



I Congresso de
**Ciências do Mar na
Margem Equatorial
Brasileira**

28 a 30 de outubro de 2024

Universidade Federal do Maranhão • São Luís - MA

Geologia Marinha da Margem Equatorial Brasileira

Alberto G. Figueiredo Jr.

João Regis dos Santos Filho

Juliane Castro Carneiro

Leonardo Junius Chapeta Santos

Natália de Jesus Lopes Chaves

Eduardo Thomaz de Aquino Ribeiro

Realização

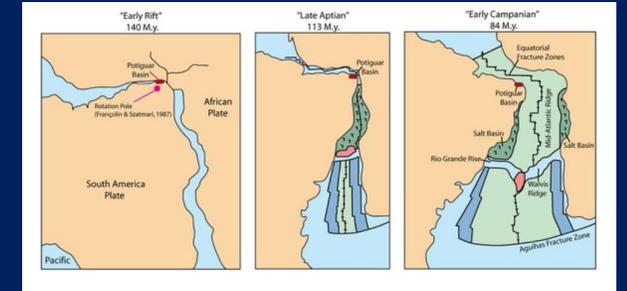


TÓPICOS:

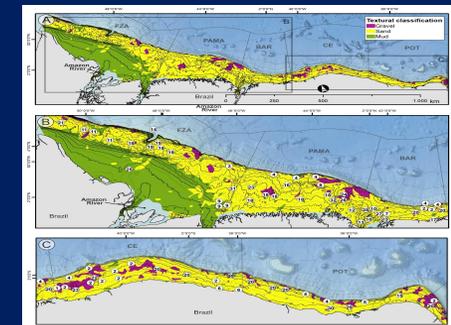
EVOLUÇÃO GEOLÓGICA DA MARGEM EQUATORIAL BRASILEIRA

HISTÓRICO DAS PESQUISAS NA MARGEM EQUATORIAL

CONHECIMENTO ATUAL DA SEDIMENTOLOGIA



Noc. Alnte Saldanha, DHN



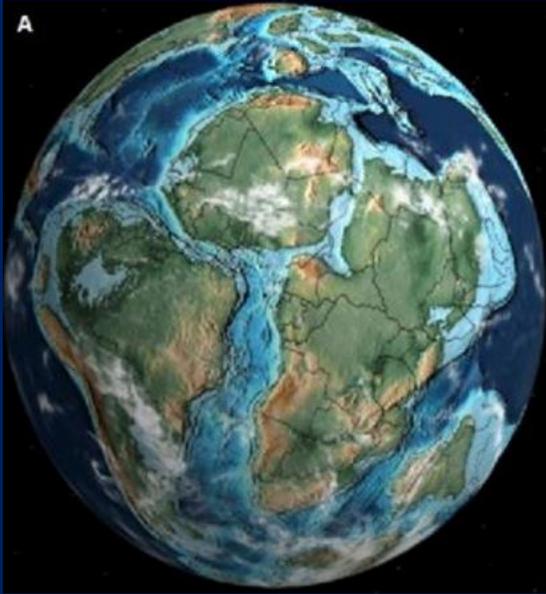
MARGEM EQUATORIAL



Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus

EVOLUÇÃO GEOLÓGICA DA MARGEM EQUATORIAL BRASILEIRA

ABERTURA DO ATLÂNTICO EQUATORIAL



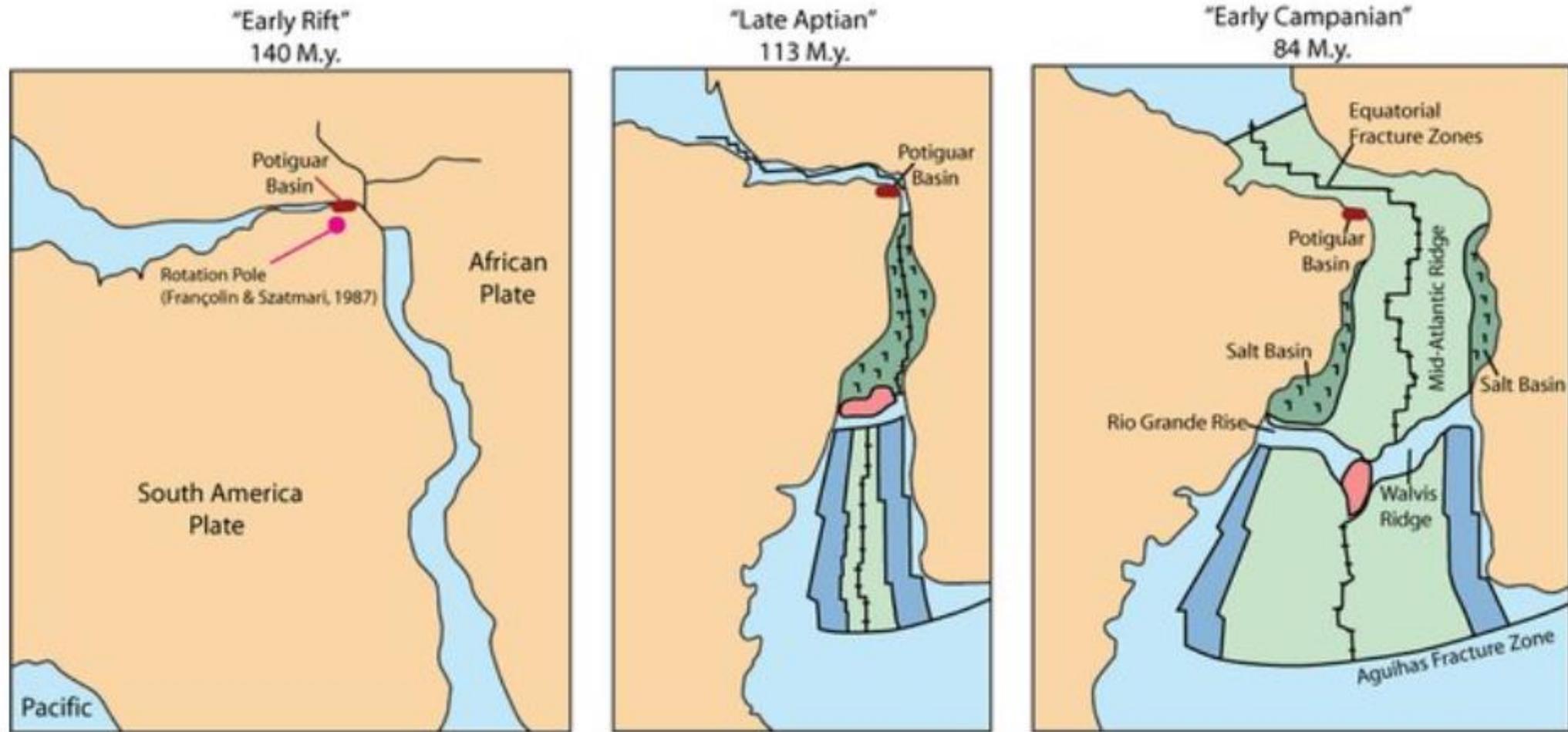
Abertura da Margem Equatorial Atlântica com a separação entre a América do Sul e África na transição Albiano (113 milhões de anos) e Cenomaniano (100,5 milhões de anos)



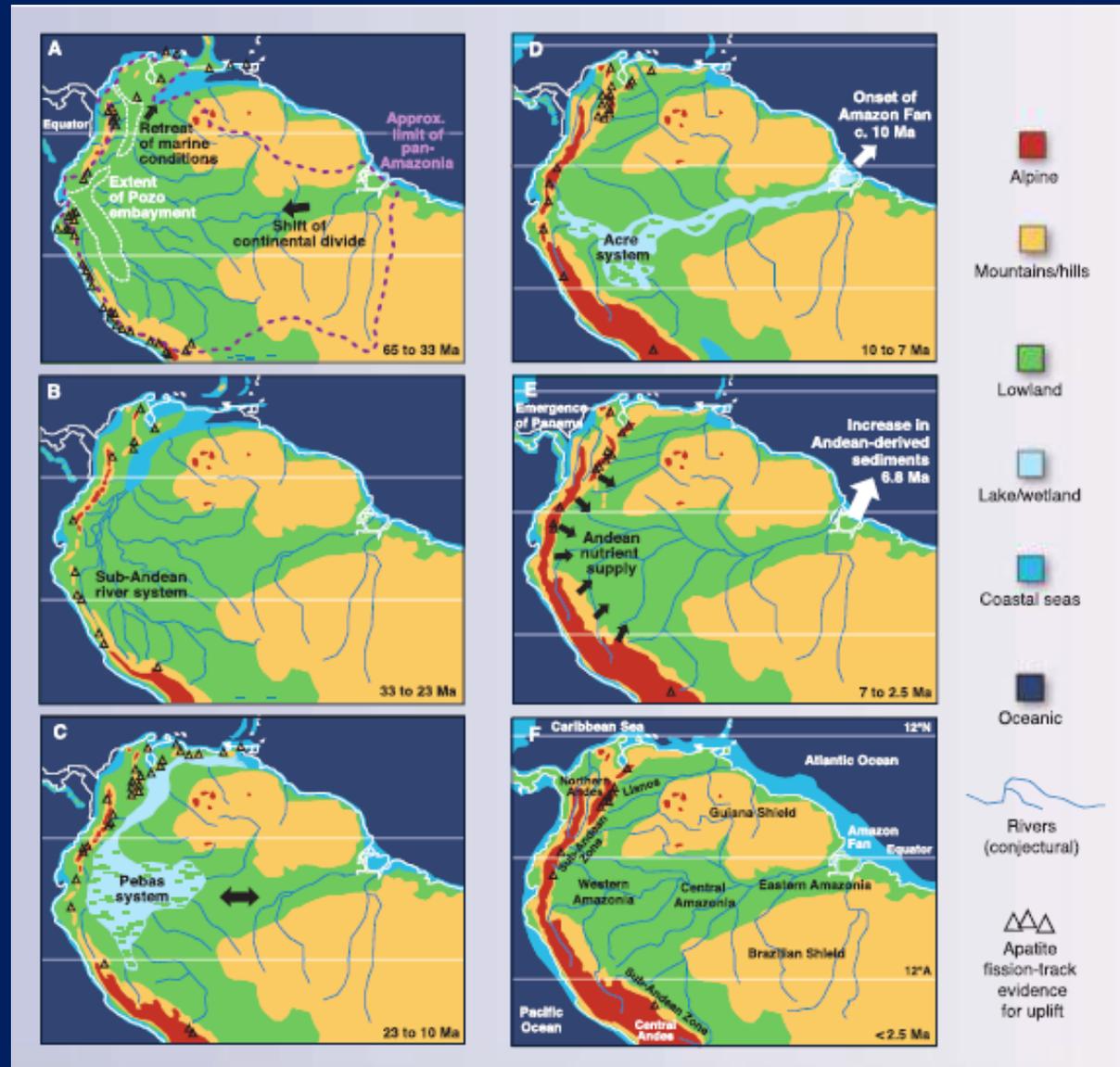
Individualização da Plataforma Sul Americana a partir do Cenomaniano. Abertura da Margem

Fonte: Francisco Leandro dos Santos, adaptado de Scotese e Golonka, 1997, *Anciente Earth*, 2015

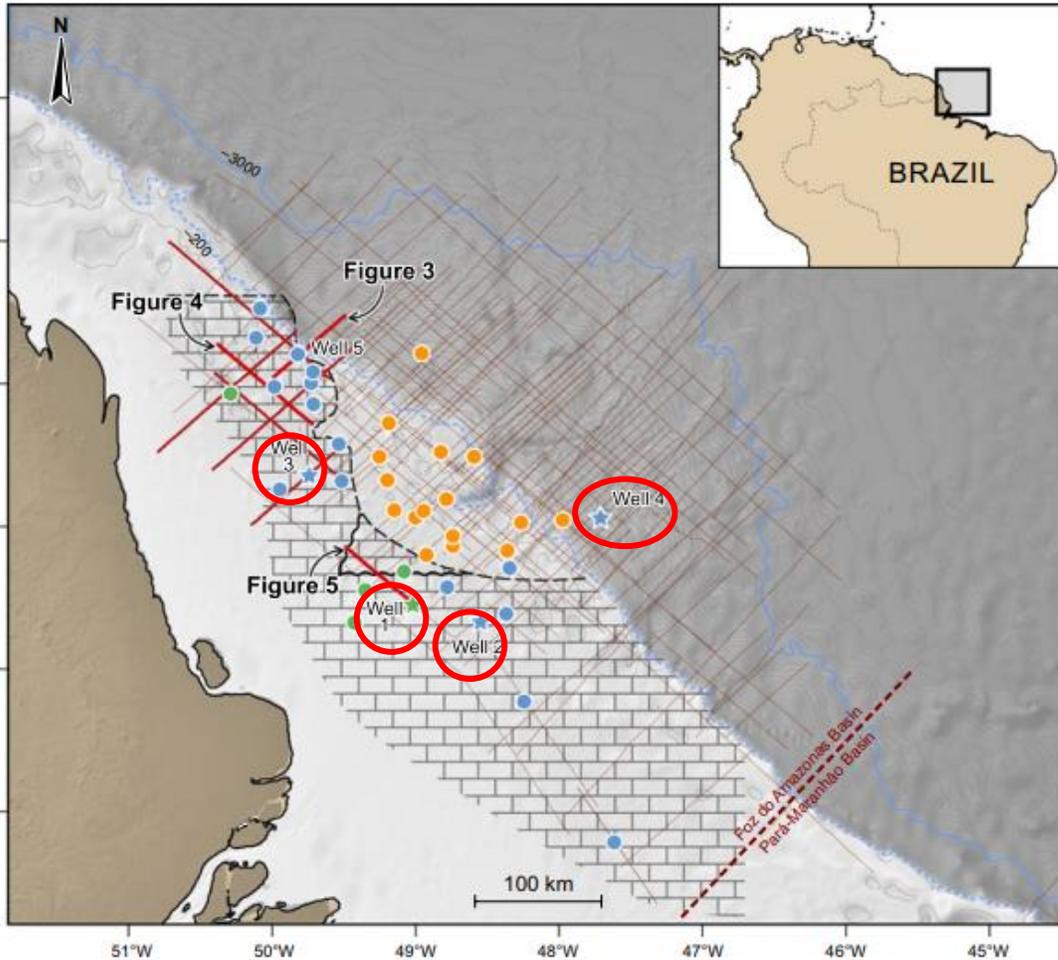
ABERTURA DO ATLÂNTICO EQUATORIAL



Amazonia through time: Andean uplift, climate change, landscape evolution, and biodiversity.



