

Risk Considerations of Transitioning CO₂-EOR Field to CO₂-storage Field: Case Study

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Outline

- **Background**
- **Motivation and Objectives**
- **Scenarios Design and Description**
- **Preliminary Results**
- **Discussion and Remarks**
- **Next Steps**

NRAP leverages DOE's capabilities to quantitatively assess and manage long-term environmental risks amidst geologic uncertainty and variability.



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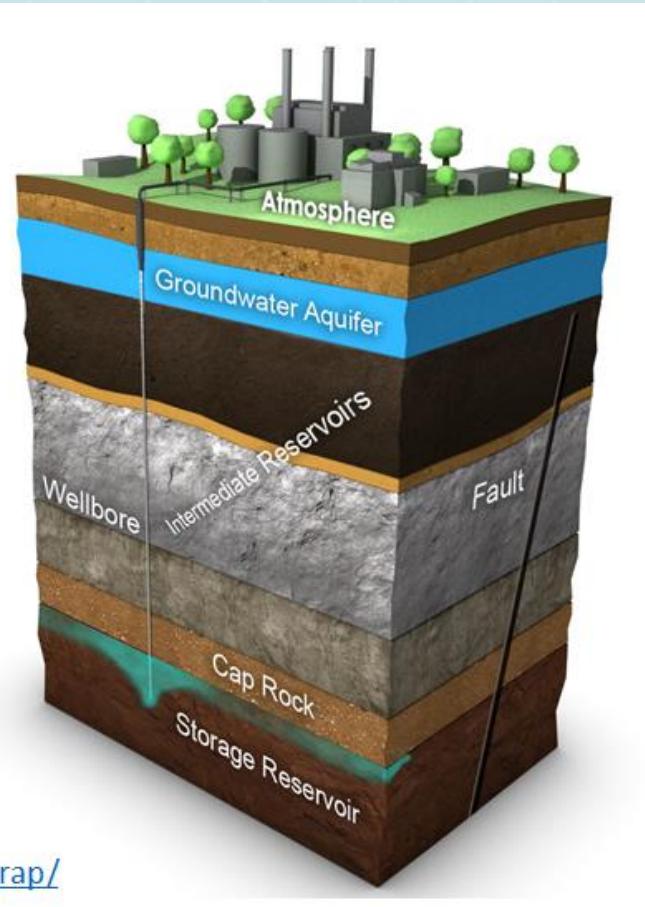
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NRAP Website: <https://edx.netl.doe.gov/nrap/>



A 3D perspective view of a geological cross-section showing various layers of the earth. The layers are labeled from top to bottom: Atmosphere, Groundwater Aquifer, Intermediate Reservoirs, Wellbore, Fault, Cap Rock, and Storage Reservoir. A factory with smokestacks is shown on the surface, and a wellbore extends downwards through the layers.

Motivation and Objectives

- Develop a conceptual & numerical simulation workflow that enables risk assessment of the transition of existing Class II CO₂-EOR injection wells to Class VI for dedicated CO₂ storage.
- Conduct numerical simulation of a realistic and practical CO₂-EOR field site transitioning.
- Develop and test a prototype reduced-order model to forecast CO₂, brine, and hydrocarbon potential leakage through wells.
- Explore influence of scenario responses reservoir that can support stakeholder decision makings for Class II to Class VI transition.



Geologic Sequestration of Carbon Dioxide

Draft Underground Injection Control (UIC) Program Guidance on Transitioning Class II Wells to Class VI Wells



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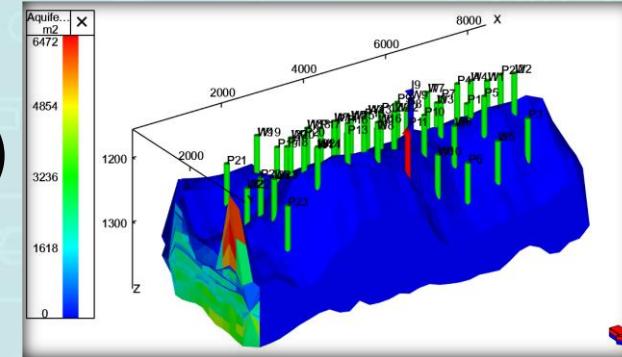
Class I Industrial and Municipal Waste Disposal Wells

Final Class VI Guidance Documents

This list of Final Class VI guidance documents below are prepared to assist:

Scenario Design

- CO₂ interaction with hydrocarbon reservoir: (Scenarios 1, 2, and 3)
- Compared hydrocarbon & saline reservoir conditions (Scenarios 2 & 4)
- Boundary condition impacts (Scenarios 2 & 3 and 4 & 5)



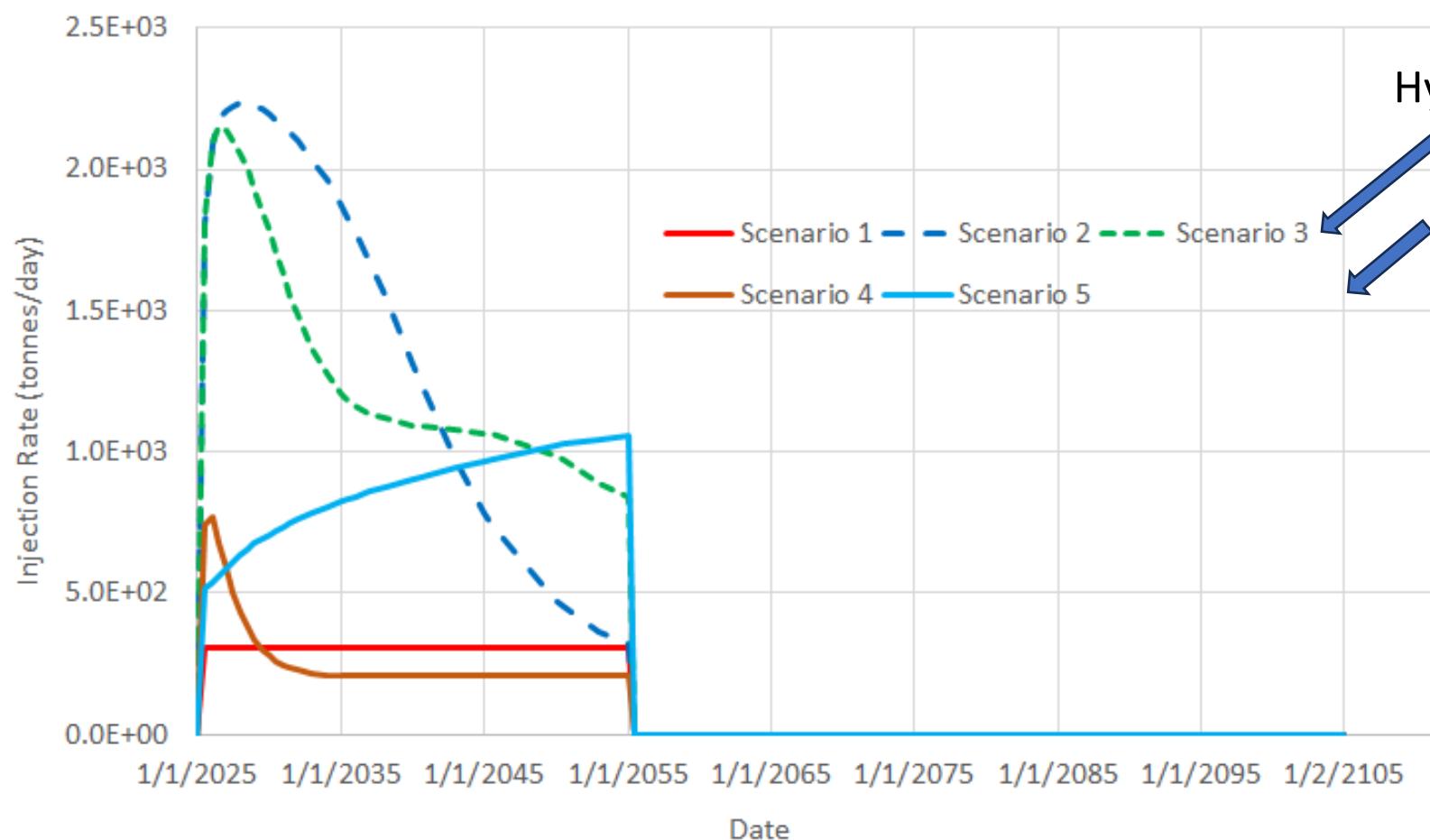
Jia W. and McPherson B., DOI:
 10.18141/1465116

