

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

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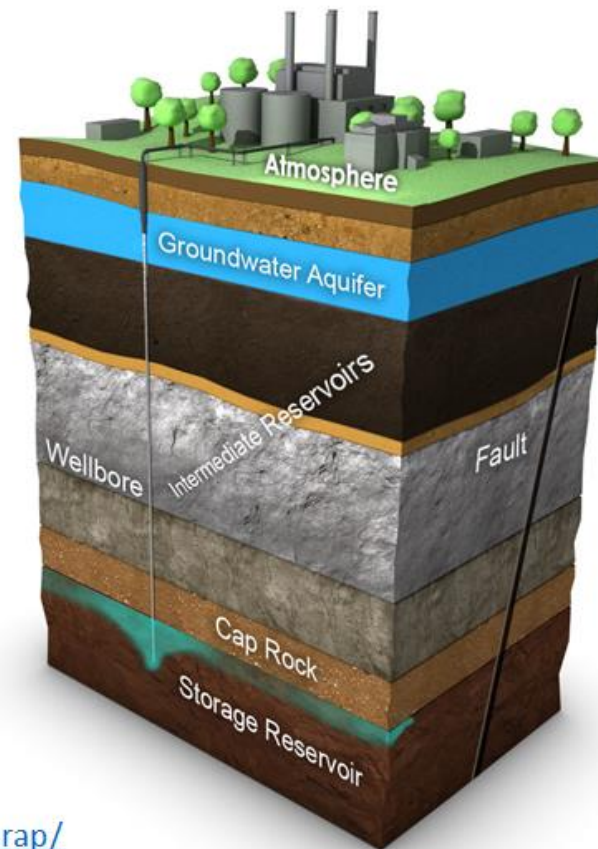
Outline

- **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.



Technical Team



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

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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.



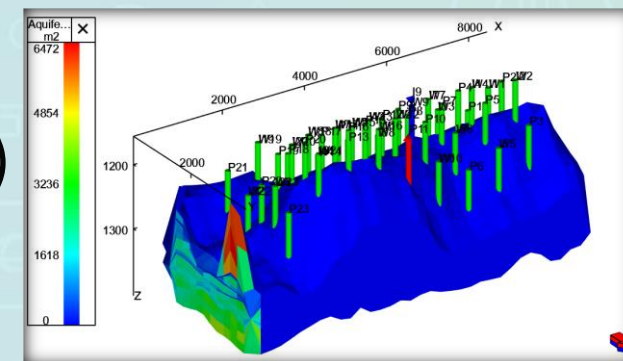
Geologic Sequestration of Carbon Dioxide

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

The screenshot shows the EPA website's navigation bar with links for Environmental Topics, Laws & Regulations, Report a Violation, and About EPA. Below this, the 'Underground Injection Control (UIC)' section is active, featuring a 'CONTACT US' link. The main heading is 'Final Class VI Guidance Documents', followed by a sub-heading 'This list of Final Class VI guidance documents below are prepared to assist:'. On the left side of the page, there are links for 'Underground Injection Control Home' and 'Class I Industrial and Municipal Waste Disposal Wells'.

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)



