

Code: # 459

Category: 04 - GROUNDWATER FLOW, WATER CYCLE, AND ECOSYSTEMS

# Hydrostratigraphic redefinition of the subsurface from Eastern Amazonian Coast, Brazil: The Marajó Aquifer.

Author: Manoel Imbiriba Junior<sup>1</sup>

Co-authors: Afonso C. Rodrigues Nogueira<sup>2</sup>; Clara Sena<sup>3</sup>; Ana Maria Góes<sup>4</sup>; José Bandeira<sup>2</sup>; Joelson Lima Soares<sup>2</sup>; Laura E. Garzón Rojas<sup>2</sup>; Anna A. Evangelista Nogueira<sup>2</sup>; Roberto E. Kirchheim<sup>1</sup>; Anja Sundal<sup>3</sup>

<sup>1</sup>Geological Survey of Brazil, Brazil. SGB-CPRM.

<sup>2</sup>University Federal of Pará, Brazil.

<sup>3</sup>University of Oslo, Norway.

<sup>4</sup>University of São Paulo, Brazil.



SECRETARIA DE  
GEOLOGIA, MINERAÇÃO  
E TRANSFORMAÇÃO MINERAL

MINISTÉRIO DE  
MINAS E ENERGIA



UiO : University of Oslo



47<sup>TH</sup> IAH  
CONGRESS  
BRASIL 2021

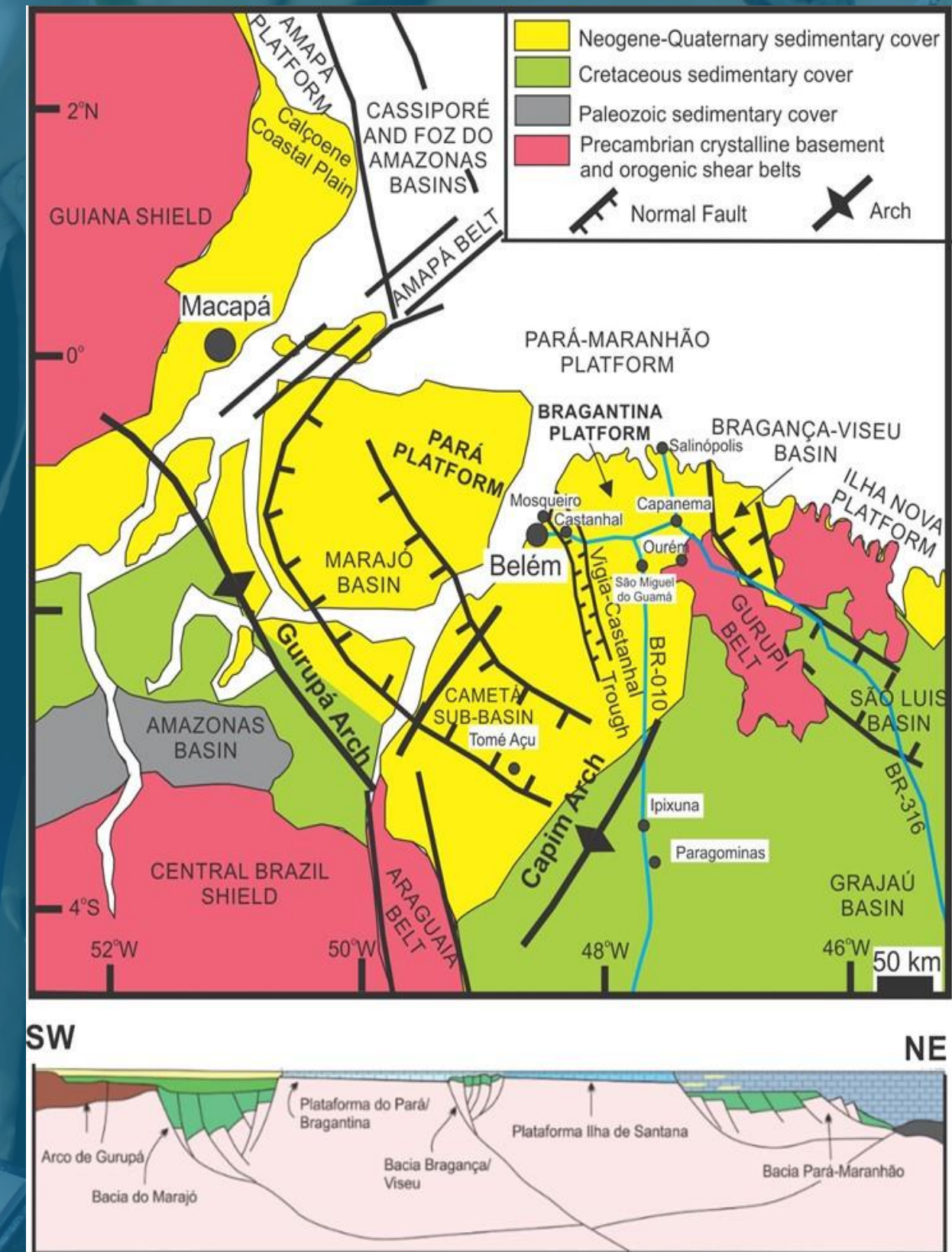


# SUMMARY

- INTRODUCTION
- OBJECTIVE
- METHODS
- RESULTS
- CONCLUSIONS

# INTRODUCTION

• The groundwater from coastal aquifers in the Eastern Amazonia coast has been documented by several research institution as universities from the northern Brazil (UFPA) mainly the geological surveys (SGB-CPRM) and recently with support from USP and UIO (Oslo). Here we characterized the hydrostratigraphy from the coastal aquifers of that region provide information for future research with this emphasis and to assist to future groundwater studies and to verify the natural and anthropogenic impacts in the potable water exploitation. The understanding of the aquifer system in this region pass for a stratigraphic reading in subsurface mapping the lithostratigraphic units with porosity and permeability that characterizes an excellent water reservoir




# OBJECTIVE


- The main objective of this work is understanding of the aquifer system for Eastern Amazonian Coast, considering a new subsurface stratigraphic framework.