Injection Cases		Reservoir Conditions	Boundary Conditions
Scenario 1	Bussiness-as-usual injection rate	Hydrocarbon reservoir	One side open
Scenario 2	Dedicated CO ₂ injection (1 MT/year)	Hydrocarbon reservoir	One side open
Scenario 3	Dedicated CO ₂ injection (1 MT/year)	Hydrocarbon reservoir	All sides open
Scenario 4	Dedicated CO ₂ injection (1 MT/year)	Saline reservoir	One side open
Scenario 5	Dedicated CO ₂ injection (1 MT/year)	Saline reservoir	All sides open

Liu G., Dilmore R., Strazisar B., Lackey G., Class II to Class VI Well Operations - Insights from Simulation-Based Investigation of CO₂-EOR to Dedicated Storage Scenario. United States: N. p., 2023. Web.

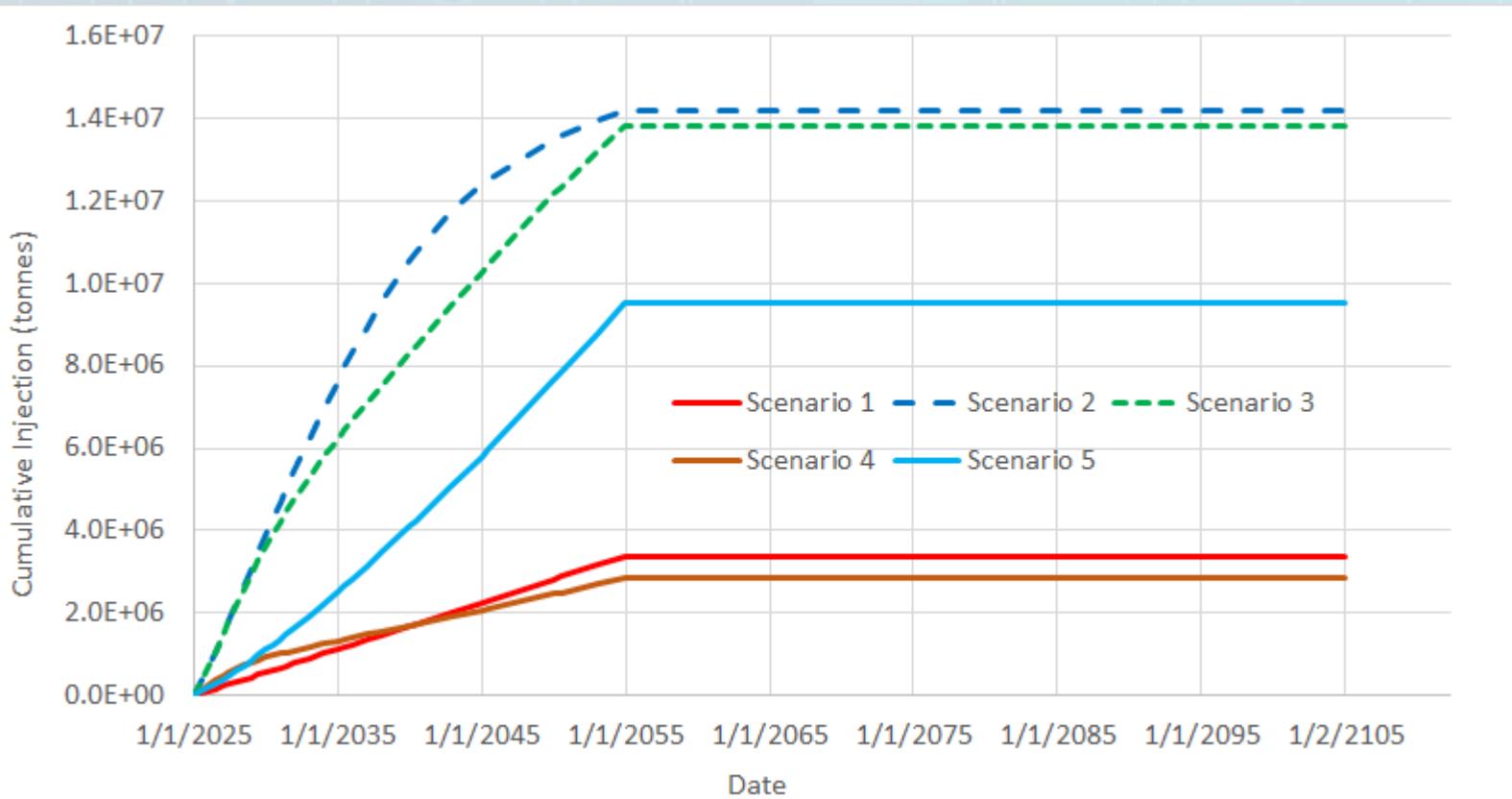
Single well, 30 years injection, and 50 years post-injection

