

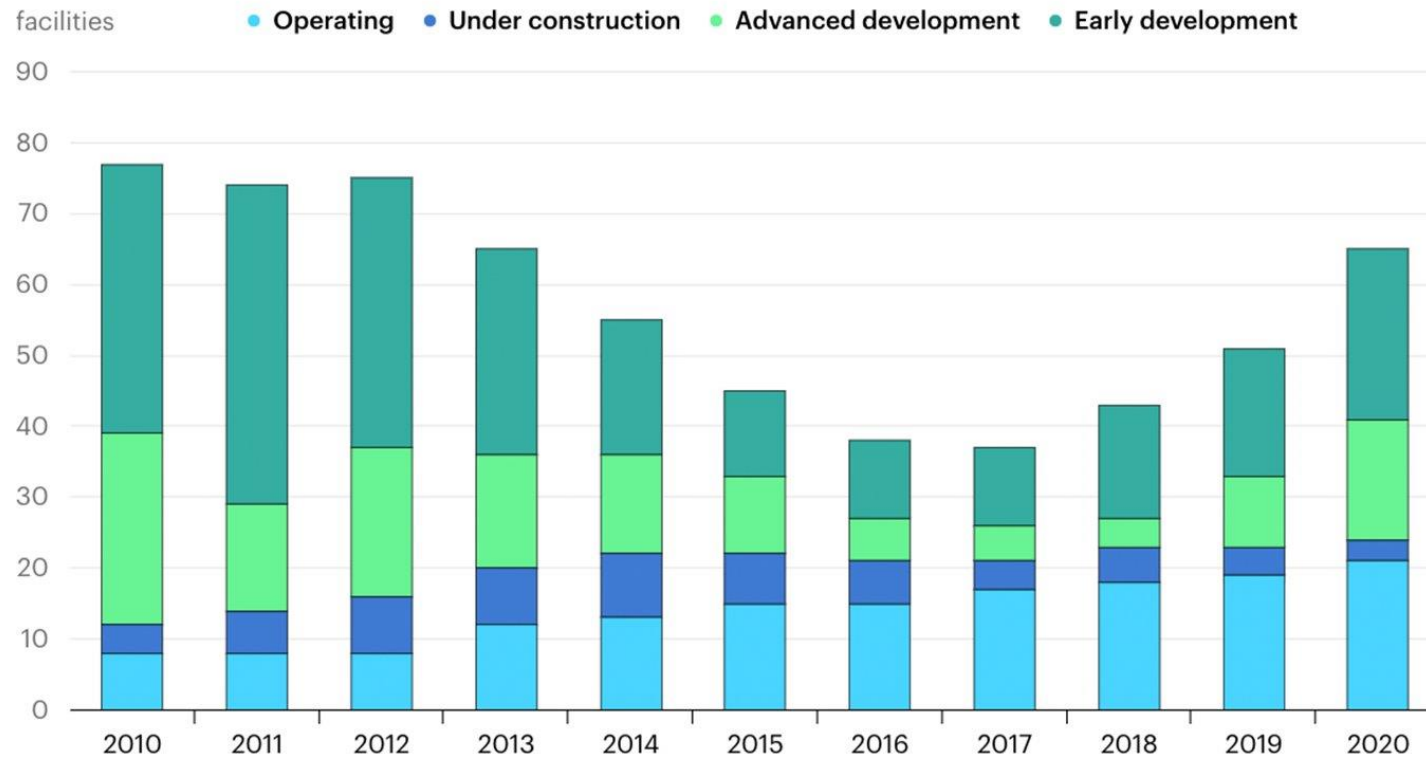


Armazenamento geológico de CO₂ – P&D em caracterização e avaliação de reservatórios no IPR/PUCRS

Prof. Rodrigo S. Iglesias – Escola Politécnica/PUCRS

World large-scale CCUS facilities operating and in development, 2010-2020

CCUS in Clean Energy Transitions: ETP Special Report

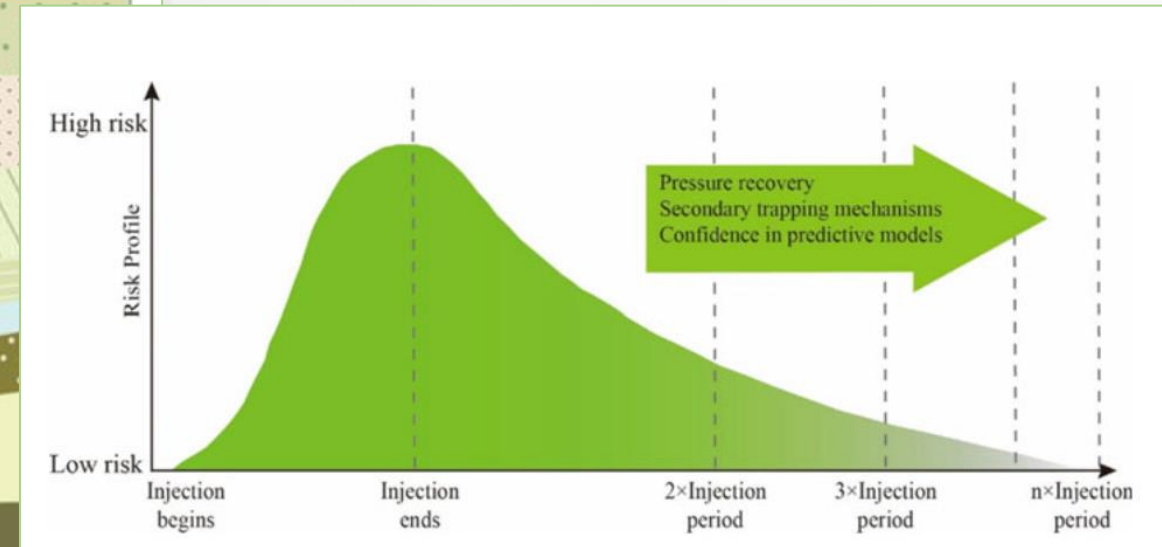
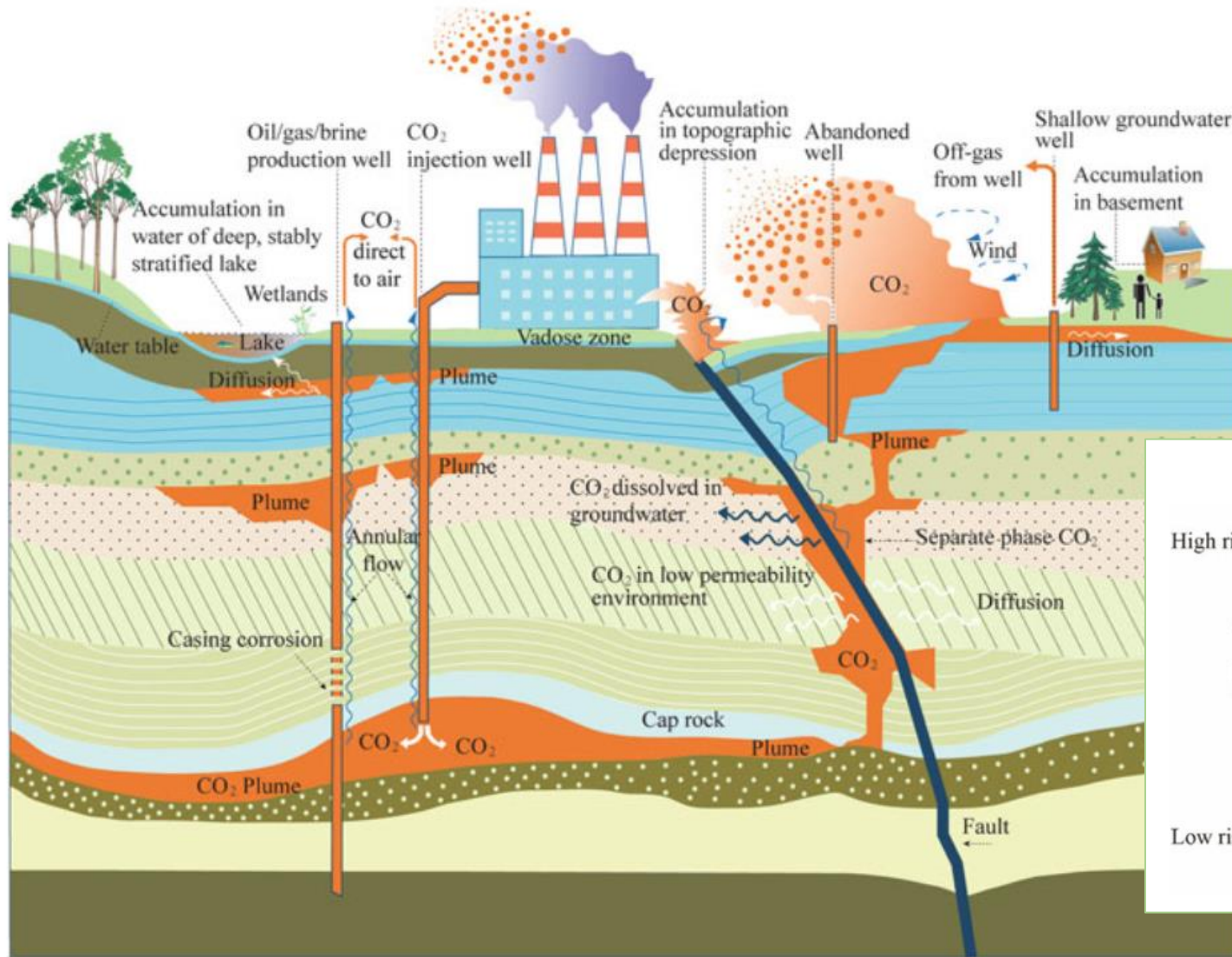