Palaeogeography, Palaeoclimatology, Palaeoecology 563 (2021) 110178

Contents lists available at ScienceDirect

 Palaeogeography, Palaeoclimatology, Palaeoecology

journal homepage: [www.elsevier.com/locate/palaeo](http://www.elsevier.com/locate/palaeo)



Review Article

Upper Oligocene-Miocene deposits of Eastern Amazonia: Implications for the collapse of Neogene carbonate platforms along the coast of northern Brazil

Afonso César Rodrigues Nogueira <sup>a,b,\*</sup>, Kamilla Borges Amorim <sup>a,c</sup>, Ana Maria Góes <sup>d</sup>, Werner Truckenbrodt <sup>a</sup>, Setembrino Petri <sup>d</sup>, Anna Andressa Evangelista Nogueira <sup>a</sup>, José Bandeira <sup>a</sup>, Joelson Lima Soares <sup>a</sup>, Lohan Barbosa Baía <sup>a</sup>, Manoel Imbiriba Júnior <sup>e</sup>, Isaac Salém Bezerra <sup>a</sup>, Camila C. Ribas <sup>f</sup>, Joel Cracraft <sup>g</sup>

<sup>a</sup> Programa de Pós-Graduação em Geologia e Geoquímica, Faculdade de Geologia, Instituto de Geociências, Universidade Federal do Pará, Rua Augusto Corrêa s/no, 66075-110, Belém, PA, Brazil

<sup>b</sup> Research Productivity of CNPq, Brazil


<sup>c</sup> Faculdade de Geociências, Universidade Federal de Mato Grosso, Av. Fernando Corrêa da Costa 2367, 78060-900, Cuiabá, MT, Brazil

<sup>d</sup> Universidade de São Paulo, Instituto de Geociências, 05508-080, São Paulo, SP, Brazil

<sup>e</sup> Hydrogeology and Monitoring, Geological Survey of Brazil, Av. Perimetral, Belém, 66095-904, Brazil

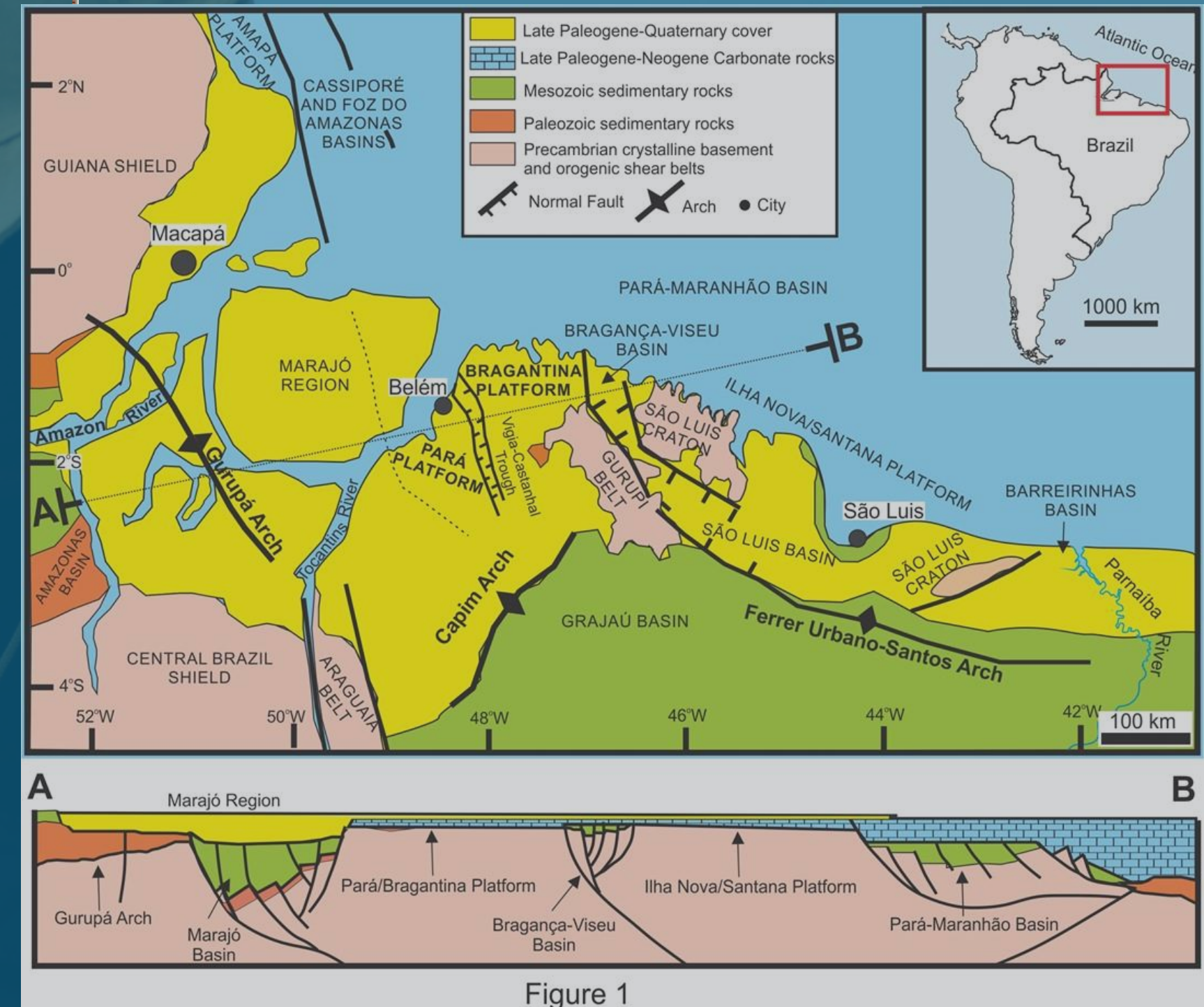
<sup>f</sup> Coordenação de Biodiversidade, Instituto Nacional de Pesquisas da Amazônia, Manaus, AM, Brazil