Injection Rate Profile

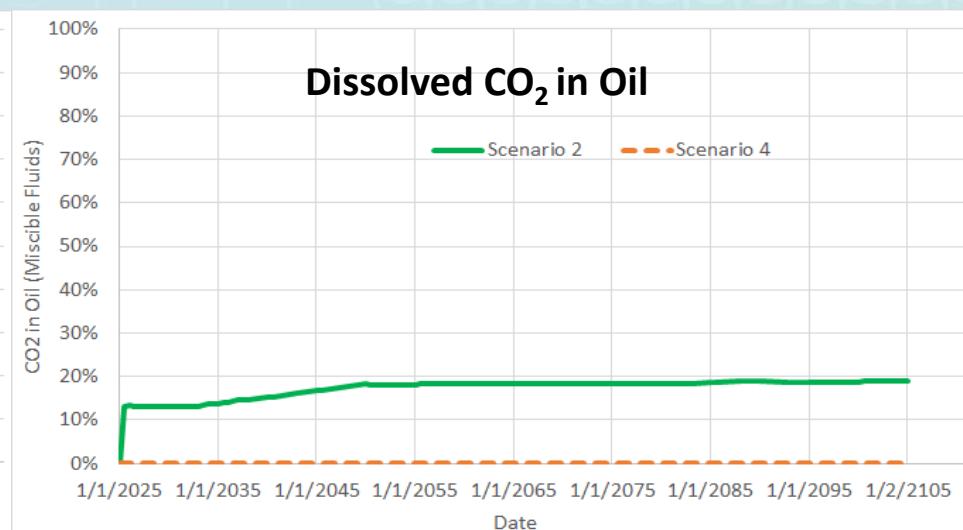
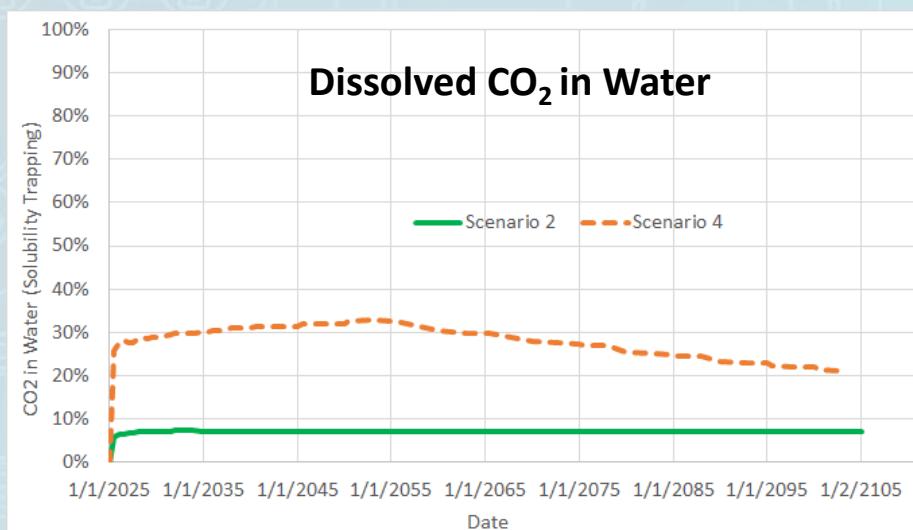
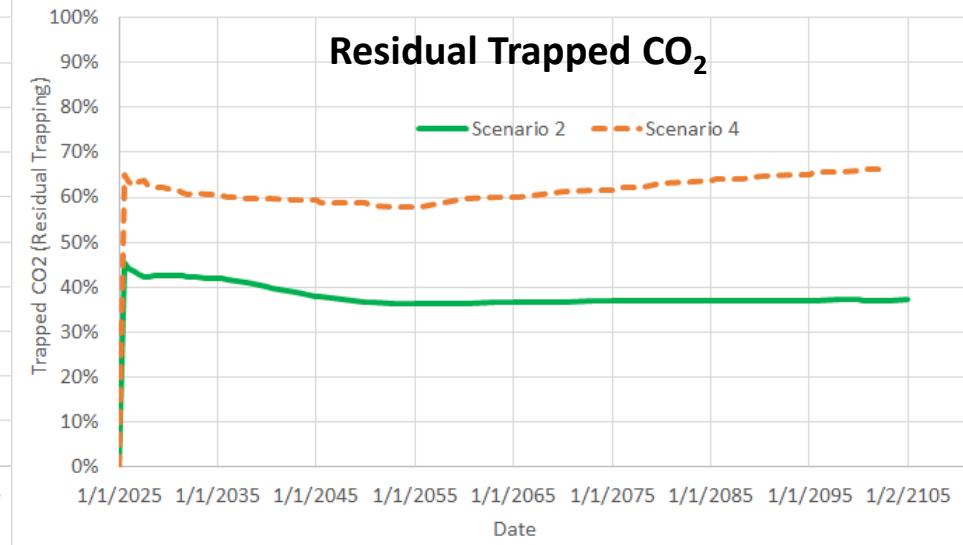
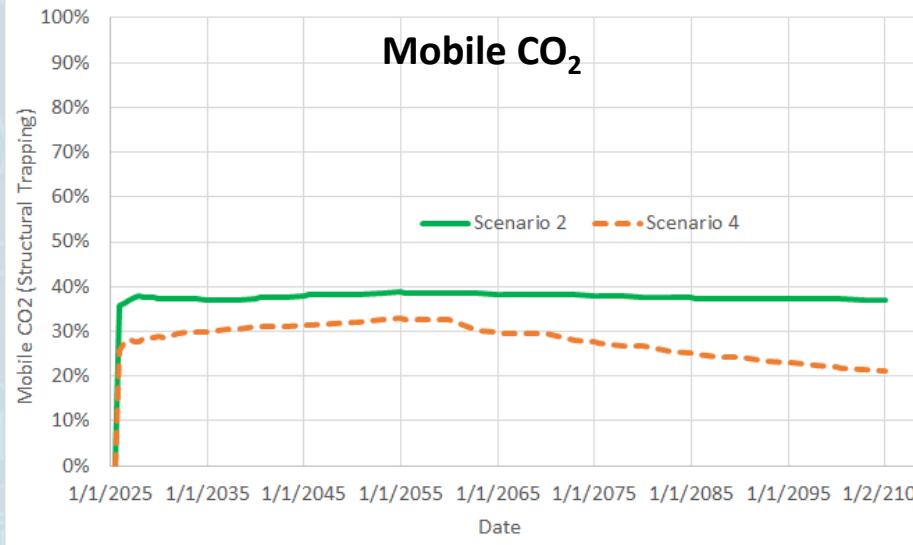


- Hydrocarbon reservoir condition stores more CO₂ except scenario 1, business-as-usual (BAU, low CO₂ injection rate)
- Opening all sides boundary significantly impacts on the injection (Liu G., et al., 2023)