Note: Includes the Petra Nova coal-fired power plant, which temporarily suspended CO₂ capture operations in May 2020 in response to low oil prices.

International
Energy Agency

IEA (2020), *Energy Technology Perspectives 2020*, IEA, Paris
<https://www.iea.org/reports/energy-technology-perspectives-2020>

Riscos do armazenamento geológico



Benson SA (2007) Geological storage of CO₂: analogues and risk management.

Li, Q. and Liu, G. (2016) Risk Assessment of the Geological Storage of CO₂: A Review, *Geologic Carbon Sequestration: Understanding Reservoir Behavior*.

Riscos do armazenamento geológico

Risco local

CO₂ na atmosfera ou sub-superfície rasa

- Asfixia humanos e animais
- Efeitos sobre plantas
- Impactos biológicos em solo (raízes, insetos, microrganismos)

CO₂ dissolvido em fluidos de formação

- Mobilização metais, outros contaminantes
- Contaminação água potável
- Interferência ecossistemas de sub-superfície

Deslocamento

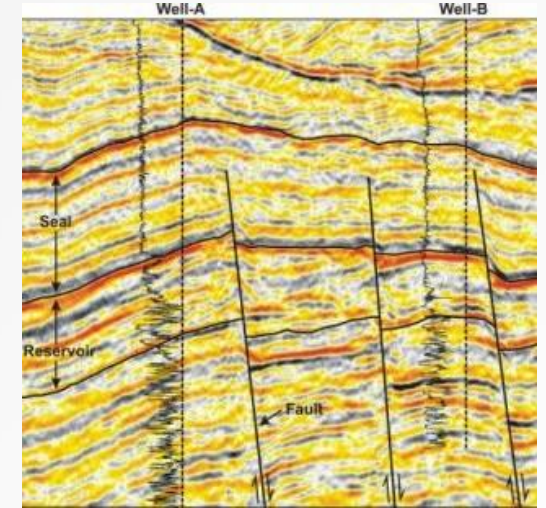
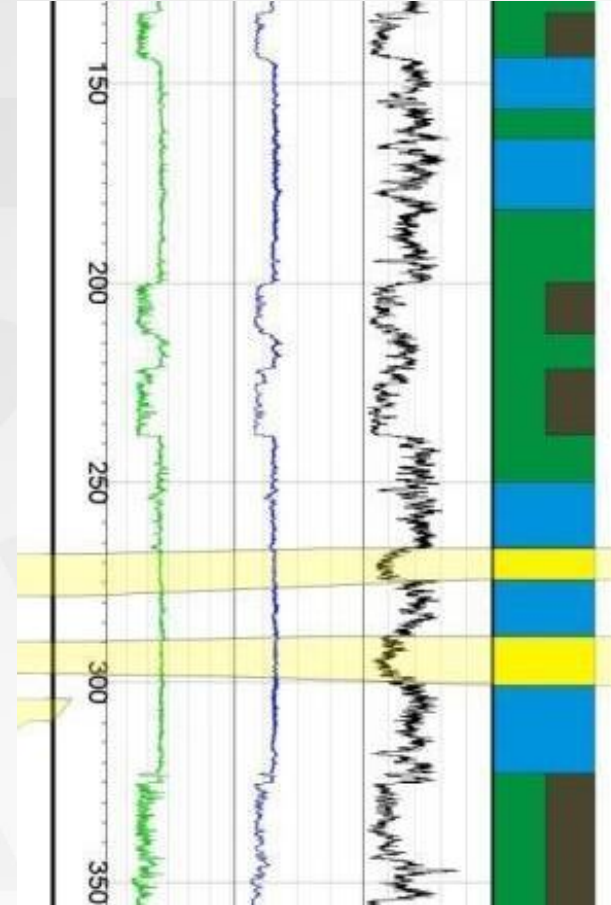
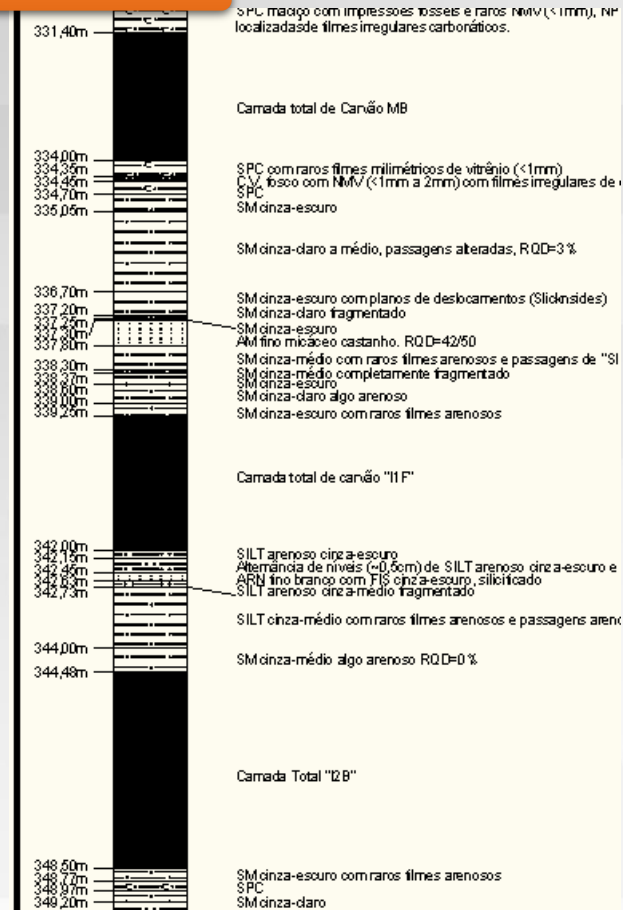
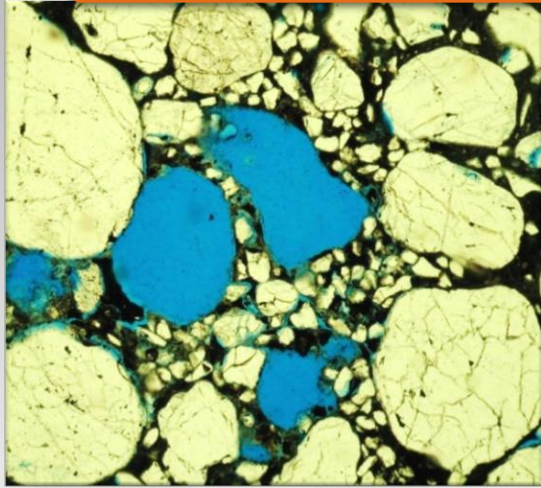
- Movimento do solo
- Reativação de falhas
- Sismicidade induzida
- Contaminação aquíferos
- Danos reservatórios hidrocarbonetos

