Risk Considerations of Transitioning CO_2-EOR Field to CO_2-storage Field: Case Study

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Disclaimer

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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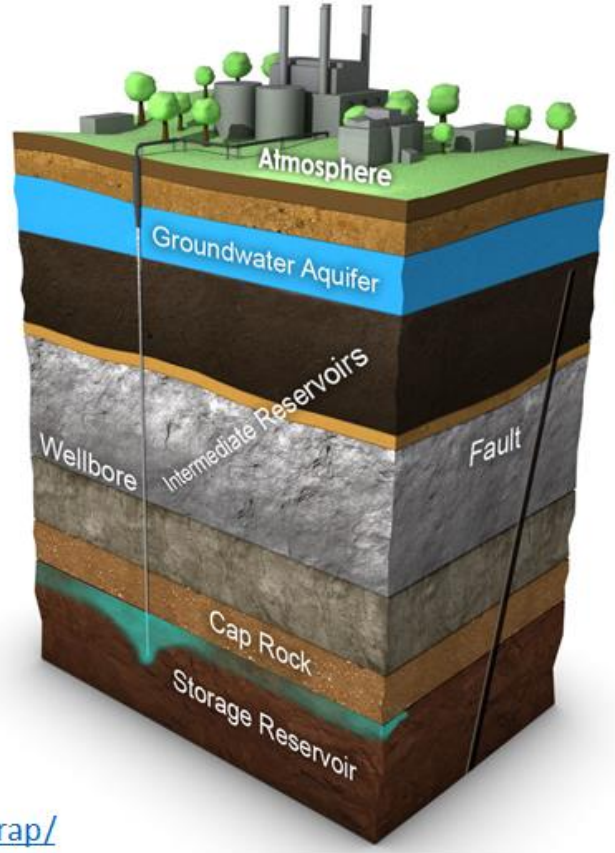

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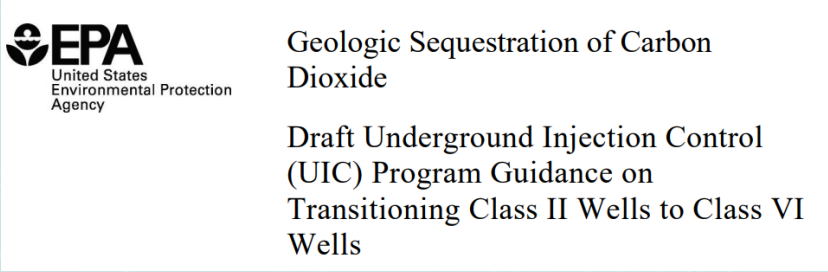
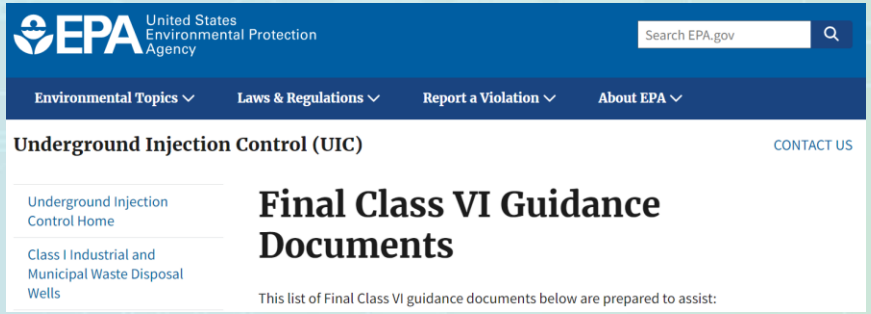
Motivation and Objectives

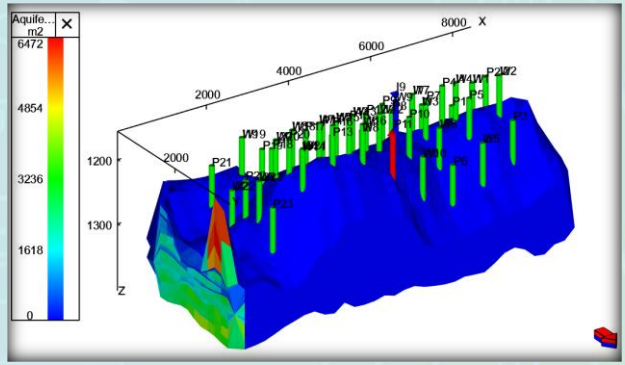
- Develop a conceptual & numerical simulation workflow that enables risk assessment of the transition of existing Class II CO_2-EOR injection wells to Class VI for dedicated CO_2 storage.
- Conduct numerical simulation of a realistic and practical CO_2-EOR field site transitioning.
- Develop and test a prototype reduced-order model to forecast CO_2, 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.





Scenario Design

- CO_2 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)



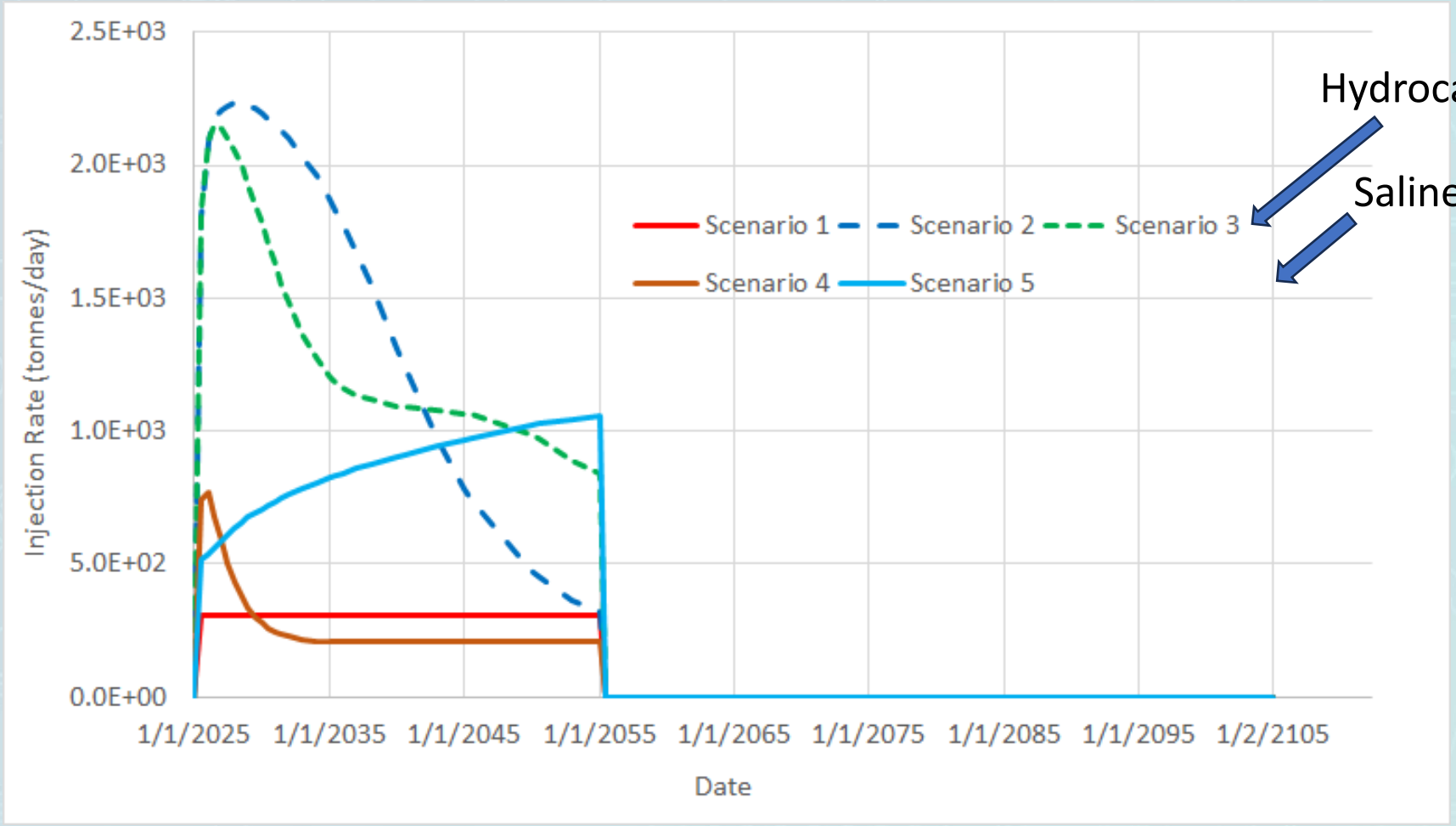
Jia W. and McPherson B., DOI: 10.18141/1465116