PLATAFORMA CARBONÁTICA (Early, 23-16ma to Late Miocene, 11-5ma)



- Wells that do not reach stratigraphic intervals older than the late Miocene.
 - Wells that reach the carbonate platform or equivalent stratigraphic level, recording an abrupt change between the carbonate platform and the siliciclastic sedimentation above.
 - Wells that reach the carbonate platform or equivalent stratigraphic level, recording a gradual change between the carbonate platform and the siliciclastic sedimentation above.
- Carbonate platform
 Amazon Paleo-canyon
 Keylines
 Shelf break

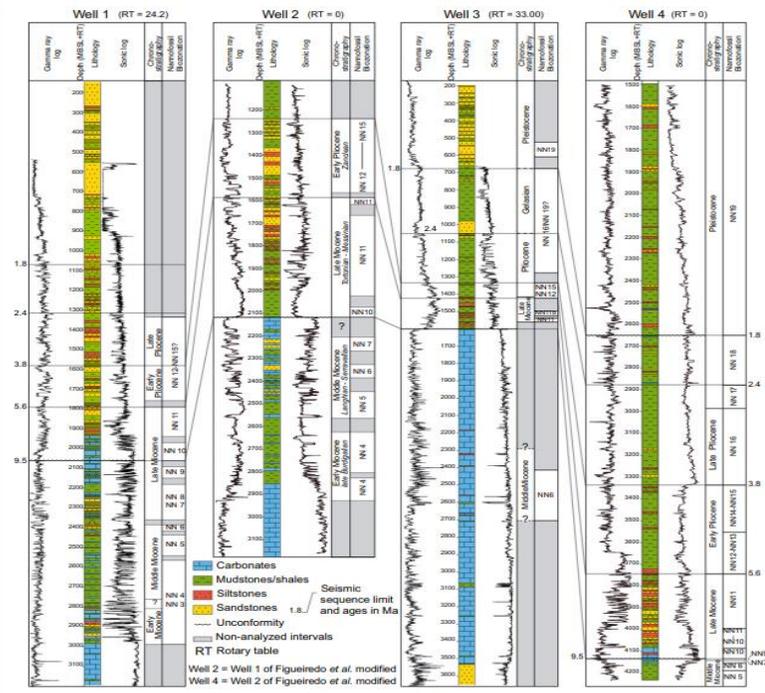
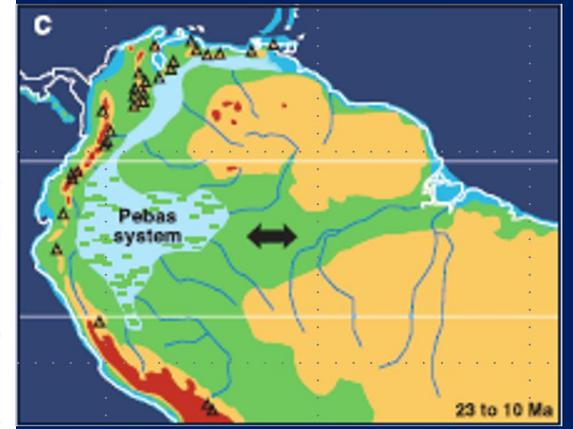


Fig. 2 Lithological and sonic logs and nannofossil biozones of four wells used to construct the late Neogene chronostratigraphic model of the Amazon Basin. In all wells, the cessation of carbonate sedimentation occurs within biozone upper NN10 or just below NN11, leading us to assign an age range of 9.5 to 8.3 Ma to this diachronous event. (Well 1 data courtesy of ANP; wells 2 and 4 after Figueiredo *et al.* (2009); and well 3 courtesy of Petrobras).



HISTÓRICO DAS PESQUISAS NA MARGEM EQUATORIAL

PROJETOS NACIONAIS E DE COOPERAÇÃO INTERNACIONAL

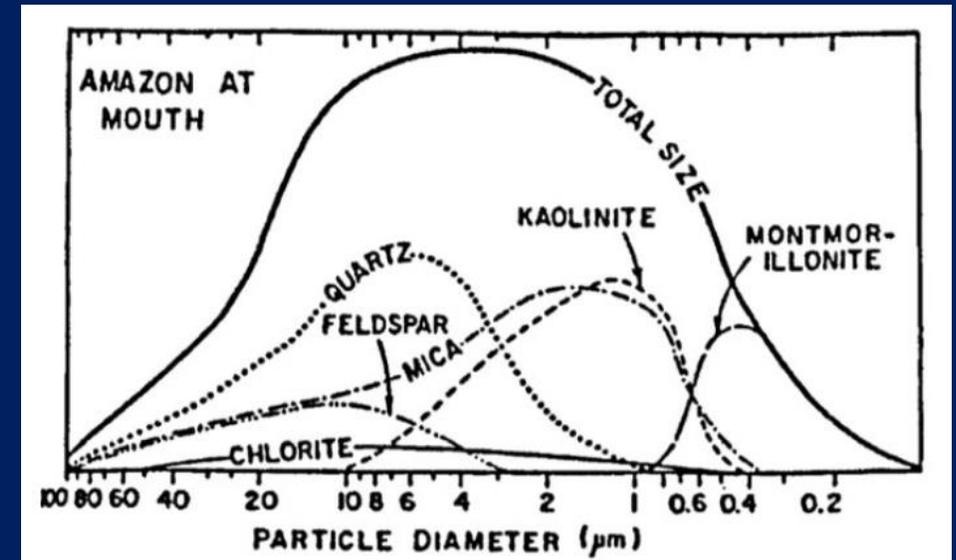
CURIOSIDADE

PROCESSO DE CRIAÇÃO DA DRAGA GIBBS



Os primeiros estudos de Ronald J. Gibbs em 1967 no Rio Amazonas foi a descarga do rio e mapa da distribuição sedimentar na plataforma. Gibbs quando pesquisava o Rio Amazonas a bordo de um navio hidrográfico da Marinha Brasileira perdeu o equipamento de amostragem que havia trazido dos US. Naquele momento solicitou ao mecânico de bordo que cortasse um tubo de ferro de uns 30cm de comprimento e 15cm de diâmetro e amarrou um saco de pano em uma das extremidades, depois prendeu o tubo a um cabo de aço e passou a coletar amostra no Rio Amazonas e assim foi criada a Draga de Gibbs.

Granulometria do Sedimento na Foz do Rio Amazonas



Ronald J. Gibbs, 1977

PROJETOS NACIONAIS E DE COOPERAÇÃO INTERNACIONAL

- **PROJETO GEOMARES** (Geomar I, 1970, Geomar II, 1972)
PGGM, CNPq, DHN

Noc. Almte Saldanha, DHN



- **PROJETO REMAC** (1972 -1974)
PETROBRAS, DNPM, CPRM, WOODS HOLE, LAMONT DOHERTY, CNEXO,
CNPq, UNIVERSIDADES

Noc. Prof. Besnard, IOUSP



- **PROJETO AMASSEDS** (1989 - 1991)
UNIVERSIDADES AMERICANAS E BRASILEIRAS, NSF, CNPq



Noc. Columbus Iselim, U. Miami



Barco Curupira, UFPA

PROJETOS NACIONAIS E DE COOPERAÇÃO INTERNACIONAL

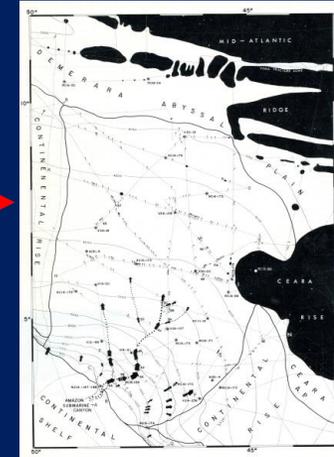
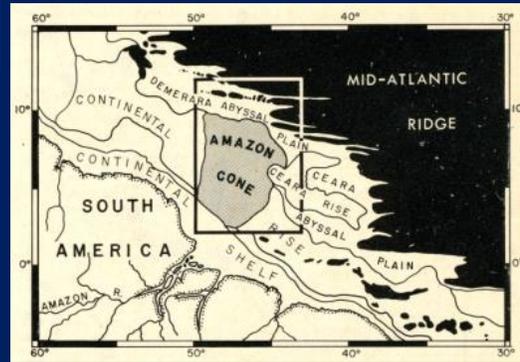
EVOLUÇÃO DO CONHECIMENTO

Amazon Cone: Morphology, Sediments, Age, and Growth Pattern

JOHN E. DAMUTH } Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York 10964
NARESH KUMAR }

Geological Society of America Bulletin, v. 86, p. 863-878, 10 figs., June 1975, Doc. no. 50618.

13 ANOS DEPOIS

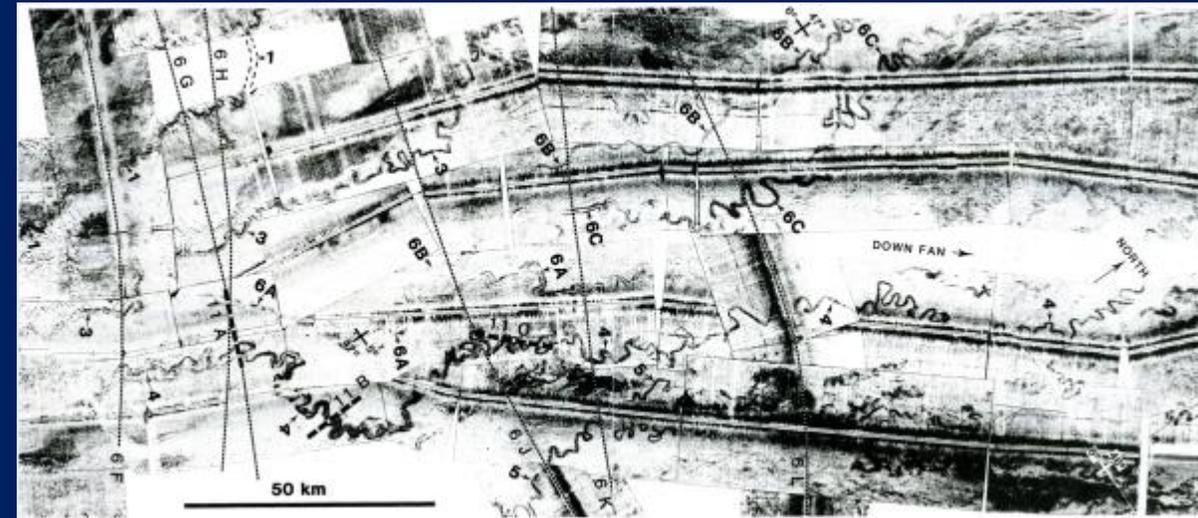
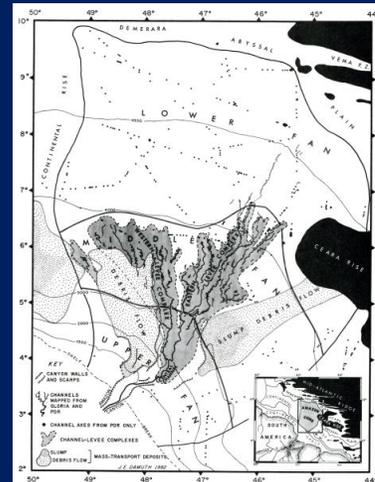


The American Association of Petroleum Geologists Bulletin
V. 72, No. 8 (August 1988), P. 885-911, 22 Figs.

The American Association of Petroleum Geologists Bulletin
V. 72, No. 8 (August 1988), P. 885-911, 22 Figs.

Anatomy and Growth Pattern of Amazon Deep-Sea Fan as Revealed by Long-Range Side-Scan Sonar (GLORIA) and High-Resolution Seismic Studies¹

JOHN E. DAMUTH,² ROGER D. FLOOD,³ RENATO O. KOWSMANN,⁴
ROBERT H. BELDERSON,⁵ and MARCUS A. GORINI⁶



PROJETOS NACIONAIS E DE COOPERAÇÃO INTERNACIONAL

- **PROJETO JOPS I, NAVIO VICTOR HENSEN** (1990 – 1991) Projeto de Cooperação Bilateral, Brasil – Alemanha MCT/MMA e ZMT/BMBF

Noc. Victor Hensen, U. Bremen



- **PROJETO REVIZEE** (1995 - 2005)
SECIRM, IBAMA, CNPq, MCT, MULTI-MINISTÉRIOS, UNIVERSIDADES
Score Norte: Dr. Maâmar El-Robrini



Noc. Antares, DHN



- **PROGRAMA MADAM, Manejo e Dinâmica em Áreas de Manguezais** (1995 – 2005) Brasil – Alemanha.

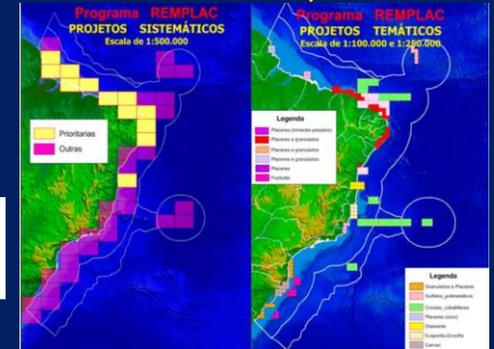
PROJETOS NACIONAIS E DE COOPERAÇÃO INTERNACIONAL

- PROJETO REMPLAC (1997 - 2005)

PSRM/CIRM, DHN, PGGM, CNPq, CPRM, MCT, MULTI-MINISTÉRIOS, UNIVERSIDADES

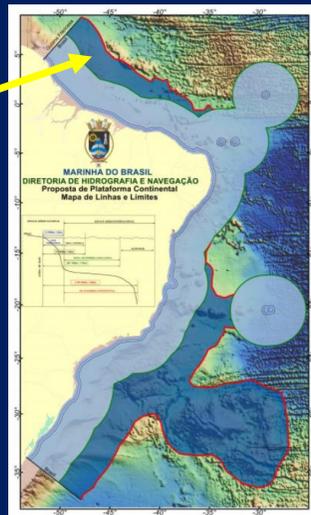
6. Ouro e Minerais Pesados da Região de Vizeu/Carutapera (Pará).

7. Levantamento do potencial aurífero da região Macapá-Calçoene, no Território do Amapá.



- PROJETO LEPLAC (1987 - 2020)

PSRM/CIRM, DHN, PETROBRAS



Extensão pleiteada pelo Brasil

Noc. Almte. Câmara, DHN



NOc. Almte. Alvaro Alberto, DHN



PROJETOS NACIONAIS E DE COOPERAÇÃO INTERNACIONAL

- **PROJETO PIATAM MAR (2004 - 2006)**
PETROBRAS (Potenciais impactos no transporte de petróleo e derivados)
UFPA, MUSEU EMÍLIO GOELDI, UNIV. FED. RURAL AMAZONAS, INST. EVANDRO CHAGAS, UNIV. EST. PARÁ, UNIV. FED. MARANHÃO, UNIV. EST. MARANHÃO, IEPA, COPPE-UFRJ
 - 18 Linhas de Pesquisa
 - 230 Pesquisadores
- **PROJETO PIATAM OCEANO (2006 - 2009)**
PETROBRAS (Potenciais impactos no transporte e produção de petróleo e derivados)
UFPA, UFF, MUSEU EMÍLIO GOELDI, UNIV. FED. MARANHÃO, UNIV. EST. MARANHÃO
 - 24 Linhas de Pesquisa
 - 30 Pesquisadores

