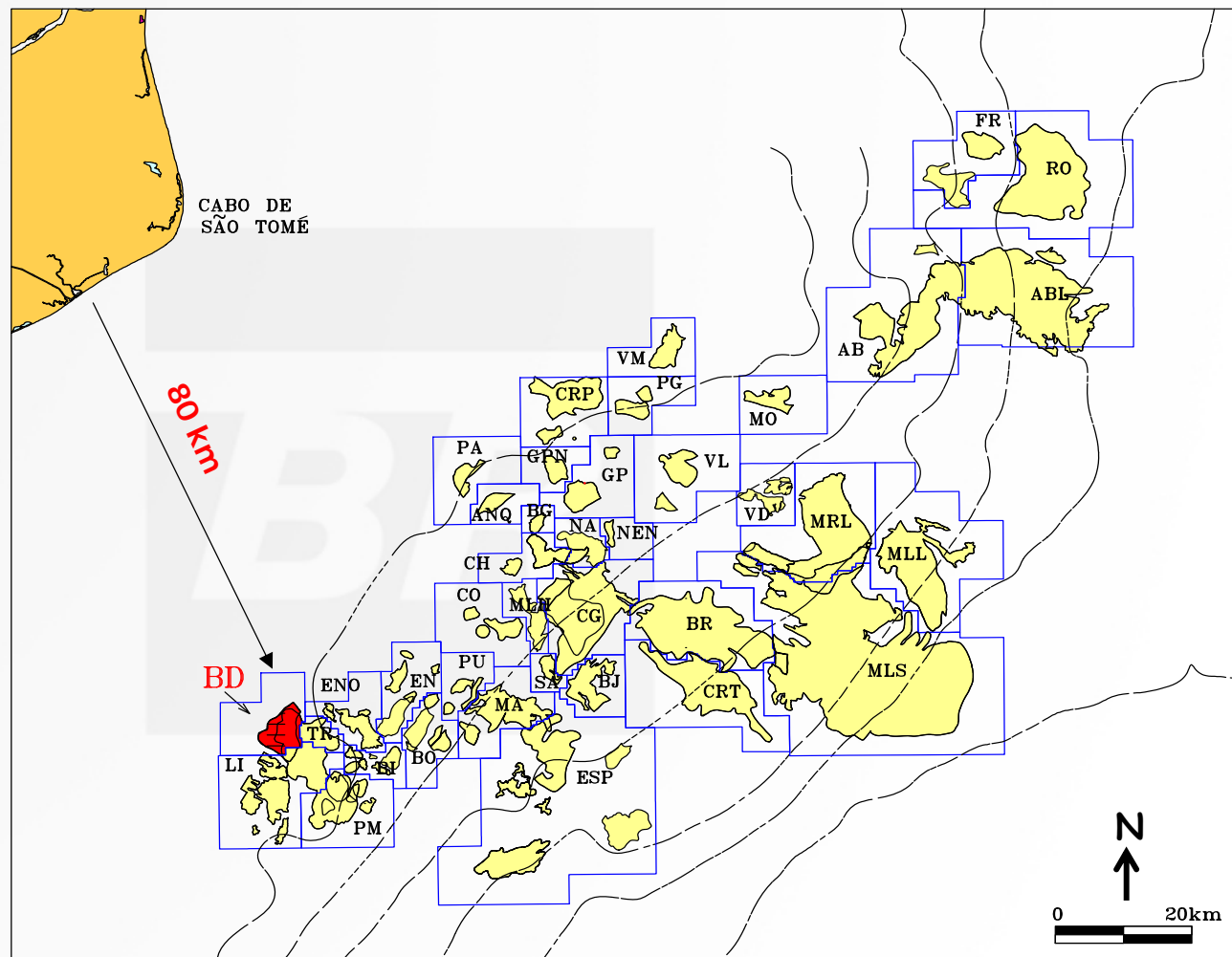
Complementary Development of Siri Reservoir

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Petrobras



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Localization – Badejo Concession

