Geoscientific Perspective

Brazilian Sedimentary Basins and the Potential and Risks for CO_2 Storage in Saline Reservoir

Ronan Ávila – Superintendency of Geological and Economic Assessment (SAG)
Rio de Janeiro, Brazil
November 26, 2024

From a Geoscientific Perspective, an Overview of Brazilian Sedimentary Basins and the Potential and Risks for CO_2 Storage in Saline Reservoir - Ronan Avila (ANP)

25-26 November 2024
Rio de Janeiro | Brazil

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NOTICE

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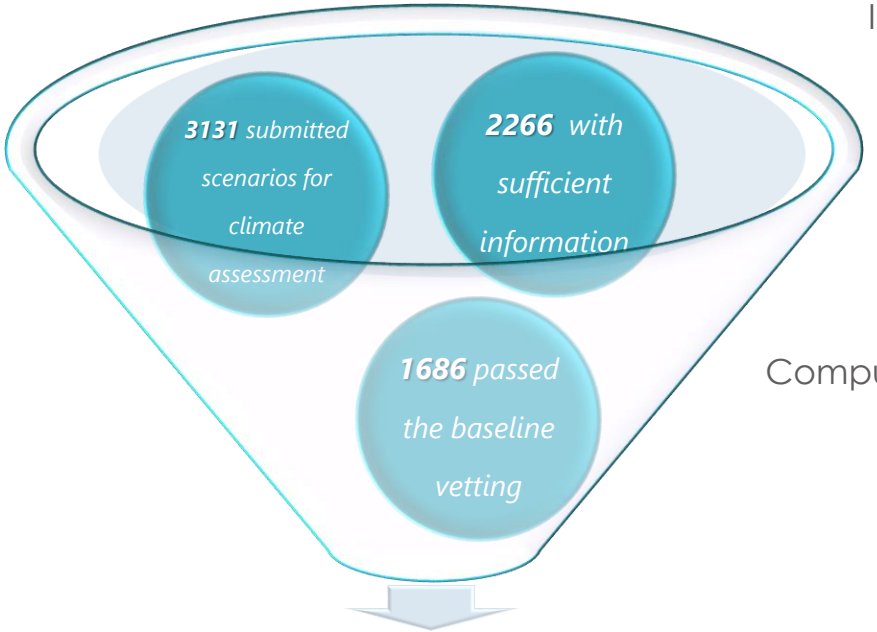
Forward-looking data, information, projections and opinions expressed during the presentation are subject to change without prior notice.

This presentation focuses on geology and geophysics, not on regulations.



There are seven Illustrated Mitigation Paths (IMP) from the AR6 scenario, one of which is Brazilian and was developed at the academy **(COOFFE MODEL)**.

Avaliable at Annex III Table II.3: https://data.ece.iiasa.ac.at/ar6/#/about

Integrated Assessment Models (IAMs)

IAMs have been crucial for IPCC reports and are being utilized in policymaking.

cenergia

(PPE/COPPE-UFRJ)

COFFEE MODEL – GLOBAL => IPCC

Computable Integrated Framework for Energy and the Environment

BLUES MODEL – BRAZIL => BRAZILIAN NDC

Brazilian Land-Use and Energy Systems model

Brazil_Second Nationally Determined Contribution (NDC)_November2024.pdf

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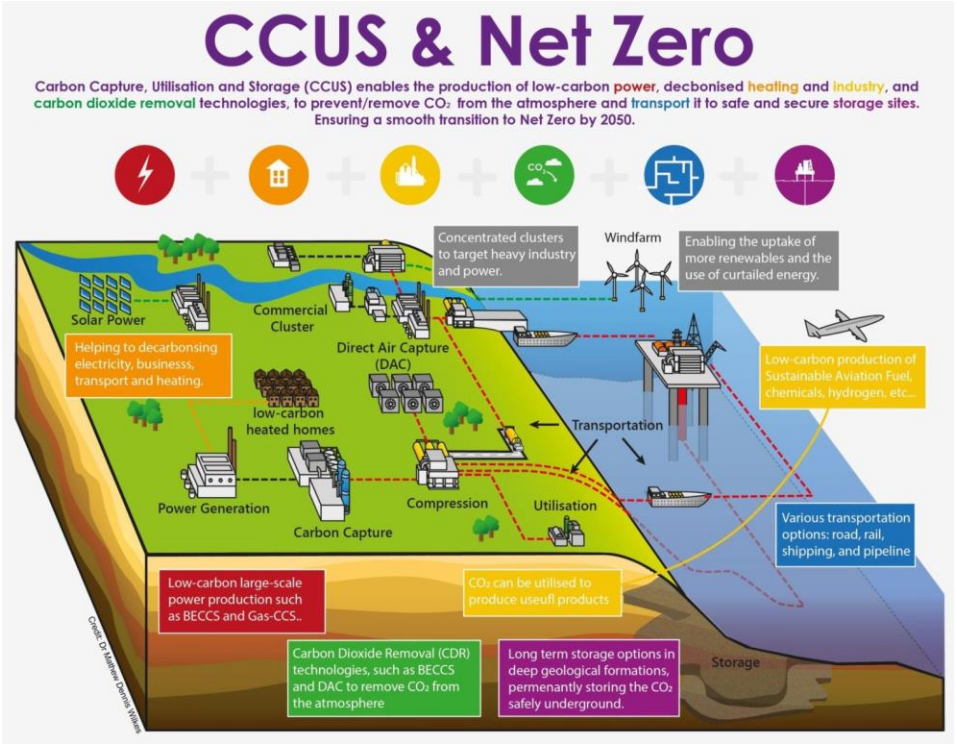
BRAZIL'S NDC

National determination
to contribute and transform



Wilkes, M. (2023) CCUS & Net Zero Illustration.
Available at: https://ukccsrc.ac.uk/ukccsrc-ecr-ccs-visual-communication-competition-2023/

"The choice to replace fossil fuels with biofuels allows potentially for the medium and long-term development of biofuel technology routes associated with **CCS** to produce negative emissions, since removals in the Land Use Change and Forestry sector alone will not be enough to offset the remaining emissions. This will depend, however, of the economic and technical feasibility of these new technologies in the medium and long term".

Brazil_Second Nationally Determined Contribution (NDC)_November2024.pdf (pg. 30)

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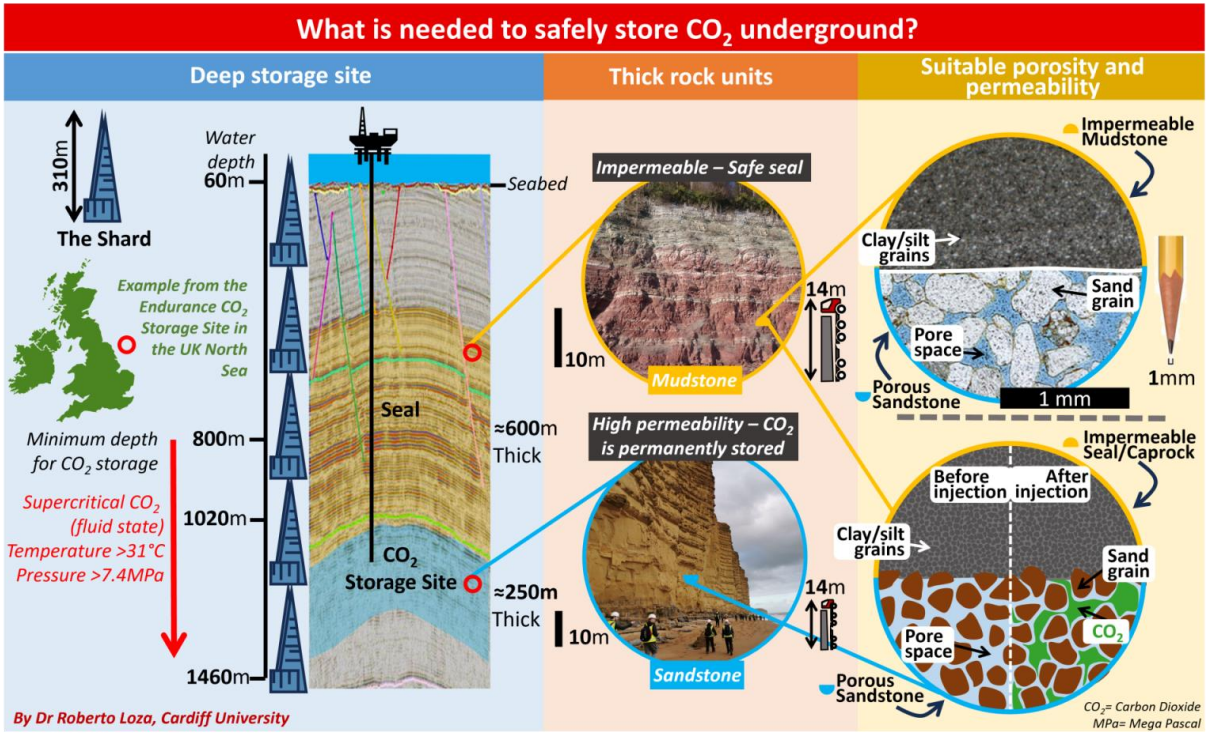
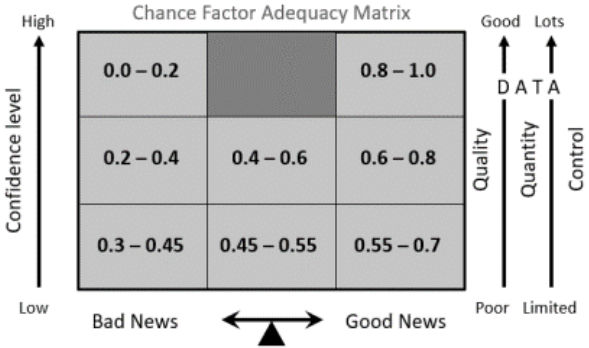
STORAGE POTENTIAL AND RISKS (SALINE RESERVOIR)



