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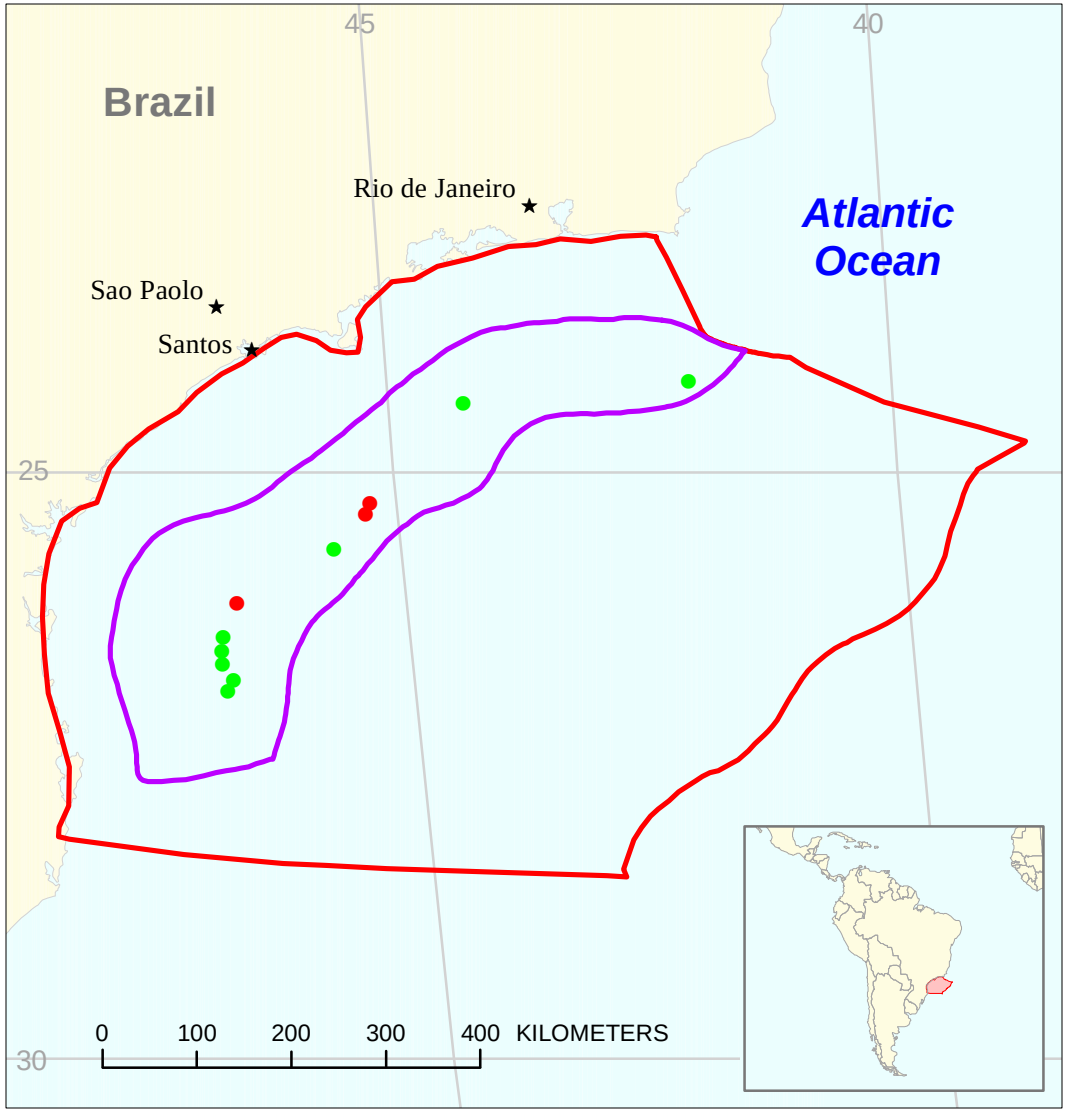
Santos Shelf
Assessment Unit 60360101