Risco global

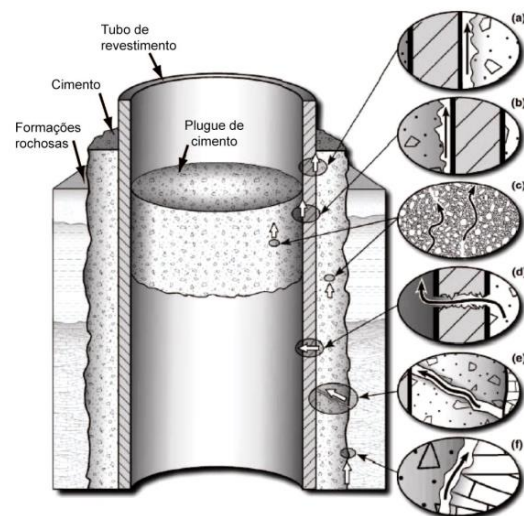
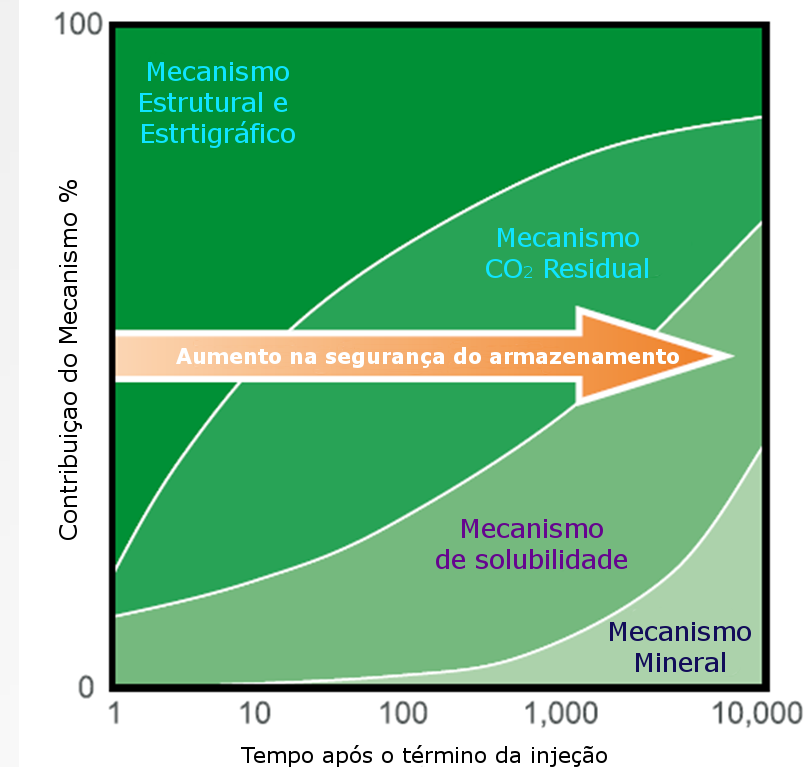
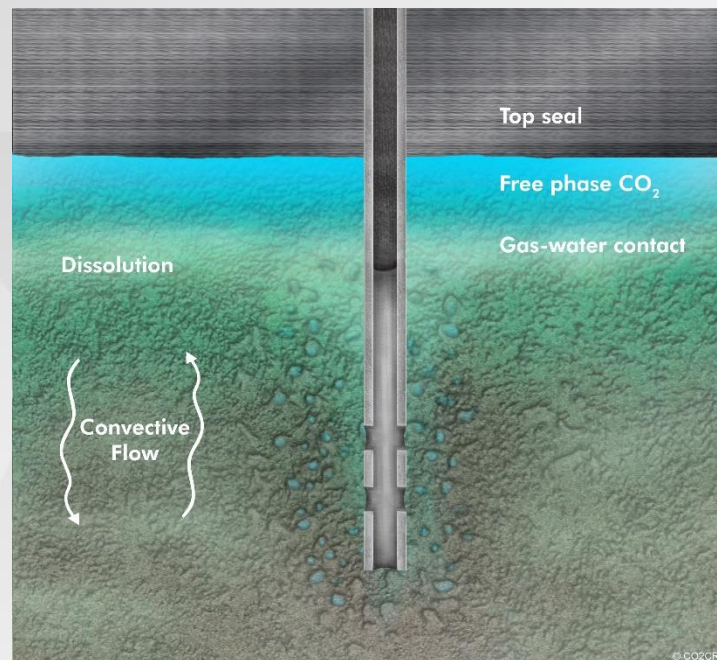
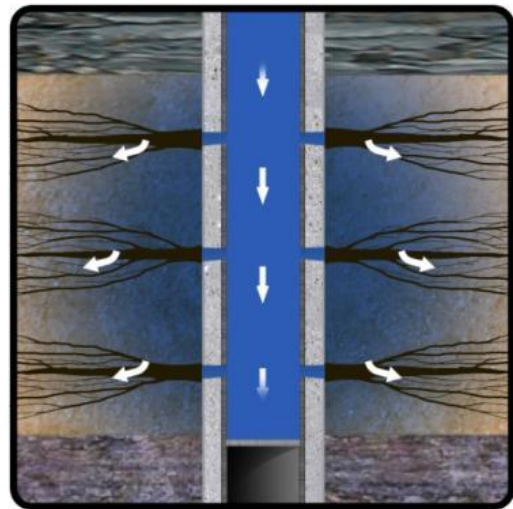
Liberação de CO₂ para atmosfera

- Caracterização do site
- Interação CO₂-reservatório
 - Interação CO₂-poços
 - Monitoramento

