

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

Formigli, J., 2007, Pre-Salt Reservoirs Offshore Brazil: Perspectives and Challenges: Bank of America Energy Conference, Web Accessed October 14, 2018, <http://www.investidorpetrobras.com.br/download/1462>

Moreira, J.L.P., C.V. Madeira, J.A. Gil, and M.A.P. Machado, 2007, Santos Basin: Bul. Geoc. Petrobras, v. 15, p. 531-549.

Saller, A., S. Rushton, L. Buambua, K. Inman, R. McNeil, and J.A.D. Dickson, 2016, Presalt stratigraphy and depositional systems in the Kwanza Basin, offshore Angola: AAPG Bulletin, v. 100/7, p. 1135-1164.

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

Marina Abelha
Eliane Petersohn

Salt Lake City, Utah
May 22rd, 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

Outline



1 Brazil's Current State

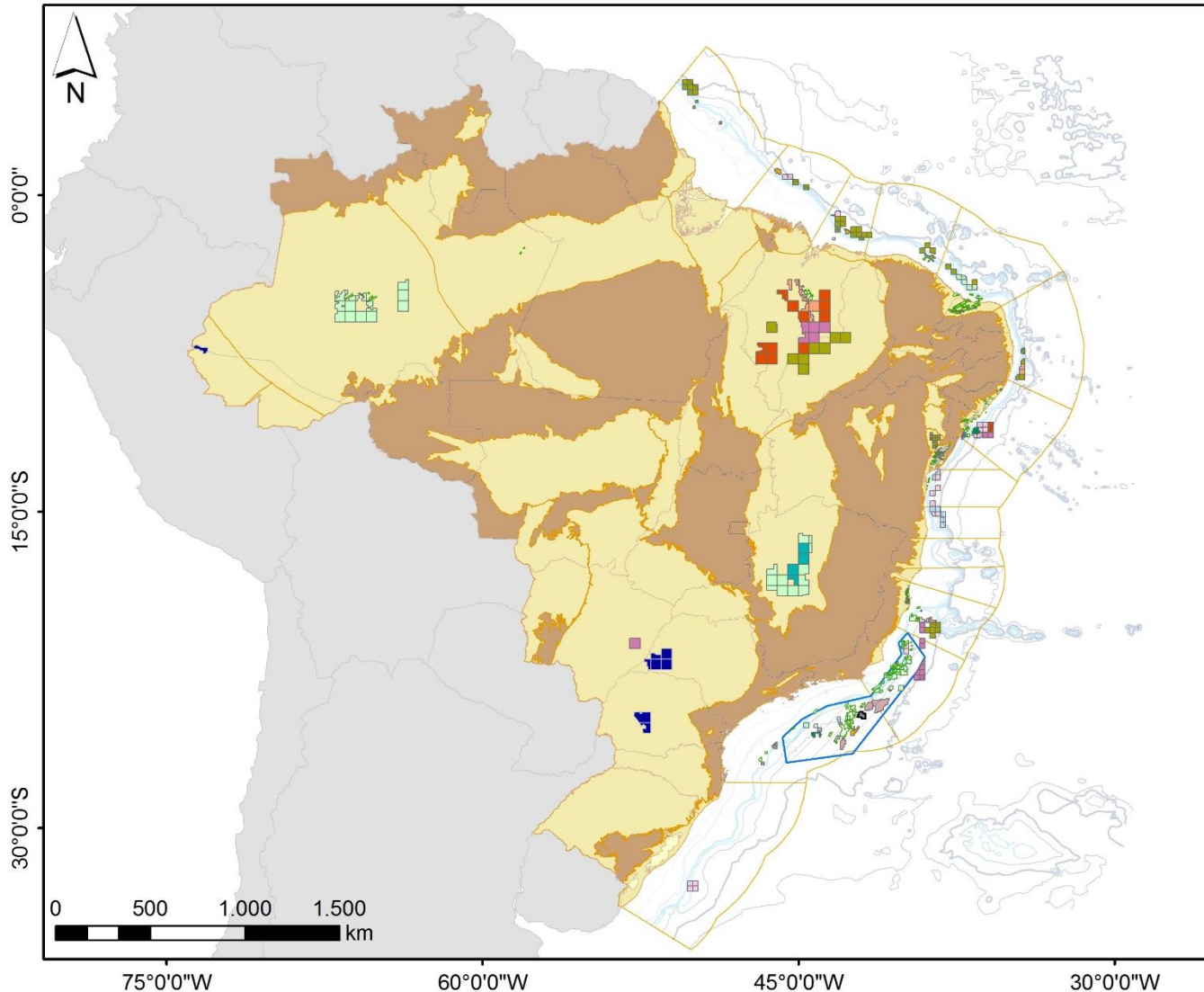
2 The Pre-Salt Play

3 2017 to 2019 Pre-Salt Licensing Rounds: Giant Leads

4 Final Remarks

Brazil's Current State

Sedimentary Area: 7.5 million km²



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

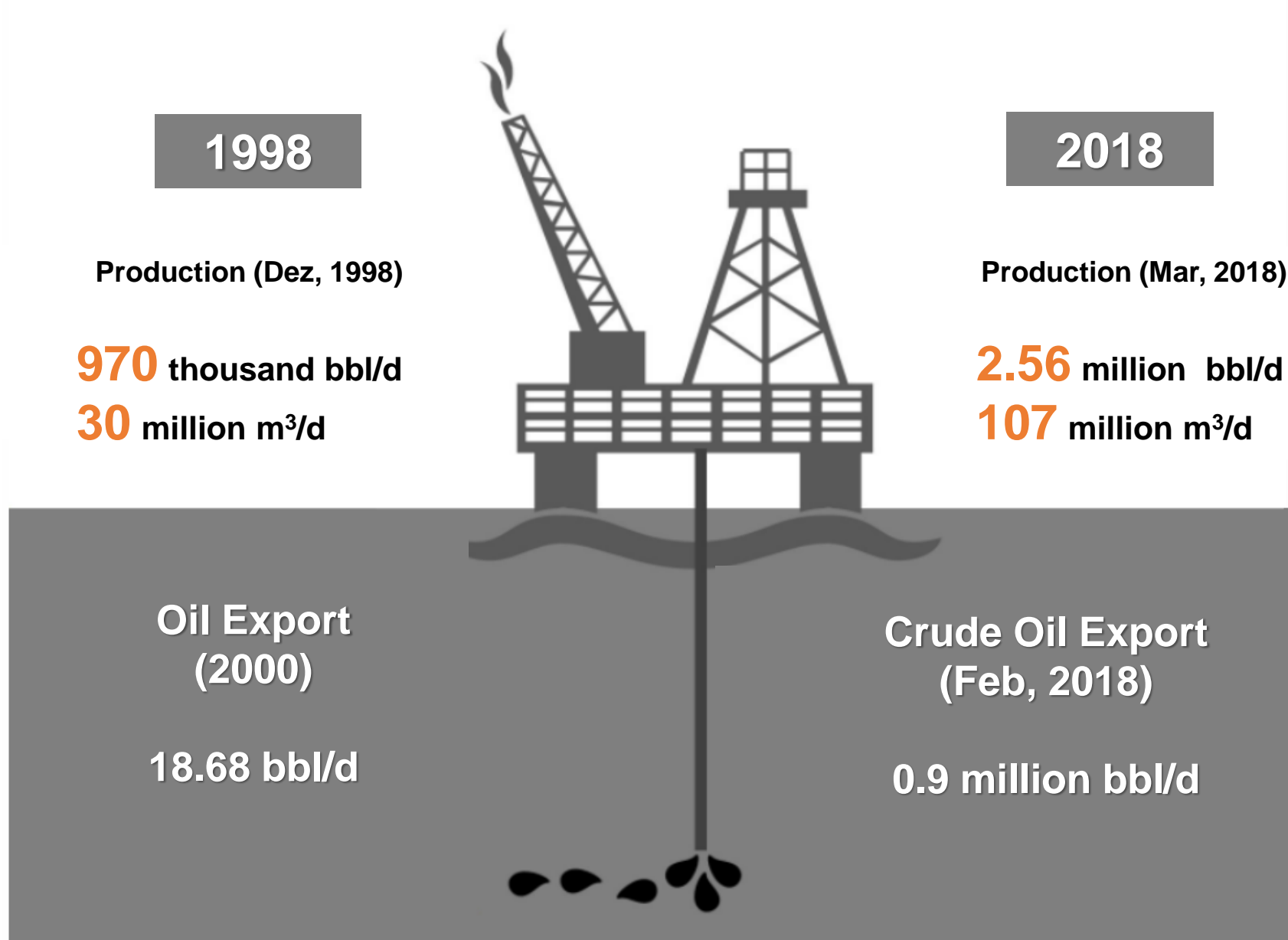
Proven Reserves
(Dez, 2017)

Oil 12.8 billion barrels

Natural Gas 367 billion m³

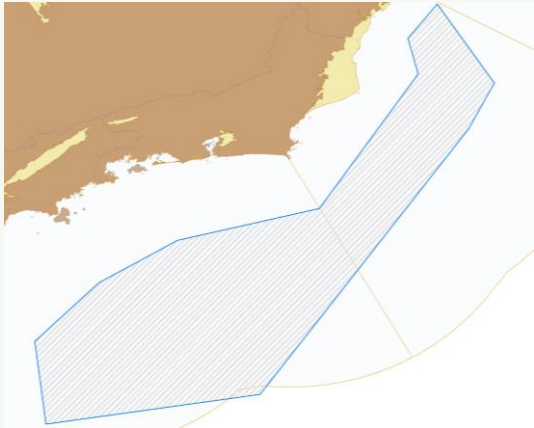
**10th largest oil producer in the world
and the largest in Latin America**

Oil Production in Brazil



Brazil's Prospectivity

Pre-Salt

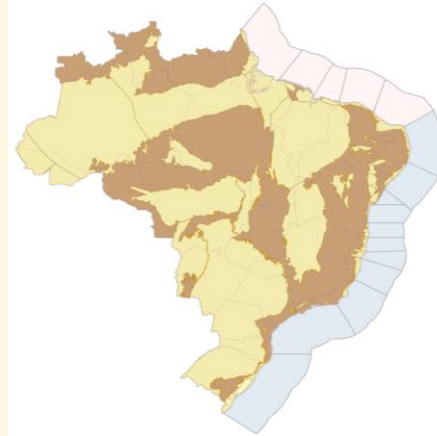


High quality **Carbonate Reservoirs** underneath the salt layer

High **well productivity** more than 30,000 bpd in the beginning of production

Potential for giant or supergiant field discoveries

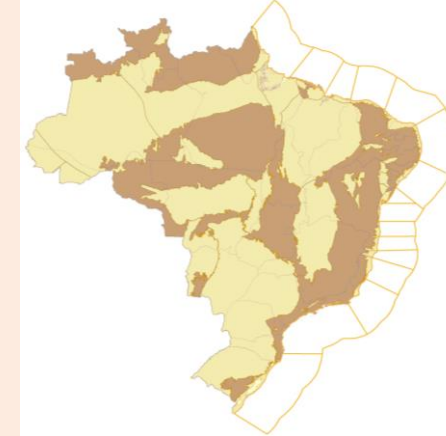
Conventional Offshore



Eastern and Equatorial Margin

Potential for oil discoveries from the Upper Cretaceous to Paleogene turbidite reservoirs

Onshore

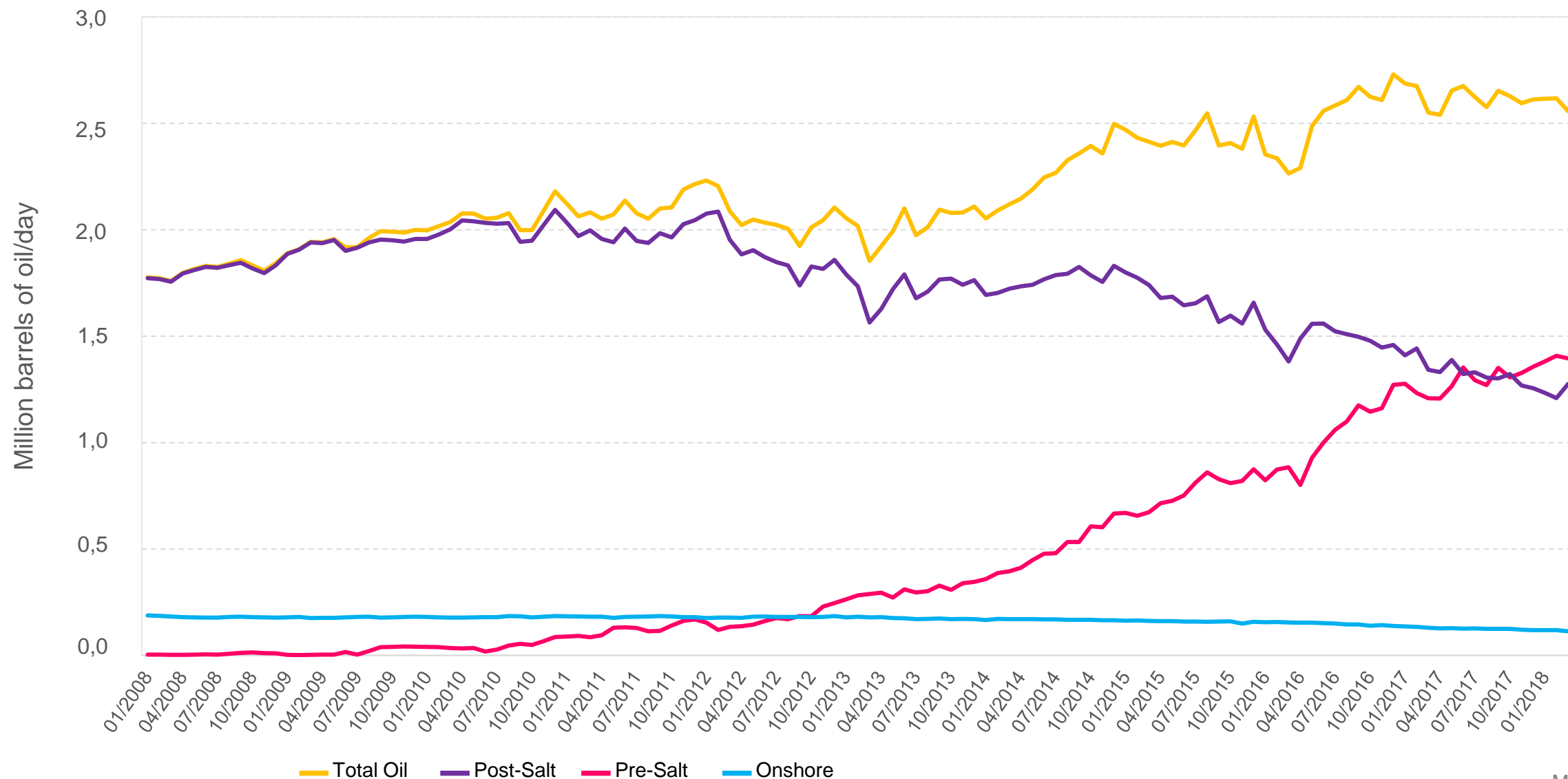


Mature Basins
(Remaining Potential)

