Western South Atlantic Seamounts: a Brazilian perspective

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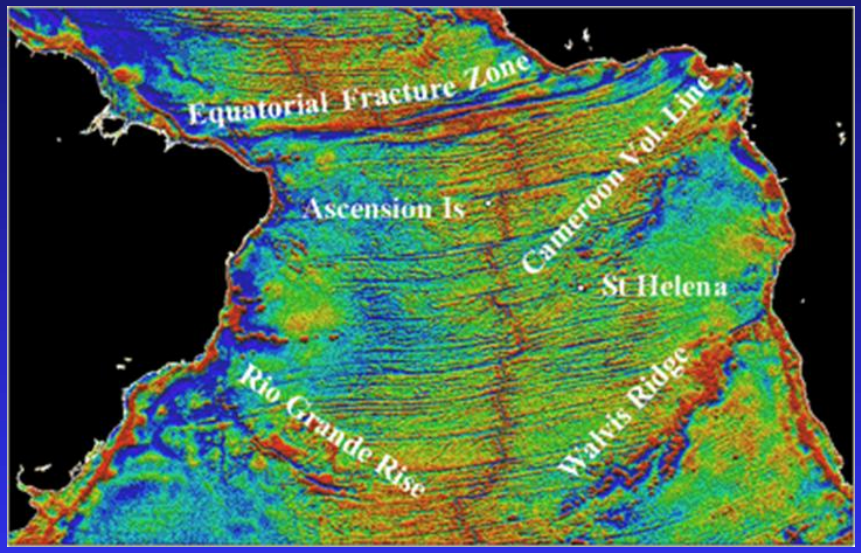
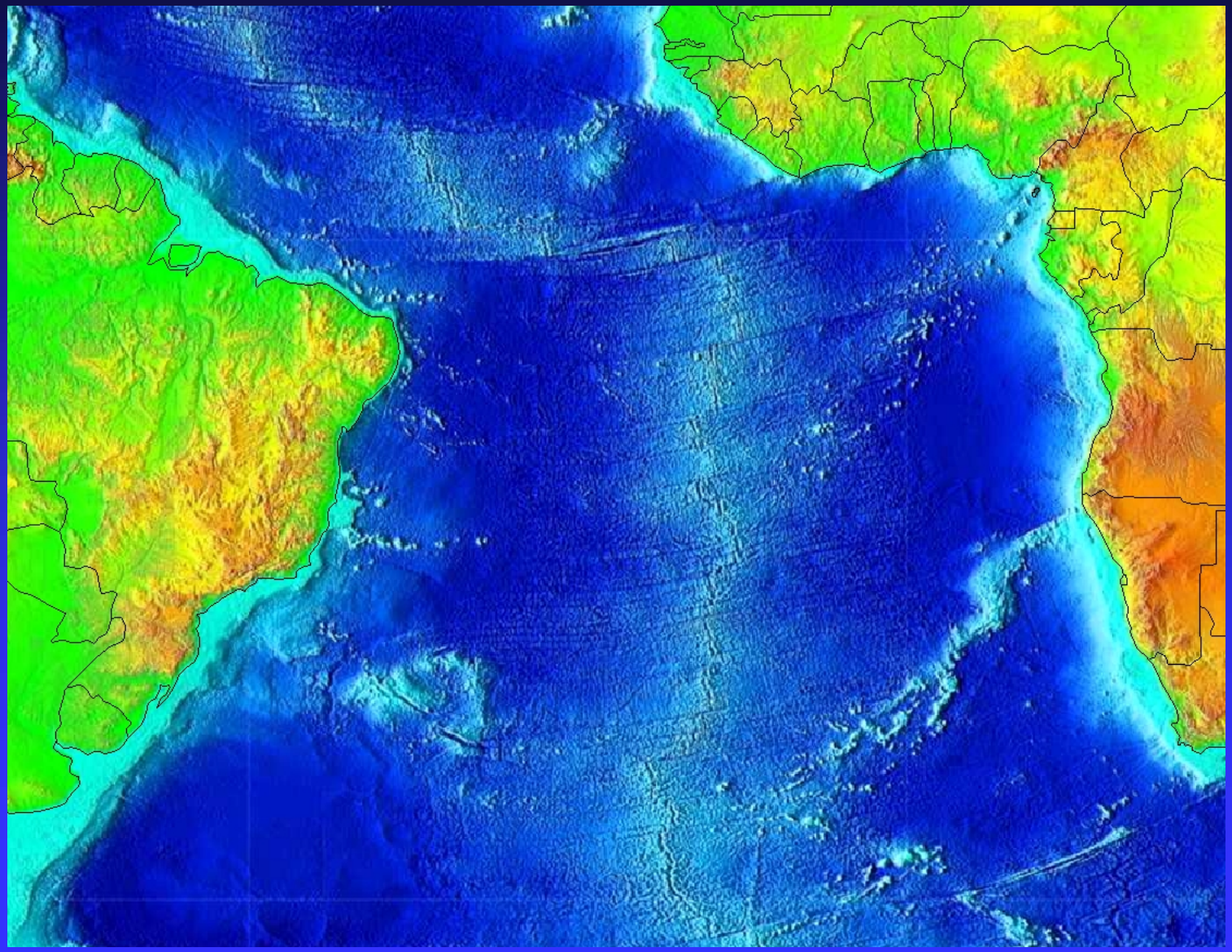
Agenda

- Objectives
- Geological features
- General water masses circulation
- Seamount Research Programmes: national and international
- Marine life at the seamounts and main questions
- Future challenges

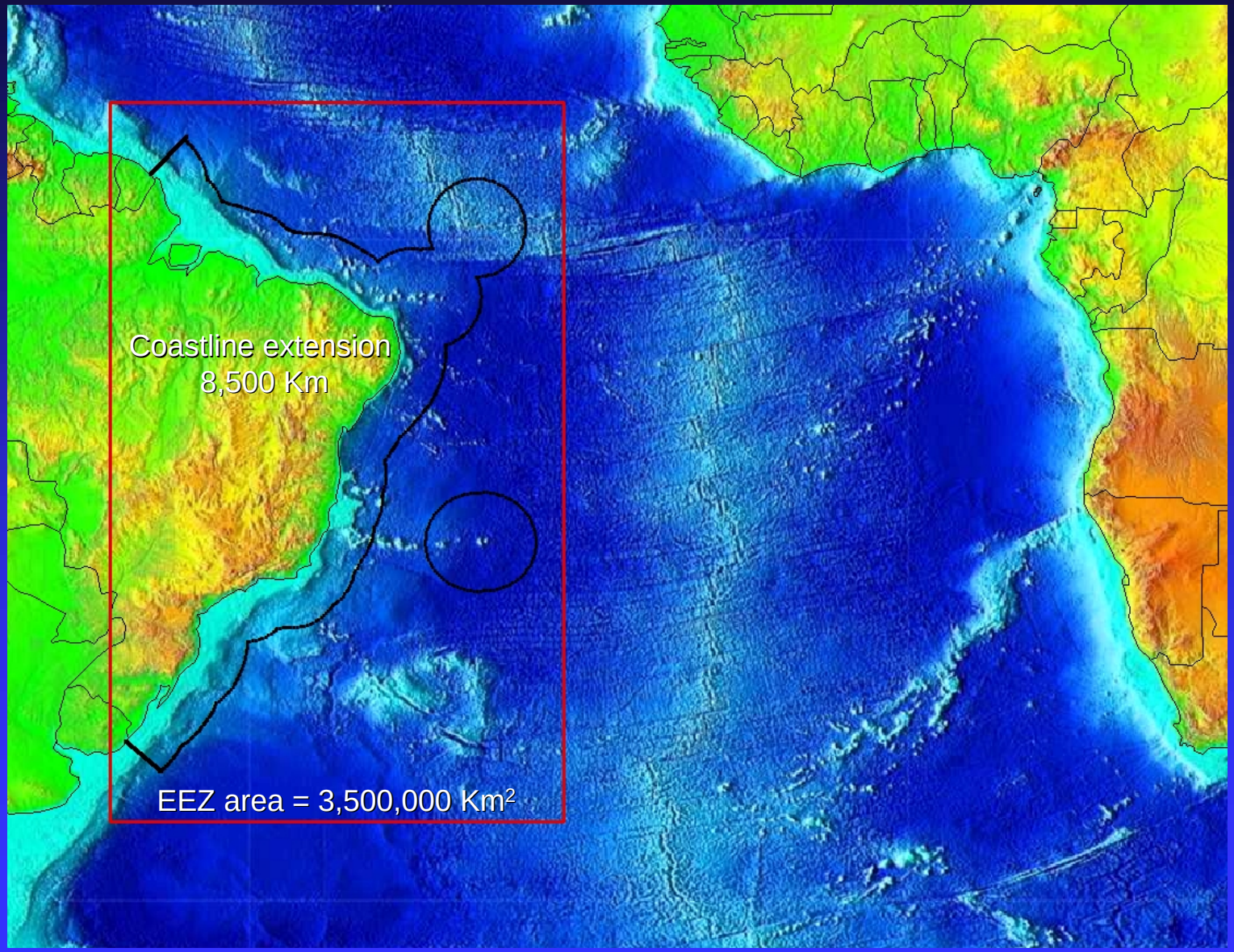


The satellite free air gravity of the Central, Equatorial and South Atlantic Oceans. Fairhead & Wilson

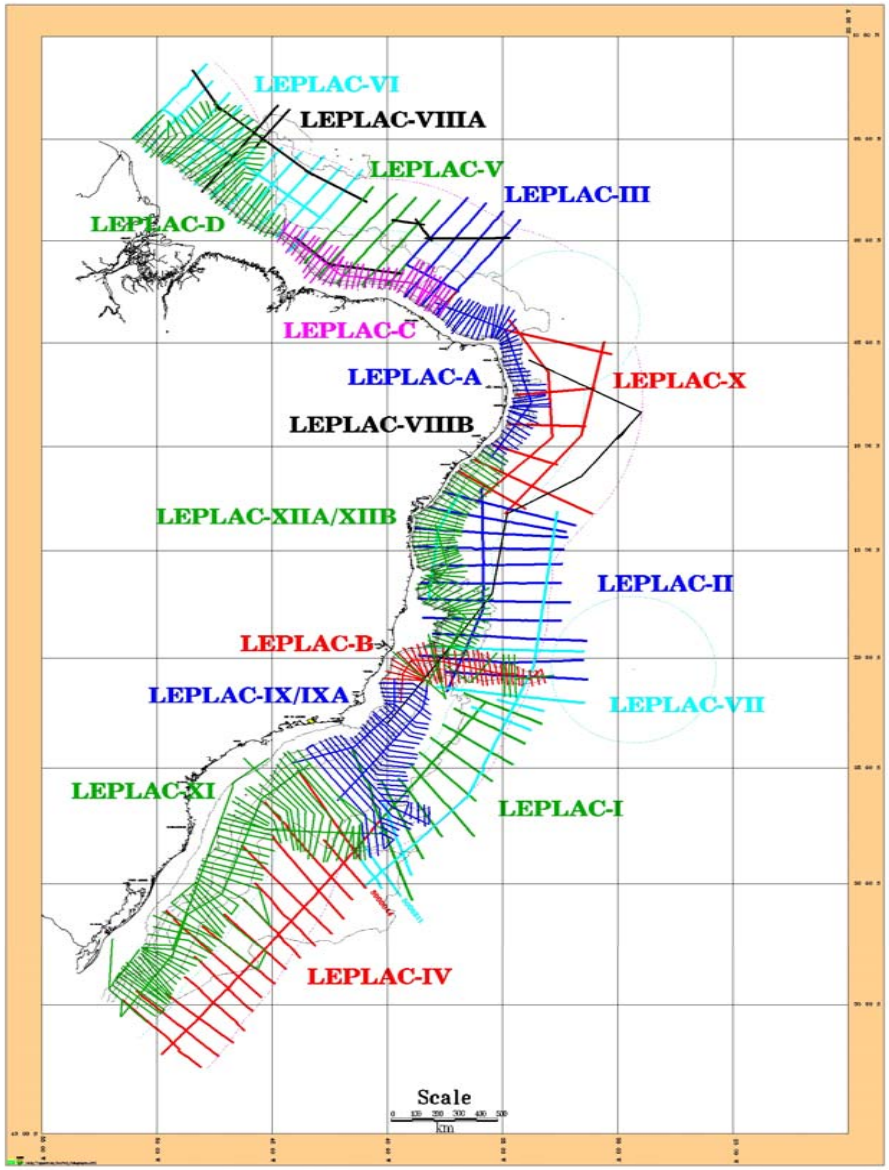
Opening of the Atlantic Ocean ~ 115 m y a