Cumulative Injection Profile

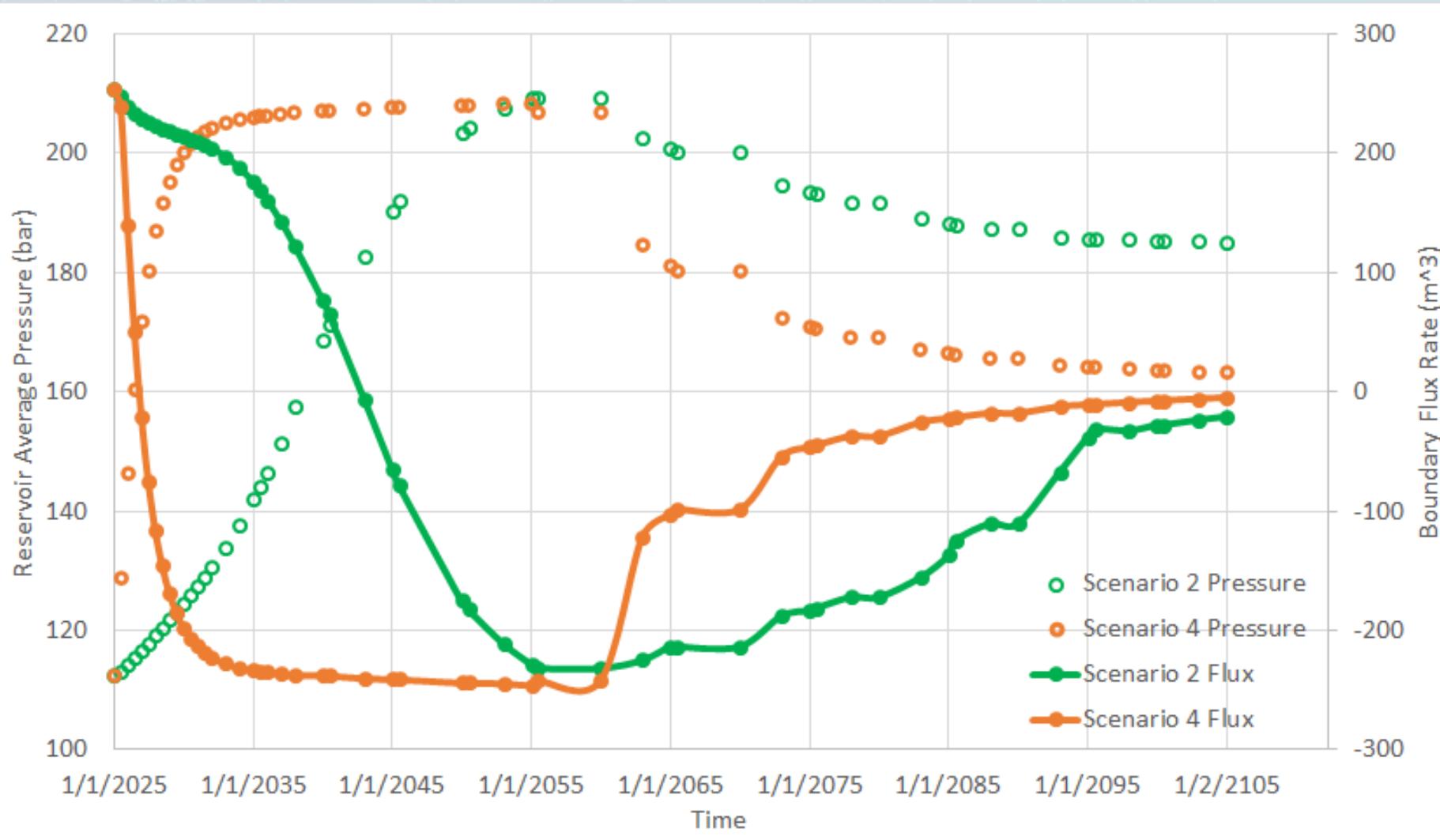


- Hydrocarbon reservoir condition can be injected more CO₂ except scenario 1, BAU
- Opening all sides boundary is much significant in saline reservoir than hydrocarbon reservoir- majorly because of fluids flow mechanisms



- Hydrocarbon reservoir does more CO₂ retention than saline reservoir due to miscible behaviors with CO₂ majorly
- Saline reservoir stores more CO₂ in water and residual trapping than hydrocarbon reservoir because of solubility rock-fluid interactions

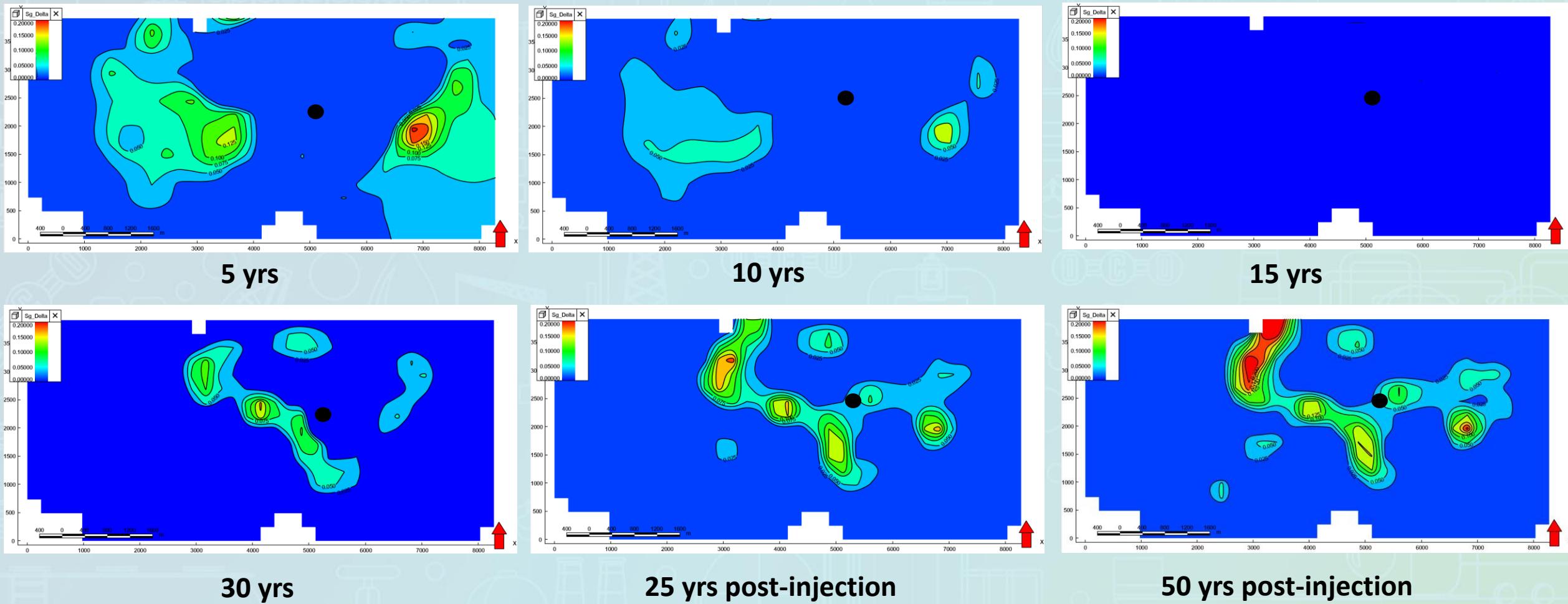
Boundary Flux Profile



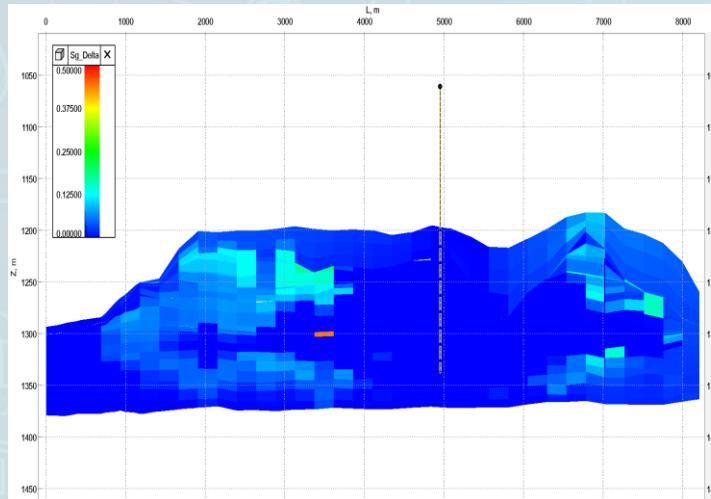
- Pressure and flux response in saline reservoir is much quicker than hydrocarbon reservoir
- Major reasons result in the differences are the miscible flow with CO_2 and compressibility of the fluids