New Frontier Basins
Solimoes Basin: Potential for light oil accumulations

Paleozoic and Proterozoic basins: gas prone

Oil Production in Brazil



Proven Reserves

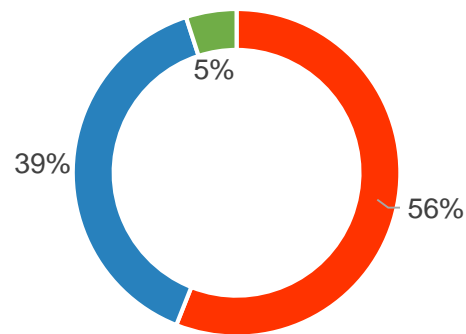
December, 2017

15 Billion boe

Oil
12.8
Billion bbl

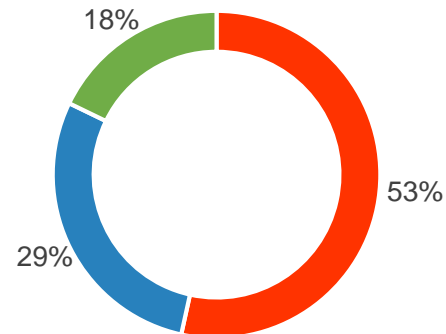
Gas
367
Billion m³

Oil Proven Reserves



■ Pre-Salt ■ Conventional Offshore ■ Onshore

Gas Proven Reserves



■ Pre-Salt ■ Conventional Offshore ■ Onshore

Pre-Salt



Conventional Offshore



Onshore



Outline



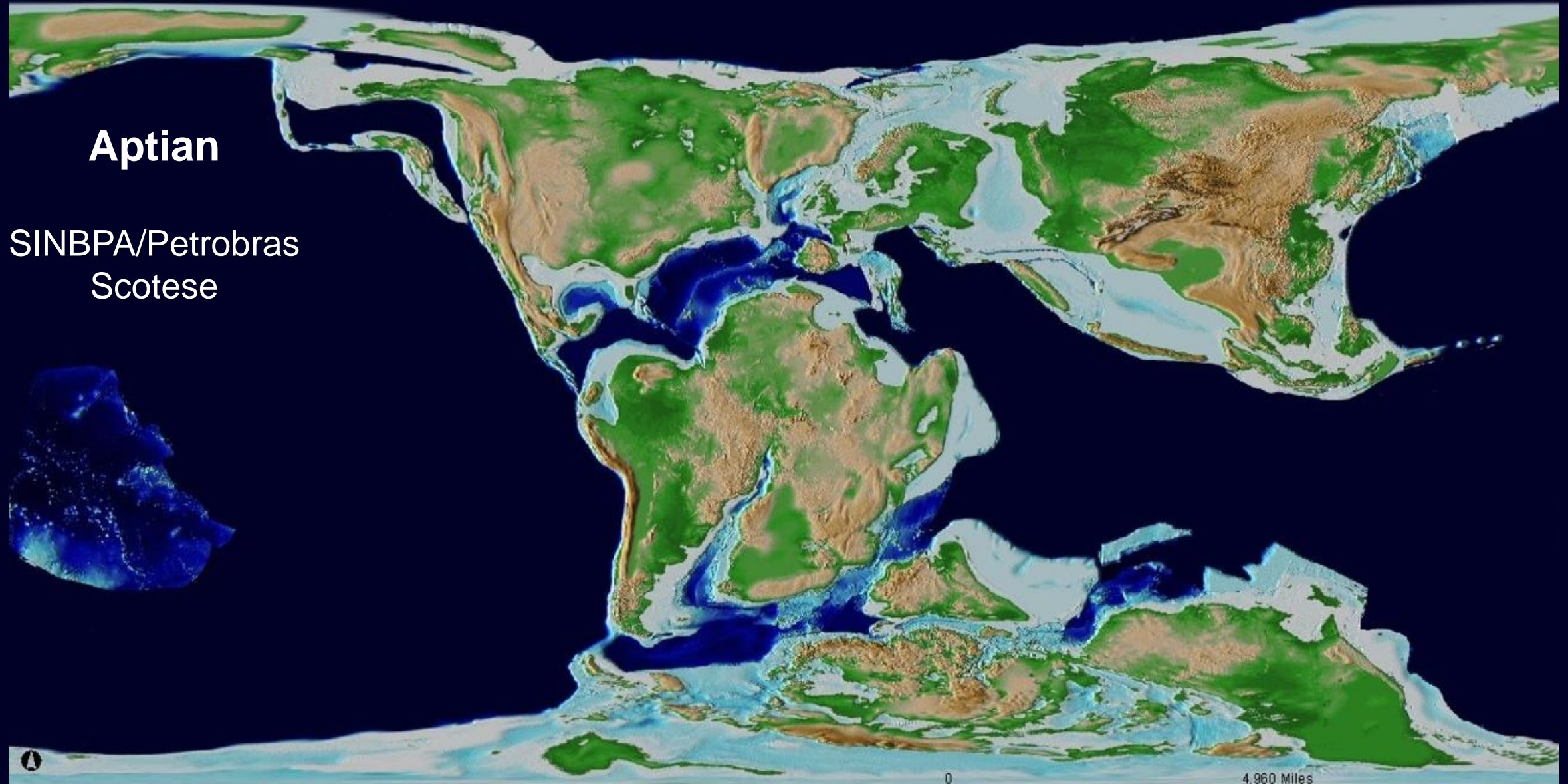
1 Brazil's Current State

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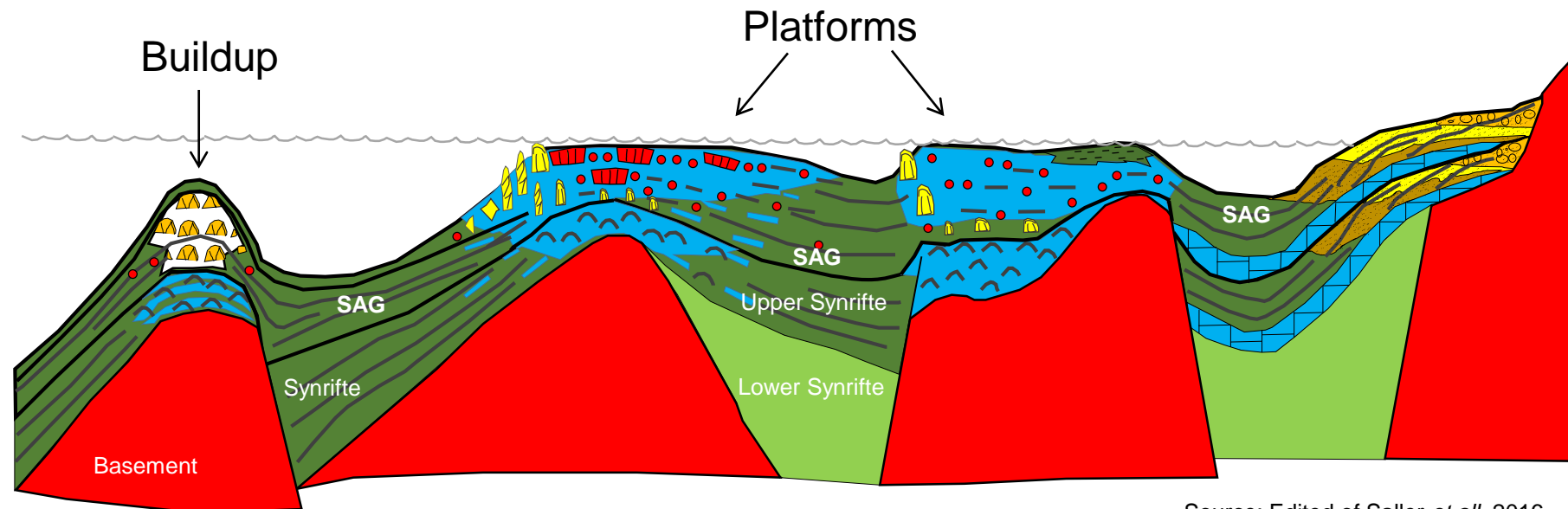
4 Final Remarks

The Pre-Salt Play

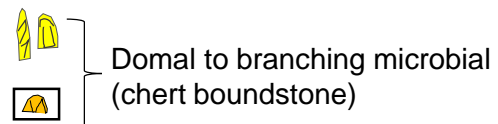


The Pre-salt Play

Depositional Model



Source: Edited of Saller *et al*, 2016.



Shrubby microbial boundstone

Shale (commonly organic-rich)

Intraclast-spherulite (packtone - grainstone)

Wackestone - packstone with spherulites

Argillaceous limestone & marl with spherulites

Lime packestone - grainstone with mollusk shells

Argillaceous limestone & marl

Mud flat dolomite

Micritic limestone (mudstone - wackestone)

Transgressive limestone

Siltstone

Sandstone

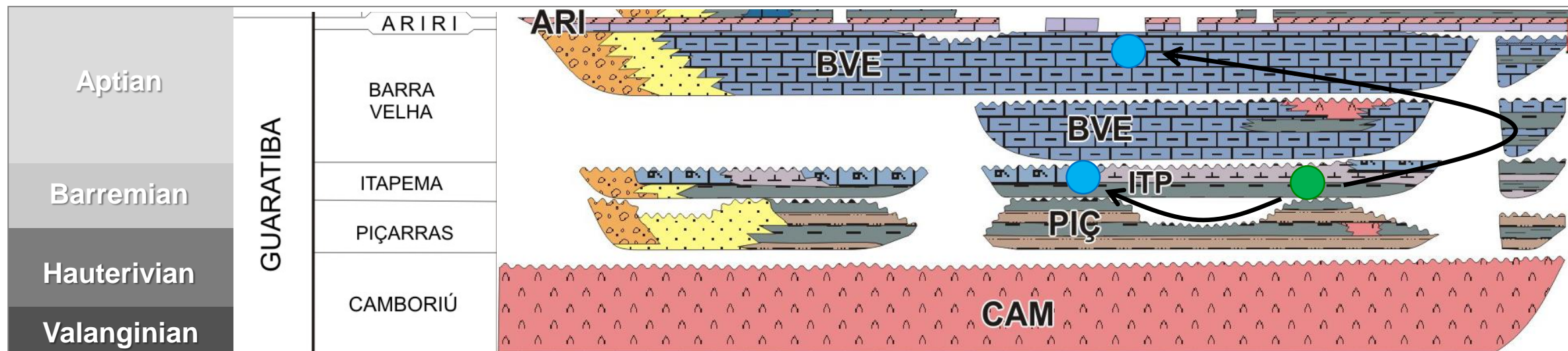
Conglomerate

Basement

The Pre-salt Play

Petroleum System

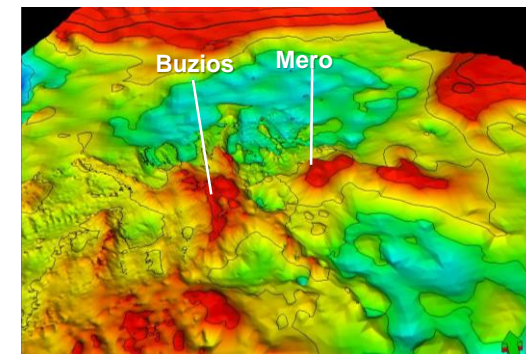
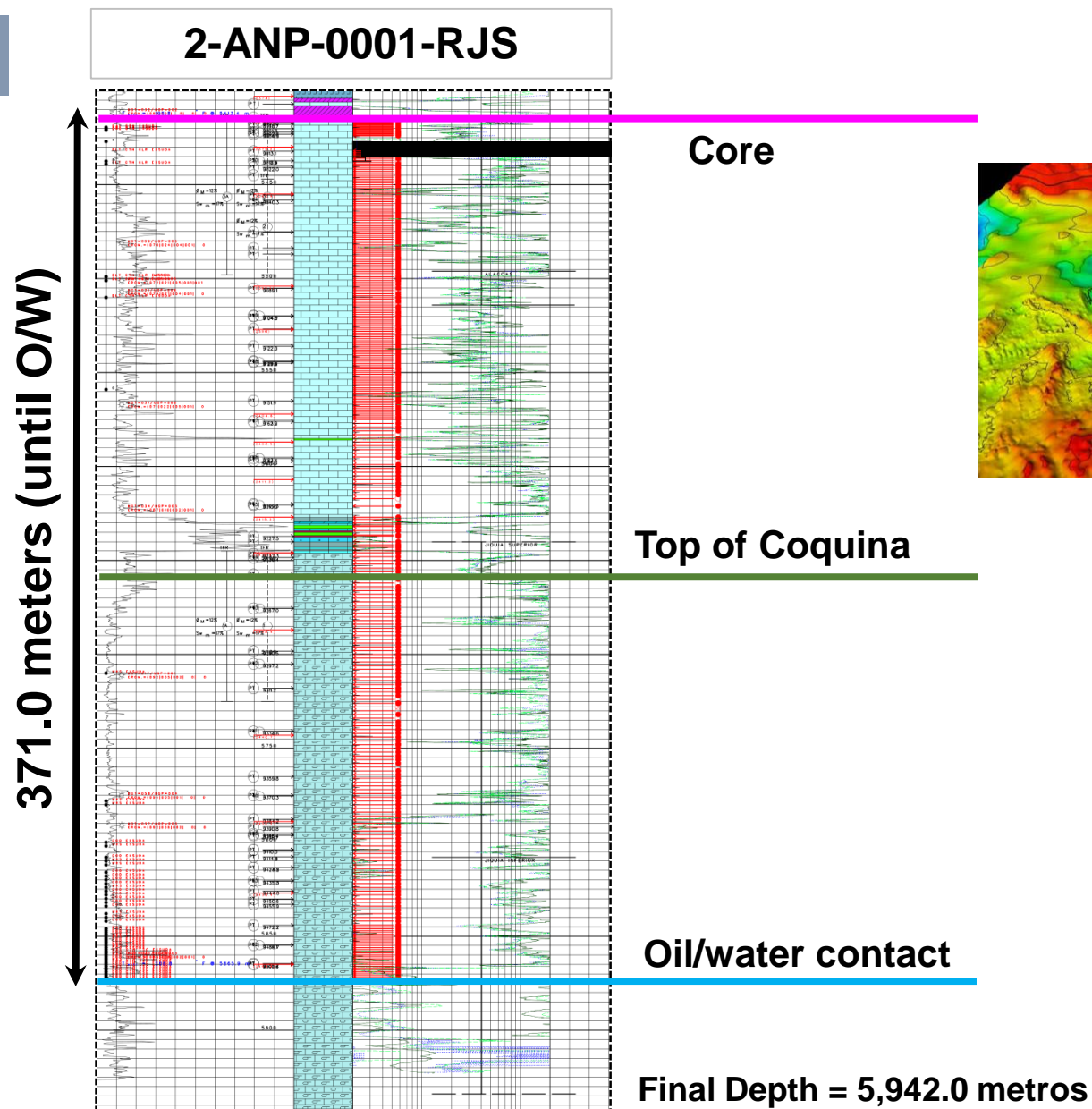
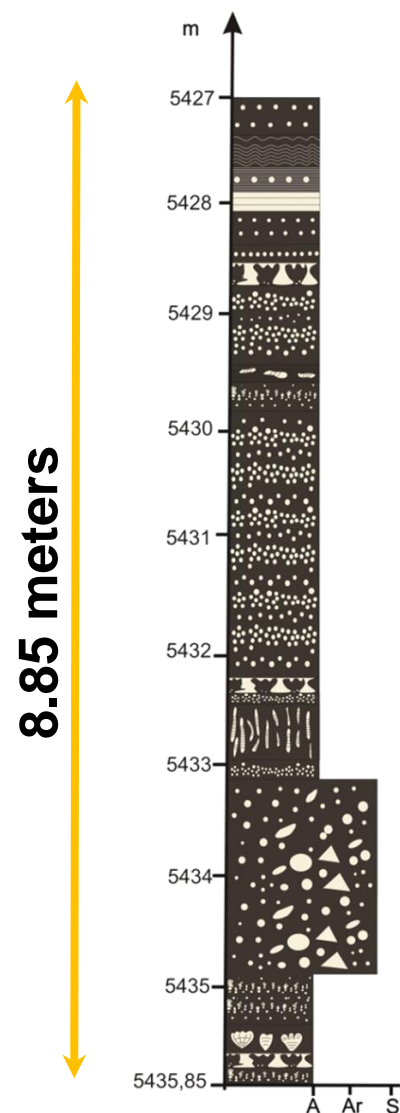
Itapema – Itapema/Barra Velha