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

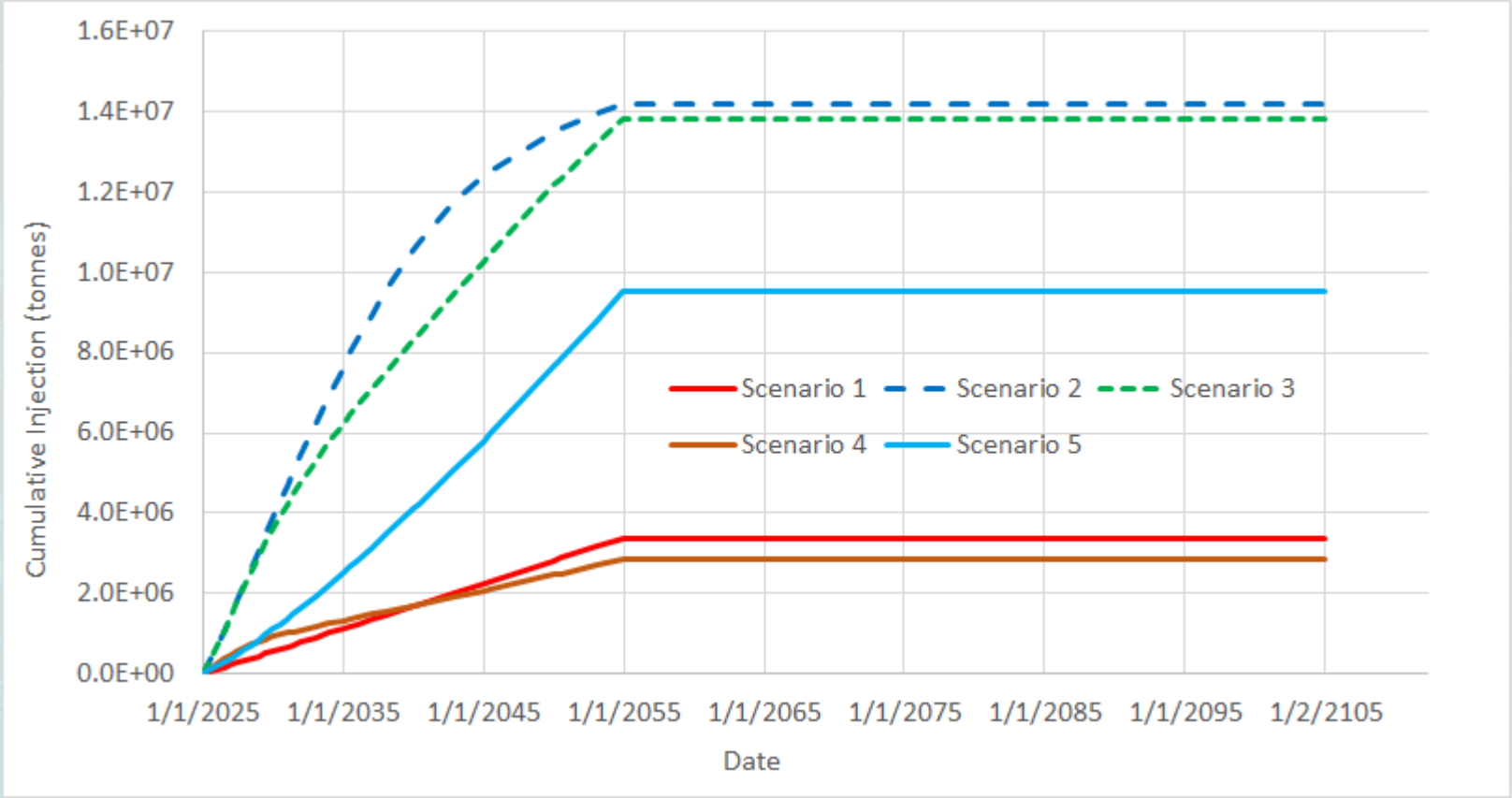


Hydrocarbon reservoir case

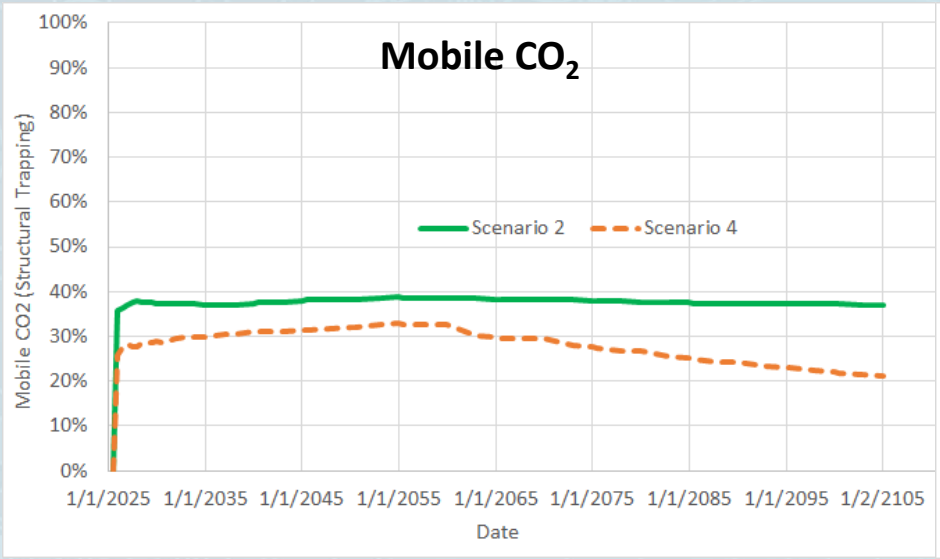
Saline reservoir case

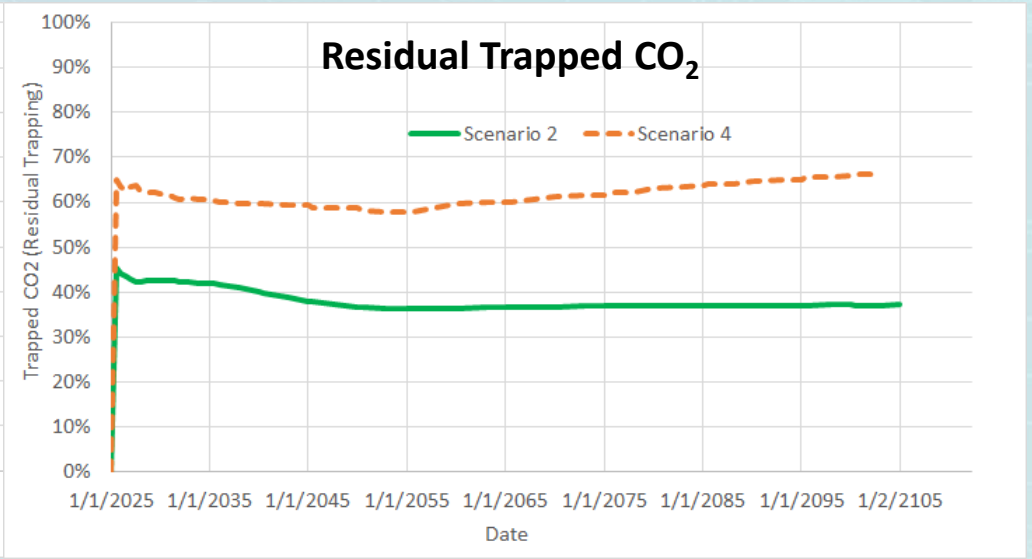
- Hydrocarbon reservoir condition stores more CO_2 except scenario 1, business-as-usual (BAU, low CO_2 injection rate)
- Opening all sides boundary significantly impacts on the injection (Liu G., et al., 2023)