Loza, R. (2023).
Available at: https://ukccsrc.ac.uk/ukccsrc-ecr-ccs-visual-communication-competition-2023/

Estimating the Chance (Pg)



Source: Rose & Associates (2023)

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UNCERTAINTY	RISK	FACTOR
How large is the overall storage efficiency?	If low: CO_2 plume will be larger and more mobile.	Geometry
Is the aquifer/reservoir open or confined (closed)?	Is the aquifer/reservoir open or confined (closed)?	
To what extent is the reservoir compartmentalized?	Small compartments: lower efficiency. Rapid pressure increase	
How effective are updip fault seals?	If faults are not sealing: no buoyancy trapping against faults	
Is there a structural or stratigraphic trapping component?	Absence of a trap reduces trapping efficiency	
How much could the injection pressure increase?	Increase: lower storage efficiency, reduced injection rates.	
How many small-scale heterogeneities are expected?	If few heterogeneities: low residual trapping efficiency	Heterogeneity
How many vertical migration feeder points are expected?	If few: low storage efficiency, plume not expanding vertically	
How many vertical heterogeneities are expected?	If few: low storage efficiency, plume not expanding laterally	
Are there permeability fairways in the reservoir?	If permeability fairways: increased directional migration of CO_2	
Are there intermediate shale layers that can act as baffles?	If not: CO_2 won't spread out and fill a larger reservoir volume.	
How large is the saturation of immobile in-situ fluids that cannot be displaced by CO_2?	More immobile in-situ fluids: reduced microscopic displacement efficiency, hence storage efficiency	Pore Scale
How uniform are pore capillary entry pressures?	If uniform: lower residual trapping efficiency	
How large are the pore throat radii, wettability, and interfacial tension?	Unfavorable values minimize residual trapping. Upward migration rate may be expectedly high.	
How much CO_2 trapped will dissolve in brine/HC, and how fast?	Poor solubility and/or slow dissolution: less CO_2 How much CO_2 trapped	

Source: Rose & Associates (2023)

Storage Efficiency (E_s)

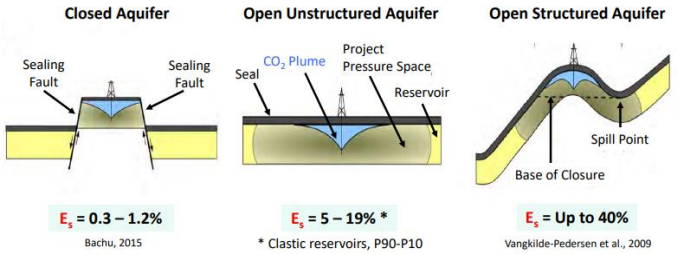
- Storage efficiency is the fraction of total pore volume filled by CO_2

$$\mathbf{M_{CO_2} = A \times h \times N/G \times \phi \times \rho_{CO_2 r} \times E_s}$$ Where $$\mathbf{E_s = E_d \times E_V}$$

Mass = Net Pore Volume x Density x ***Storage Efficiency***

- Storage efficiency is the product of:
  - Microscopic displacement efficiency, E_d
  - Volumetric displacement efficiency, E_V

E_s Values Depend on Reservoir Configuration



Source: Bump & Hovorka, (2023)

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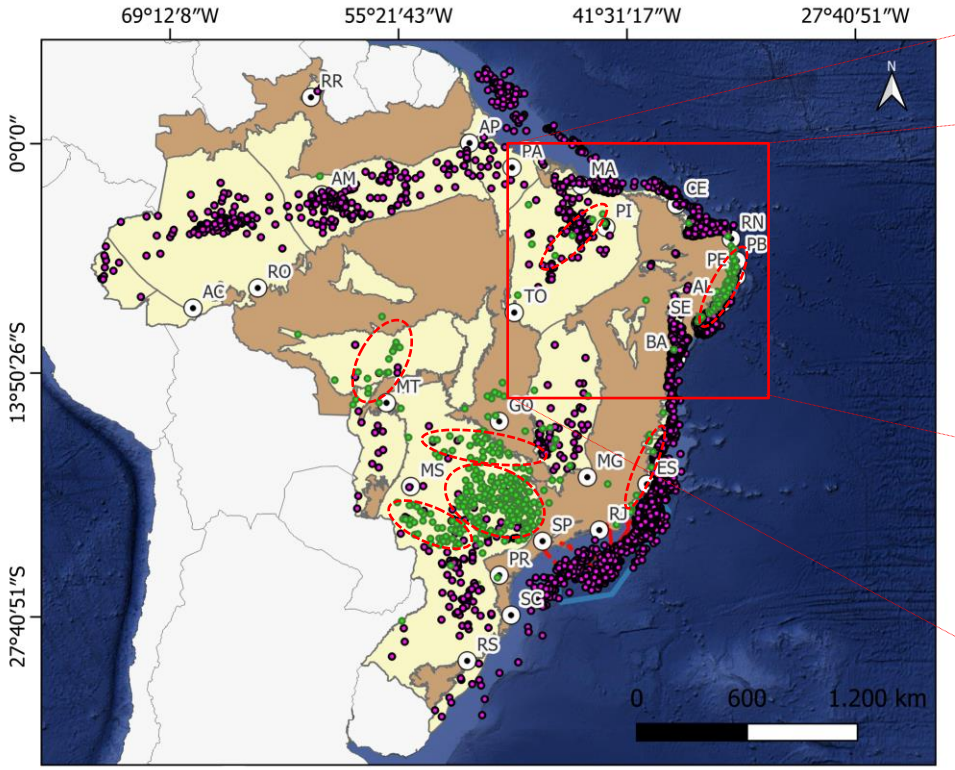
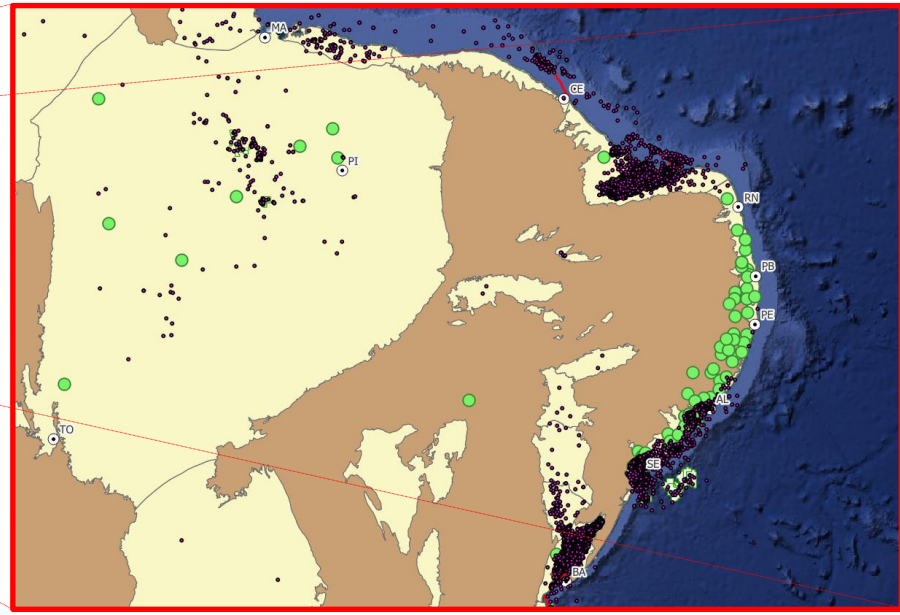
THE POTENTIAL OF BECCS (1st Approach)





