Santos Basin: 40 Years from Shallow to Deep to Ultra-Deep Water*

Fávio Juarez Feijó[1]

Search and Discovery Article #10553 (2013)
Posted December 16, 2013

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Developments

Santos Basin—350,000 km^2

- 1970-1987: 59 dry holes; one discovery—Merluza Gas Field (0.07 tcf)
- 1988-1998: 45 wells, some small discoveries (e.g., Tubarao Field (30 mmbbl)
- 1999-2005: 81 wells, some medium-sized discoveries (e.g., Mexilhao, Tambuata fields)
- 2006-2012: 166 wells, huge discoveries (e.g., Lula Field, 8 Bbbl)
- 2013: Sagitarius Field—31° API oil, sub-salt carbonate, 6150 m depth, 1871 m water depth

Hydrocarbon Type and Age and Type of Reservoir

- Gas in Santonian turbidites--1984 (4900 m)
- Oil in Albian grainstones--1988-2001 (4500 m)
- Oil and gas in Santonian-Campanian turbidites--1999-2005 (4200 m)
- Oil and gas in Aptian carbonates--2006-2012 (6000 m)

Selected References

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Mohriak, W.U., 2008, Tectonica de sal autoctone e aloctone na margem sudeste brasileira, *in* W.U. Mohriak, P. Szatmari, and S.M.C. Anjos, eds., Sal: Geologia e Tectonica. Editora Beca, Sao Paulo, Brazil, p. 300–313.

Selected Website

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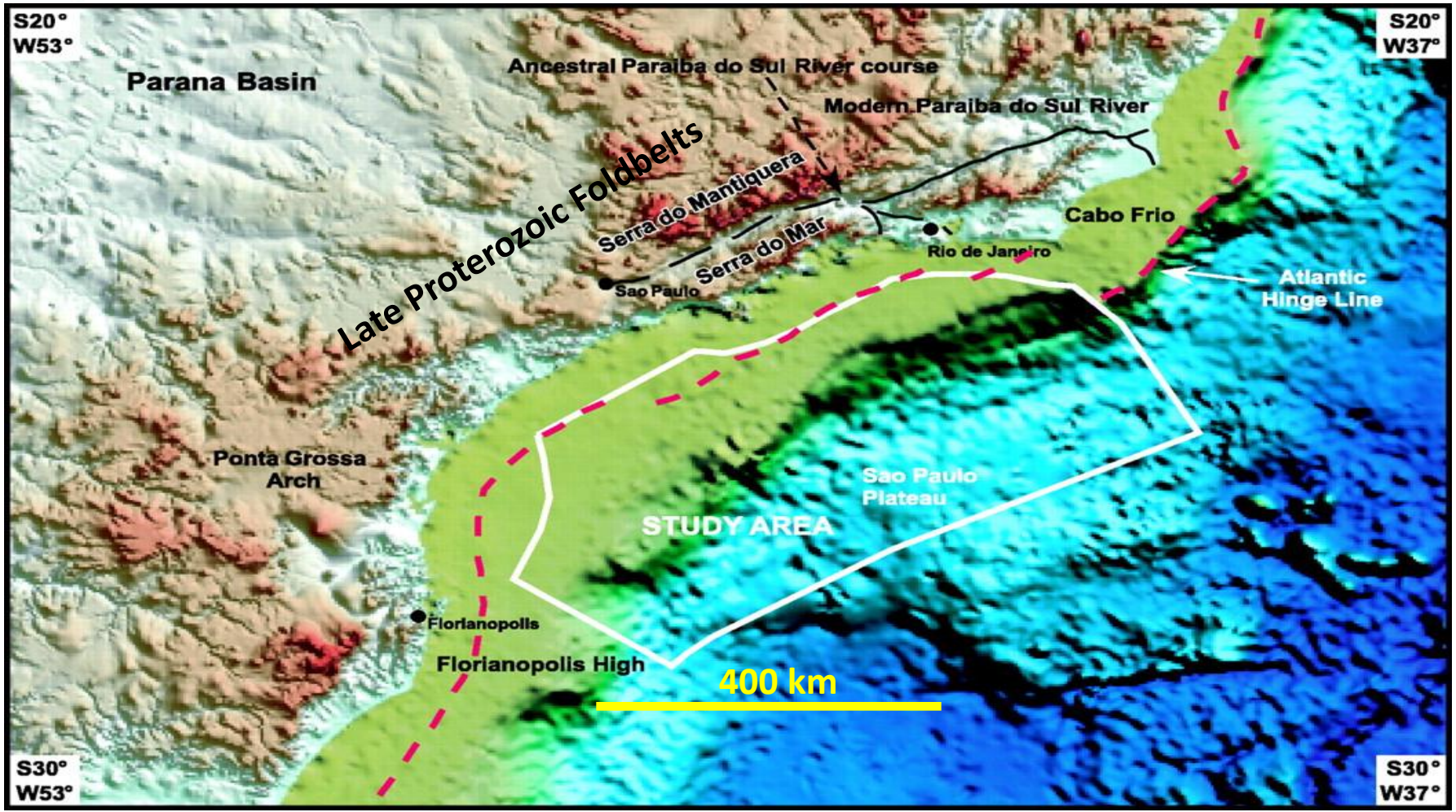
SANTOS BASIN