Stratigraphic chart: Moreira *et al.*, 2007

The Pre-salt Play

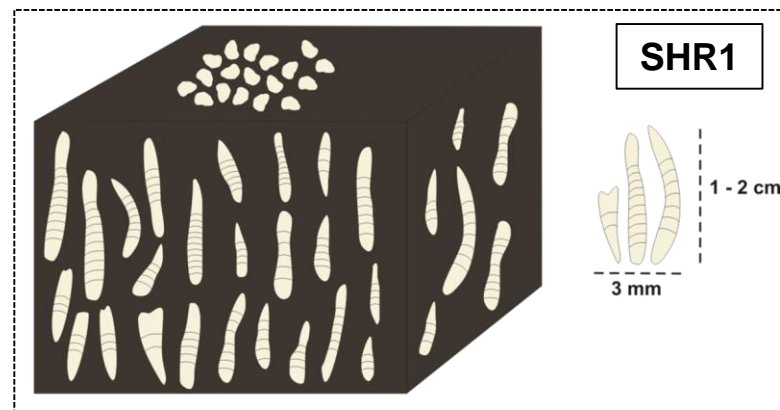
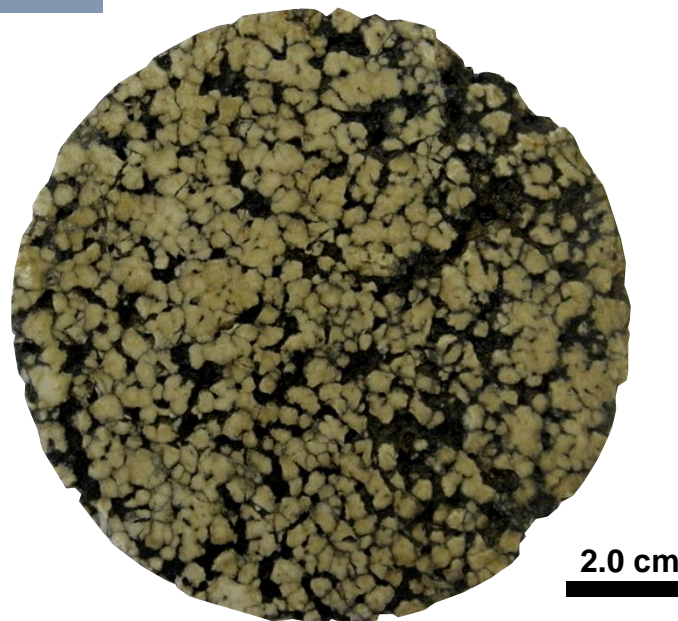
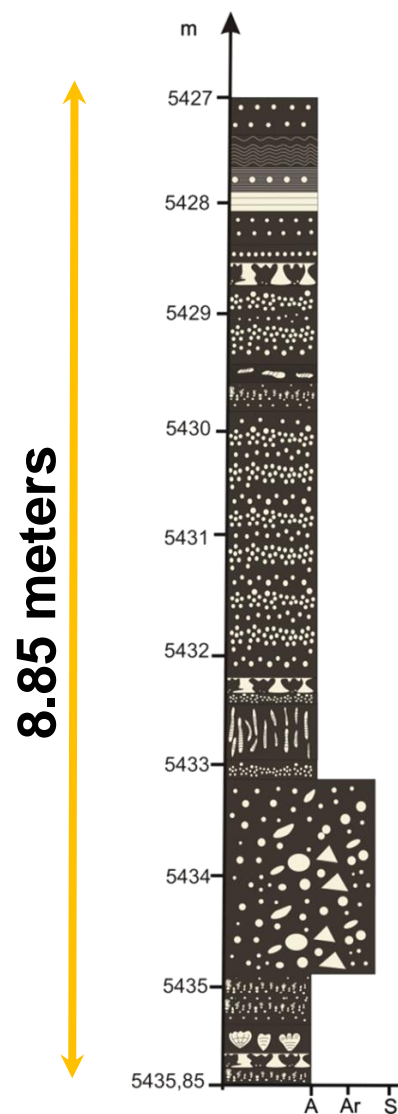
Buzios Field – Facies Example



The Pre-salt Play

Buzios Field – Facies Example

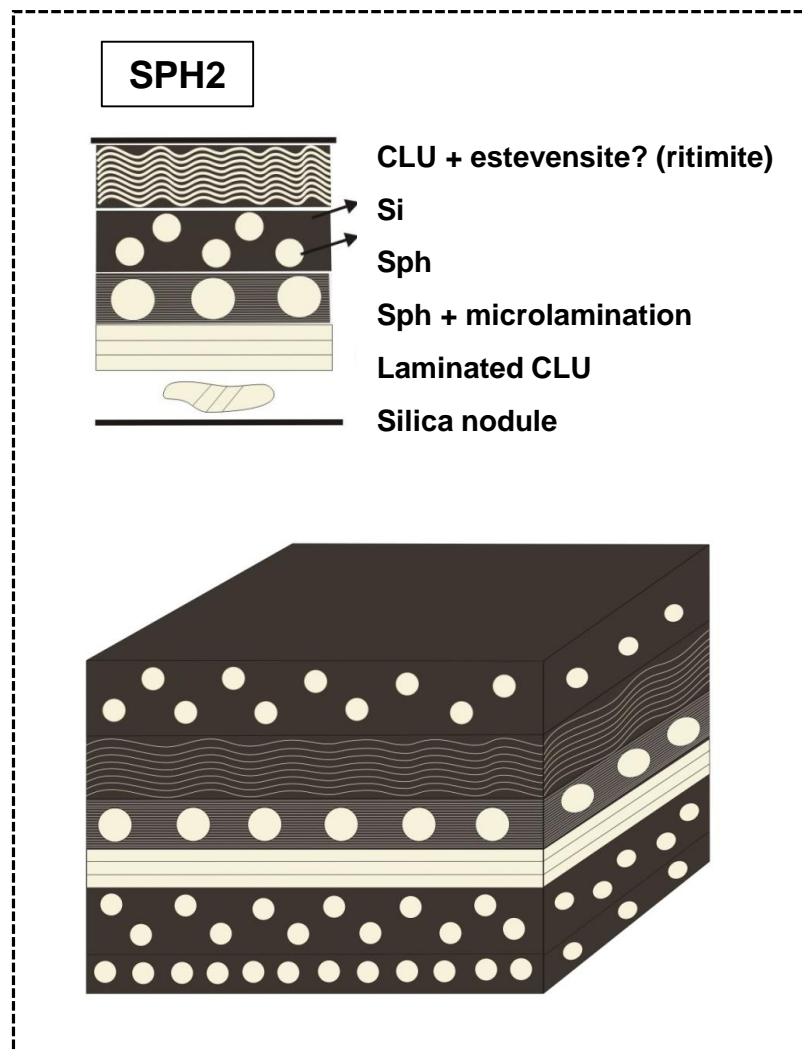
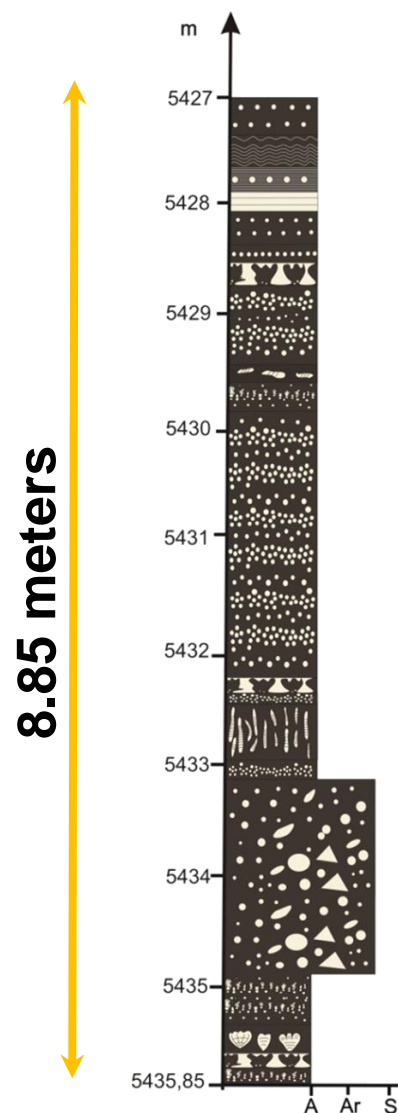
Schrubs



The Pre-salt Play

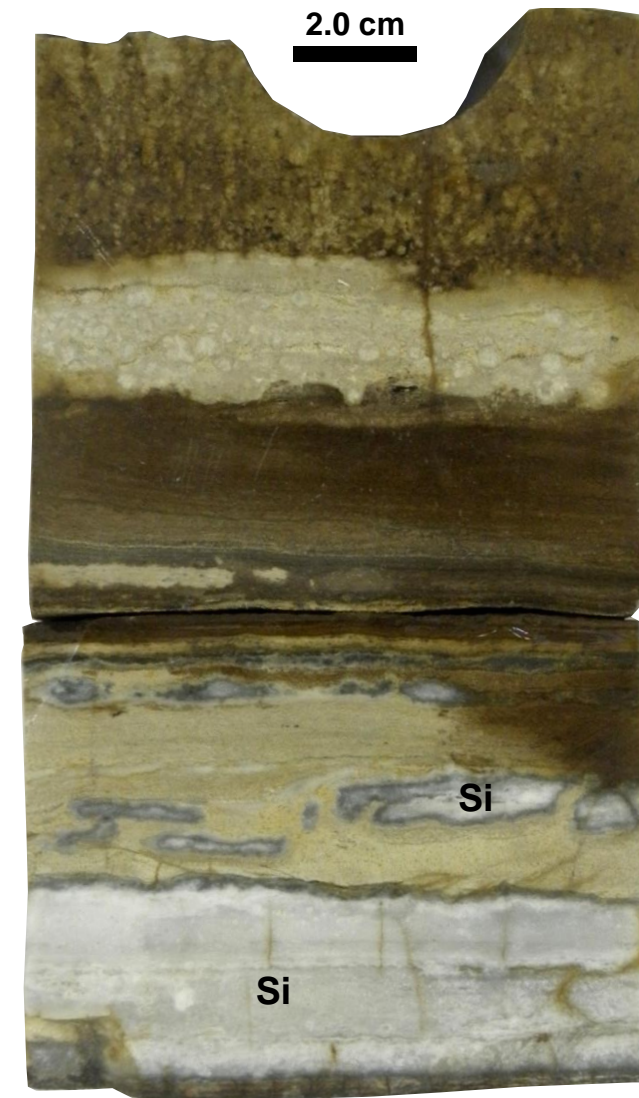
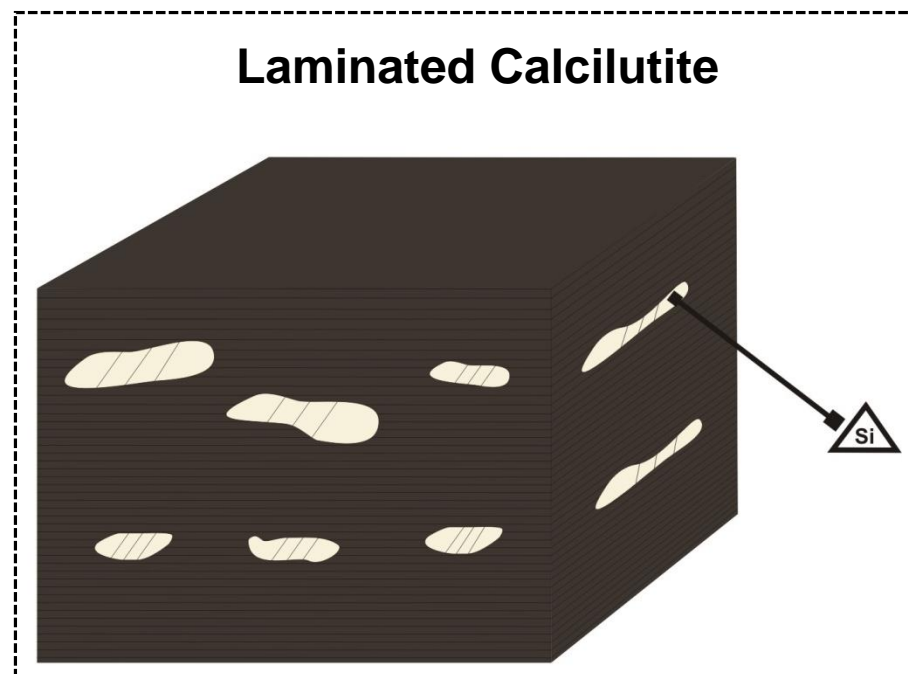
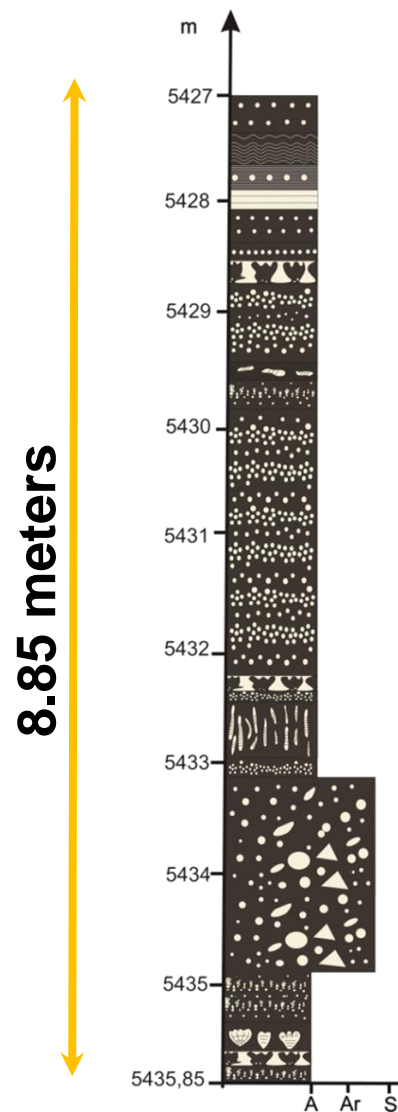
Buzios Field – Facies Example

Spherulite



The Pre-salt Play

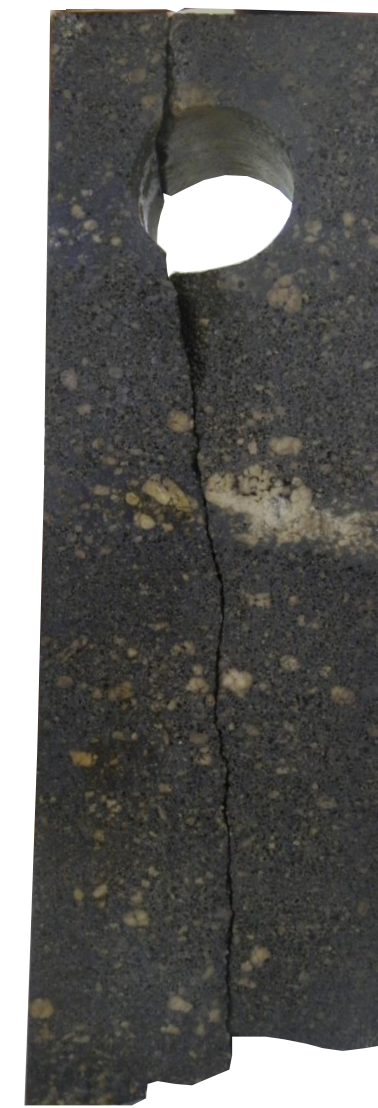
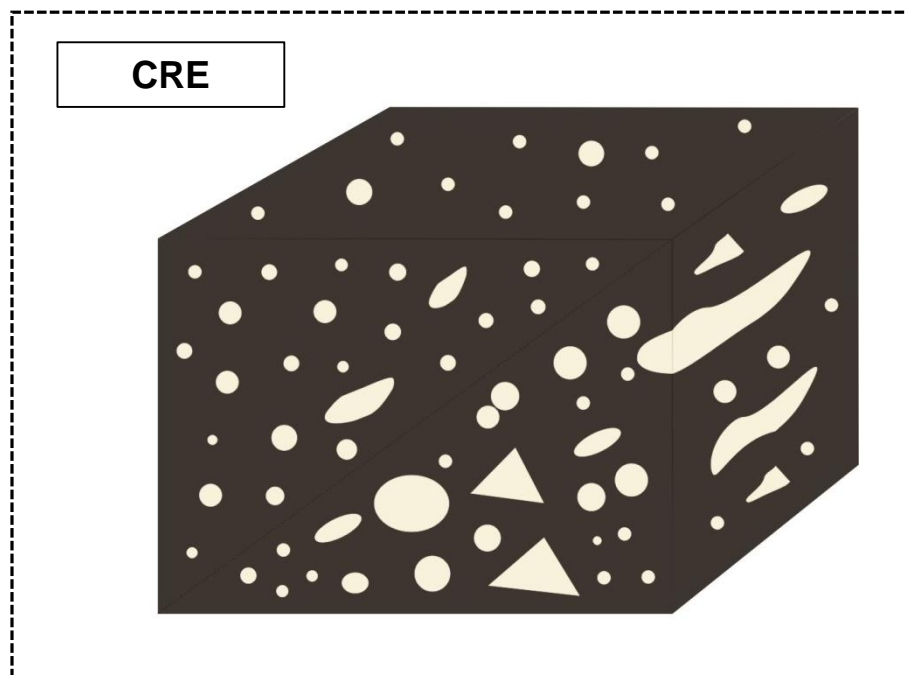
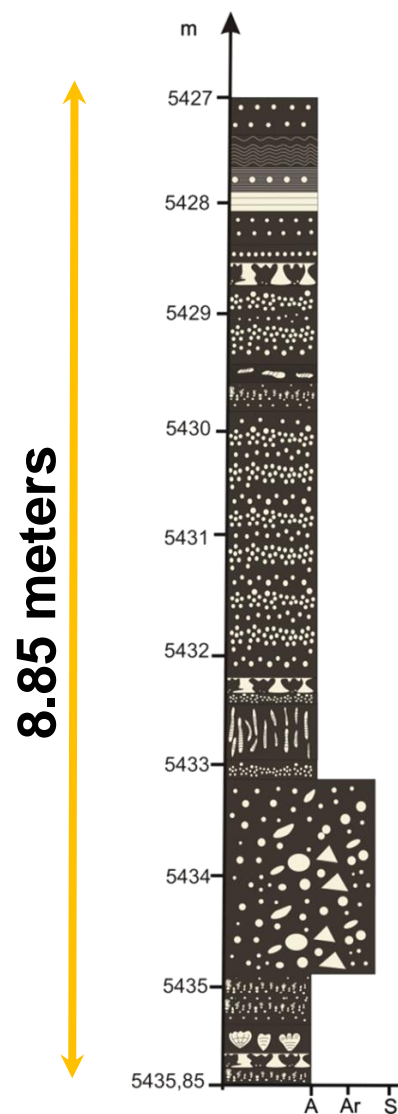
Buzios Field – Facies Example