Scenario 2: CO₂ Plume Difference by Prior to CO₂ Injection (Top view)

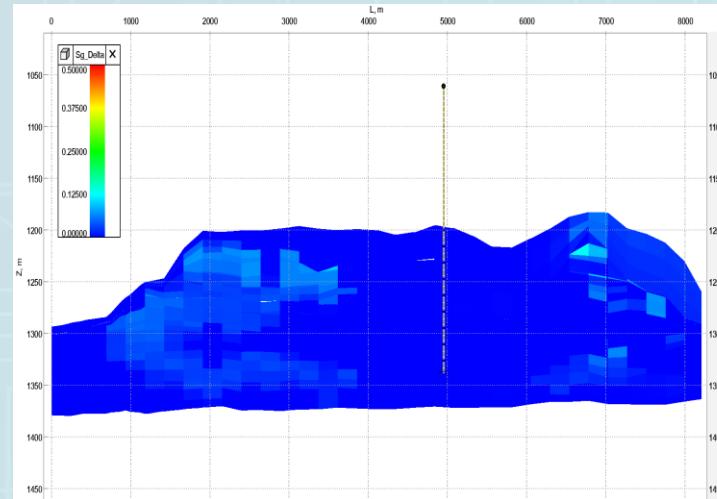
Minimum miscible pressure (MMP) is ~1,850 psi. What happen if reservoir pressure is below and above MMP?



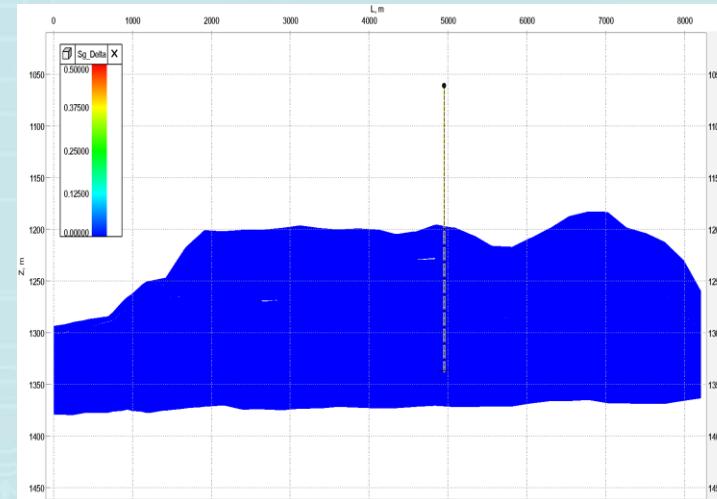
Scenario 2: CO₂ Plume (Cross-sectional view)