40 years from shallow to ultra-deep water

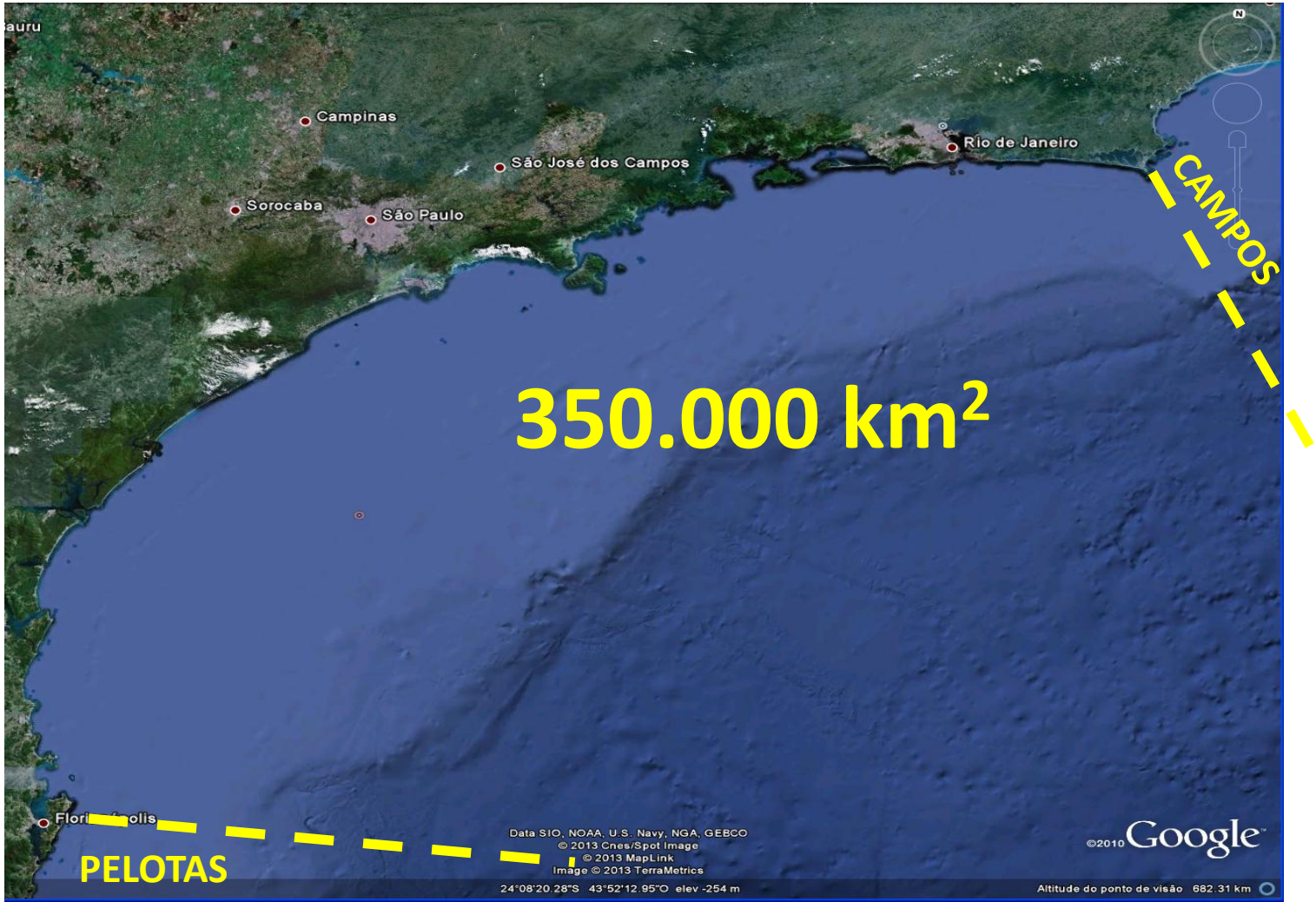
Flávio Juarez Feijó
Petrobras

Basement from +1 km to -10 km

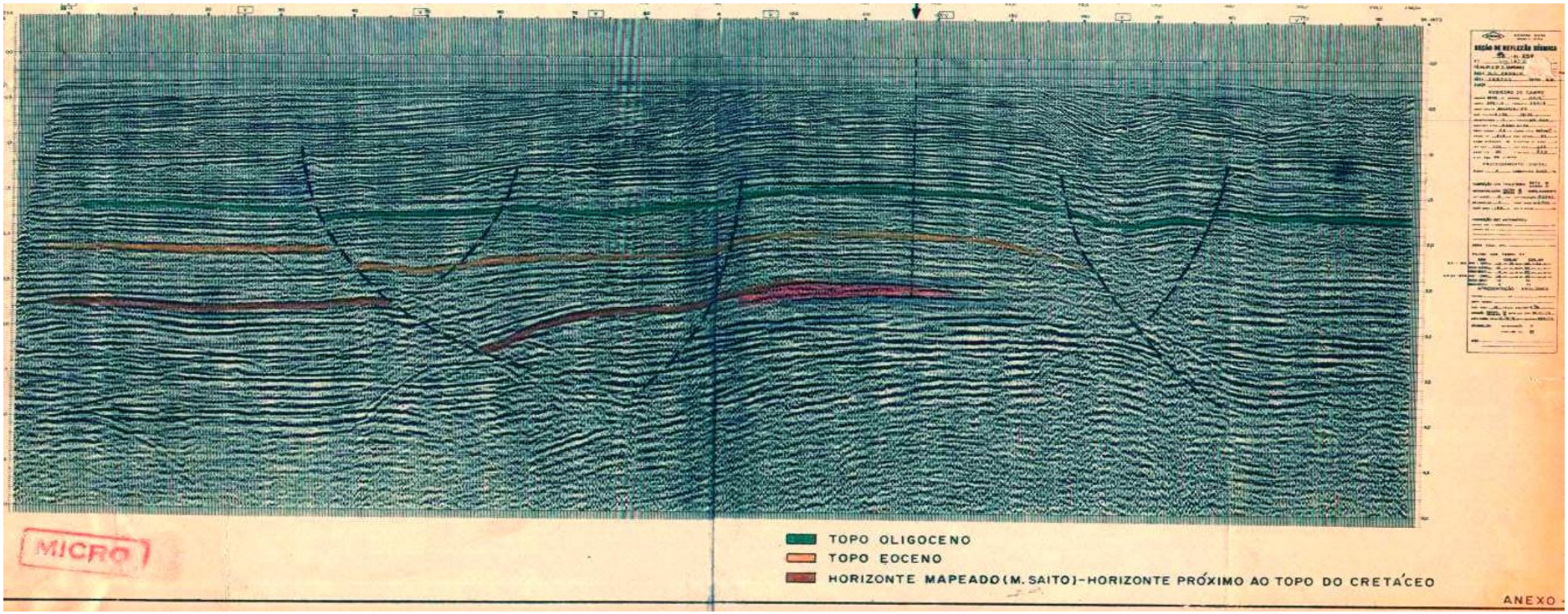


Modica & Brush AAPG Bull. 2004

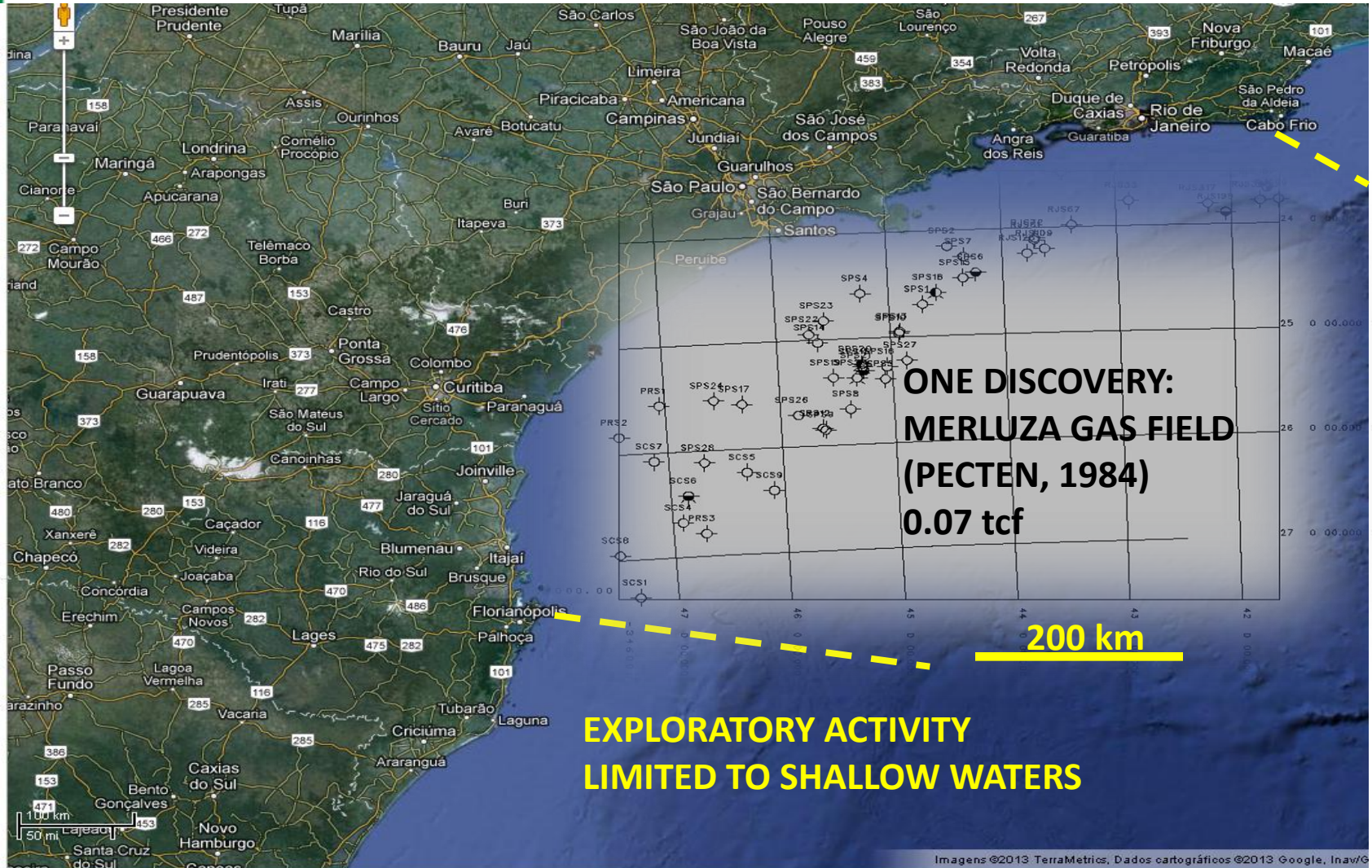
SANTOS BASIN



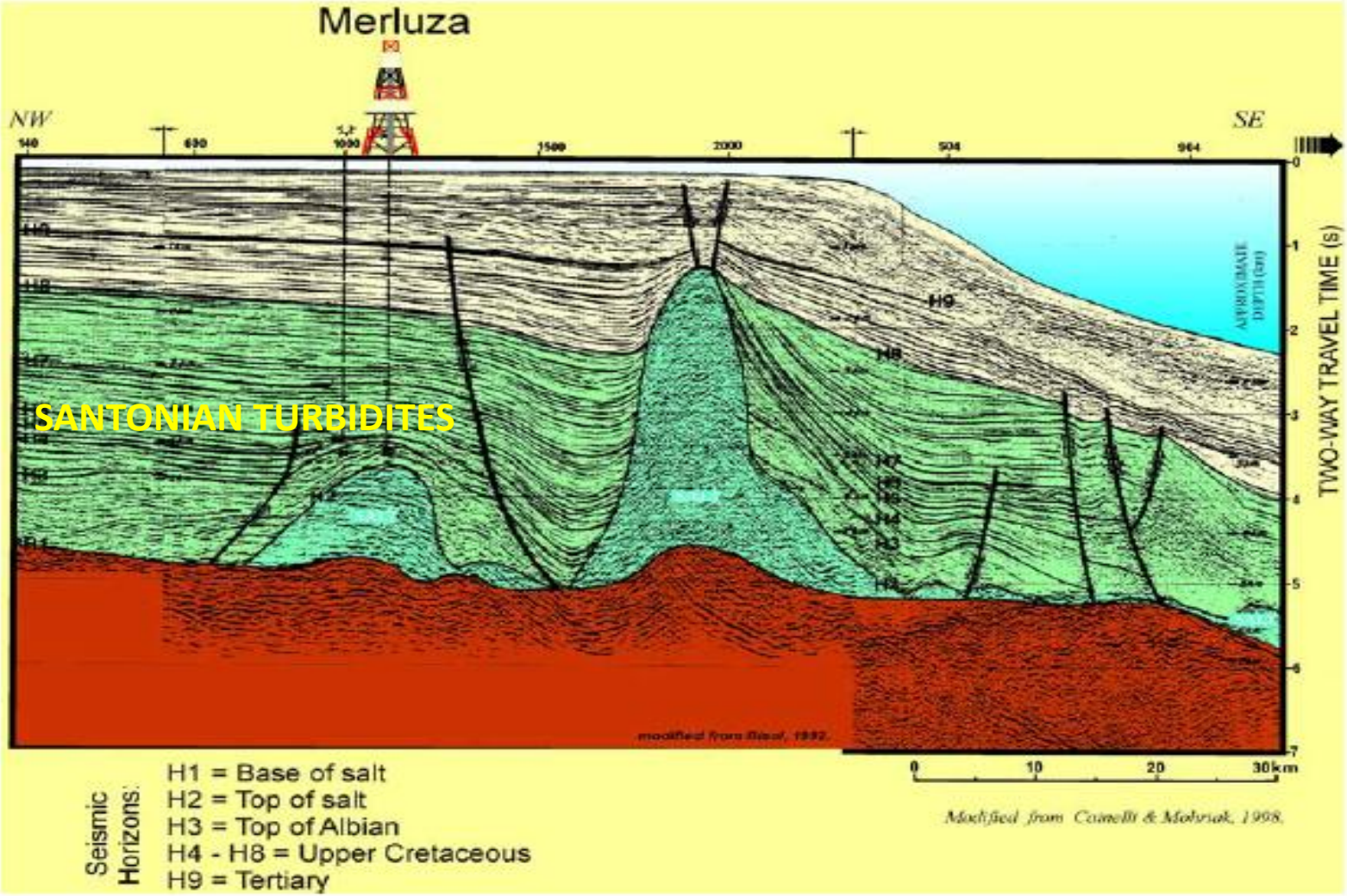
THE OLD SEVENTIES



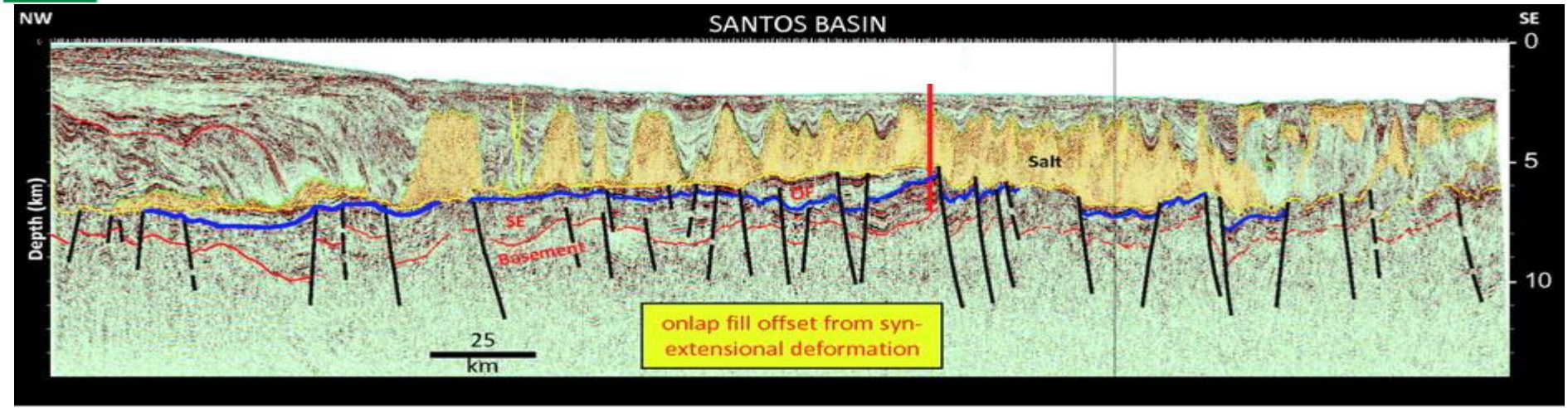
1970 – 1987: 59 DRY HOLES

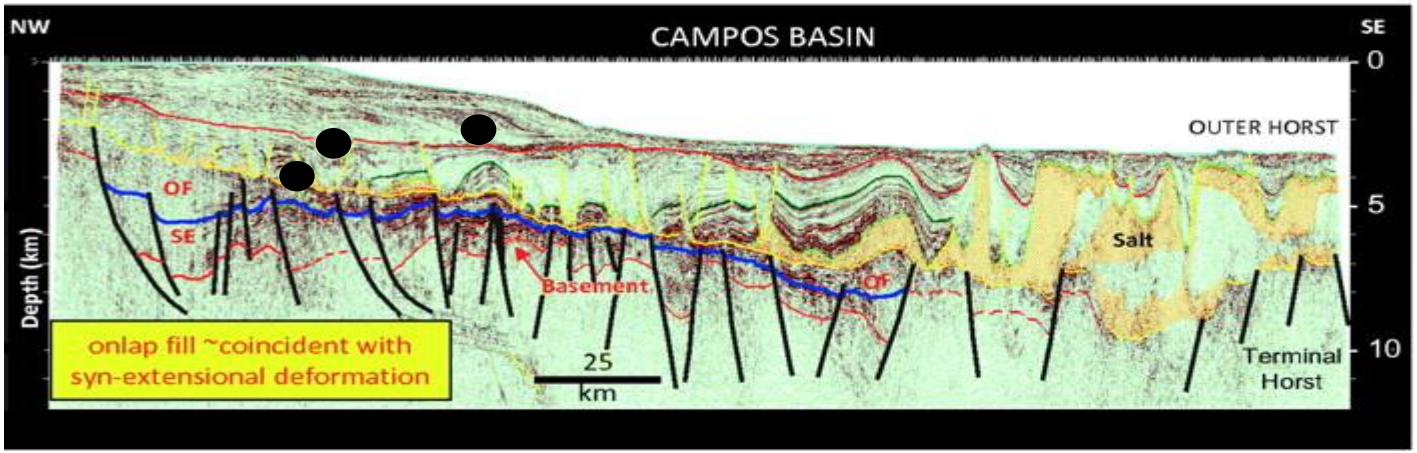


PETROBRAS Merluza Field: Pecten 1984



PETROBRAS THE RICH NEIGHBOR, 1974 - 1985

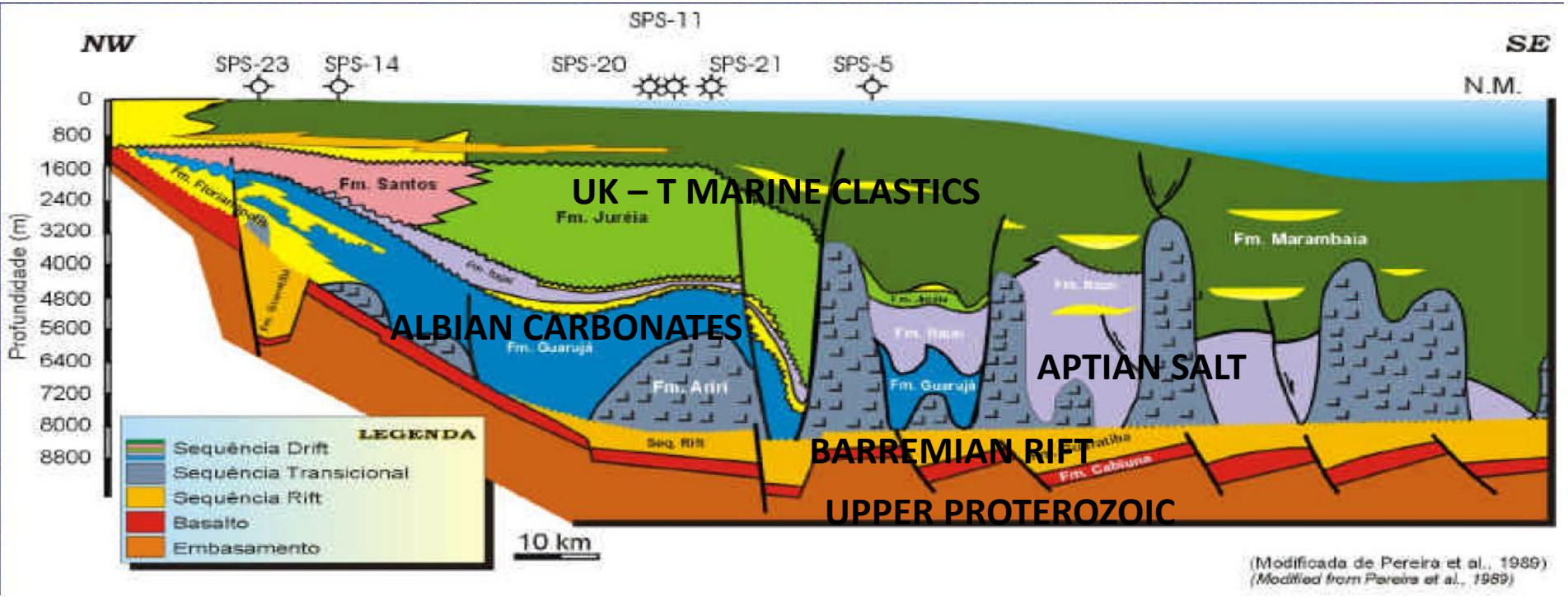




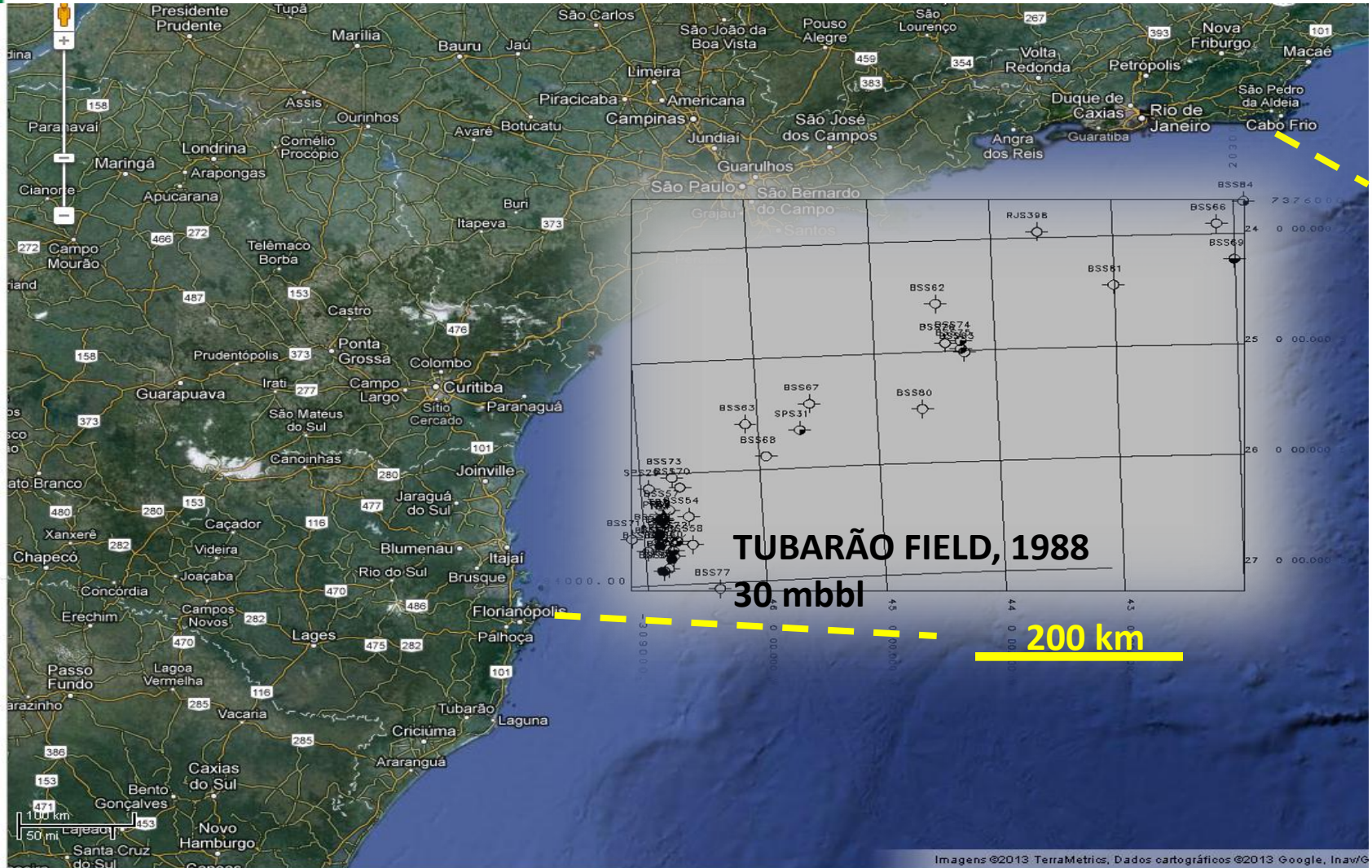
OF – Onlap Fill Sequence
SE – Syn-Extensional Sequence