Ethanol Plant

Wells

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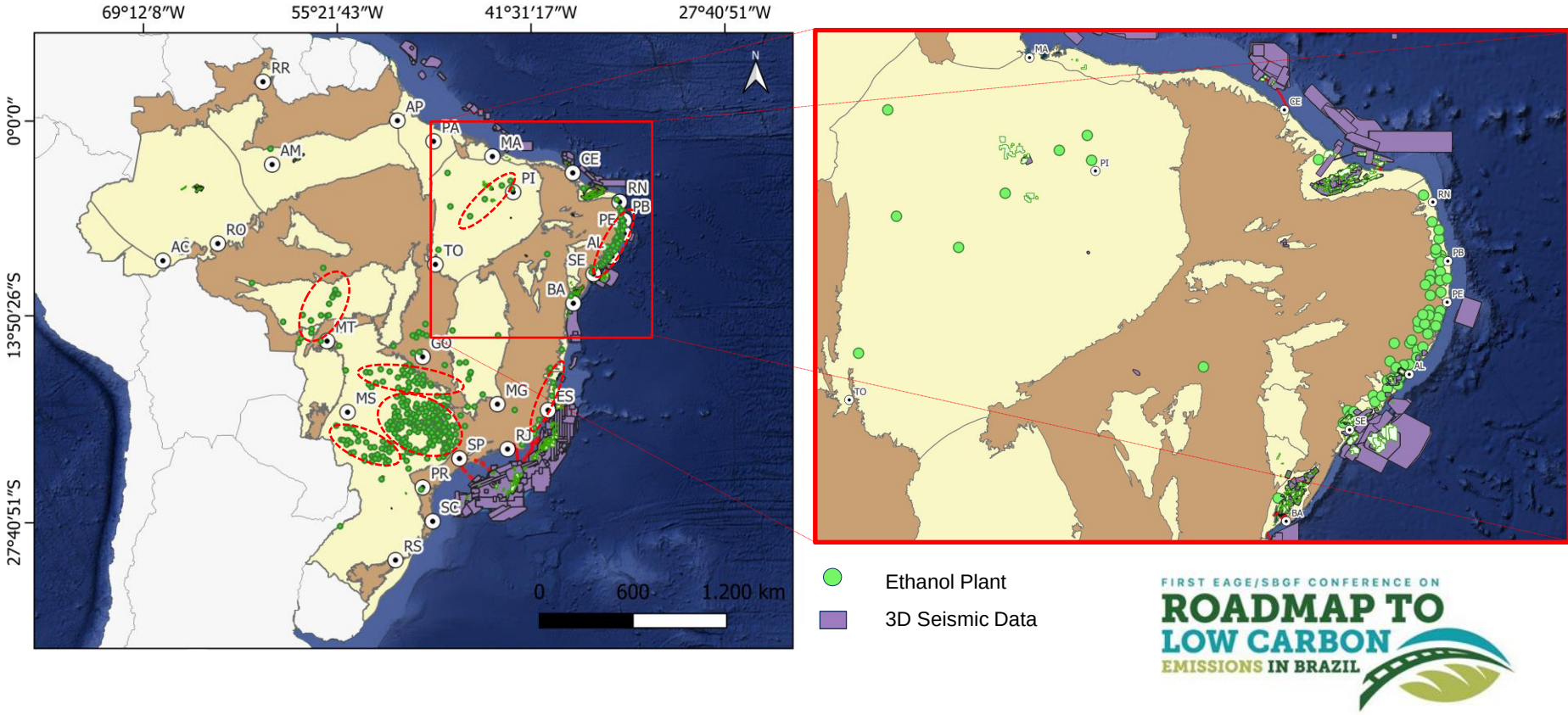
THE POTENTIAL OF BECCS (1st Approach)



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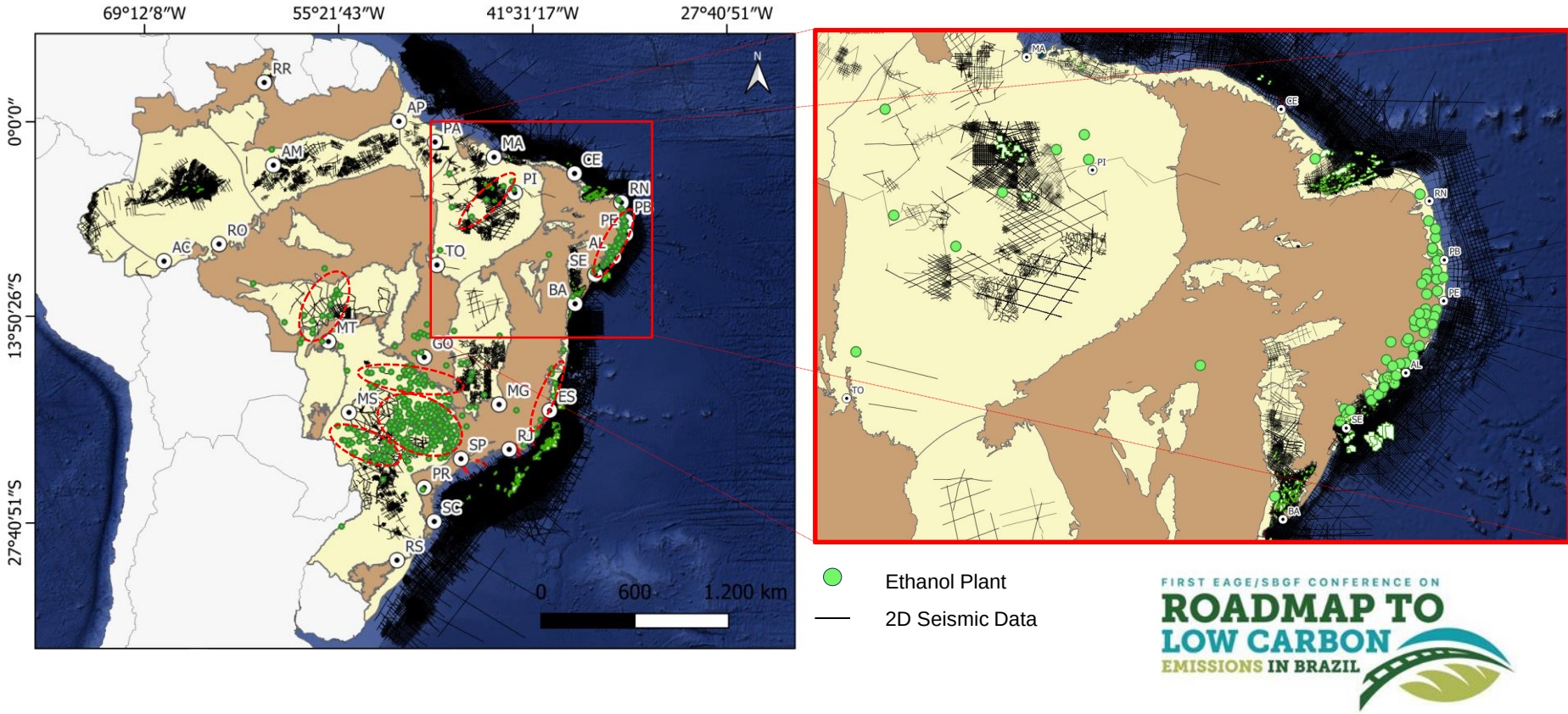

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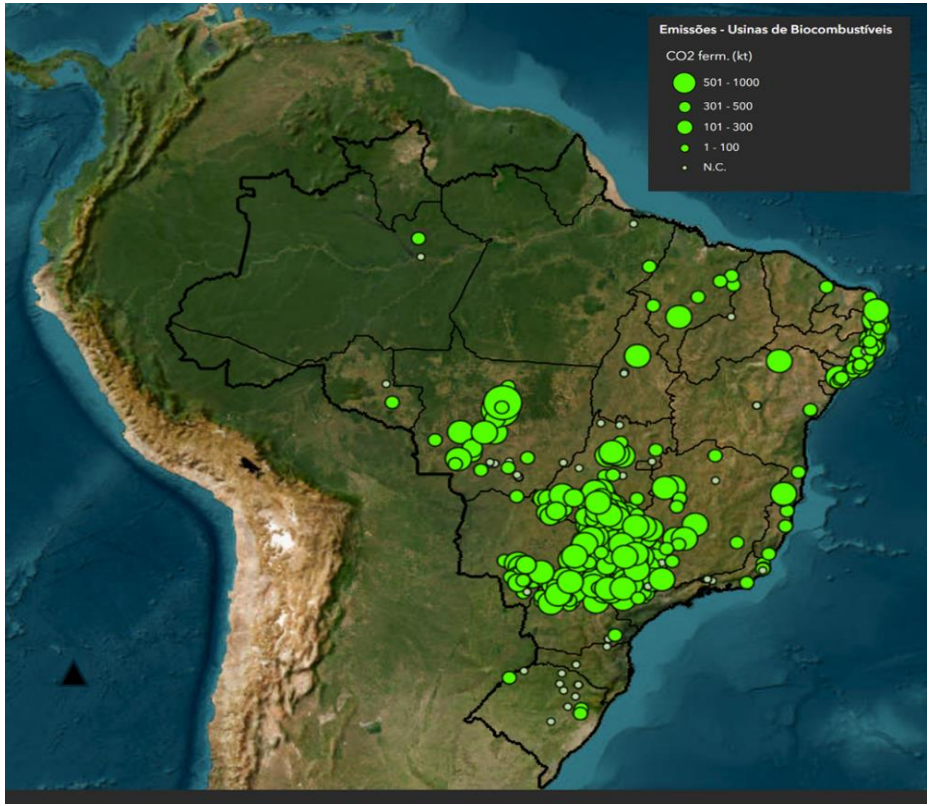

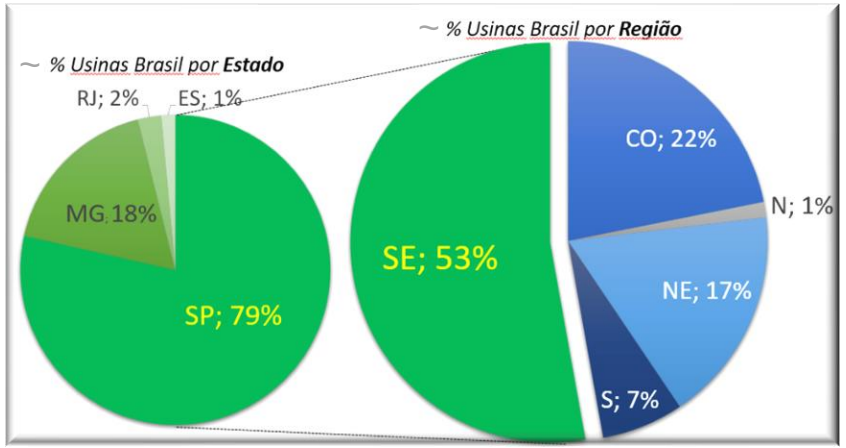

Source: Plataforma GIS CCUS Brasil. Porto Alegre: IPF, 2024). Avaliable at https://www.pucrs.br/ipr/plataforma-gis-ccus-brasil/ .