Brazilian EEZ definition

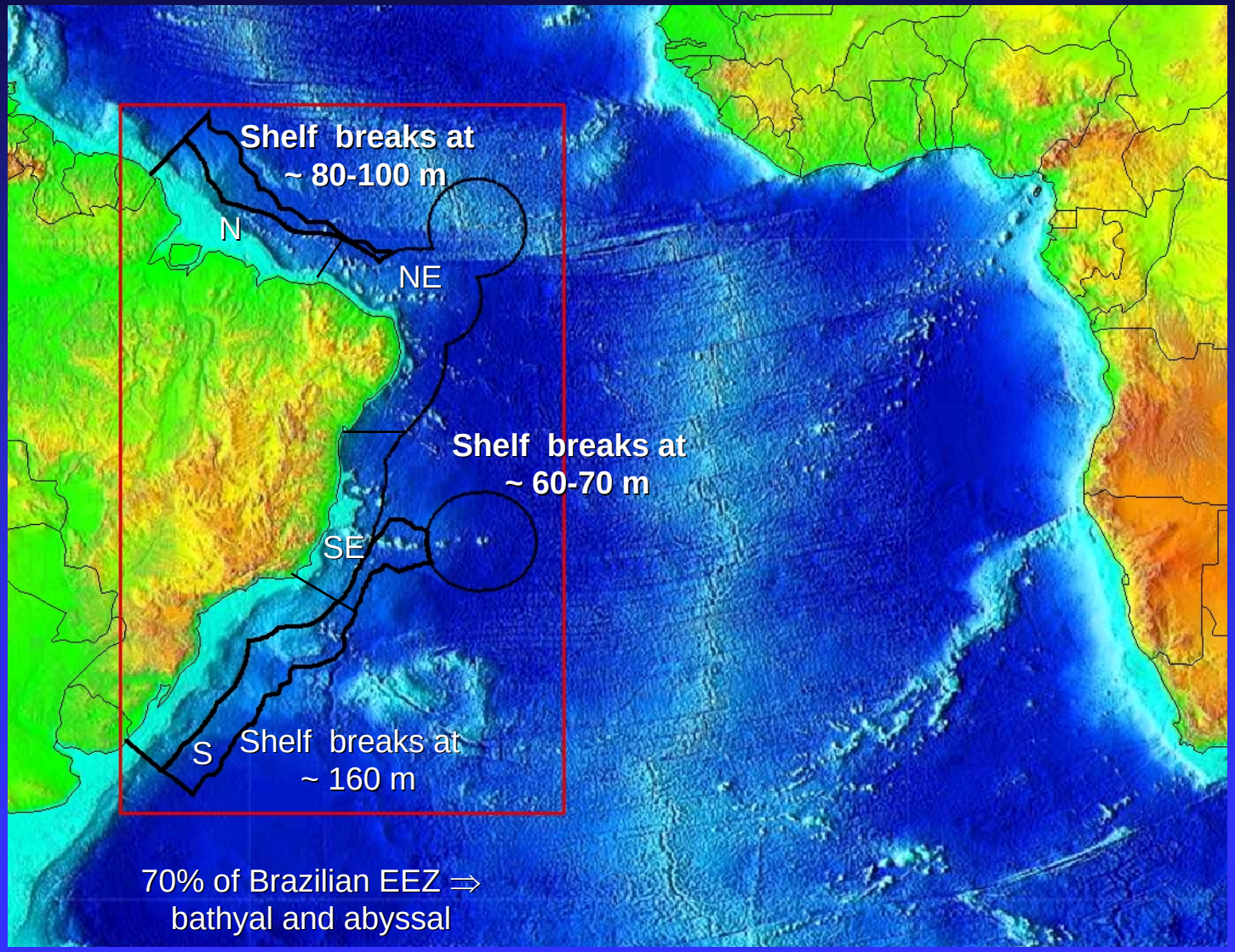


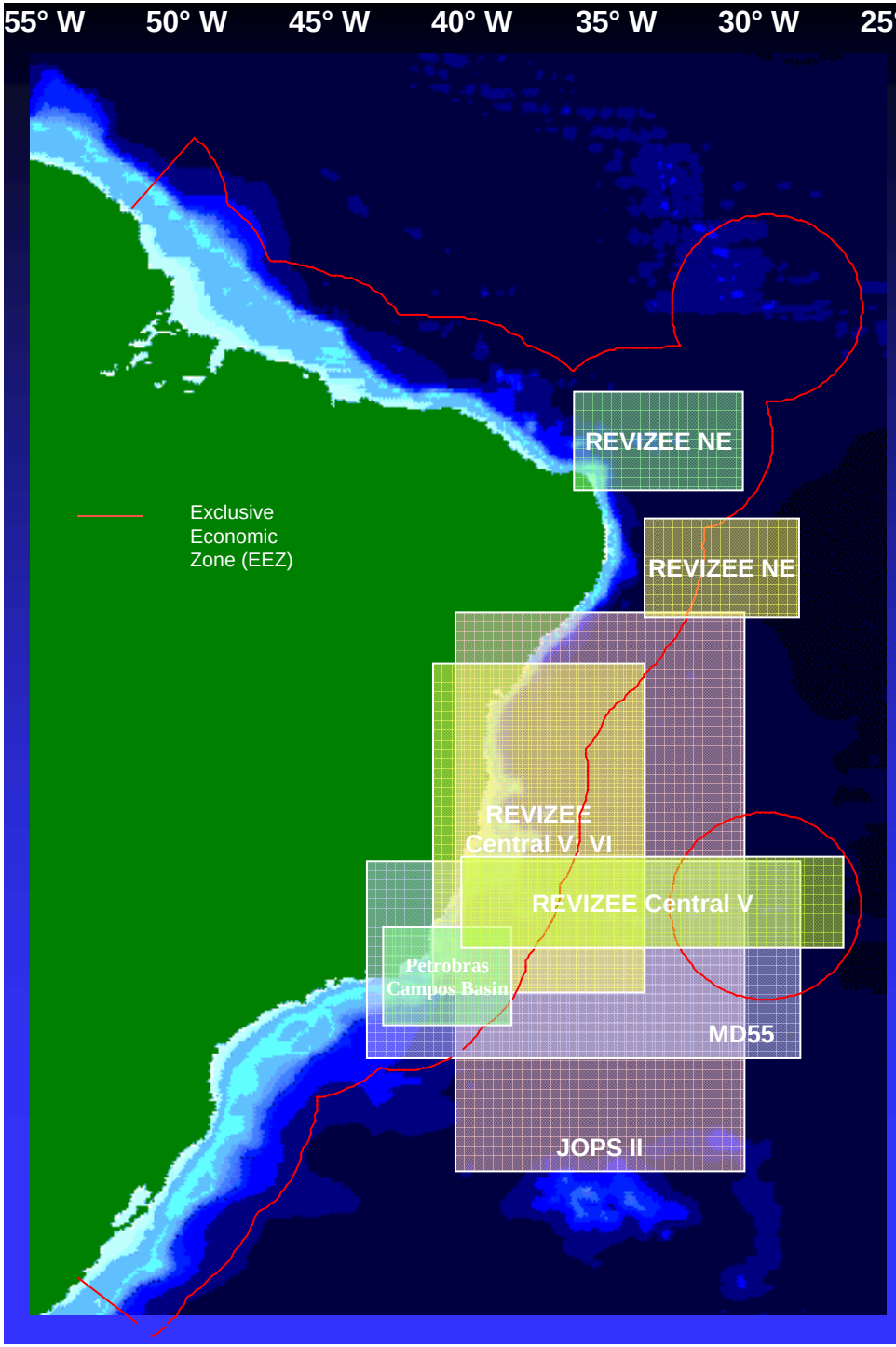
Bathymetric, Geophysical, and Biological data acquisition



- LEPLAC: Brazilian EEZ
  - *Area definition*
- REVIZEE: biological sampling within the EEZ
  - *Benthic samples on the shelf and continental margin*
  - *Plankton and Fisheries offshore*

Brazilian EEZ definition

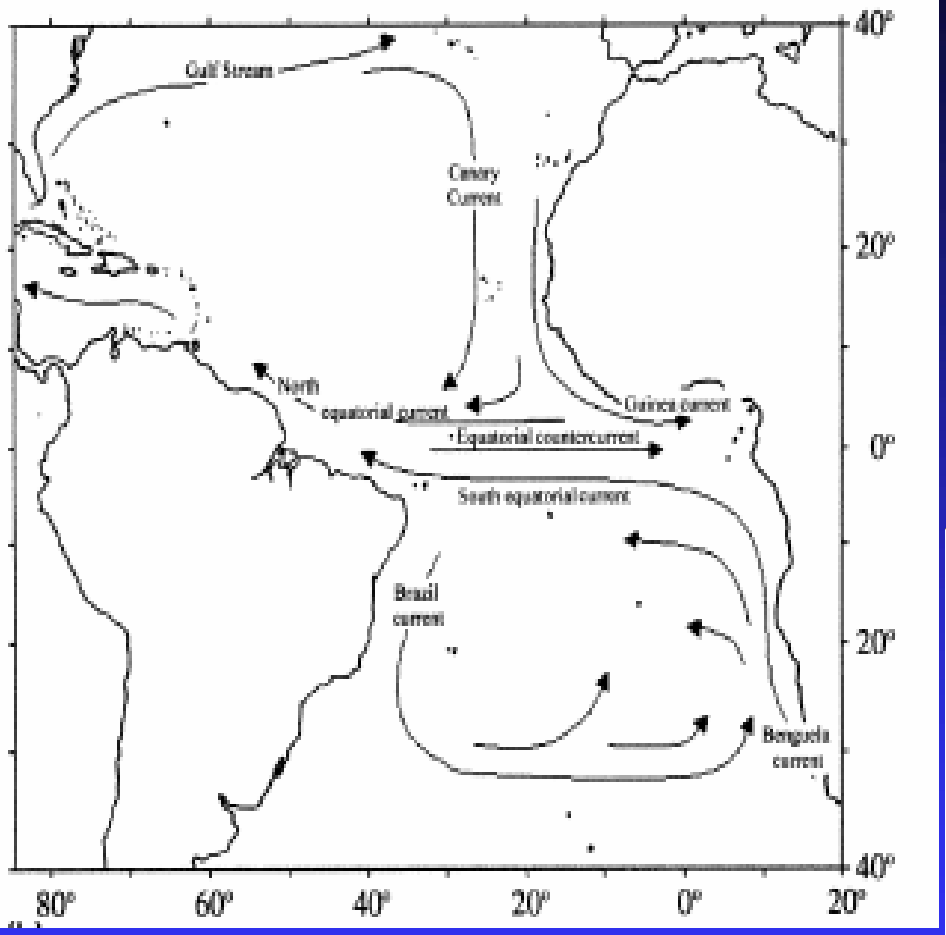




Biological Sampling Programmes: Seamounts

- MD55:
  - *Franco Brazilian Expedition (Allan Guille)*
  - *Vitoria / Jaseur / Davis / Dogaressa / Columbia / Is Trindade / Is Martin Vaz*
- JOPS II:
  - *German Brazilian Cooperation*
- REVIZEE:
  - *Northeast (NE)*
  - *Central V & VI*
- PETROBRAS

Main currents circulation



Dispersal + biogeography on continental shelf ⇒ organisms influenced by shelf processes, i.e., river outflows, topography (rock reefs, true reefs), temperature, shelf extension, depth…

In deeper water situation is certainly different as influence from turbulence and upwelling processes can be stronger, more related to features of water masses, and less from shelf processes.