http://pg.geoscienceworld.org/content/16/3/217/F11.expansion.html

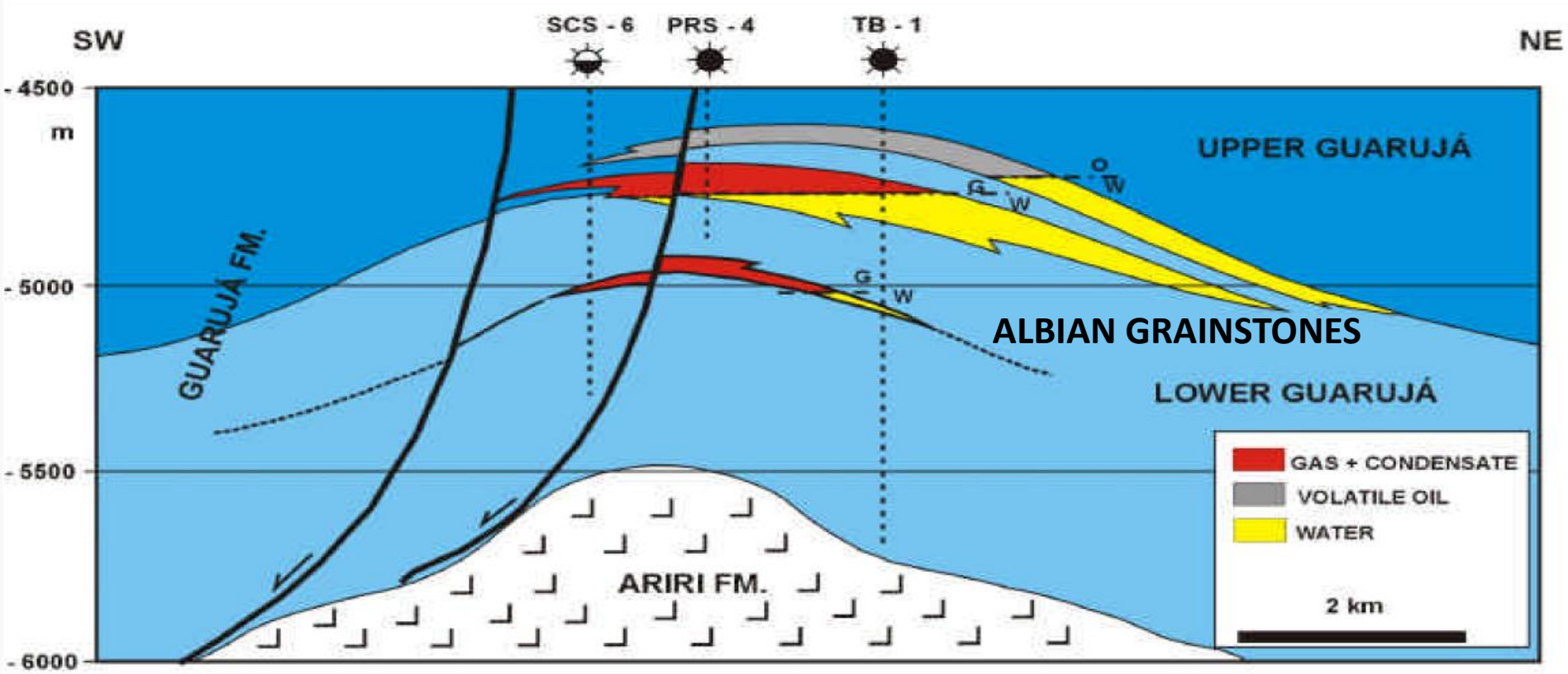
SANTOS BASIN 1988



PETROBRAS 1988-1998: 45 WELLS, SOME SMALL DISCOVERIES

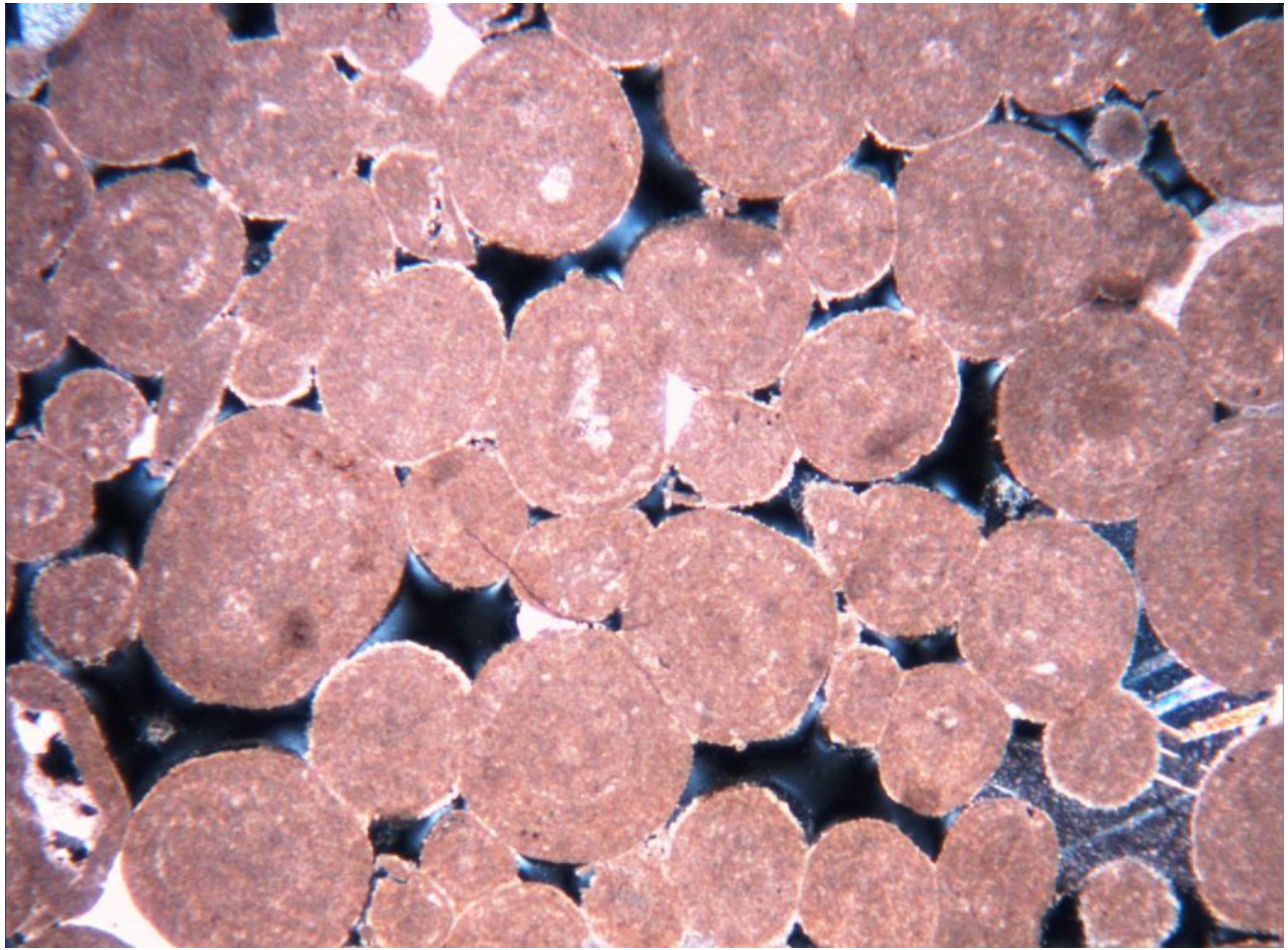


TUBARÃO OIL FIELD, 1988



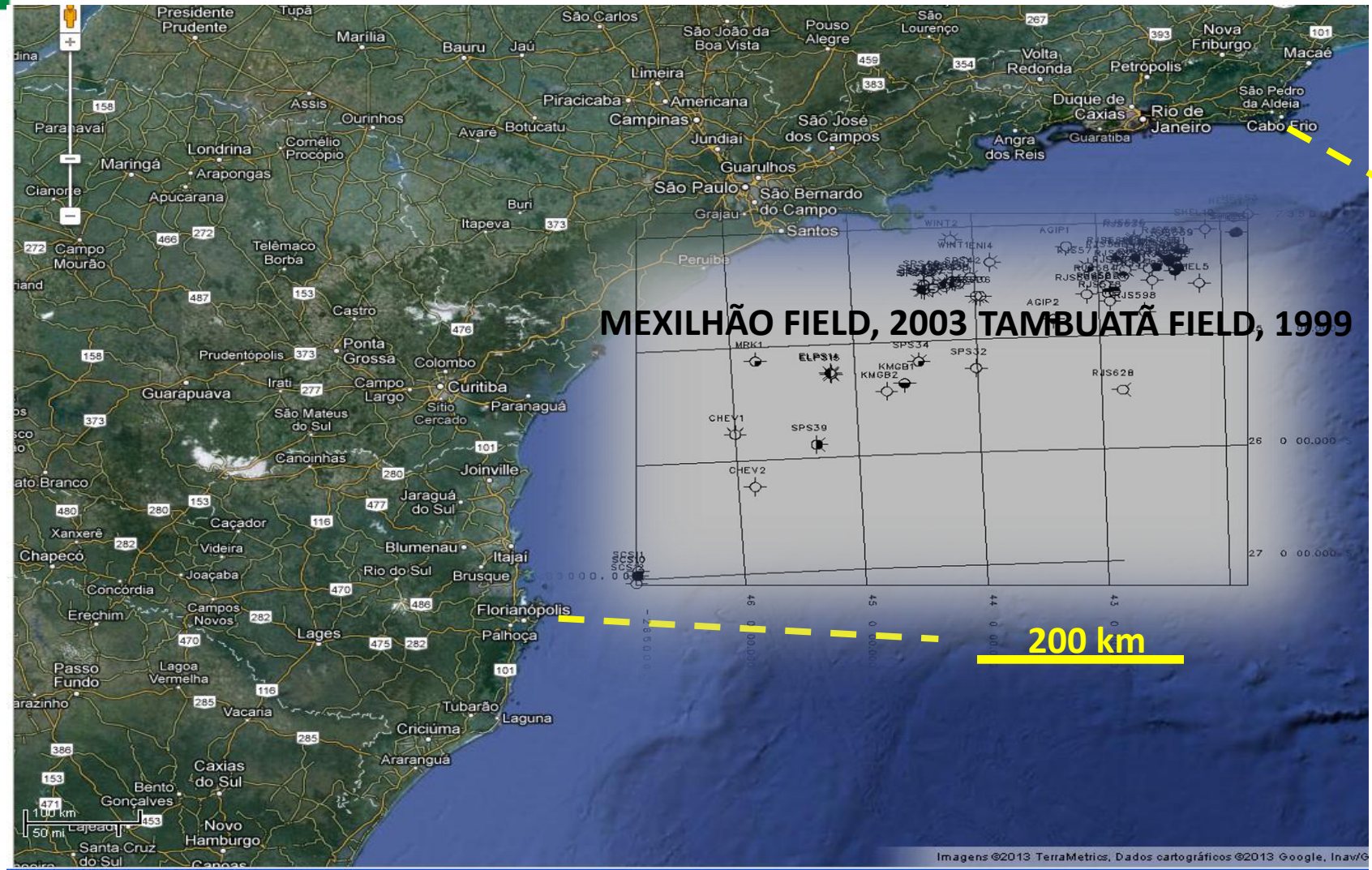
AGÊNCIA NACIONAL DE PETRÓLEO 2004

ALBIAN GRAINSTONE

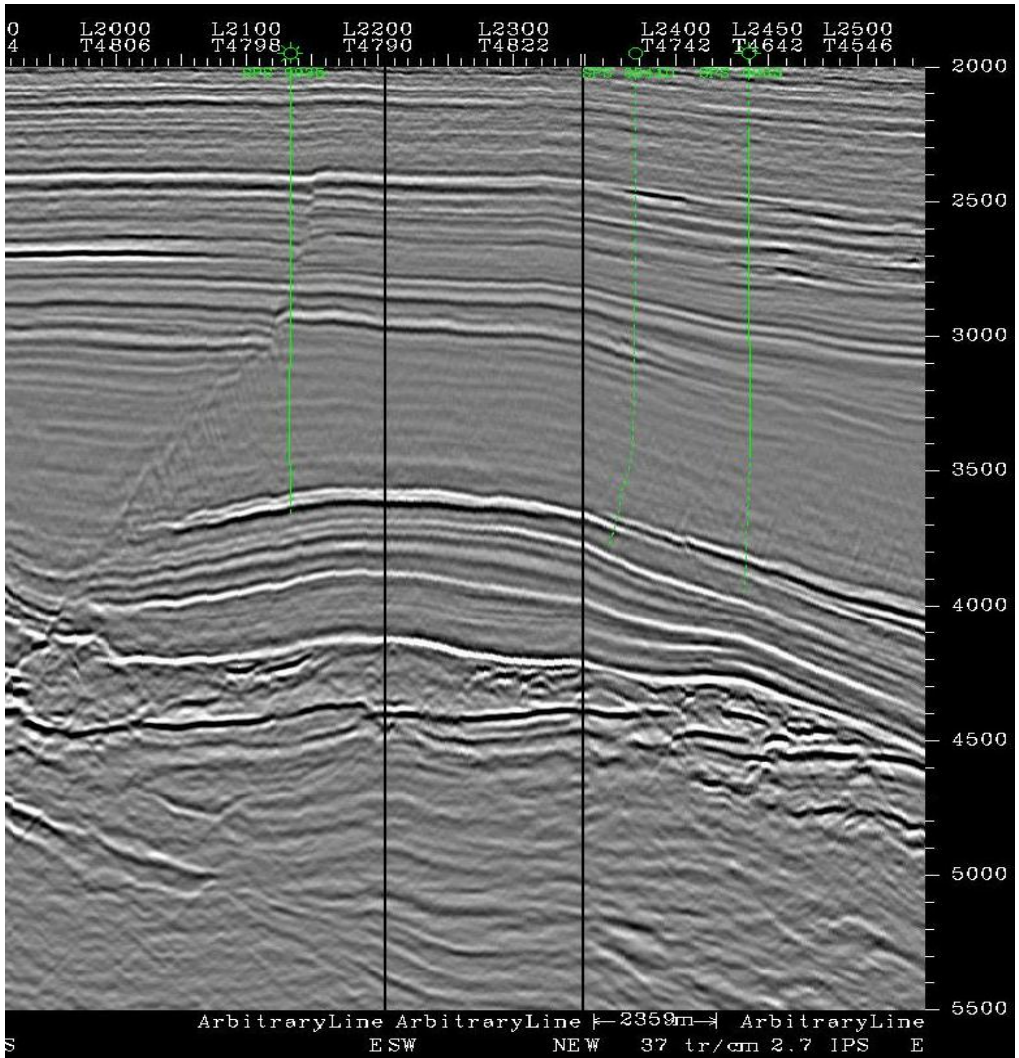


PRIMARY INTERPARTICLE POROSITY AT 4732 M

PETROBRAS 1999-2005: 81 WELLS, SOME MEDIUM-SIZED DISCOVERIES

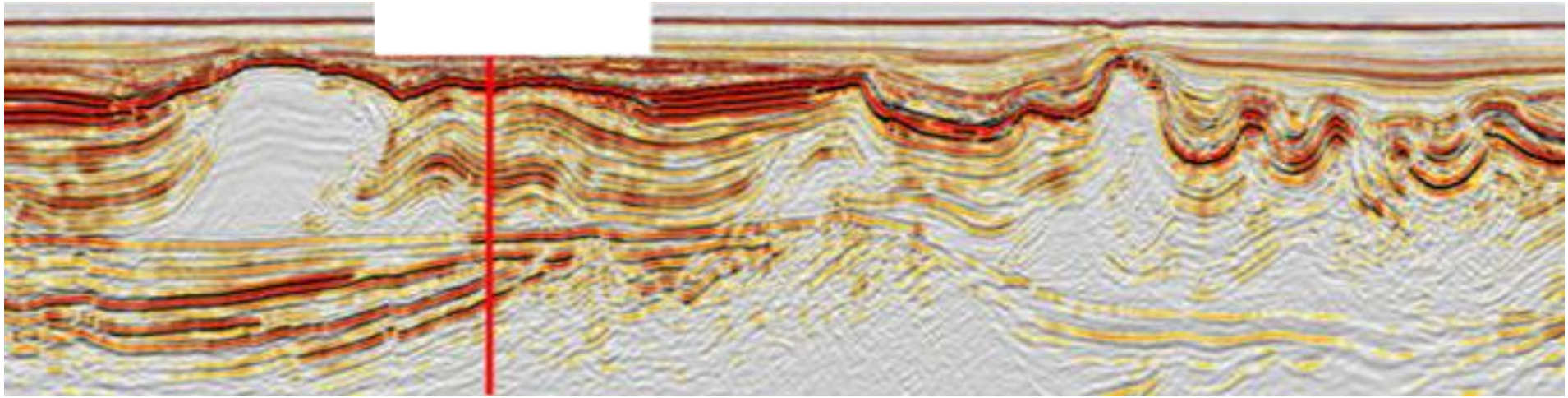


MEXILHÃO GAS FIELD, 2003



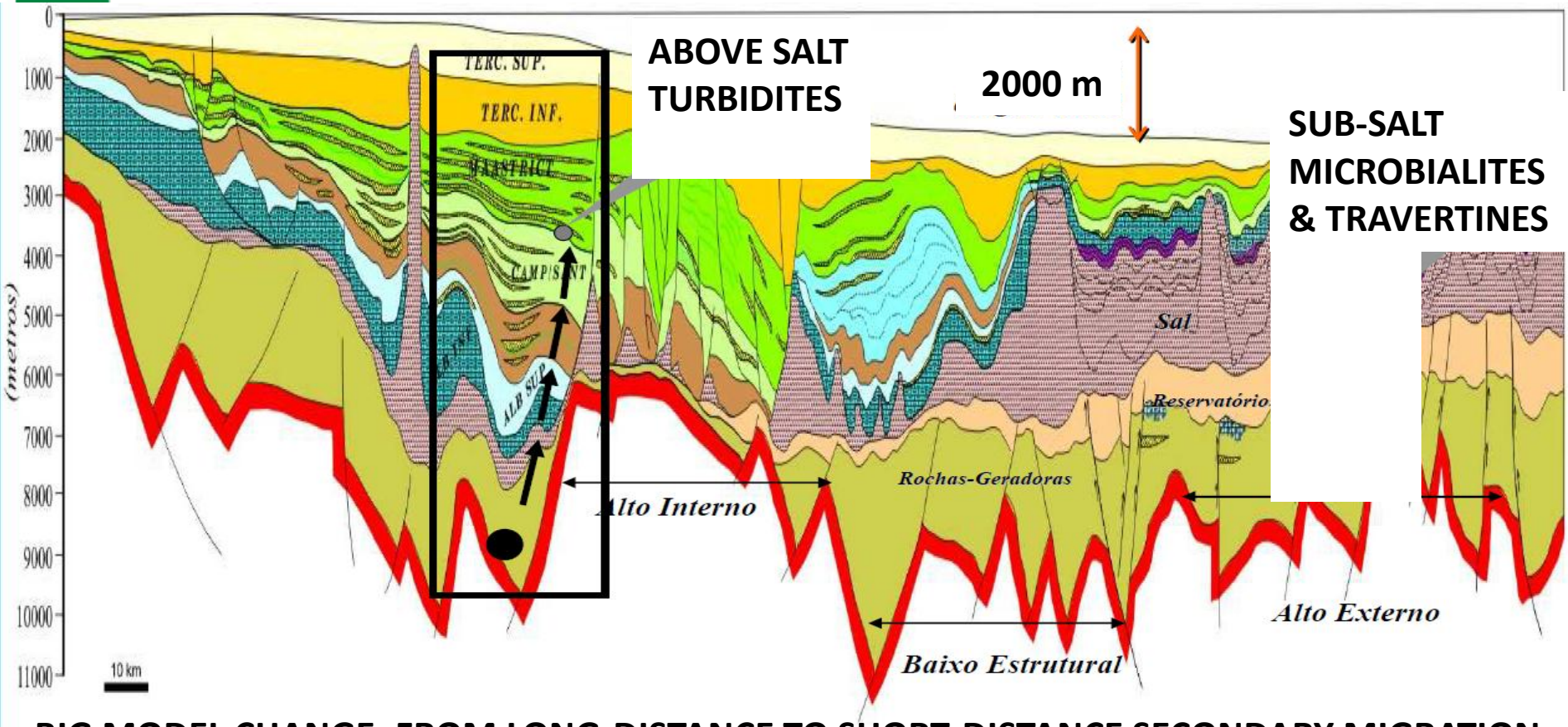
PETROBRAS SANTOS BASIN 2005

Santos basin, a gas-prone basin?