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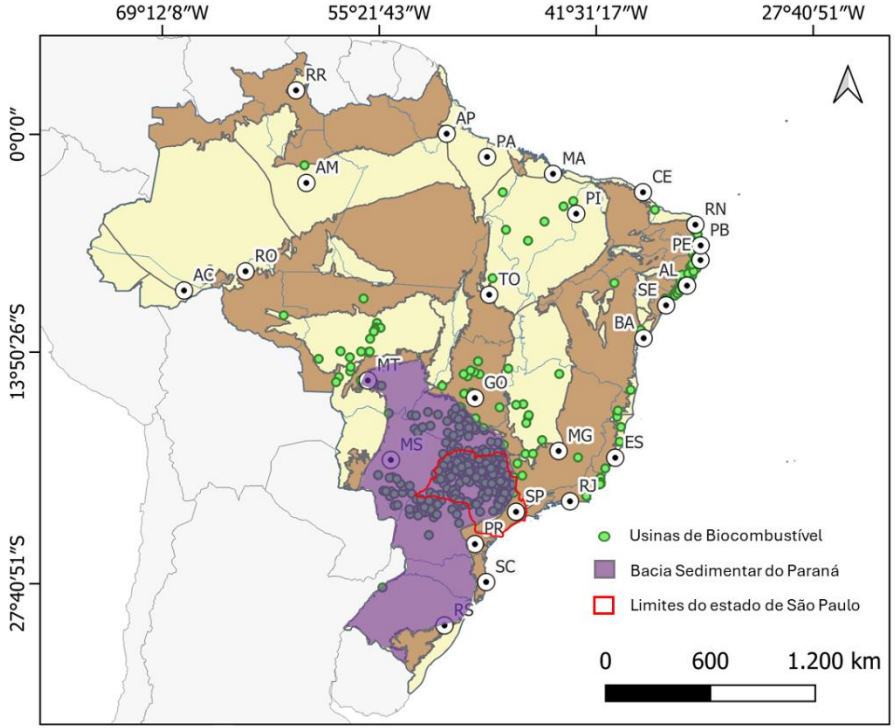
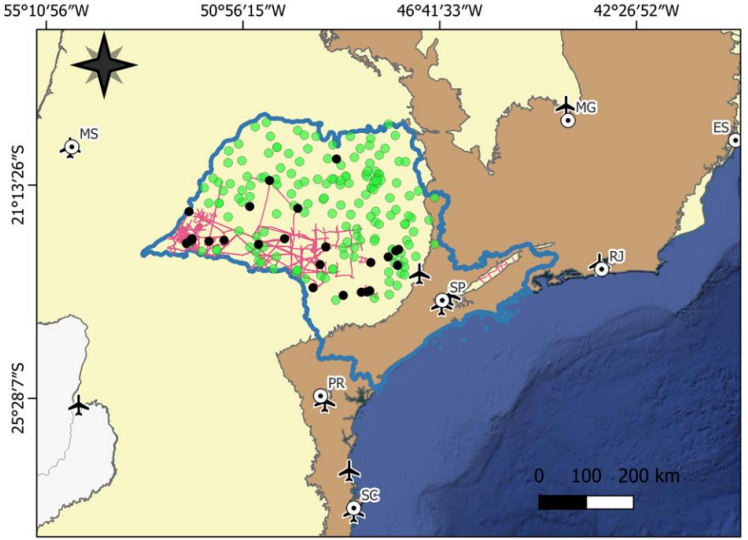
THE POTENTIAL OF BECCS (São Paulo State)





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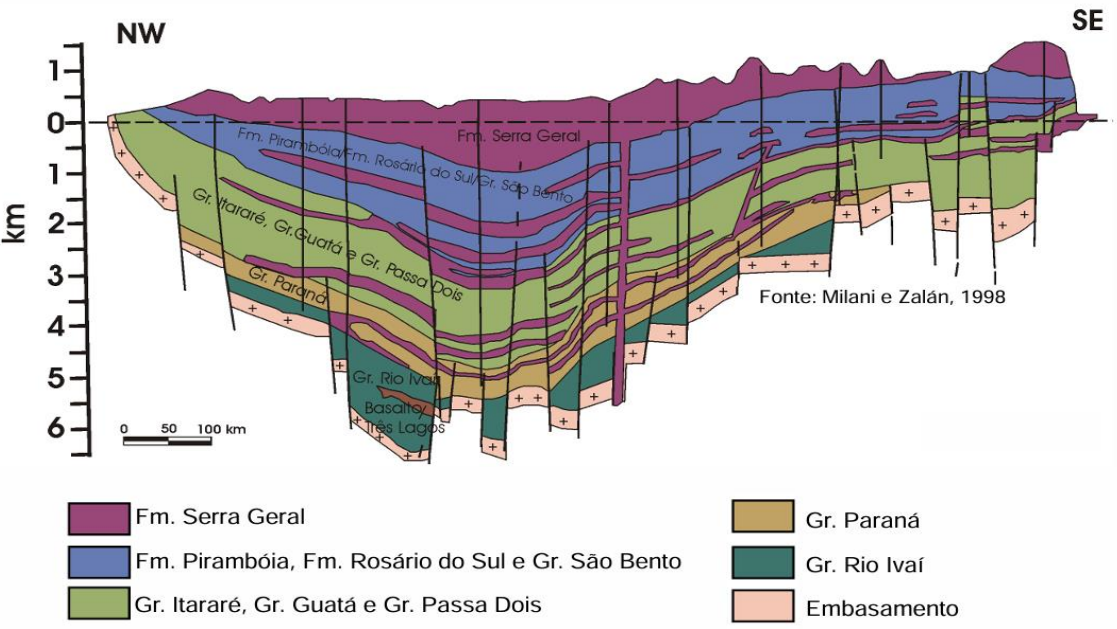
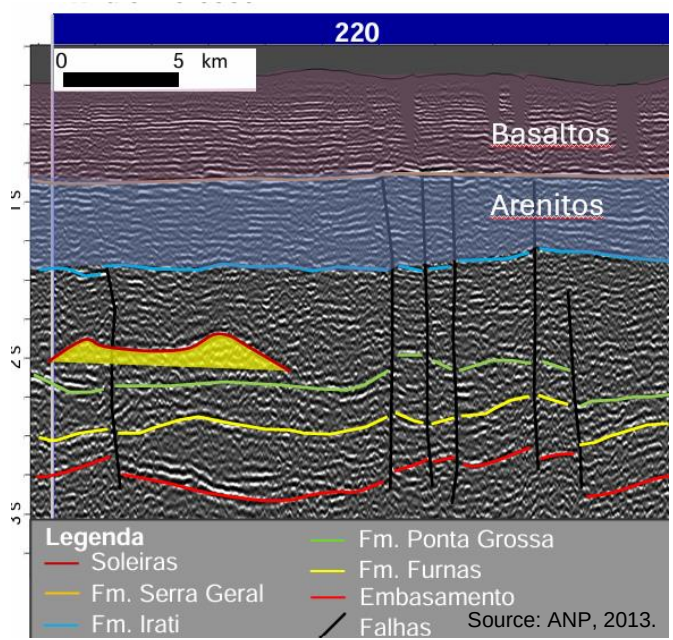
THE POTENTIAL OF BECCS (Parana Basin)