<sup>g</sup> Department of Ornithology, American Museum of Natural History, New York, NY, USA



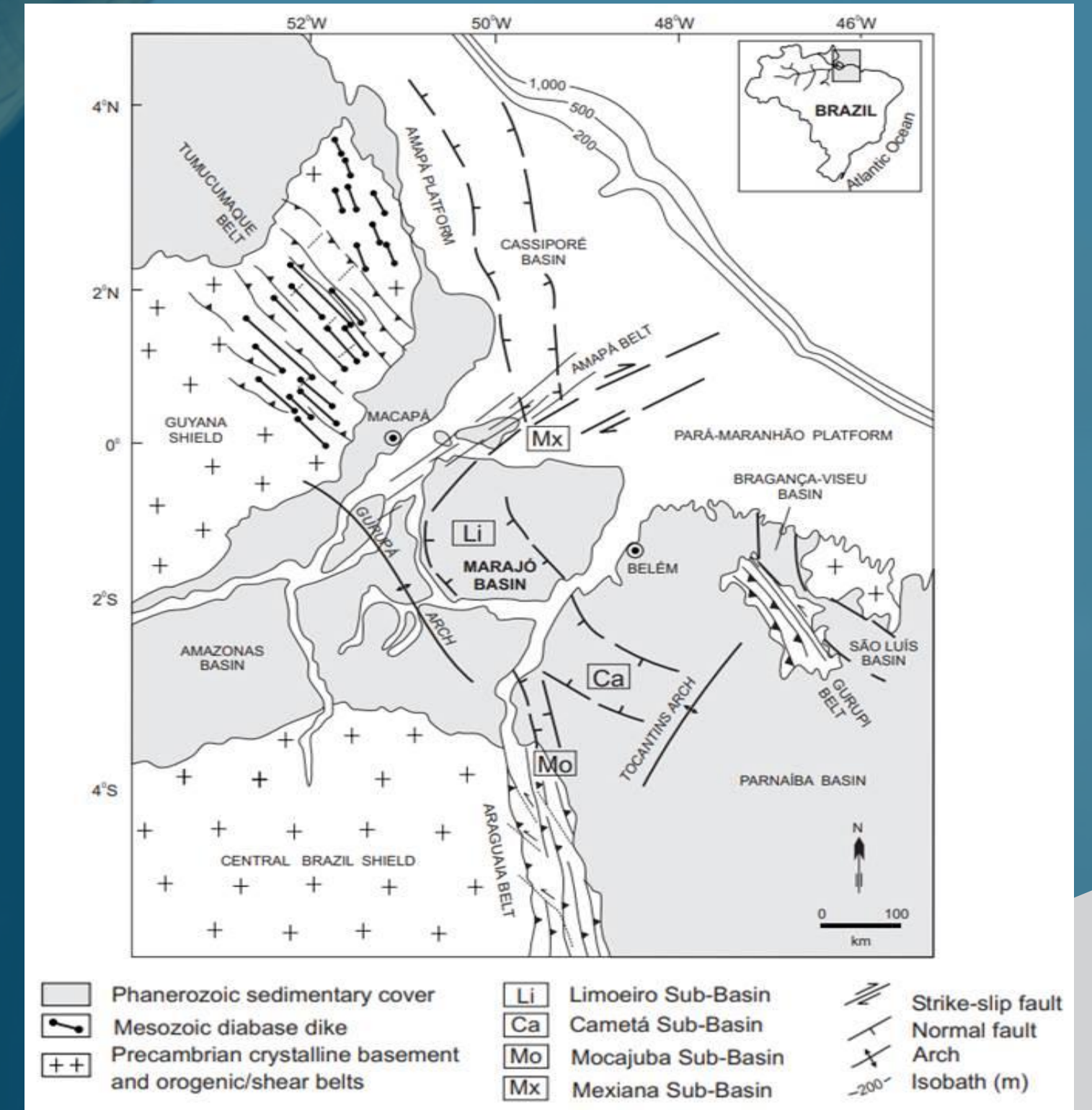
# Geology and Tectonic of the Eastern of Amazonian Coast

- Previous works about the hosted rocks of these aquifers have considered the Mesozoic and Neogene deposits and at least basins and tectonic platforms distributed along of Eastern Amazonian Coast. The main segments are the Marajó, Bragança –Viseu, Grajaú and São Luis basins and the Bragantina Platform in the central part of the area (Soares et al. 2007; Nogueira et al. 2021) Other secondary tectonic segment are the Vigia-Castanhal trough, the limit between Eastern Marajó Basin and Bragantina Platform.