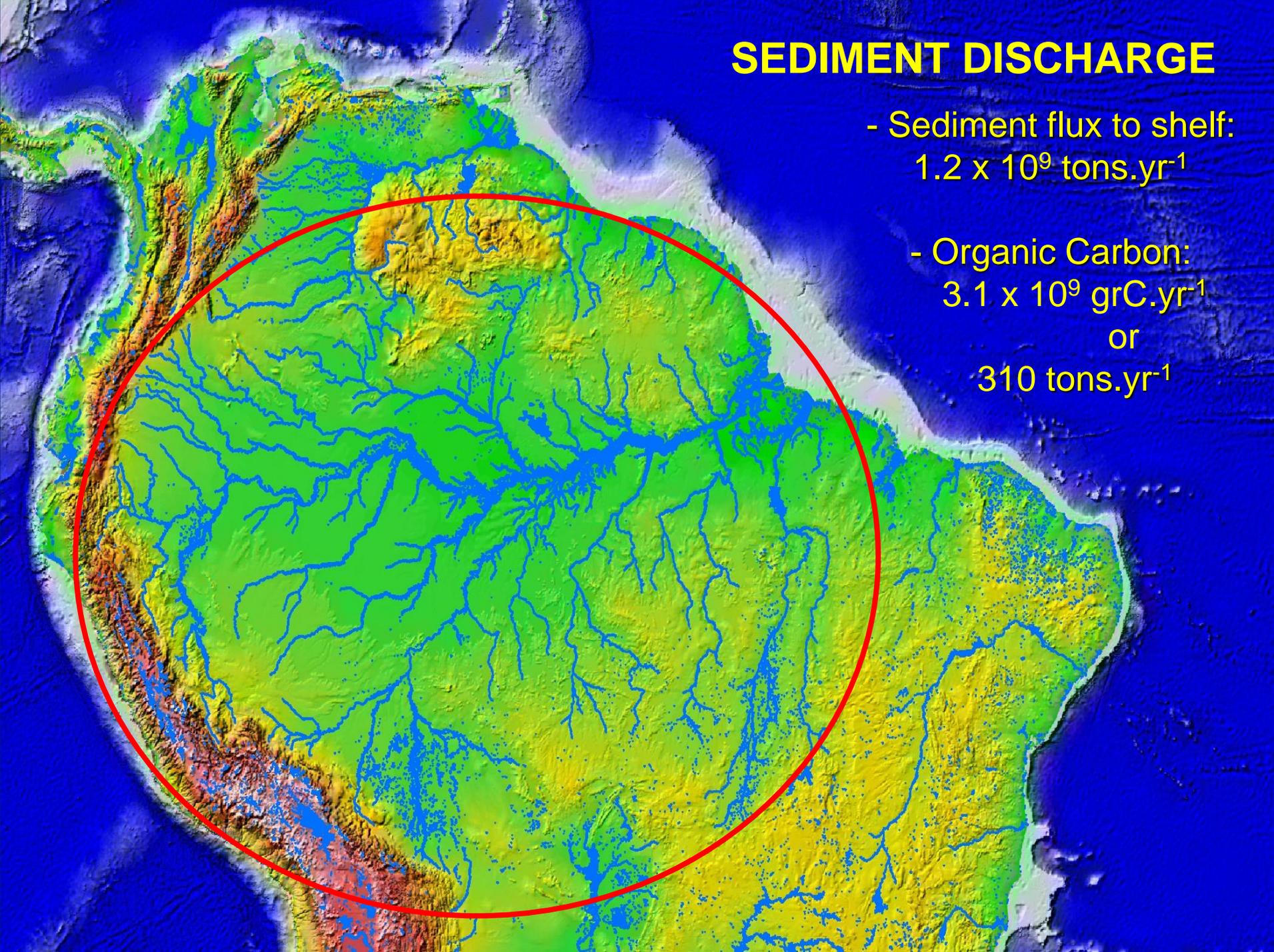
NHo. Amorim do Valle, DHN



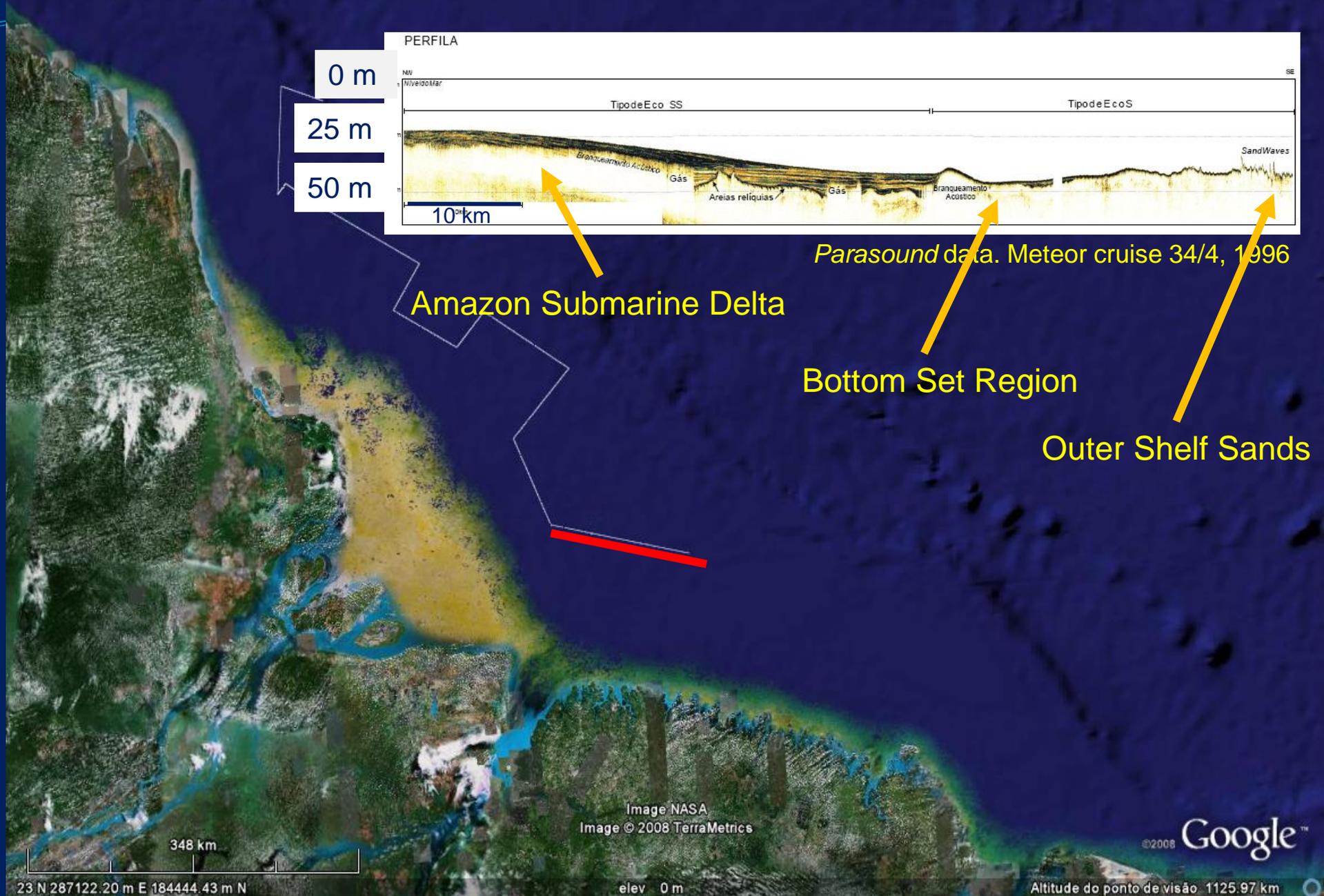
CONHECIMENTO ATUAL DA SEDIMENTOLOGIA

SEDIMENT DISCHARGE

- Sediment flux to shelf:
 $1.2 \times 10^9 \text{ tons.yr}^{-1}$
- Organic Carbon:
 $3.1 \times 10^9 \text{ grC.yr}^{-1}$
or
 310 tons.yr^{-1}



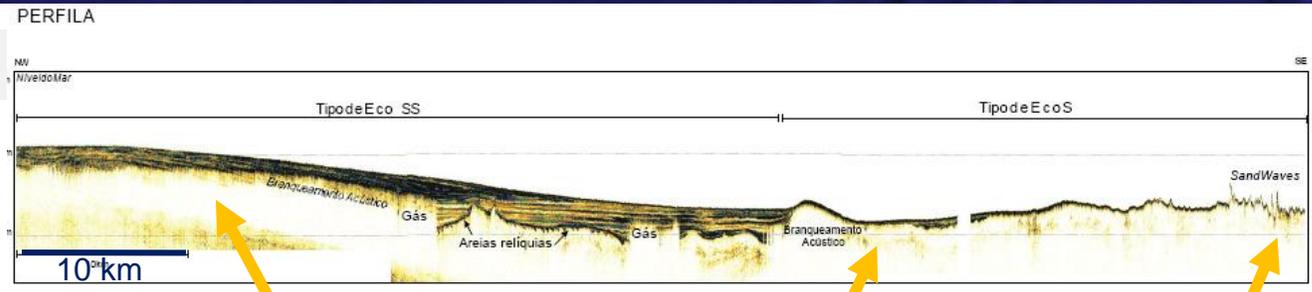
STRATIGRAPHY AND SEDIMENT DISTRIBUTION



0 m

25 m

50 m



Amazon Submarine Delta

Parasound data. Meteor cruise 34/4, 1996

Bottom Set Region

Outer Shelf Sands

348 km
23 N 287122.20 m E 184444.43 m N

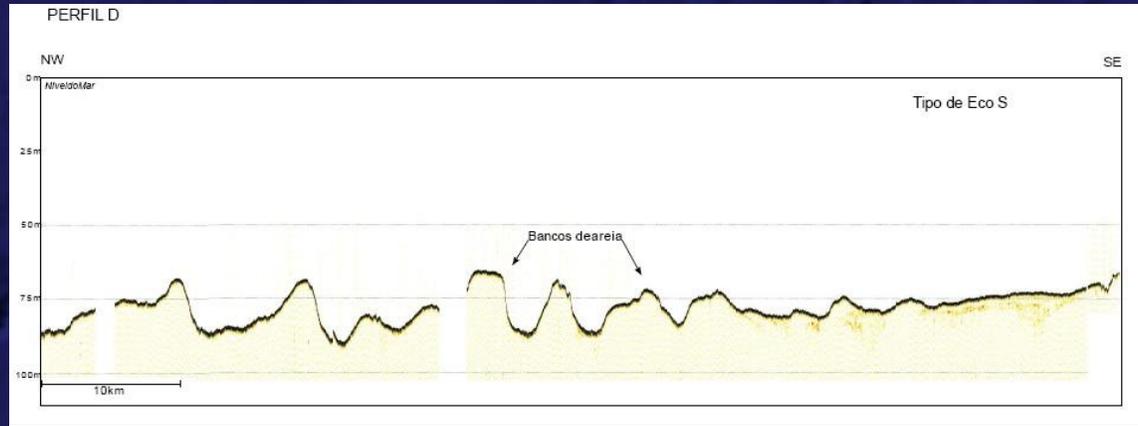
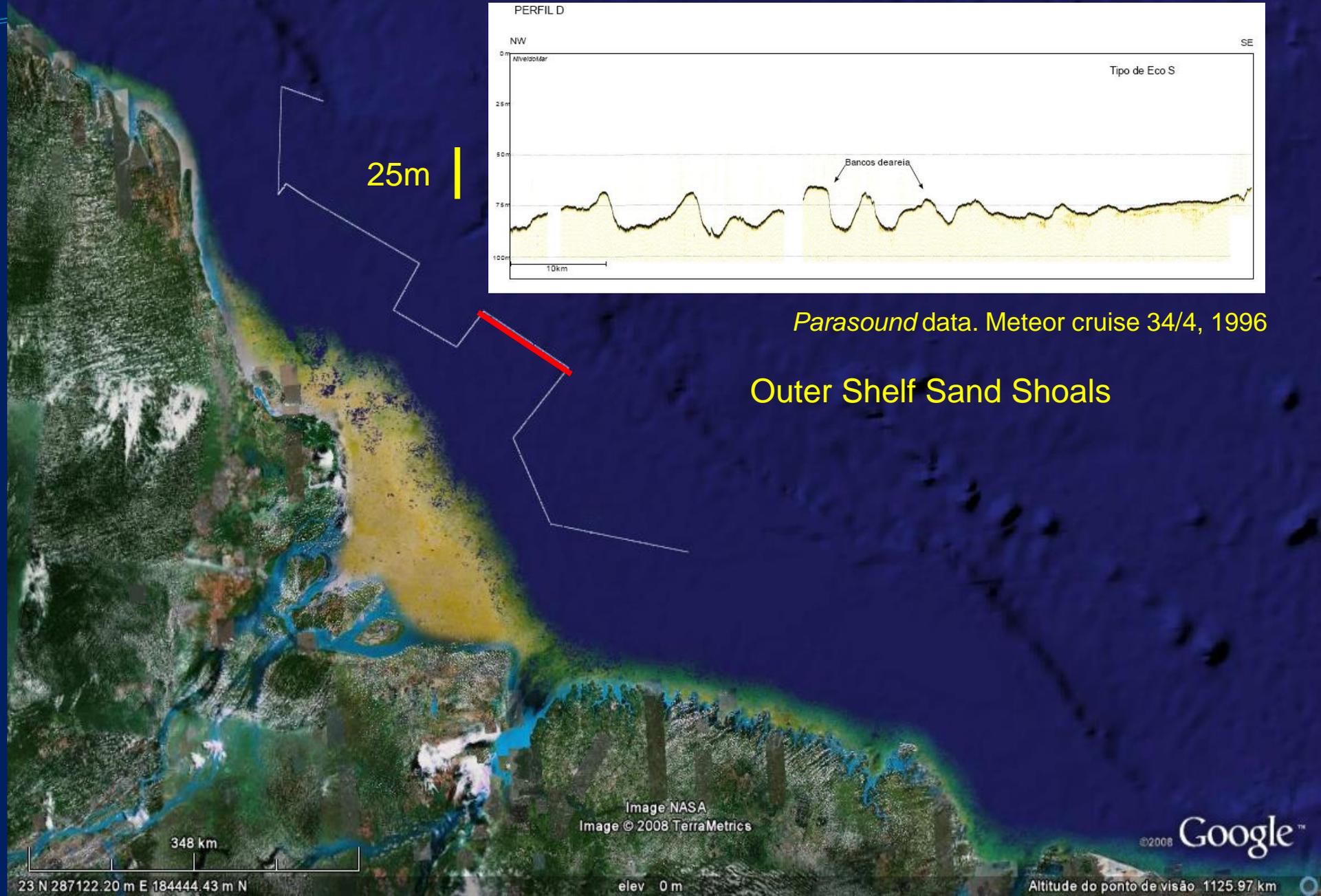
Image NASA
Image © 2008 TerraMetrics

elev 0 m

Altitude do ponto de visão 1125.97 km

©2008 Google™

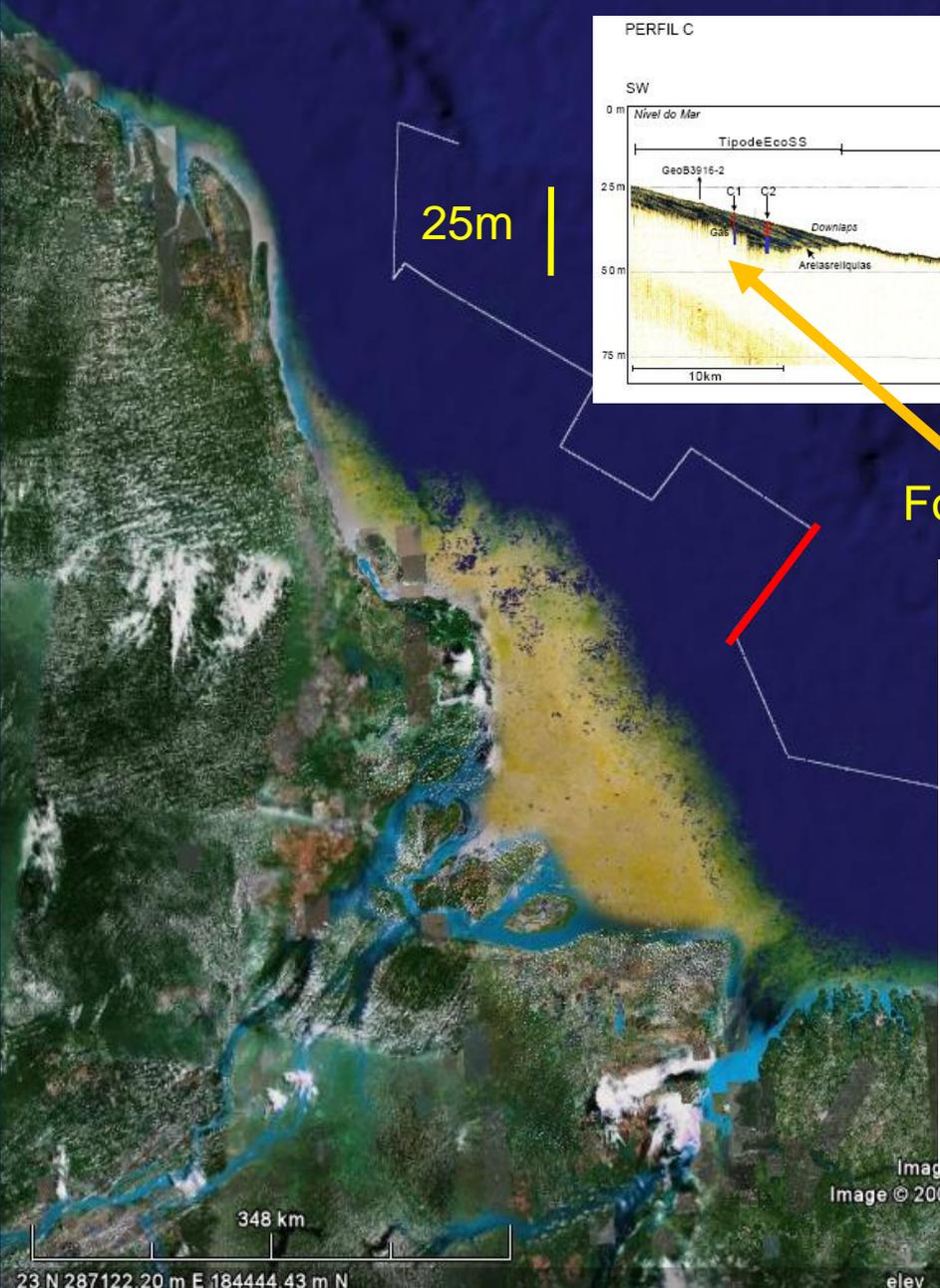
STRATIGRAPHY AND SEDIMENT DISTRIBUTION



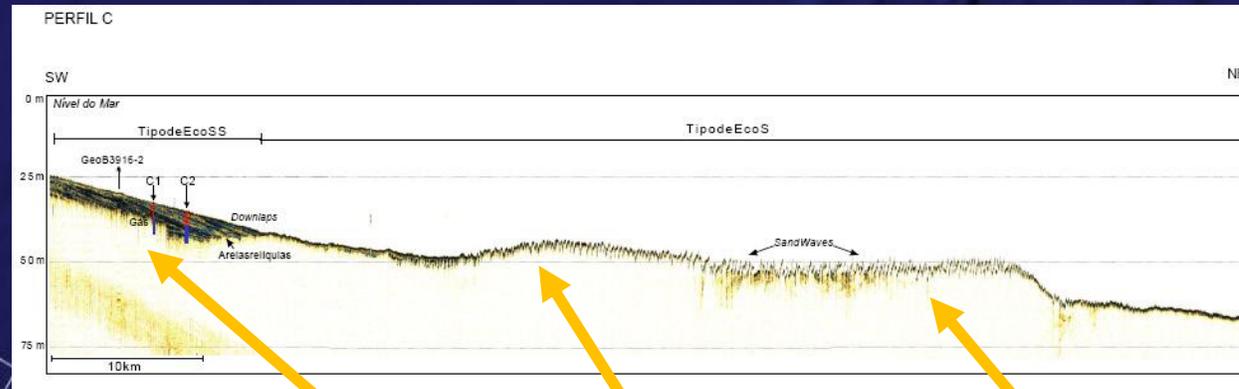
Parasound data. Meteor cruise 34/4, 1996