CGG VERITAS

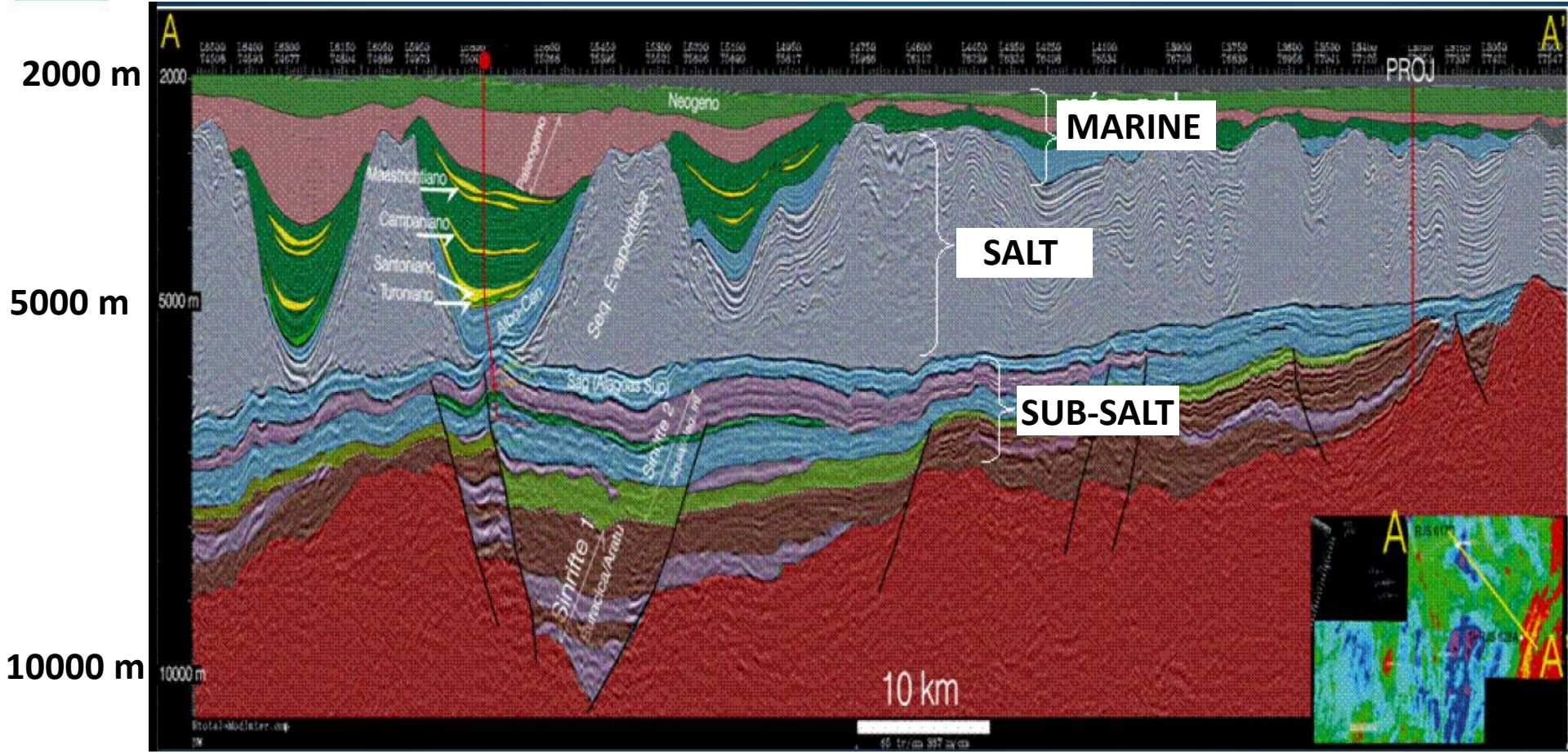
PETROBRAS SANTOS BASIN



BIG MODEL CHANGE: FROM LONG-DISTANCE TO SHORT-DISTANCE SECONDARY MIGRATION FROM ABOVE SALT TO SUB-SALT RESERVOIRS

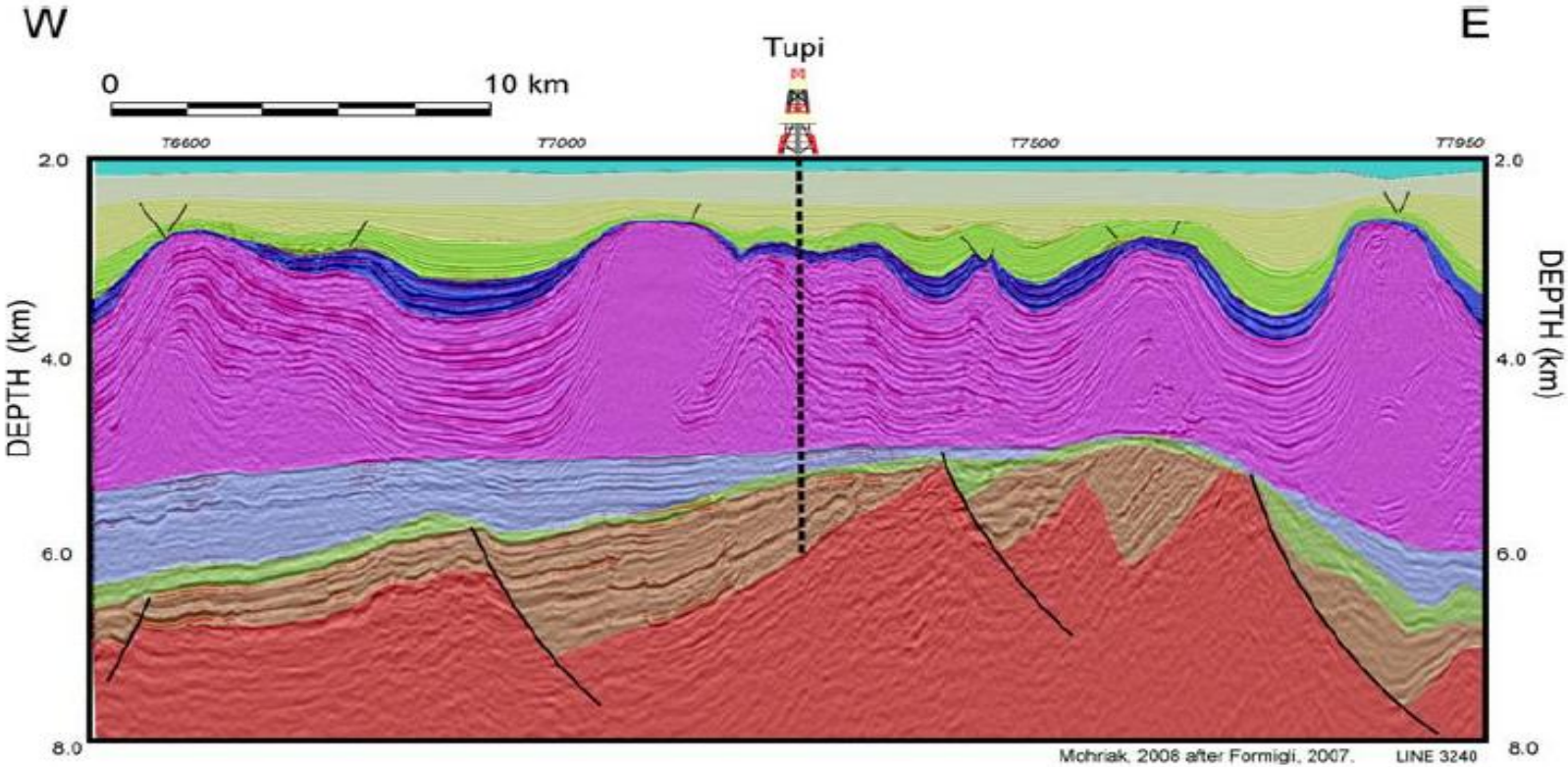
DRILLING AND PRODUCTION CHALLENGES: 2000 m WATER + 2000 m UK-T + 2000 m SALT

TUPI LEAD, A BOLD MOVE



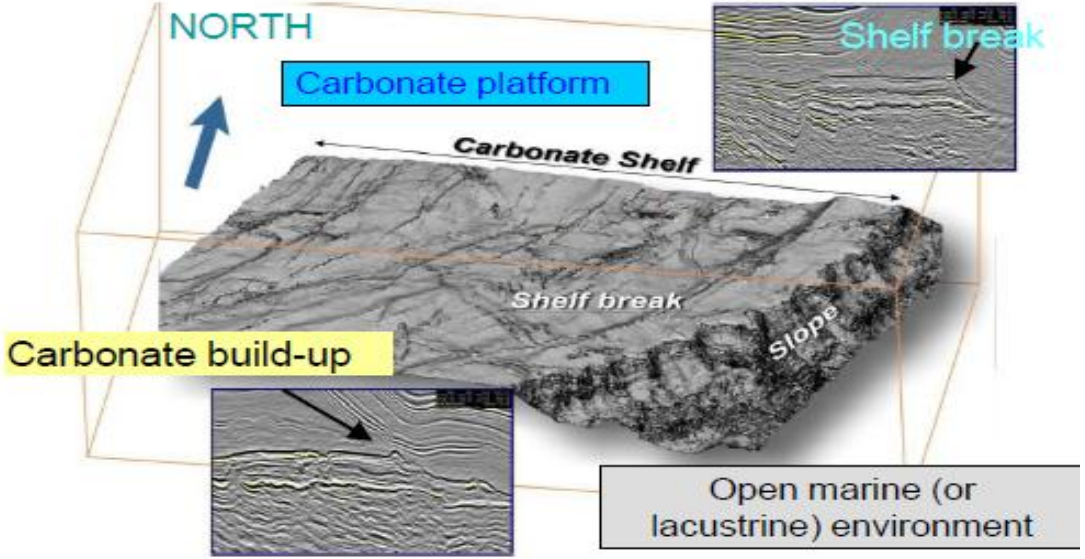
Formigli 2007

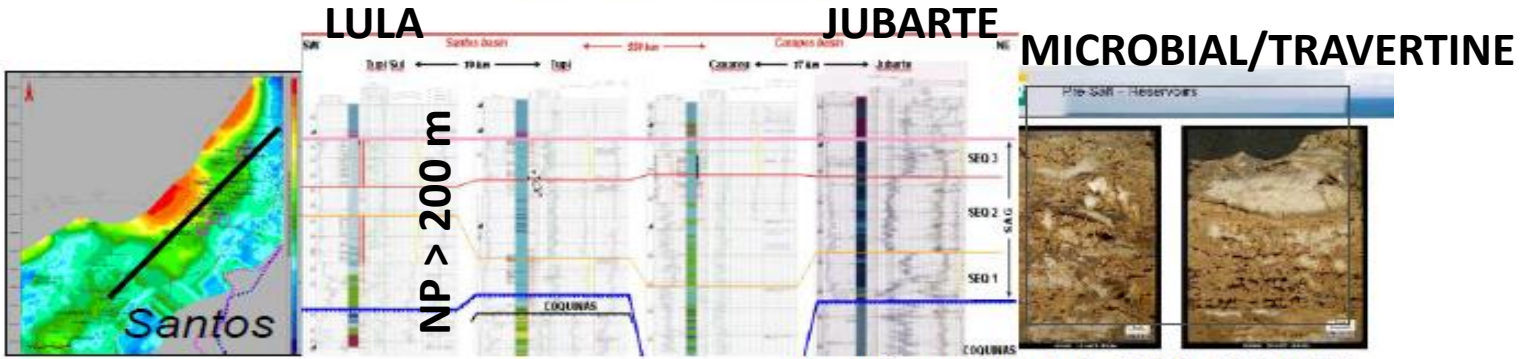
TUPI LEAD = LULA (SQUID) FIELD



Upper Tertiary (siliciclastic rocks)
Lower Tertiary (siliciclastic rocks)
Upper Cretaceous (siliciclastic rocks)
Cenomanian/Albian (carbonate rocks)
Aptian (evaporites)
Aptian (carbonate rocks)
Barremian (siliciclastic rocks)
Neocomian (siliciclastics / volcanics)
Basement (pre-rift/Precambrian)

PETROBRAS SANTOS BASIN APTIAN CARBONATE ROCKS

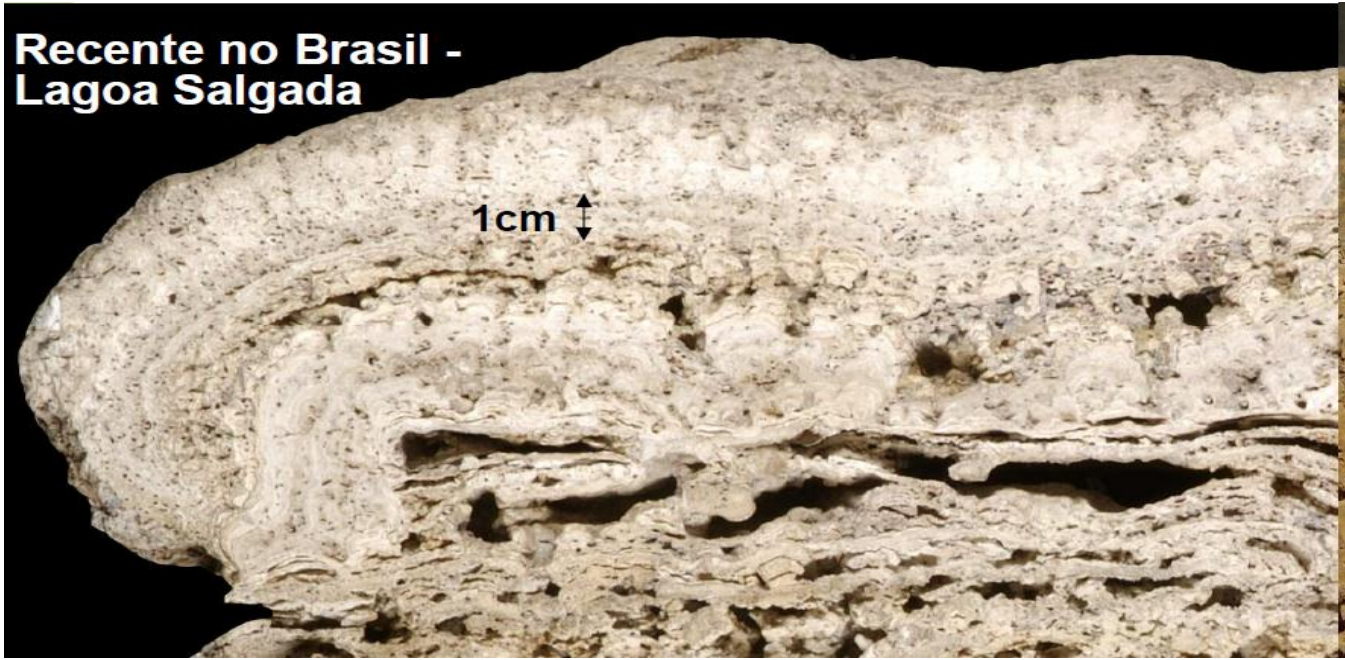




From Carminati et al., 2008, 19th WPC

Extract from Tupi 3D seismic - No scale

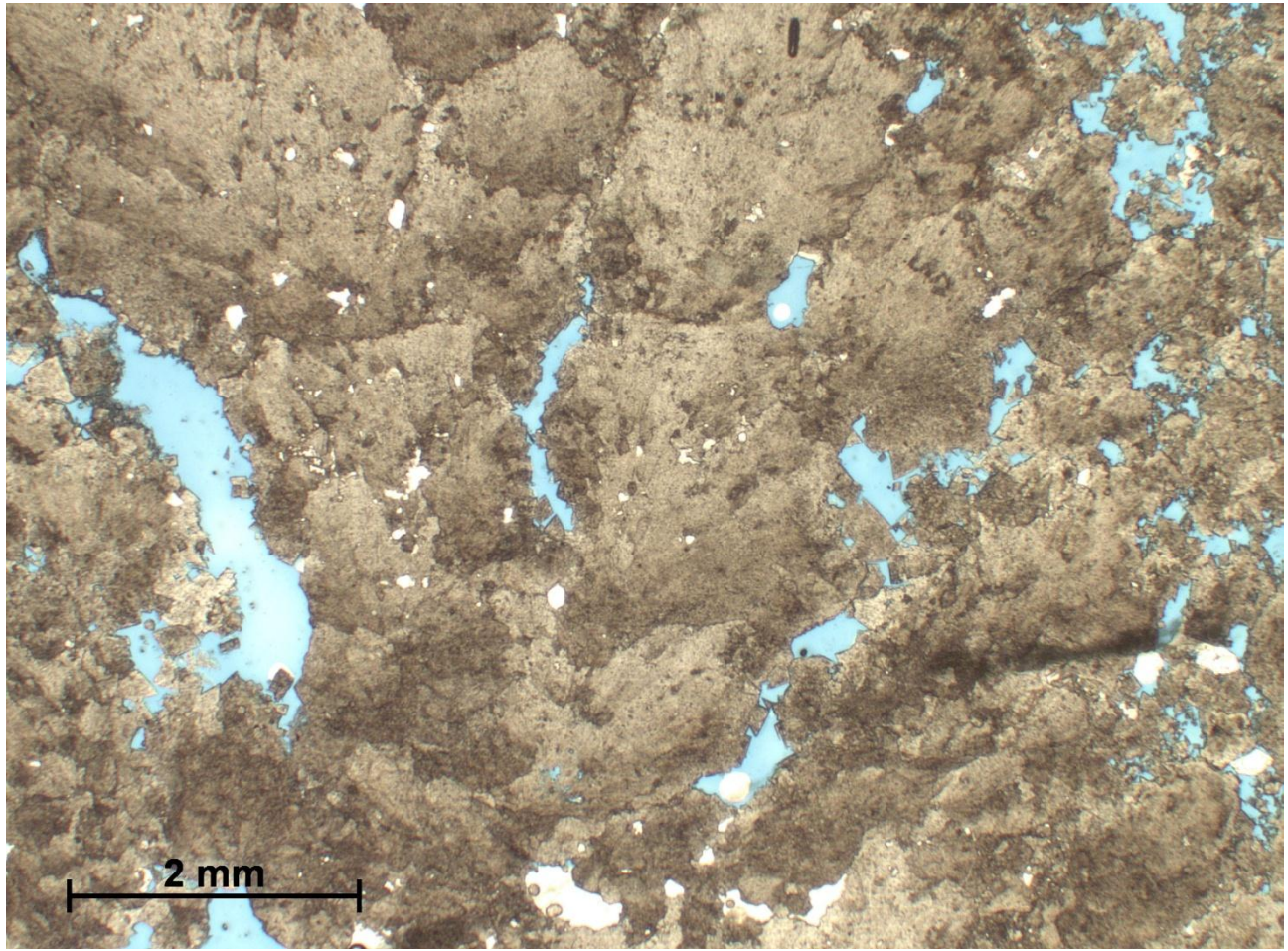
MICROBIAL RESERVOIRS



RECENT APTIAN

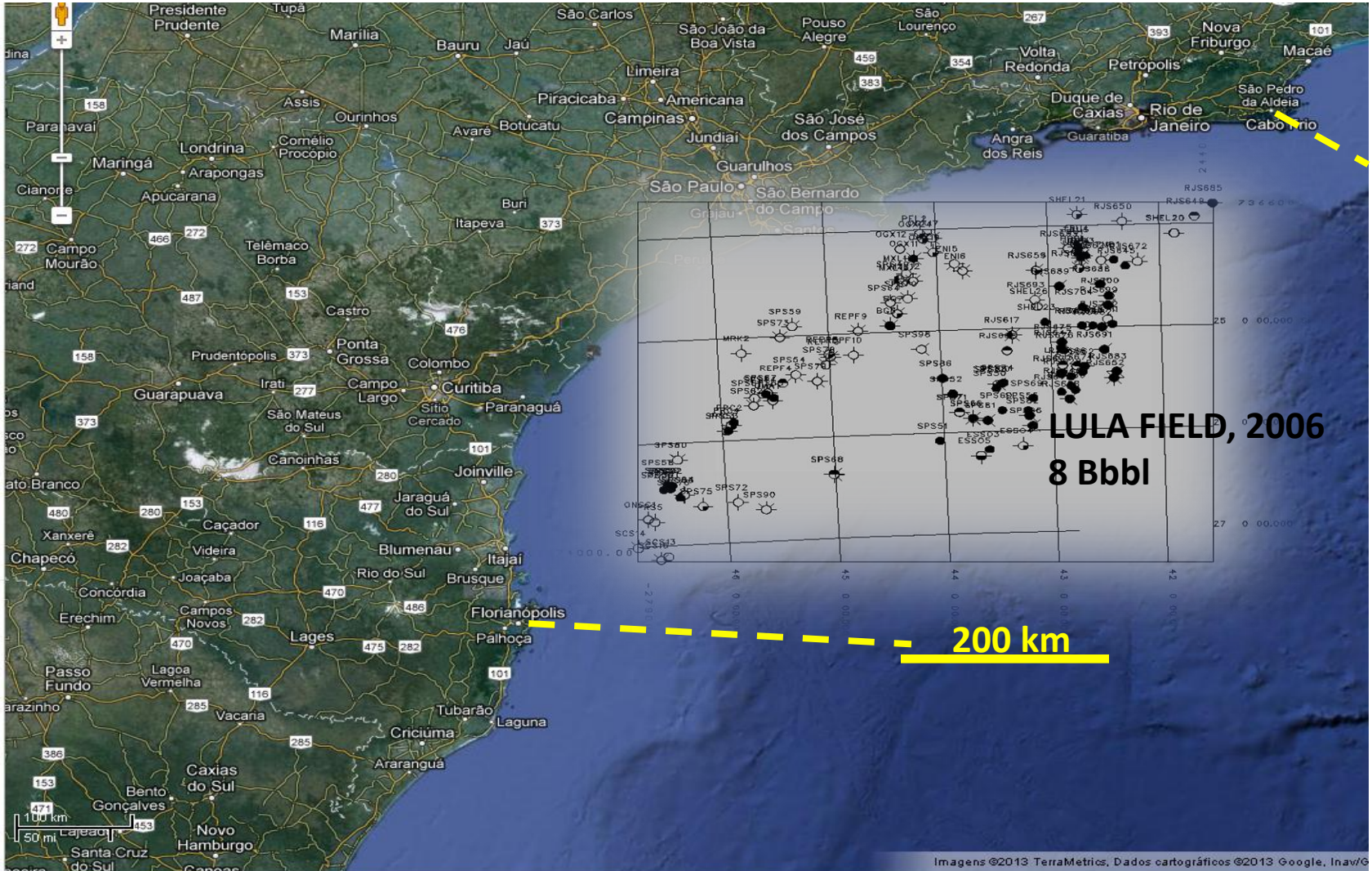
BIG CHALLENGE: HOW TO PREDICT POROSITY BEHAVIOR FROM INTEGRATION OF SEISMIC, WELL LOGS AND ROCK DATA