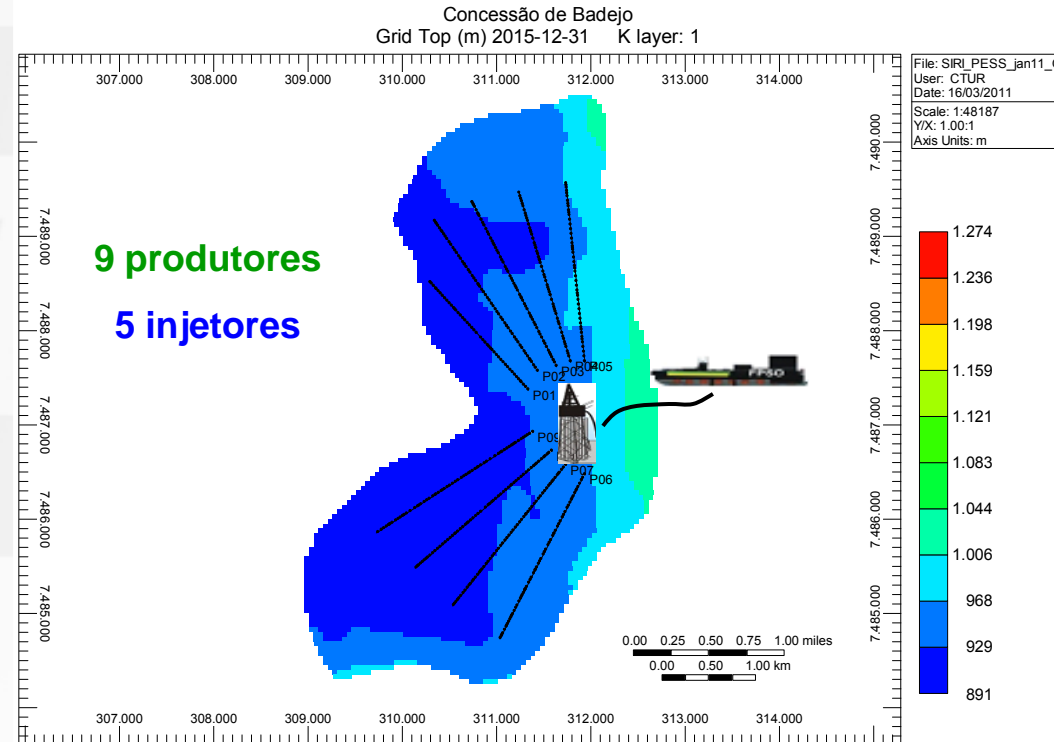


- Southwest of Campos Basin
- Water depth of 95 m



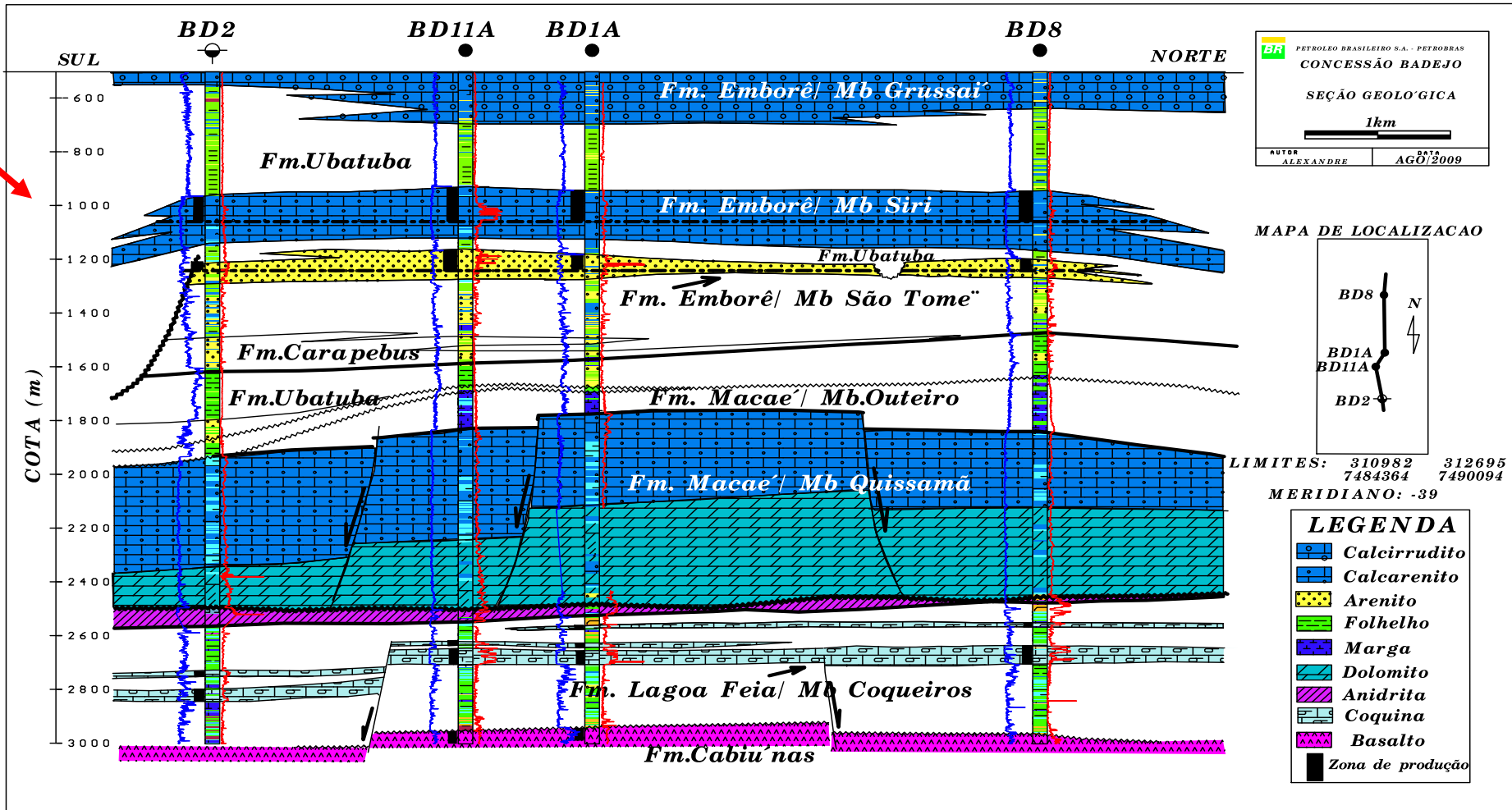
Development Plan (Conceptual Phase – 2A)