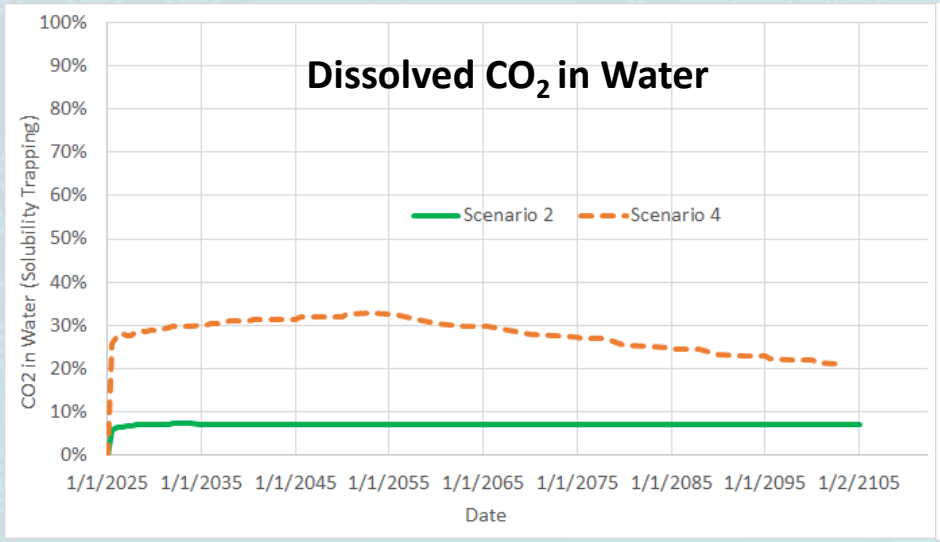
Cumulative Injection Profile

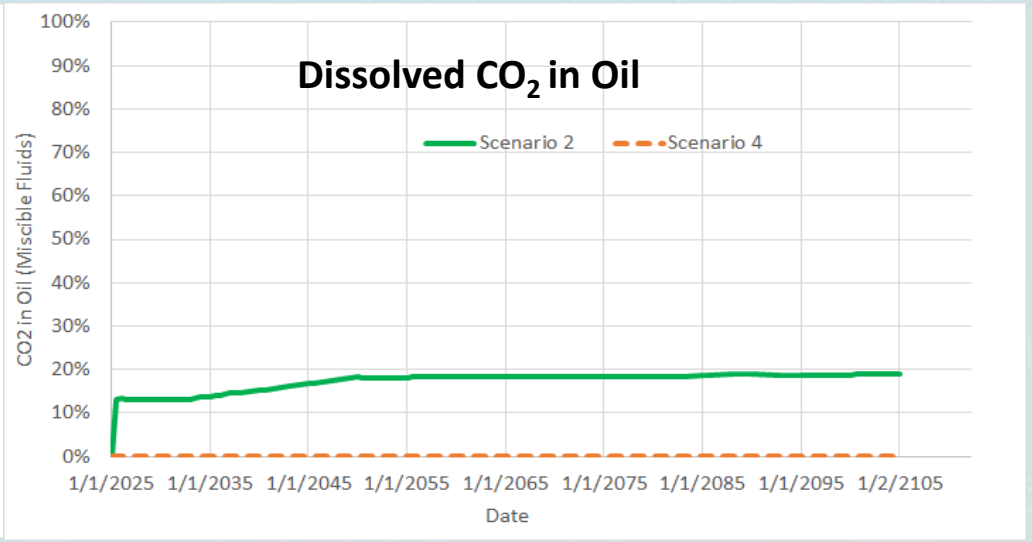


- Hydrocarbon reservoir condition can be injected more CO_2 except scenario 1, BAU
- Opening all sides boundary is much significant in saline reservoir than hydrocarbon reservoir- majorly because of fluids flow mechanisms



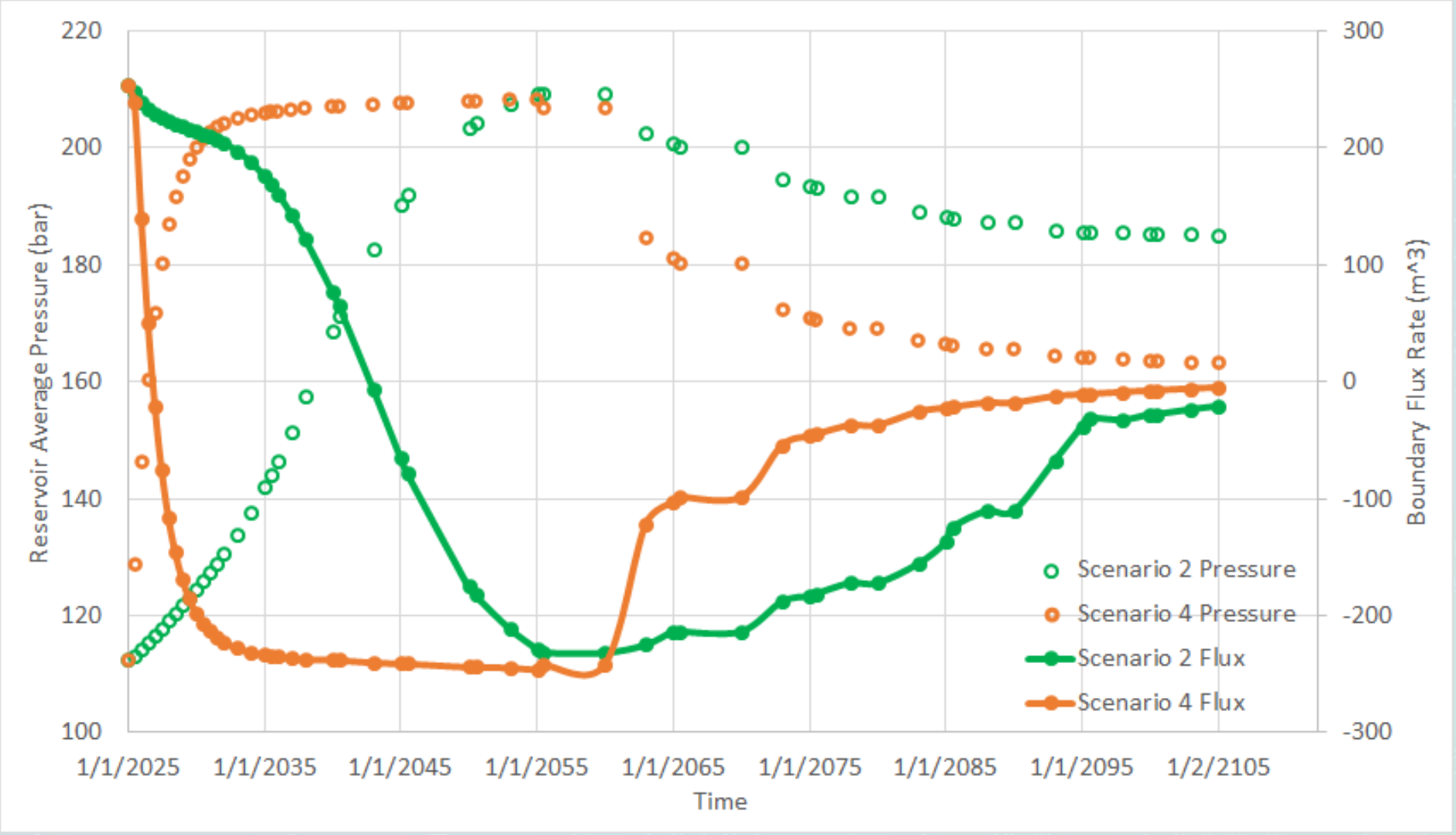






- Hydrocarbon reservoir does more CO_2 retention than saline reservoir due to miscible behaviors with CO_2 majorly
- Saline reservoir stores more CO_2 in water and residual trapping than hydrocarbon reservoir because of solubility rock-fluid interactions