Santos Shelf Assessment Unit 60360101

Santos Basin Geologic Province 6036

Geologic Summary

Detailed map of this assessment unit

Exploration/Discovery-History Data

- Plots of Known Field Sizes
- Plots of Grown Resources
- Tables

Assessment Input Data

Assessment Results

- Assessment Unit Summary
- Detailed Assessment Results
- Undiscovered Field-Size Distributions

USGS PROVINCE: Santos Basin (6036) **GEOLOGIST:** C.J. Schenk

TOTAL PETROLEUM SYSTEM: Guaratiba-Guaruja (Cretaceous) Composite (603601)

ASSESSMENT UNIT: Santos Shelf (60360101)

DESCRIPTION: This assessment unit encompasses the shelf area of the Santos Basin, and is bounded to the north by the Cabo Frio Arch, to the south by the Florianopolis Arch, to the west by the pre-Albian hingeline, and to the east by the shelf edge at approximately 400 m water depth.

SOURCE ROCKS: Source rocks may be organic-bearing mudstones of the lower Aptian Guaratiba Formation, mudstones of the Albian Guaruja Formation, and possibly Turonian mudstones.

MATURATION: Estimates of maturation from temperatures and sediment thickness suggest that Aptian mudstones reached maturity for gas in the Late Cretaceous-Early Tertiary, at about the same time Albian-Turonian mudstones reached maturity for oil.

MIGRATION: Migration may have been mainly vertical along the numerous listric faults in the Late Cretaceous and Tertiary sedinentary section. For Aptian gas to migrate, faults must have breached the Aptian salt, a situation observed in seismic sections.

RESERVOIR ROCKS: Major reservoirs include high-energy carbonate grainstones of the Albian shelf edge, similar to Albian carbonate reservoirs in the Campos Basin. Other reservoirs include Late Cretaceous and lower Tertiary turbidite sandstones.

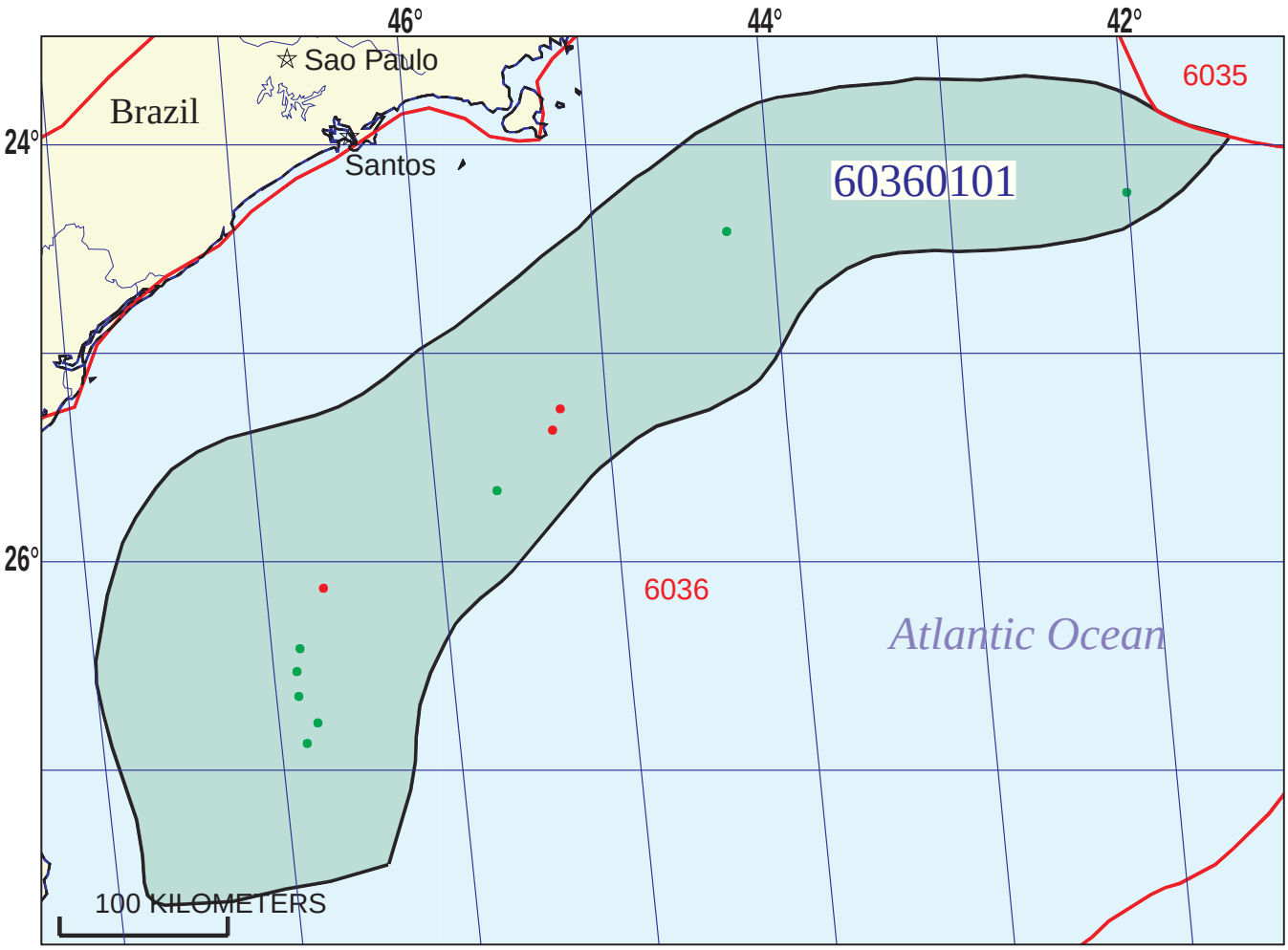
TRAPS AND SEALS: The main trap types in this assessment unit are related to salt movement that ponded turbidite and other sandstones between the salt ridges. Traps in carbonate reservoirs are largely related to the development of secondary porosity in shelf-edge grainstone reservoirs. Seals are mainly intraformational mudstones.