Outer Shelf Sand Shoals

STRATIGRAPHY AND SEDIMENT DISTRIBUTION

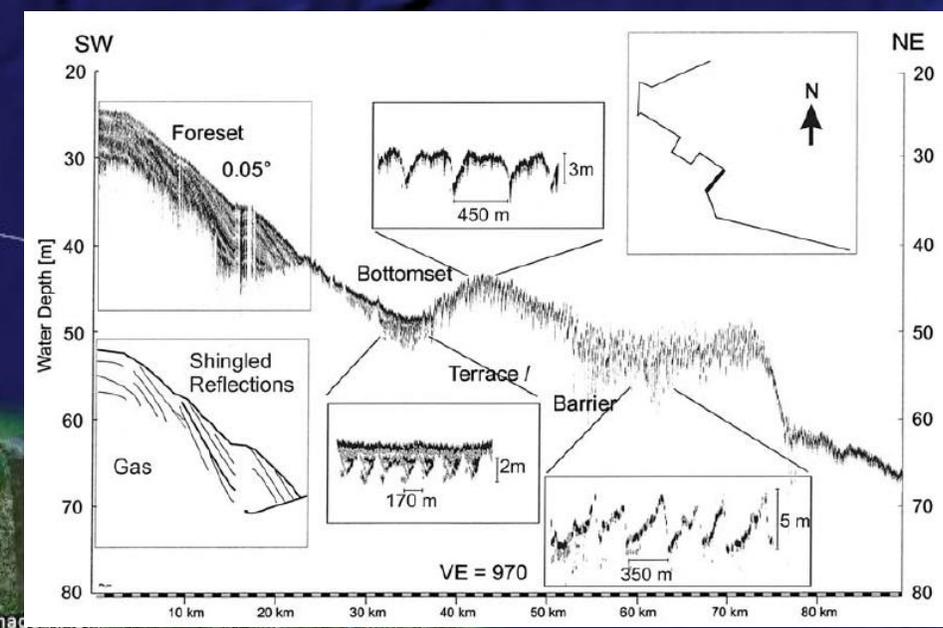


25m



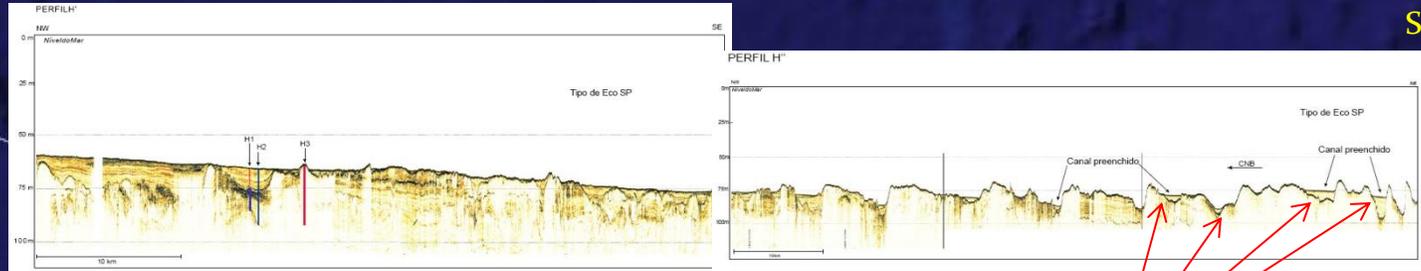
Parasound data. Meteor cruise 34/4, 1996