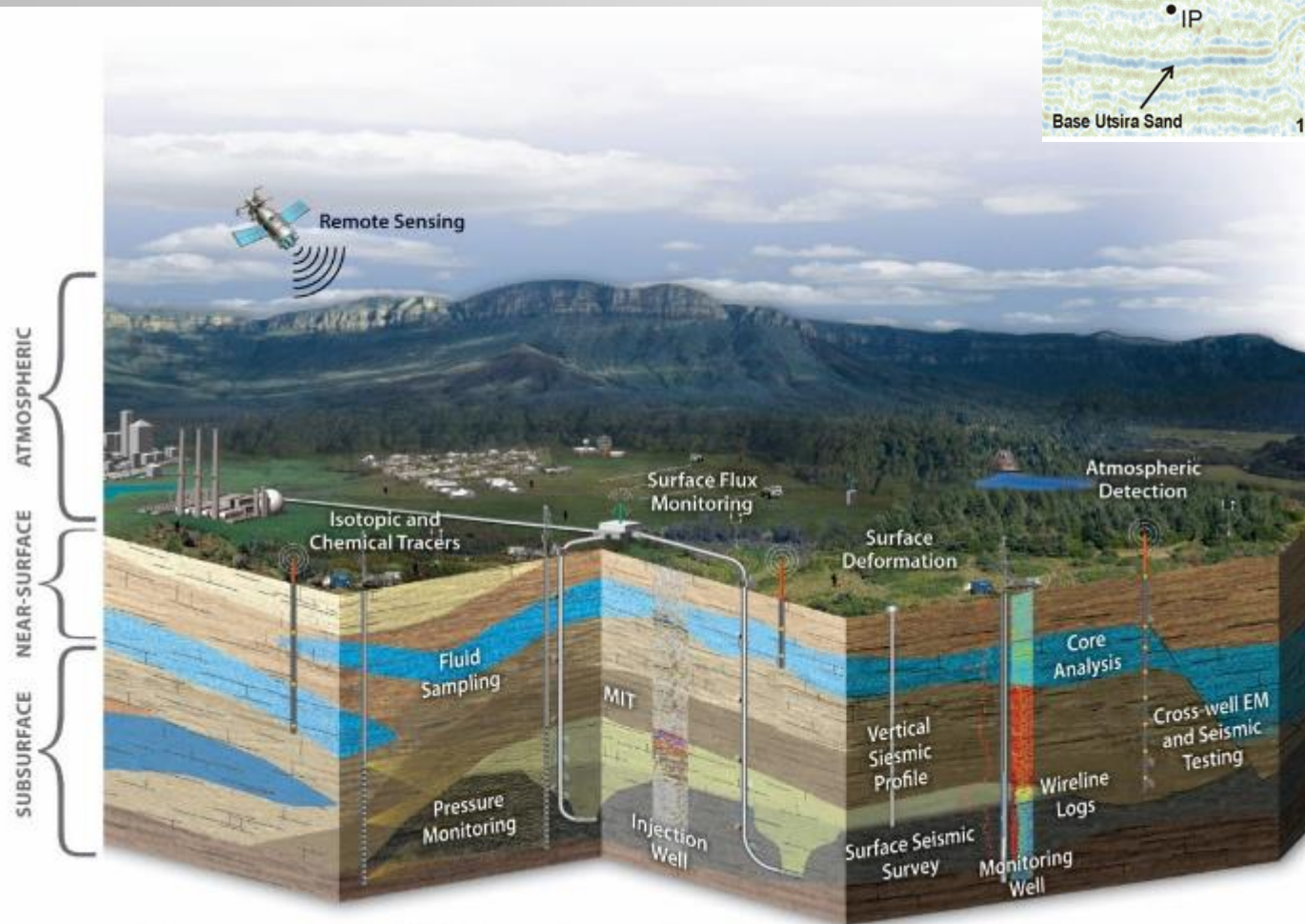
➤ Caracterização do site



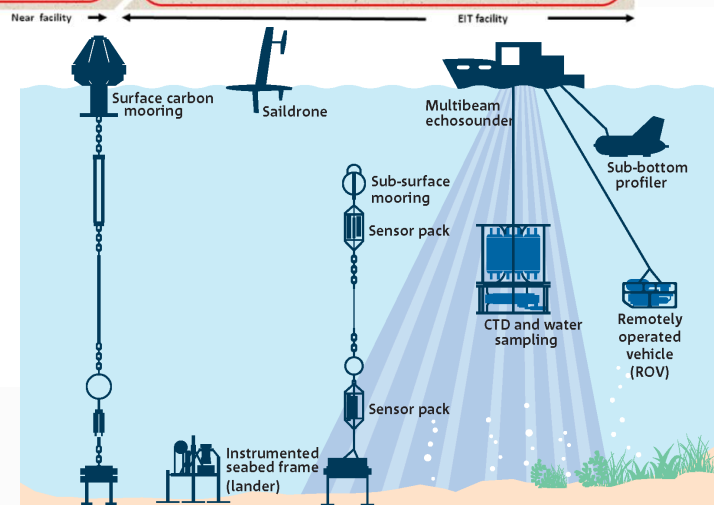
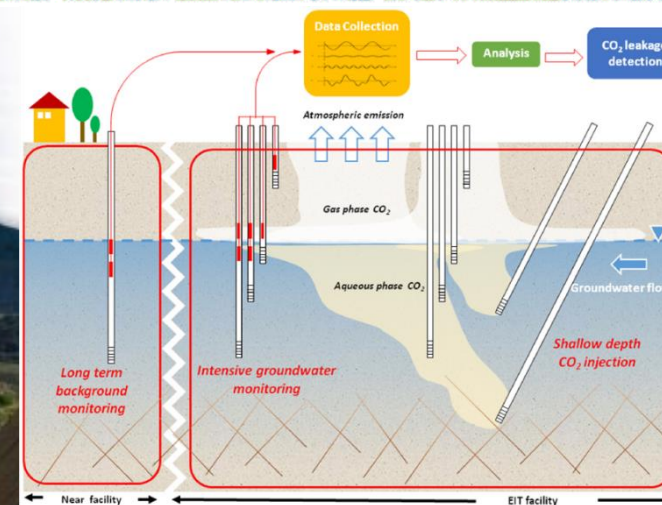
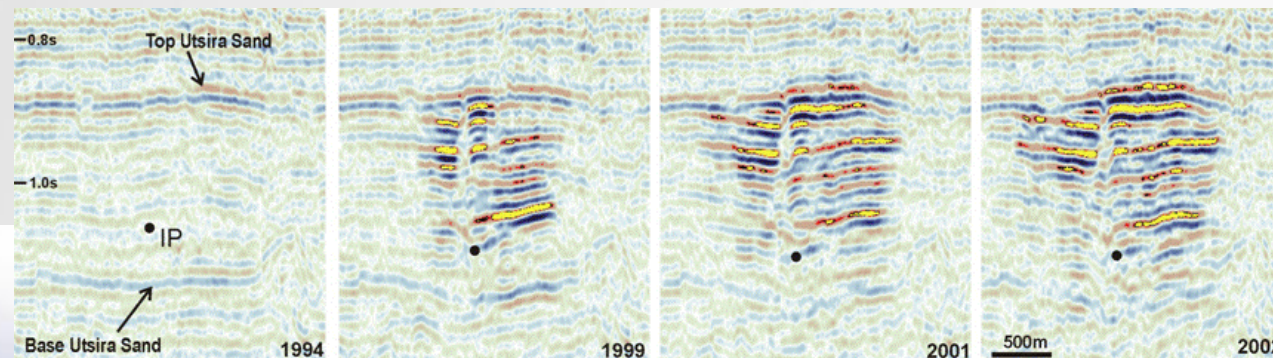
➤ Interações CO₂-reservatório/poço