The Pre-salt Play

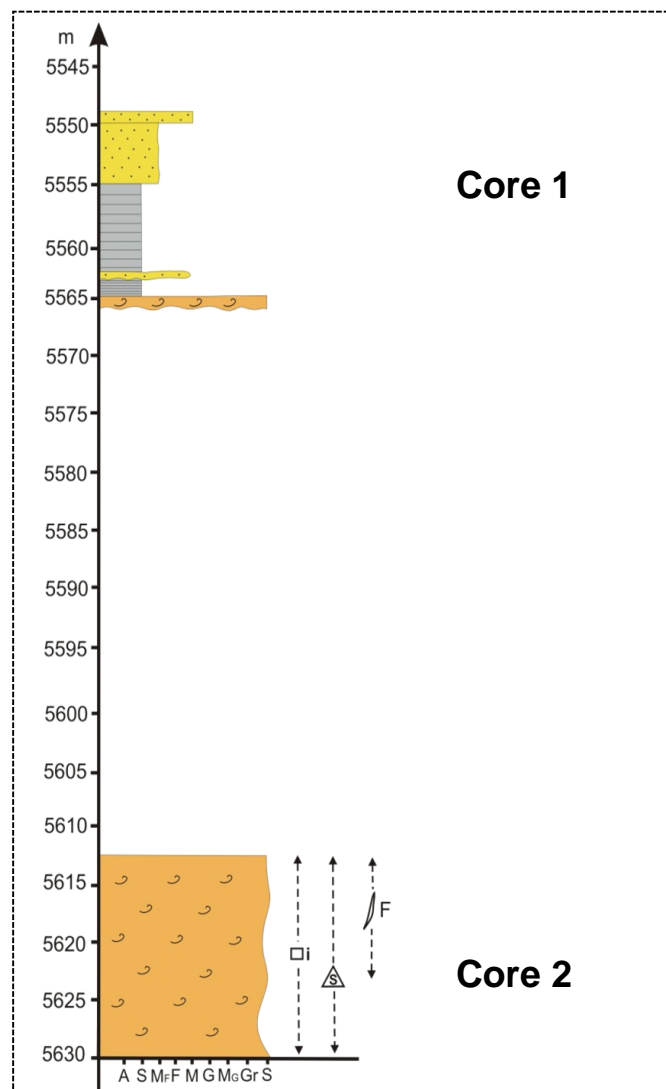
Buzios Field – Facies Example

Calcareenite

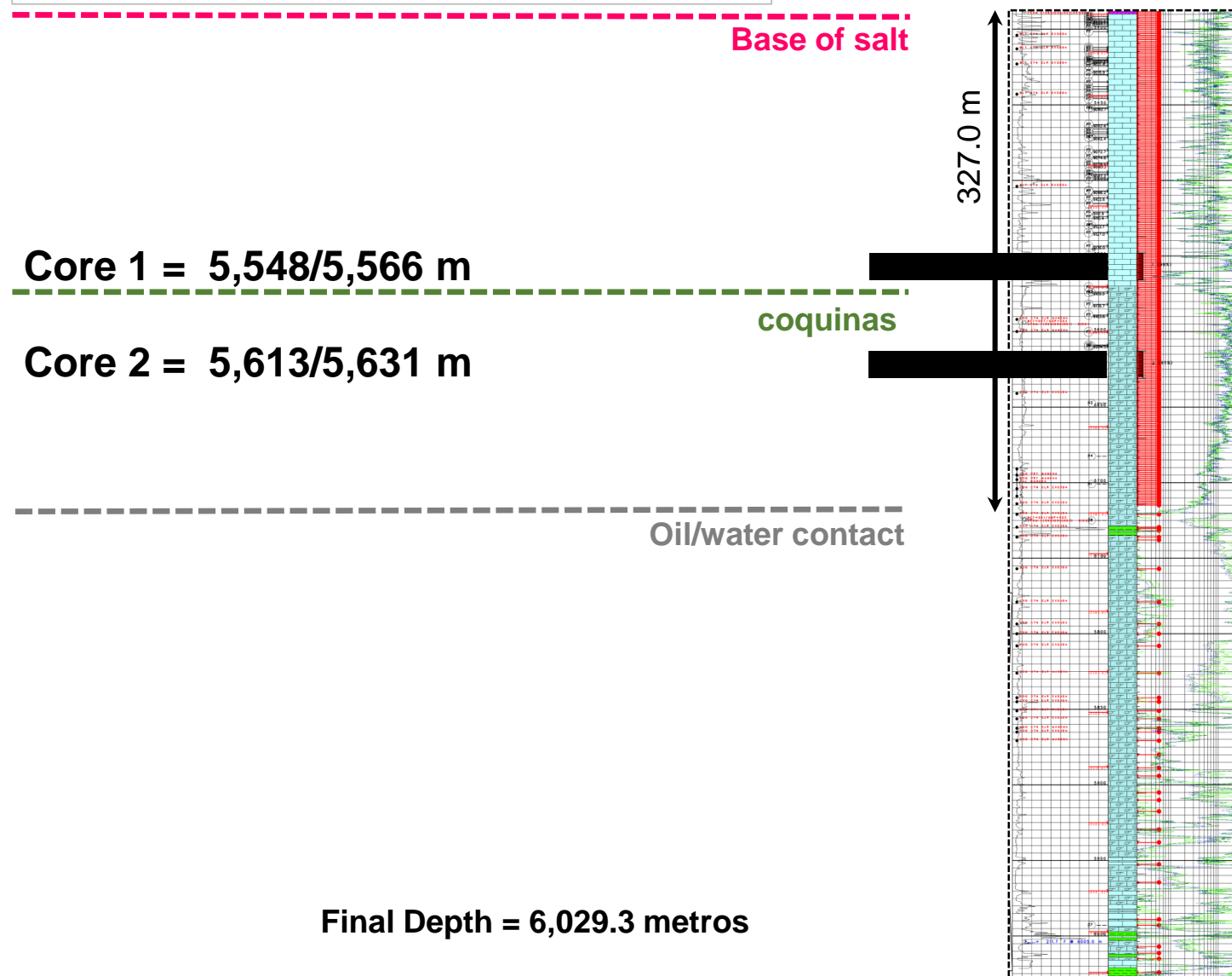


The Pre-salt Play

Mero Field – Facies Example

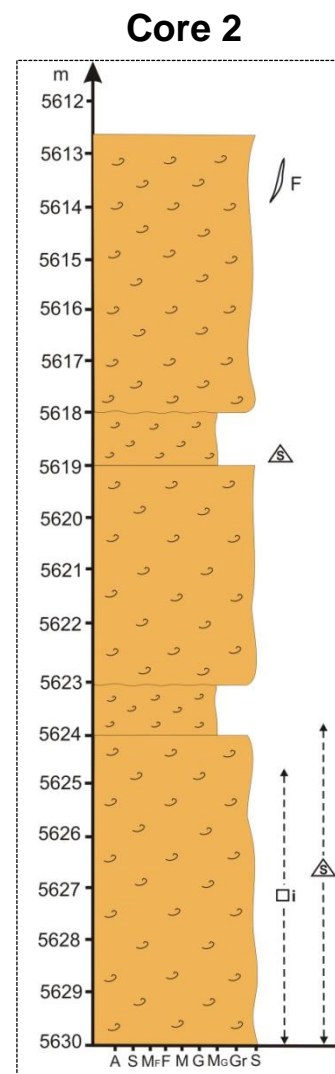
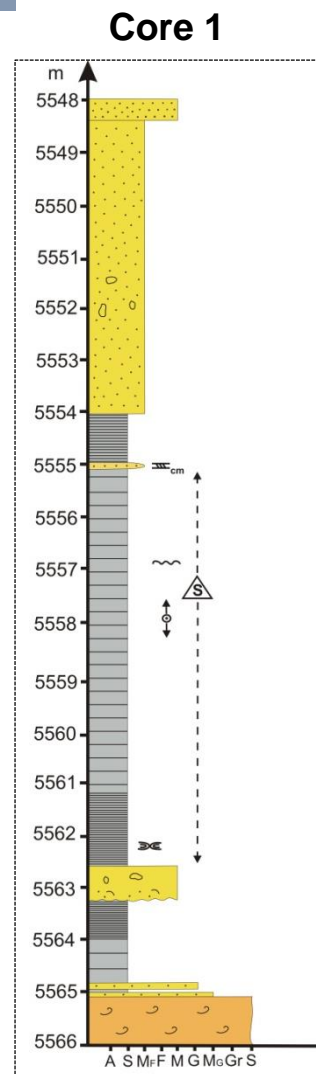
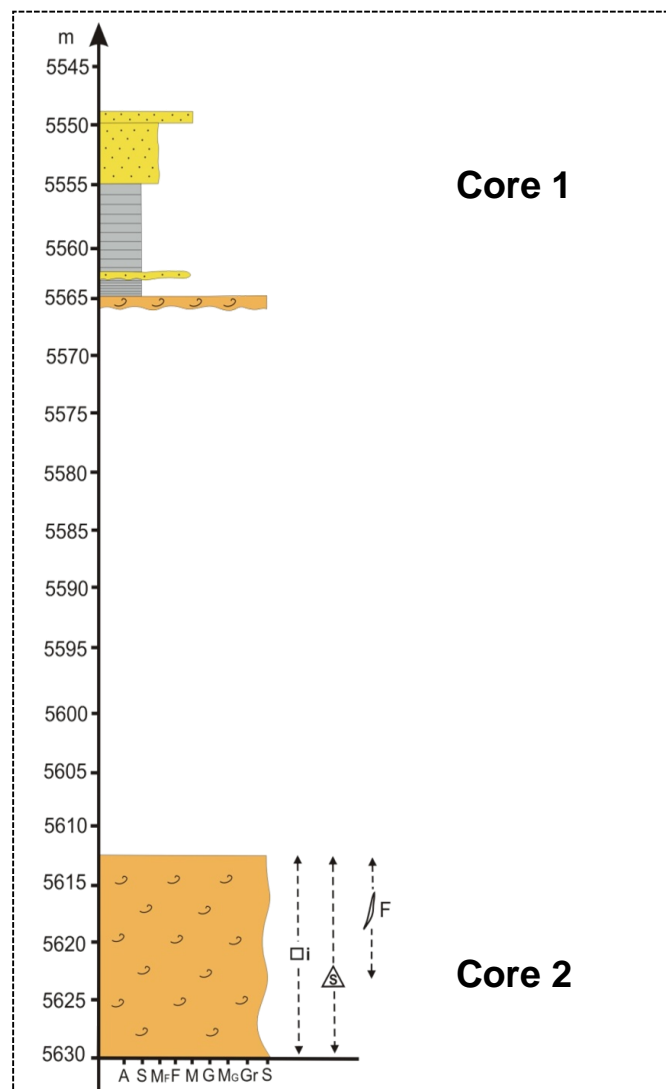


2-ANP-0002A-RJS



The Pre-salt Play

Mero Field – Facies Example



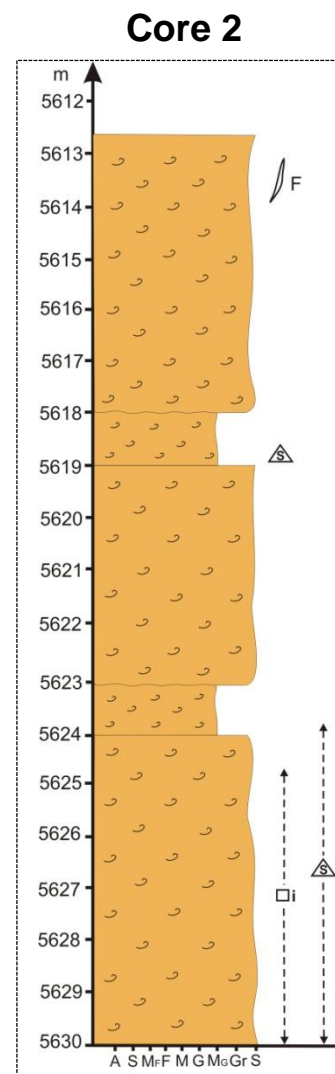
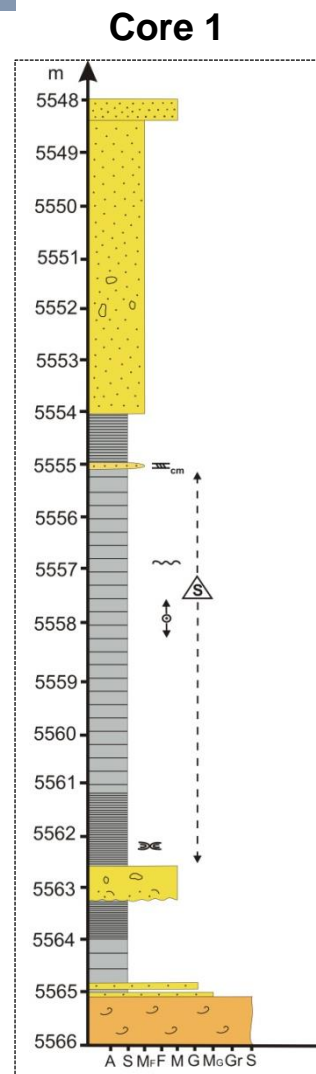
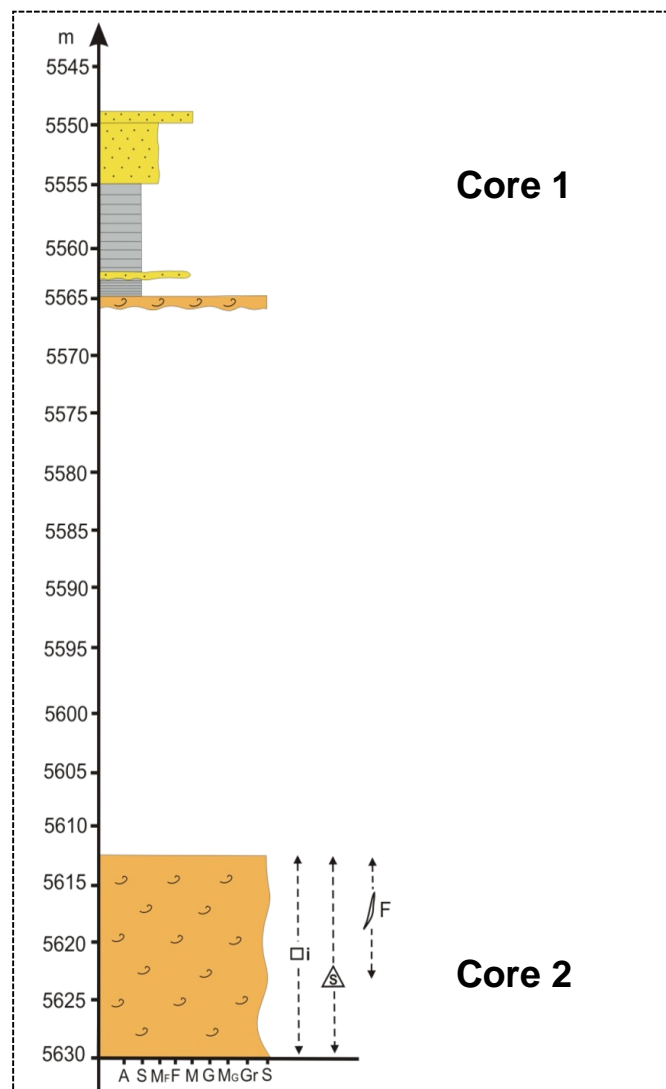
Calcareenite