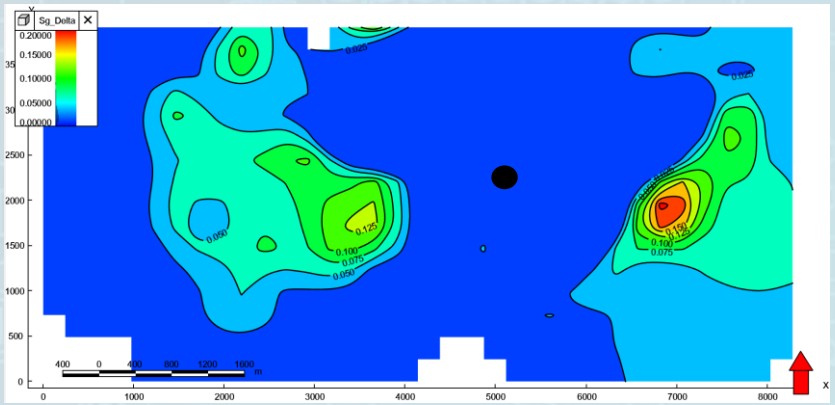
Boundary Flux Profile



- 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: CO_2 Plume Difference by Prior to CO_2 Injection (Top view)

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



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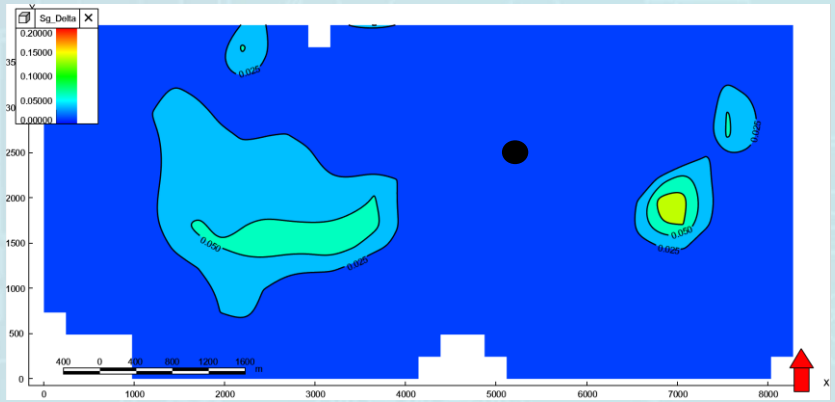

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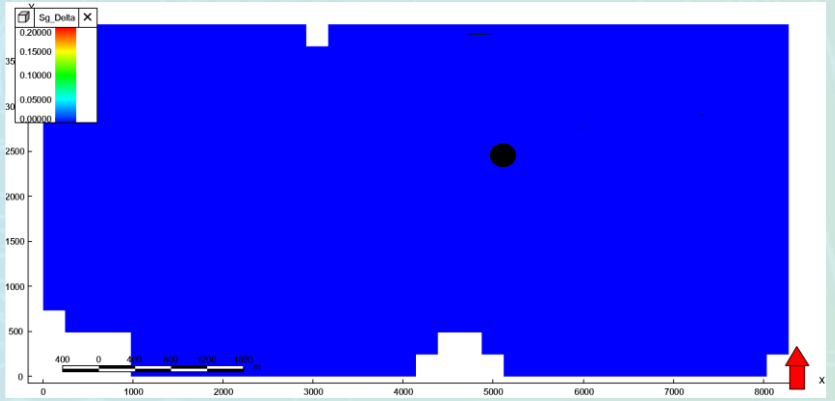

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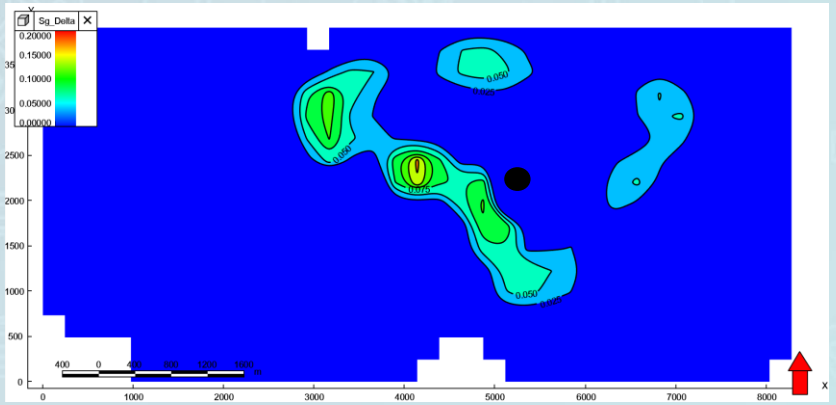

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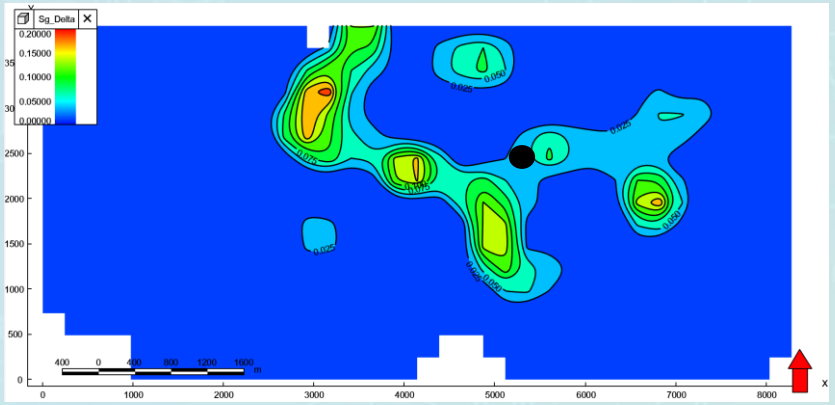
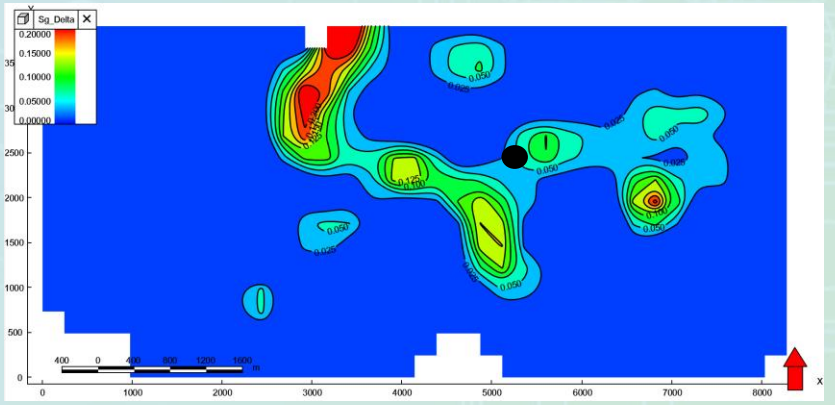
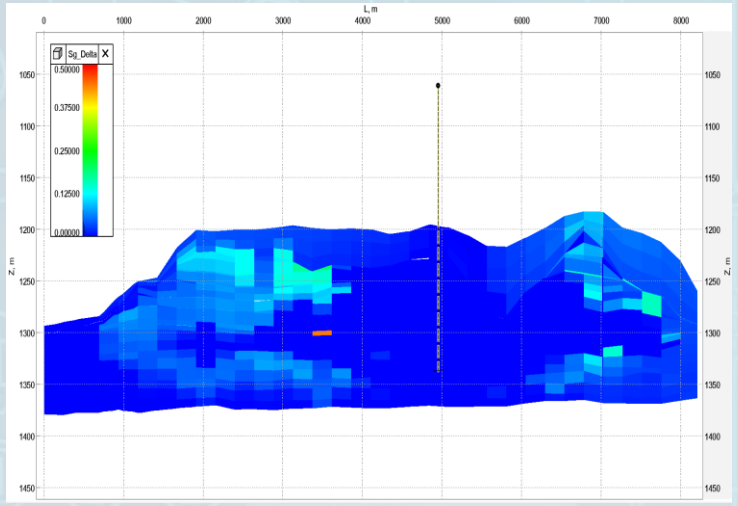