- 1 jackup
- 1 FPSO
- Oil capacity: 50.000 bpd
- Liquid capacity: 100.000 bpd
- Lifting method: ESP
- Horizontal producing and injector wells
(horizontal length up to 2000 m)
- Average liquid rate per well: 12.000 bpd
- Max. water injection rate per: 25.000 bpd
- PDG is installed in all wells



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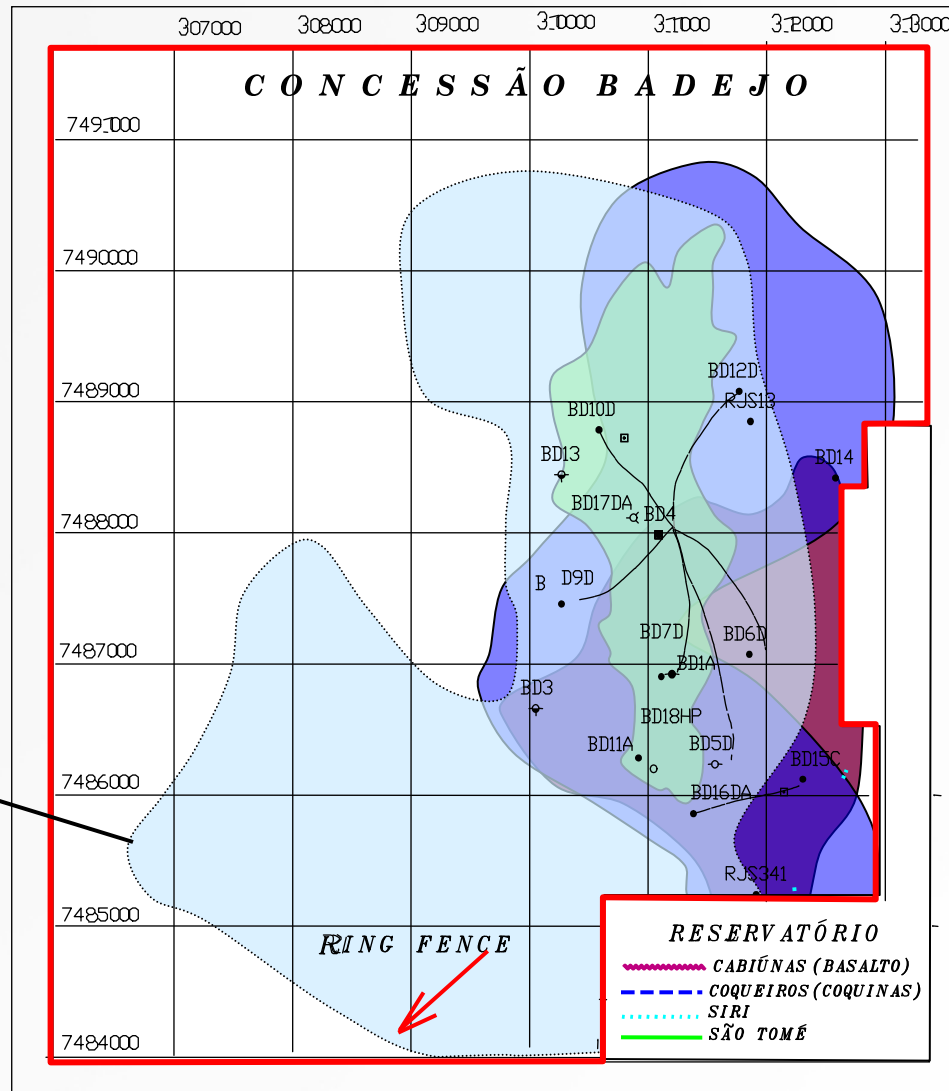
Geological Section – Badejo Concession