3.0 cm

The Pre-salt Play

Mero Field – Facies Example



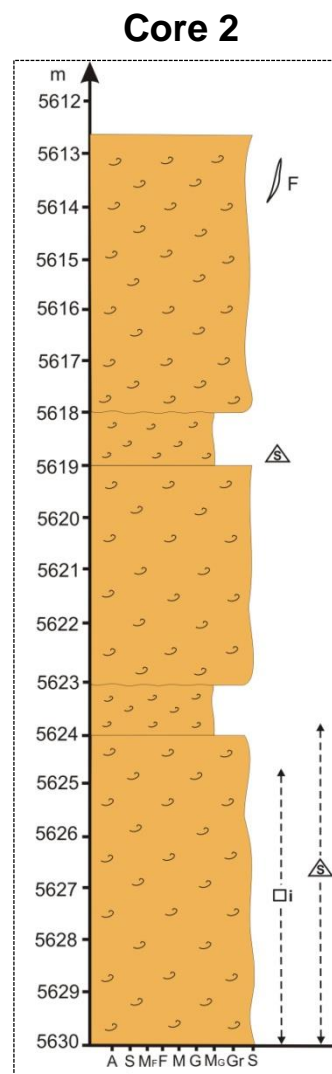
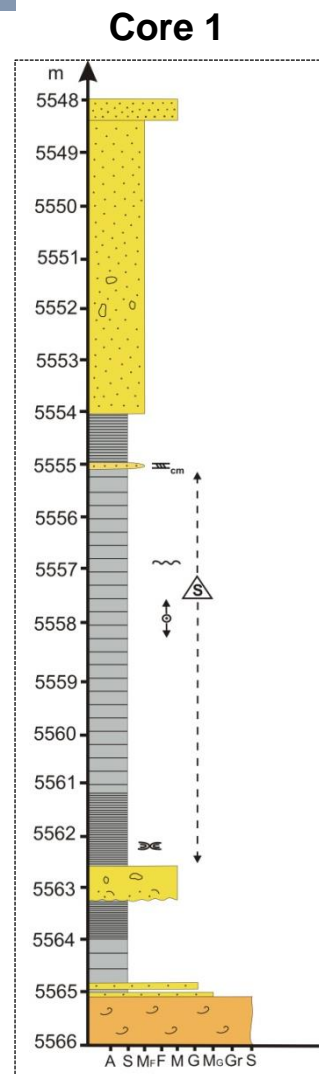
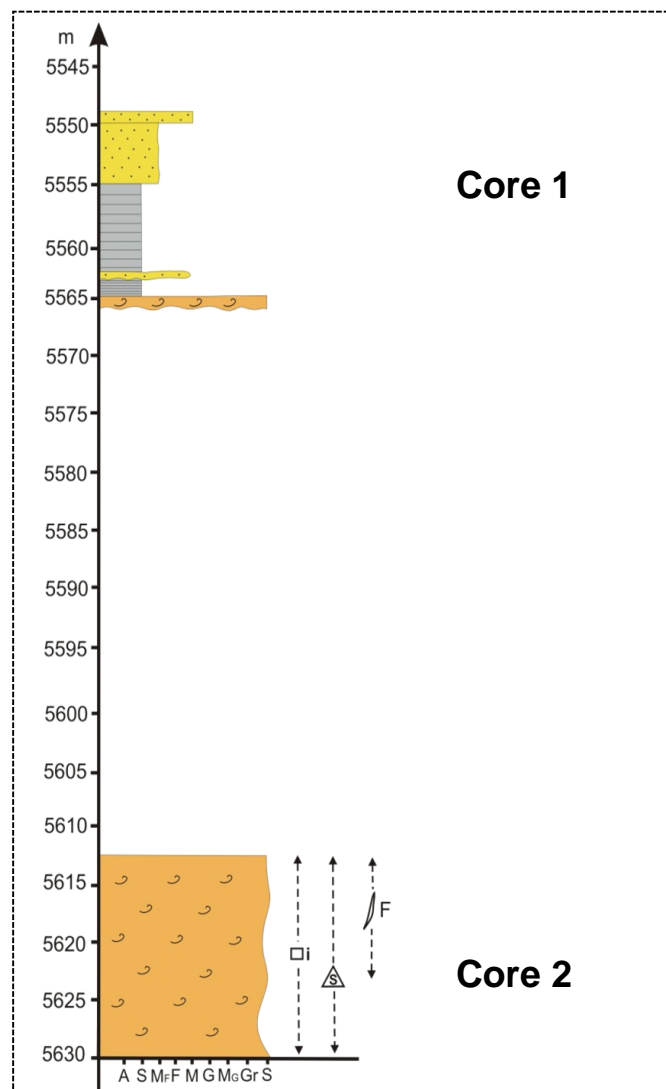
Laminated calcilutite



3.0 cm

The Pre-salt Play

Mero Field – Facies Example

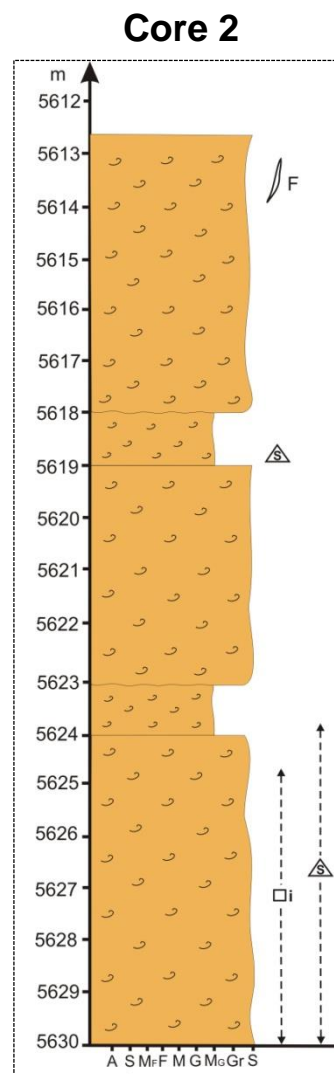
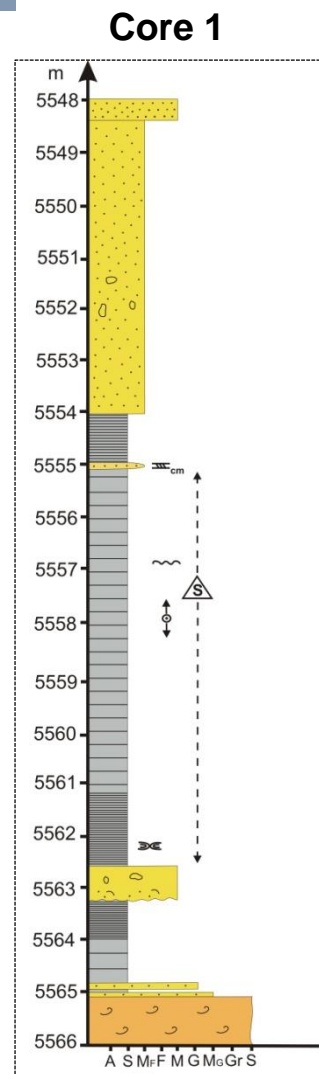
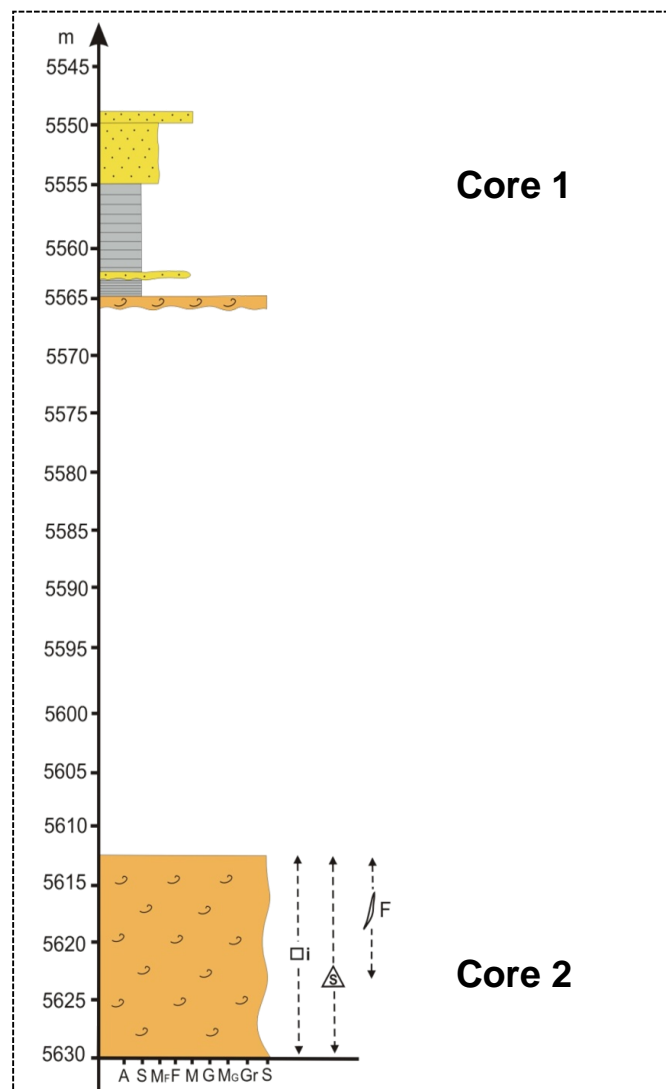


Crenulated lamination calcilutite



The Pre-salt Play

Mero Field – Facies Example

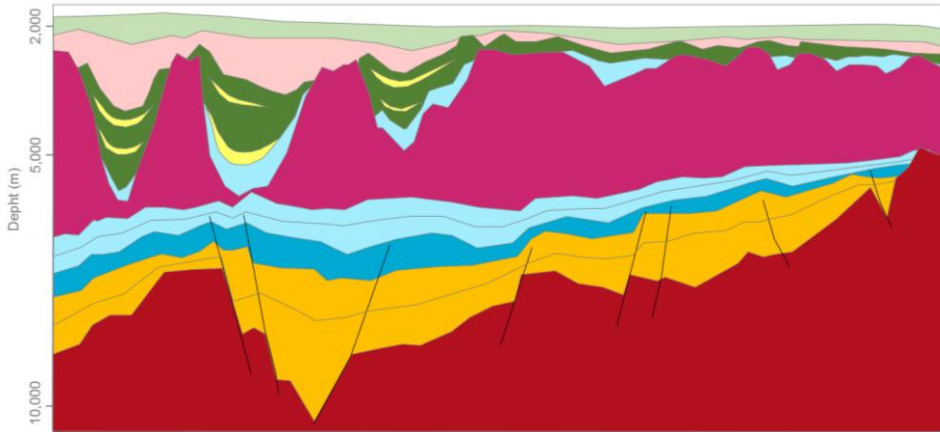


Calcirudite

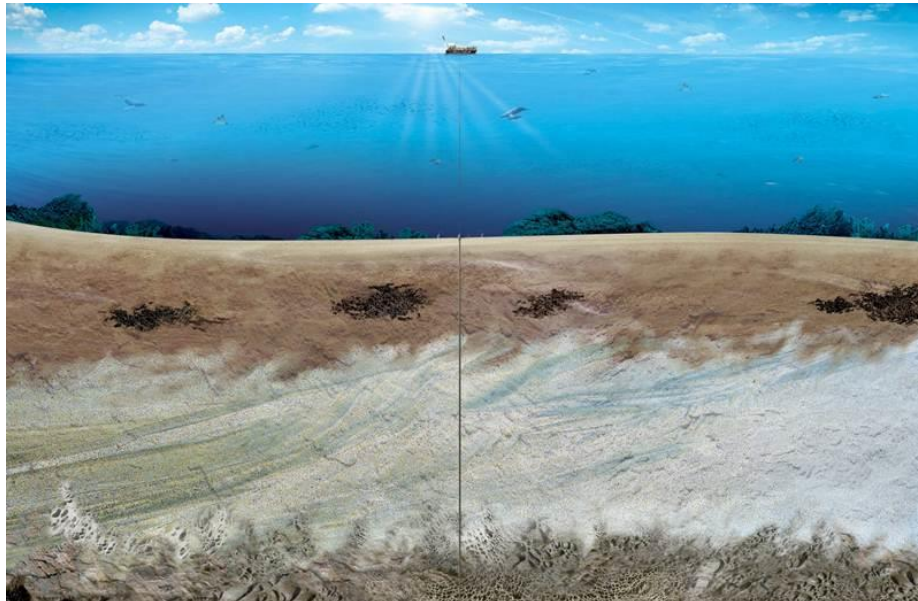


4.0 cm

Pre-salt Prospectivity



After Formigli, 2007



Source: Petrobras

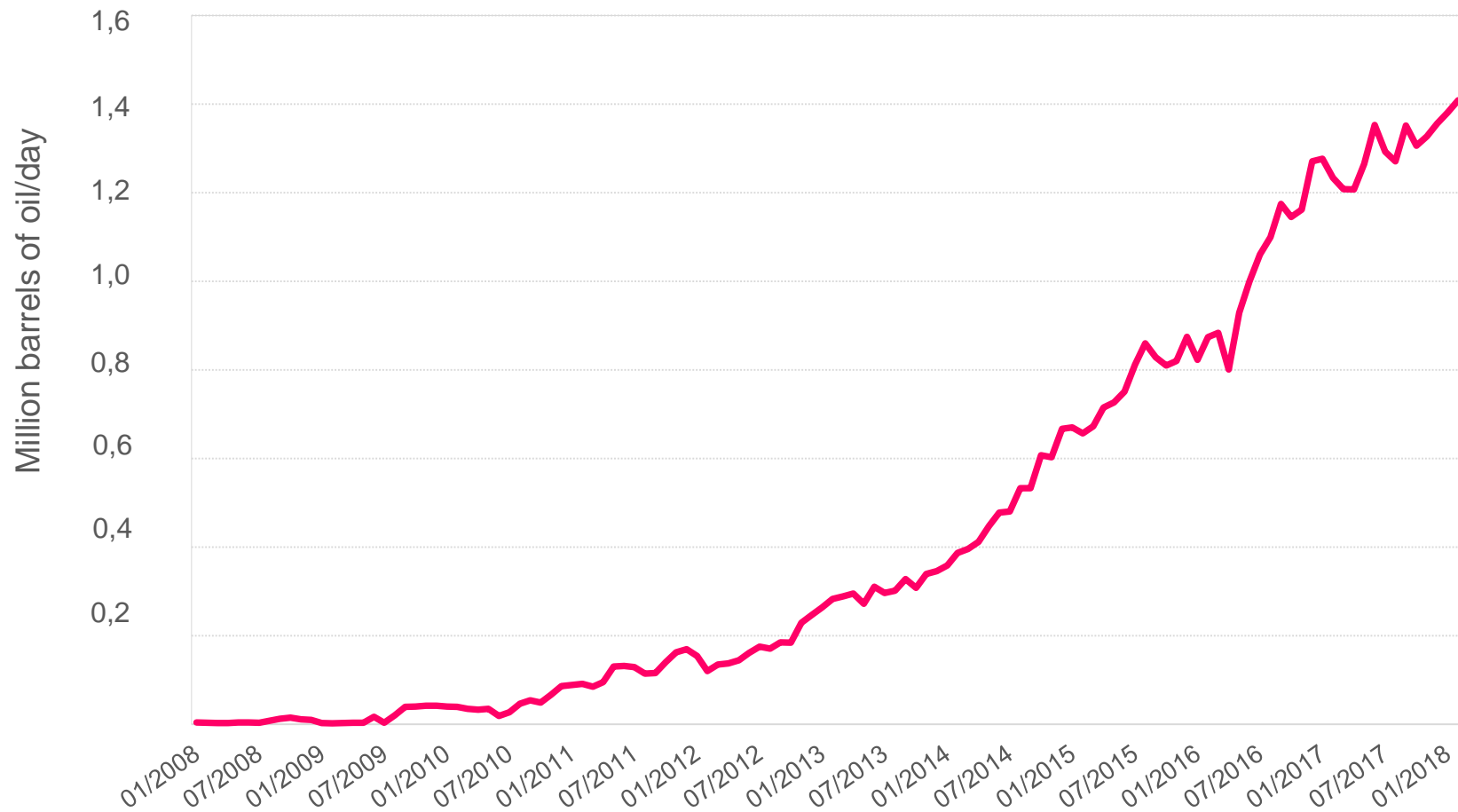
The Pre-Salt comprises huge accumulations underneath the salt layers;

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:

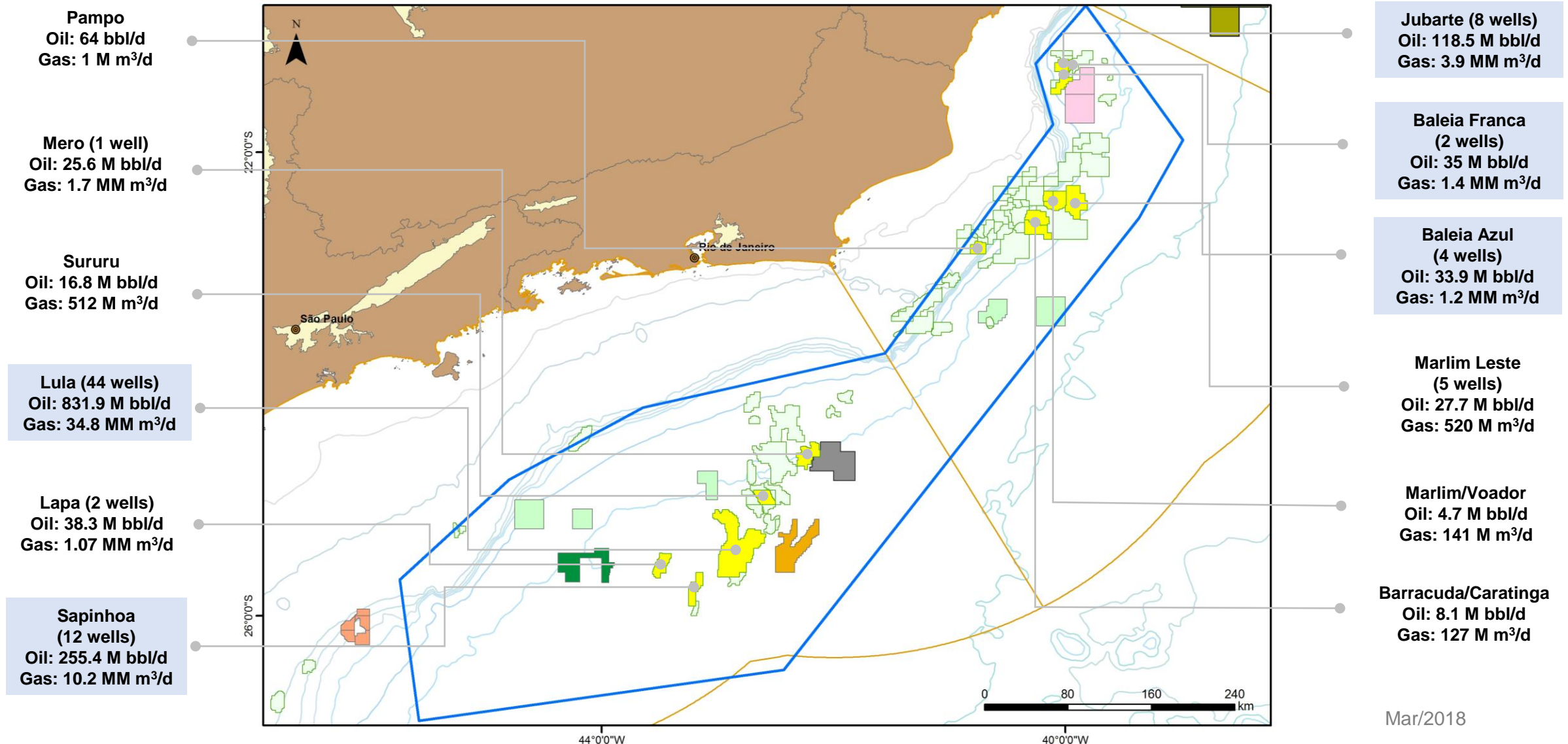
58 in Santos Basin
25 in Campos Basin



The Pre-salt Play Production



~1.4 million barrels of oil/day



Outline



1 Brazil's Current State

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3 2017 to 2019 Pre-Salt Licensing Rounds: Giant Leads

4 Final Remarks

Bidding Rounds Schedule



4th PSC Bidding Round

2018
(06.07.18)

2018
(09.28.18)

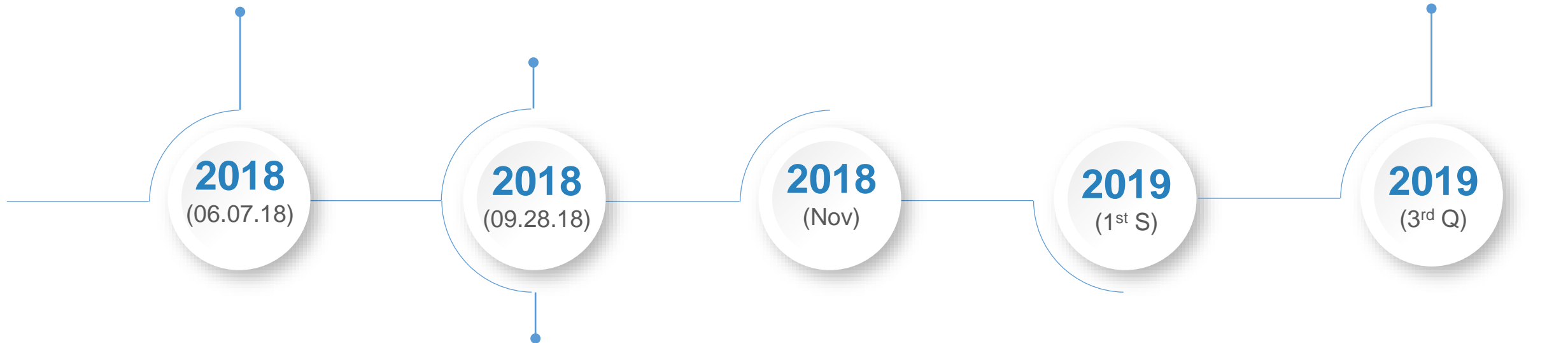
2018
(Nov)

2019
(1st S)

2019
(3rd Q)

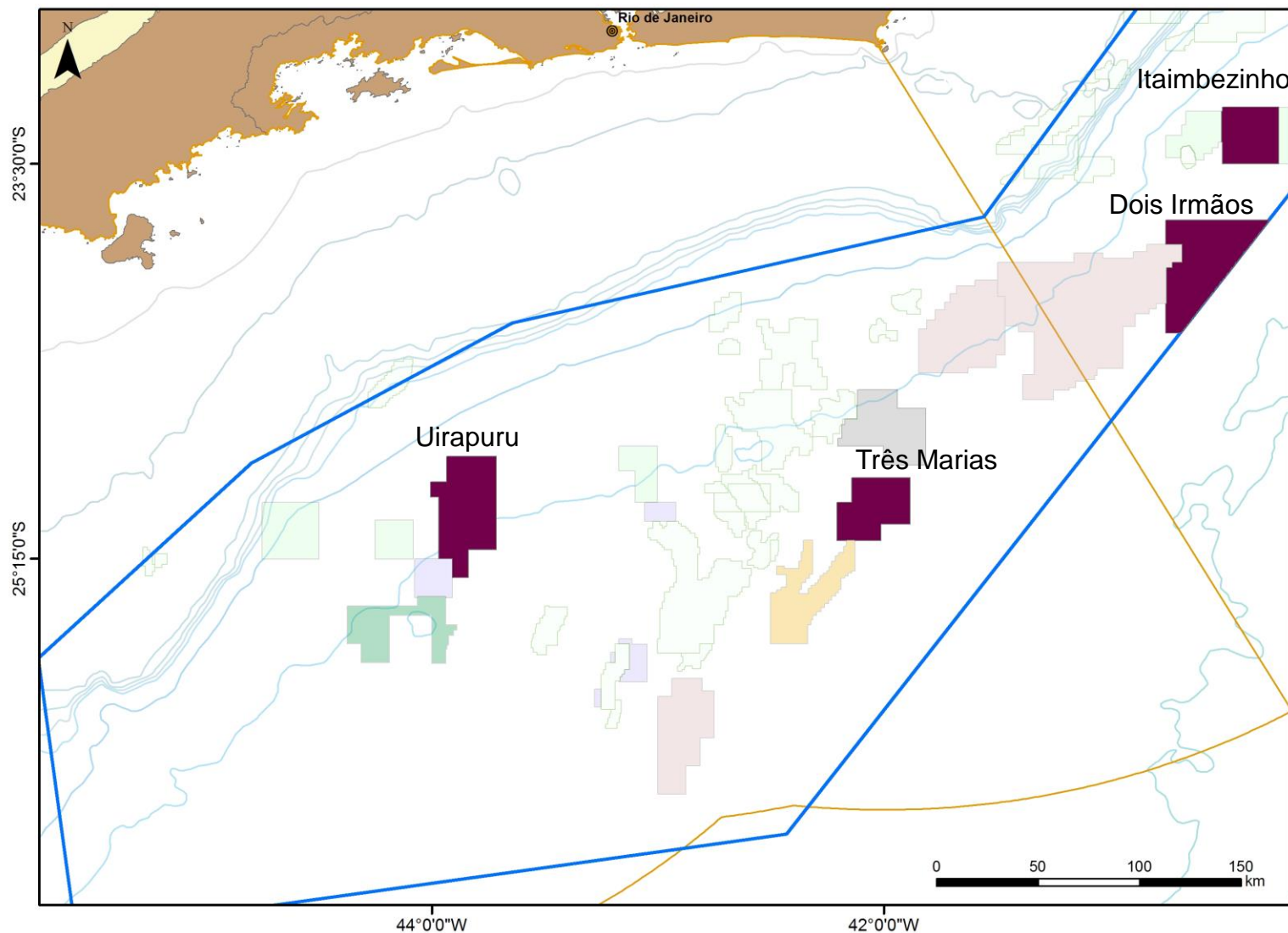
6th PSC Bidding Round

5th PSC Bidding Round



4th Pre-salt Bidding Round

PRE-SALT
Brazil 4
PRODUCTION SHARE



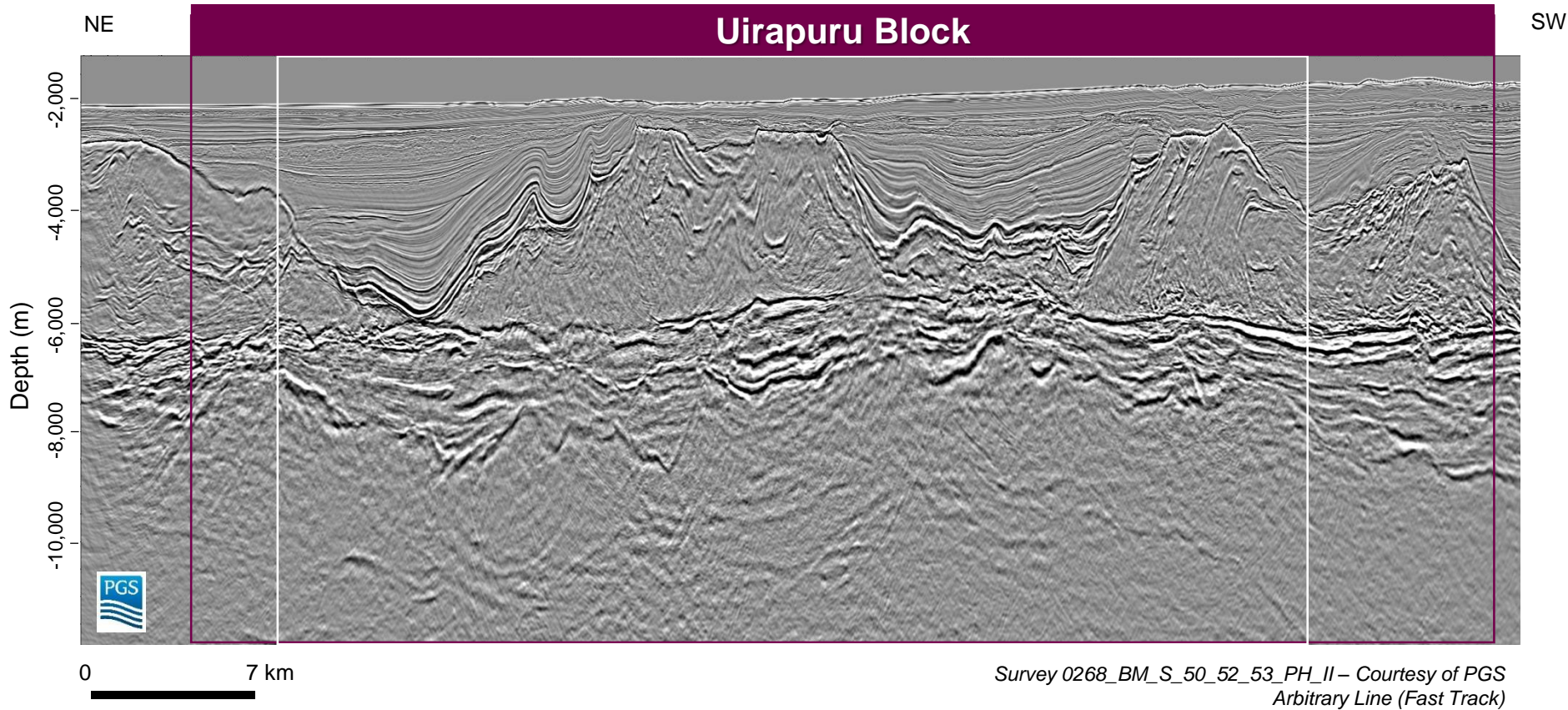
Public session for
submission of bids:

Jun the 7th, 2018

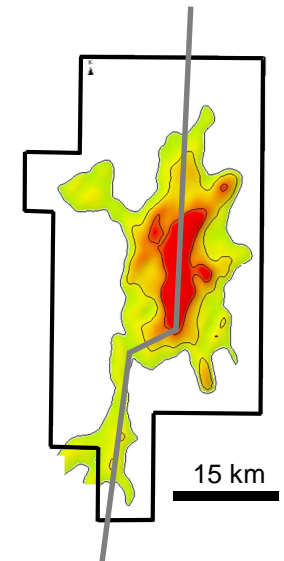
4 blocks in Pre-Salt play

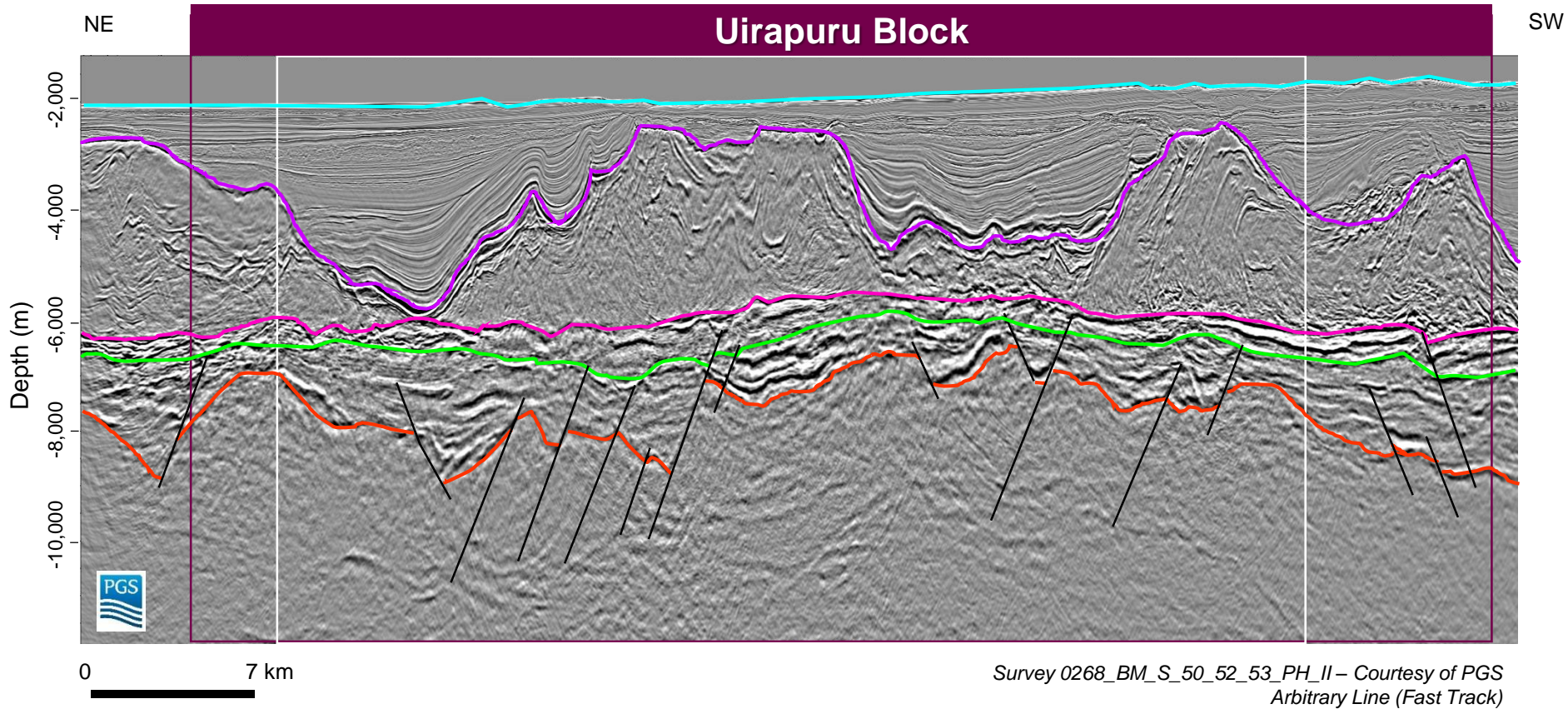
Potential for **huge** oil discoveries

Unrisked oil in place volume (P50)
~14 billion barrels



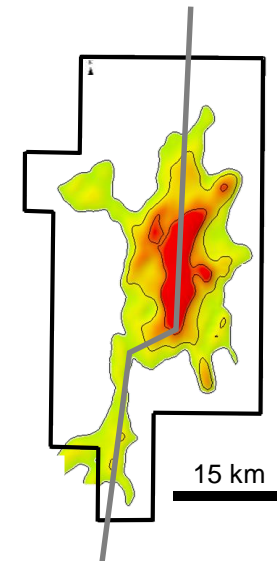
Unrisked in place
oil volume (P50)
7.8 billion barrels