25 yrs post-injection



50 yrs post-injection

Scenario 2: CO_2 Plume (Cross-sectional view)



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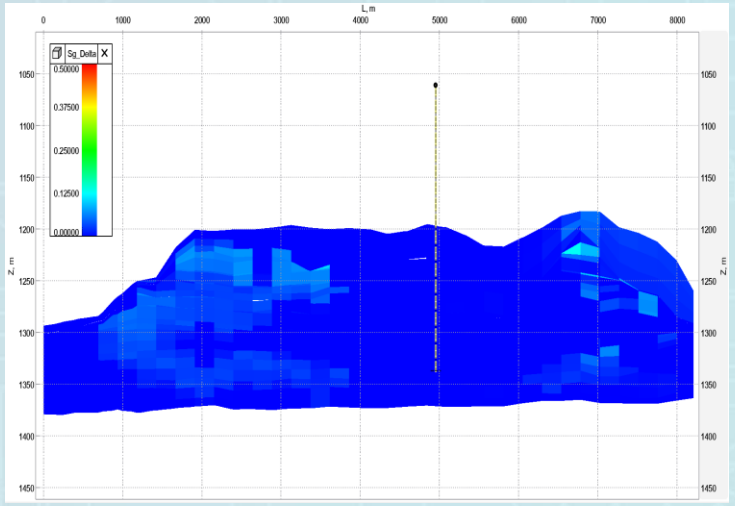

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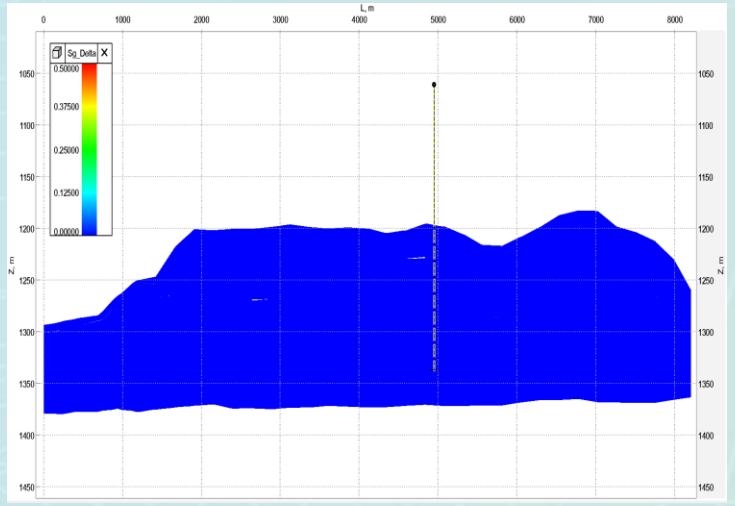

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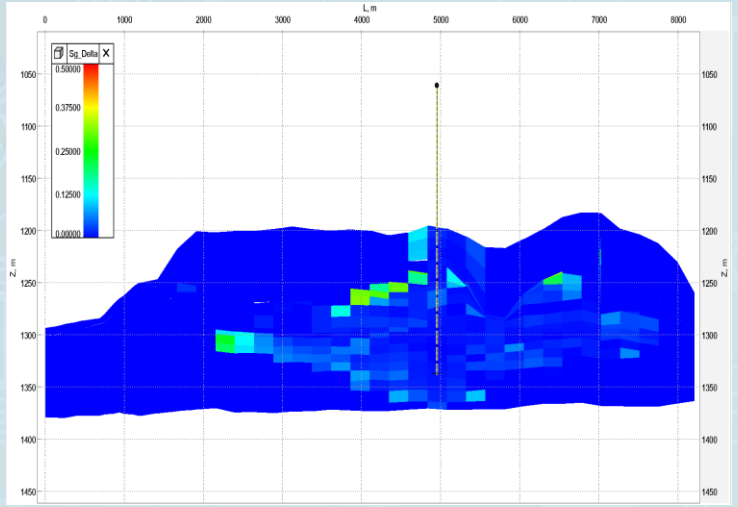

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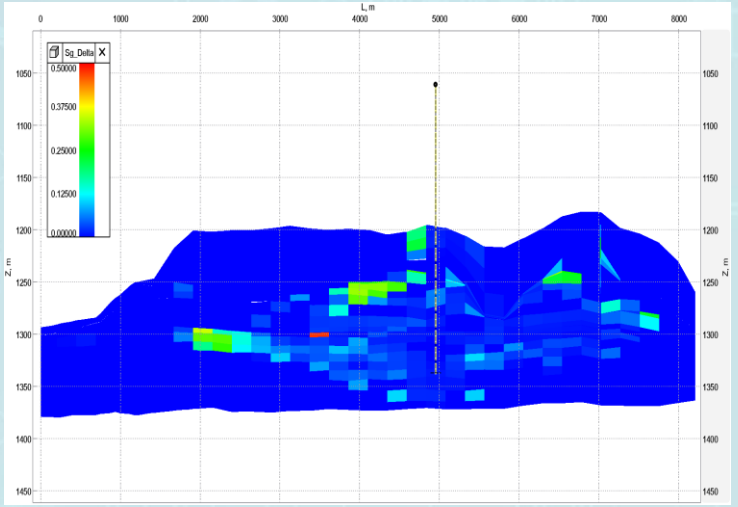
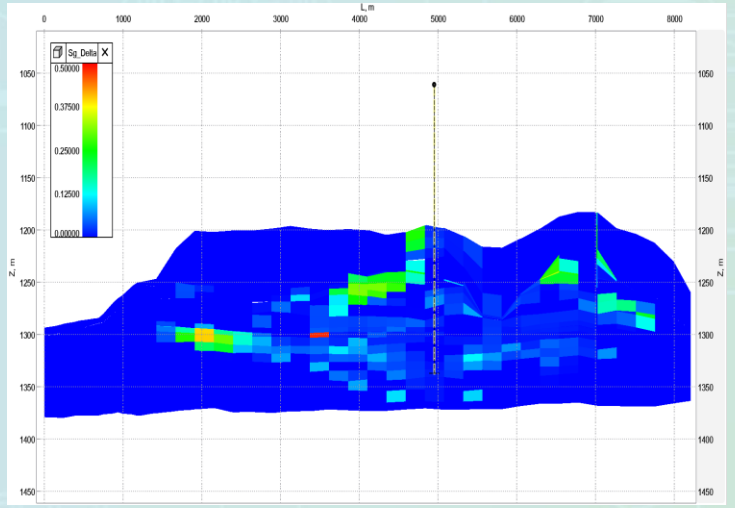
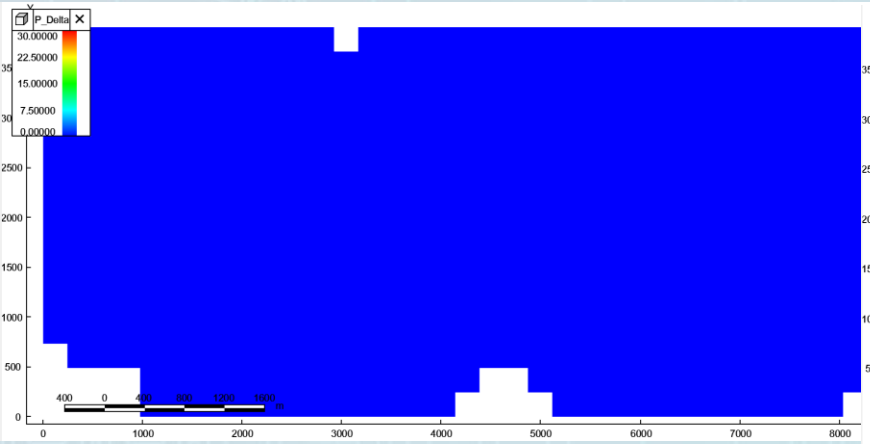