Foreset, Outer Shelf Sands and Sand Waves

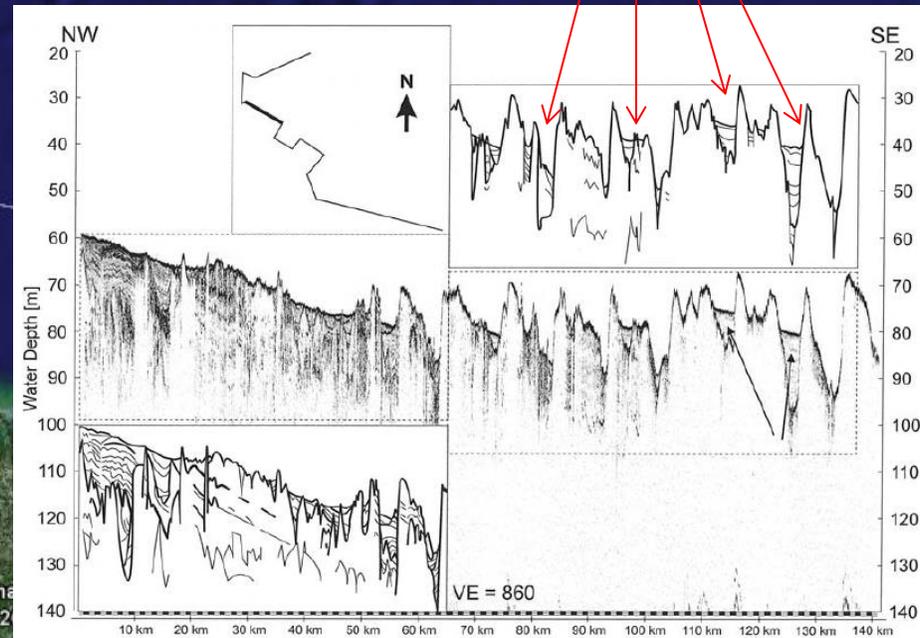


Hübscher, Figueiredo, Kruse and Spieß, 2002

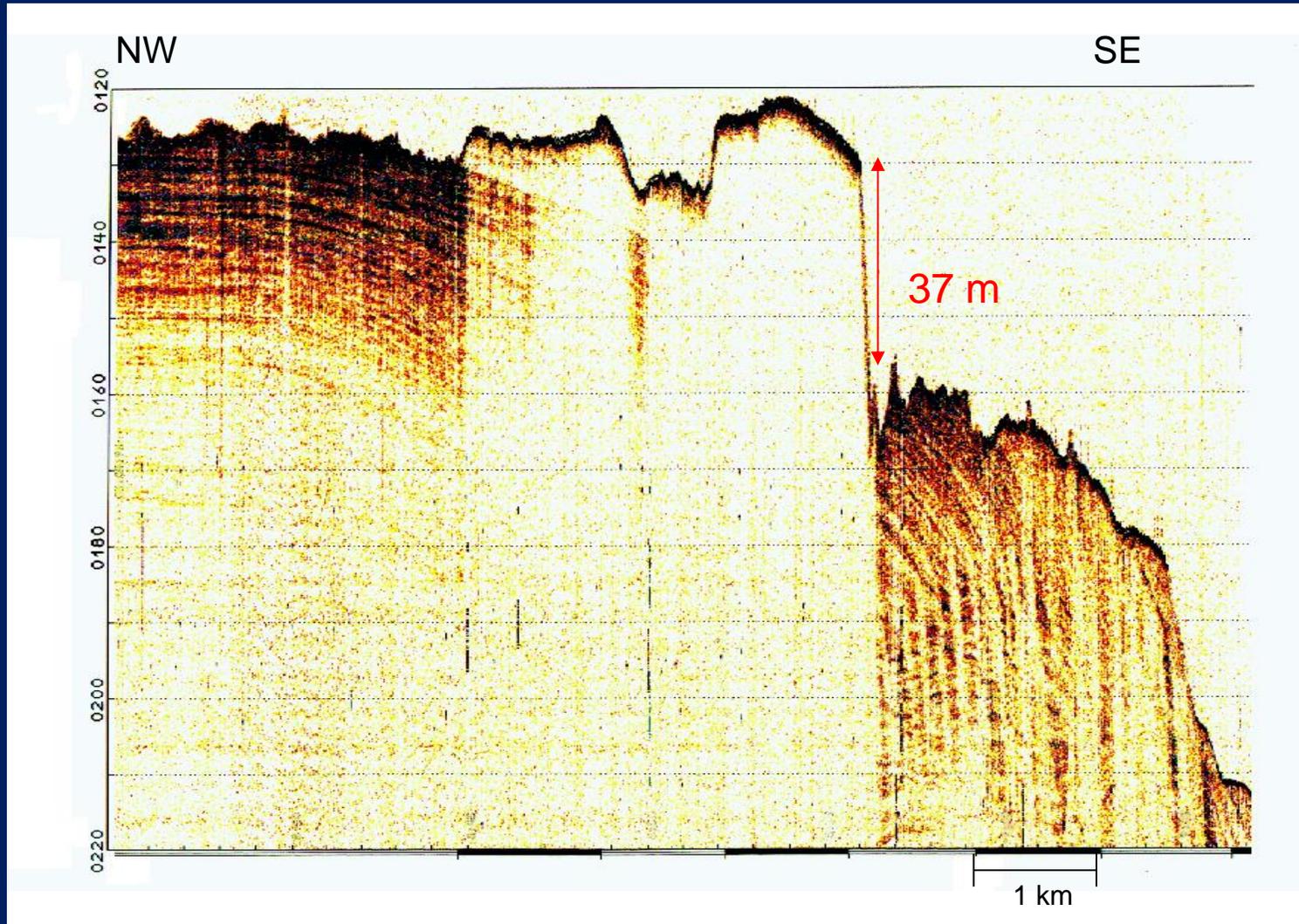
STRATIGRAPHY AND SEDIMENT DISTRIBUTION



Unleveled Inter-ridge Fill
Outer Shelf Tidal Ridges



ARENITO (Beach Rock) NA BORDA DA PLATAFORMA COM CAPEAMENTO DE CARBONATO



Meteor Cruise 34-4, 1996, Parasound System

IDENTIFICAÇÃO DE FUNDO CARBONÁTICO COM A SÍSMICA

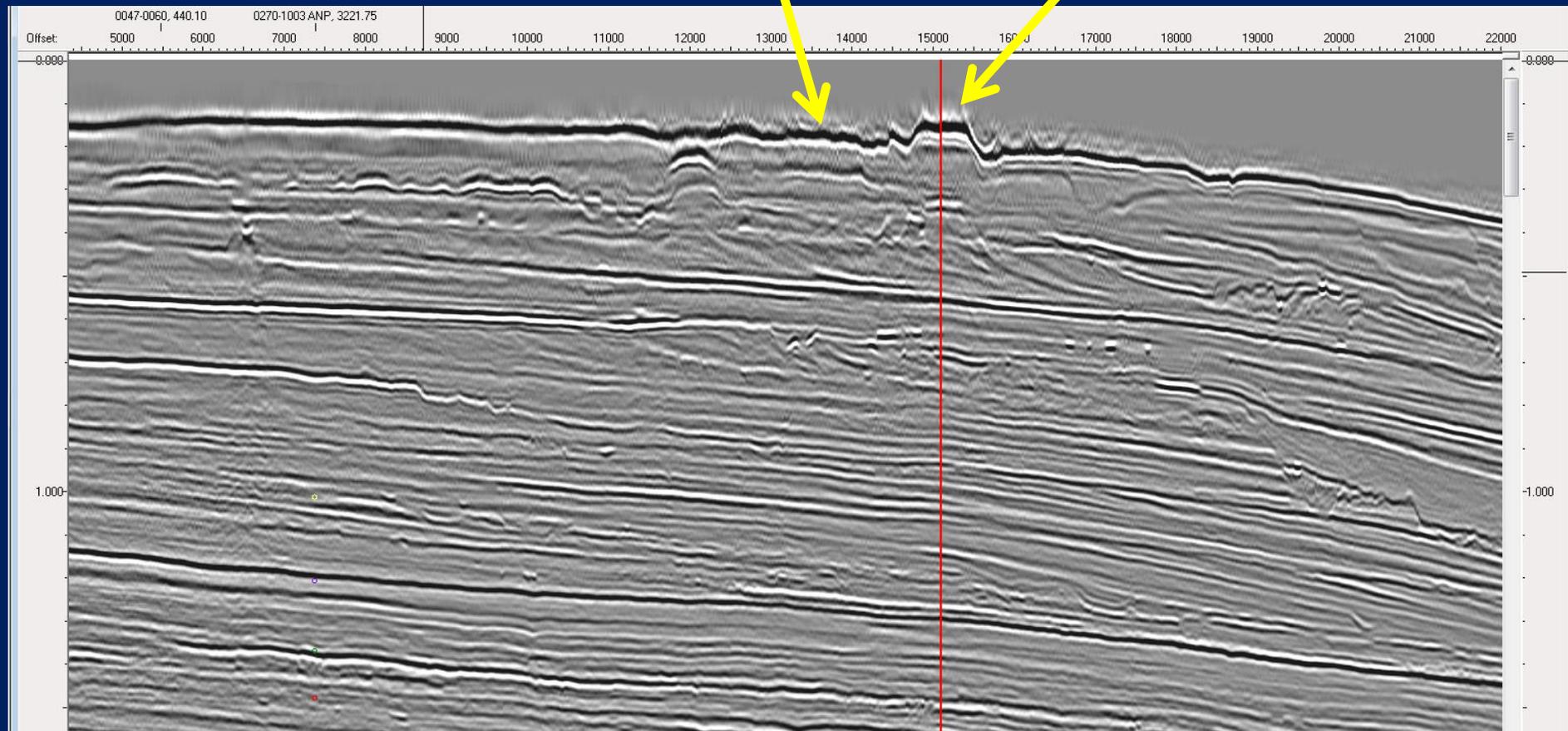
Mapa de Linhas Sísmicas 3D



SEISMIC LINE CROSSING THE REEF

Caráter de Eco Típico de Superfície Carbonática

Arenito capeado com carbonato



DISTRIBUIÇÃO SEDIMENTAR

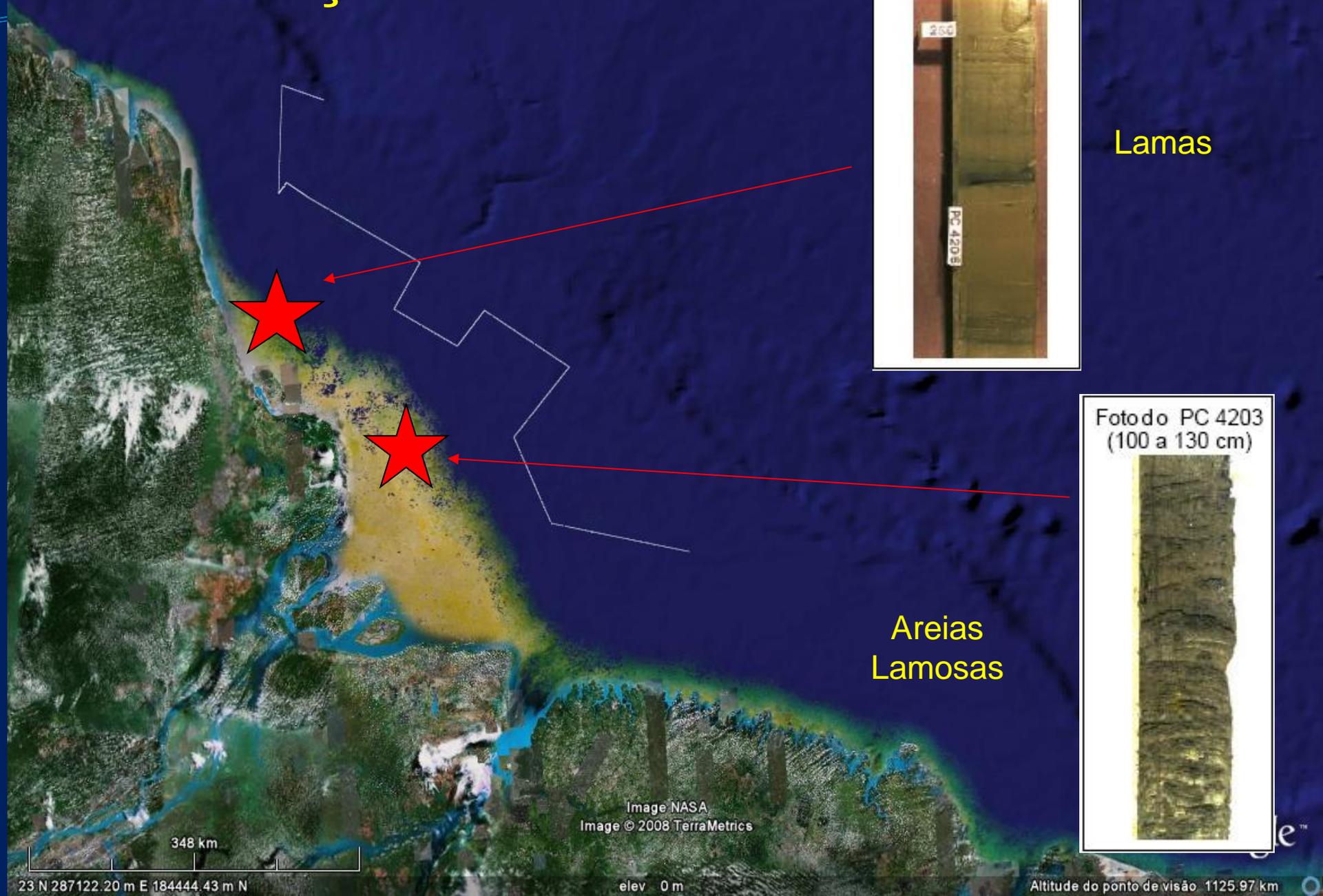


FOTO do PC 4206
(250 a 280cm)



Lamas

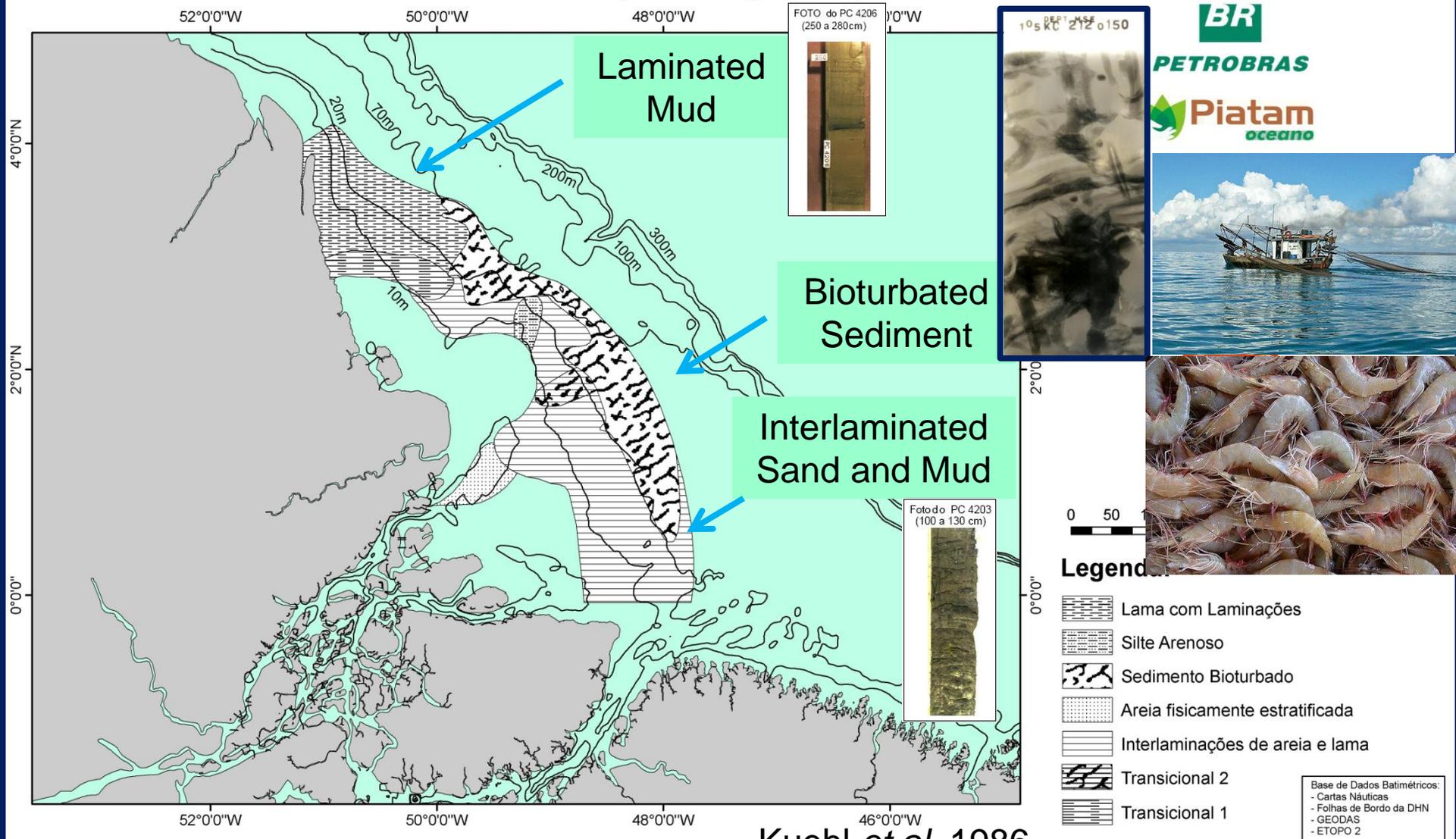
Foto do PC 4203
(100 a 130 cm)



Areias
Lamosas

X-RAY RADIOGRAPHY FACIES

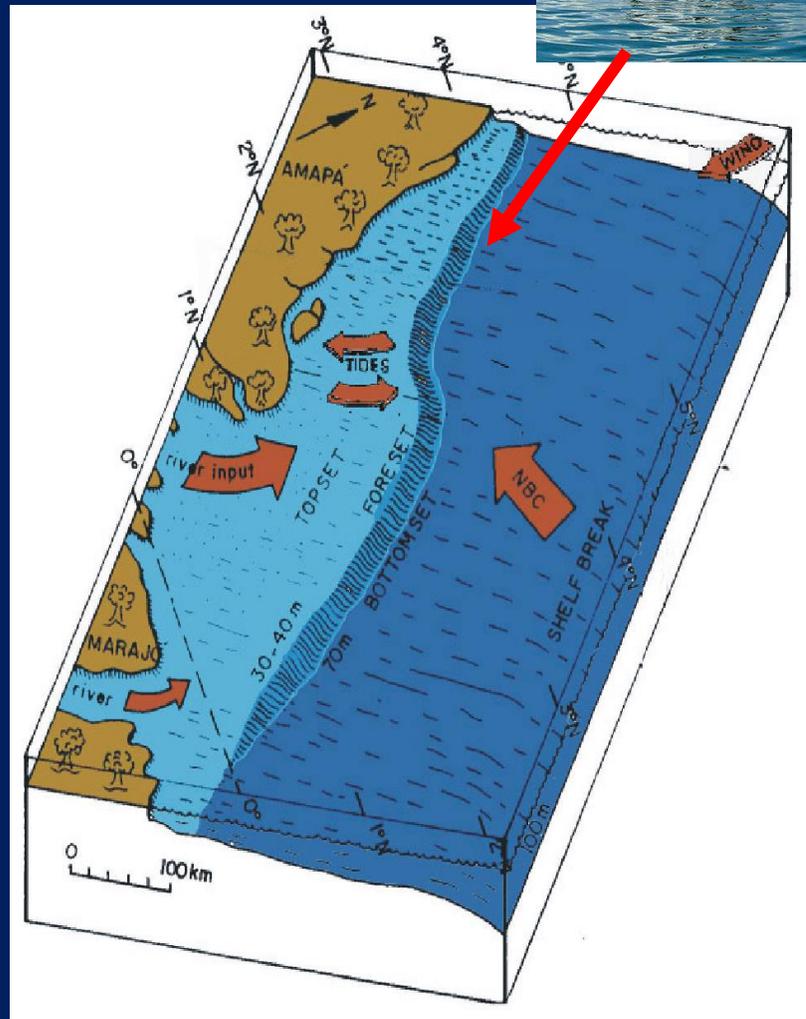
Fácies Sedimentares (Radiografia)



Kuehl *et al.* 1986

Kuehl *et al.* (1986)

A LAMA DO PRODELTA E A PESCA DO CAMARÃO-ROSA



- Os melhores rendimentos são obtidos no período de fevereiro à junho (Aragão, J.A.N. & Cintra, I.H.A., 2015).
- A safra acontece no período das cheias (Paiva et al., 2000)

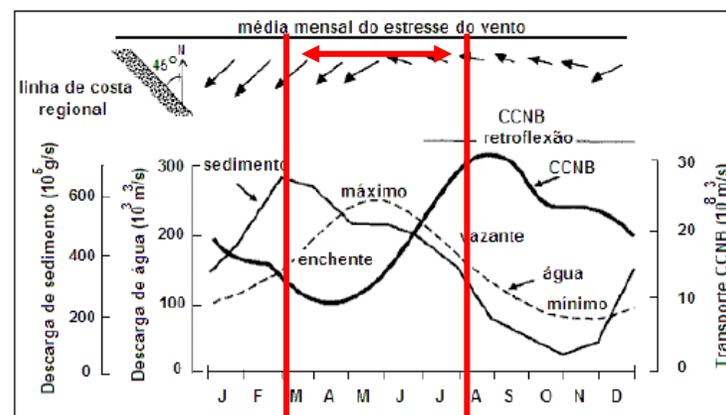


Figura 8. Variação sazonal de fatores que afetam a sedimentação na costa amazônica (Nittrouer et al., 1995).

Mesophotic bioclastic and bioconstructions of the Western South Atlantic Equatorial Margin: Biogeomorphology insights from the Amazon and Semi-Arid Coast Reef Systems.