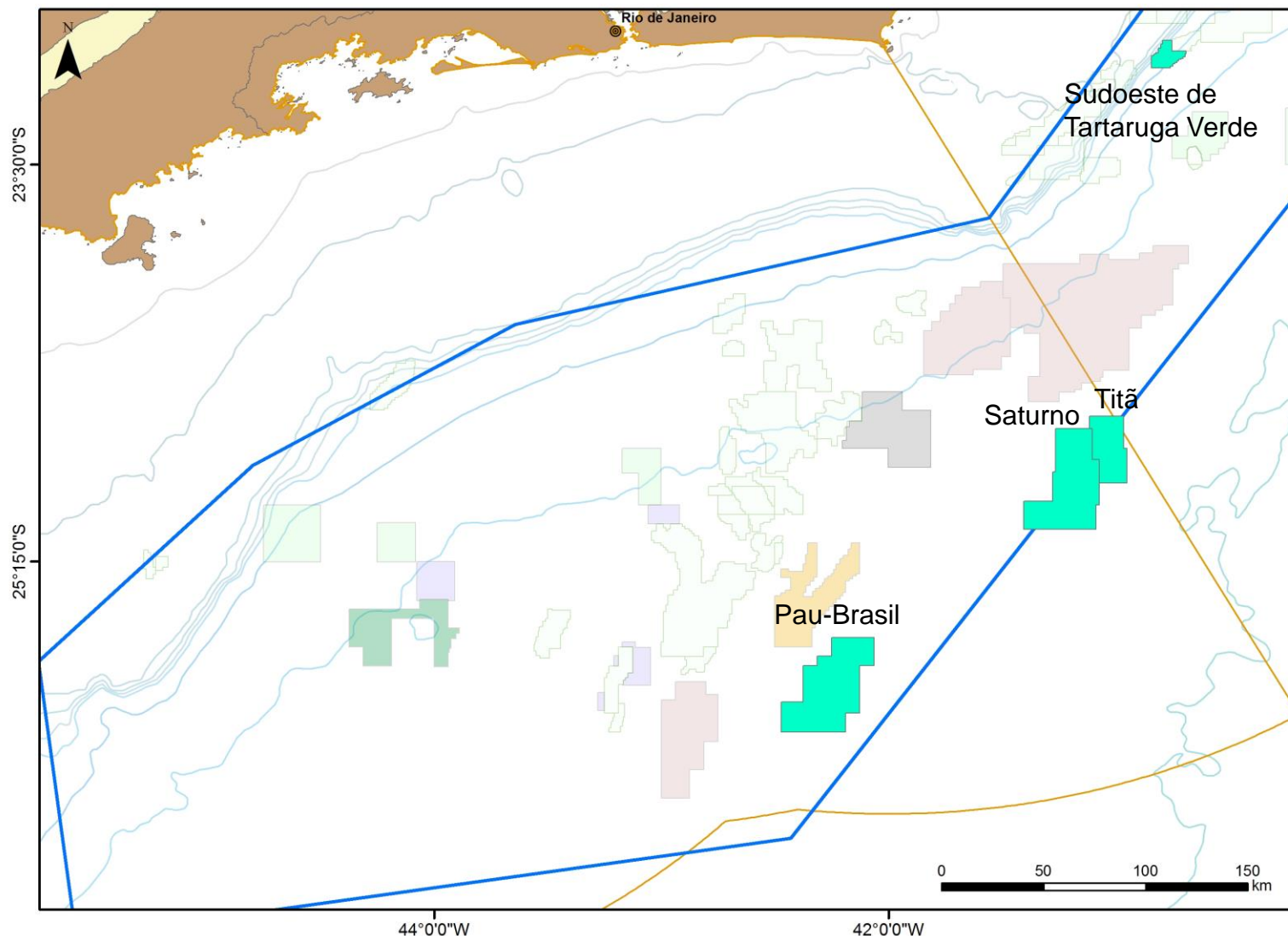
- Sea Bottom
- Top of Salt (Aptian/Albian)
- Base of Salt (Aptian)
- Base of Sag (Aptian)
- Basement
- Fault

Unrisked in place
oil volume (P50)
7.8 billion barrels



5th Pre-salt Bidding Round

PRE-SALT
Brazil 5
PRODUCTION SHARE



Public session for
submission of bids:

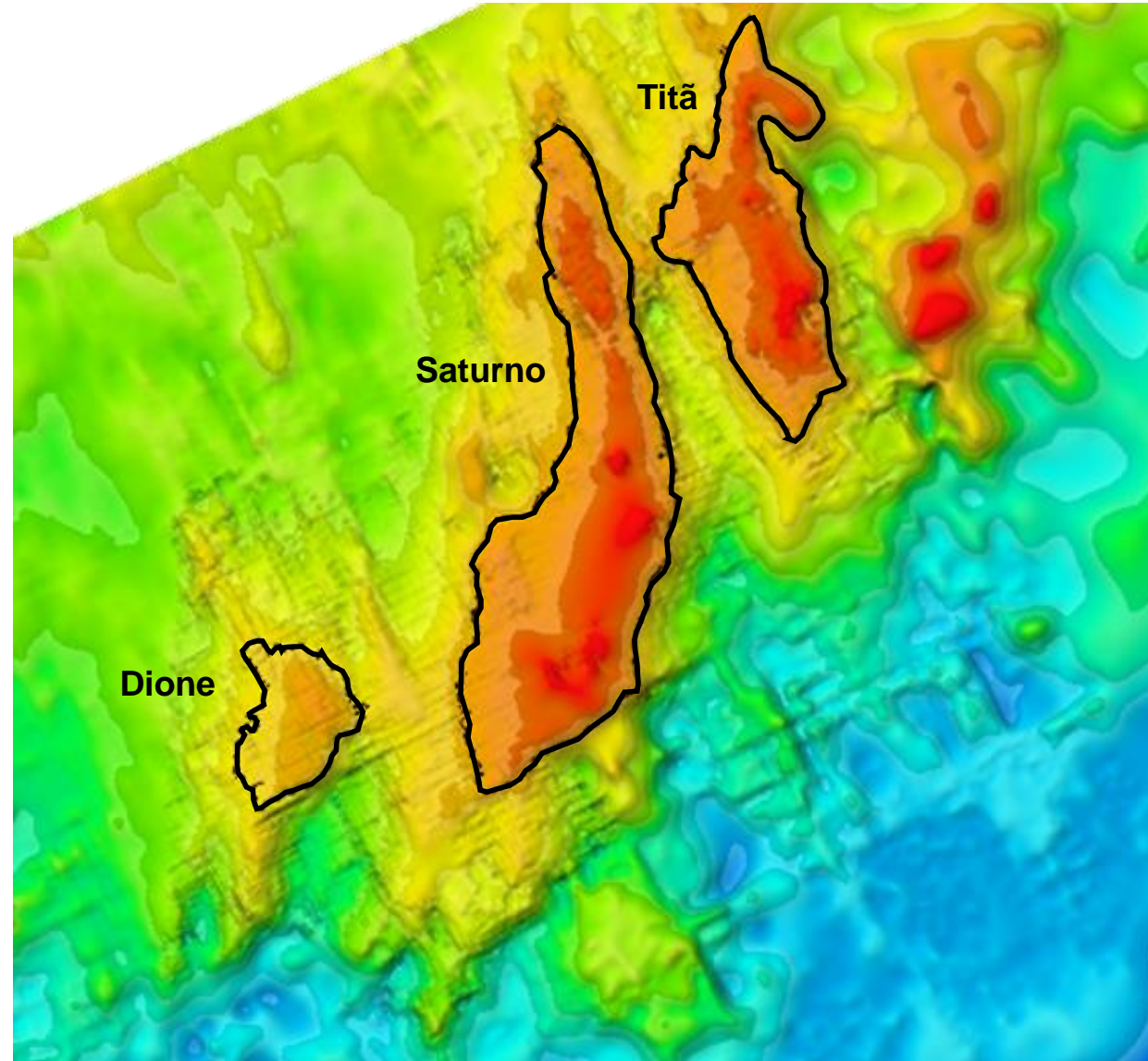
September the 28th, 2018

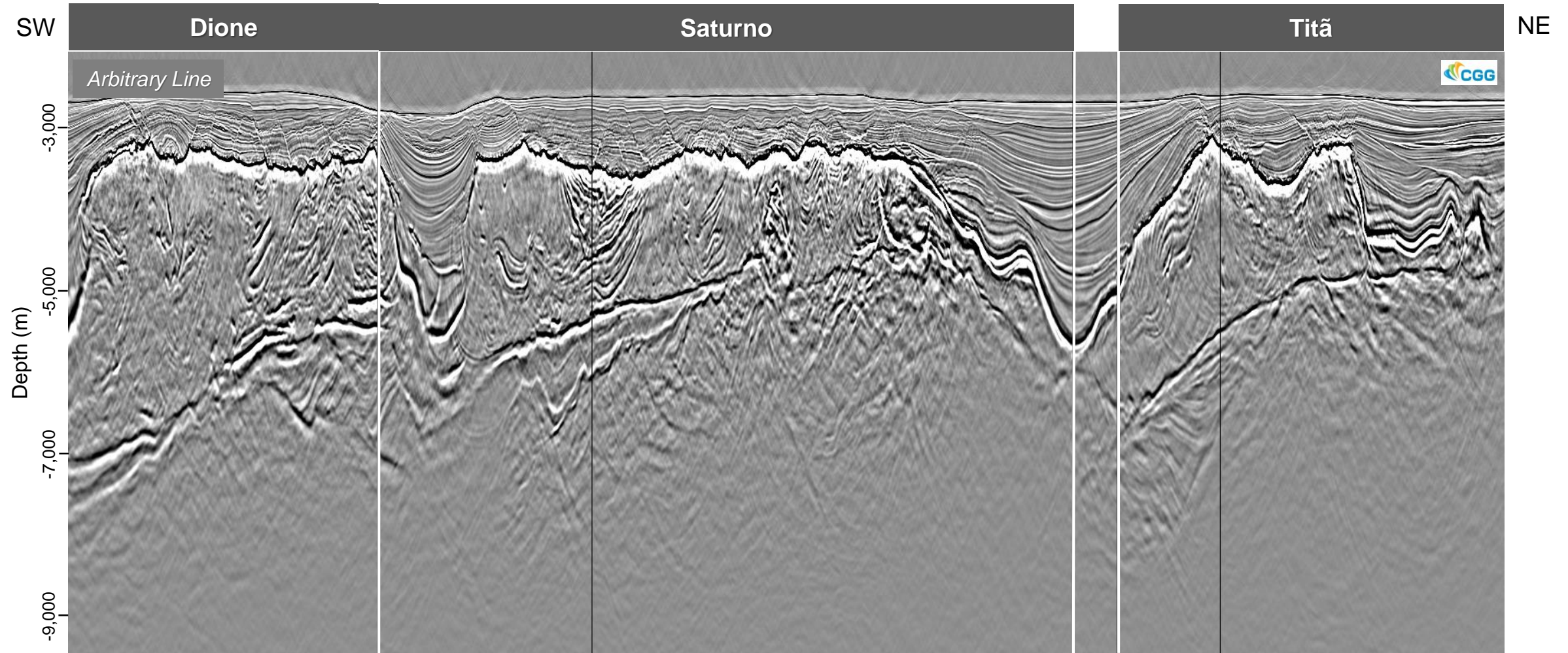
This auction will include 4 blocks:
Saturno, Tita, Pau-Brasil and
Sudoeste de Tartaruga Verde