25 yrs post-injection



50 yrs post-injection

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



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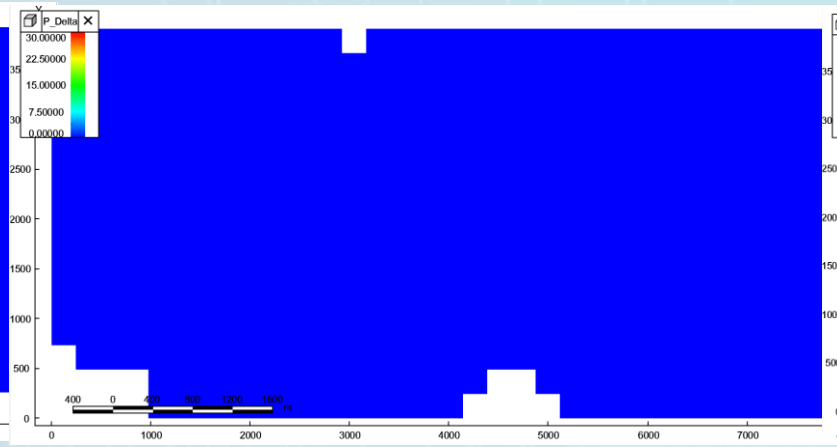

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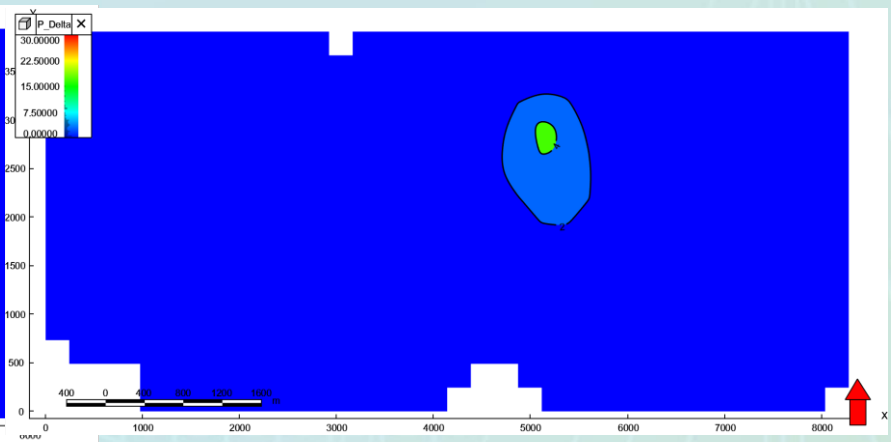

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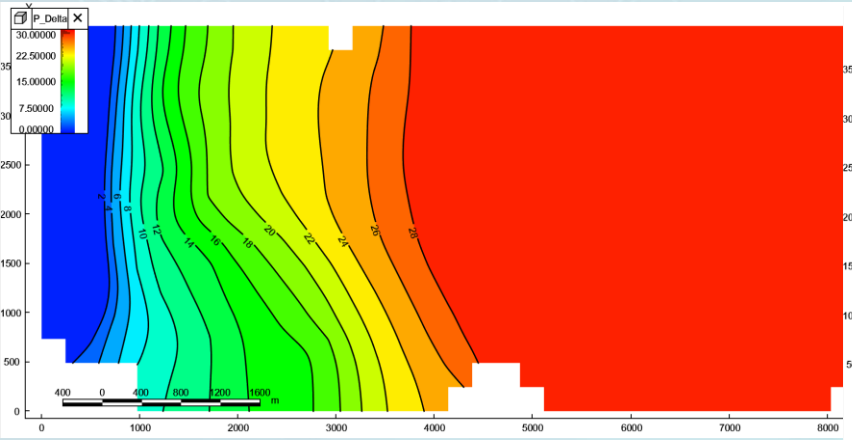

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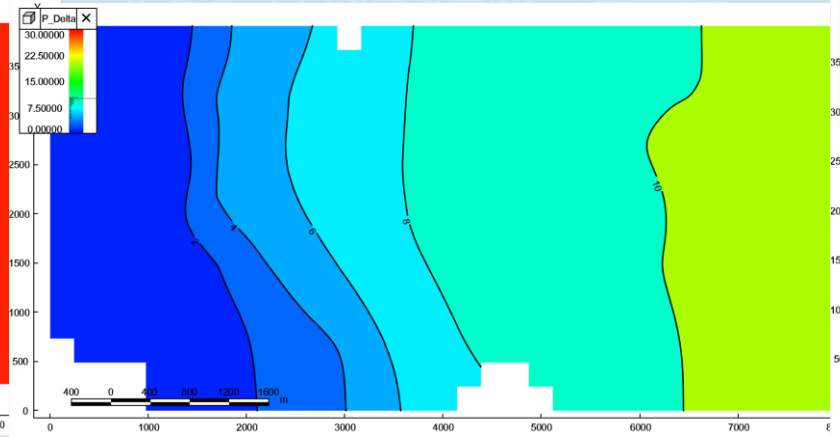
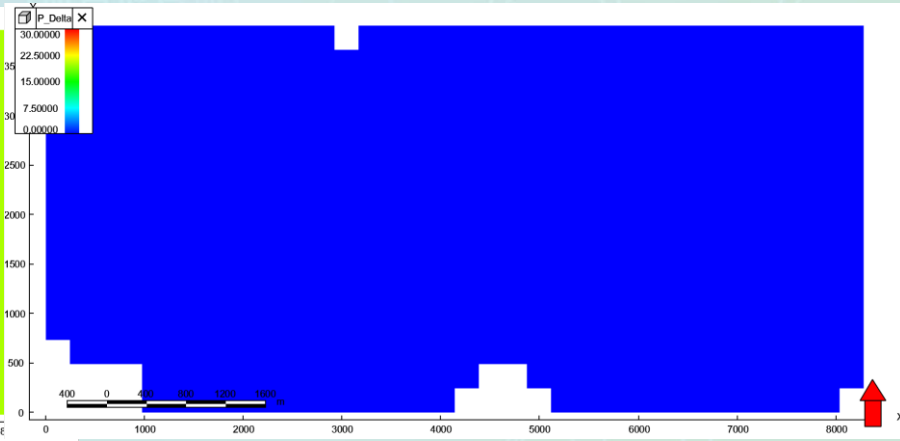
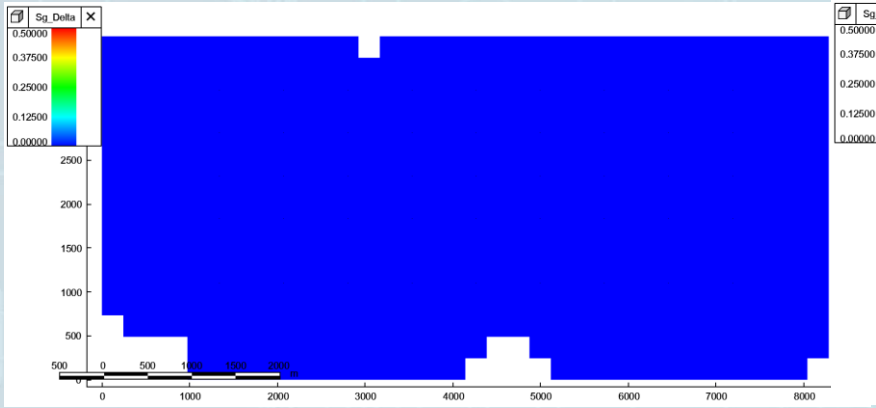


25 yrs post-injection



50 yrs post-injection

Scenario 4: CO_2 Plume Difference Prior to CO_2 Injection (Top view)