REFERENCES:

Cainelli, C., and Mohriak, W.U., 1998, Geology of the Atlantic eastern Brazilian basins; Brazilian Geology, Part II: American Association of Petroleum Geologists International Conference and Exhibition Short Course Notes, Rio de Janeiro, Brazil, chapter paginated.

Demercian, S., Szatmari, P., and Cobbold, P.R., 1993, Style and pattern of salt diapirs due to thin-skinned gravitational gliding, Campos and Santos basins, offshore Brazil: Tectonophysics, v. 228, p. 393-433.

Ramos, R., Duraes, E., Fochesatto, L., and Gamboa, L., 1998, Deep reservoirs in the Santos Basin, Brazil, *in* Mello, M.R., and Yilmaz, P.O., eds., 1998 American Association of Petroleum Geologists International Conference and Exhibition, Rio de Janeiro: Extended Abstracts Volume, p. 702-703.



Santos Shelf
Assessment Unit - 60360101

EXPLANATION

- Hydrography
- Shoreline
- 6036 — Geologic province code and boundary
- Country boundary
- Gas field centerpoint
- Oil field centerpoint
- 60360101 — Assessment unit code and boundary

Projection: Robinson. Central meridian: 0

SEVENTH APPROXIMATION
NEW MILLENNIUM WORLD PETROLEUM ASSESSMENT
DATA FORM FOR CONVENTIONAL ASSESSMENT UNITS

Date:……..	11/5/99		
Assessment Geologist:……..	C.J. Schenk		
Region:……..	Central and South America	Number:	6
Province:……..	Santos Basin	Number:	6036
Priority or Boutique……	Boutique		
Total Petroleum System:……	Guaratiba-Guaruja (Cretaceous) Composite	Number:	603601
Assessment Unit:……..	Santos Shelf	Number:	60360101
* Notes from Assessor	MMS growth factor, MMS offshore data set. Campos Basin partial analog Turbidite and Carbonate Units (60350101 & 60350102).		