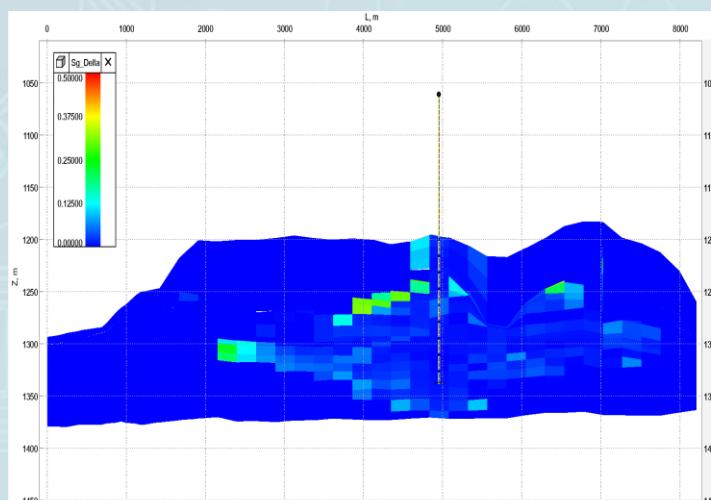
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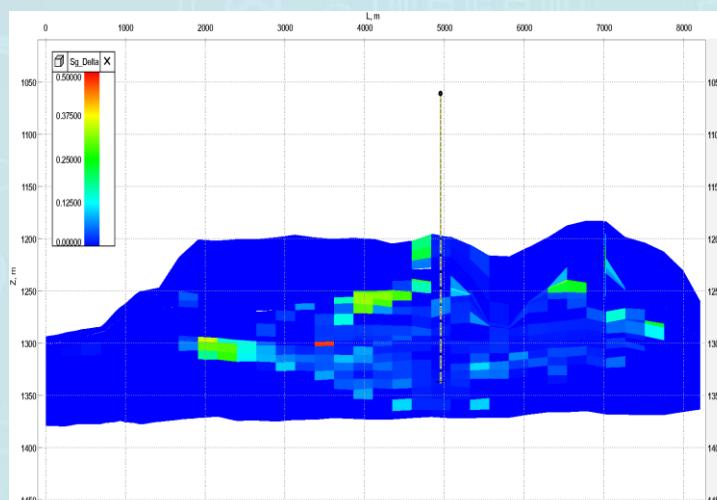
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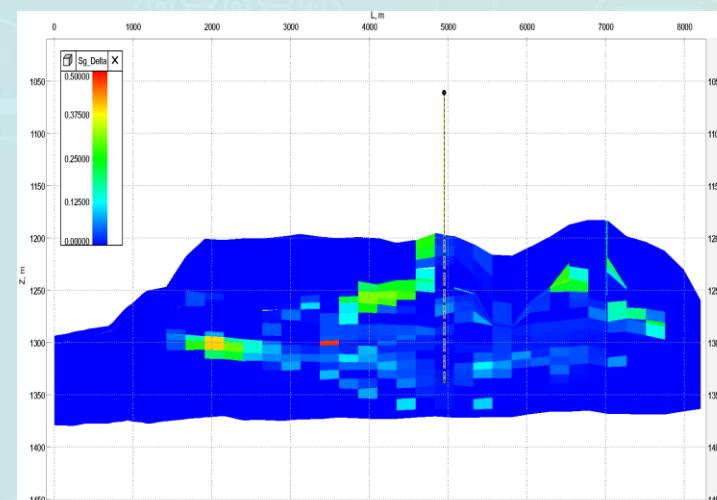
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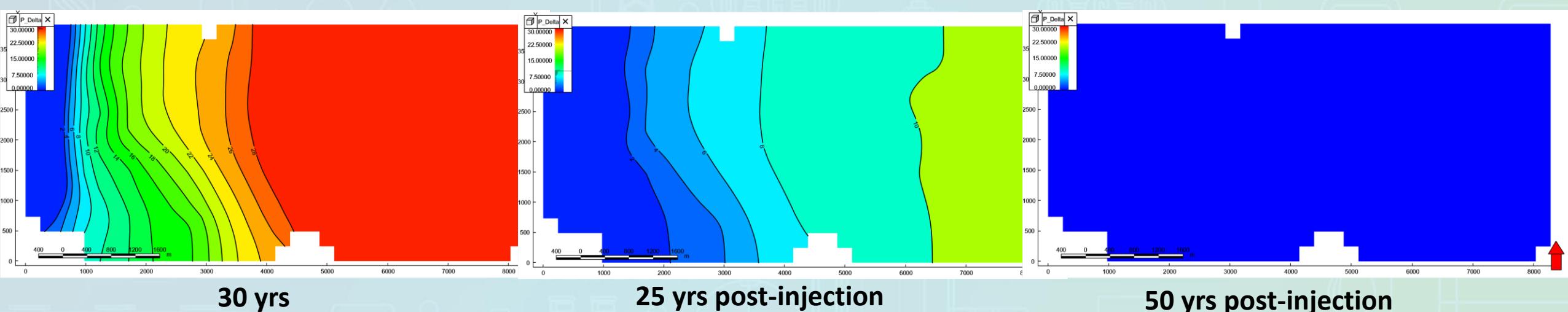
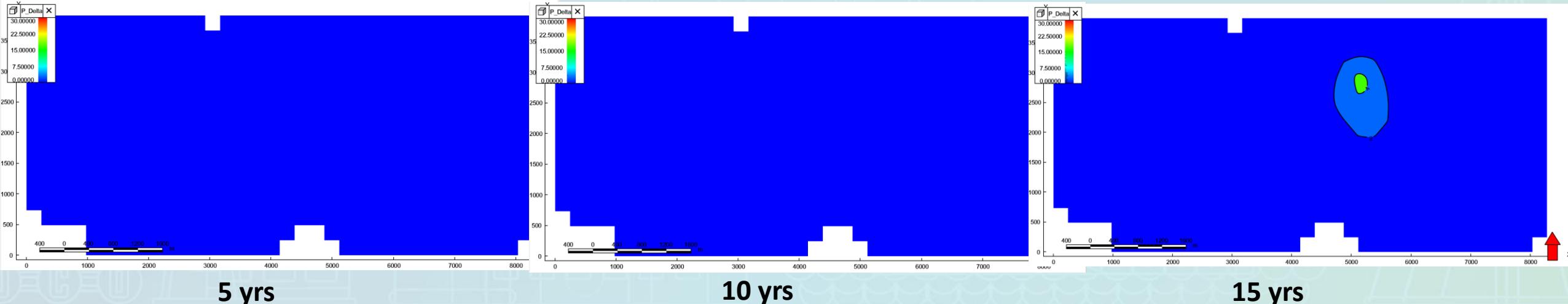


25 yrs post-injection

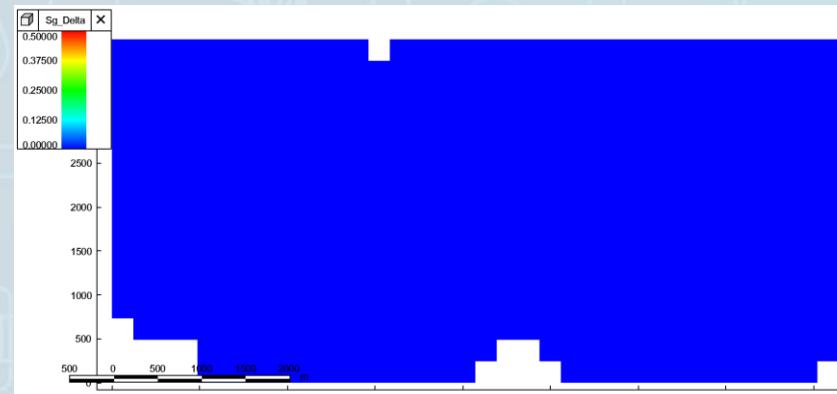


50 yrs post-injection

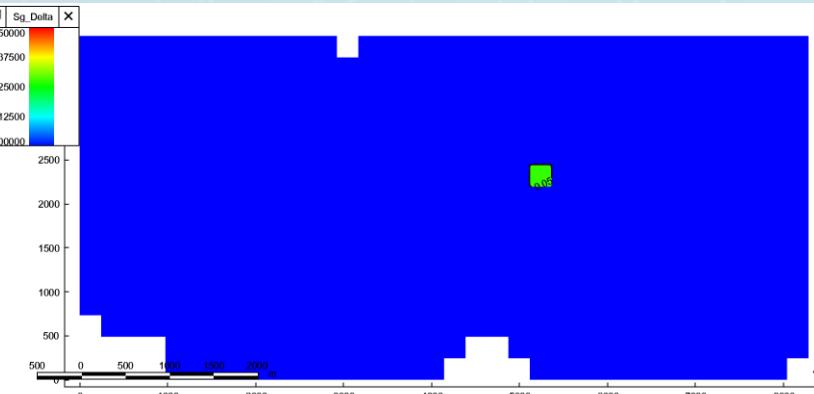
Scenario 2: Pressure Difference Maximum 30 bar, 435 psi (Top view)



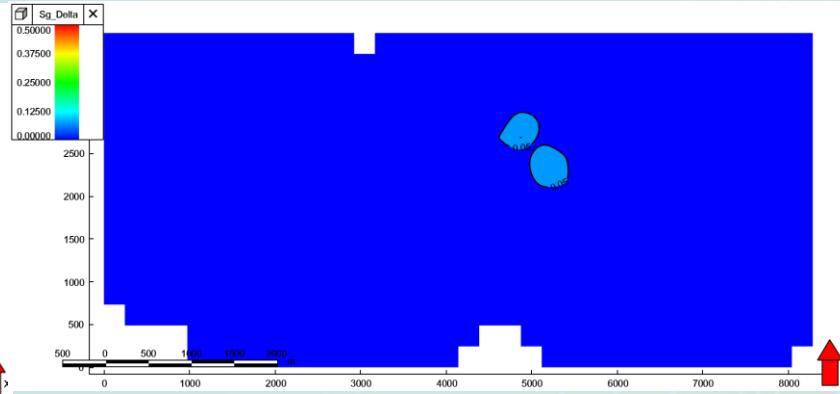
Scenario 4: CO₂ Plume Difference Prior to CO₂ Injection (Top view)