# Geology and Tectonic of the Eastern of Amazonian Coast

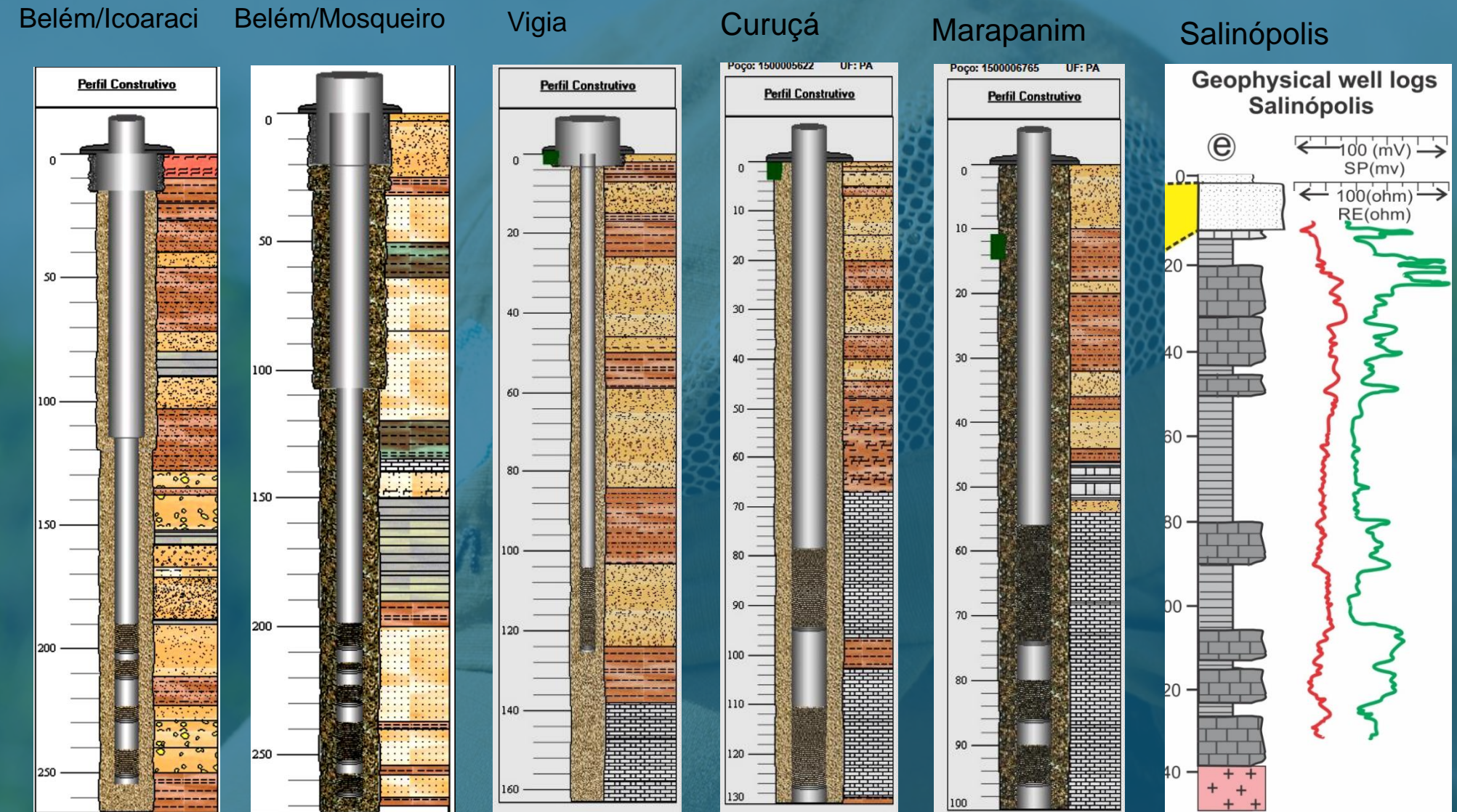
- Paleozoic sediments and basement crystalline rocks occur as windows on the Neogene deposits and large Paleozoic basins represent the southern part of the area. Amazon Basin is found in the East of the area without evolution connection with Cenozoic-Quaternary deposits of Eastern Amazonian Coast. The aquiferous system of these regions has been considered as a unique system hosted in Cenozoic deposits (Matta 2010, CPRM 2000) represented by Oligocene-Miocene carbonate rocks from Pirabas Formation (Maury, 1925, Ferreira et al. Goes et al. 1990) and Middle Miocene siliciclastics deposits from Barreiras Formation (Rossetti et al. 1989).



# METHODS

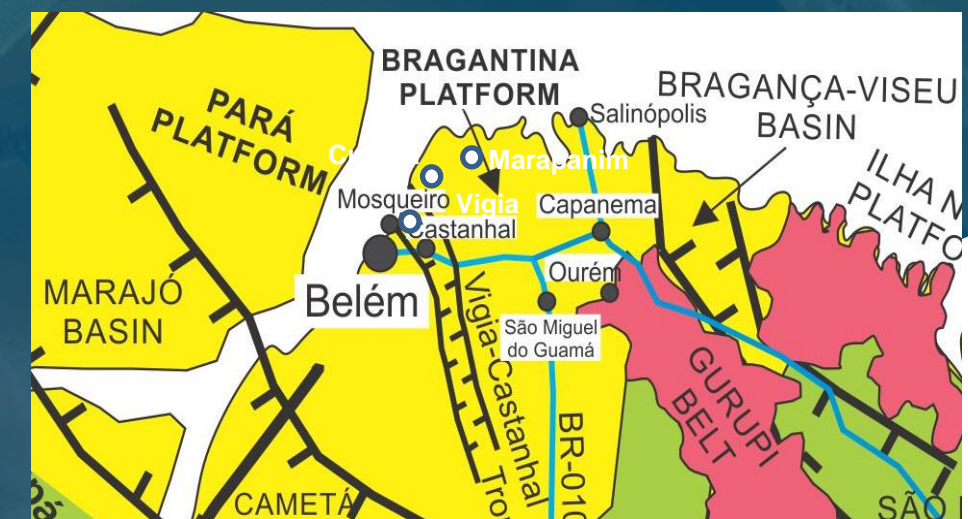
- Lithostratigraphy – The previous description of sedimentary units followed the proposal of Nogueira et al. (2021) where the Miocene Pirabas Formation is restricted to the Bragantina Platform while the correlated unit in the Eastern Marajó basin are the siliciclastic of the Marajó Formation both unit overlaid by Mid-Miocene Barreiras Formation.

- Hydrostratigraphy – The new proposal provide a readjustment of understanding from aquifers system occurrence in the Eastern Amazonia.