CHARACTERISTICS OF ASSESSMENT UNIT

Oil (<20,000 cfg/bo overall) **or** Gas (≥20,000 cfg/bo overall):… Oil

What is the minimum field size?……. 4 mmboe grown (≥1mmboe)
(the smallest field that has potential to be added to reserves in the next 30 years)

Number of discovered fields exceeding minimum size:…… Oil: 7 Gas: 2

Established (>13 fields) _____ Frontier (1-13 fields) X Hypothetical (no fields) _____

Median size (grown) of discovered oil fields (mmboe):
1st 3rd 62 2nd 3rd 122 3rd 3rd _____

Median size (grown) of discovered gas fields (bcfg):
1st 3rd 718 2nd 3rd 697 3rd 3rd _____

Assessment-Unit Probabilities:

Attribute	Probability of occurrence (0-1.0)
1. **CHARGE:** Adequate petroleum charge for an undiscovered field ≥ minimum size……	1.0
2. **ROCKS:** Adequate reservoirs, traps, and seals for an undiscovered field ≥ minimum size……	1.0
3. **TIMING OF GEOLOGIC EVENTS:** Favorable timing for an undiscovered field ≥ minimum size	1.0

Assessment-Unit GEOLOGIC Probability (Product of 1, 2, and 3):…….. 1.0

4. **ACCESSIBILITY:** Adequate location to allow exploration for an undiscovered field ≥ minimum size…… 1.0

UNDISCOVERED FIELDS

Number of Undiscovered Fields: How many undiscovered fields exist that are ≥ minimum size?:
(uncertainty of fixed but unknown values)

Oil fields:……min. no. (>0)	10	median no.	125	max no.	275
Gas fields:……min. no. (>0)	5	median no.	65	max no.	140

Size of Undiscovered Fields: What are the anticipated sizes (**grown**) of the above fields?:
(variations in the sizes of undiscovered fields)

Oil in oil fields (mmbo)……min. size	4	median size	30	max. size	5000
Gas in gas fields (bcfg):……min. size	24	median size	180	max. size	20000

Assessment Unit (name, no.)
Santos Shelf, 60360101

AVERAGE RATIOS FOR UNDISCOVERED FIELDS, TO ASSESS COPRODUCTS

(uncertainty of fixed but unknown values)

Oil Fields:	minimum	median	maximum
Gas/oil ratio (cfg/bo)……	1000	2000	3000
NGL/gas ratio (bngl/mmcfg)……	30	60	90

Gas fields:	minimum	median	maximum
Liquids/gas ratio (bngl/mmcfg)……	22	44	66
Oil/gas ratio (bo/mmcfg)……			

SELECTED ANCILLARY DATA FOR UNDISCOVERED FIELDS

(variations in the properties of undiscovered fields)

Oil Fields:	minimum	median	maximum
API gravity (degrees)……	25	40	55
Sulfur content of oil (%)……	0.2	0.5	1.8
Drilling Depth (m) ……	1500	3000	5000
Depth (m) of water (if applicable)……	50	200	400

Gas Fields:	minimum	median	maximum
Inert gas content (%)……			
CO_2 content (%)……	0.5	1	1.5
Hydrogen-sulfide content (%)……	0.25	0.5	1
Drilling Depth (m)……	1500	4000	6500
Depth (m) of water (if applicable)……	50	200	400