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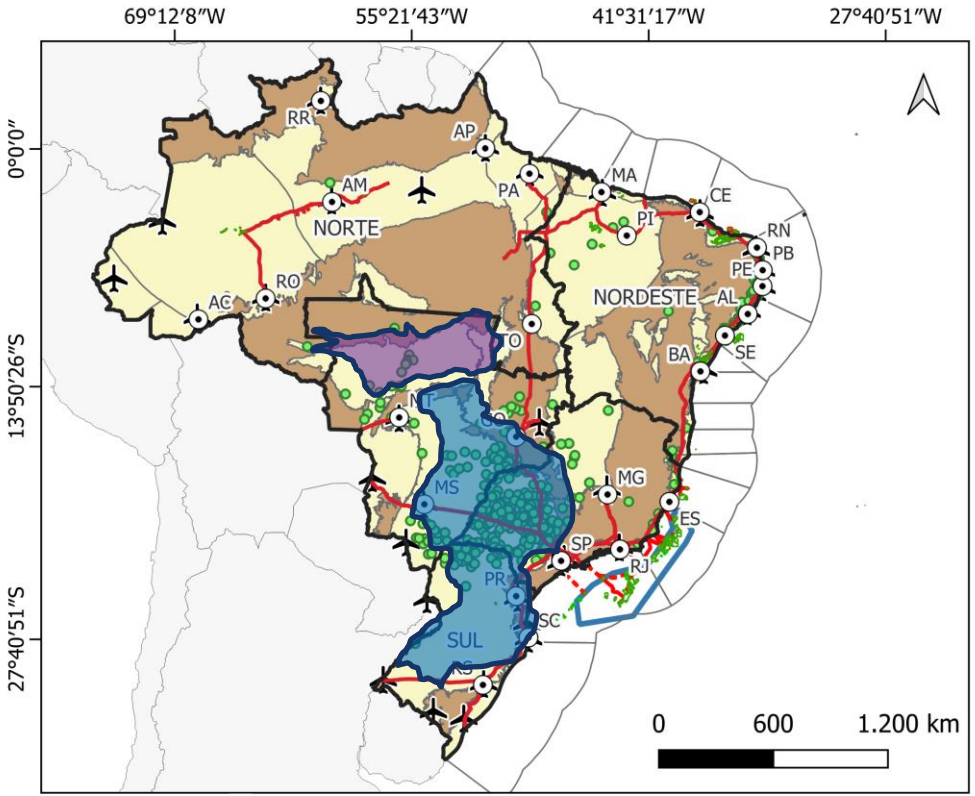
THE POTENTIAL OF BECCS (EXAMPLES)



Legend

- Offshore Sedimentary Basin
- Cratonic Areas
- Onshore Sedimentary Basin
- **Parecis** - Proterozoic
- Parana - Paleozoic
- Ethanol Plant
- Oil & Gas Pipeline
- State Limits
- Oil & Gas Fields
- Presalt Polygon

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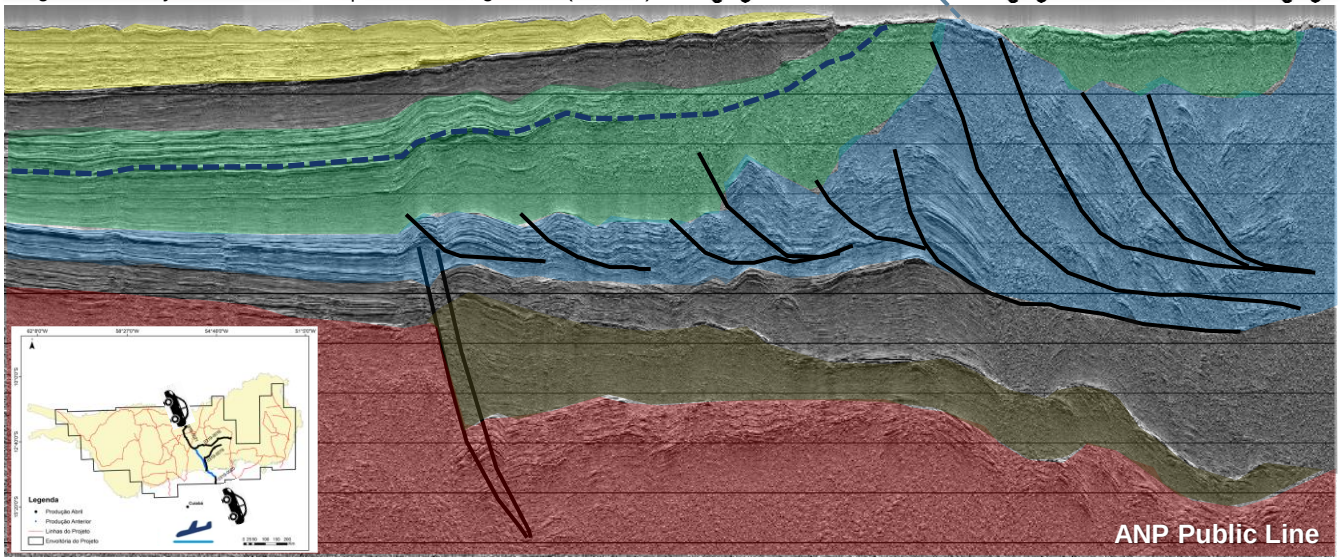
THE POTENTIAL OF BECCS (Parecis Basin)

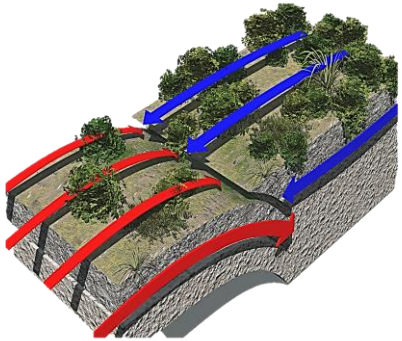
Agriculture: Soybeans and Cotton | Corn and Sugarcane (Ethanol)

Limestone Mining

Cattle. Euclayptus

Cuiabá Airport





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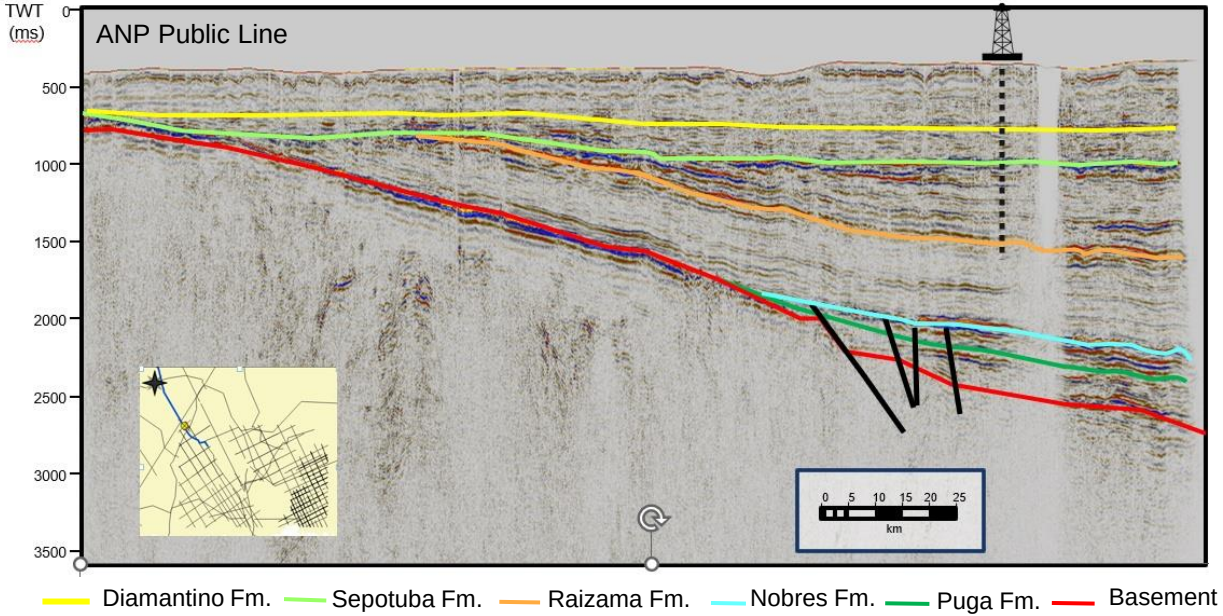
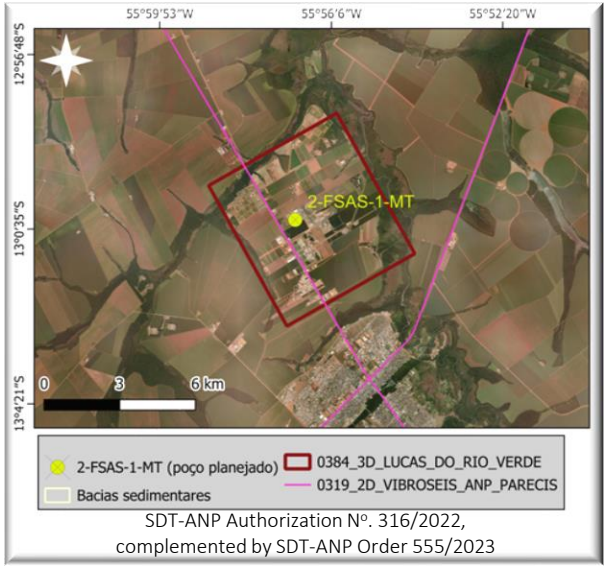
THE POTENTIAL OF BECCS (Parecis Basin)