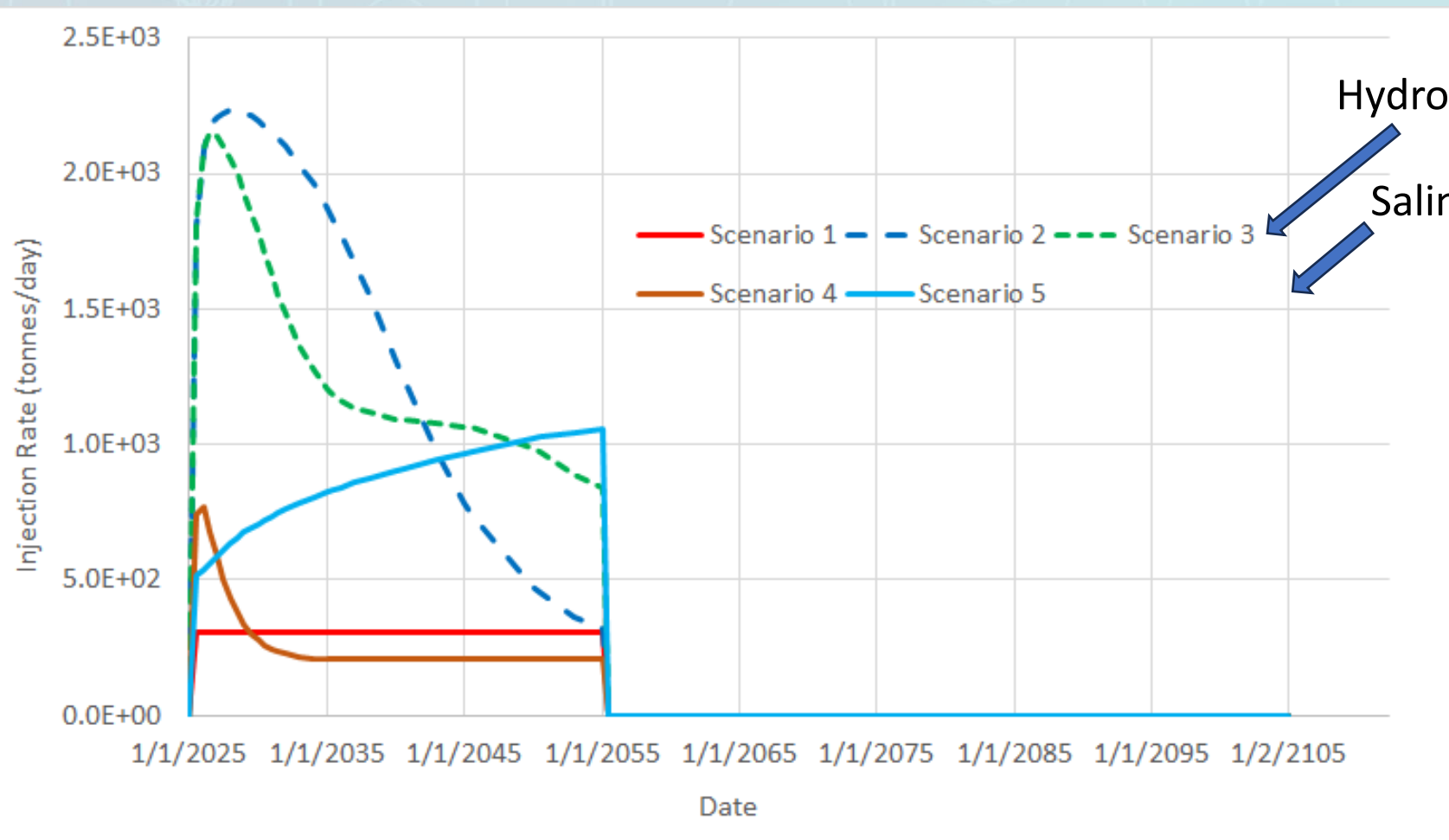
Jia W. and McPherson B., DOI:
10.18141/1465116

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.