SECONDARY POROSITY AT 5500 M

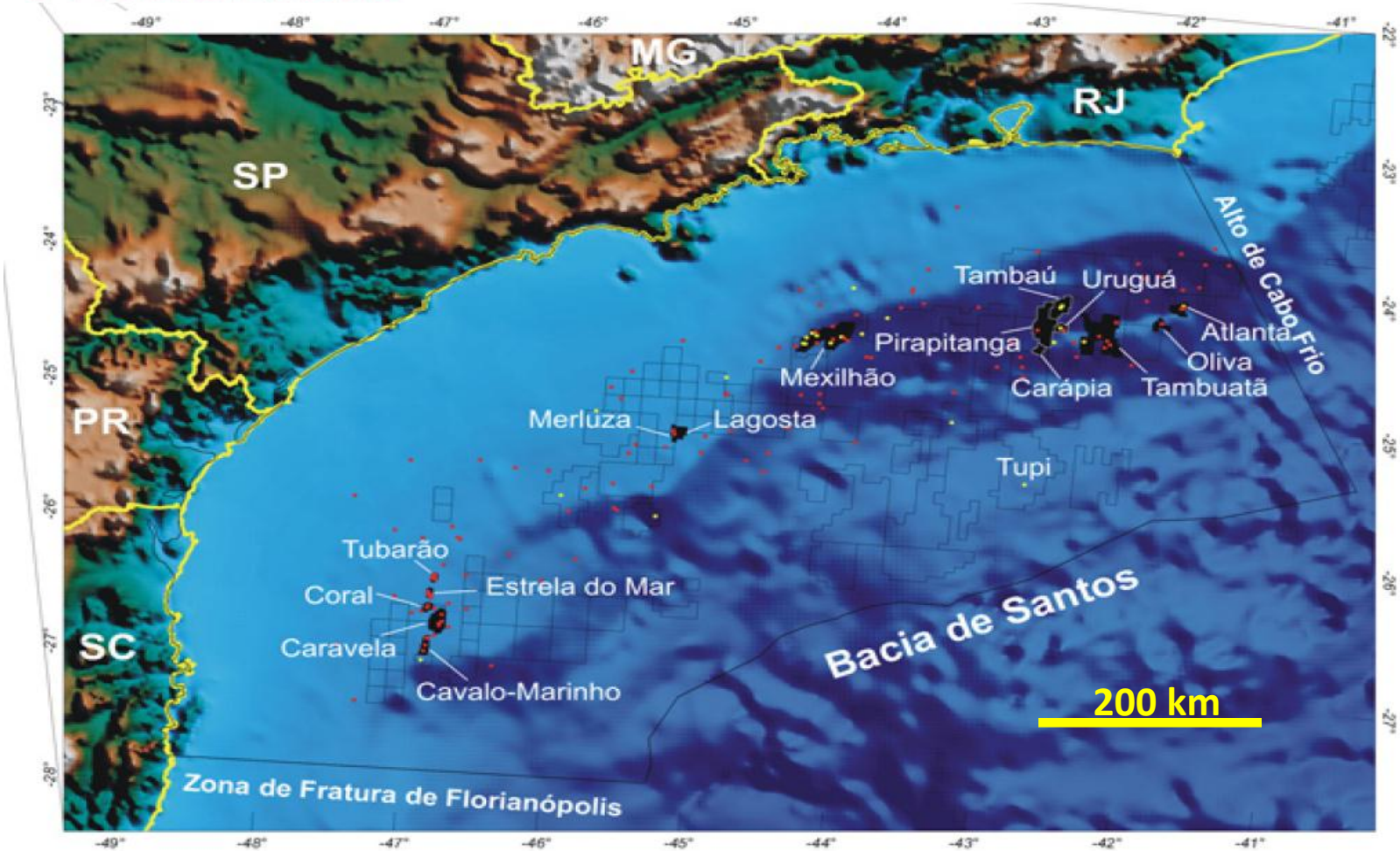


Terra et al., 2010

PETROBRAS 2006-2012: 166 WELLS, HUGE DISCOVERIES



PETROBRAS SANTOS BASIN 2008

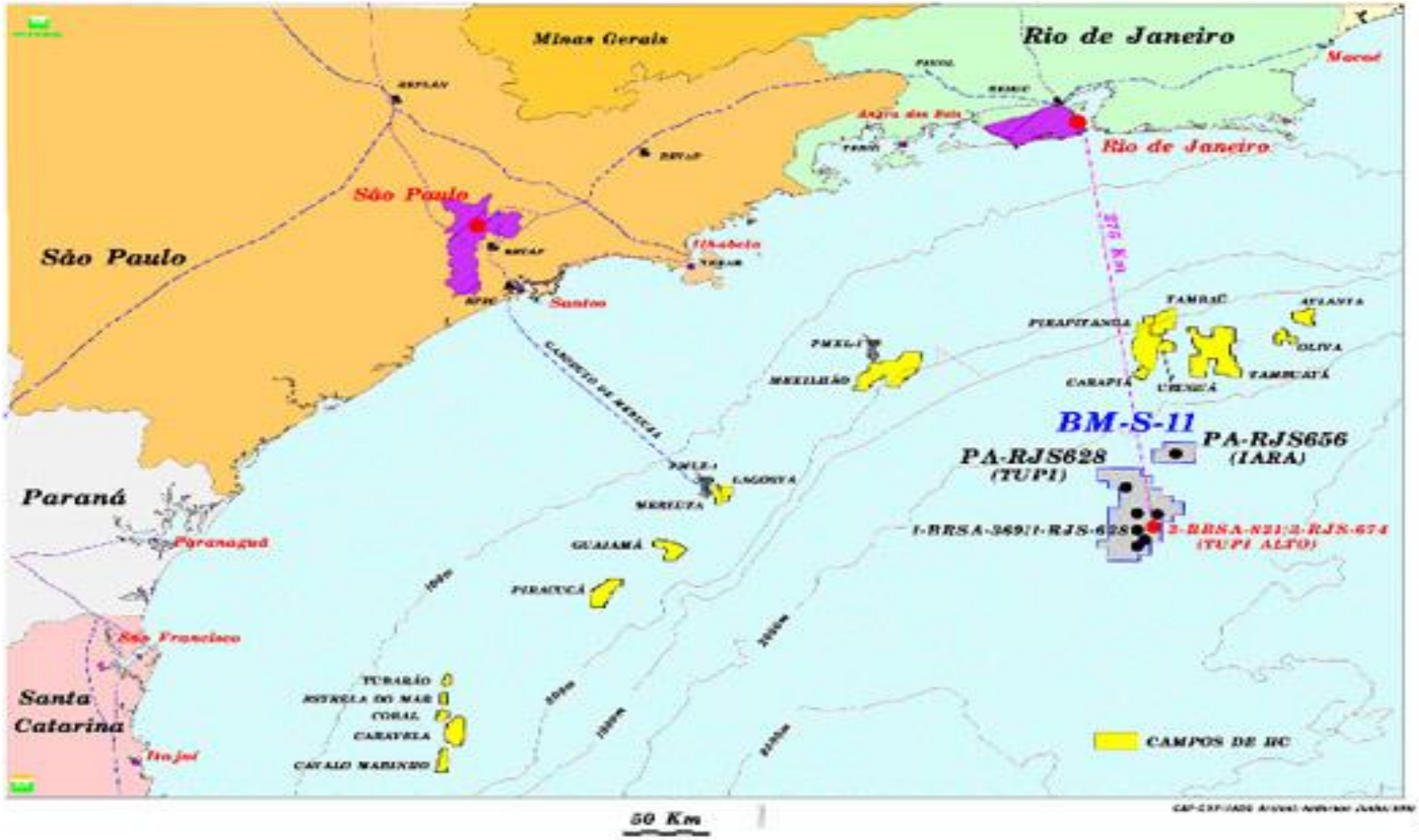


Chang et al., 2008, Revista Brasileira de Geociências

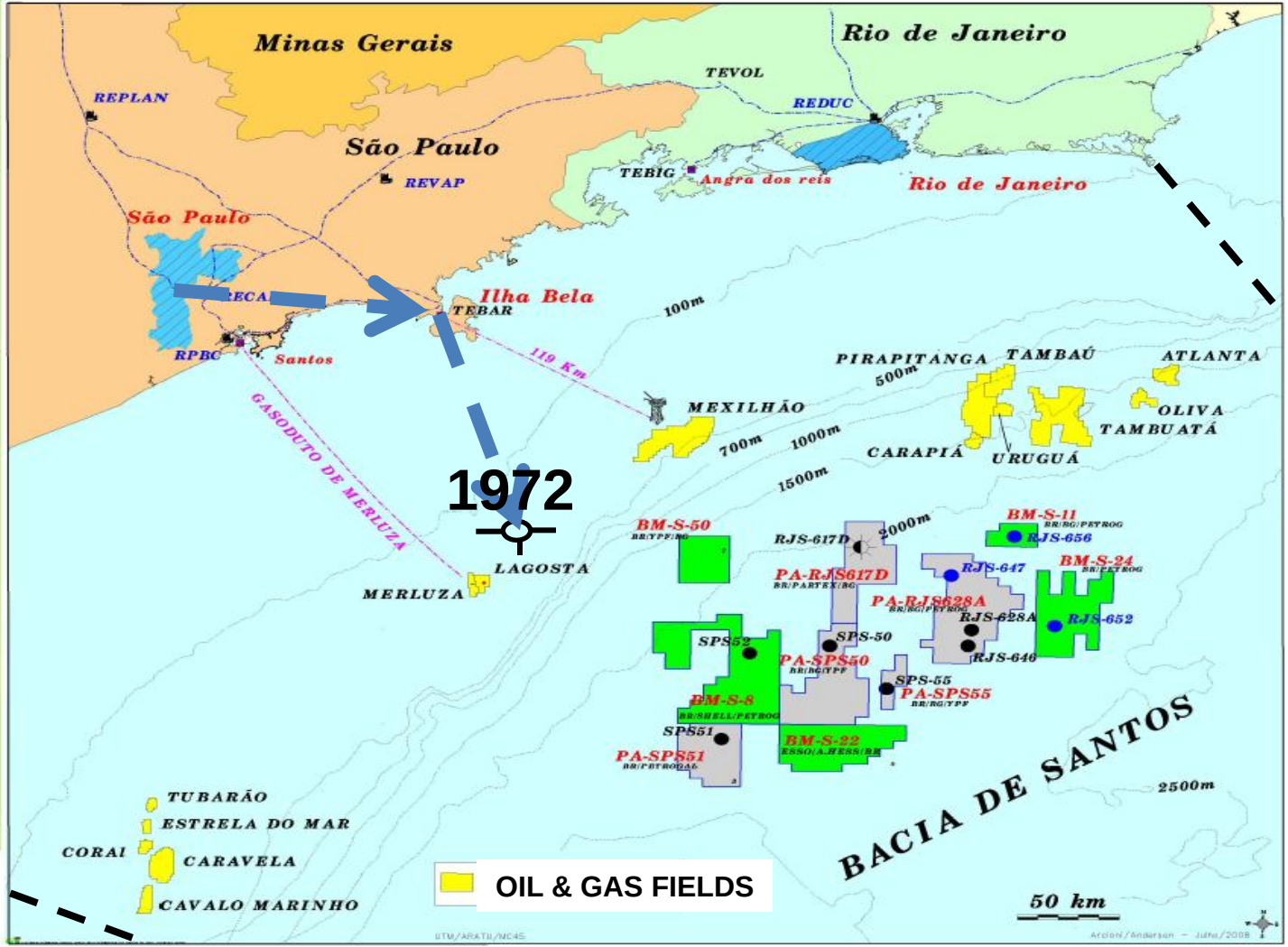
SANTOS BASIN 2008

PETROBRAS SANTOS BASIN 2009

PETROBRAS SANTOS BASIN 2010



PETROBRAS SANTOS BASIN 1972-2012 SUMMARY



My first chopper flight

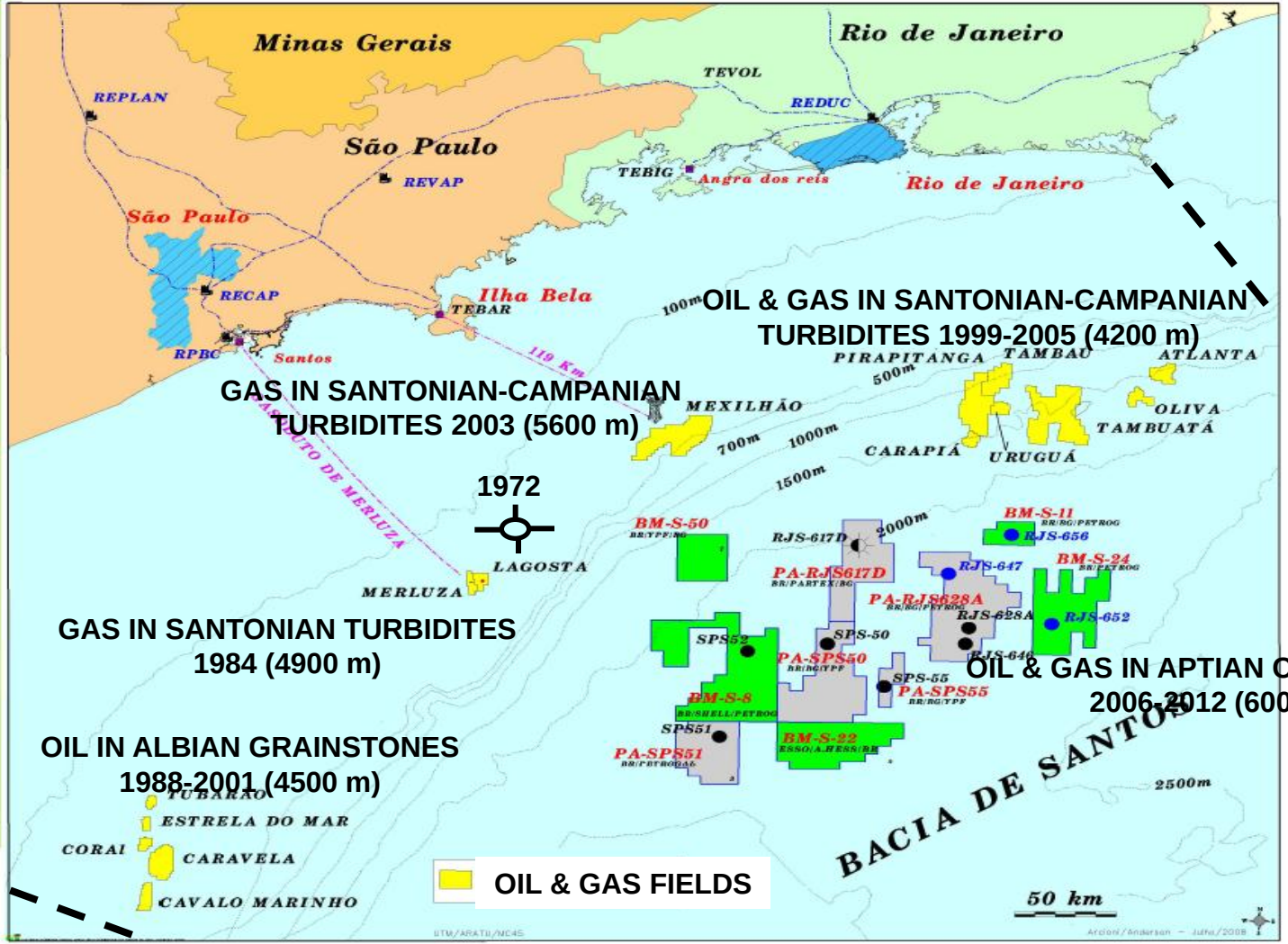
Hard to take off
Too much weight