## Boreholes from the RIMAS Project

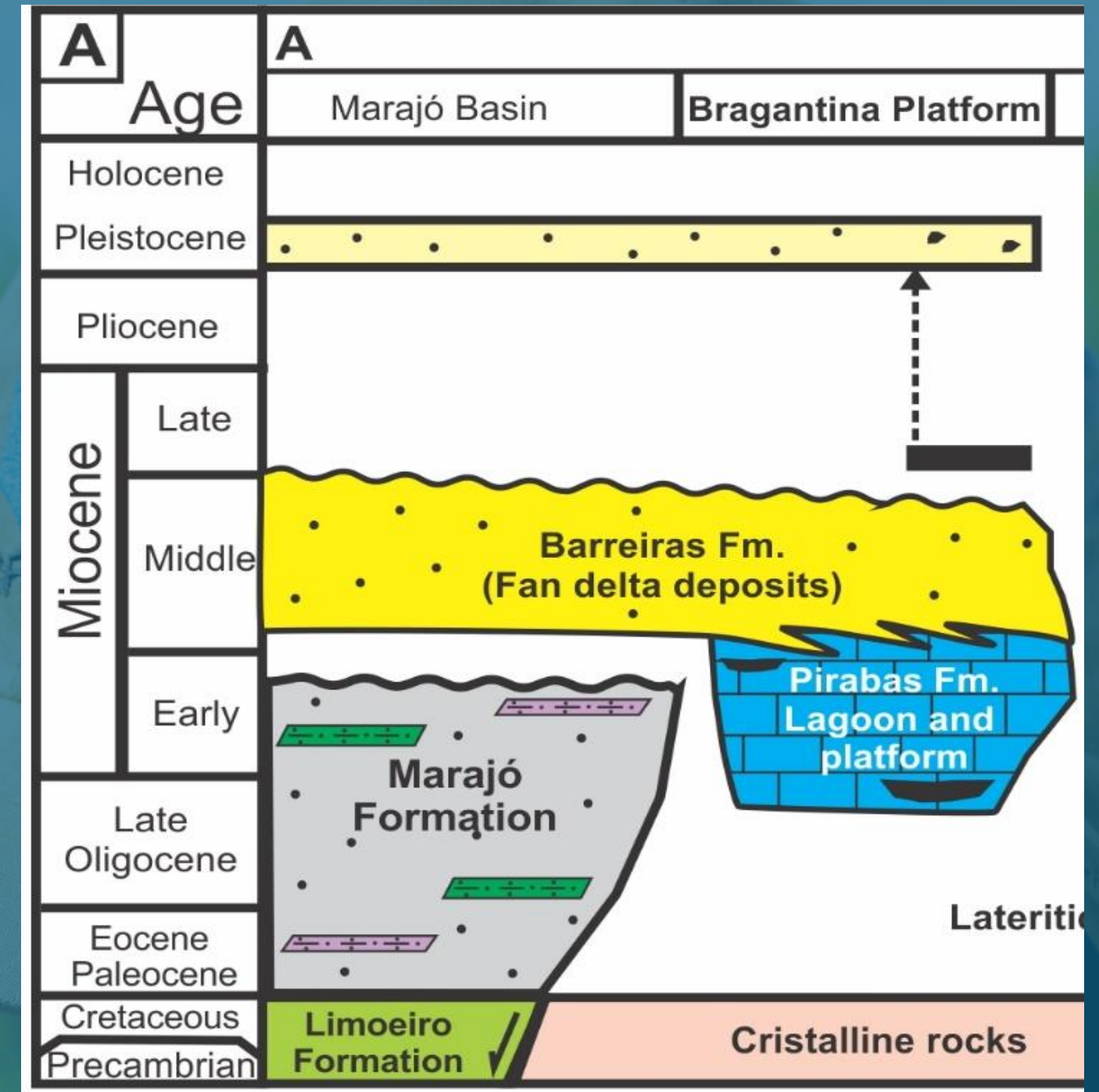
The comparison of boreholes from Eastern Marajó Basin and Bragantina Platform exhibits notable difference between the carbonate and siliciclastic content.



# RESULTS

Following the proposal of Nogueira et al. (2021) the Miocene Pirabas Formation is restricted to the Bragantina Platform and the Marajó Formation (Petri 1954) is the main unit that hosted the aquifers system of the Belem district and are now included in the Eastern Marajó Basin.

The Mid-Miocene Barreiras Formation considered previously as a subsurface unit reaching up to 90m-thick, is in fact, a surface unit with up to 40 m-thick.