| 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 |

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

Injection Rate Profile

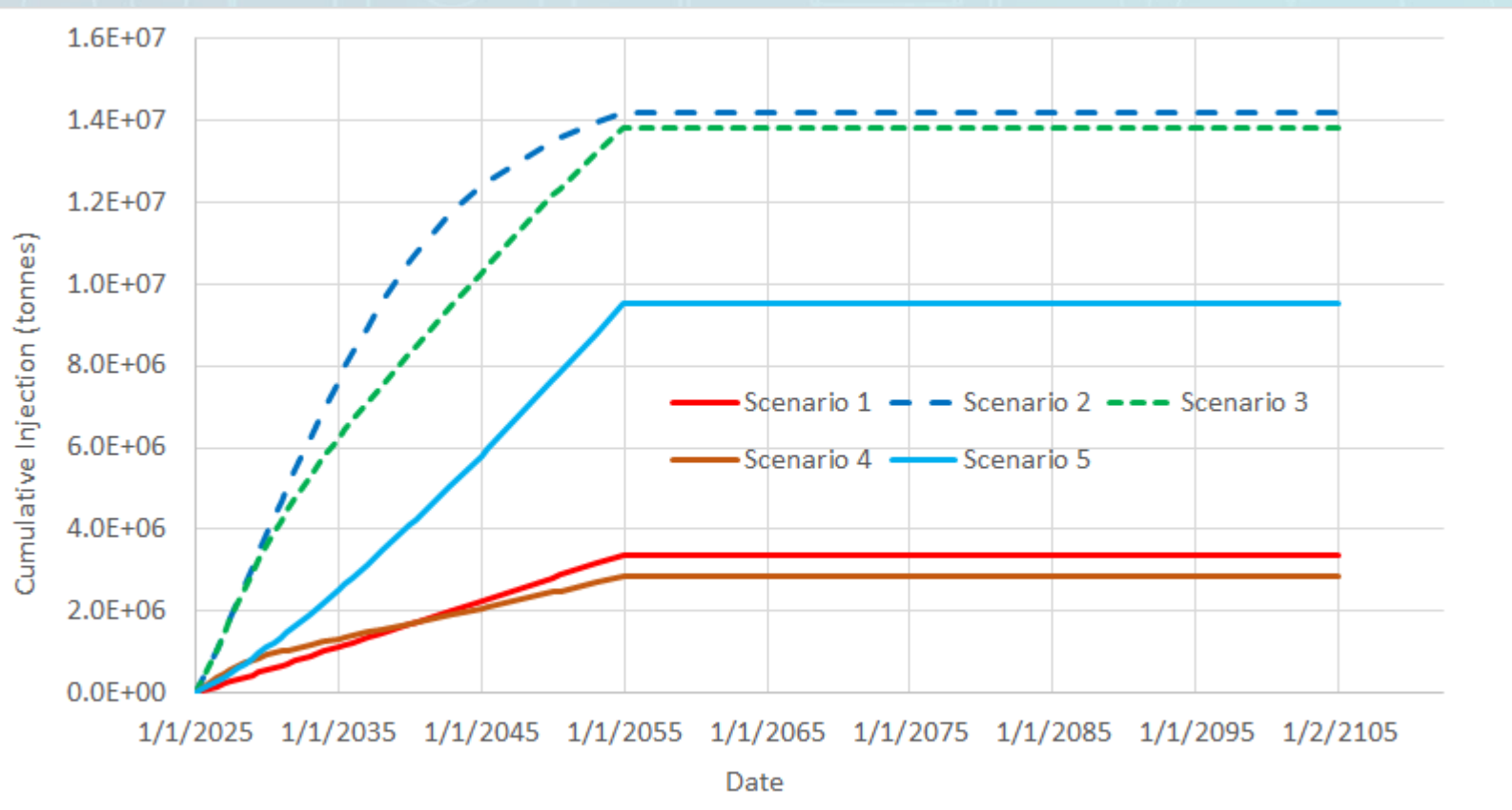


Hydrocarbon reservoir case