Aéroporto de Congonhas - SP

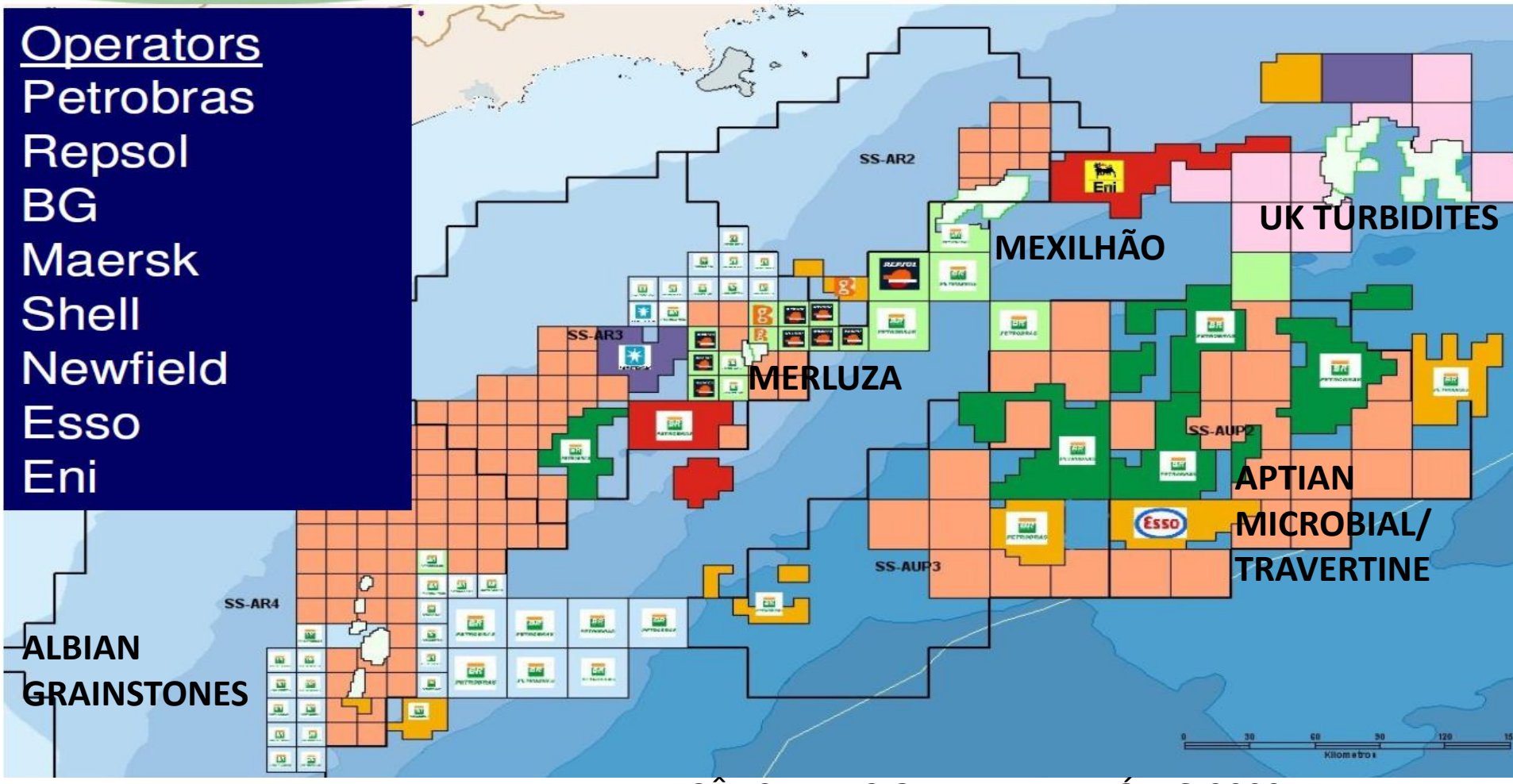
My first drillship

Two long weeks
Only cuttings
Dry hole
Pitch, Roll, Heave

SANTOS BASIN 1972-2012

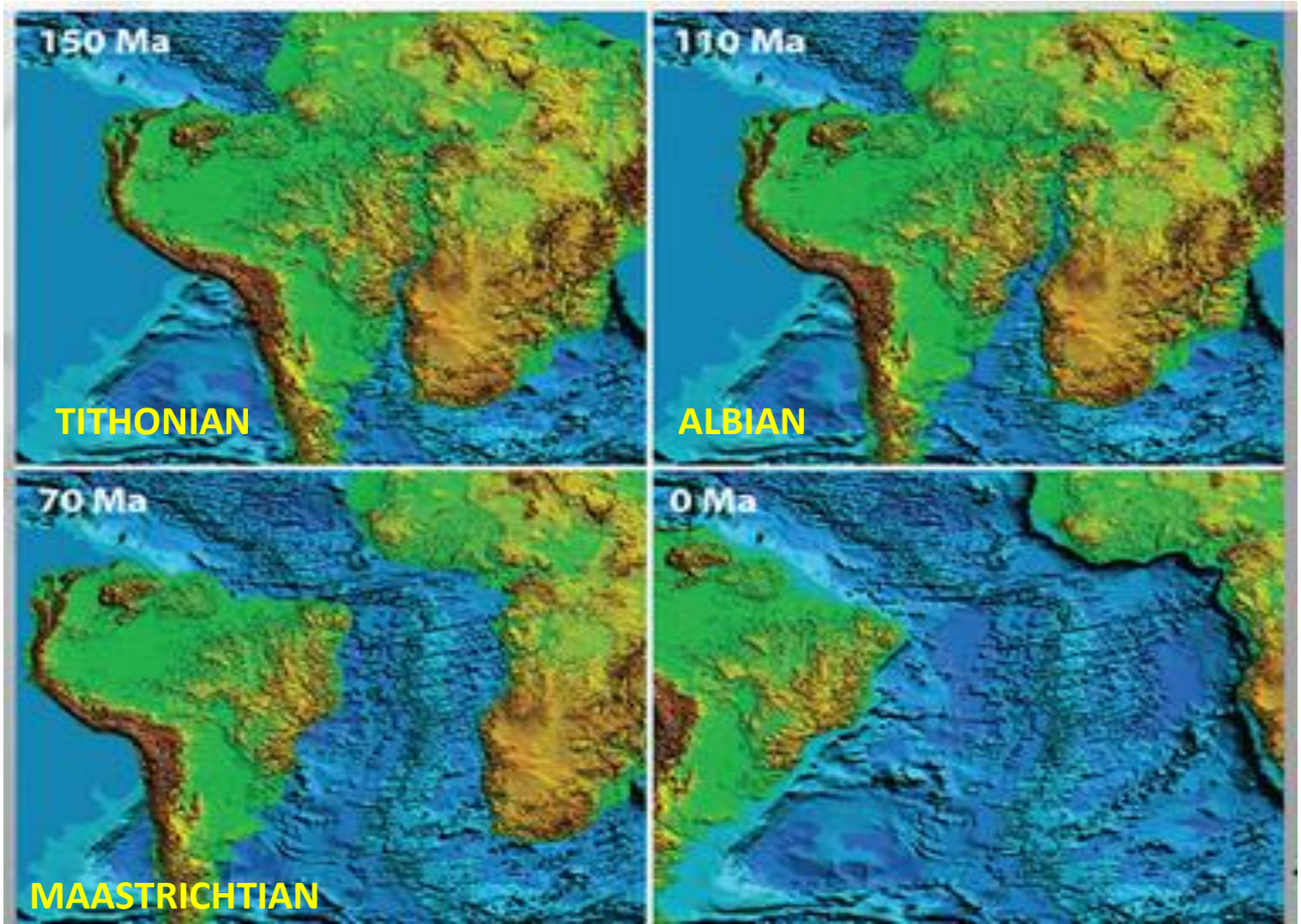


OPERATOR COMPANIES 2009

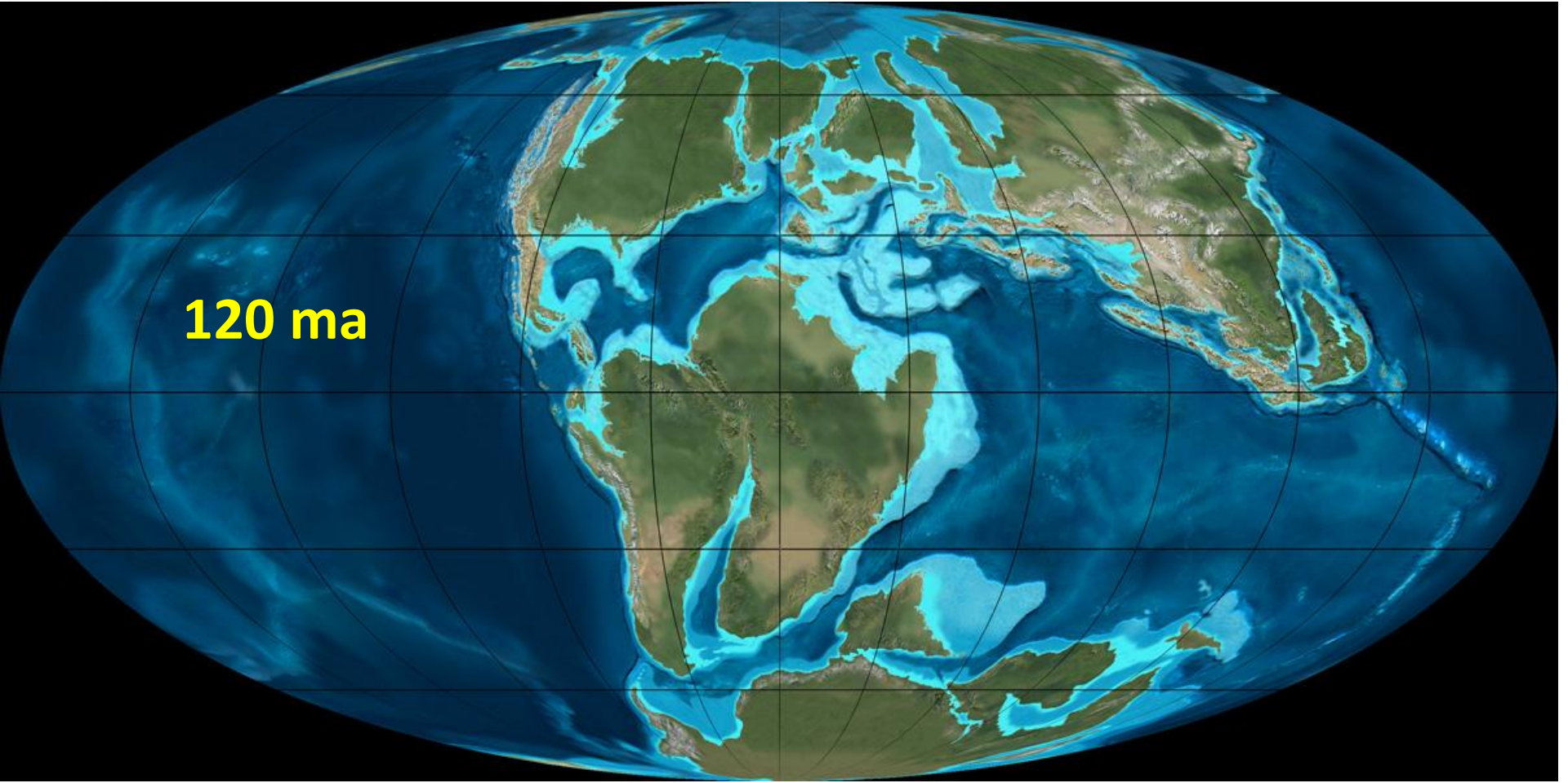


AGÊNCIA NACIONAL DE PETRÓLEO 2009

SOUTH ATLANTIC EVOLUTION

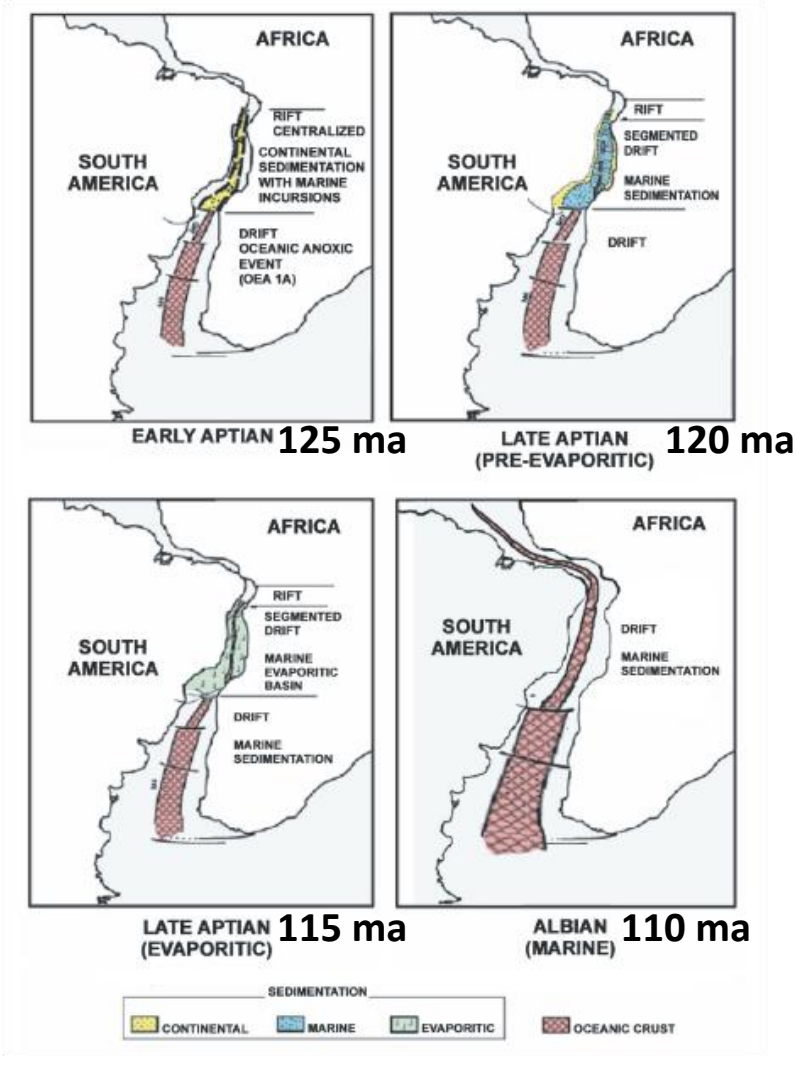


SOUTH ATLANTIC EVOLUTION



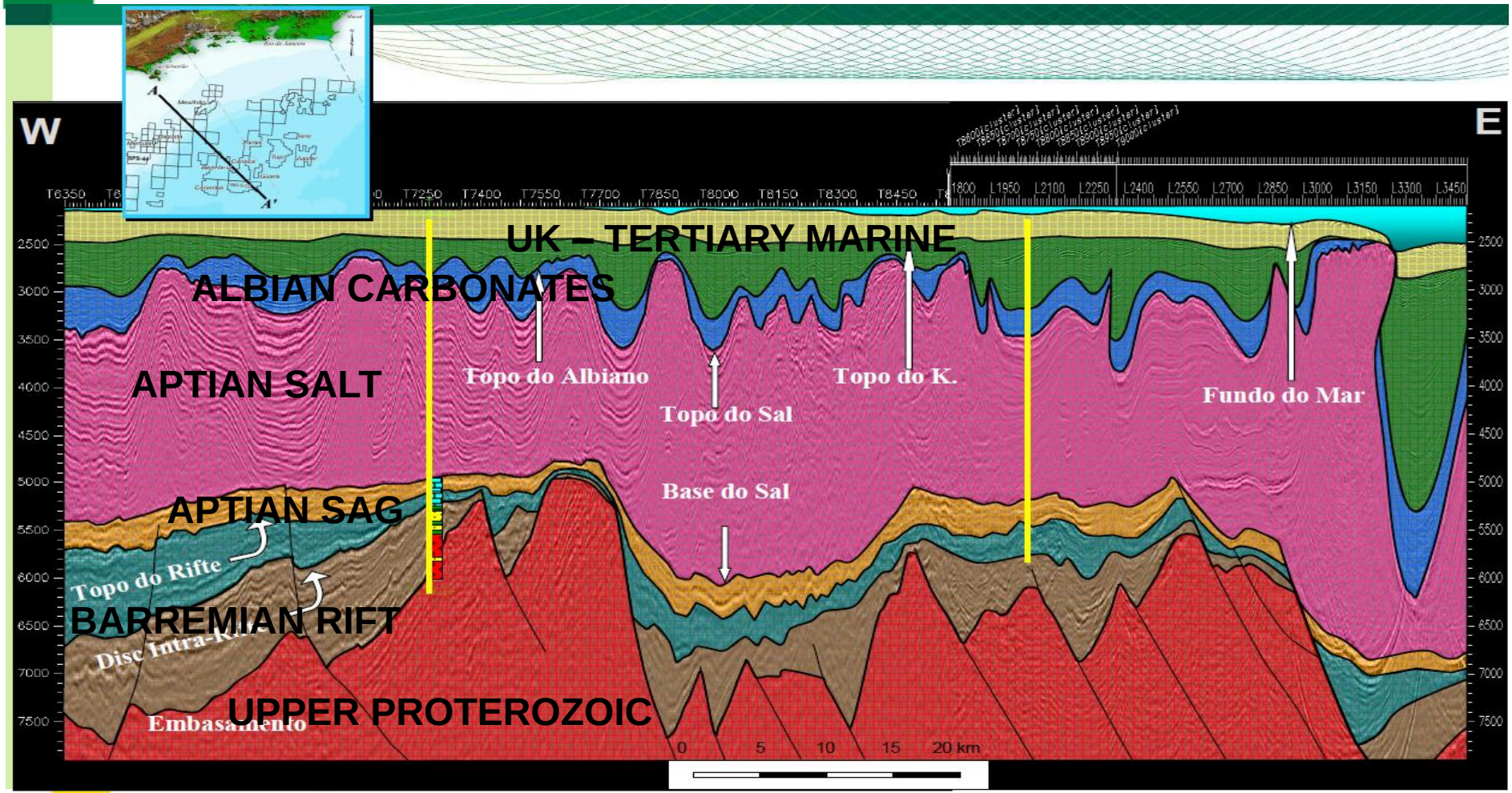
http://www2.nau.edu/rcb7/120moll.jpg

SOUTH ATLANTIC EVOLUTION