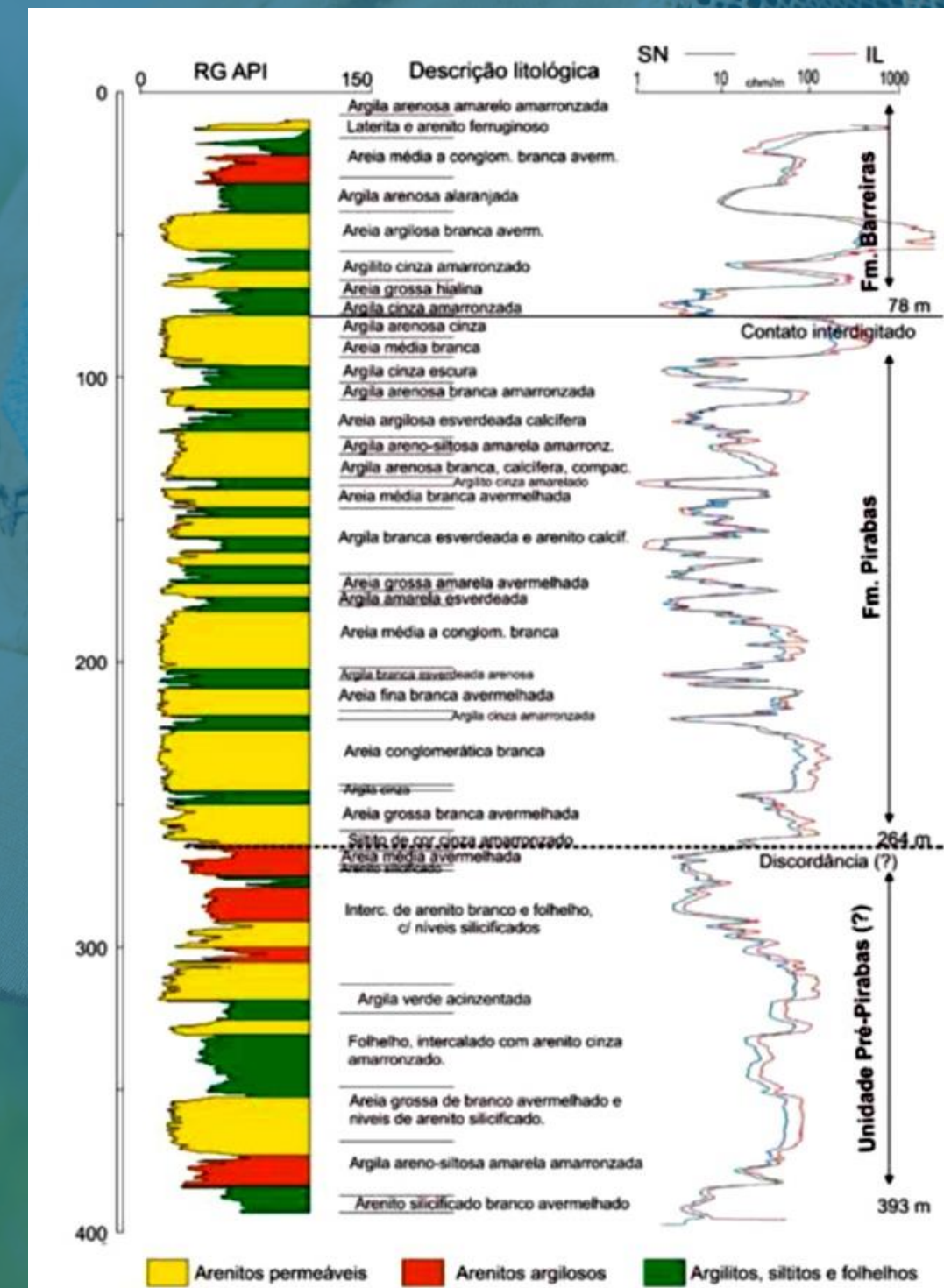



LITHOSTRATIGRAPHY (Nogueira et al. 2021)



# Results

The siliciclastics deposits previously interpreted as Barreiras in subsurface are reinterpreted as Oligocene-Miocene Marajó Formation that reach above 200 m- thick overlaid Cretaceous rocks. The hydrostratigraphy of the Eastern Amazonia coast is now readjusted and modified with strong implications to the understanding of water exploitation in this region.