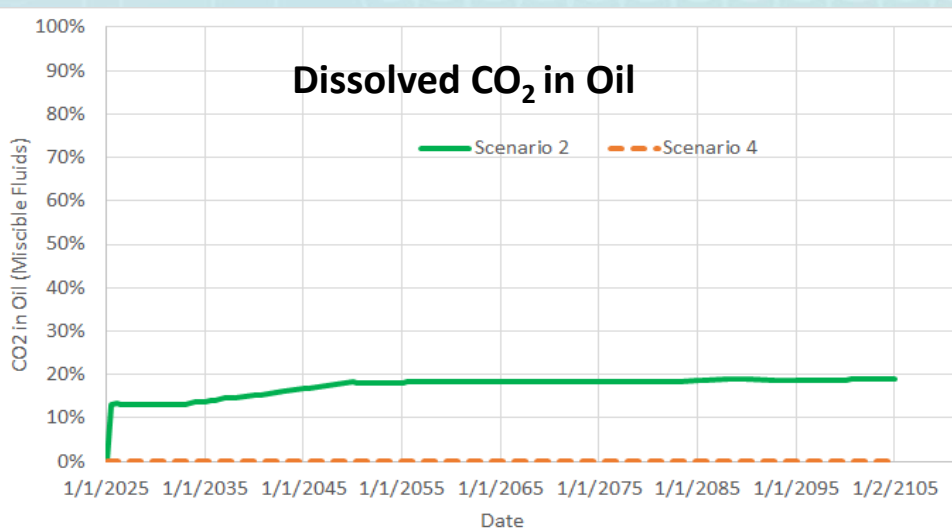
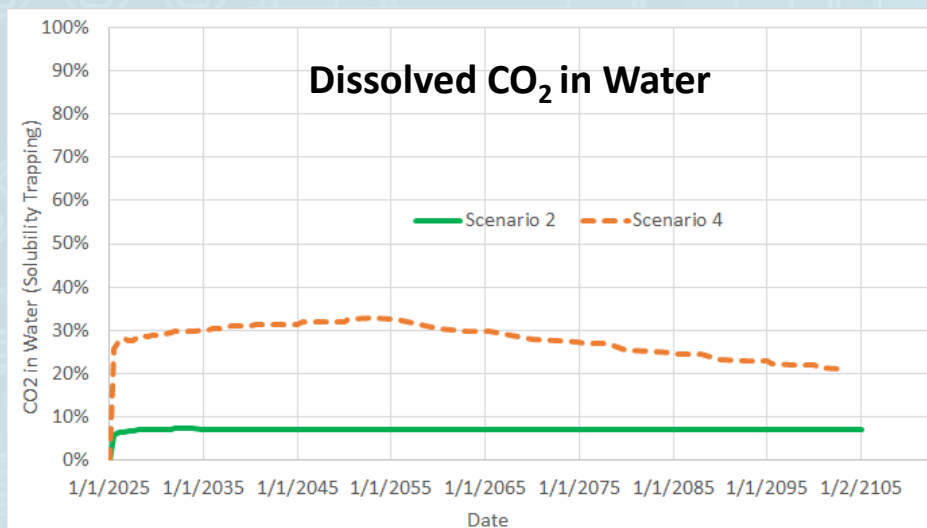
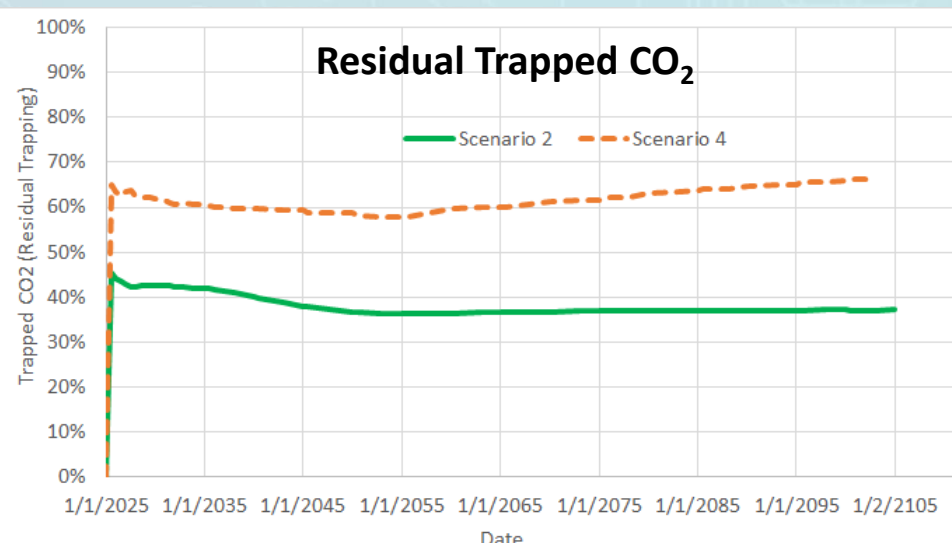
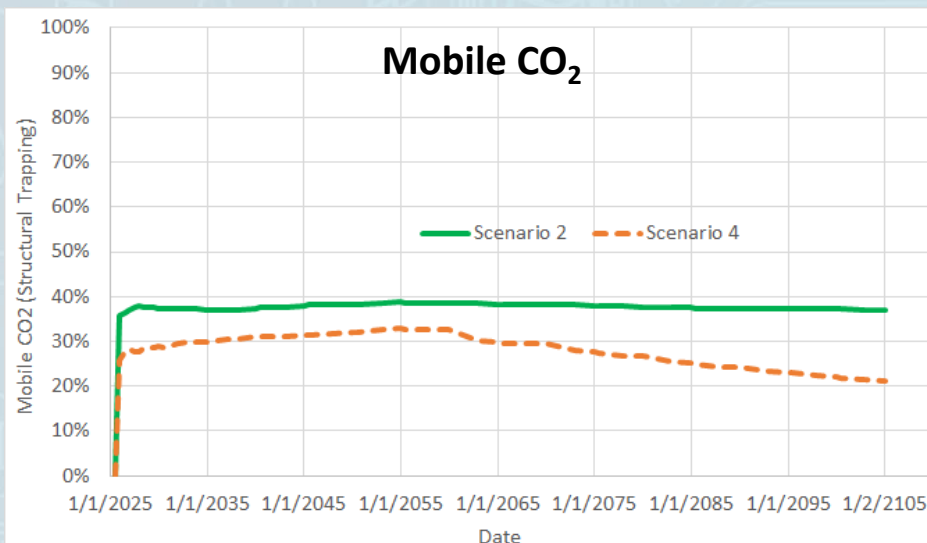
Saline reservoir case