SDT-ANP Authorization Nº. 316/2022,
complemented by SDT-ANP Order 555/2023

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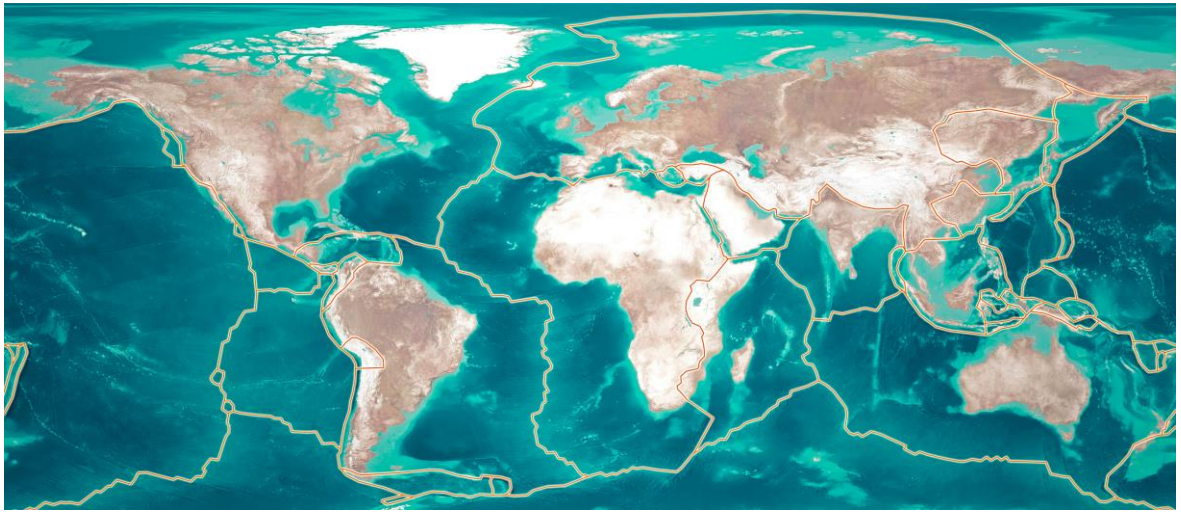
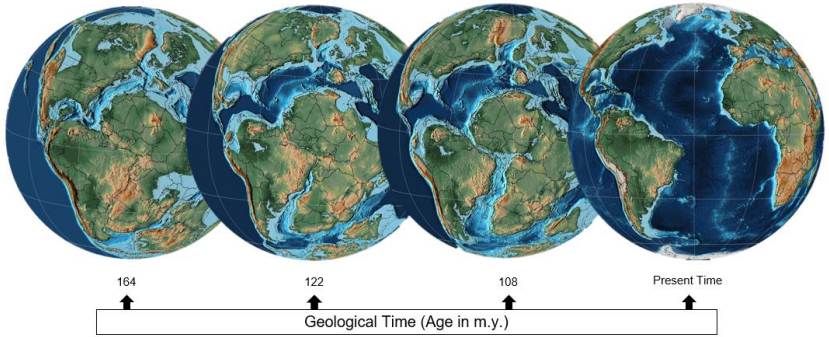
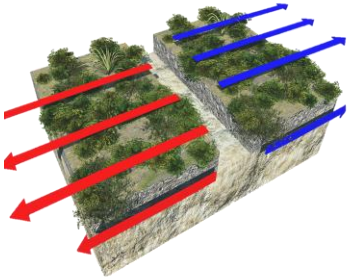
THE POTENTIAL OF CCS-HUB (Offshore)



Passive margins tectonic plate. Brazil experiences relatively calm tectonic conditions characterized by low seismicity (earthquake). This stability is a favorable factor for ensuring safety in the permanent geological storage of CO_2.





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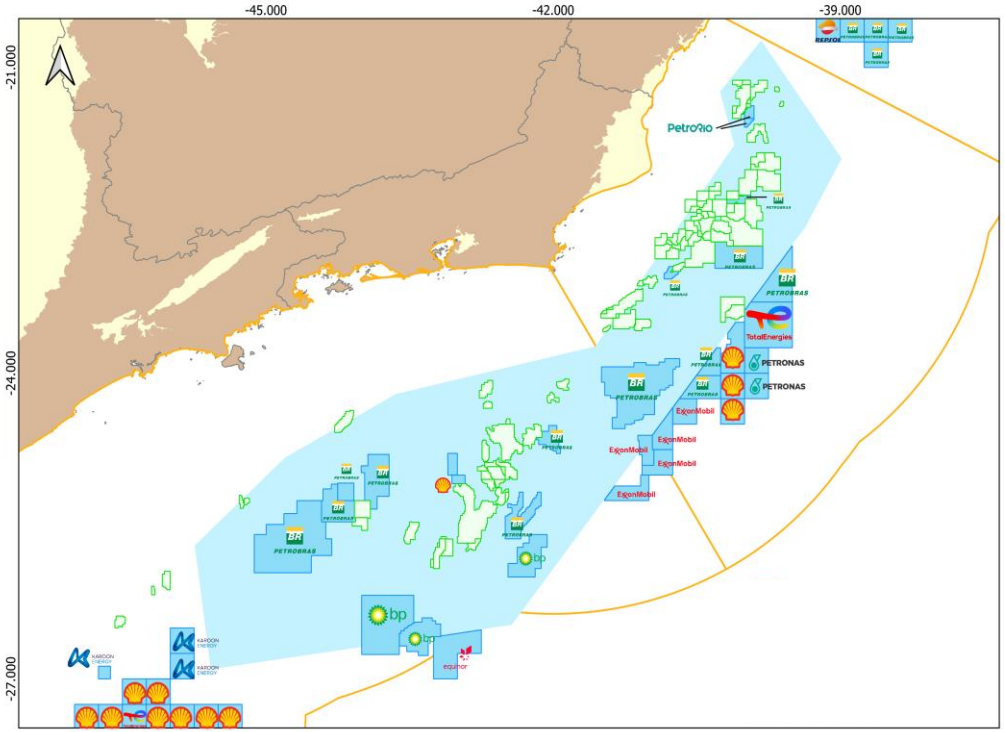
THE POTENTIAL OF CCS-HUB (Offshore)



Campos Basin

The Campos Basin is located primarily in front of the state of Rio de Janeiro. This area is home to industries that produce high levels of CO_2 emissions, hard to abate, such as the cement, steel, and metallurgical industries. Additionally, there are large saline reservoir offshore, as well as depleted oil fields that can be studied for permanent storage purposes, possibly in a HUB model.

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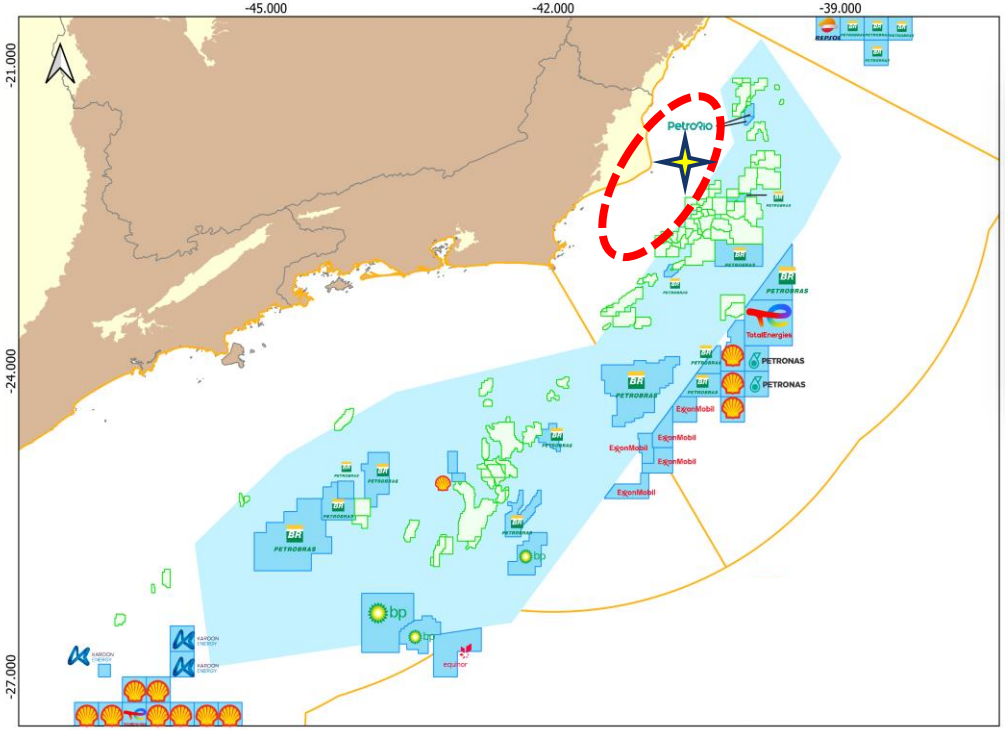
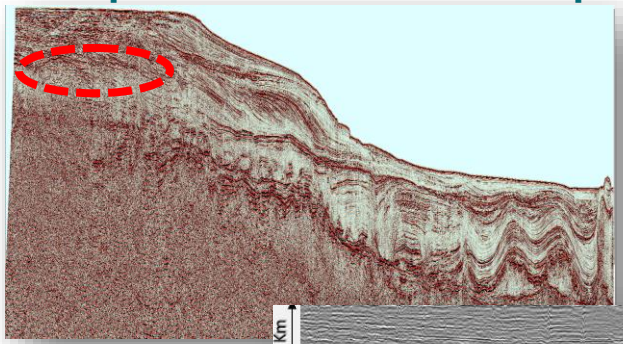
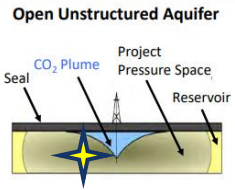
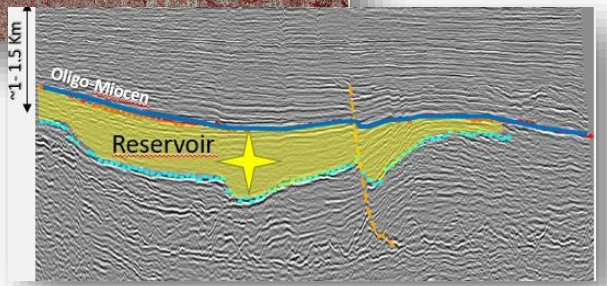
THE POTENTIAL OF CCS-HUB (Offshore)