➤ Monitoramento

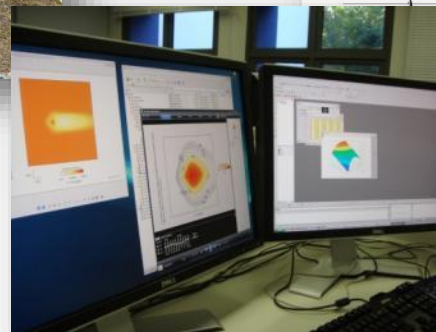
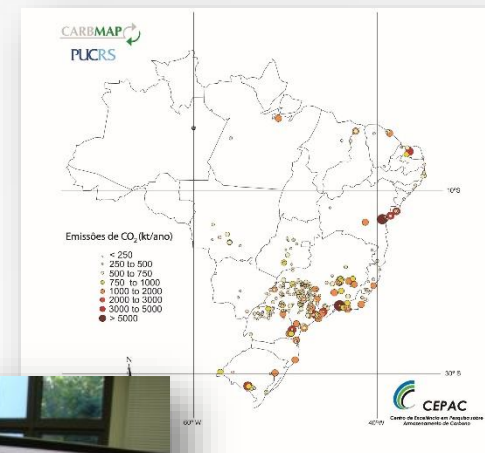
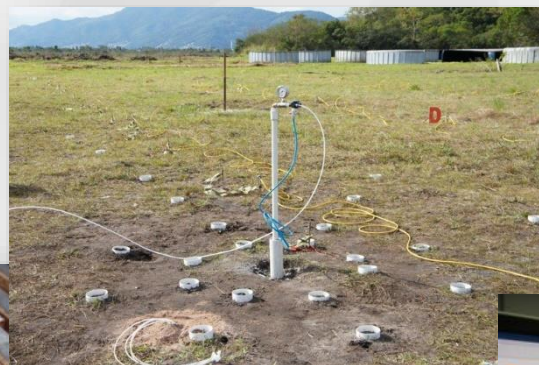
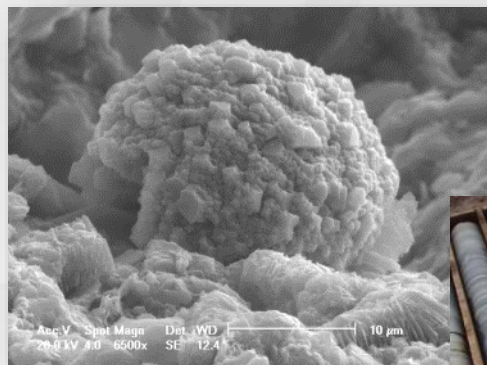


Background Image Courtesy of Schlumberger Carbon Services

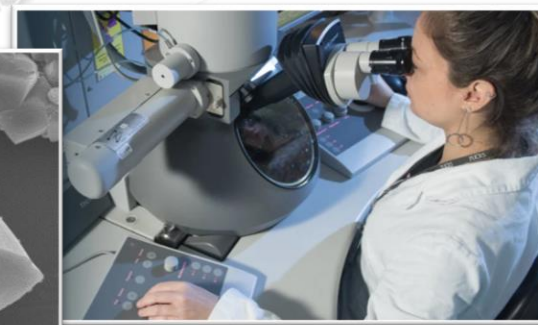
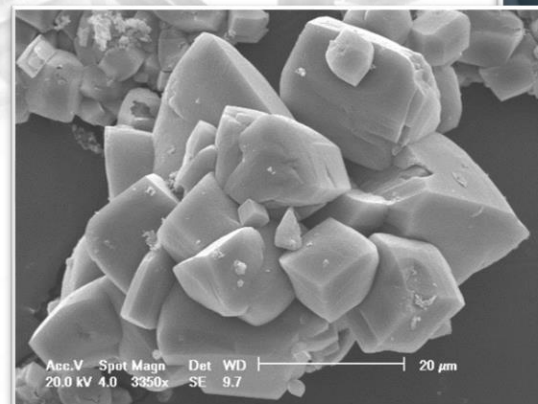
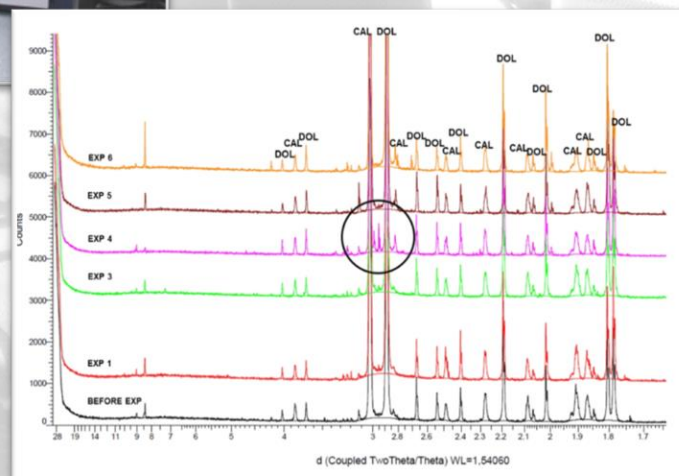
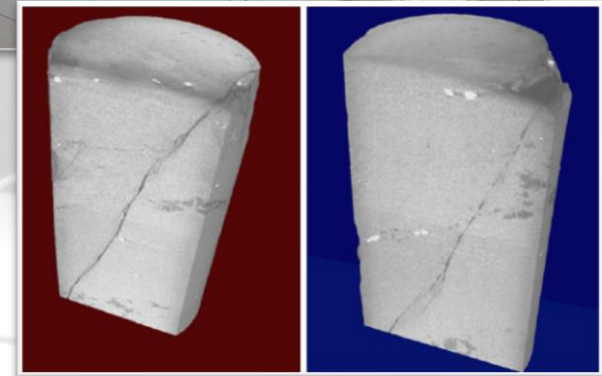
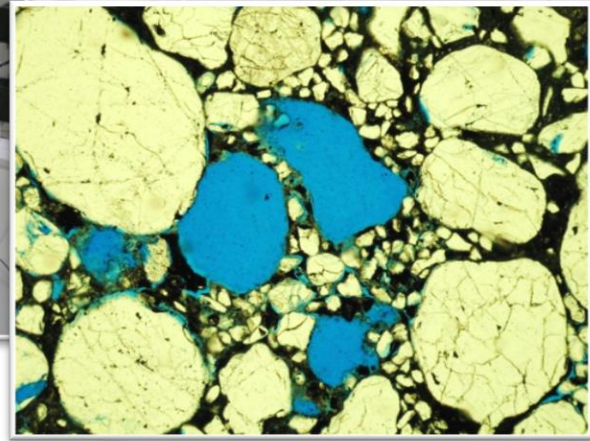


P&D no IPR/PUCRS

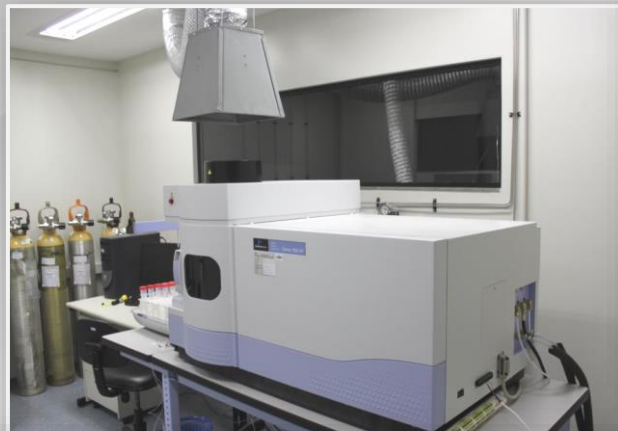
- Caracterização de reservatório e selo
- Interações CO₂-reservatório/poço (modelagem experimental e numérica)
- Mapeamento de fontes de CO₂ e acoplamento com potenciais reservatório
- Monitoramento ambiental
- Capacitação em CCUS



A laboratory instrument, likely a microanalyzer, featuring a sample holder with multiple sample positions and a detector unit on top. The instrument has a control panel with a dial and three buttons (black, green, red).