- 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

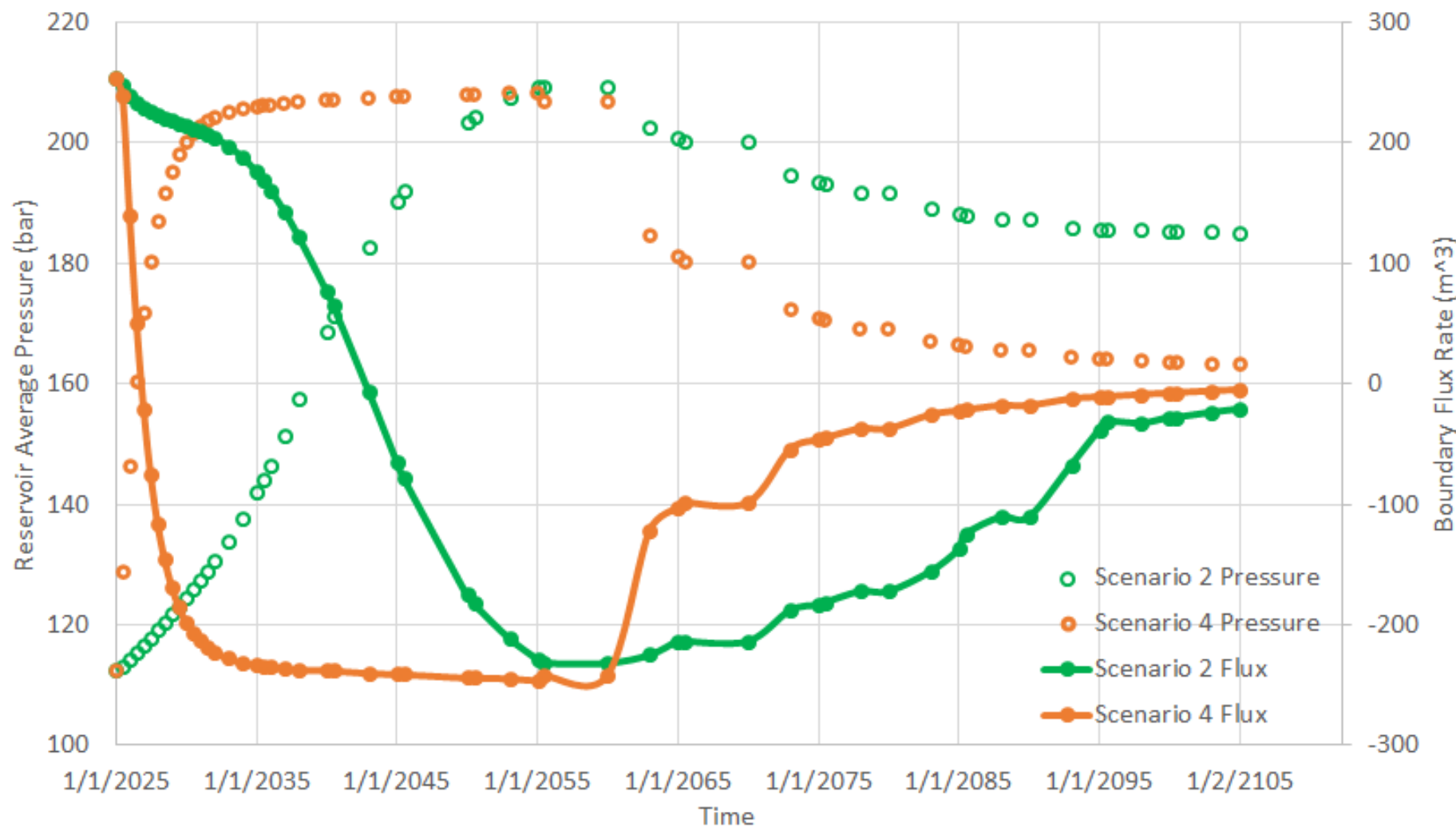


- Hydrocarbon reservoir condition can be injected more CO₂ except scenario 1, BAU
- Opening all sides boundary is much significant in saline reservoir than hydrocarbon reservoir- majorly because of fluids flow mechanisms



- 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

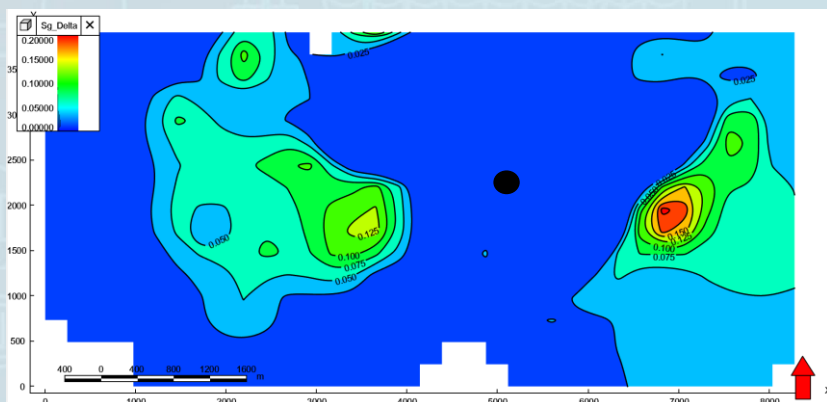
Boundary Flux Profile



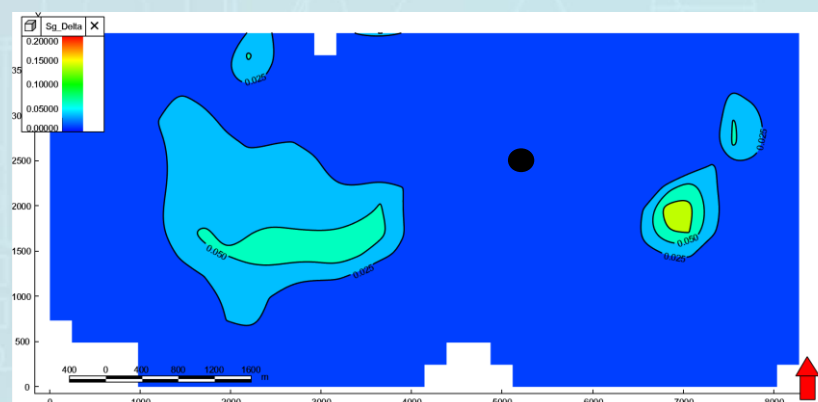
- Pressure and flux response in saline reservoir is much quicker than hydrocarbon reservoir
- Major reasons result in the differences are the miscible flow with CO₂ and compressibility of the fluids

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

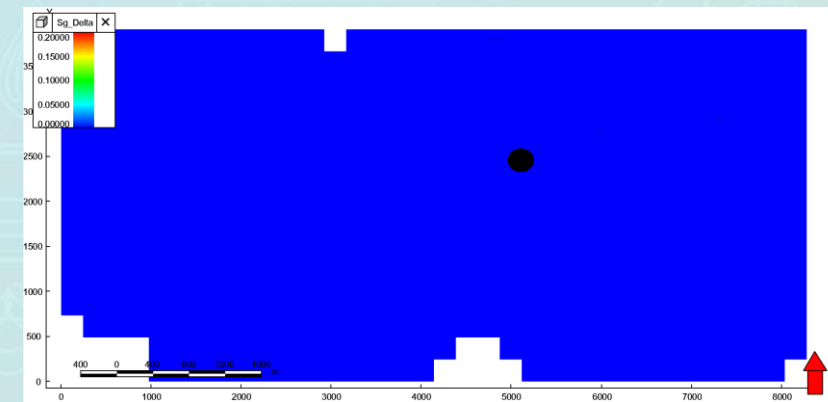
Minimum miscible pressure (MMP) is ~1,850 psi. What happen if reservoir pressure is below and above MMP?