João Regis dos Santos Filho¹

João Victor Moraes da Costa Anjos²

Cleverson Guizan Silva²

Allan Kardec Duailibe Barros Filho³

Gilberto Tavares de Macedo Dias²

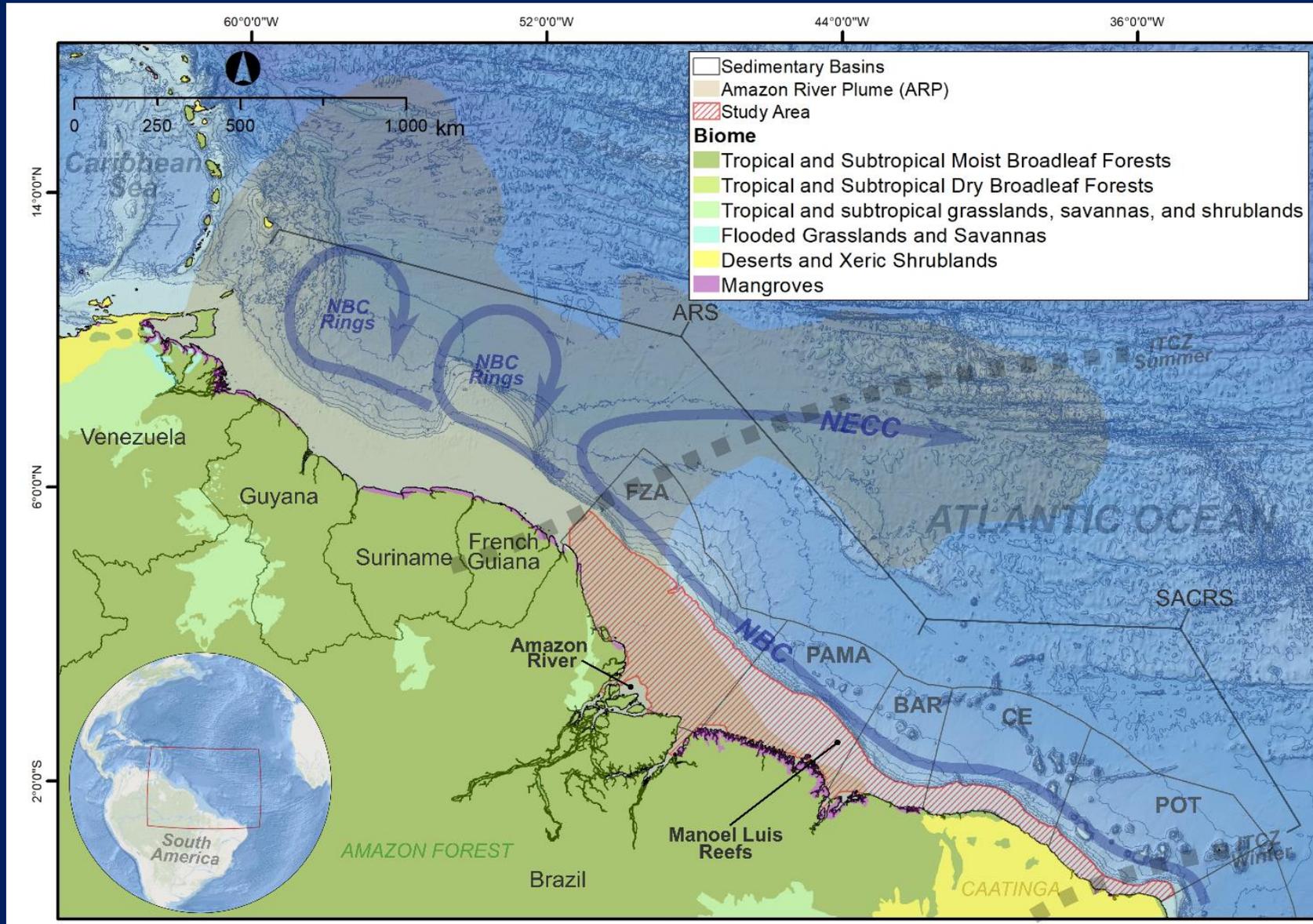
Alberto Garcia Figueiredo Jr.²

Amanda Bourguignon Cecilio²

Juliane Castro Carneiro²

**Manuscrito do artigo submetido à Marine Geology.
Atualmente em revisão dos pares.**

A CORRENTE NORTE BRASILEIRA, SUAS RETROFLEXÕES E VÓRTICES, A PLUMA DE SEDIMENTO DO AMAZONAS



BASE DE DADOS

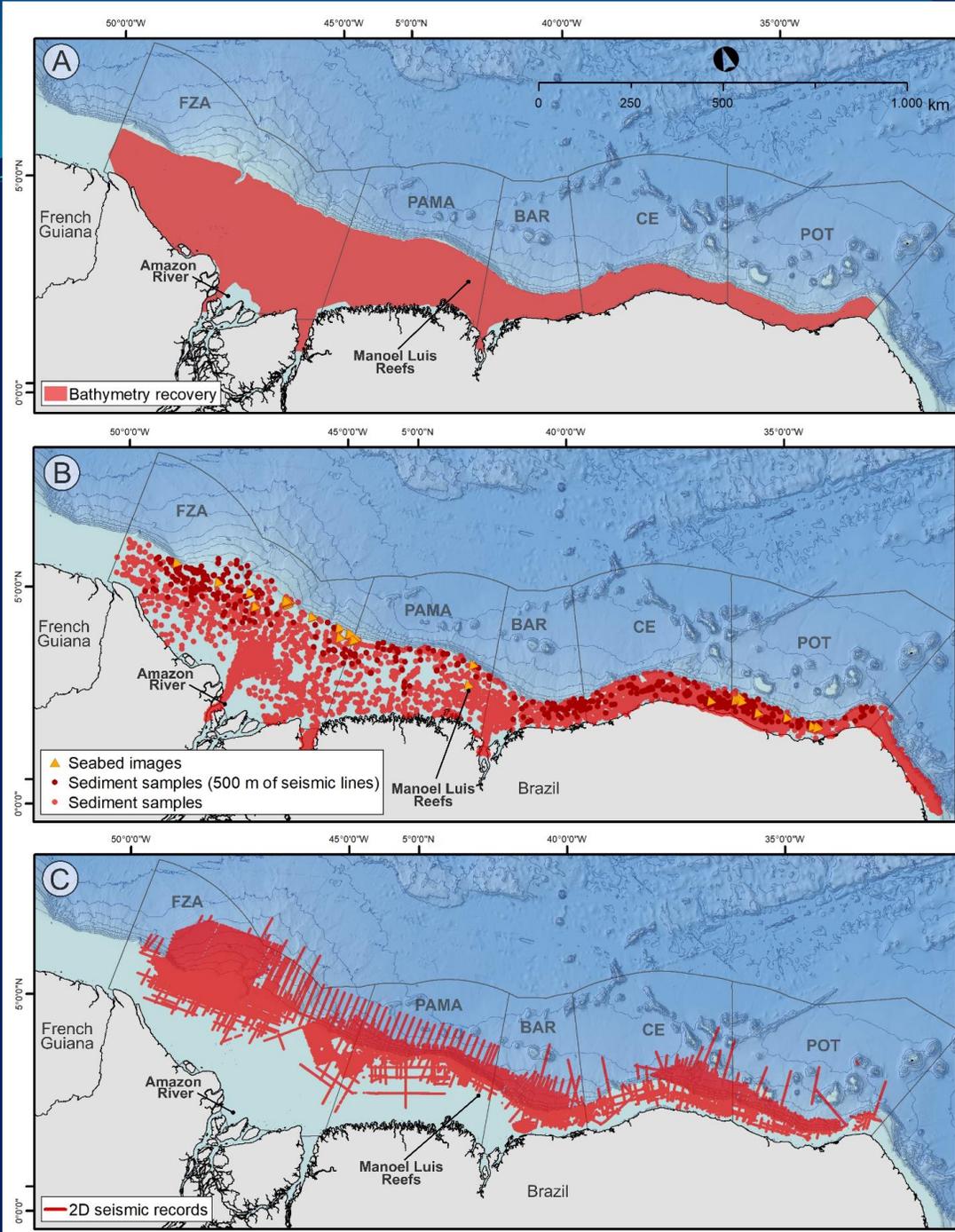
Dados de Batimetria 962.385 pontos

Dados de amostragens de sedimento
5.515 amostras

Imagens de fundo 28 imagens

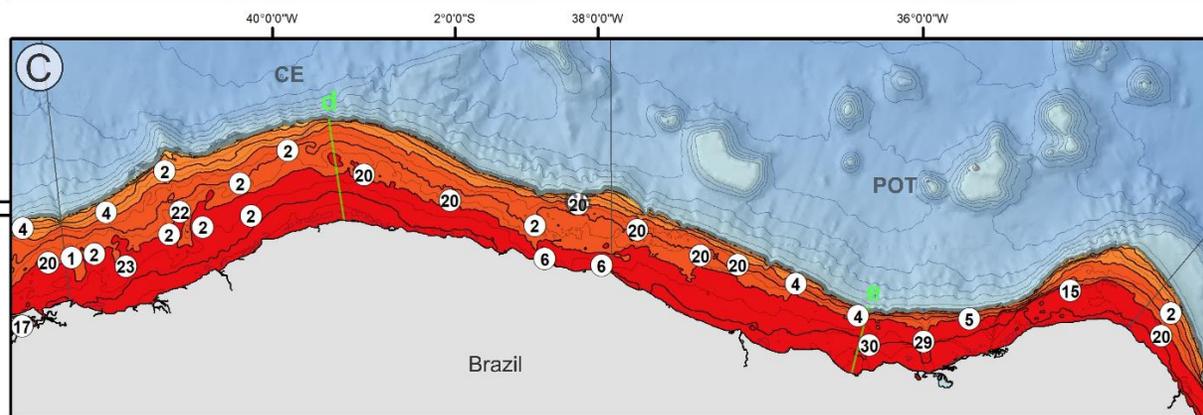
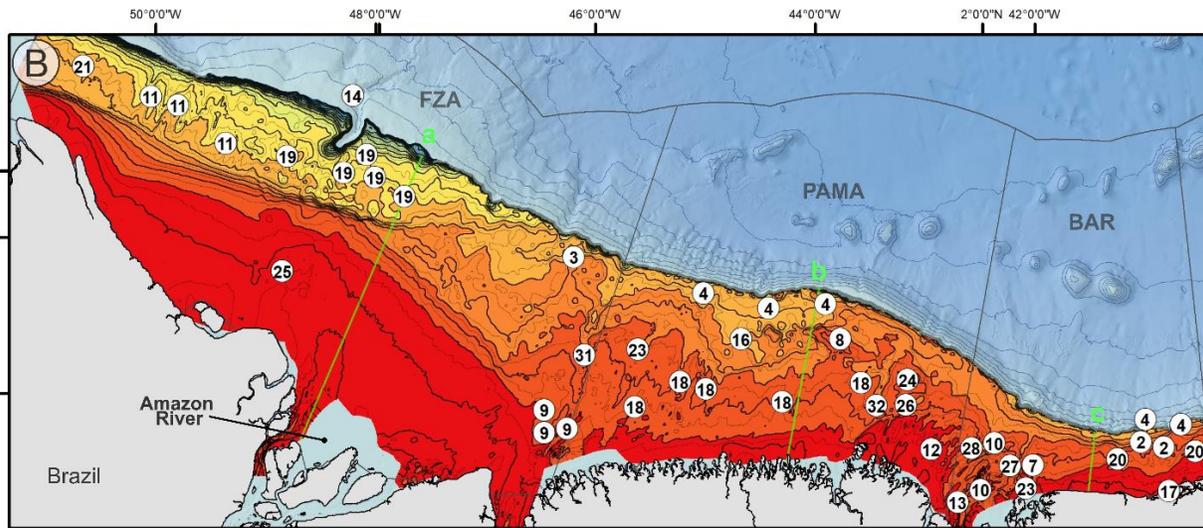
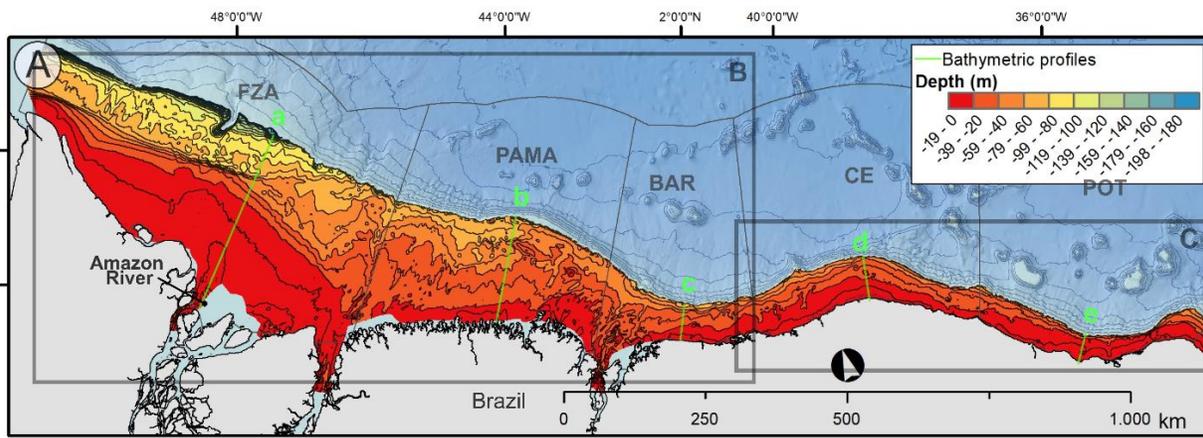
Linhas sísmicas 384 linhas

Santos Filho et al., 2024



GEOHABITATES

Mapa batimétrico



Id	List of Geomorphological Features
1	Incised Valley
2	Elevation
3	Elevation (possibly bioconstructed)
4	Shelf-break Elevation (possibly bioconstructed)
5	Beachrocks
6	Bank
7	Maranhense Depression Bank
8	Álvaro Bank
9	Pará Tidal Banks
10	Golfão Maranhense Banks
11	Wavy Sandy Banks
12	Cururupu Bank Field
13	Golfão Maranhense Channel
14	Amazon Canyon
15	Coroa das Lavadeiras Sand-body
16	Gurupi Platform Delta Edge
17	Paraíba Delta
18	Sand Ribbons
19	Wavy bottom (highly reflective bottom without sub-bottom reflectors)
20	Rough bottom
21	Rough bottom (reflective bottom and discontinuous reflectors)
22	Coreaú River Paleovalley
23	Unidentified paleovalley
24	Manoel Luis Reefs
25	Amazonas Submarine Delta
26	Cururupu Valley
27	São Marcos Valley
28	Cumá Valley
29	Açú submarine Valley
30	Apodi submarine valley
31	Pará submarine valley
32	Turiacu submarine valley

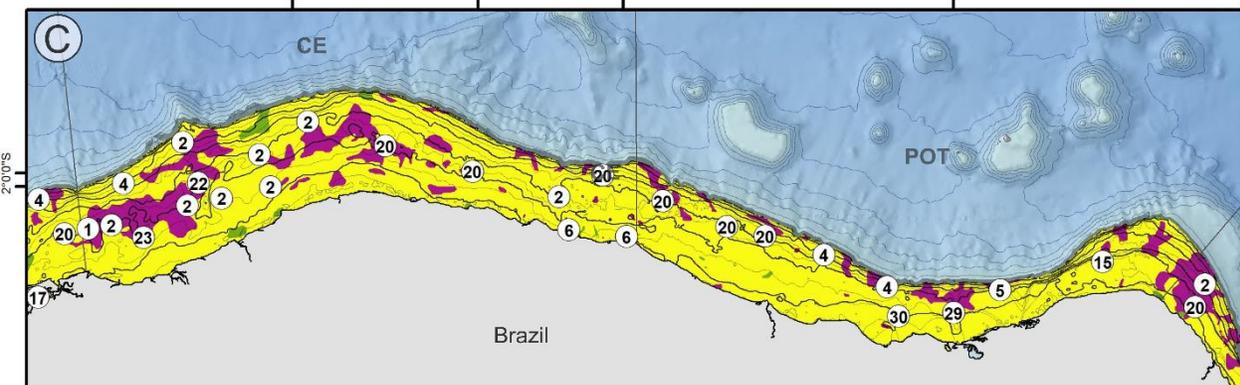
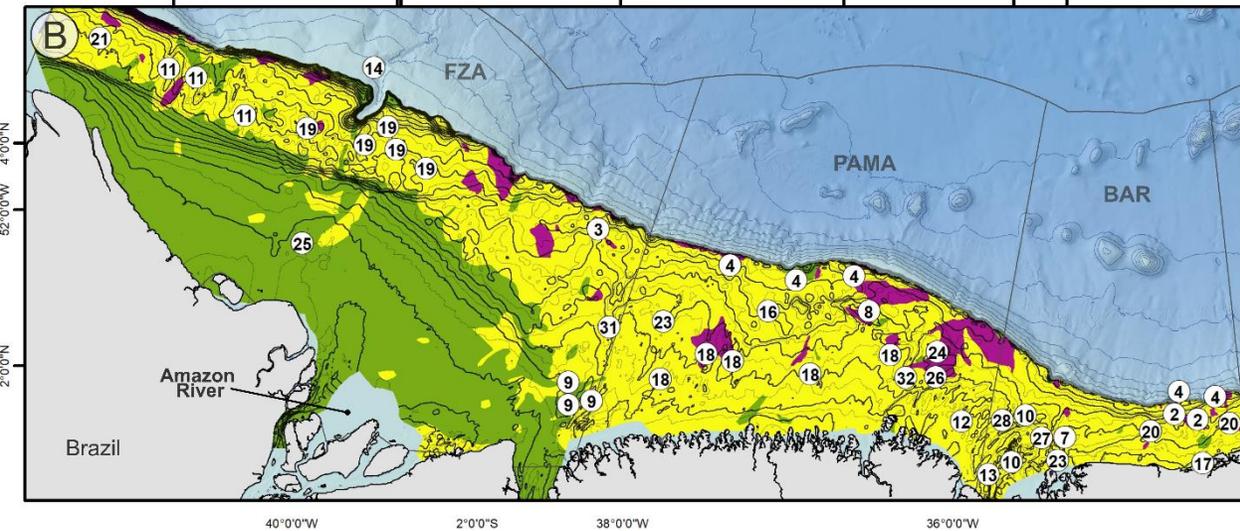
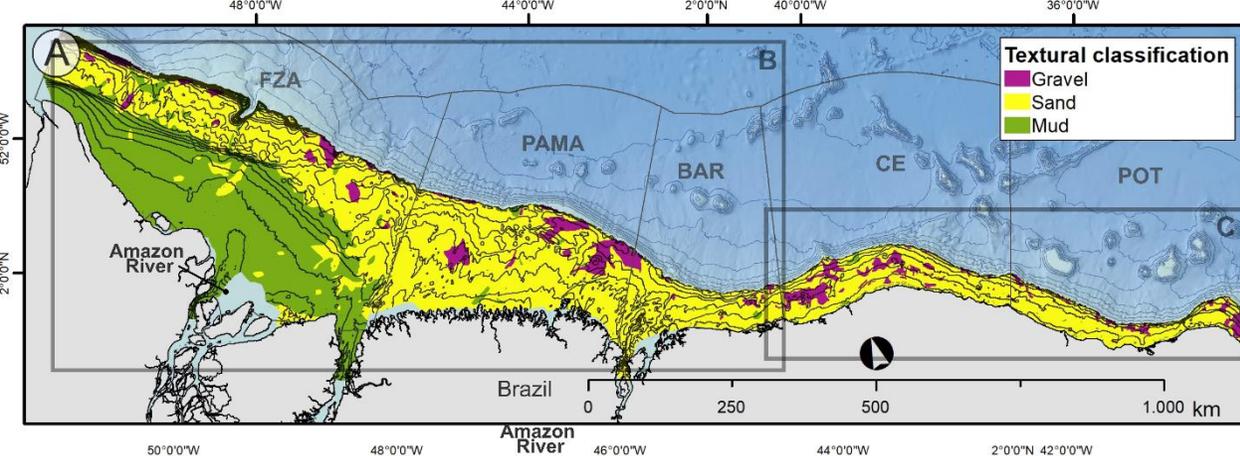
GRANULOMETRIA DO SEDIMENTO

Granulometria dos sedimento com base em 5.515 amostras, imagens de fundo e feições geomorfológicas