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

Base of Salt
Depth Structural Map

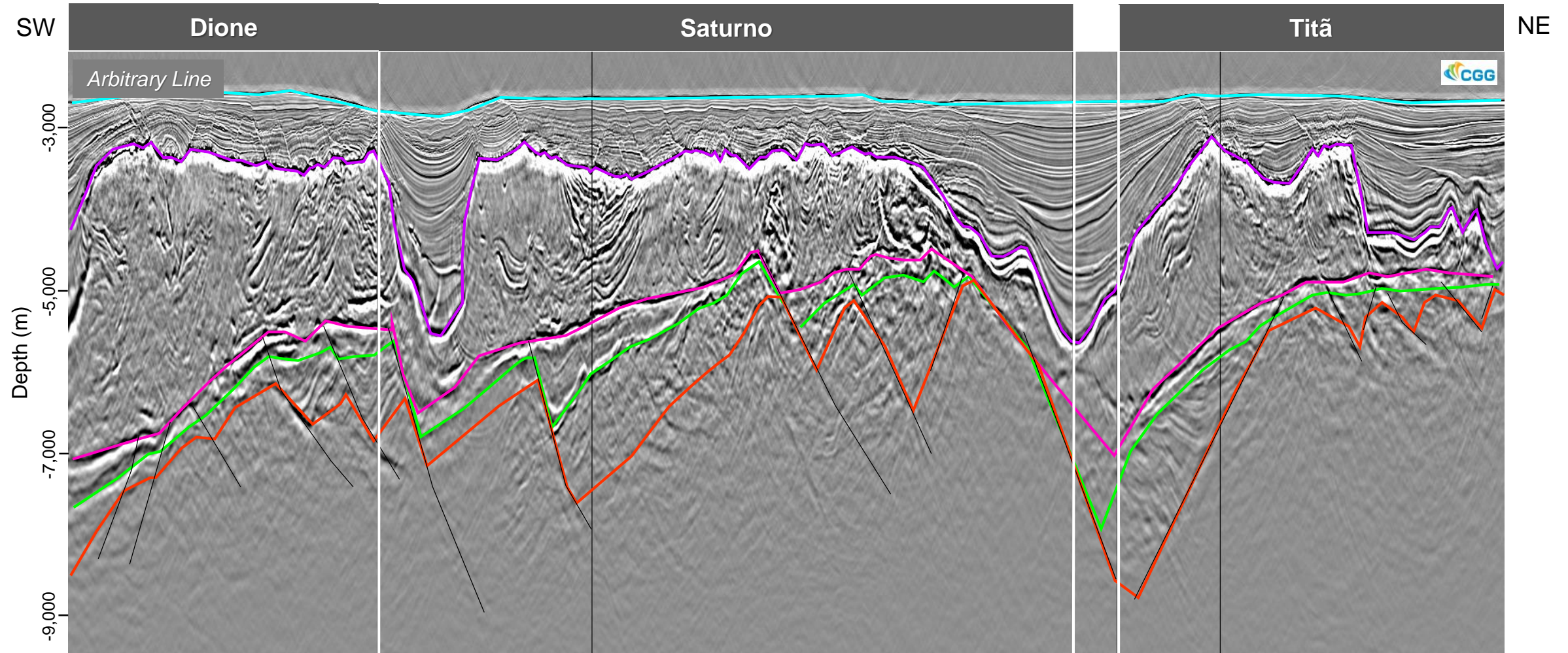
25 km





Survey: 0264_BM_SANTOS_FASE_VII_B – Courtesy of CGG

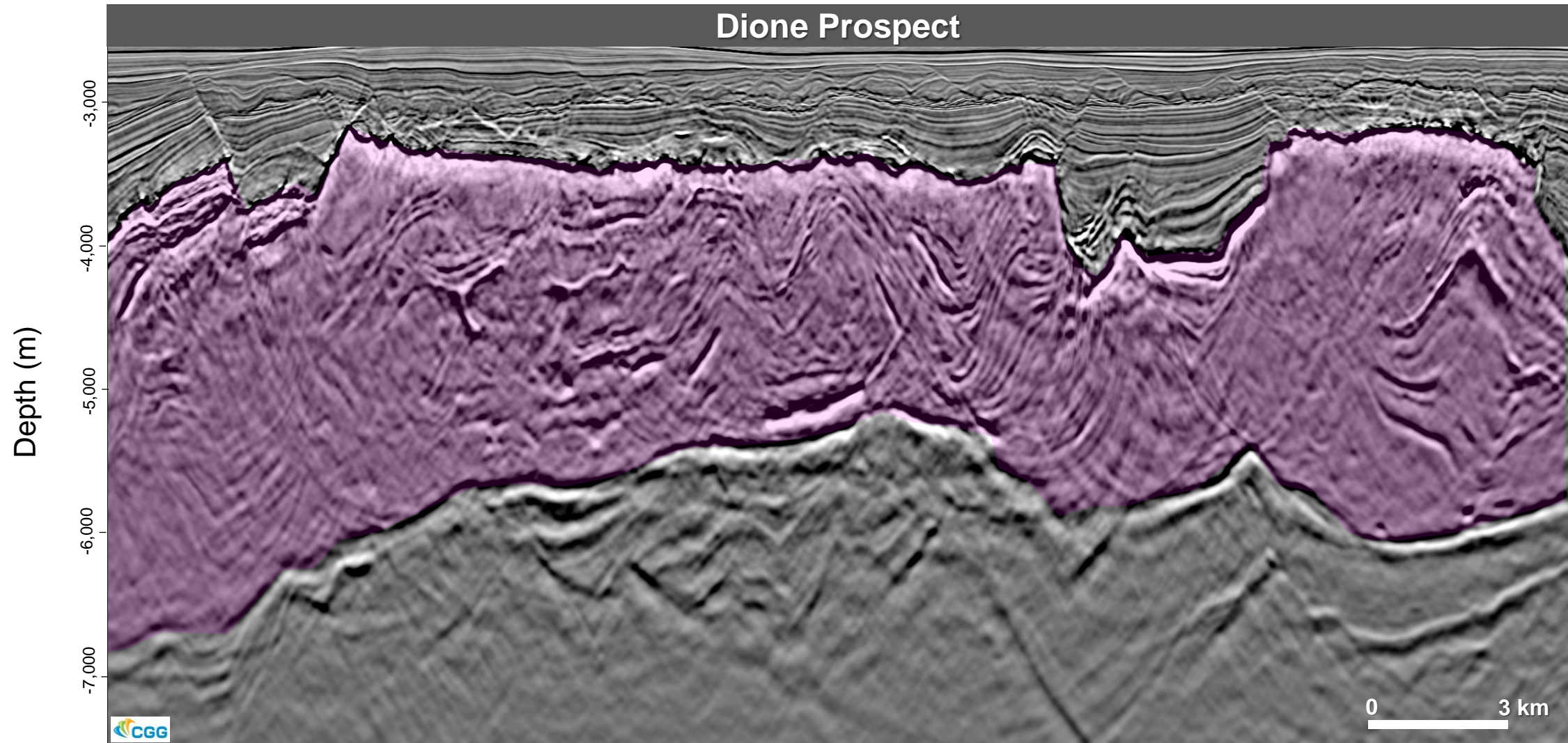
5 km



Survey: 0264_BM_SANTOS_FASE_VII_B – Courtesy of CGG

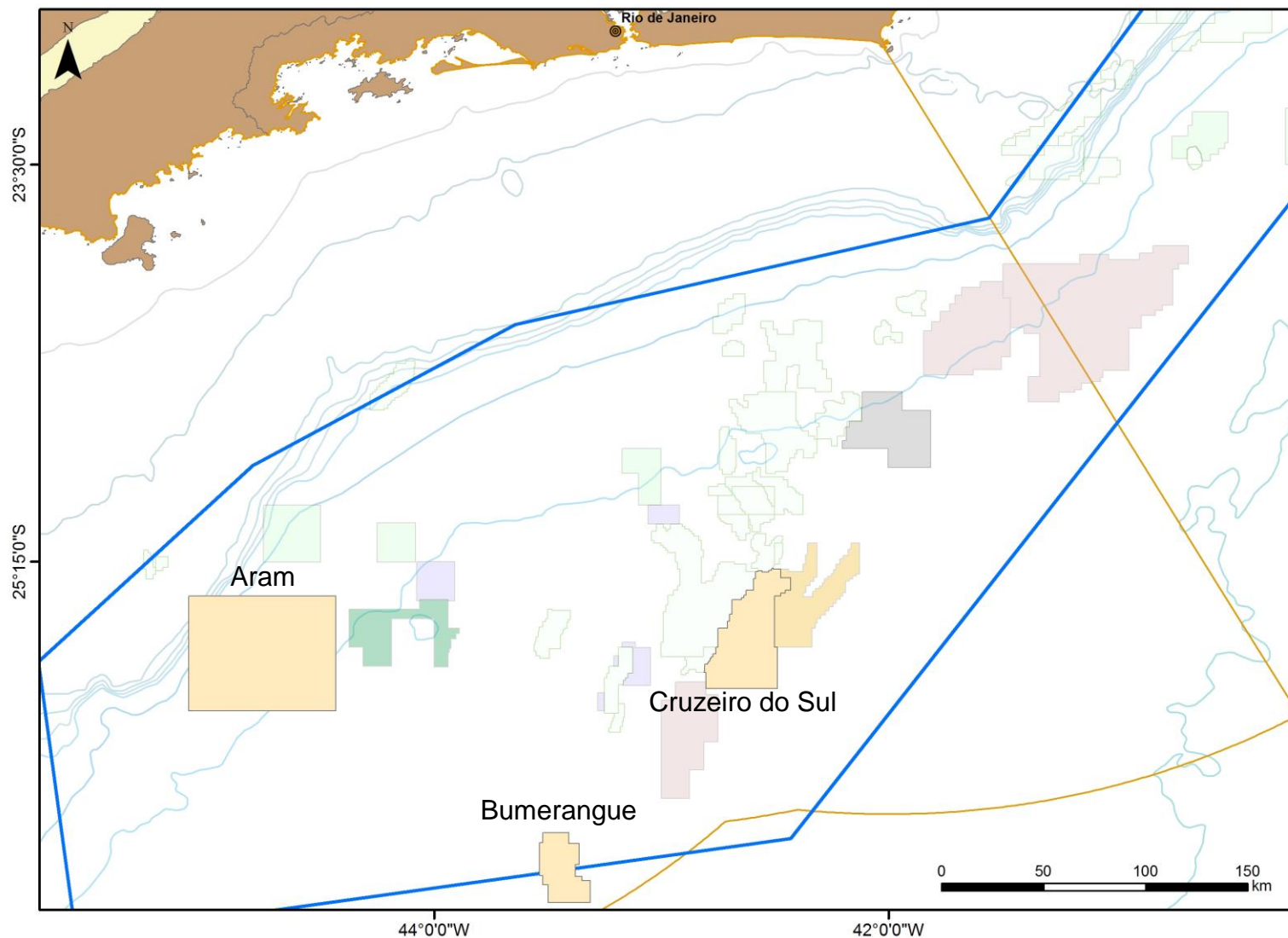
- Sea Bottom
- Base of Salt (Aptian)
- Basement
- Top of Salt (Aptian/Albian)
- Base of Sag (Aptian)
- / Fault

5 km

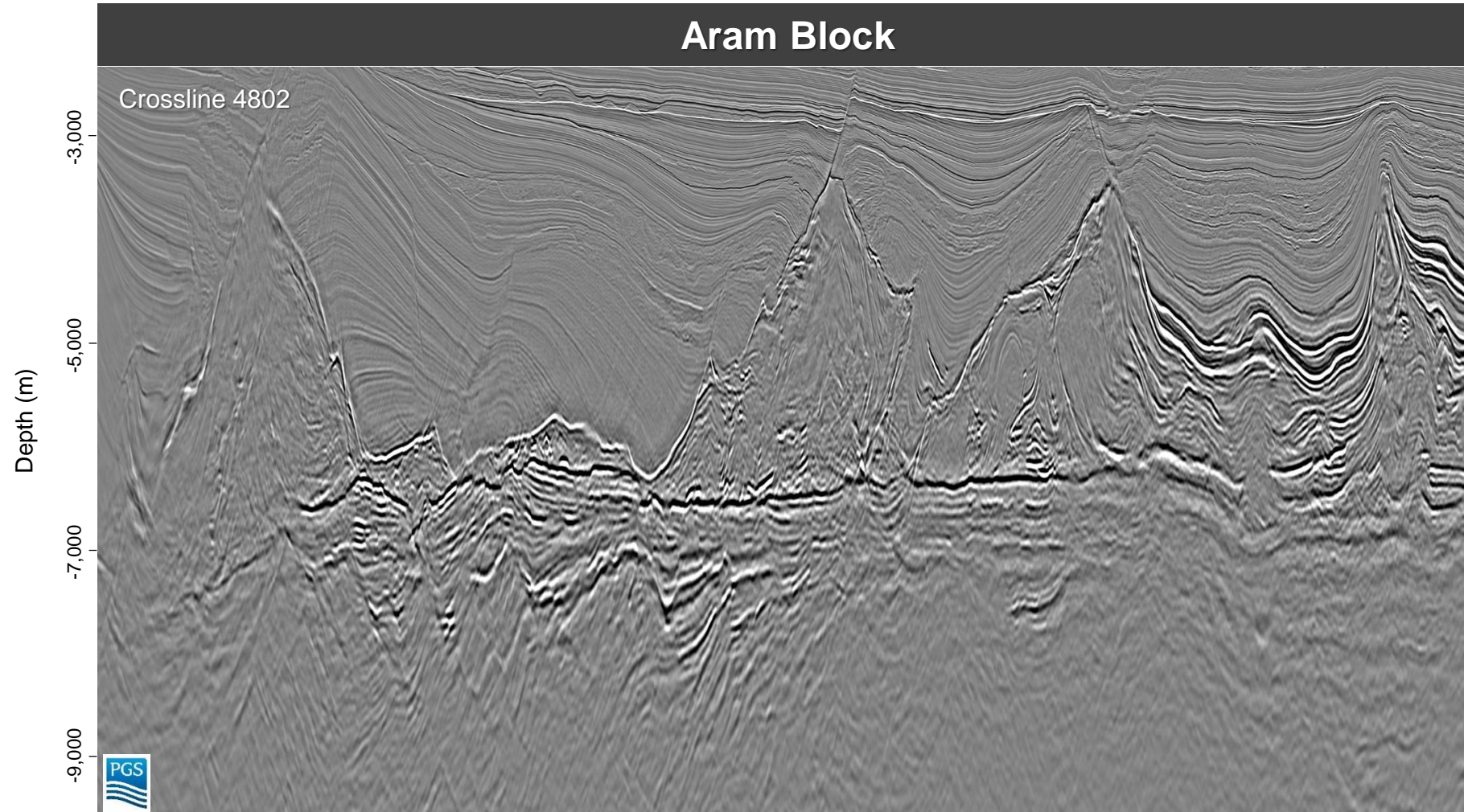


6th Pre-salt Bidding Round

PRE-SALT
Brazil 6
PRODUCTION SHARE



3 blocks in Pre-Salt play
including **giant** leads

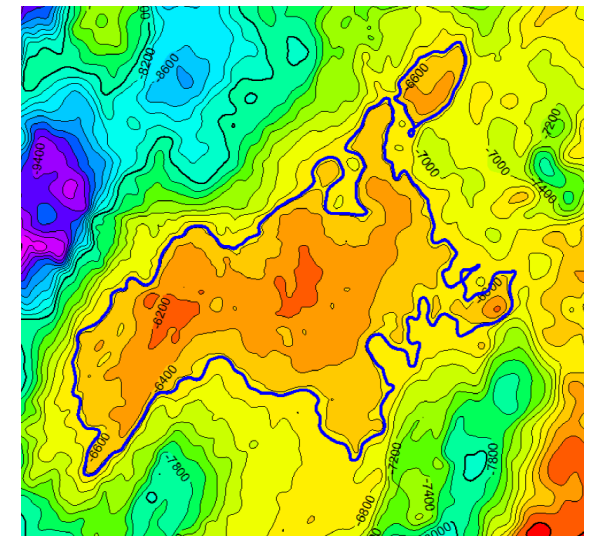


Prominent Basement High

Four-way Closure

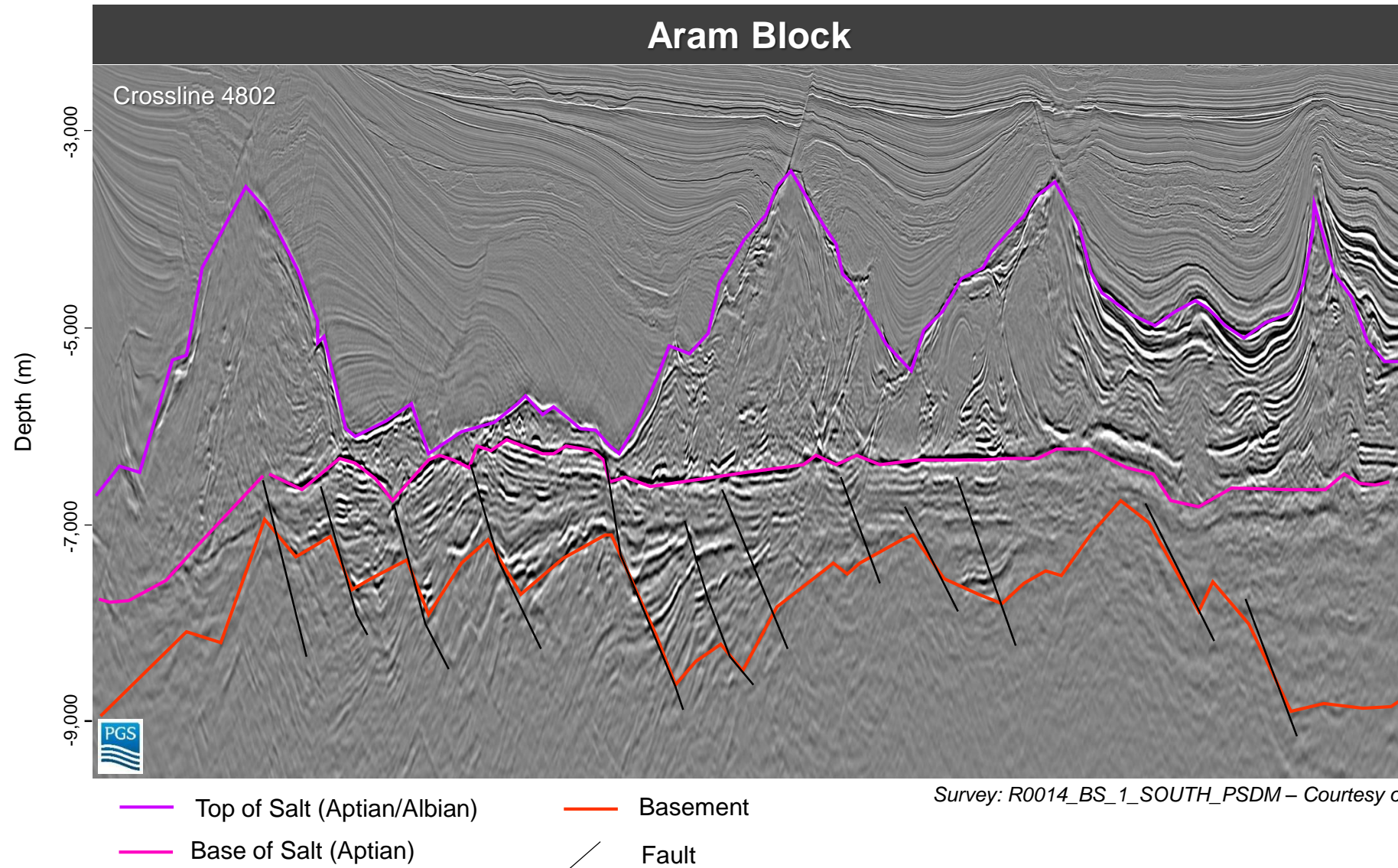
Amplitude Anomalies

Area: 1,500 km²



25 km

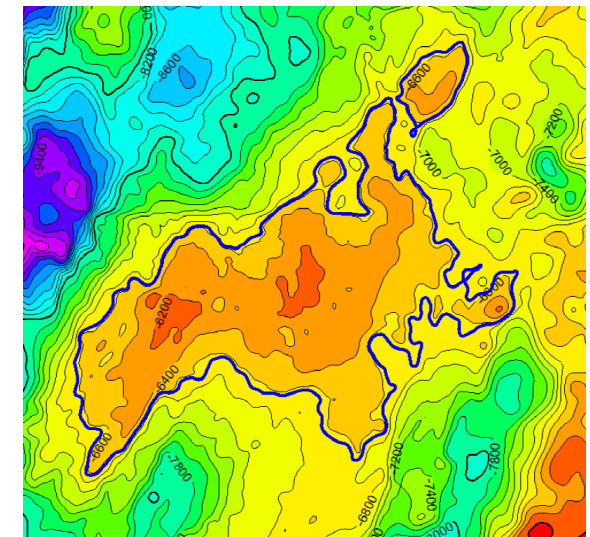
Survey: R0014_BS_1_SOUTH_PSDM – Courtesy of PGS



Survey: R0014_BS_1_SOUTH_PSDM – Courtesy of PGS

Prominent Basement High
Four-way Closure
Amplitude Anomalies

Area: 1,500 km²



25 km

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Final Remarks



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 unrisks in place volume surpasses 30 billion barrels of oil for the 4th and 5th Pre-Salt Licensing Rounds.

National Agency of Petroleum, Natural Gas and Biofuels

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