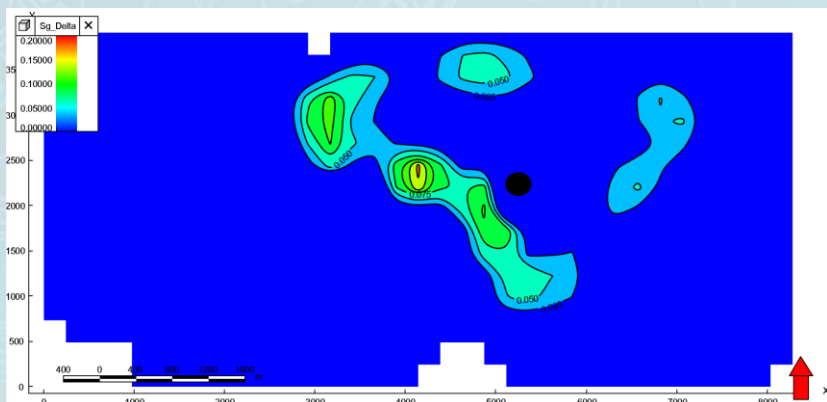
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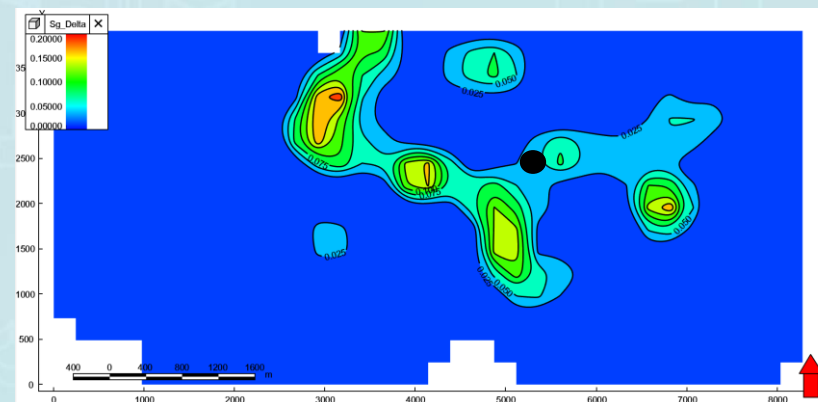
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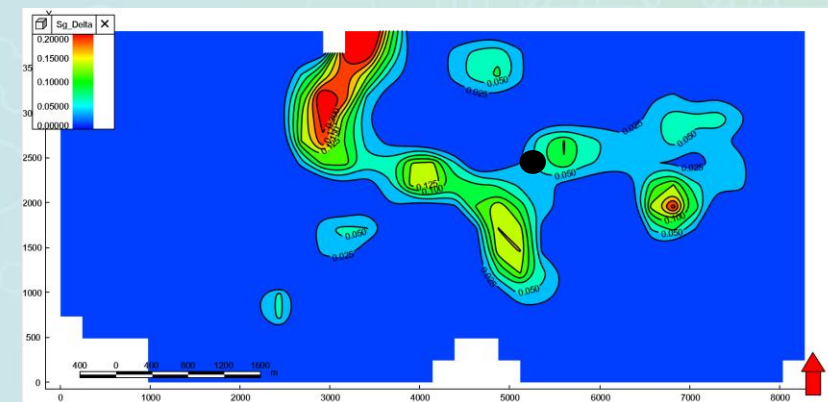
15 yrs