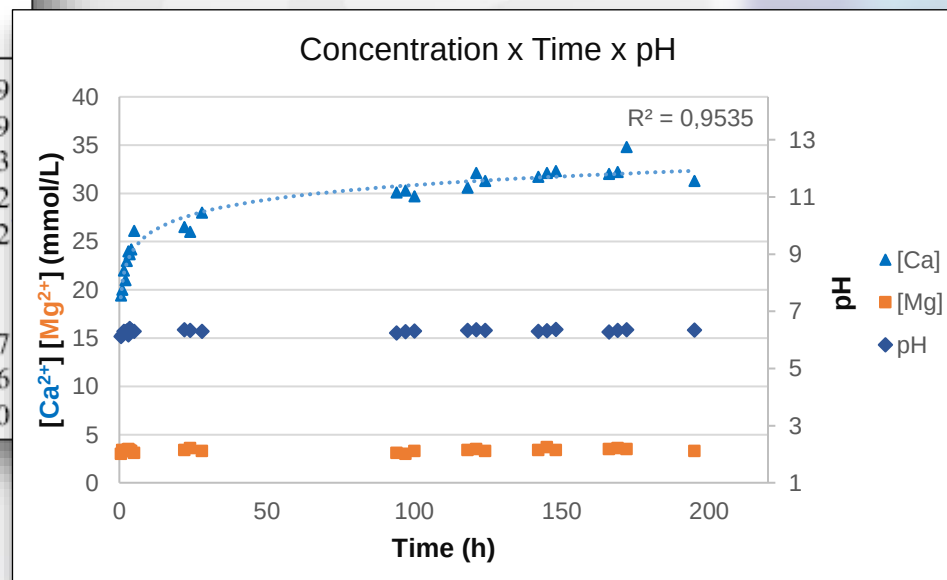


Caracterização fluidos



Water chemistry (in millimole/kg)

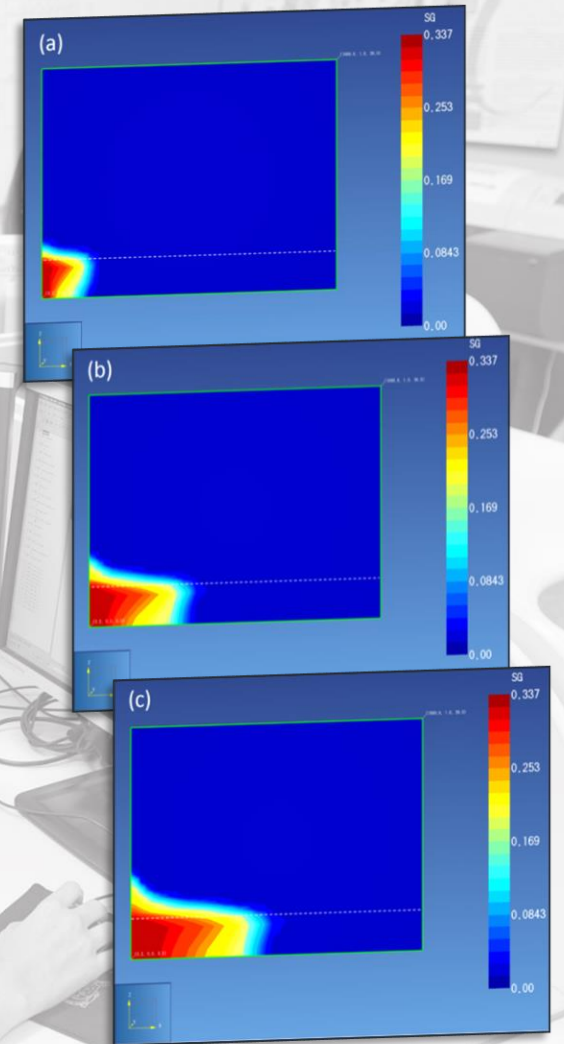
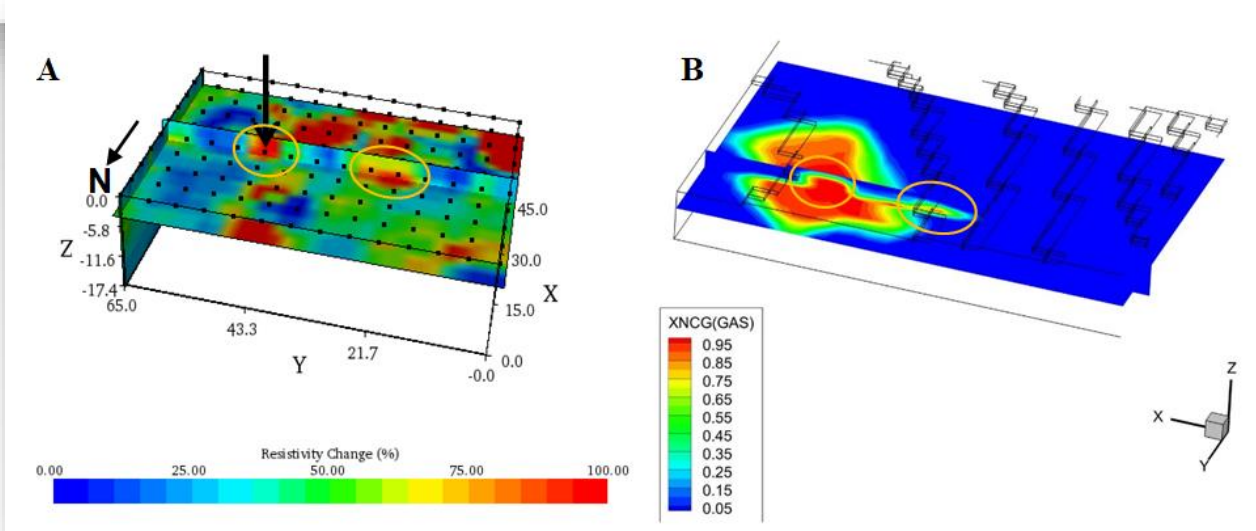
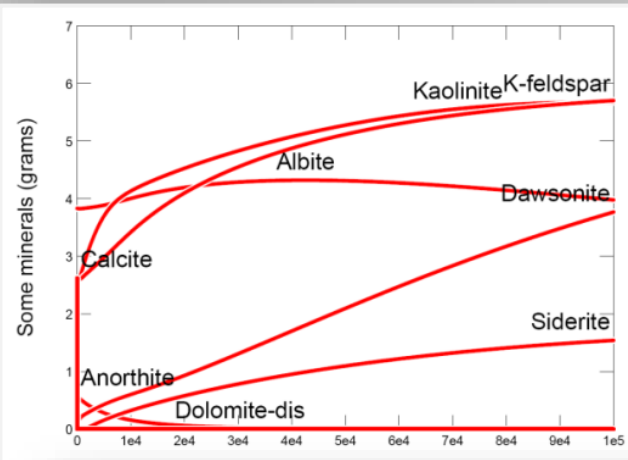
Time (h)	pH ^a	Na	K	Ca	Mg	Cl
Initial brine	7.15	1927	752	15.6	1403	5659
502		1618	586	16.8	1123	4679
670	4.73	1892	629	20.0	1172	4683
1005	4.70	1931	611	20.5	1185	4612
1412	4.86	1892	611 ^b	20.5	1185 ^b	4612
<i>CO₂ inject</i>						
1413						
1487	5.33	2251	831	30.2	1634	5777
2013	5.63	1679	675	18.5	1279	5346
3335	5.61	1644	639	17.6	1201	5300