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Limits of the Reservoirs – Badejo Concession

Limits of Siri Reservoir from previous geological model.



General Info – History of Siri Reservoir

1975 – Discovery of Badejo Field (1-RJS-13).

Siri reservoir was not tested as there was no interest in heavy oil.

1981 – Start of the production of Badejo Field.

1997 – Formation test in 7-BD-11A.

Production rate of 95 m³/d.

Viscosity at reservoir of 320 – 380 cP.

2002 – Reservoir acquisition data well (ADW) proposed (horizontal well of 2000m).

2004 – Drilling of horizontal well, 9-BD-18HP.

Oil rate during test: 350 m³/d with ESP.

Bottom hole fluid monophasic sample.

Pilot production system proposed.

Apr/2008 – Start of pilot production system.

FPSO Cidade Rio das Ostras

2015 – Beginning of definitive production system.



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General Data – Reservoir Characteristics

RESERVOIR	COQUINA	BASALTO	SIRI	SÃO TOMÉ
Core samples (wells/meters)	1/82	7/153	2/80	1/14
Formation	Lagoa Feia	Cabiúnas	Emborê	Emborê
Lithology	Limestone	Basalt	Limestone	Sandstone
Area (km ²)	15	28	23	6
Net Pay (m)	15	100	70	30
Porosity (%)	12	?	25	26
Permeability (mD)	250	? fracture	1-10000	10-1050
Water Saturation (%)	15	?	36	24
Gas/Oil Contact (m)	-	-	-	-
Oil/Water Contact (m)	-2938	-3113	-1050	-1236



General Data – Fluid Characteristics

RESERVOIR	COQUINA	BASALTO	SIRI	SÃO TOMÉ
PVT analysis	15	1	2	1
°API	30	28	12.3	12.4
P_i (kgf/cm ²)	293	350	100.7	120.5
P_{sat} (kgf/cm ²)	253	102	88	109.8
$P_{current}$ (kgf/cm ²)	100 @ -2850	88 @ -2950	97 @ -995	119
Viscosity at reservoir (cP)	1.2	2.5	314	145
Temperature (°C)	88	90	48	53
Bo_i (m ³ /m ³)	1.53	1.2	1.06	1.068
Bg (m ³ /m ³)	0.0043 @ 253 kgf/cm ²	0.0089 @ 136 kgf/cm ²	0.016 @ 70 kgf/cm ²	0.014 @ 70 kgf/cm ²
Rs_i (m ³ /m ³)	156	58	25	27