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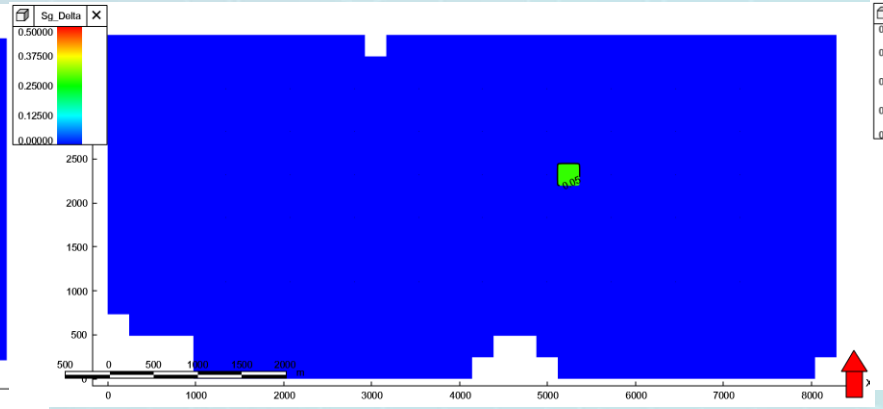

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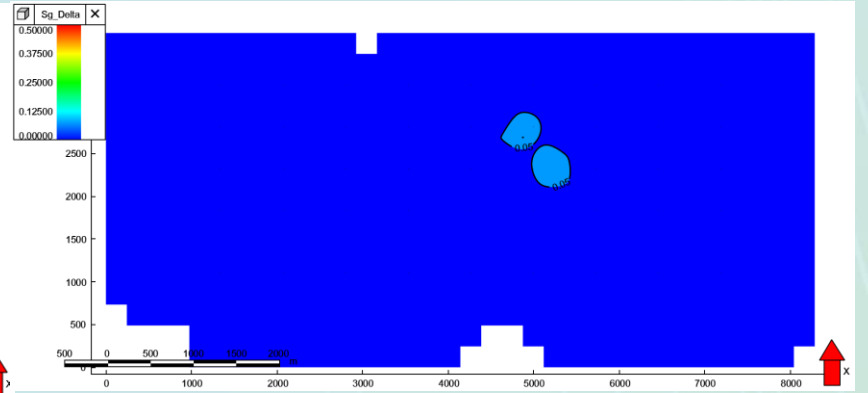

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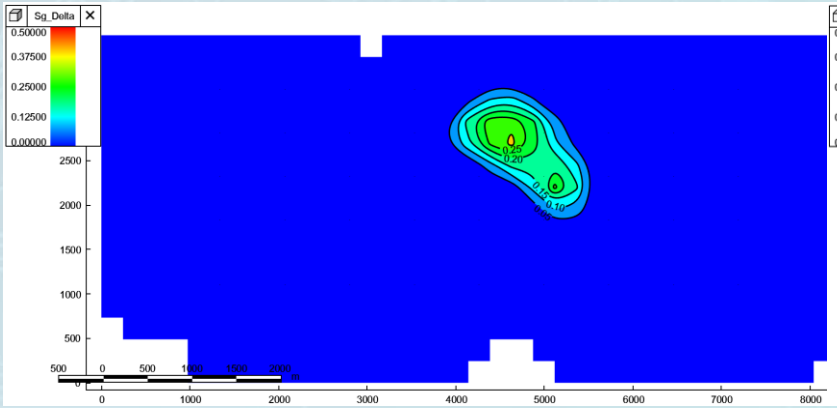

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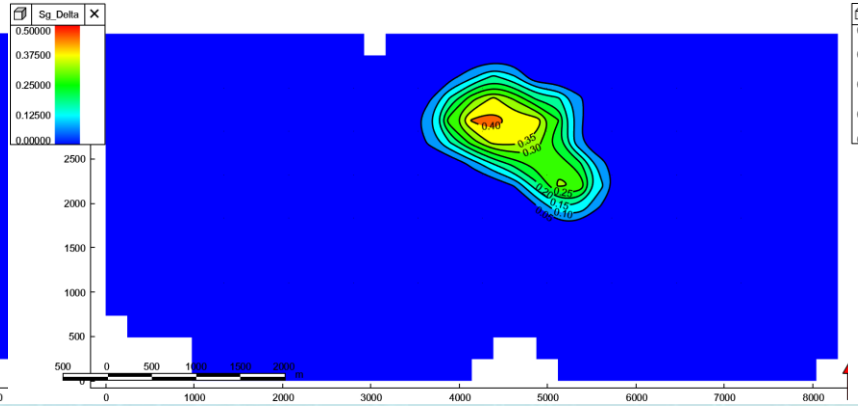
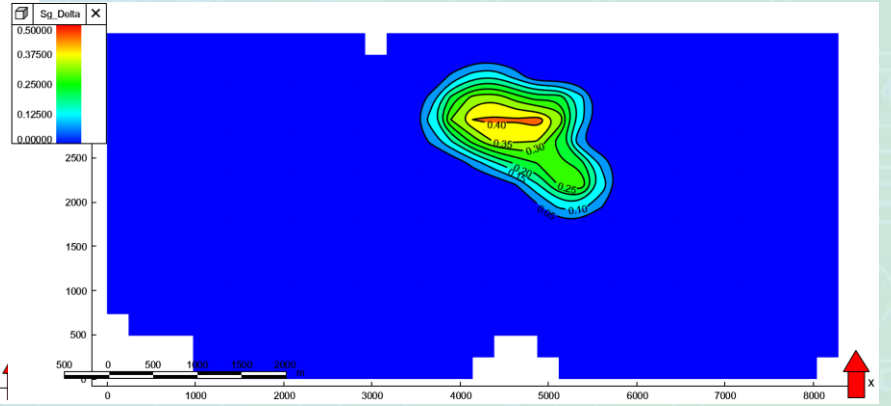
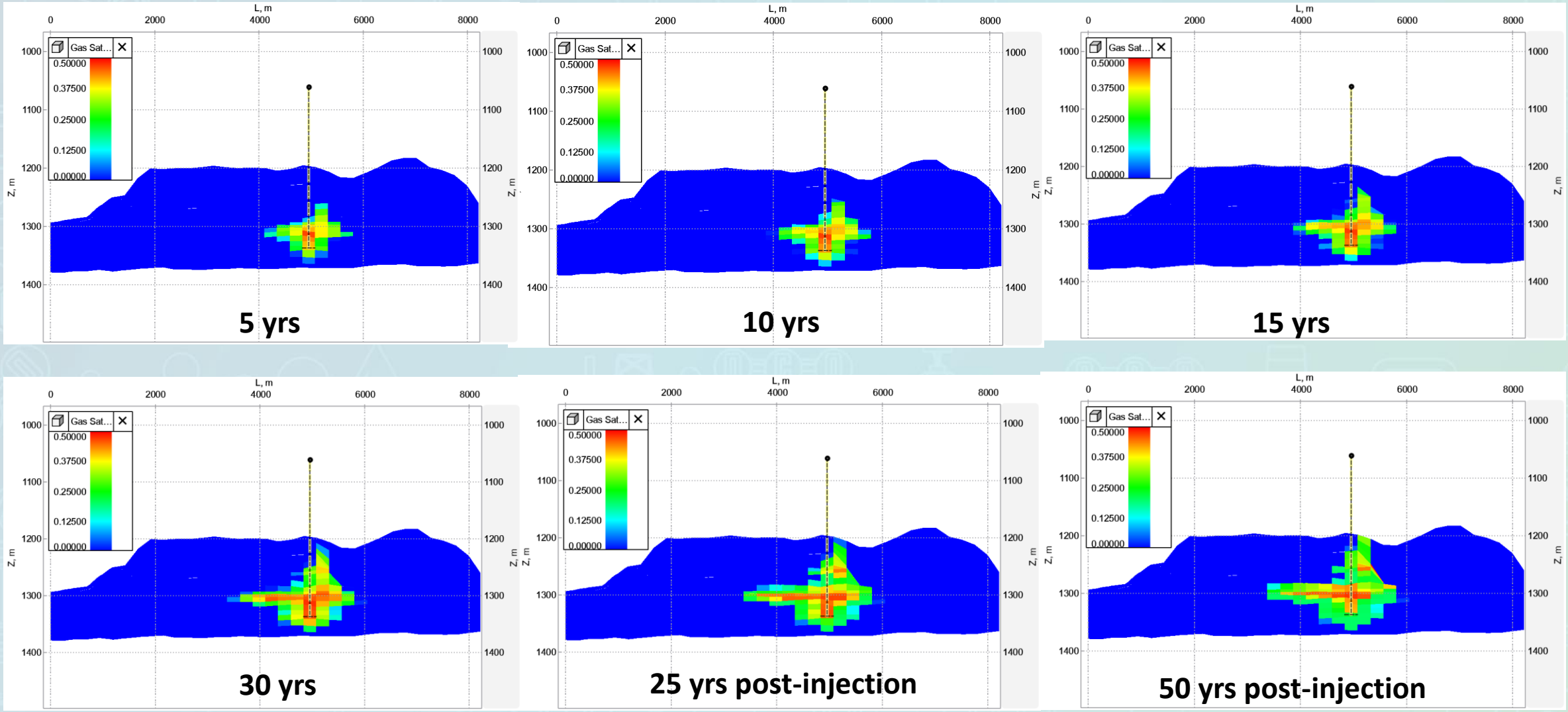