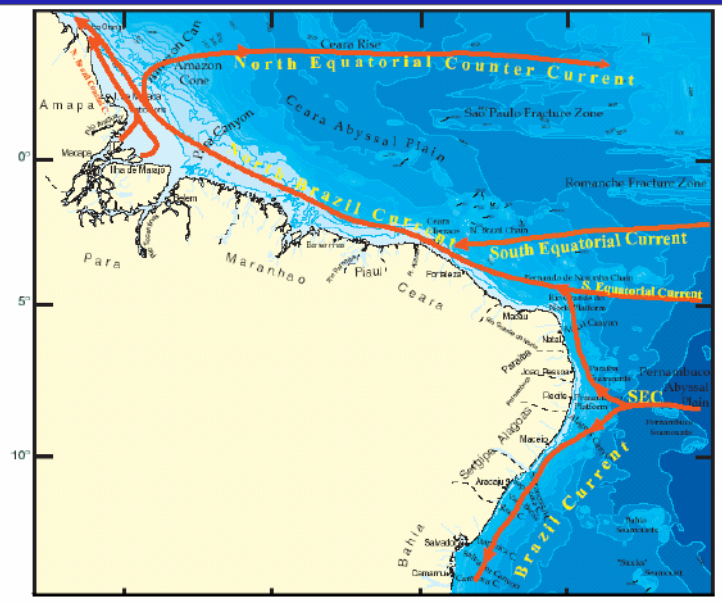
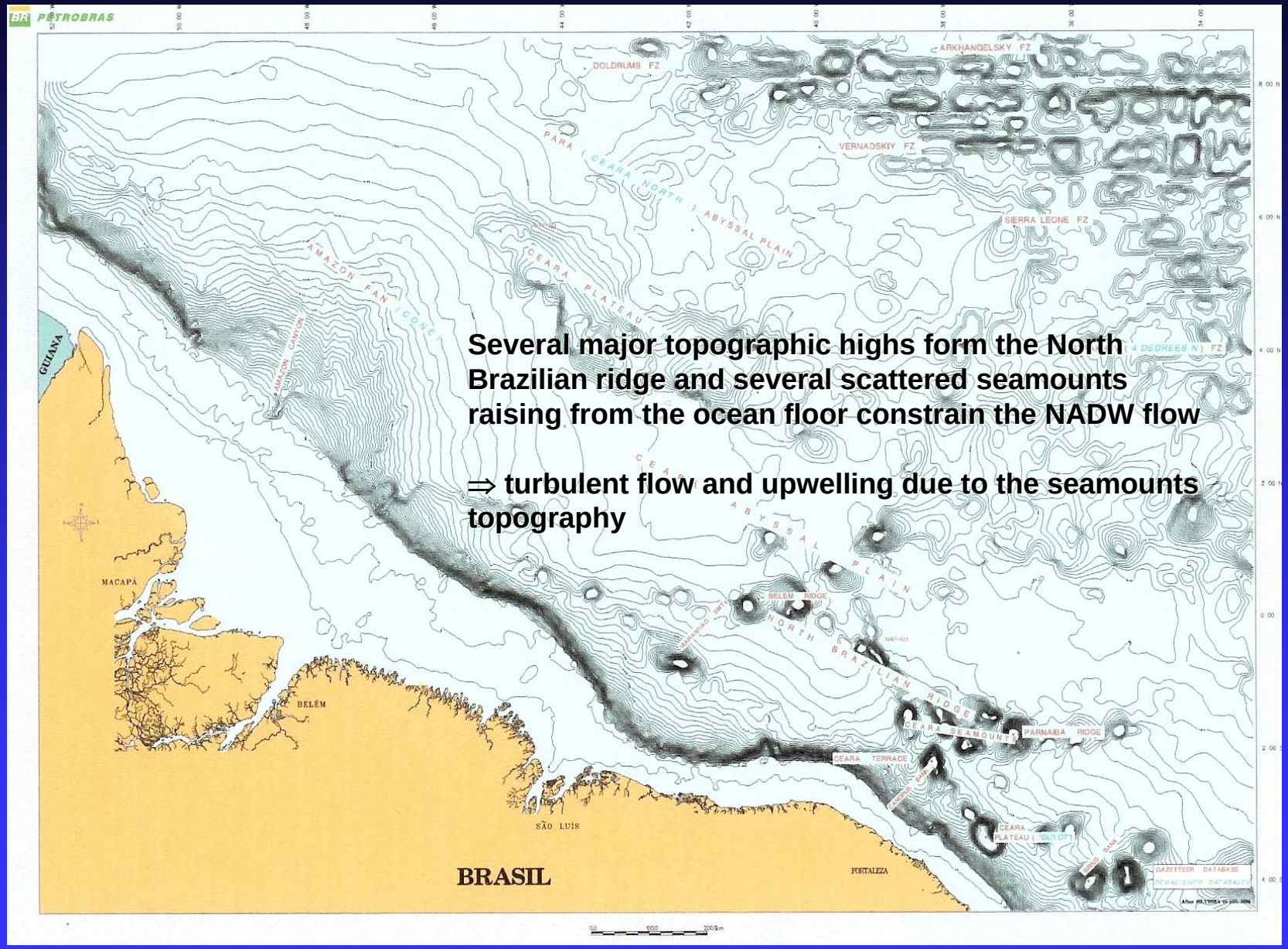
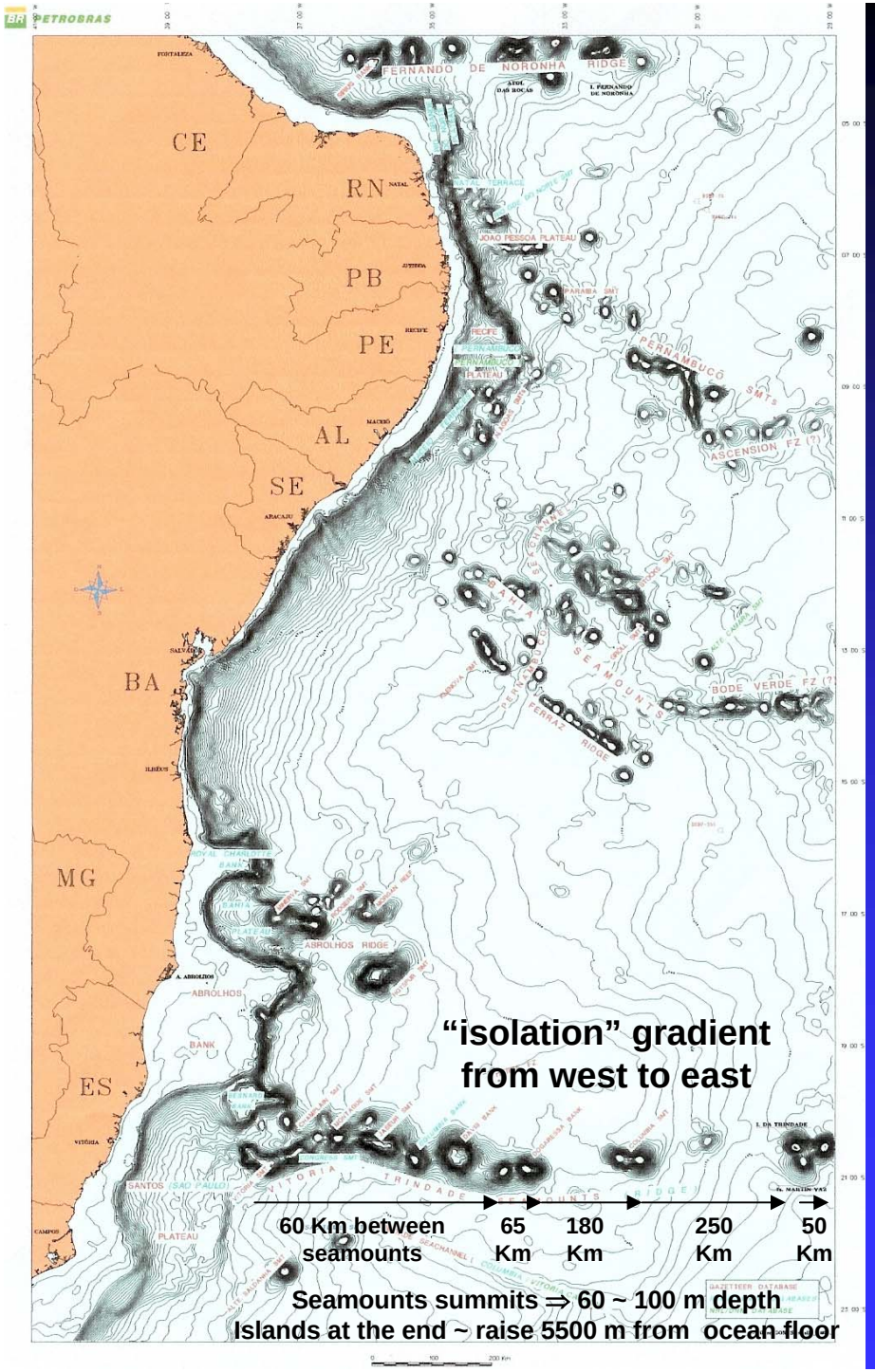


Figura 5.1-12: Mapa esquemático mostrando a influência das principais correntes sobre a plataforma continental e região offshore norte-nordeste do Brasil. South Equatorial Current (SEC)= Corrente Sul Equatorial (CSE); North Equatorial Counter Current= Contracorrente Norte Equatorial; North Brazil Current= Corrente Norte do Brasil (CNB) e Brazil Current= Corrente do Brasil. (www.egi.utah.edu/ProjectFeatures/Seabed).

Seamounts adjacent to the Northern Brazilian Margin



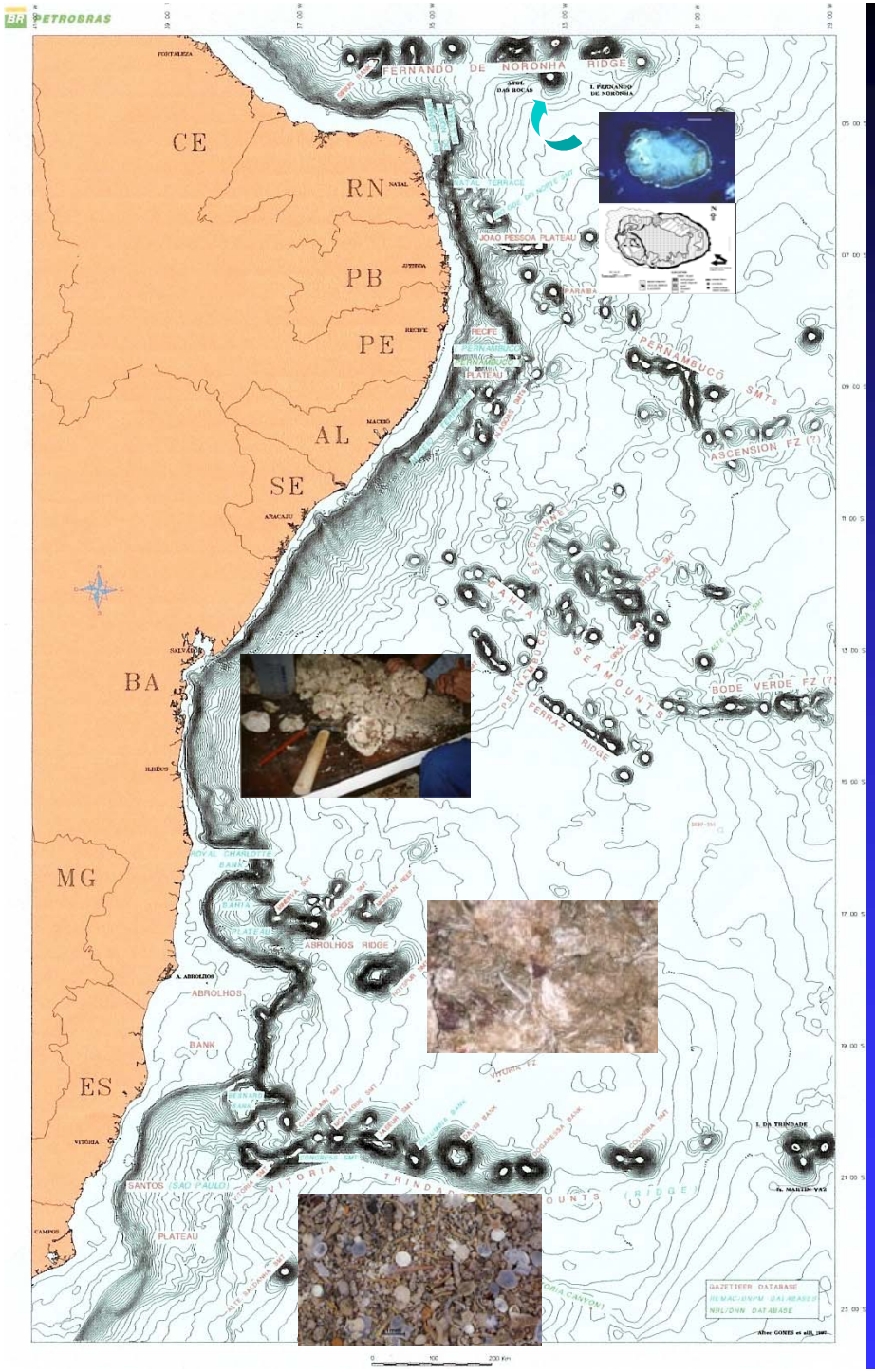
Koji Jinno & Jairo Marcondes de Souza (6th SBGF 278)