Campos Basin (São Tomé Example)







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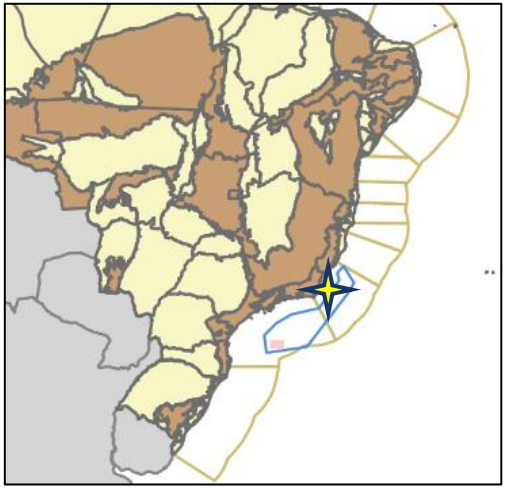
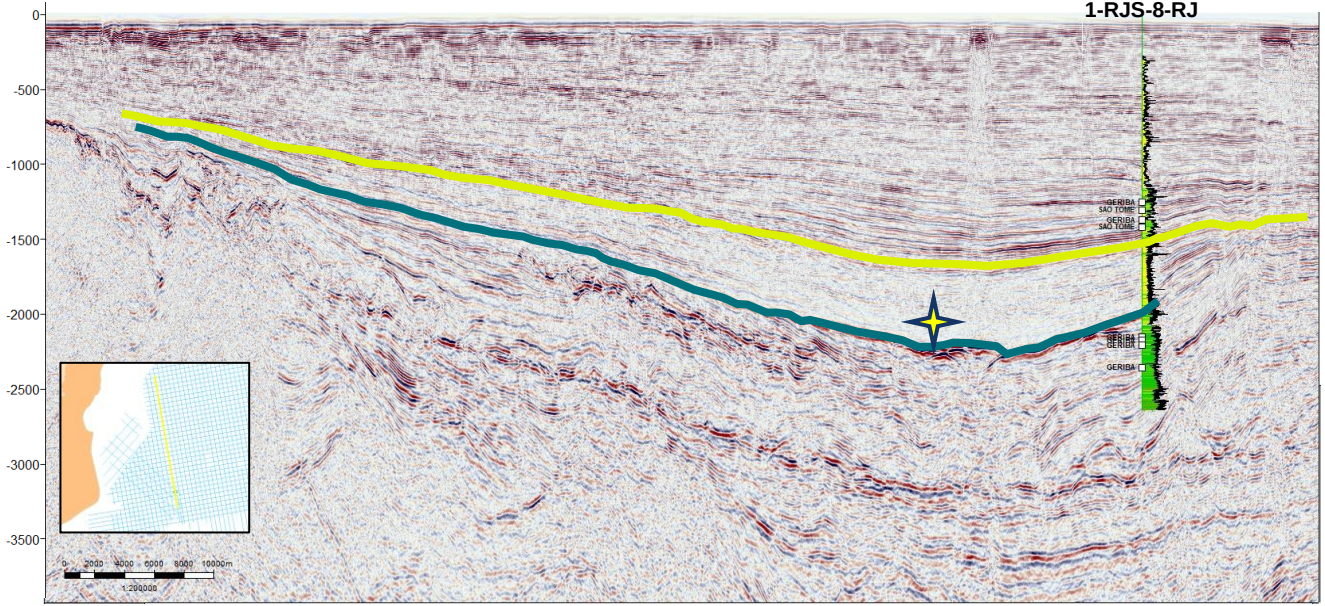
THE POTENTIAL OF CCS-HUB (Saline Reservoir)
São Tomé Example CAMPOS BASIN





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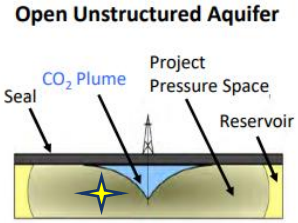

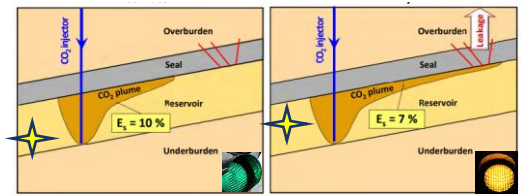

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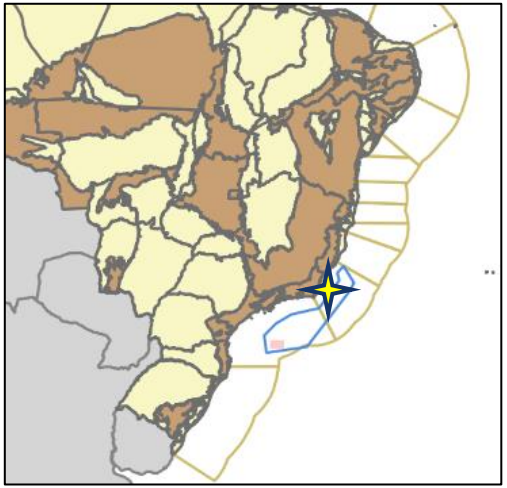
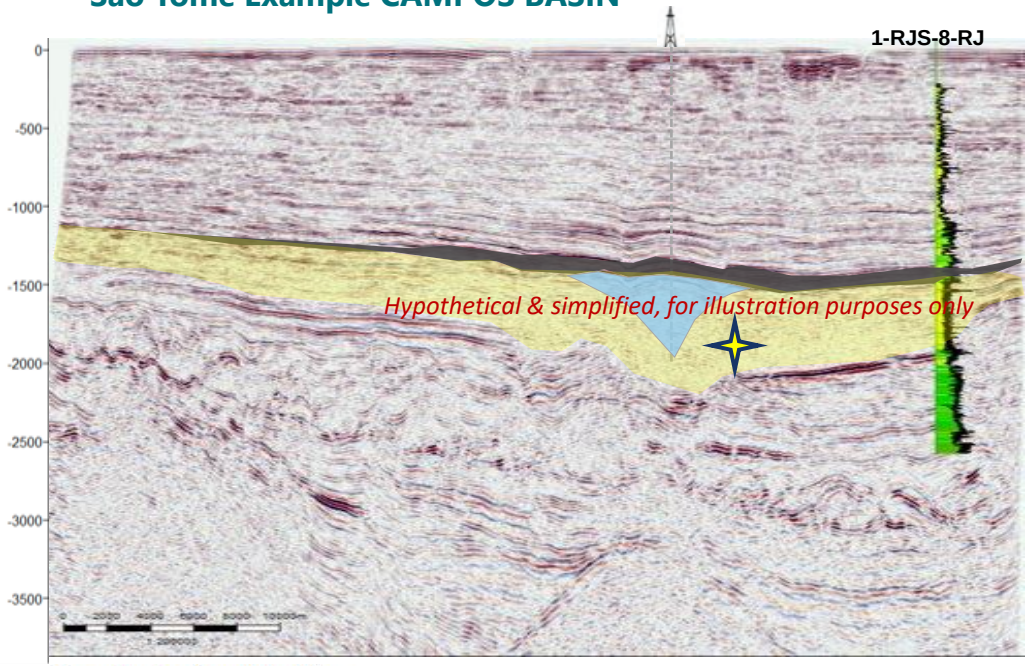
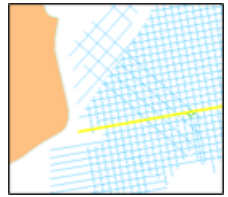
Rose and Associates, 2023

THE POTENTIAL OF CCS-HUB (Saline Reservoir)
São Tomé Example CAMPOS BASIN







Open Unstructured Aquifer

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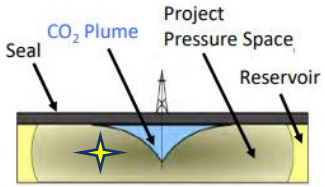