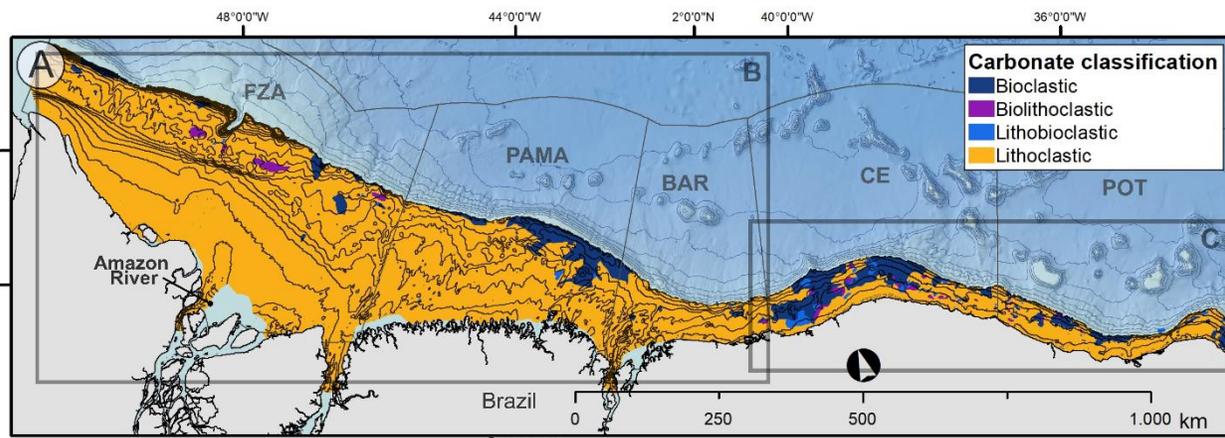
Granulometria dos sedimento nas bacias FZA, PAMA e BAR

Granulometria dos sedimento nas bacias CE e POT

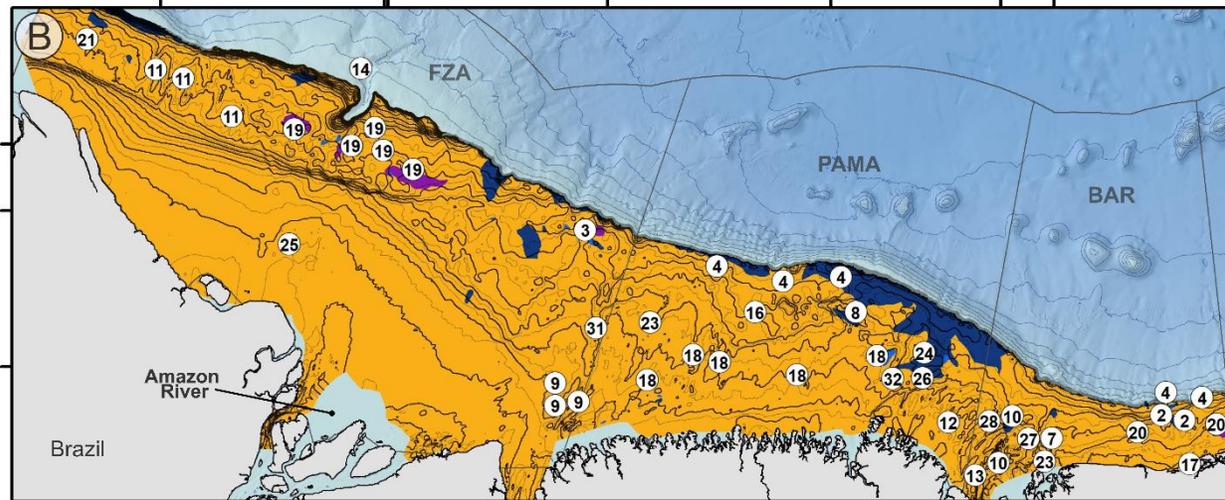
Santos Filho et al., 2024



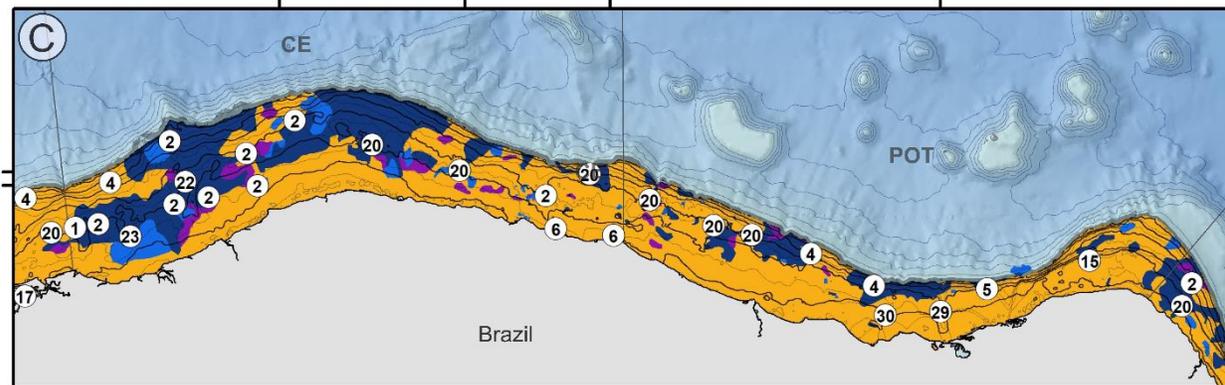
CLASSIFICAÇÃO DO CARBONATO



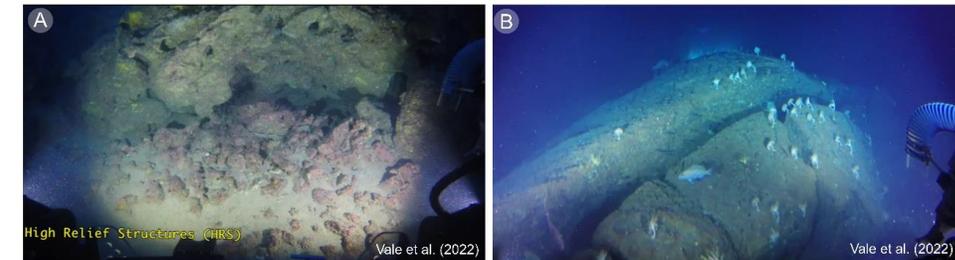
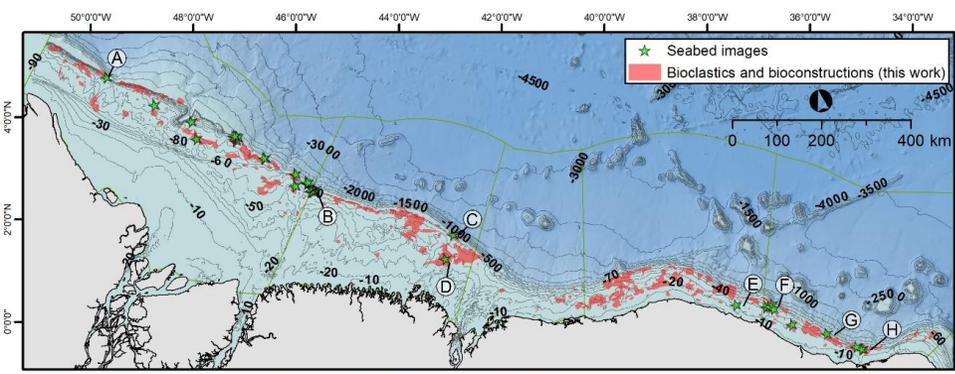
Classificação do carbonato nas bacias FZA, PAMA e BAR



Classificação do carbonato nas bacias CE e POT

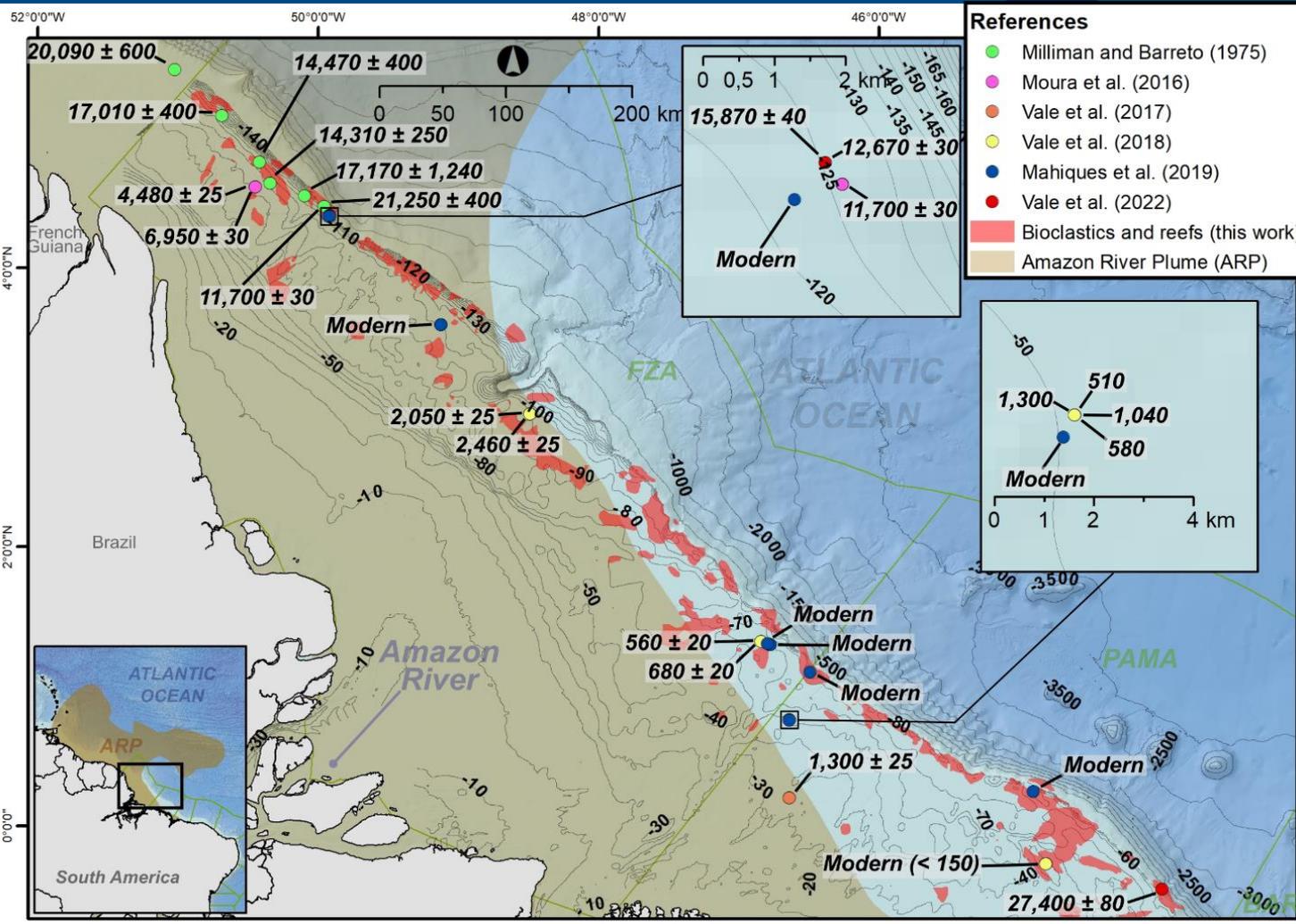


ÁREAS DE SEDIMENTO CARBONÁTICO E IMAGENS DE BIOCONSTRUÇÕES



Imagens provenientes de: Vale et al. (2022), Dias et al. (2021) are shown in D. Carneiro et al. (2022), Silva et al. (2018) and Soares et al. (2018)

IDADES DO SEDIMENTO CARBONÁTICO E POSIÇÃO MÉDIA DA PLUMA DO AMAZONAS





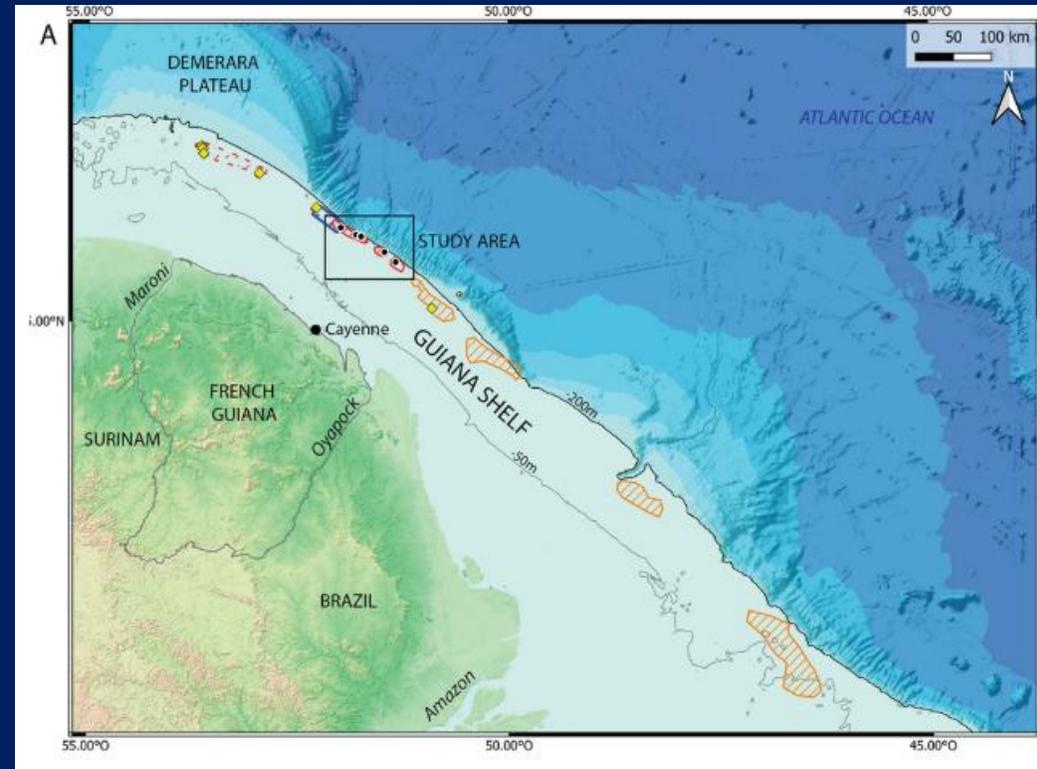
Beachrocks of the last low sea level, substrate of the Great Amazon Reef system along the outer Guiana shelf

Pierre Giresse¹ · Lies Loncke¹ · Arnauld Heuret^{2,3} · François Longueville⁴ · Alexandre Casanova² · Mahrez Sadaoui¹