Seamounts adjacent to the NE & SE Brazilian margin

- Fernando de Noronha Ridge ⇒ Atol das Rocas
  - *Fisheries*
  - *Ecological reserve*
- Pernambuco Seamounts
- Bahía Seamounts
- Abrolhos Bank
  - *National Park ~ 48,000 Km^2*
- *Royal Charlotte Bank*
  - *~ 8400 Km^2*
- Vitória-Trindade Seamounts ⇒ Martins Vaz & Trindade Islands
  - *MD55 – 7 seamounts and islands*
  - *REVIZEE – whole chain + adjacent area*

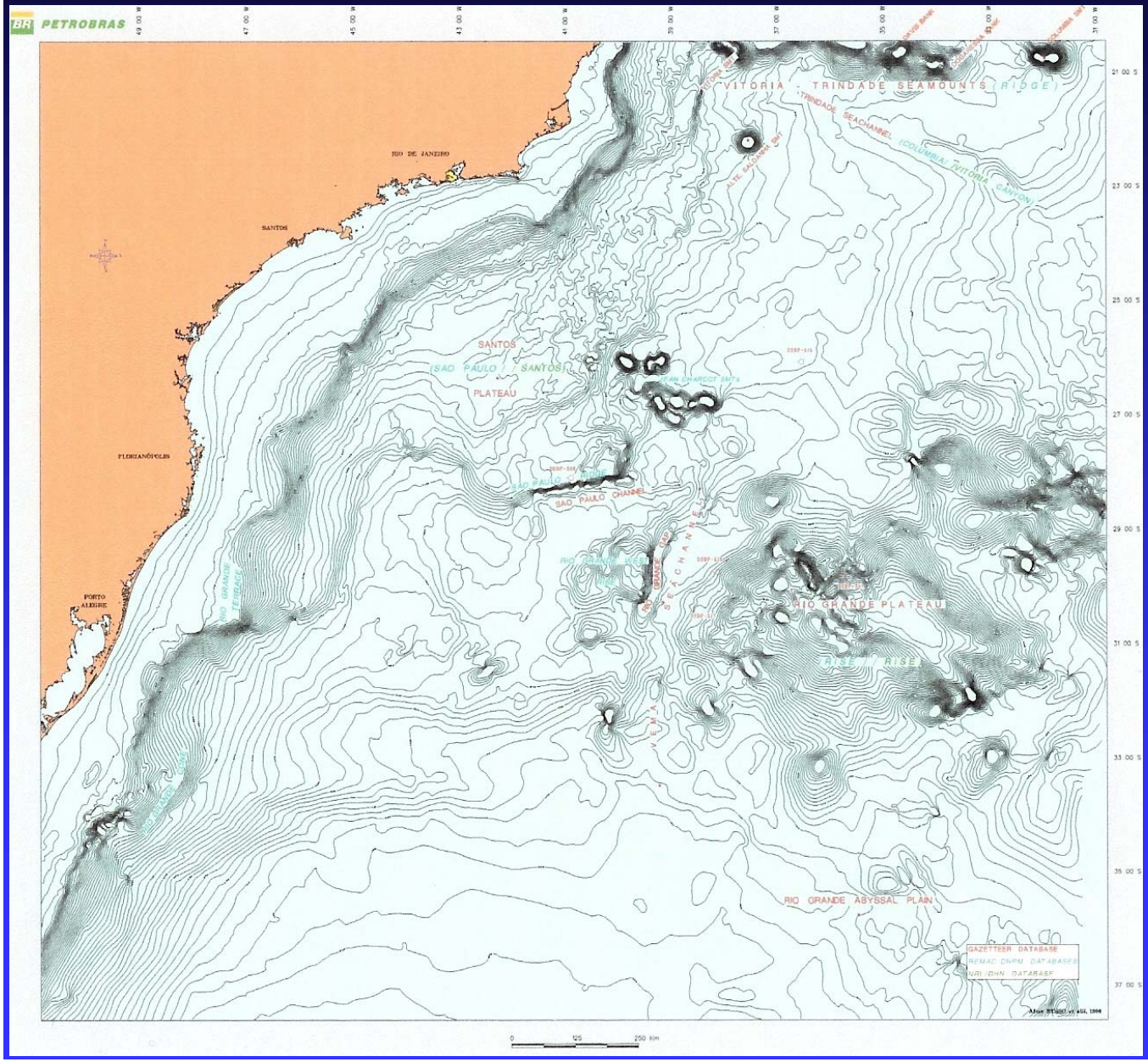
Koji Jinno & Jairo Marcondes de Souza (6th SBGF 278)
Helena Lavrado (in Press)



Types of substrate

- Sand + biogenic calcareous pebbles ⇒ molluscs + bryozoans
- Branched corallineous algae ⇒ bryozoans, corals, molluscs, benthic foraminifera
- Nodules and algae concretions ⇒ brachiopods, burrowing organisms, echinoderms (ophiuroids)

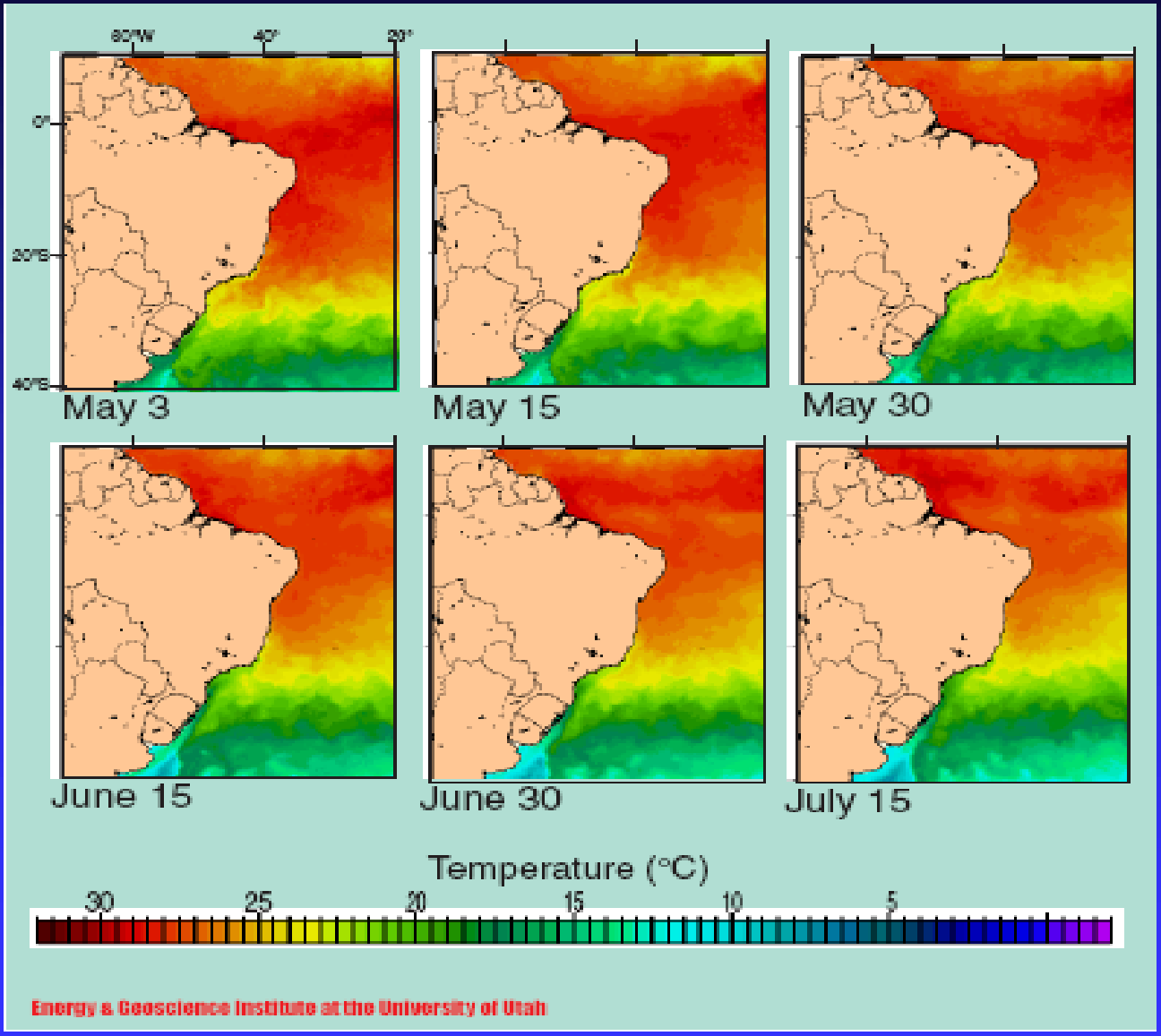
Seamounts adjacent to the southern Brazilian margin



- São Paulo Plateau
  - *volcanic ridge / São Paulo Channel + seamounts*
  - *Vema Channel / AABW flow*
- Rio Grande Rise
  - *giant dome summit 300 ~ 600 m*
  - *cobalt crusts and mangenese nodules*

Koji Jinno & Jairo Marcondes de Souza (6th SBGF 278)

Sea surface Temperatures (ºC)



- North of the Vitoria-Trindade Chain ⇒ warmer temperatures of the South Equatorial Current dominate the margin at the northern border where they meet cooler waters of the North Equatorial Current
- South of the Trindade Chain ⇒ water masses are more stratified as the southward flow of the Brazil Current encounters the subtropical gyre south of Rio de Janeiro

Segall et al

Biological Sampling Strategies

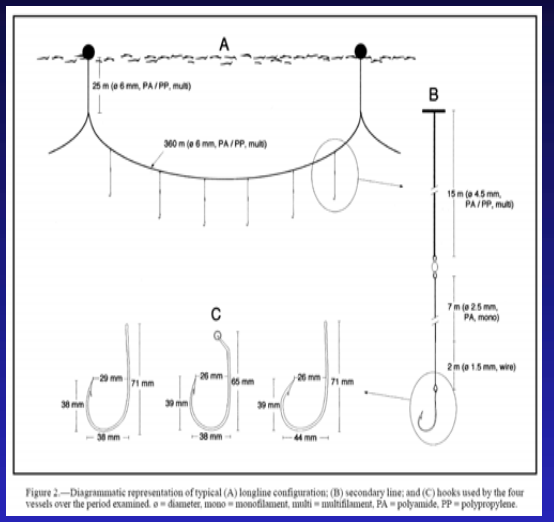
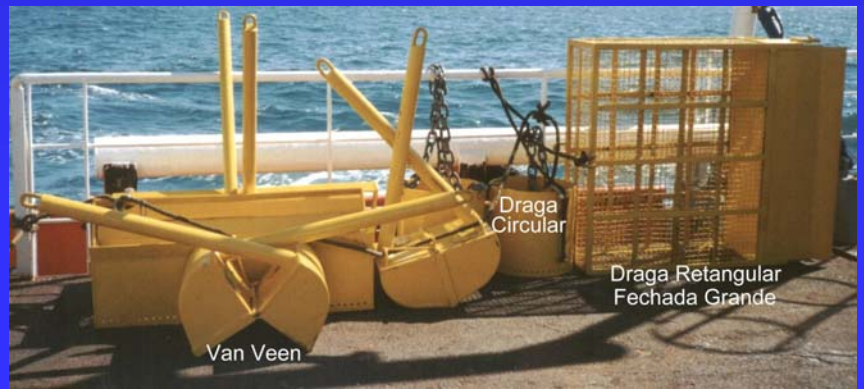


Figure 2.—Diagrammatic representation of typical (A) longline configuration; (B) secondary line; and (C) hooks used by the four vessels over the period examined. ø = diameter, mono = monofilament, multi = multifilament, PA = polyamide, PP = polypropylene.