30 yrs

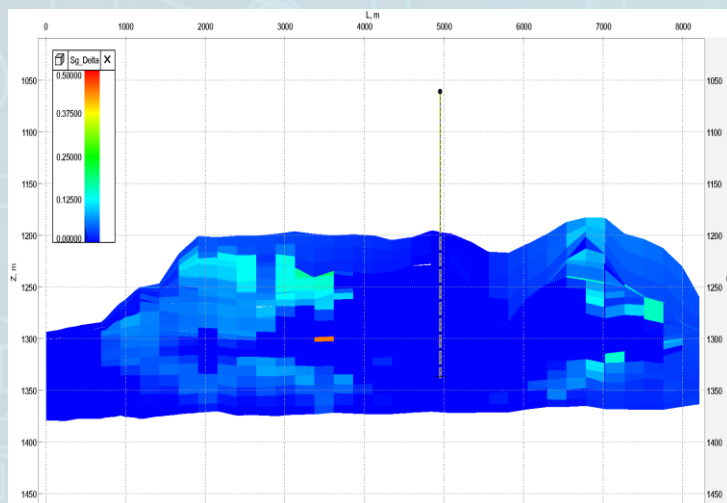


25 yrs post-injection

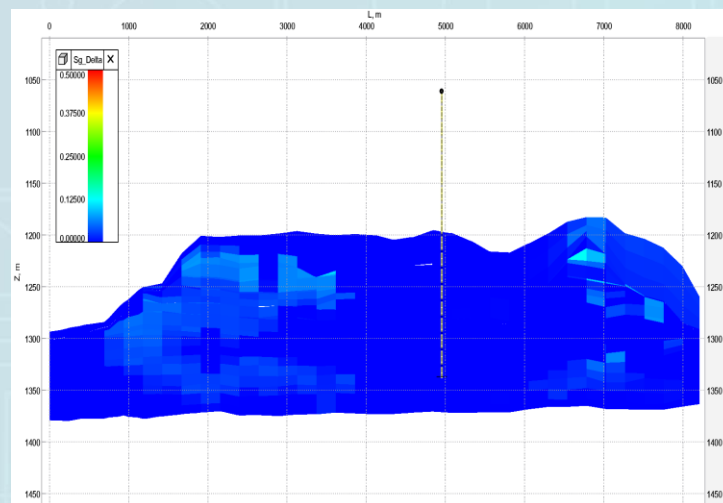


50 yrs post-injection

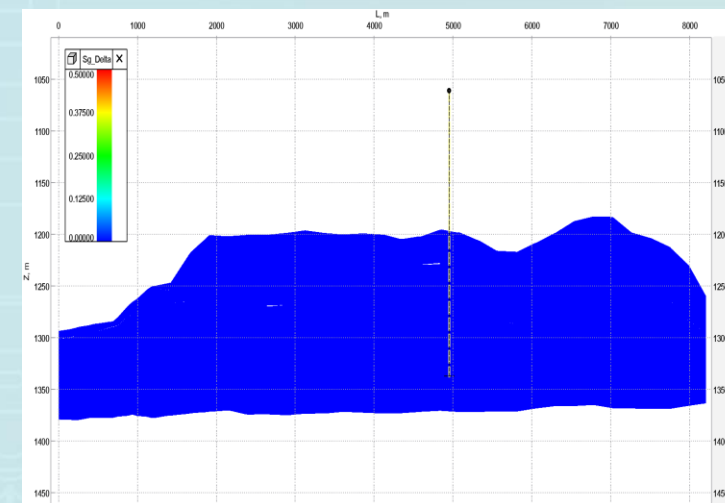
Scenario 2: CO₂ Plume (Cross-sectional view)



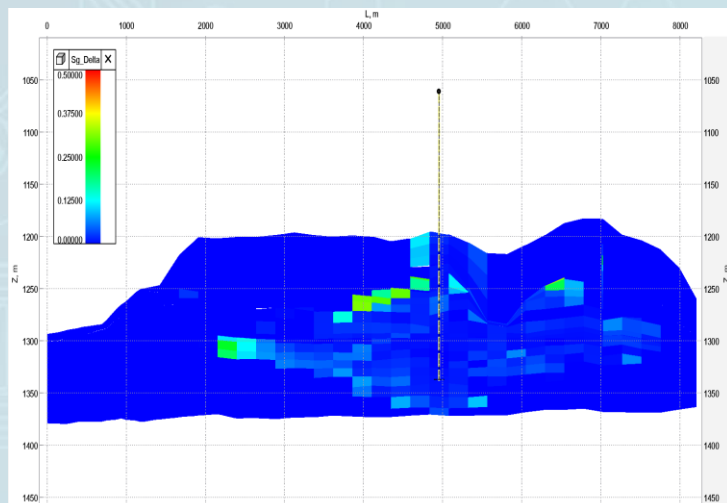
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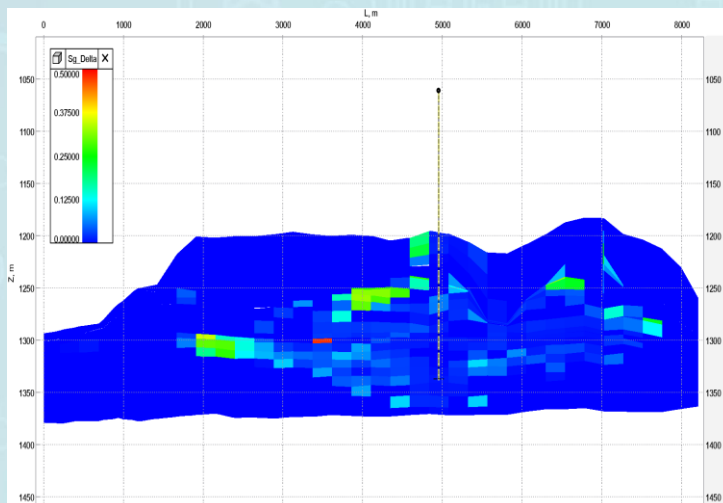
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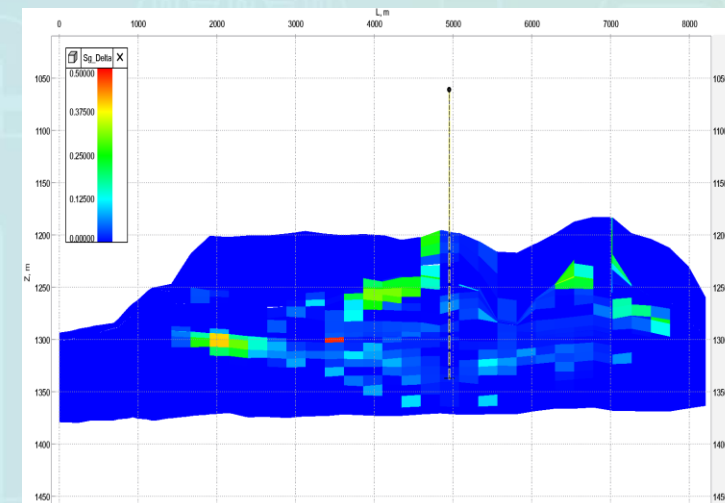
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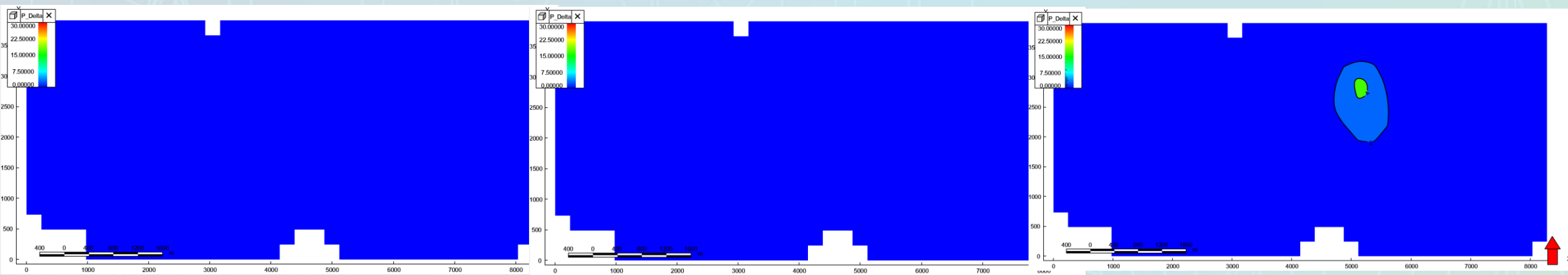