Received: 11 October 2022 / Accepted: 19 May 2023 / Published online: 29 May 2023
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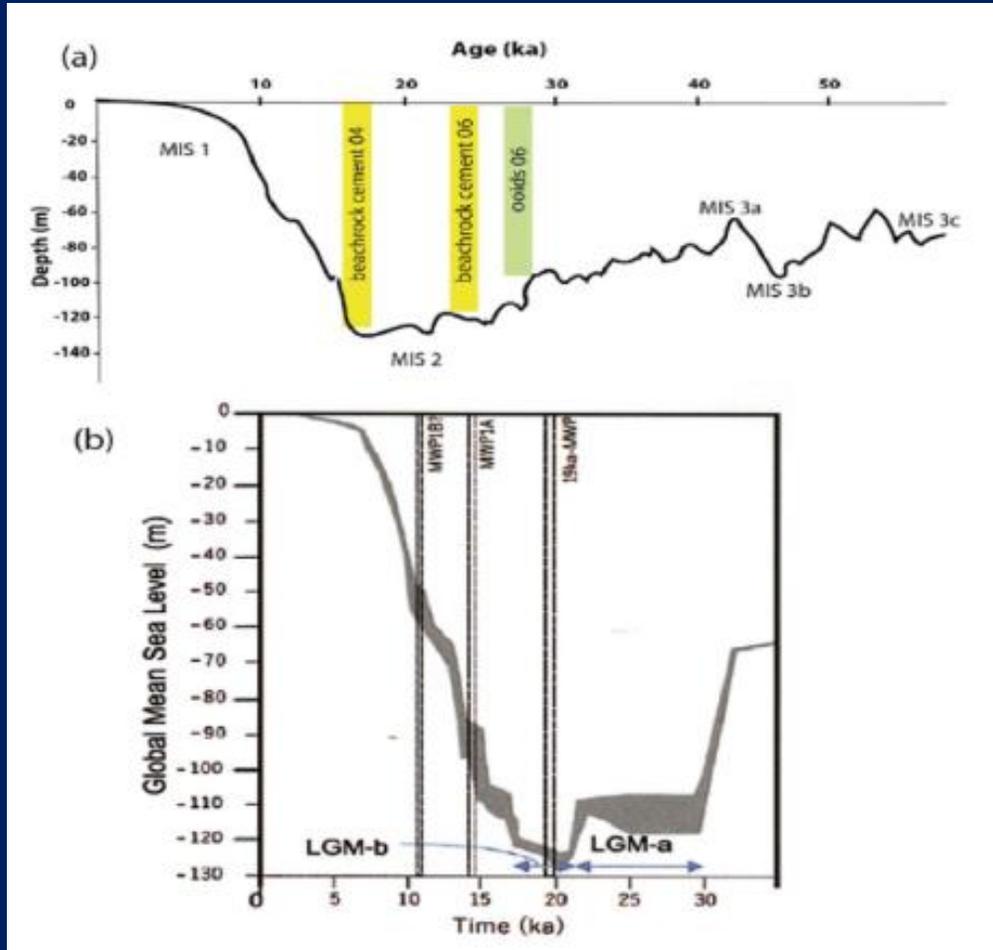
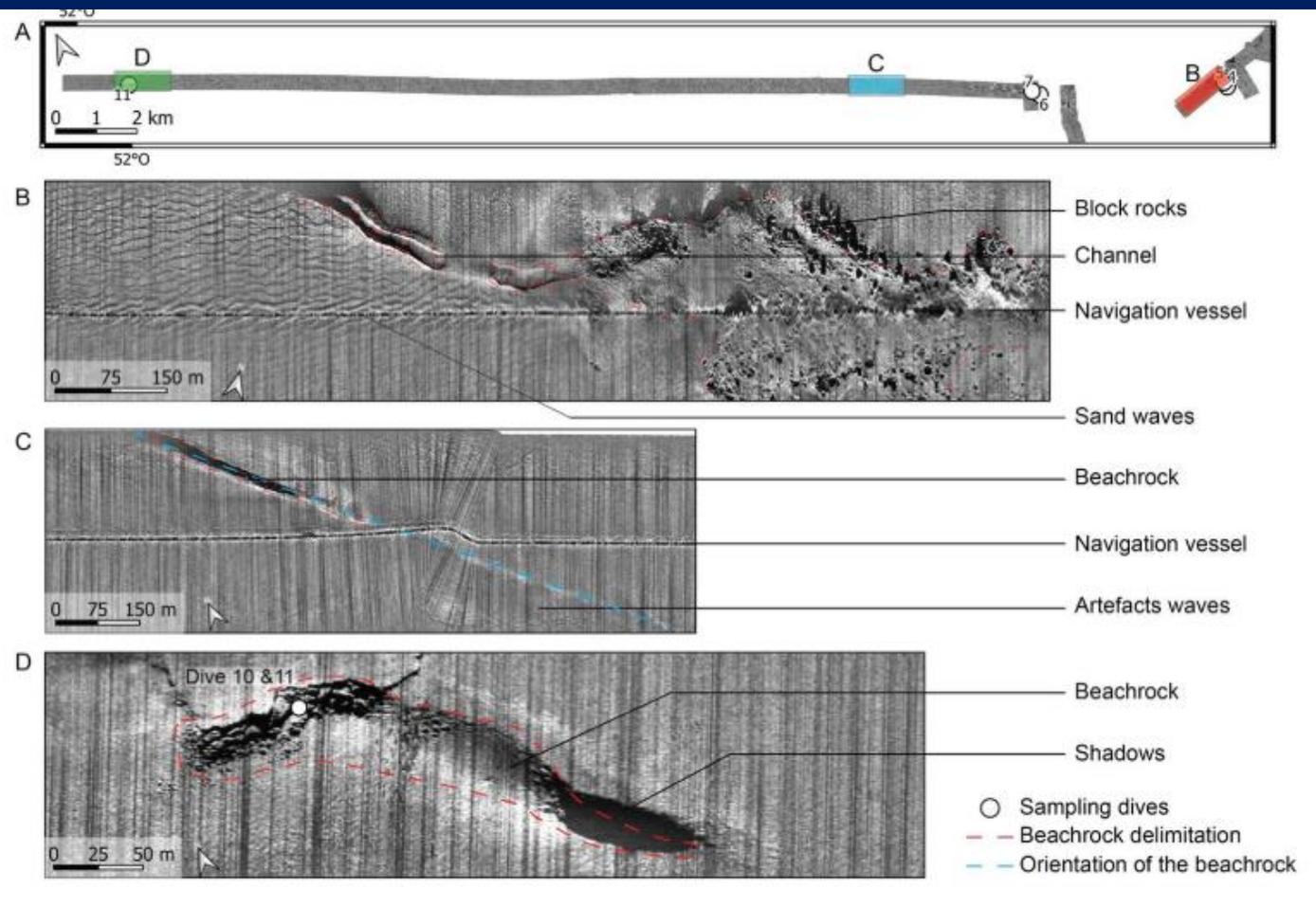
Abstract

The Great Amazon Reef System is a living biogenic mesophotic reef ecosystem that has been recently described along the shelf break of Brazil. An oceanographic cruise was carried out in 2019 along the outer edge of the French Guiana Shelf. A side-scan sonar survey was conducted to locate reef outcrops and allowed twelve in situ 80- to 120-m depth dives and sampling of the reef rocks and peripheral sands. The majority of the hard rocks are composed of biological concretions. However, several fragments revealed the inside presence of sandstone clasts. These clasts, more or less enveloped by biogenic coatings, probably represent destroyed clasts of *underlying or neighboring beachrock banks*. Their dominant cement is micritic



Trabalho recente na Guiana Francesa indicando que a base dos recifes são beachrocks. Assim como ocorre em outras regiões da Margem Brasileira.

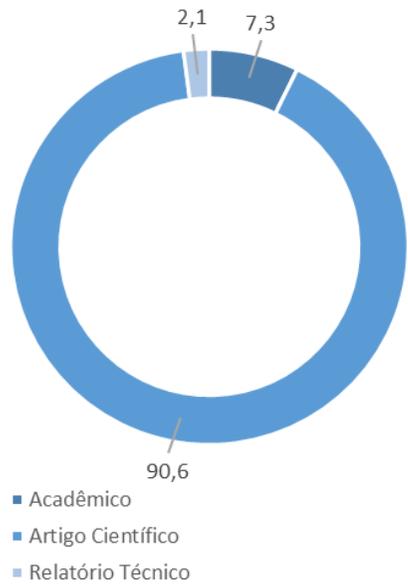
Giresse et al. 2023)



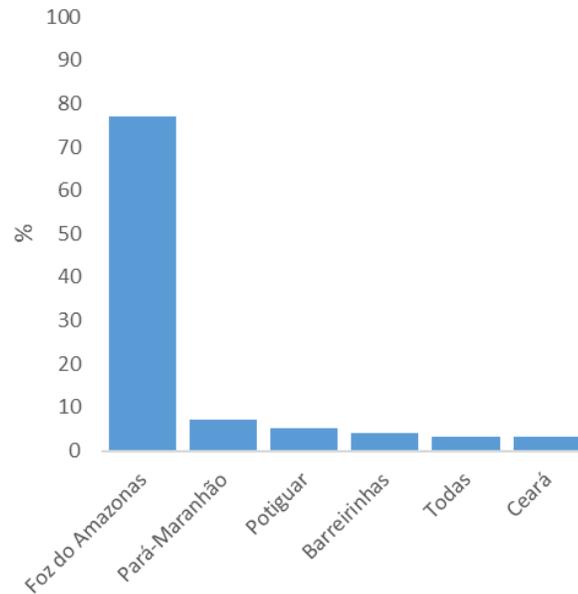
Tais formações se originaram durante a regressão marinha do MIS3 até o Máximo Regressivo do MIS 2. Foram posteriormente afogados e colonizados por organismos incrustantes.

Distribuição Parcial das Publicações em Geologia Marinha na Margem Equatorial Brasileira

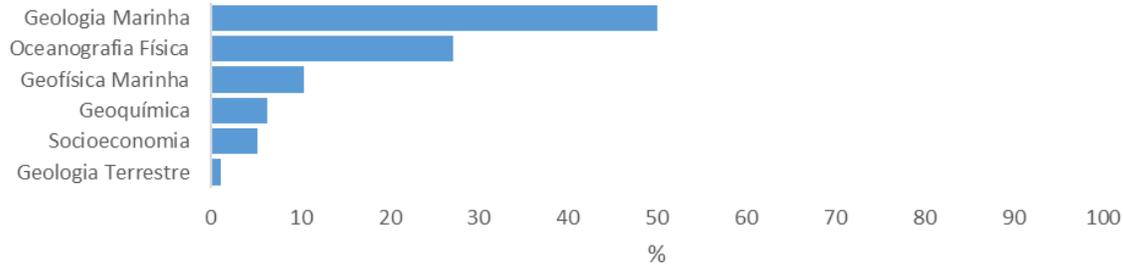
A- Tipo de Publicação (%)



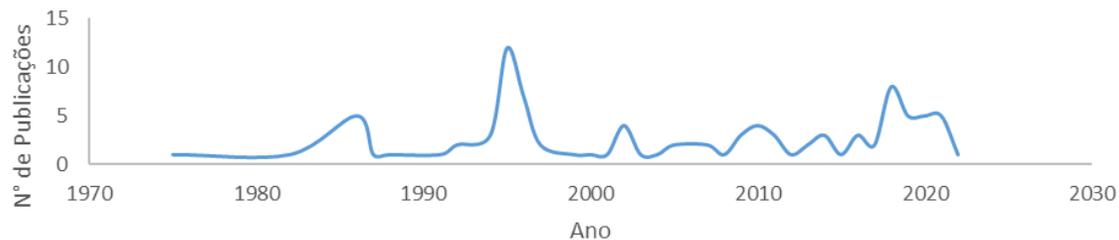
B- Bacias Marginais (%)



C- Tema da Publicação (%)



D- Número de Publicações/Ano



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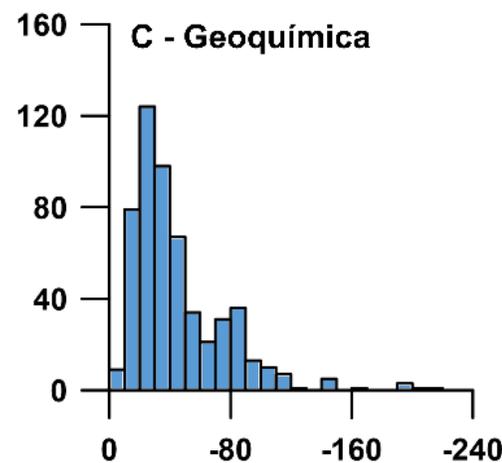
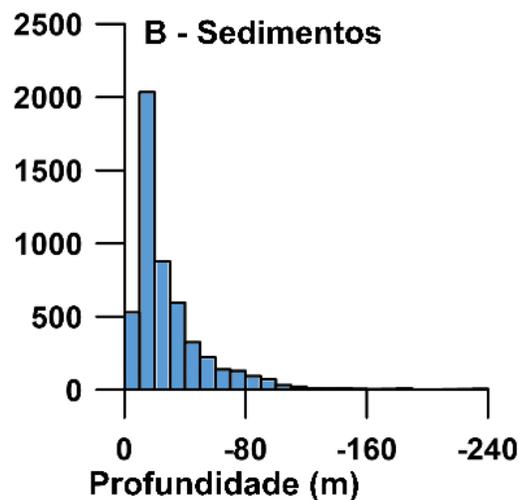
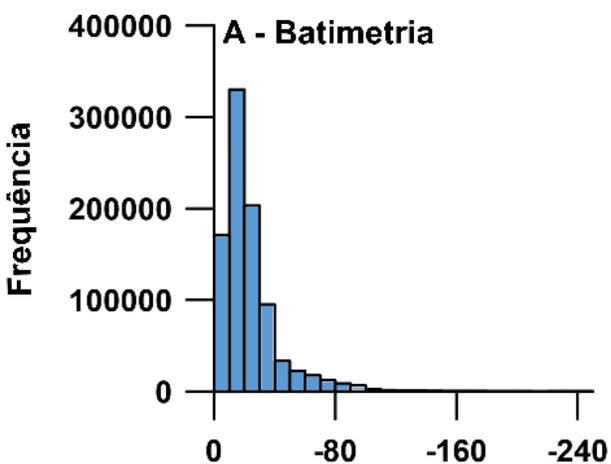
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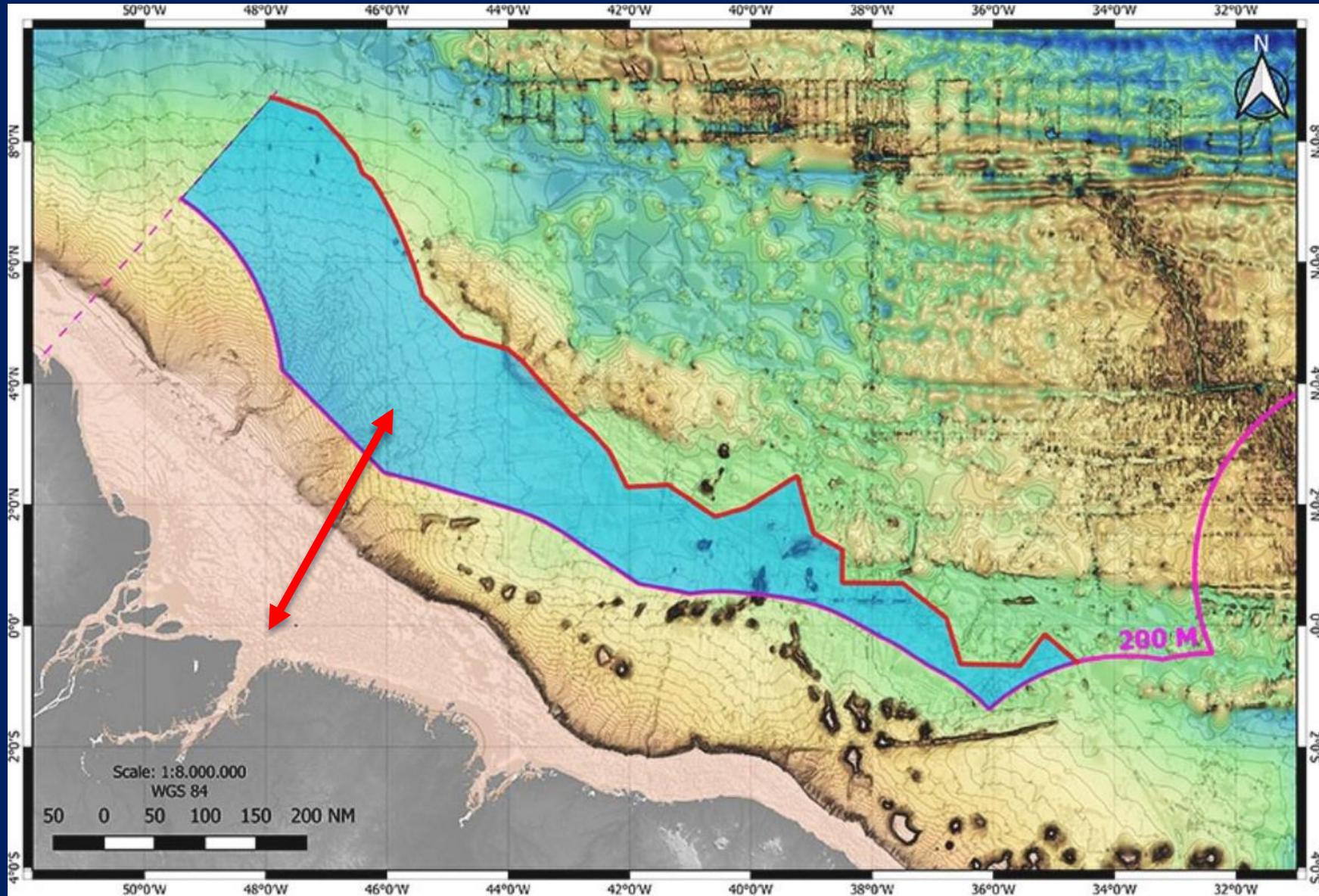


Frequências das profundidades dos pontos de batimetria (A), sedimentos (B) e geoquímica (C)



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NOVOS DESAFIOS NA MARGEM EQUATORIAL COM A APROVAÇÃO DA EXTENSÃO DA PLATAFORMA CONTINENTAL JURÍDICA BRASILEIRA



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