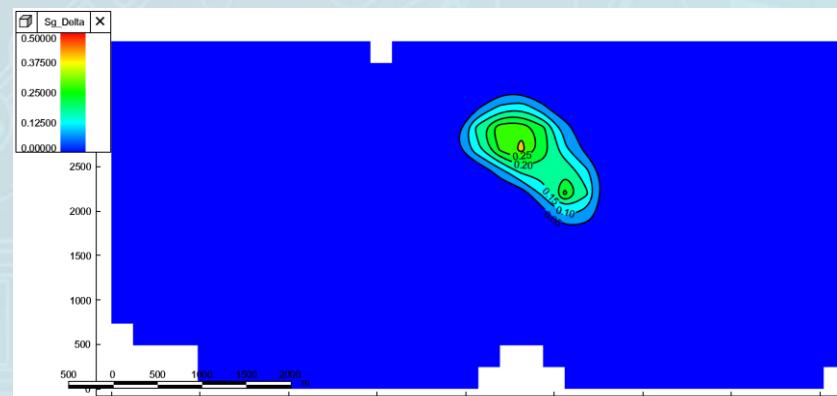
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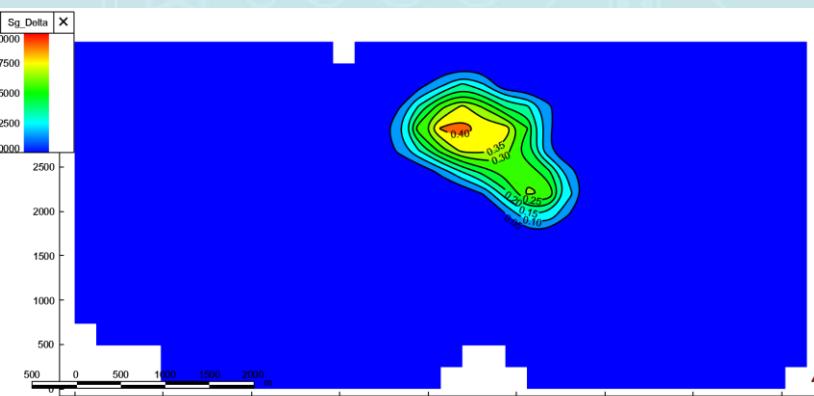
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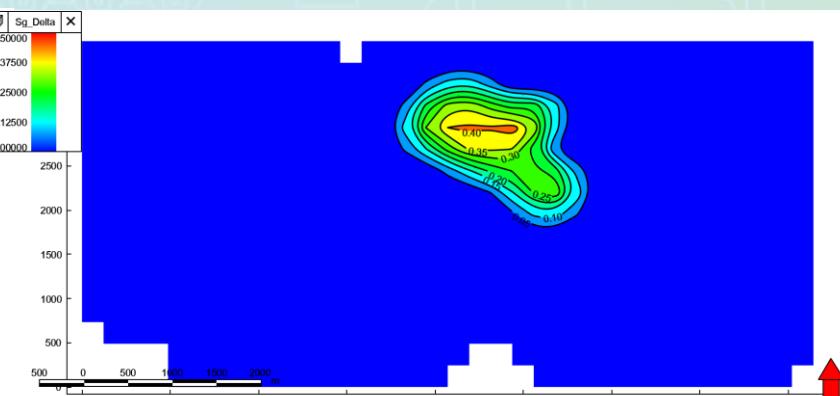
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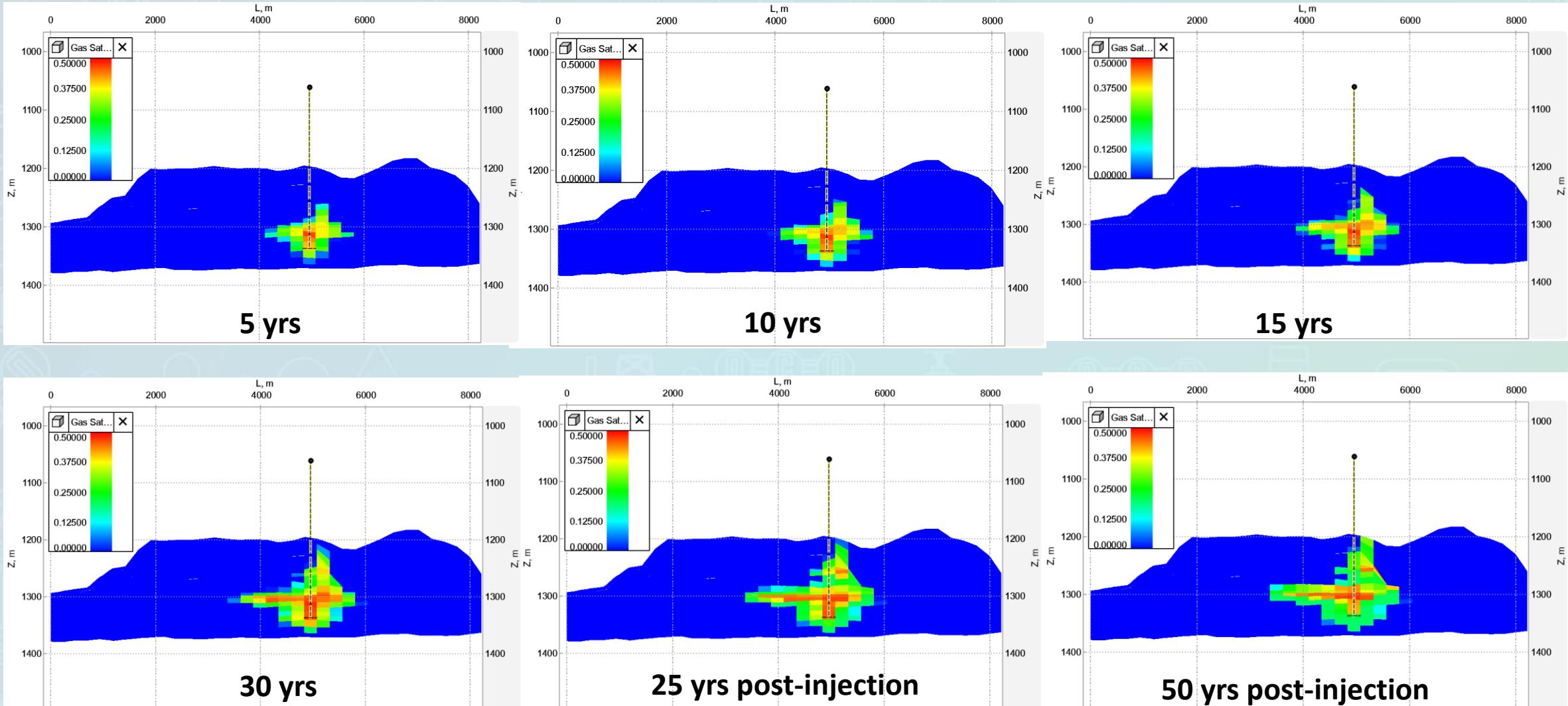