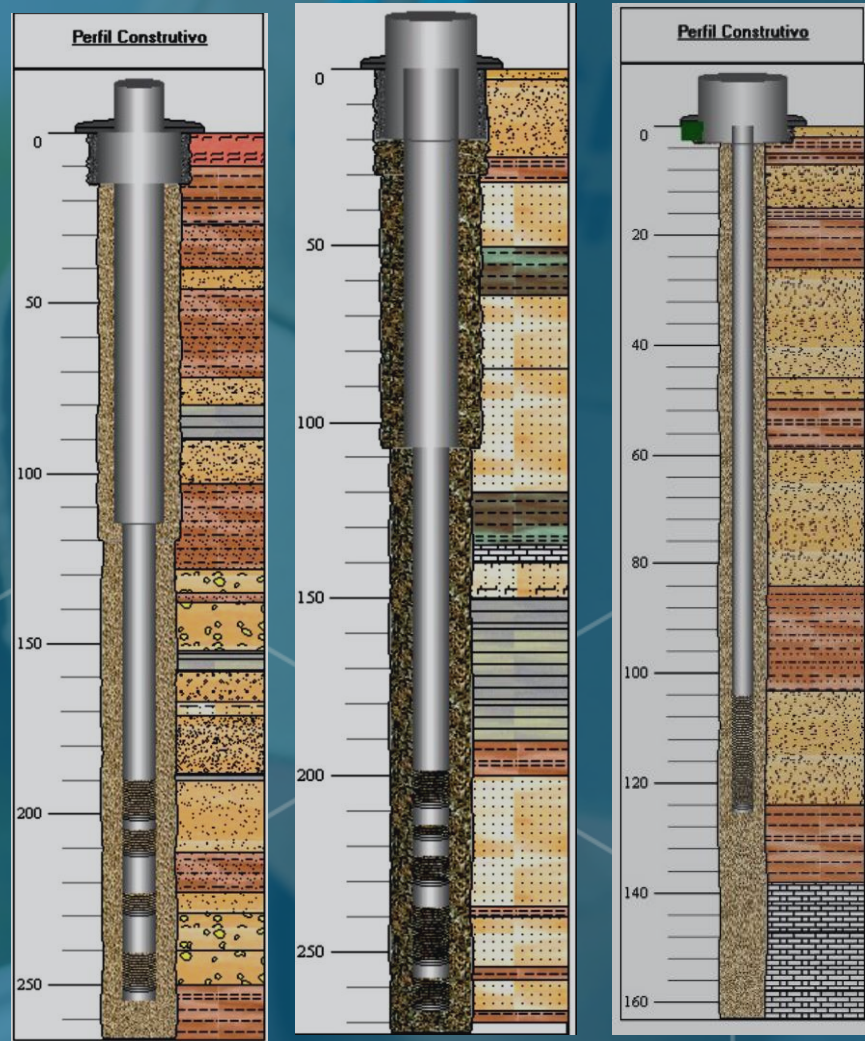
 ANA  
AGÊNCIA NACIONAL DE ÁGUAS

**ESTUDOS HIDROGEOLÓGICOS PARA A  
GESTÃO DAS ÁGUAS SUBTERRÂNEAS  
DA REGIÃO DE BELÉM/PA**

# RESULTS

## EAST EDGE OF MARAJÓ BASIN

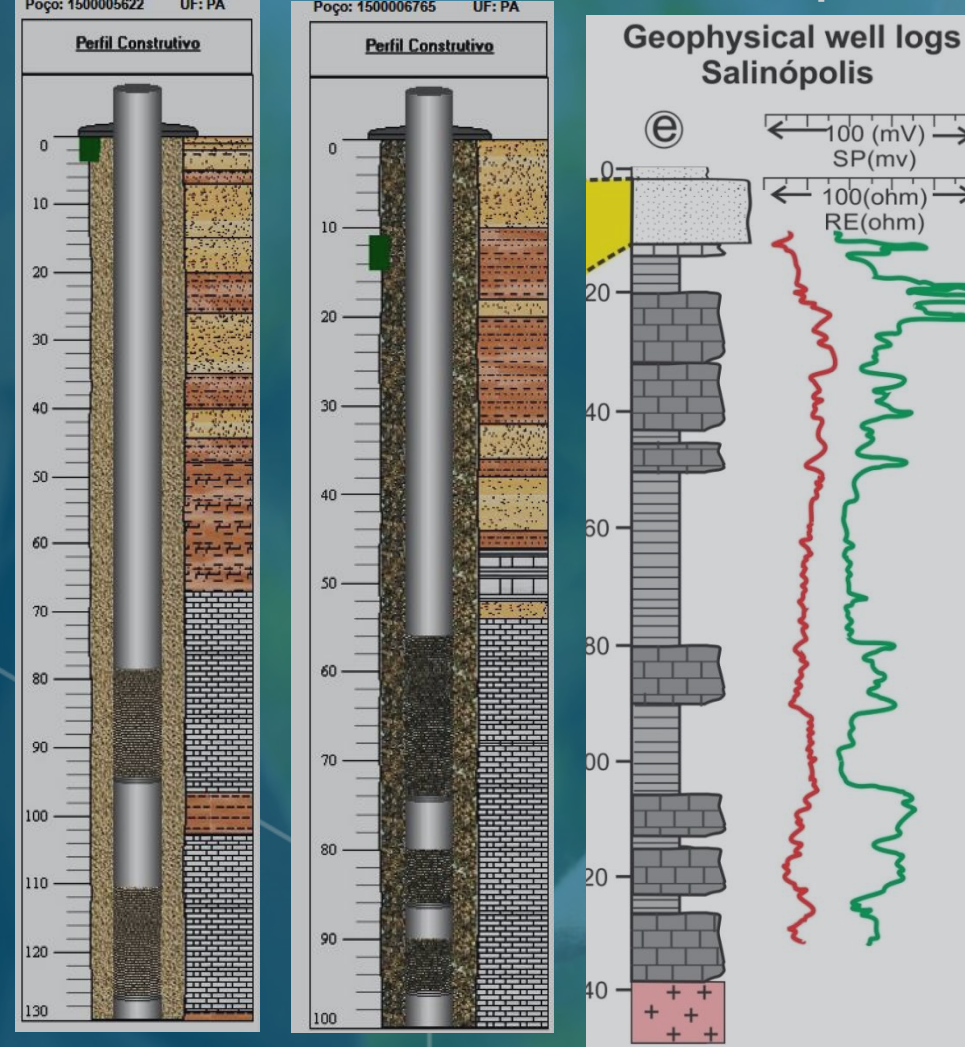
Belém/Icoaraci    Belém/Mosqueiro    Vigia