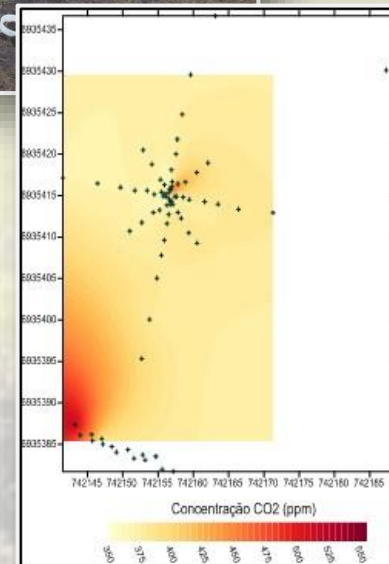
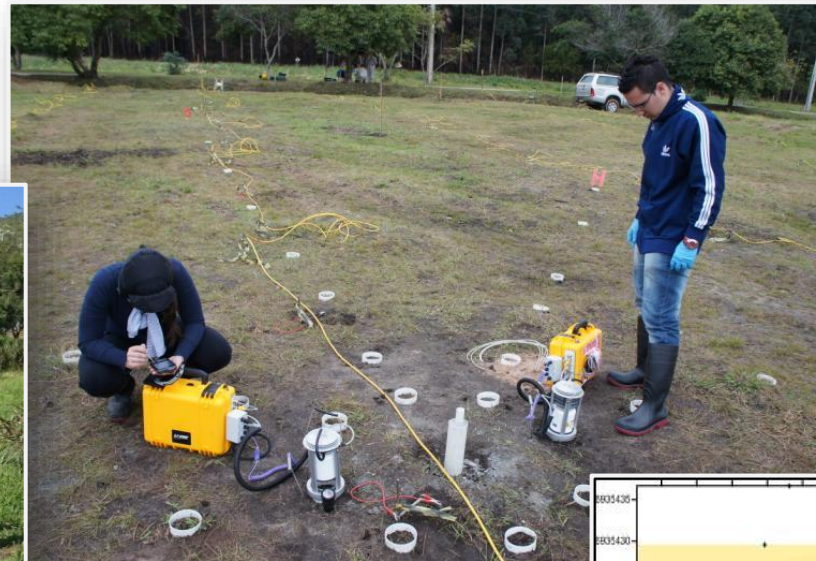
Modelagem experimental



Modelagem numérica



Monitoramento ambiental



Projetos 2007-2019



Interação CO₂-rocha-fluido Campo de Buracica (Fm. Sergi), Bacia do Recôncavo. (PETROBRAS)

Integridade de reservatórios de petróleo, Campos de Enchova e Siri, Bacia de Campos. (PETROBRAS)

Geoquímica do Pré-sal: Projeto GEOQUIPS. (PETROBRAS)

Previsão de qualidade de reservatório no Pré-sal: Projeto PREVISAL. (PETROBRAS)

Estudo comparativo de medidas de permeabilidade relativa em regimes transiente e permanente em reservatórios do pré-sal - Projeto PERMEAR (PETROBRAS)

Diagênese de reservatórios do Santoniano, Bacia de Santos. (PETROBRAS)

Interação CO₂-rocha-fluido Fm. Furnas e Ponta Grossa, Bacia do Paraná. (PUCRS)

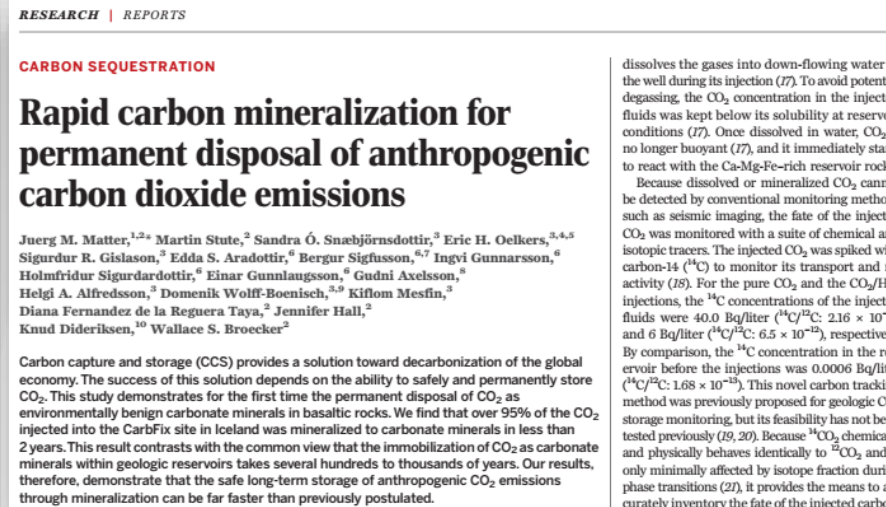
Interação CO₂-rocha-fluido Fm. Rio Bonito, Bacia do Paraná. (PUCRS, CNPq)

Interação CO₂-rocha-fluido Fm. Rio Bonito, Palermo e Irati, Bacia do Paraná. (PETROBRAS, CNPq)

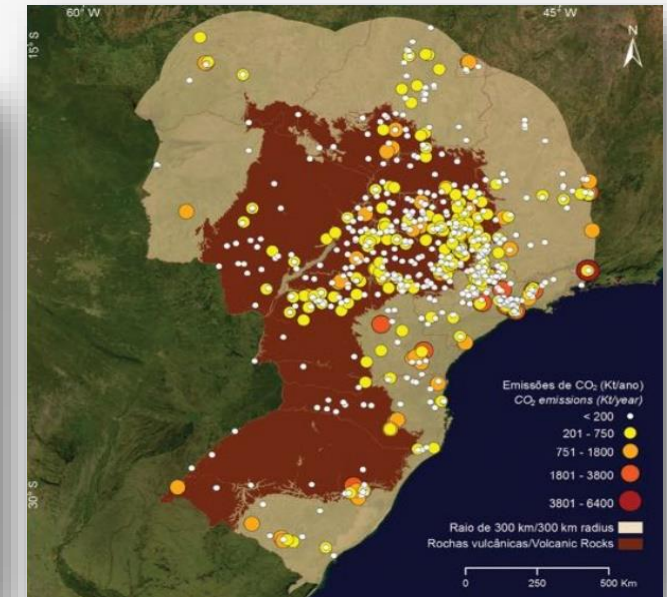
Projeto Experimental de Tecnologias Avançadas para Medição, Monitoramento e Verificação (MMV) de CO₂ em Sites de Armazenamento Geológico - PROJETO CO₂MOVE