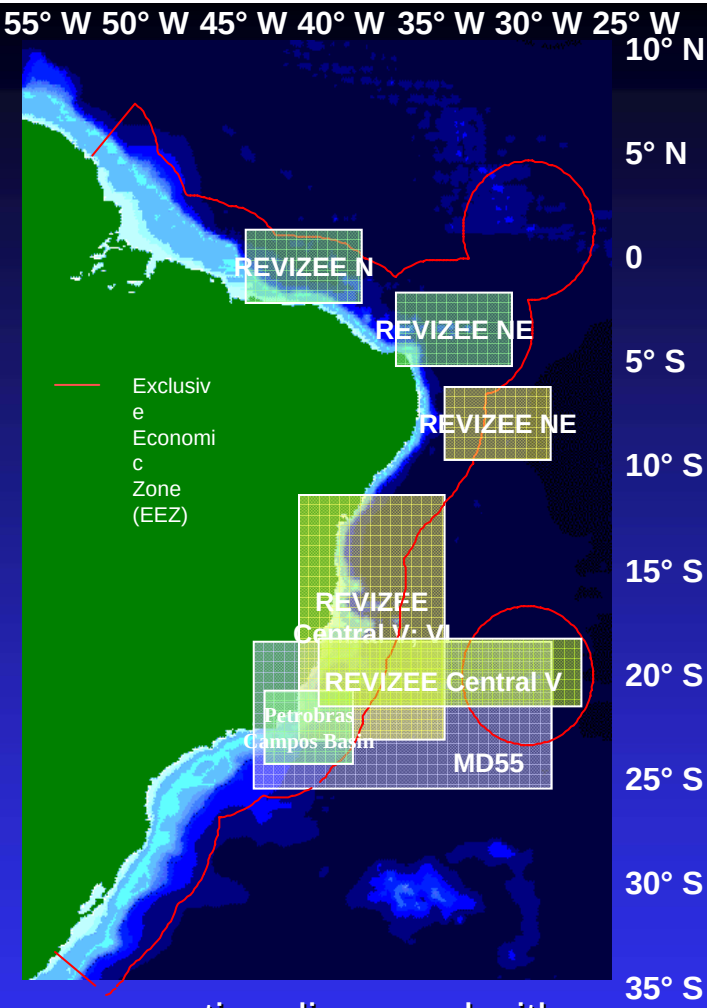
Some biological questions…

- How is the faunistic evolution from Cabo Frio, where the upwelling of sub-antarctic water occurs, to the Abrolhos Continental Slope, situated at the limit of tropical coralline ecosystems? (MD55 / REVIZEE)
- What are depth ranges for abundance, biomass, species richness, diversity? (MD55 / REVIZEE / Petrobras)
- What effects do major river outflows have on bathyal benthic fauna? (REVIZEE)
- Canyons *vs* non-canyon? (Petrobras)
- How closely related to Caribbean benthic fauna (or even Antarctic) is the Brazilian bathyal fauna including seamounts? (REVIZEE / PROANTAR / Petrobras)

Methodologies

Field work

- MD 55 [multidisciplinary effort ⇒
  - pelagic (34#)
  - & benthic (66#)]
- REVIZEE [pelagic & benthic (>200 each)]
  - Gear used:
    - Water / Plankton (Niskin/plankton nets)
    - Benthos (dredges/trawls/corers)
  - Biomass:
    - weight (MD55)
    - bio-volume (REVIZEE)
  - Treatment of samples: depended on taxa protocols for preservation discussed with individual taxonomists, but for most samples ⇒
    - molecular studies
    - fixed in 4% buffered formaline and transferred to 70% alcohol
    - organisms photographed on board (depending on taxa and sampling depth prior to fixation to register color)



REVIZEE Central

- From São Tomé (RJ) to Salvador (BA) including Vitória-Trindade seamounts (ES) + Bahia seamounts
- Main cruises:
  - Central V
  - Central VI

Helena Lavrado (in press)

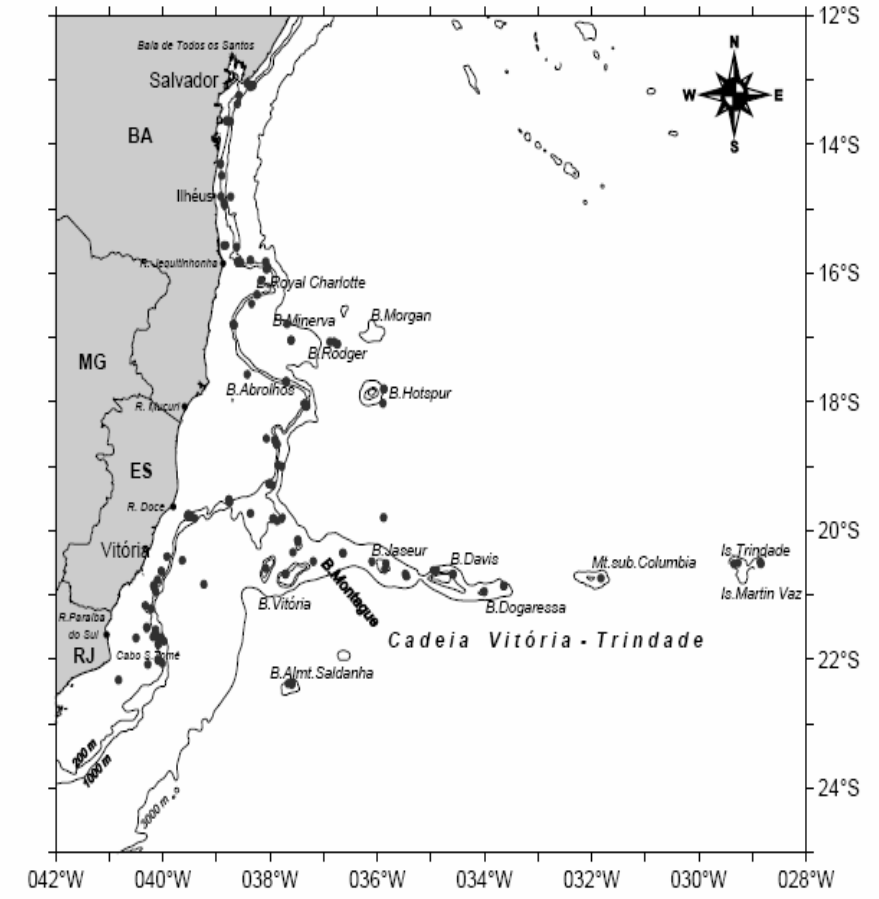


Tabela 1: Dados das campanhas oceanográficas realizadas para coleta de Bentos no Score Central, durante o programa REVIZEE.

Campanha	Período	Faixa batimética	Número de estações
Central I	06/02 –01/05/1996	20-130m	61
Central II	19/10 - 23/11/1997	20-570m	67
Central V	28/06 - 21/07/2001	20-2076m	49
Central VI	11/06 - 28/06/2002	53-1020m	42

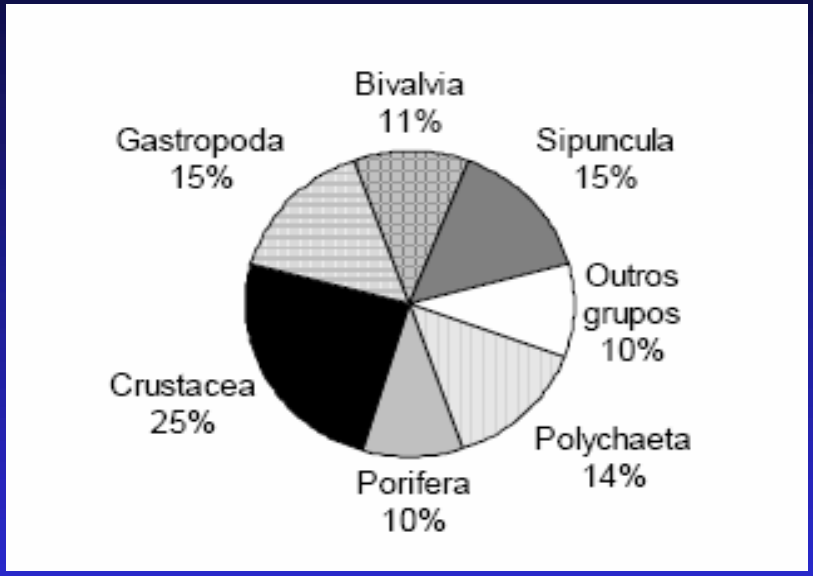
Tabela 2: Faixa batimétrica e localização geográfica das estações de coleta de bentos do Score Central

Faixa Batimétrica	Número de estações	%	Estado	Número de estações	%
< 50m	36	16,4	BA	64	30,1
50-100m	111	50,7	ES	110	51,6
100-250m	20	9,1	RJ	39	18,3
250-500m	26	11,9			
500-1000m	18	8,2			
> 1000 m	8	3,7			

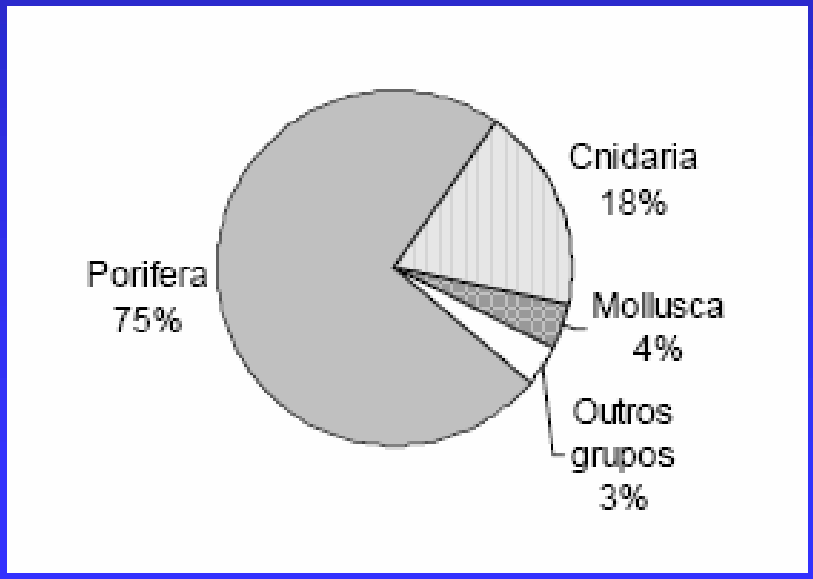
- Depth ranges (5):
  - < 75 m
  - 75-100 m
  - 100 – 250 m
  - 250 – 500 m
  - > 500 (benthos max 2000 m)