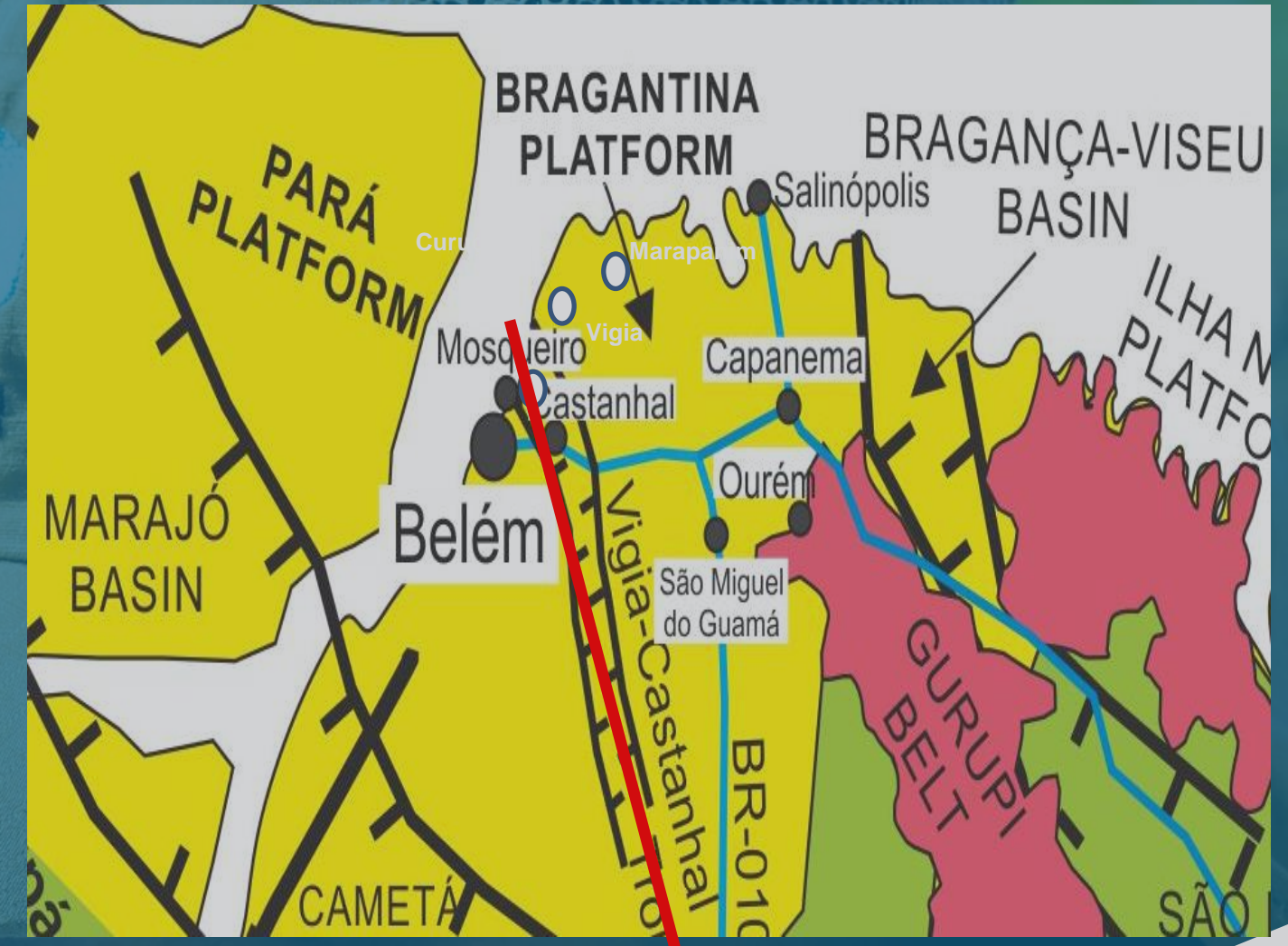
Subsurface: Marajó Formation

## BRAGANTINA PLATFORM

Curuçá    Marapanim    Salinópolis



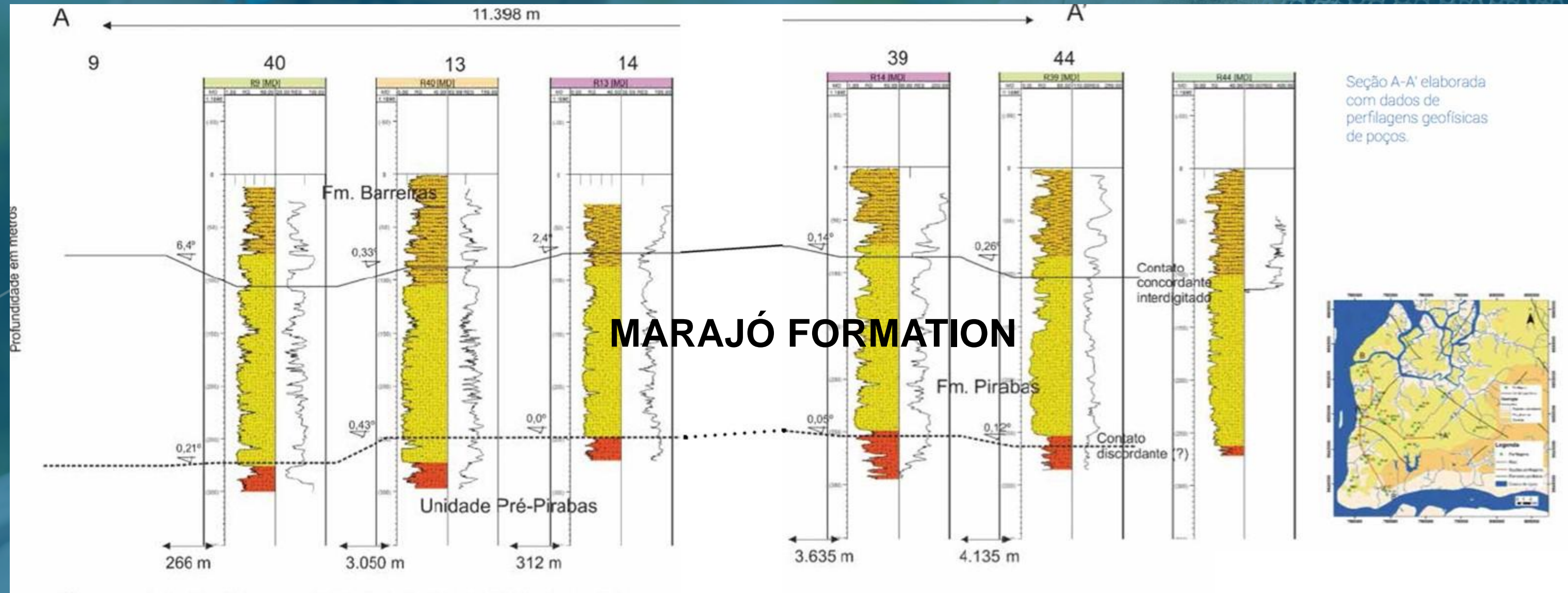
Subsurface: Pirabas Formation



This difference represent the distinct geotectonic compartments from the Eastern Amazonian Coast – The deposition in the Marajó Basin and Bragantina Platform

# RESULTS – IMPLICATIONS FOR HYDROGEOLOGY

- The hydrostratigraphy proposed here allows us to draw new strategies to manage groundwater exploration on the Eastern Amazonian coast and mitigate actions to protect this aquifer's groundwater resources.



# CONCLUSIONS

- The new proposal indicates that the 120 m-thick Pirabas Formation, generally observed below 50m deep in the wells, is restricted to the Bragantina Platform (BP). Their siliciclastic correlate deposits in the Eastern Marajó Graben (EMG) are the Miocene Marajó Formation.
- The 70 m-thick subsurface succession in Eastern Marajó Graben, previously considered Barreiras deposits, is also reinterpreted here as the Marajó Formation, which comprises mudrock and fine- to coarse-grained sandstone.
- The 40 m-thick Barreiras Formation is exposed in the EMG and BP. It does not belong to the Eastern Amazonia coast's aquiferous system, which is now wholly inserted in the Marajó Formation.
- The hydrostratigraphy proposed here allows us to draw new strategies to manage groundwater exploration on the Eastern Amazonian coast and mitigate actions to protect this aquifer's groundwater resources.

# Thanks!



**SERVIÇO GEOLÓGICO  
DO BRASIL – CPRM**

SECRETARIA DE  
GEOLOGIA, MINERAÇÃO  
E TRANSFORMAÇÃO MINERAL

MINISTÉRIO DE  
MINAS E ENERGIA



PÁTRIA AMADA  
**BRASIL**  
GOVERNO FEDERAL

**Manoel Imbiriba Junior**

Geoscience Researcher  
55+ (91) 99987-2200



**47<sup>TH</sup> IAH  
CONGRESS  
BRASIL 2021**