Armazenamento CO₂ em rochas ígneas

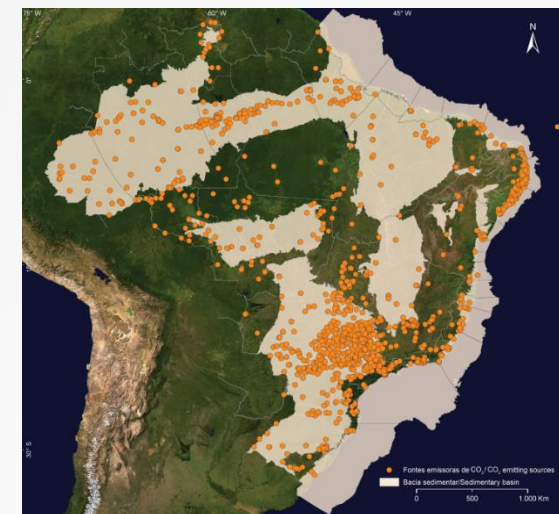
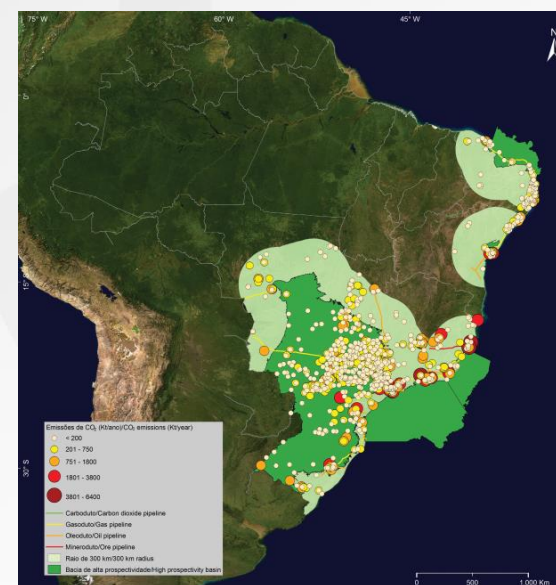
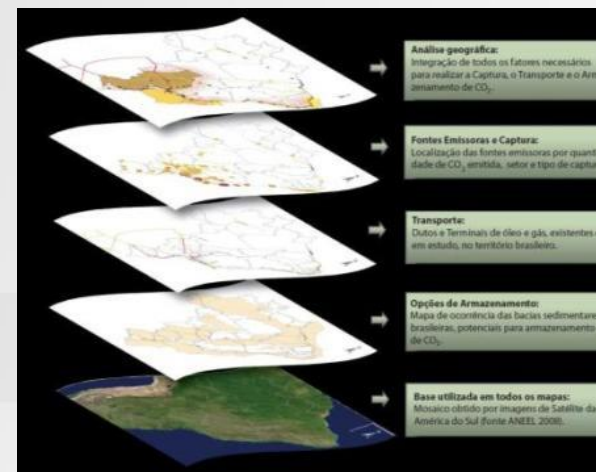
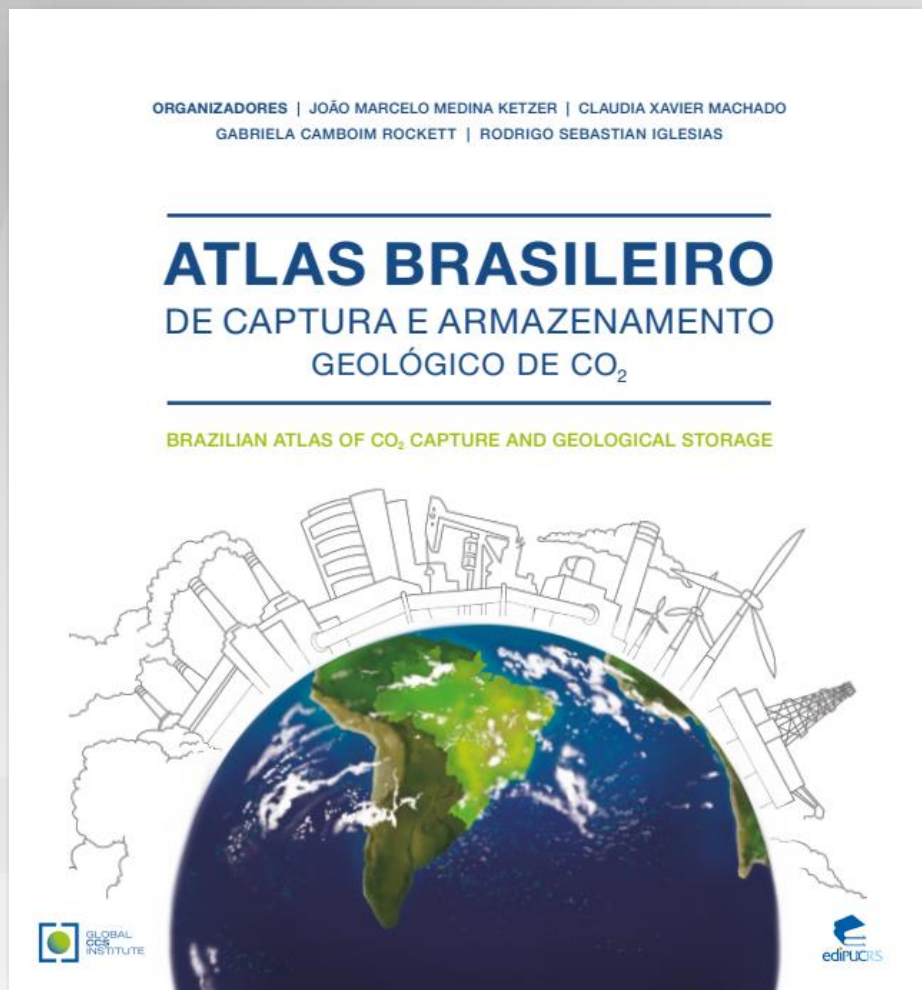
- Potencial de armazenamento em basaltos – rápida mineralização de CO₂ injetado, observada em 2 anos (projetos piloto na Islândia e EUA)
- Bacias da margem leste brasileira com rochas vulcânicas associadas
- Modelagem interações CO₂-basaltos do RS



Science 2016;352(6291):1312–4.



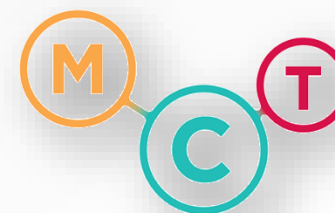
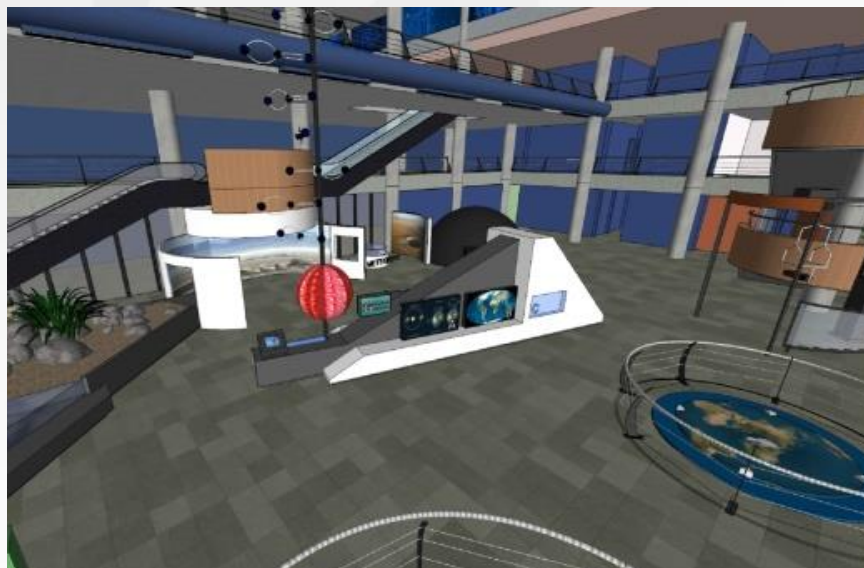
Atlas Brasileiro



Capacitação em CCUS

- Capacity building on CCUS:
4 training courses
(basic and advanced)
- Museum exhibit on climate change & CCUS started 2020
(CSLF funded)

Understanding
Carbon
Capture and
Storage



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Obrigado pela atenção



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