REVIZEE Central: macrobenthos results

- Relative abundance of main macrofaunal groups

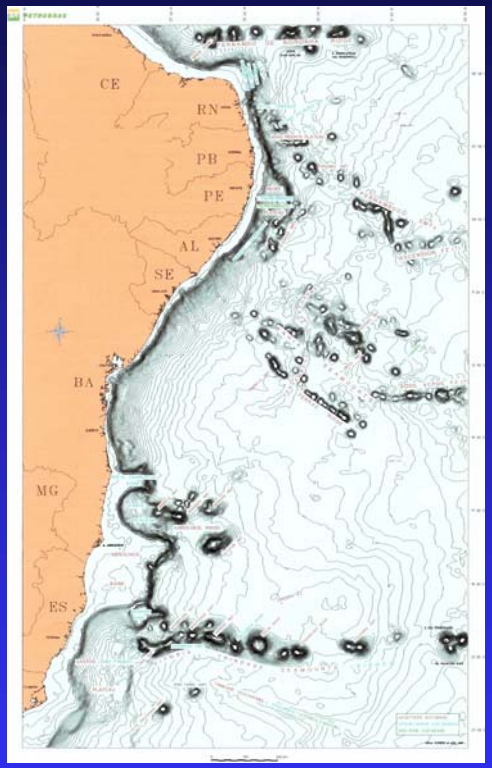


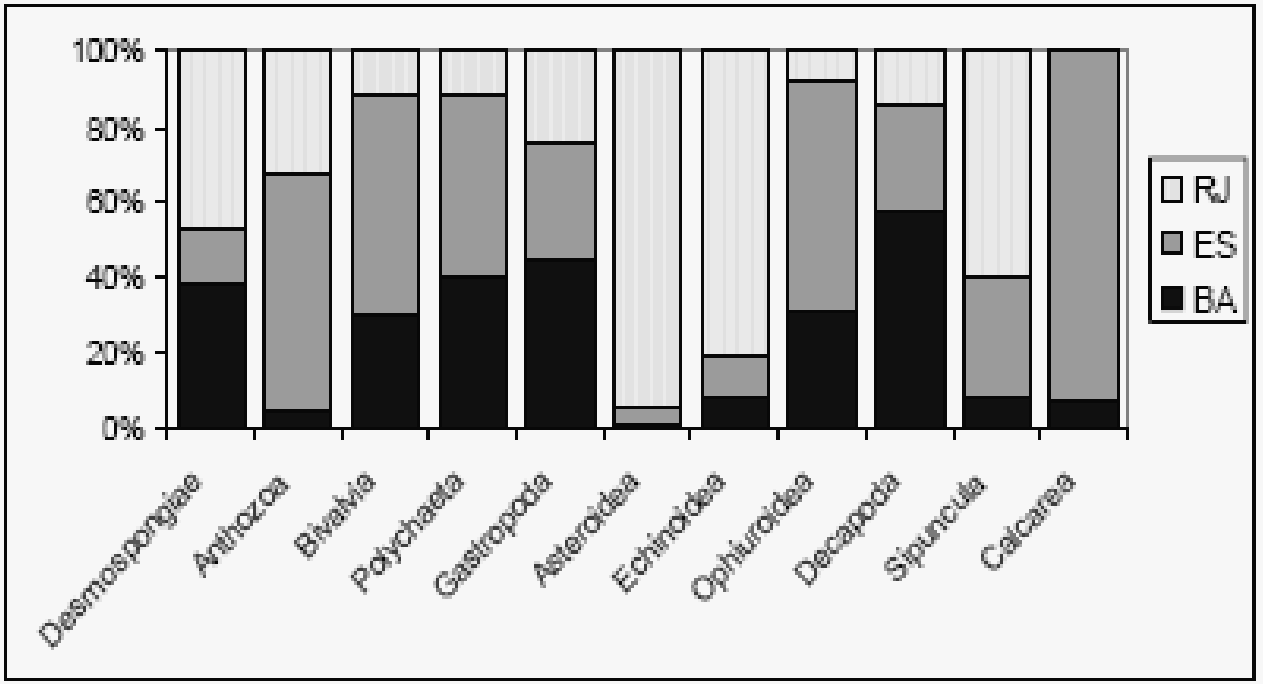
- Higher biomass: Porifera, Cnidaria, Mollusca



Helena Lavrado (in press)

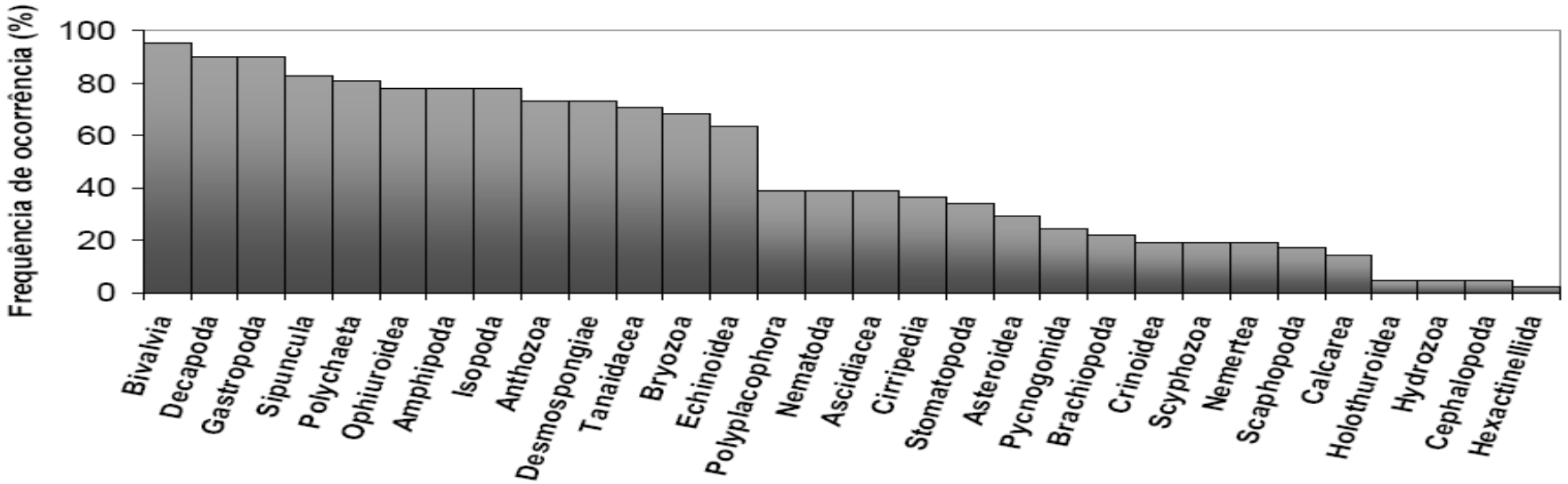
REVIZEE Central: biomass per Brazilian State

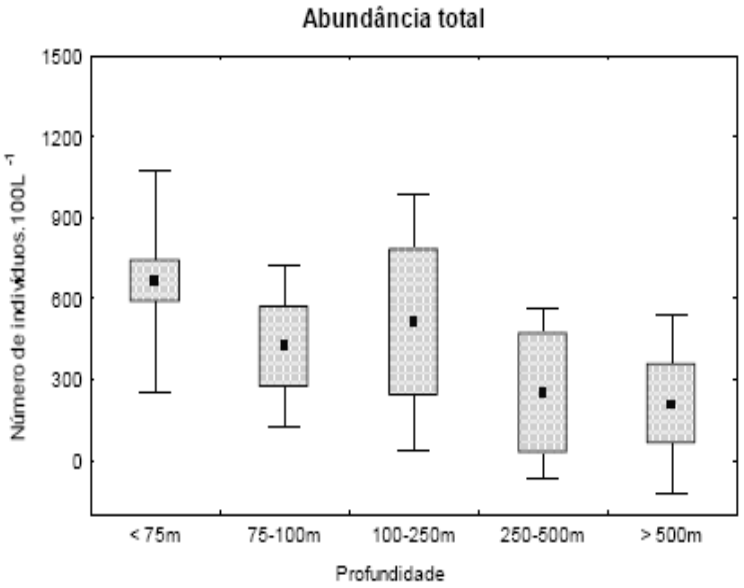




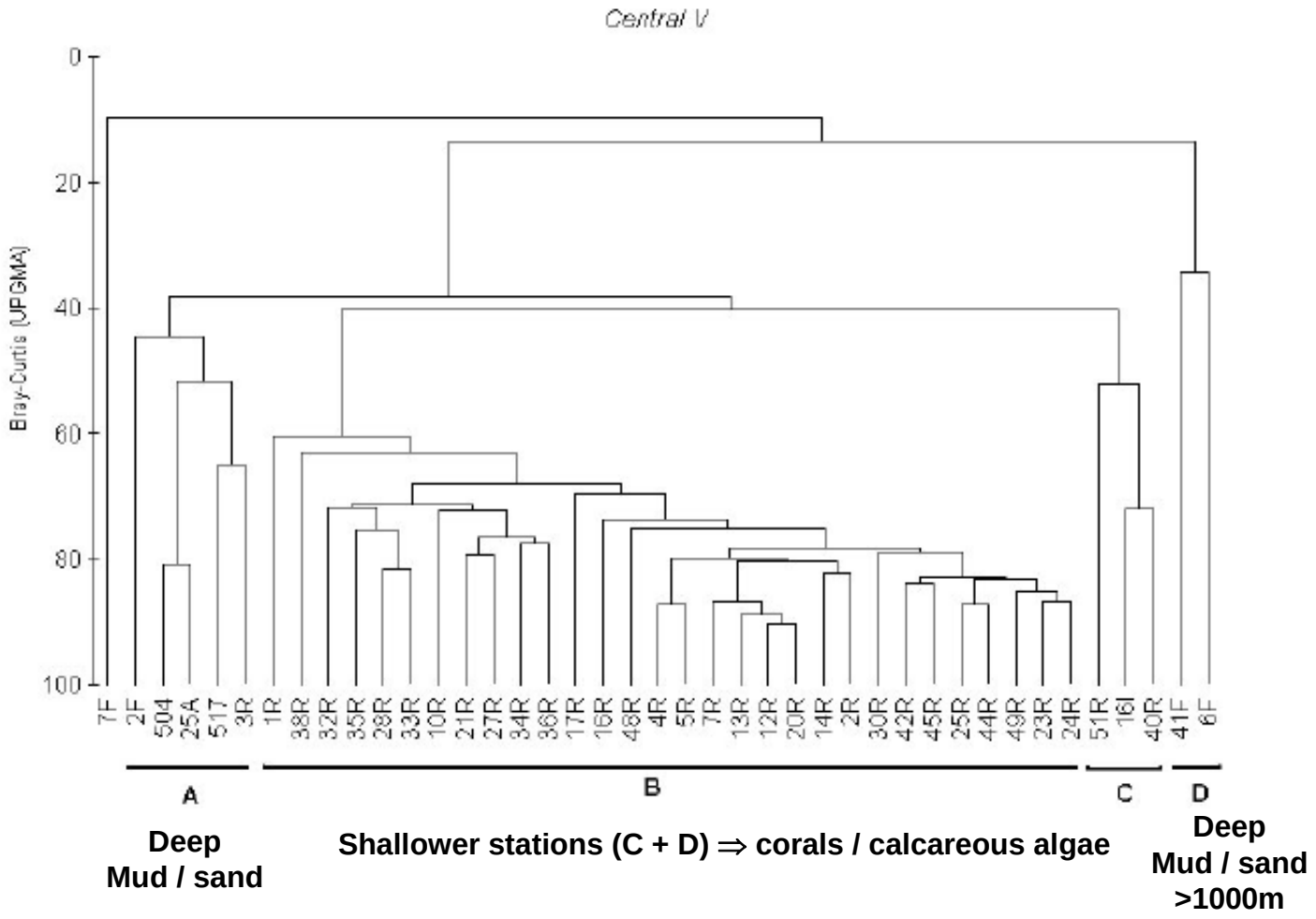
- Rio de Janeiro (RJ): Asteroidea, Echinoidea, Sipuncula, Desmospongiae
- Espírito Santo (ES): Calcareous algae, Ophiuroidea, Anthozoa, Bivalvia, Polychaeta
- Bahía (BA): Decapoda, Gastropoda, Desmospongiae, Polychaeta, Bivalvia, Ophiuroidea

Frequency and total abundance





- Benthic macrofauna total abundance (number of individuals.100L^{-1}) per studied depth (m)
- 90% of #s $\Rightarrow$ 100 ind.100L^{-1}, but 1/3 of this = >1000 ind.100L^{-1} (<75m, mainly at the Vitoria-Trindade Chain