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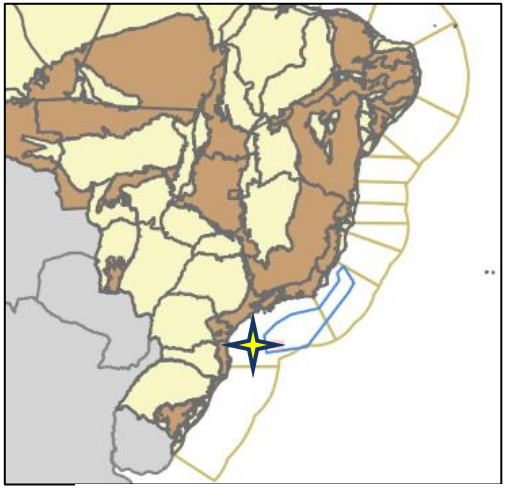
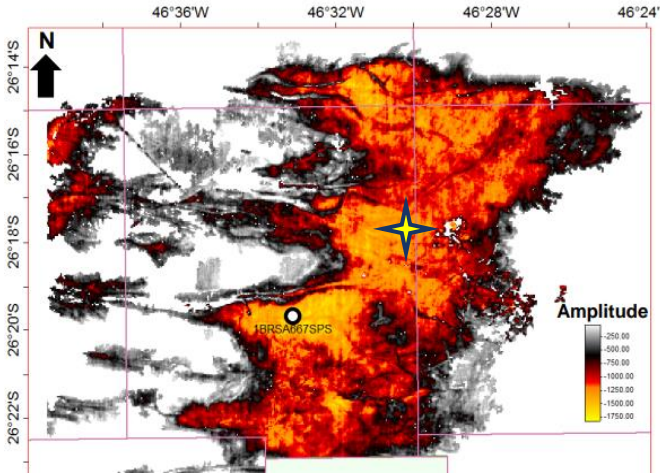
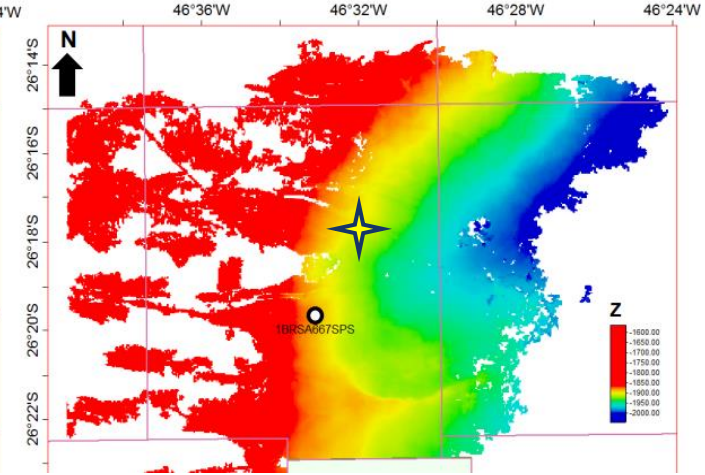
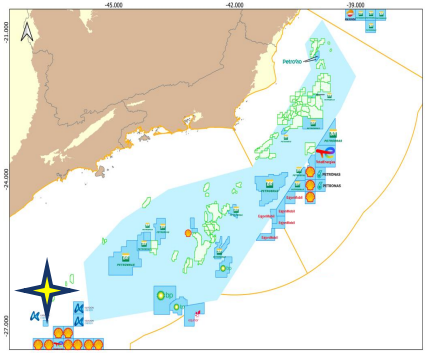
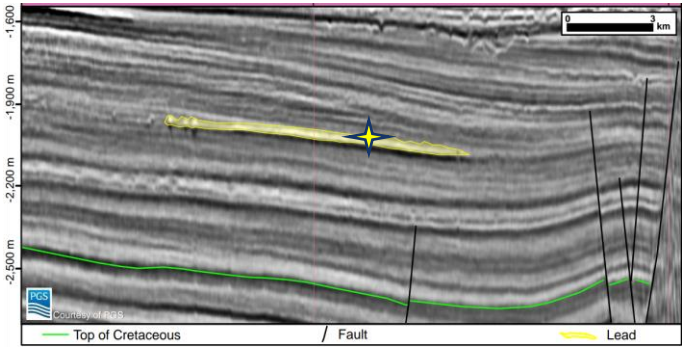
THE POTENTIAL OF CCS-HUB (Saline Reservoir)
Sandstone Turbidite – Oligocene - SANTOS BASIN











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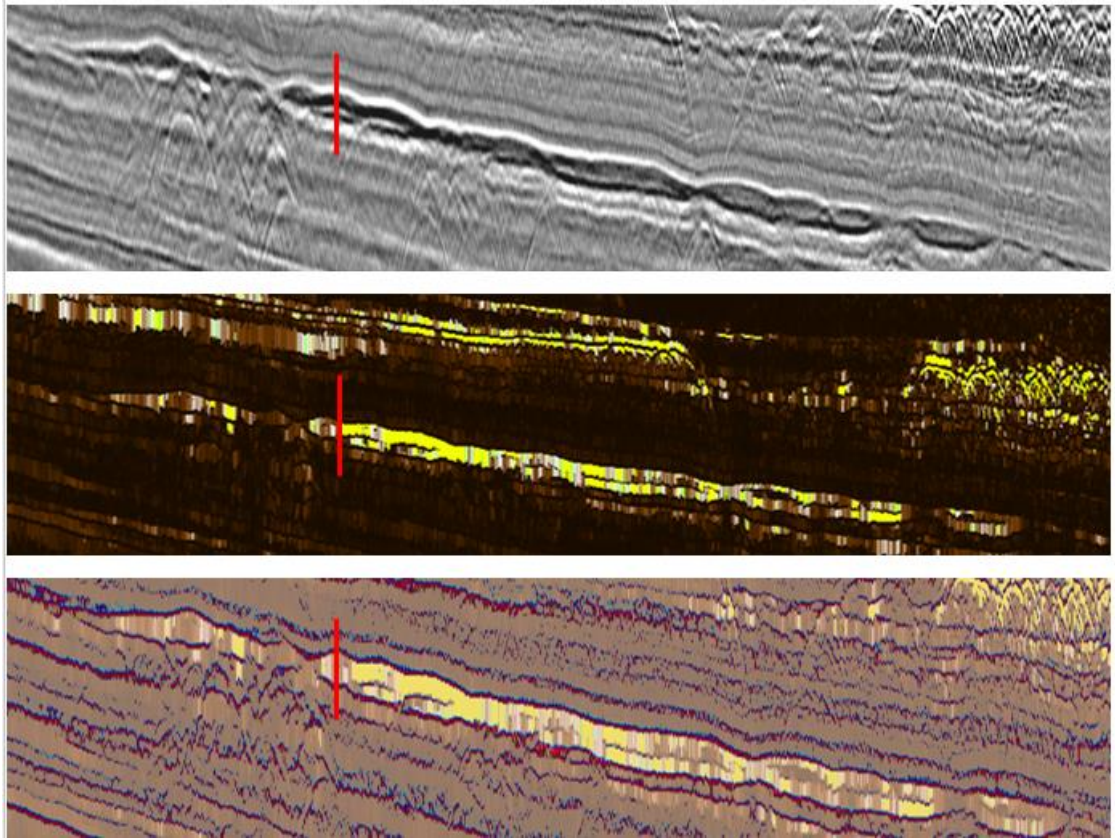
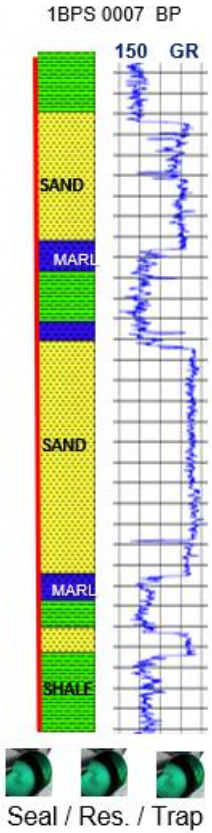
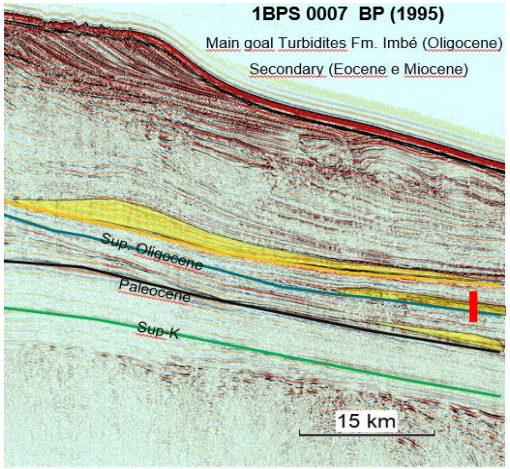
THE POTENTIAL OF CCS-HUB (Saline Reservoir)
Sandstone Turbidite – Oligocene - PELOTAS BASIN







FIRST EAGE/SBGF CONFERENCE ON
ROADMAP TO LOW CARBON EMISSIONS IN BRAZIL

LAW Nº. 14,993, October 8, 2024

https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2024/lei/L14993.htm

"The text promotes sustainable low-carbon mobility **and the capture and geological storage of carbon dioxide**..."

"CHAPTER VI - Activities In the Carbon Dioxide Capture and Geological Storage Industry

Art. 26. The exercise of carbon dioxide capture activities **for geological storage purposes**, its transport through pipelines, and geological storage **will be carried out with authorization from the ANP** § 4º "Except" EOR.

Art. 28. The ANP is responsible for regulating carbon dioxide capture activities for geological storage purposes, its transport through pipelines, and its geological storage."

" … "

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THANK YOU!

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