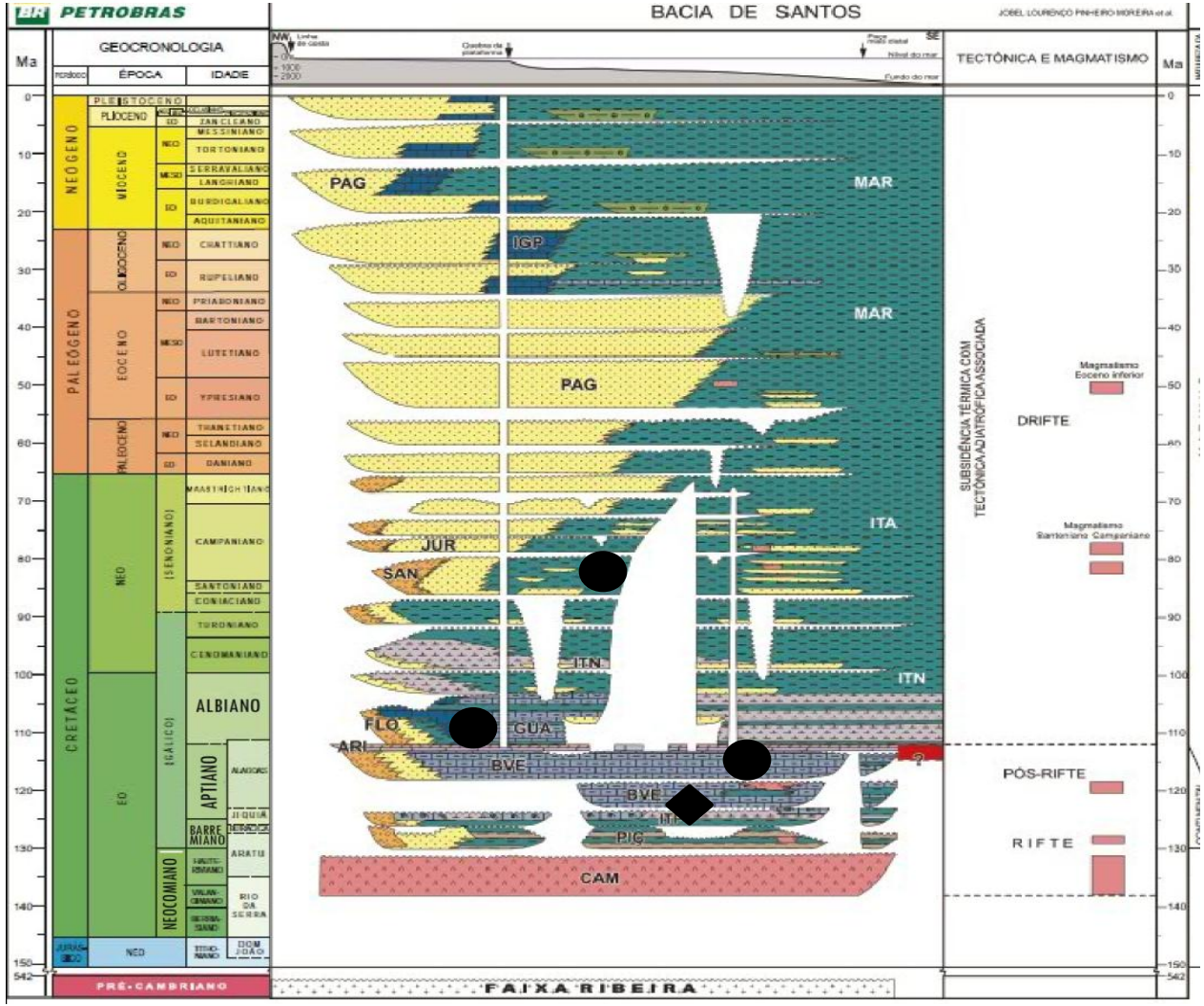


J.L.DIAS, 2005

SANTOS BASIN 3D SEISMIC



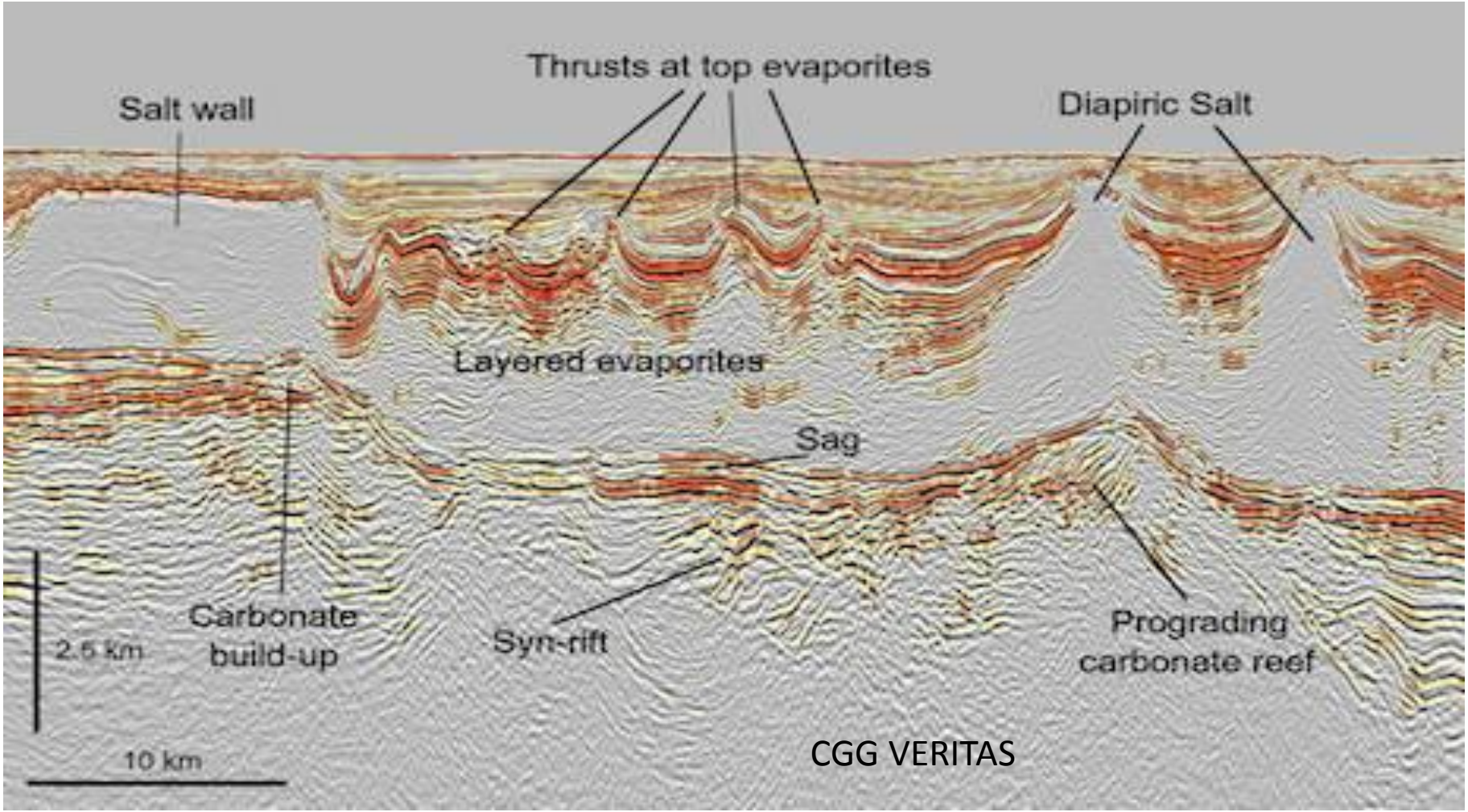
PETROBRAS SANTOS BASIN



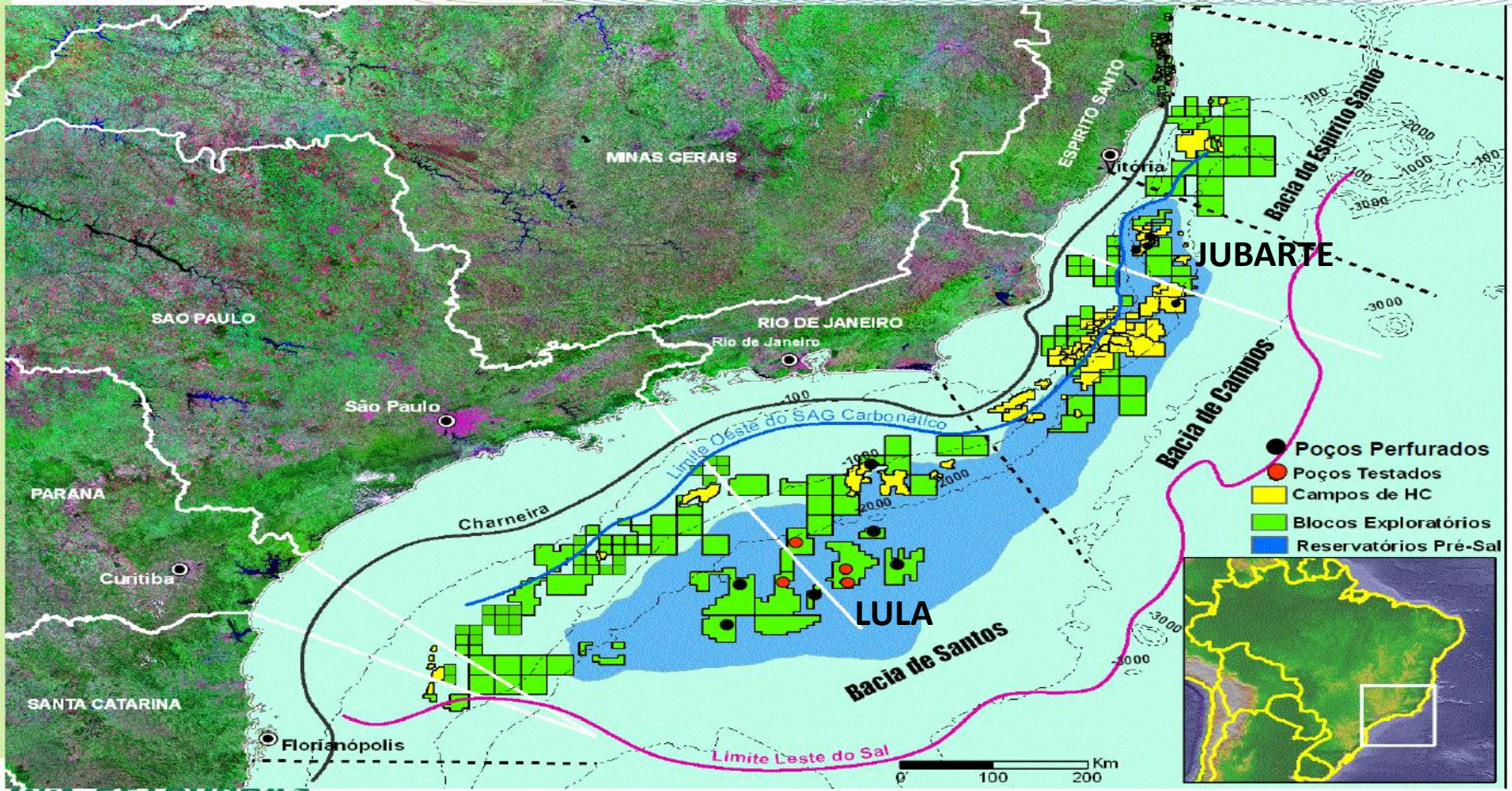
● RESERVOIRS

◆ SOURCE ROCKS

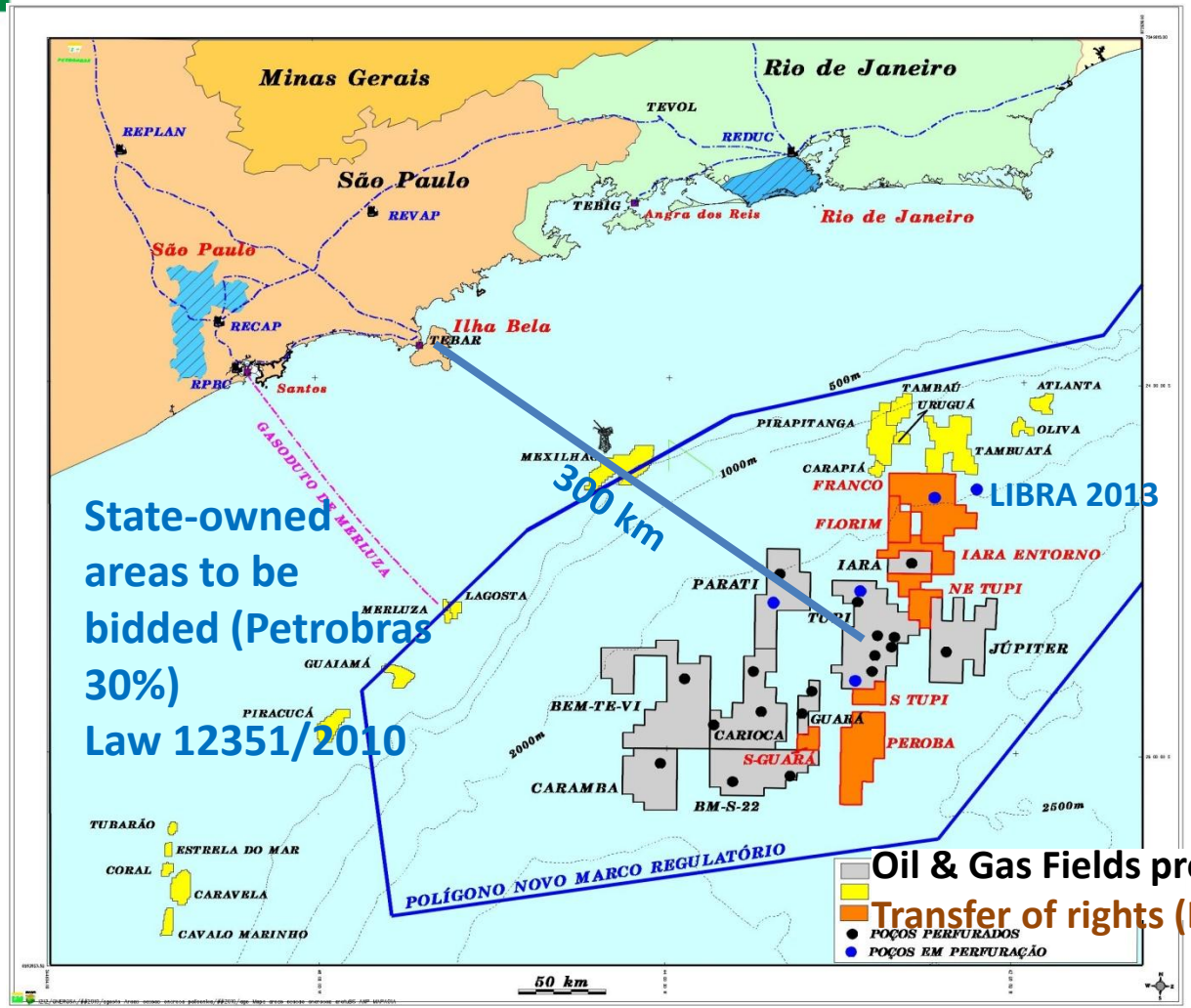
THICK SALT AS A SEAL



SUB-SALT PROVINCE



DEEP (AND FAR) WATERS 2013

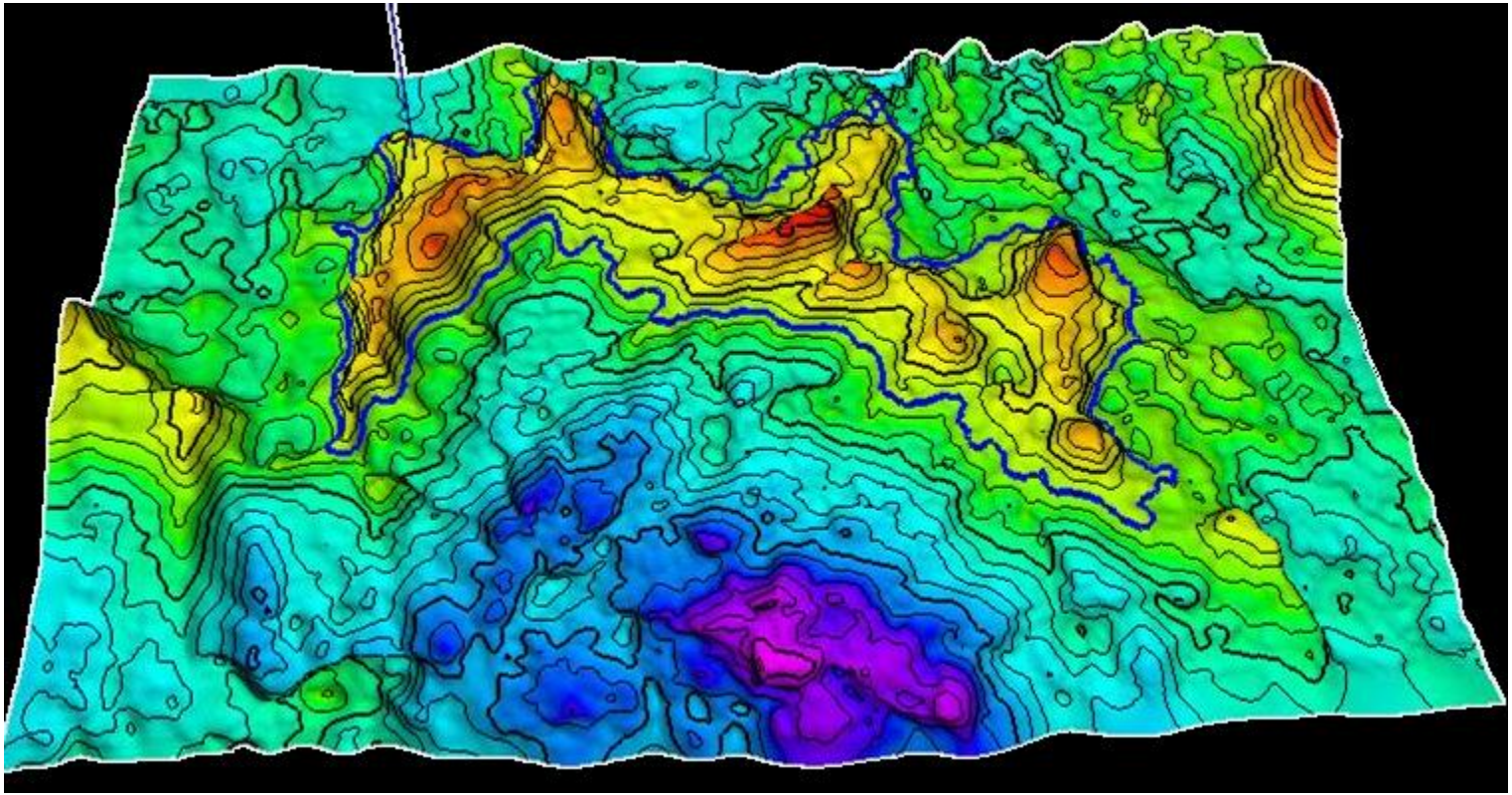


State-owned areas to be bidded (Petrobras 30%)
Law 12351/2010

Oil & Gas Fields producing and under development

Transfer of rights (Law 12276/2010)