Assessment Unit (name, no.)
Santos Shelf, 60360101

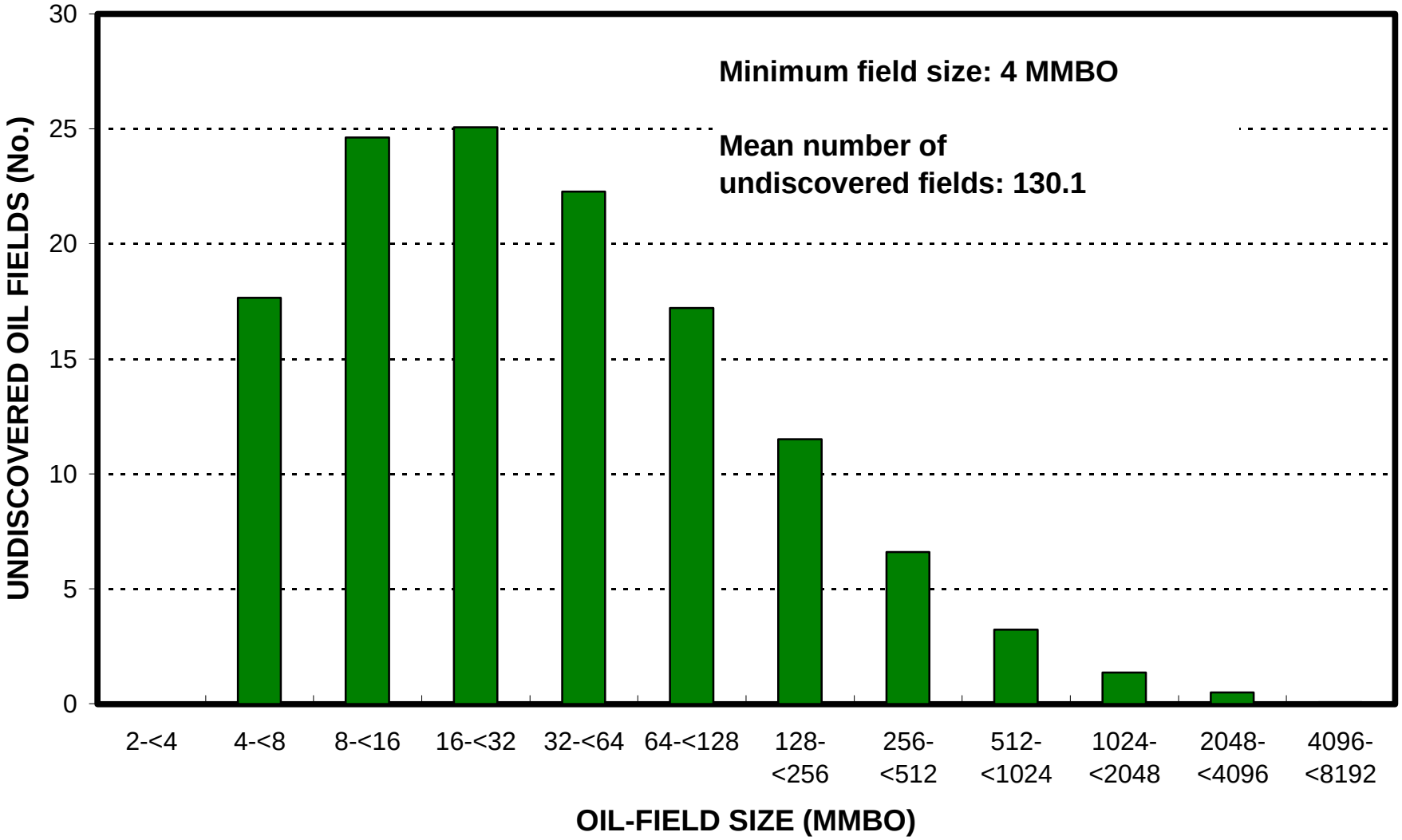
ALLOCATION OF UNDISCOVERED RESOURCES IN THE ASSESSMENT UNIT TO COUNTRIES OR OTHER LAND PARCELS (uncertainty of fixed but unknown values)

1. Brazil represents 100 areal % of the total assessment unit

Oil in Oil Fields:	minimum	median	maximum
Richness factor (unitless multiplier):……			
Volume % in parcel (areal % x richness factor):…		100	
Portion of volume % that is offshore (0-100%)……		100	

Gas in Gas Fields:	minimum	median	maximum
Richness factor (unitless multiplier):……			
Volume % in parcel (areal % x richness factor):…		100	
Portion of volume % that is offshore (0-100%)……		100	

Santos Shelf, AU 60360101
Undiscovered Field-Size Distribution



Santos Shelf, AU 60360101
Undiscovered Field-Size Distribution