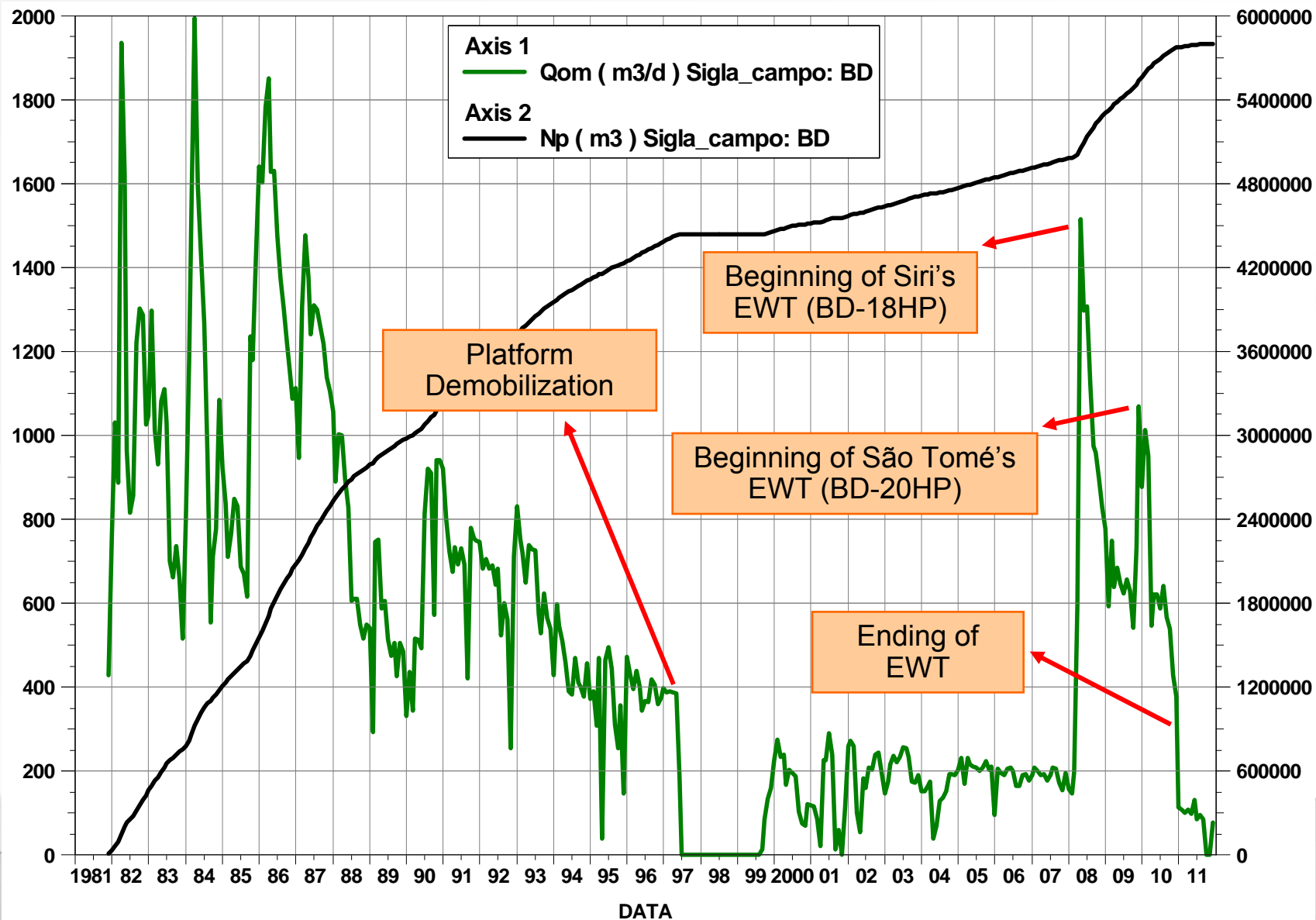
Volumes e Reserves (MM m³) – Dez/2011

Badejo Concession

Production Zone	VOIP	Np	Recovered Fraction (%)	Reserve 1P	Reserve 2P	Reserve 3P	Recovery Factor (%)
CB-BD7D	6,675	0,975	14,6	0,065	0,065	0,065	15,6
CB-RJS258	5,913	0,911	15,4	0,048	0,048	0,048	16,2
CB-RJS341	6,847	1,050	15,3	0,037	0,037	0,037	15,9
CQ10-BD16DA	0,005	0,000	0,0	0,000	0,000	0,000	0,0
CQ10-BD9D	0,002	0,000	0,0	0,000	0,000	0,000	0,0
CQ40/50/60	7,213	2,248	31,2	0,076	0,076	0,076	32,2
SR	233,000	0,509	0,2	14,047	16,741	19,242	8,5
ST	18,000	0,107	0,6	0,000	0,000	3,259	18,7