25 yrs post-injection

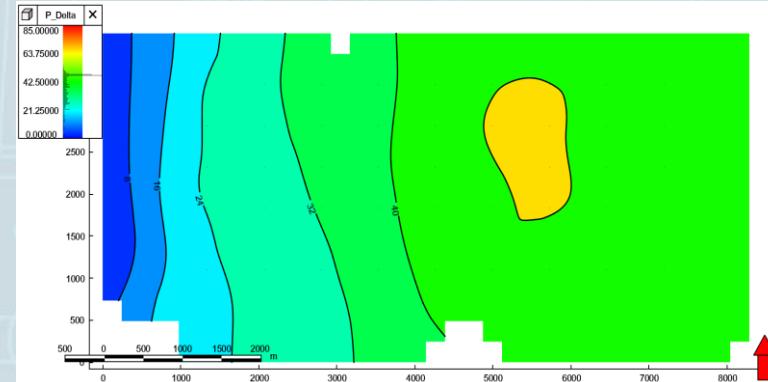


50 yrs post-injection

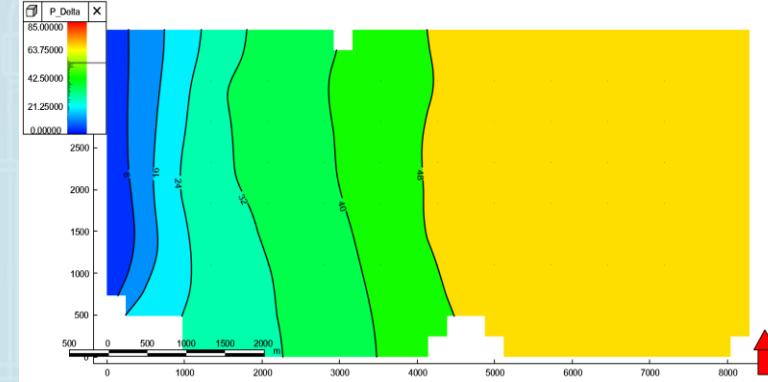
Scenario 4: CO₂ Plume (Cross-sectional view)



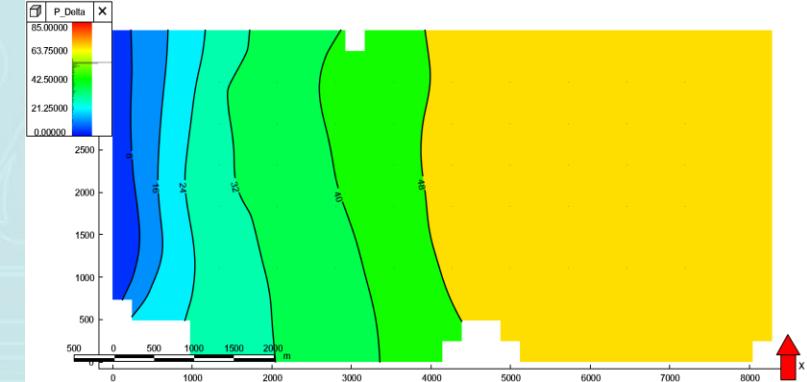
Scenario 4: Pressure Difference Maximum 85 bar, 1233 psi (Top view)



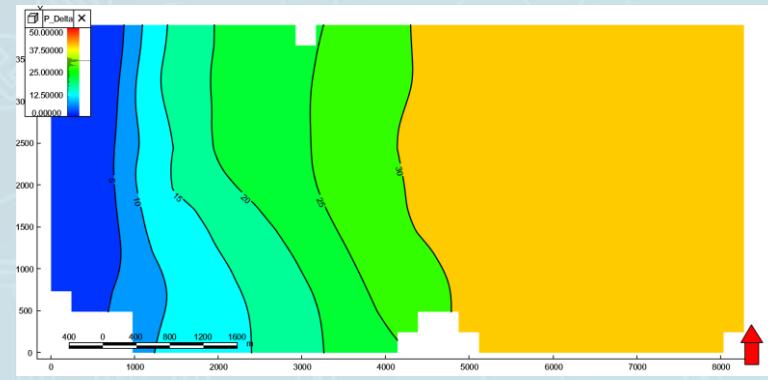
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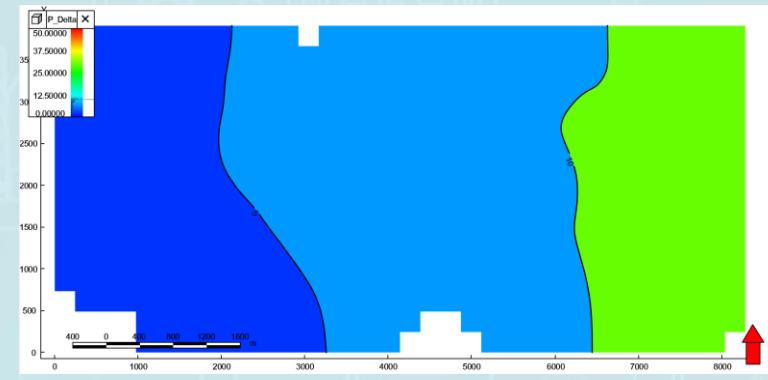
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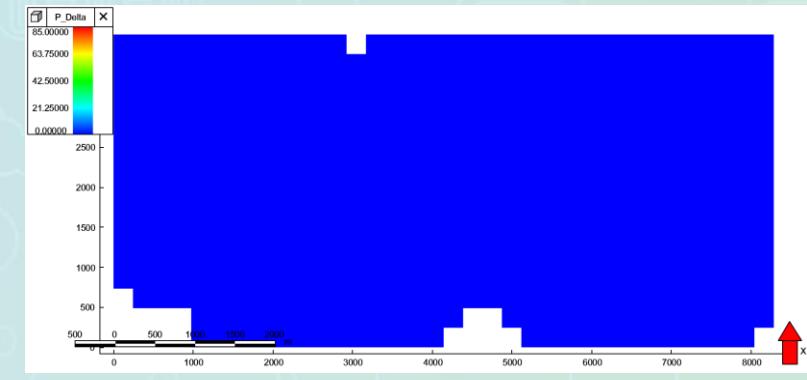
15 yrs



30 yrs



25 yrs post-injection



50 yrs post-injection

Remarks

- CO₂ can be injected more in hydrocarbon reservoir than saline reservoir
- Based on CO₂ storage mechanisms, the CO₂ is much more interacting with hydrocarbon than in the saline reservoir
- Pressure build-up in the hydrocarbon reservoir is lower than in saline reservoir
- However, due to miscible fluid dynamics in hydrocarbon reservoir, there is much larger area of review (AOR) than saline reservoir
- Model domain size is adequate to capture CO₂ plume extend but not pressure propagation

Net Steps

- Continue analysis to quantify risk profile for scenarios regarding to CO₂, brine, and hydrocarbon potential leakage, as well as south-side boundary extension
- Summary the conceptual & numerical simulation workflow and enables risk assessment of transition to Class VI well.

Acknowledgement

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