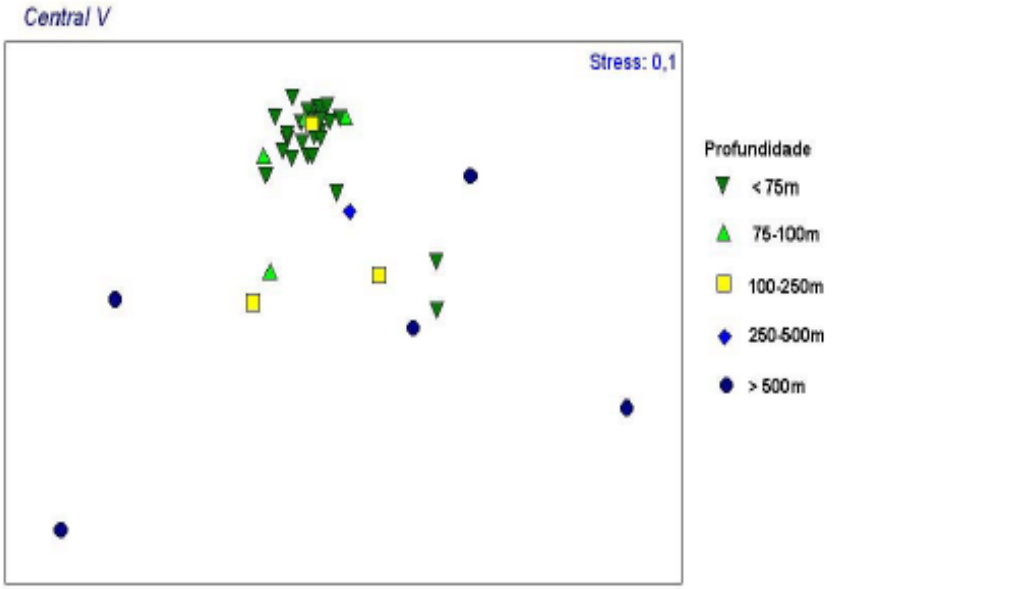


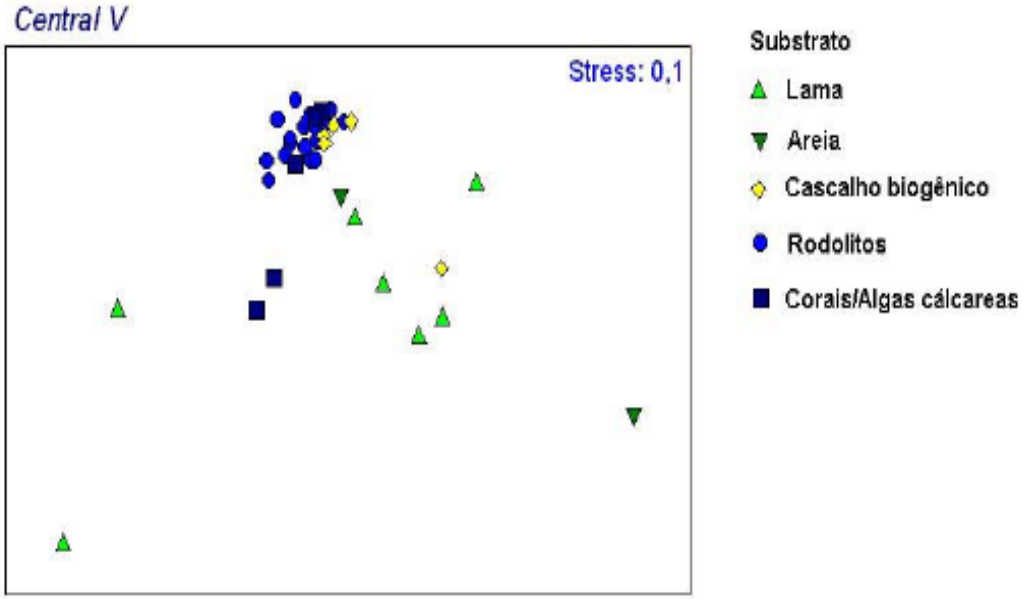
Interaction between benthos, substrate, and depth

- Biological matrix – estimated abundance of benthic macrofaunal taxa using Bray-Curtis similarity
- There is a significant difference between groups formed by shallower stations from the deep ones (R=0.571, p=0.001)
- This bears relationship to the type of substrate

MDS: sampling stations

- Macrobenthic estimated abundance / depth / type of substrate
- Corroborates Bray-Curtis analyses ⇒ deep stations separated
- Shallower #s ⇒ usually calcareous concretions
- Deeper #s⇒ fine sands or mud





NE Brazilian Seamounts

TABLE I. Location, dominant reef type, area and distance from mainland for each Atlantic site

	Northwestern Atlantic		Brazilian province			Central Atlantic	
			Brazilian coast		Brazilian offshore islands		
	Bermuda	Cayman Islands	Paraíba	Três Ilhas Archipelago	St Paul's Rocks	Ascension Island	St Helena Island
Latitude	32°18′N;	19°30′N;	07°00′S;	20°36′S;	00°55′N;	07°55′S;	15°58′S;
Longitude	64°46′W;	80°10′W;	34°50′W;	40°22′W;	29°21′W;	14°25′W;	05°43′W;
Dominant reef type	Corals, calcareous algae and vermetid reefs	Corals	Calcareous algae, corals, and vermetid molluscs	Rocky with a veneer of corals, calcareous algae and vermetid reefs	Poor in coral; rocks overgrown with algae and zoanthids	Rocky, calcareous algae reefs	Rocky, coralline algae cobbles
Shallow platform area >50 m deep (km^2)	~180	~300	~350	~10	~0·5	~250	~150
Distance from mainland (km)	1049	—	—	—	1000	1536*	1870*
Surface water temperature (°C) (Winter–Summer)	18–28	25–28	24–27	20–26	25–27	21–26	17–23
References	Smith-Vaniz *et al.*, 1999	Burgess *et al.*, 1994	Maida & Ferreira, 1997	Gasparini & Floeter, 2000	Edwards & Lubbock, 1983*a*	Price & John, 1980	Edwards, 1990

*Distance from Africa (nearest land).

Floeter & Gasparini (2000)

NE Fisheries

- 513 continental shelf marine shore fish ⇒ 323 live in coral or rocky reefs (12.7% not found in other provinces)
- NE+SE ⇒ 353 spp
- But, several fish spp show biogeographical link between Caribbean and Brazilian Oceanic Islands [eg, Fernando de Noronha (340 Km from the coast); St Peter & St Paul (at MAR)]

Luiz Rocha (2003). Journal of Biogeography, 30:1161-1171

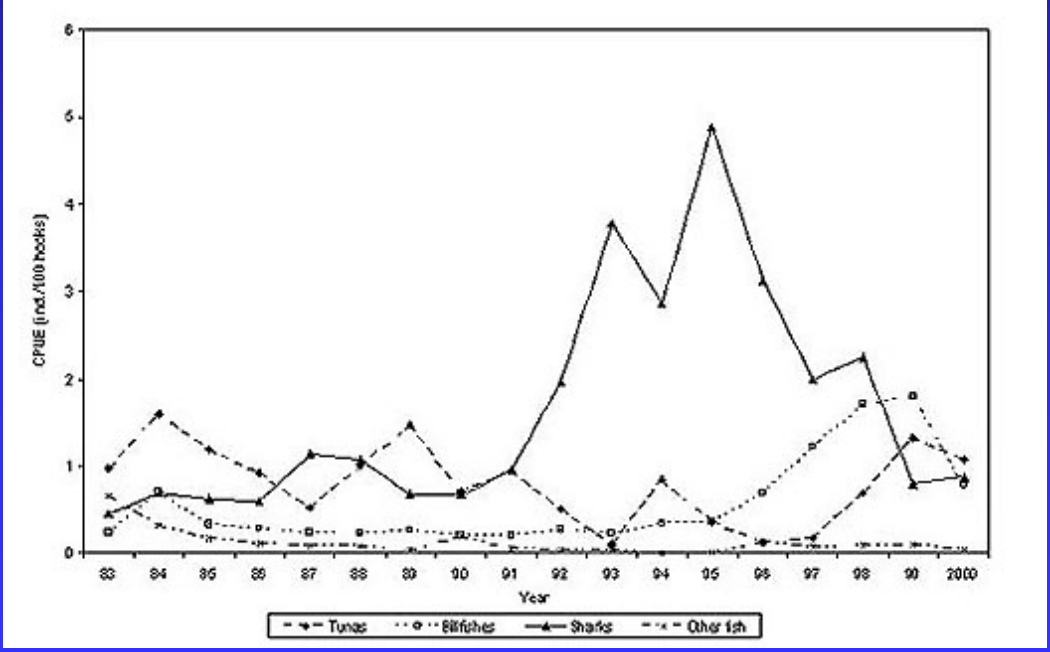


Figure 1. Yearly mean CPUE of tunas, sharks, billfishes and others fishes caught by Brazilian longliners off northeast Brazil, from July 1983 to December 2000 (Hazin et al 2001)

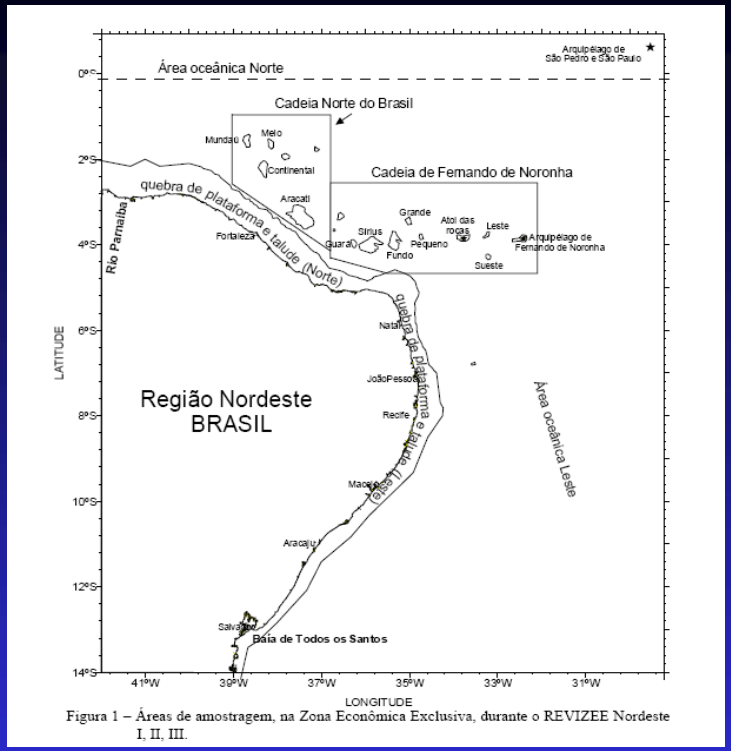


Figura 1 – Áreas de amostragem, na Zona Econômica Exclusiva, durante o REVIZEE Nordeste I, II, III.