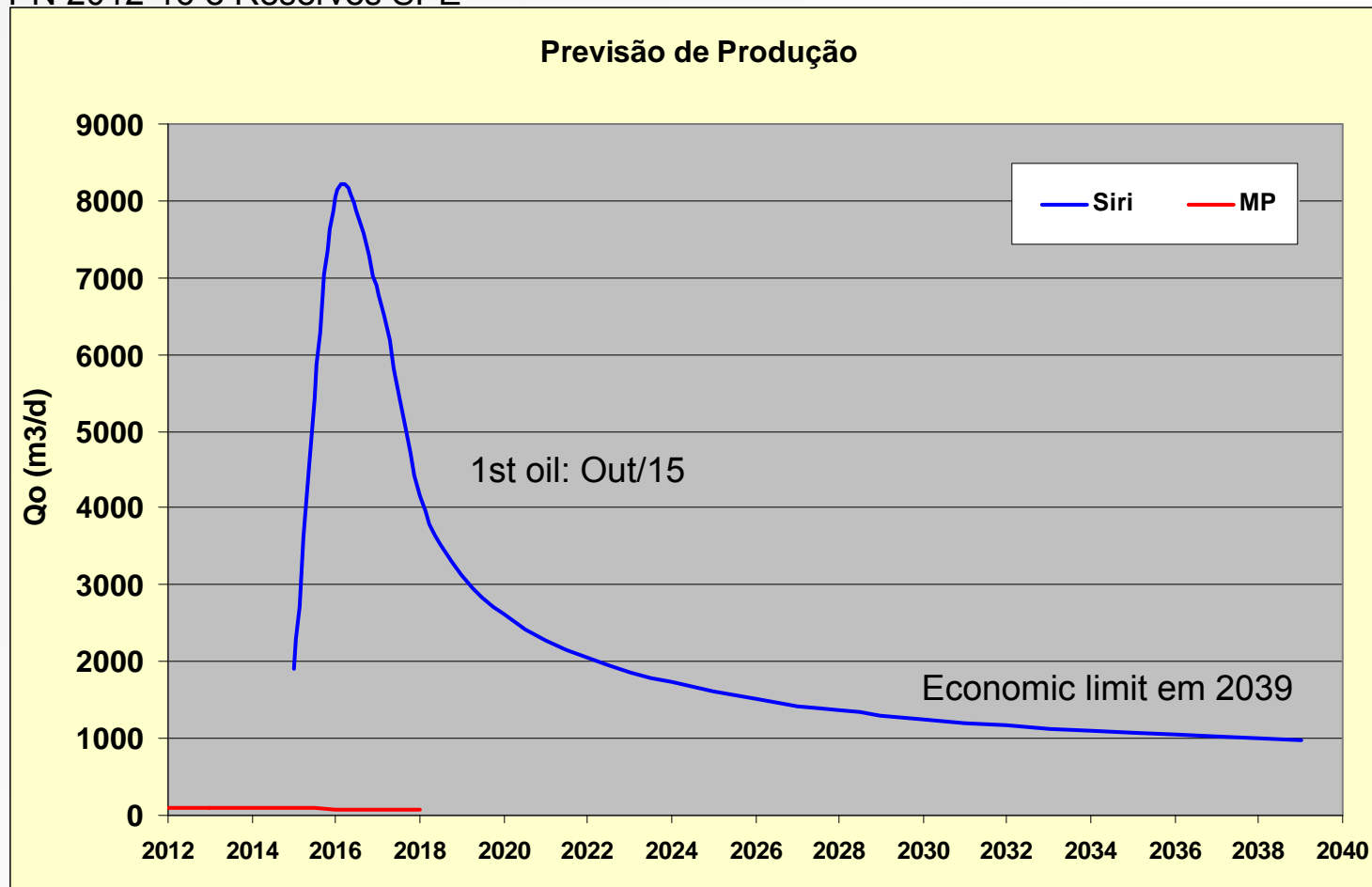
- Producing
- Under development
- Without project

General Data – Field Production History



General Data – Projects Production Prevision MP e DP

PN 2012-16 e Reserves SPE



OBS: Siri's forecast based on pessimist geological model generated before ADWs.

Siri Reservoir – Challenges

• Reservoir

- Water injection: low swap efficiency due the mobility ratio favorable to water;
- Reservoir pressure near the bubble point ($\Delta P \sim 12 \text{ kgf/cm}^2$);
- Improve the efficiency of well acidizing to maximize the effective horizontal length (up to 2000m).

• Other areas

- Flow assurance in wells with oil viscosity of 314 cP (reservoir condition);
- Drilling/completion wells in shallow reservoir ($\sim 1000\text{m}$) and with ESP;
- Avoid the occurrence of *gas lock* in ESP;
- Temperature in process system over than 130°C ;
- Difficulties in gas/oil separation (need of chemical products injection).



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