25 yrs post-injection

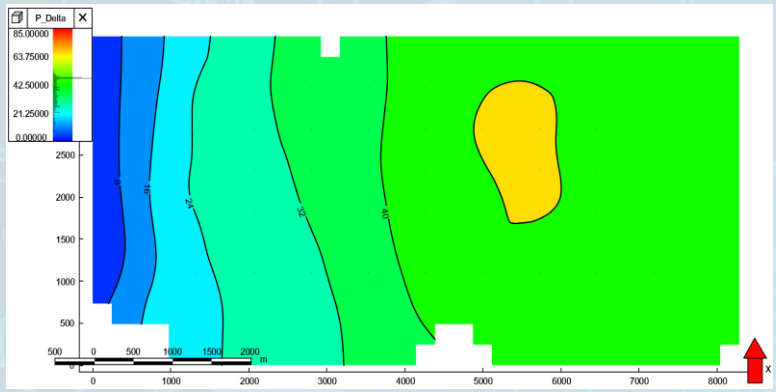


50 yrs post-injection

Scenario 4: CO_2 Plume (Cross-sectional view)



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



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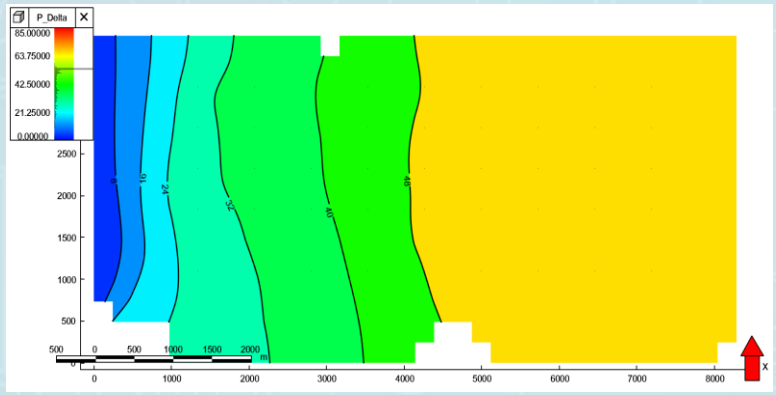

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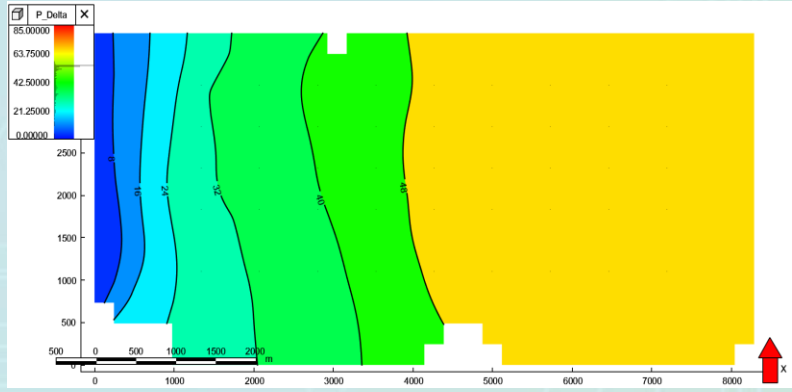

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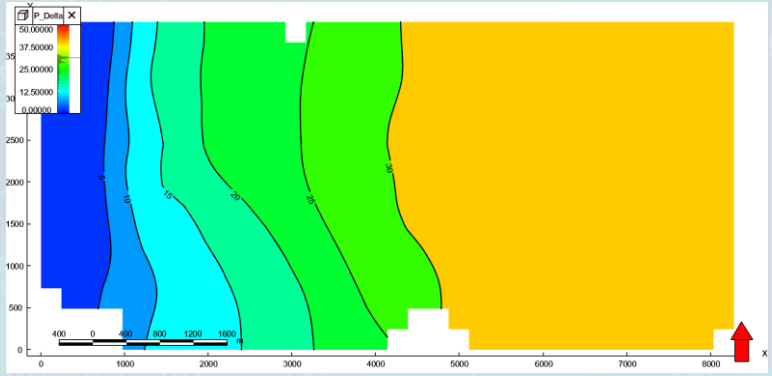

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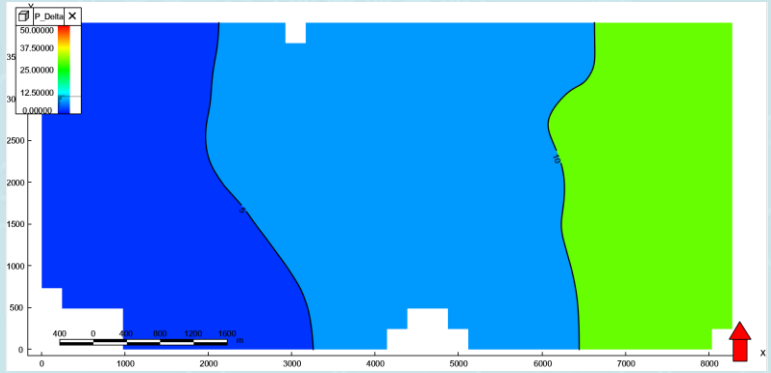
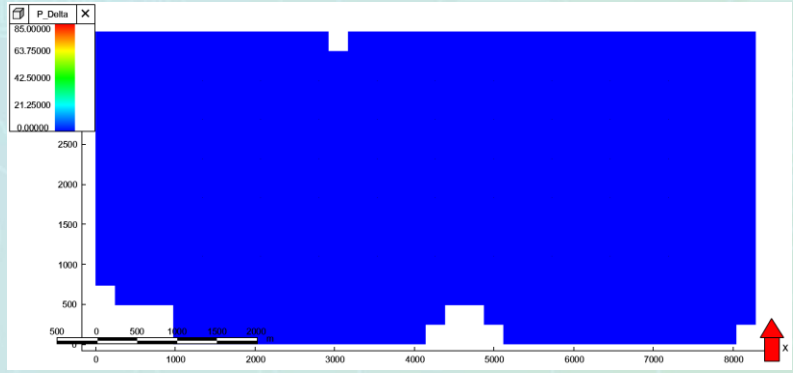


25 yrs post-injection



50 yrs post-injection

Remarks

- CO_2 can be injected more in hydrocarbon reservoir than saline reservoir
- Based on CO_2 storage mechanisms, the CO_2 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 CO_2 plume extend but not pressure propagation

Net Steps

- Continue analysis to quantify risk profile for scenarios regarding to CO_2, 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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