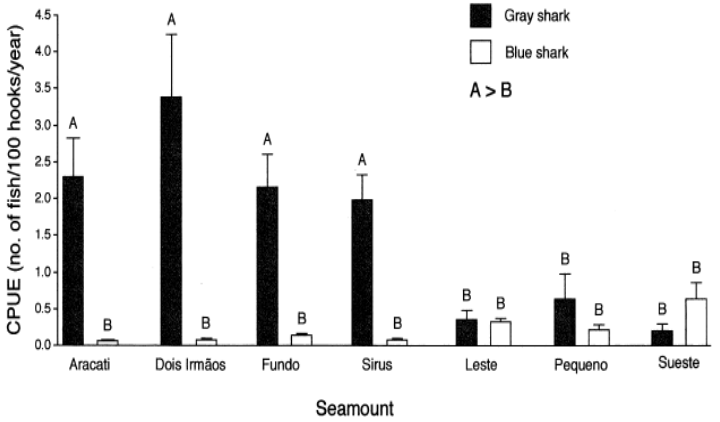
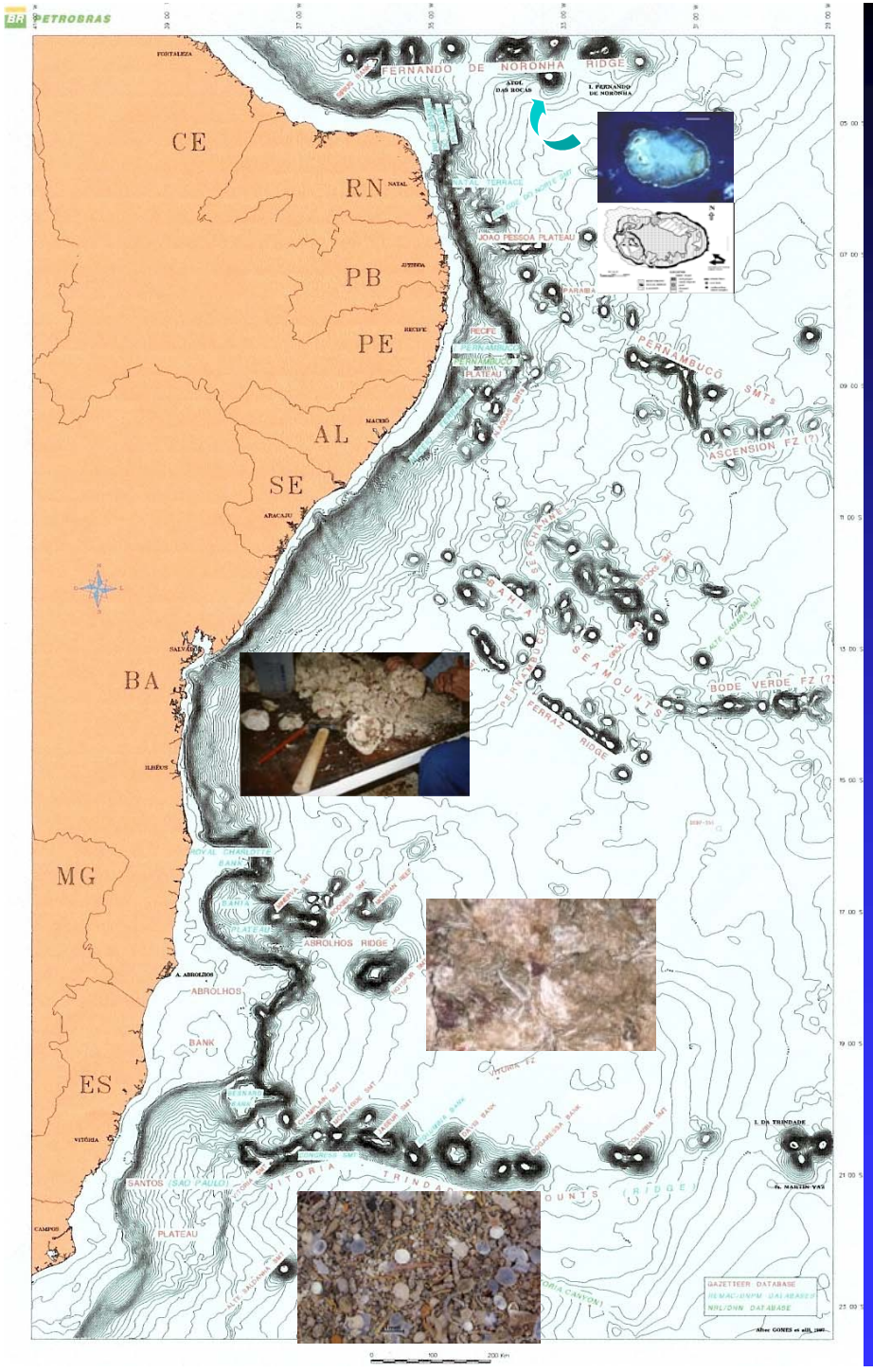


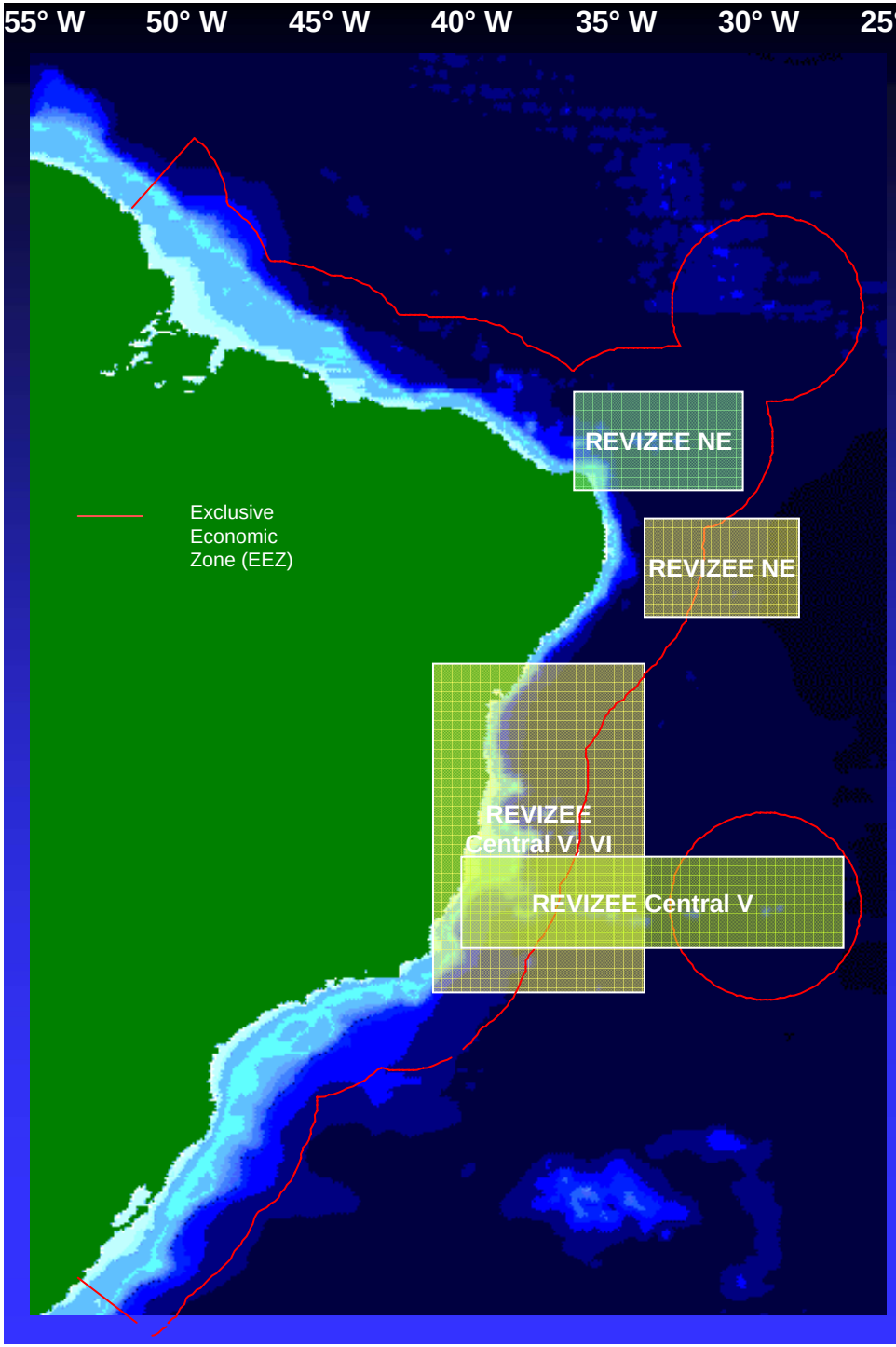
Figure 4.—Differences in arithmetic mean yearly CPUE (±SE) of (A) gray shark, and (B) blue shark across different seamounts. <, >, and = indicate direction of differences detected in Tukey's comparison of means test.

(Hazin et al 1998)



In conclusion (1)…

- The very large Brazilian marine ecosystem is hydrologic and topographically complex with contrasting dominant ecosystems:
  - calcareous algae and coralline systems to the north
  - followed by tropical and subtropical oligotrophic systems with contact zones between them
  - eutrophic systems closest to the coast around Cabo Frio in the southeast and also in the South Brazilian region



In conclusion (2)…

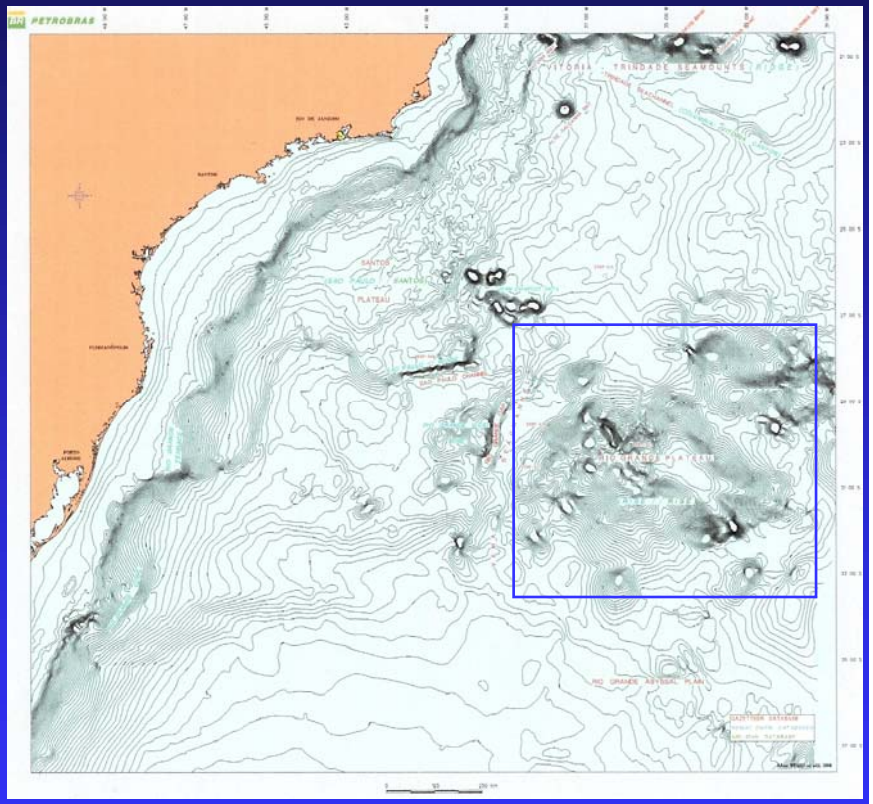
- Generally, the large Brazilian marine ecosystem is considered low in productivity (<150gC.m-2.yr-1) based on SeaWiFS global primary productivity estimates
- But, areas where seamounts are present can be considered ‘hotspots’ for highest species richness and economically important to the fish industry

In conclusion (3)…

- Calcareous algae, corals, molluscs, crustaceans, sponges and echinoderms are the most abundant megabenthic organisms on the seamounts.
- Most seamount summits are built mainly by calcareous algae that contribute to the accumulation of biogenic debris creating a good substrate for sessile and burrowing organisms.
- Many new occurrences and new species to be described from the large Brazilian marine ecosystem, especially regarding those from the continental margin, deep sea and adjacent seamounts

Challenges….

- Major upwelling and turbulent submarine flows and the occurrence of cobalt crusts and manganese nodules can be expected in the Area adjacent to the Brazilian jurisdiction ⇒ the Rio Grande Rise
- Organisms such as hexactinellids, corals and associated fauna could be expected
- Much more isolated and potentially higher endemism
- Which would be the relationship between Southern Ocean, East Atlantic and/or Pacific on faunal composition of the Rio Grande Rise? Degree of isolation (?)
- (James) Is this area likely to be exploited? If so, maybe this would be an important target area from the Atlantic to be explored



Where are the Brazilian data?

- Fisheries journals
- http:/www.biotaneotropica.org.br and other Brazilian journals
- REVIZEE book – Central coming up in June / July
- MD 55 report + Zoosystema volume + other papers published separately – Echinoderm meetings
- Taxonomy efforts in Brazil:
  - Government
  - Petrobras

Deep-Sea Project Taxonomy

Clovis Barreira e Castro – MN/UFRJ (Cnidaria)

Debora Pires - MN/UFRJ (Cnidaria – Deep-sea corals)

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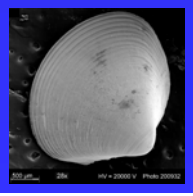
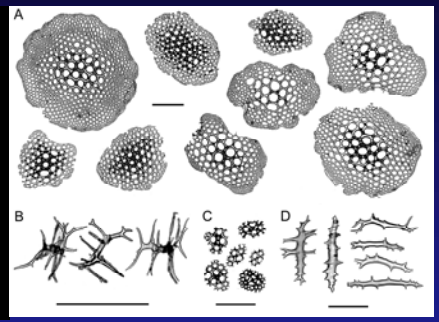
Paulo Costa – UNIRIO (Fish)

Ricardo Absalão – IB/UFRJ (Mollusca)

Fábio Hazin – UFRPE (NE Fish)





Deima validum

Cheiraster sepitus

Pseudostichopus depressus

Synaphobranchidae

S.brevidorsalis

S.oregoni

S.affinis

Ophiophycis mirabilis

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Thank you!