LIBRA PROSPECT

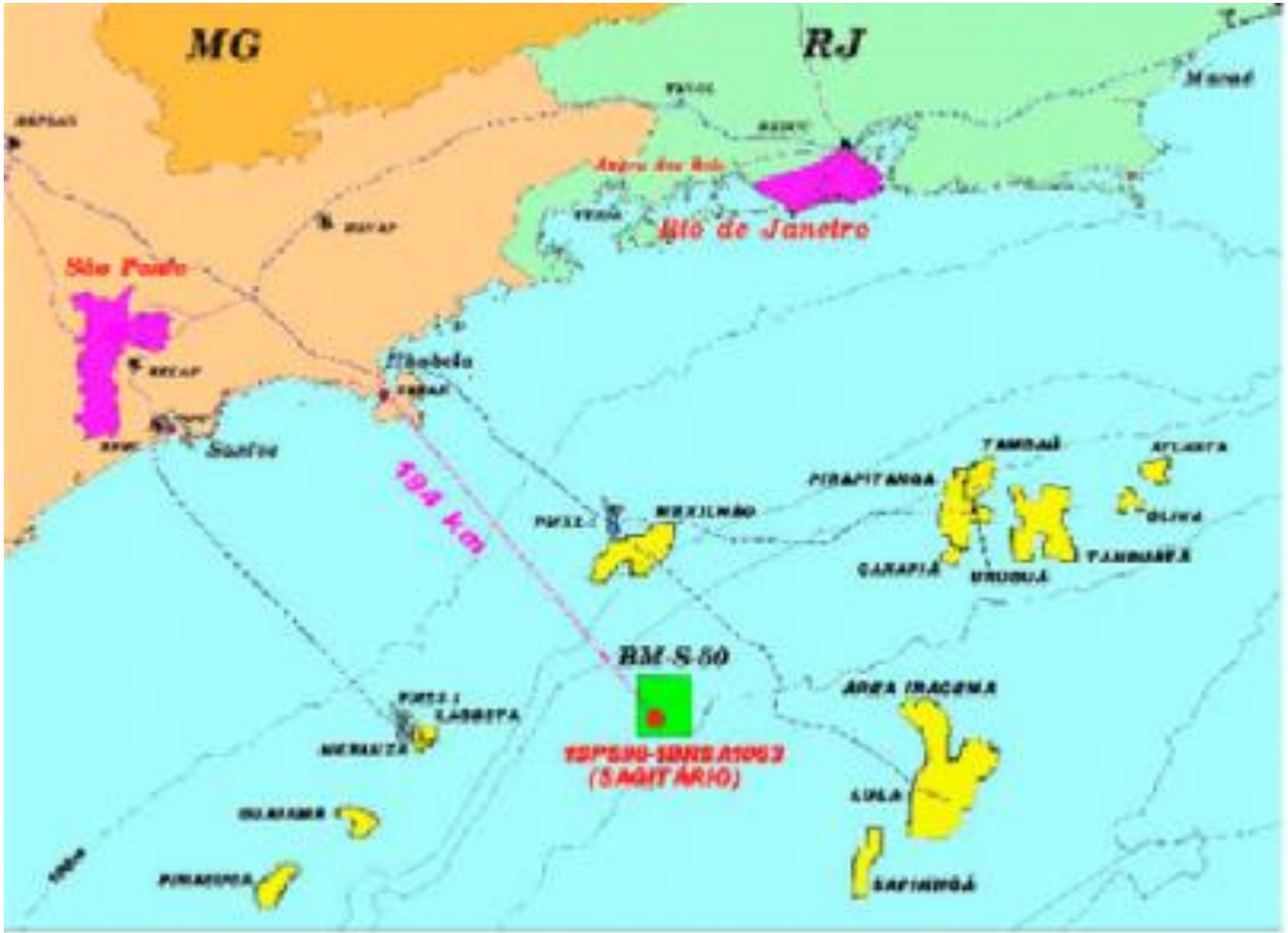


BASE SALT STRUCTURAL DEPTH MAP

NP = 326 M **RESERVES = 8-12 Bbbl 27º API OIL**

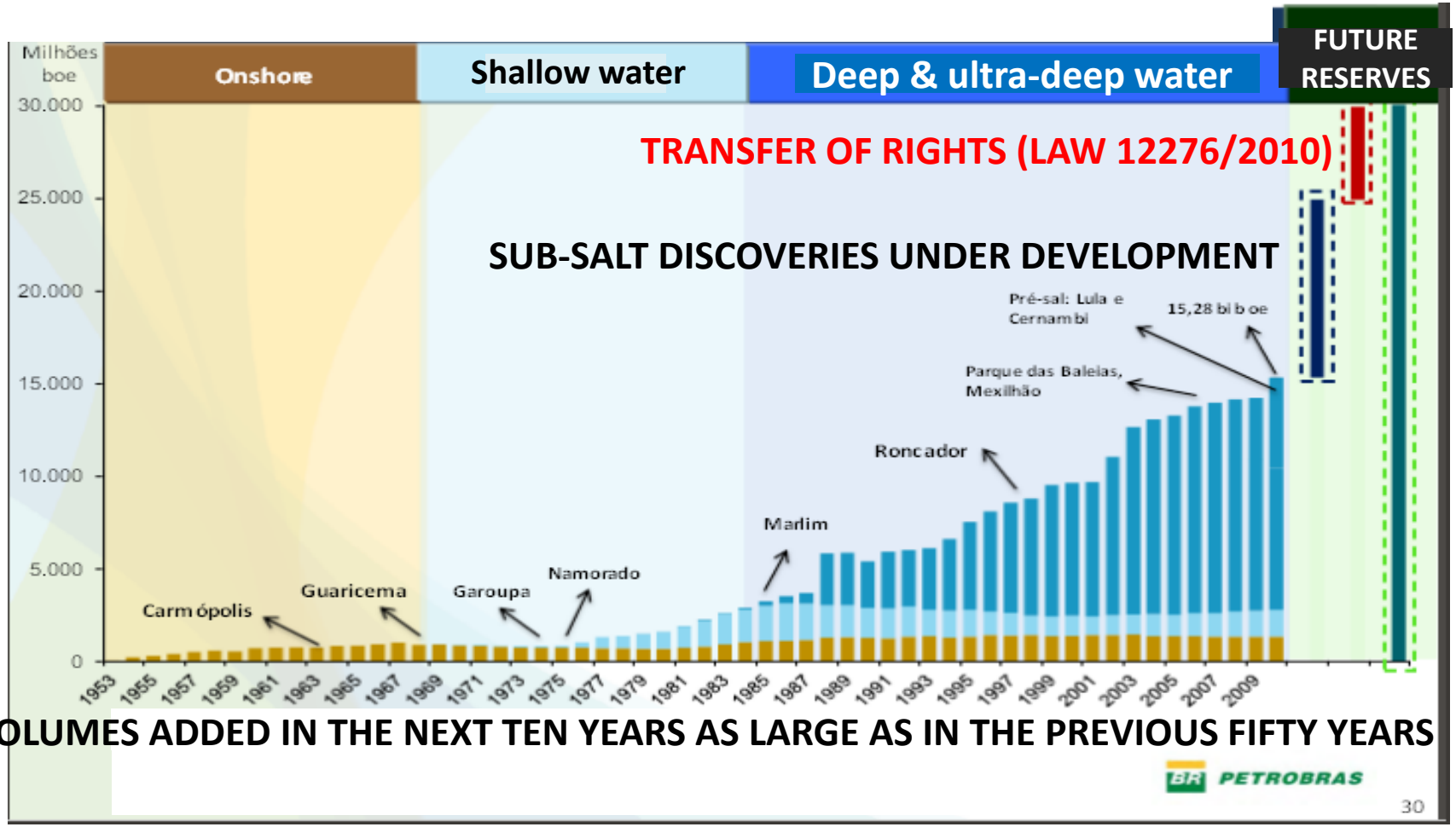
ANP 2013

PETROBRAS SAGITARIUS 2013



31º API OIL
SUB-SALT CARBONATE
6150 m deep
1871 m WD
PETROBRAS 60%
BG 20%
REPSOL SINOPEC 20%

PETROBRAS

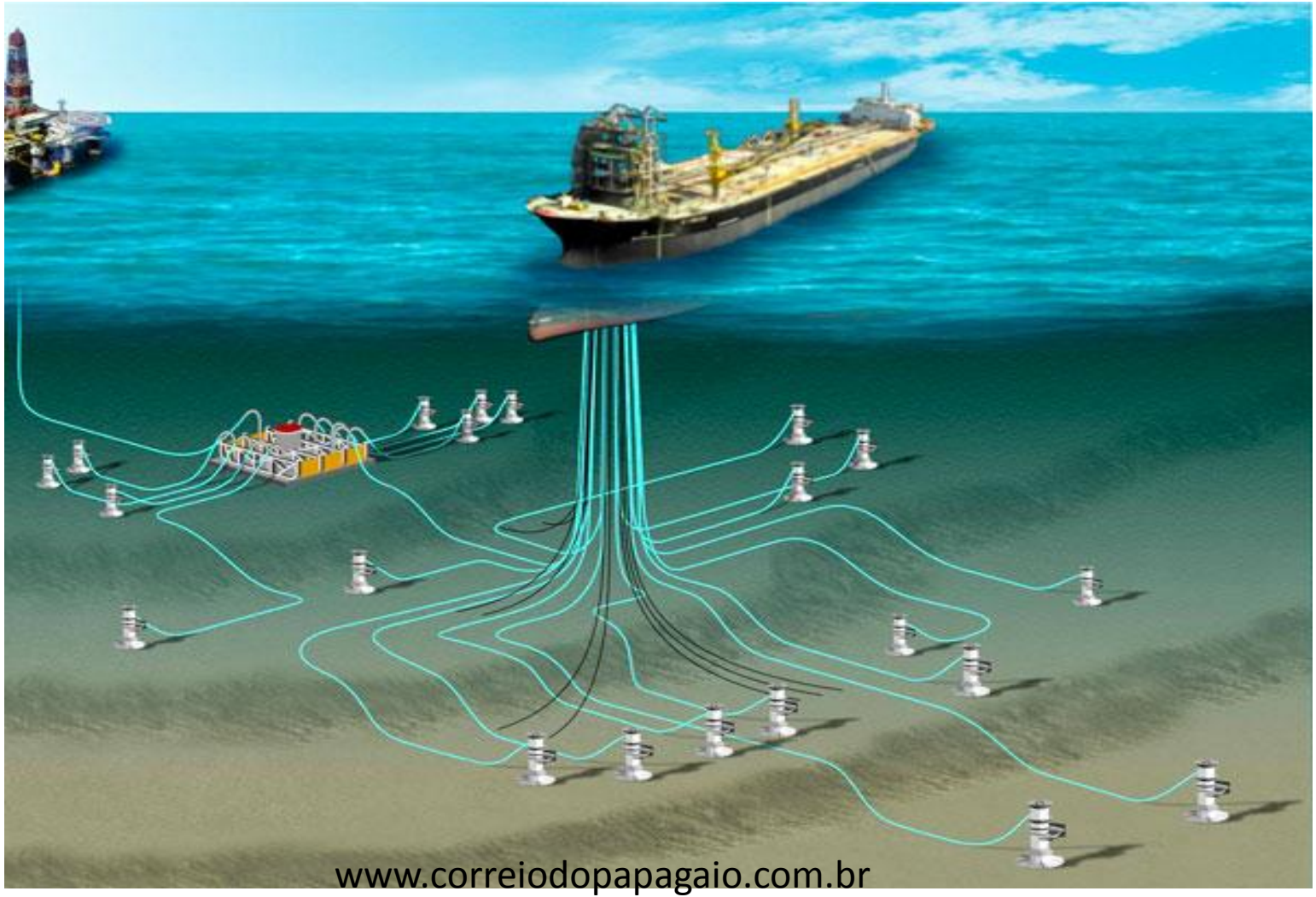


VOLUMES ADDED IN THE NEXT TEN YEARS AS LARGE AS IN THE PREVIOUS FIFTY YEARS

www.slideshare.net/petrobrasri/visao-geral-petrobrassetembro2011

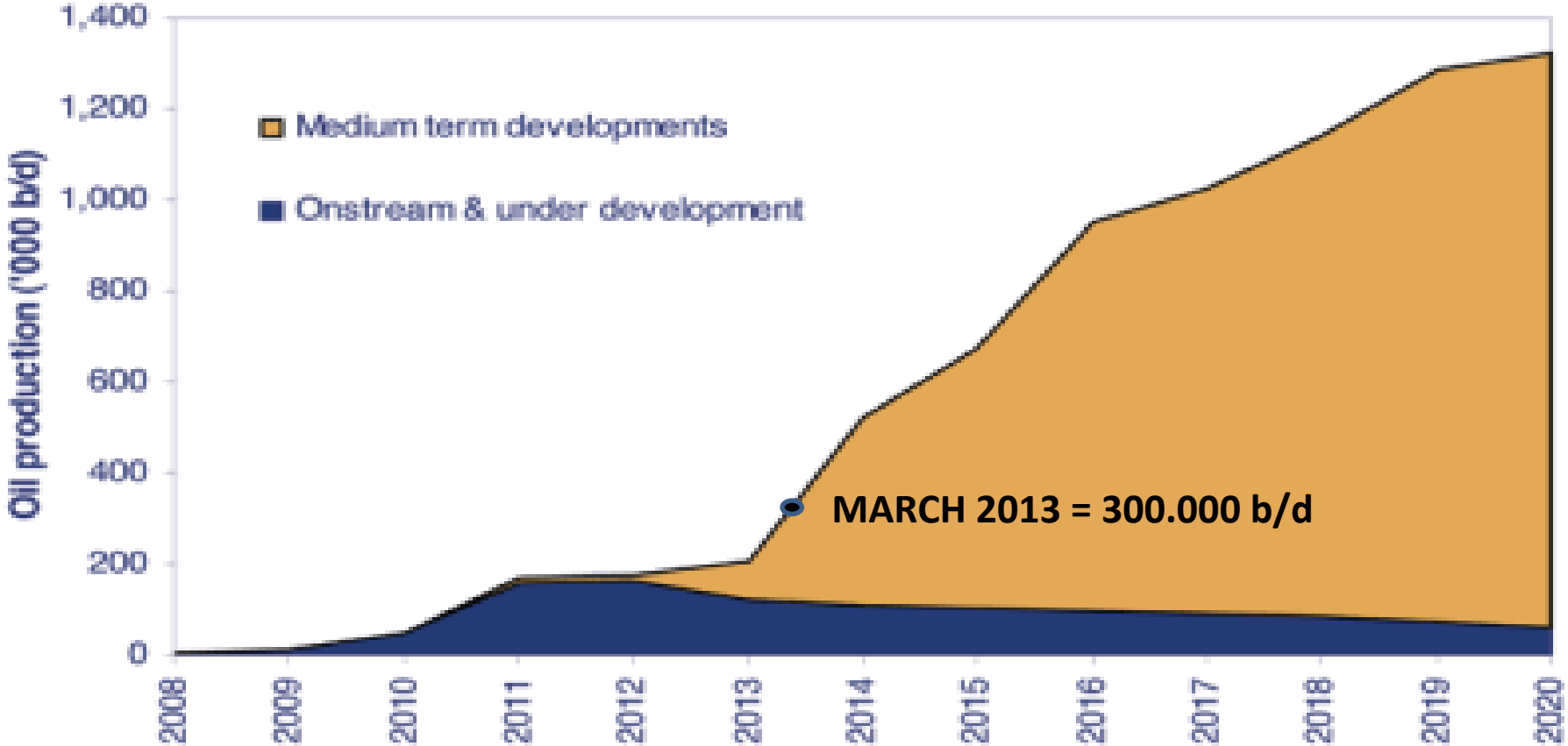
Node:Seed Point

PETROBRAS SANTOS BASIN



www.correiodopapagaio.com.br

PETROBRAS OIL PRODUCTION FROM SUB-SALT



Source: Wood Mackenzie

www.offshore-mag.com

DO NOT GIVE UP EVEN AFTER 59 DRY HOLES IN 18 YEARS

Thank you!

fjfeijo@uol.com.br