25 yrs post-injection



50 yrs post-injection

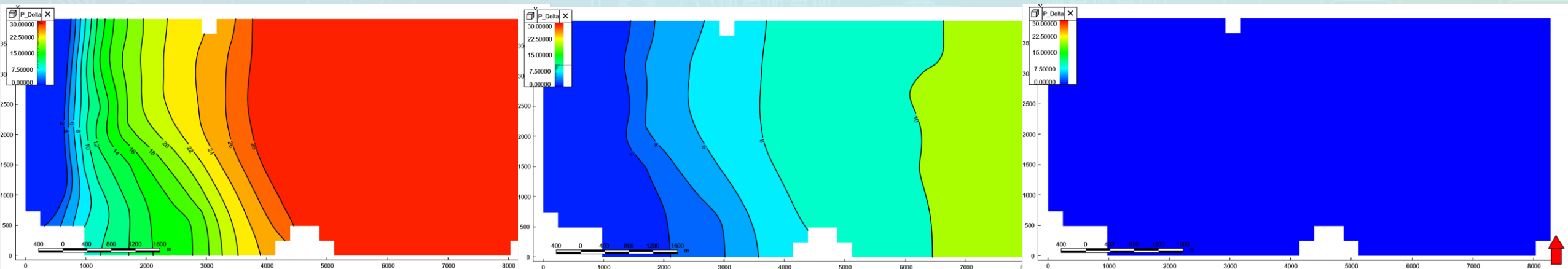
Scenario 2: Pressure Difference Maximum 30 bar, 435 psi (Top view)



5 yrs

10 yrs

15 yrs

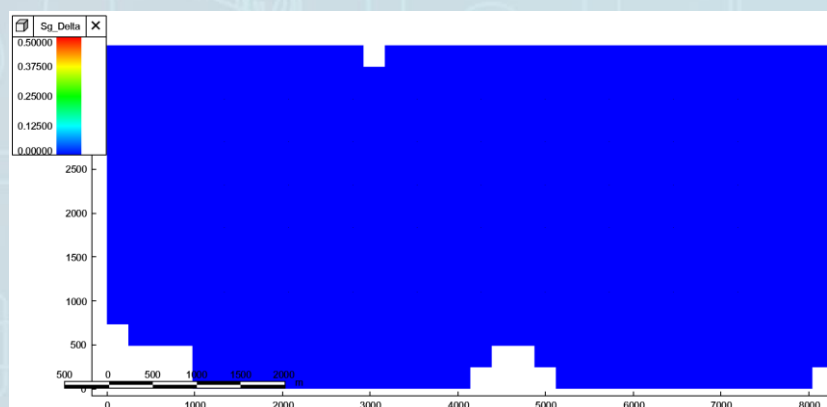


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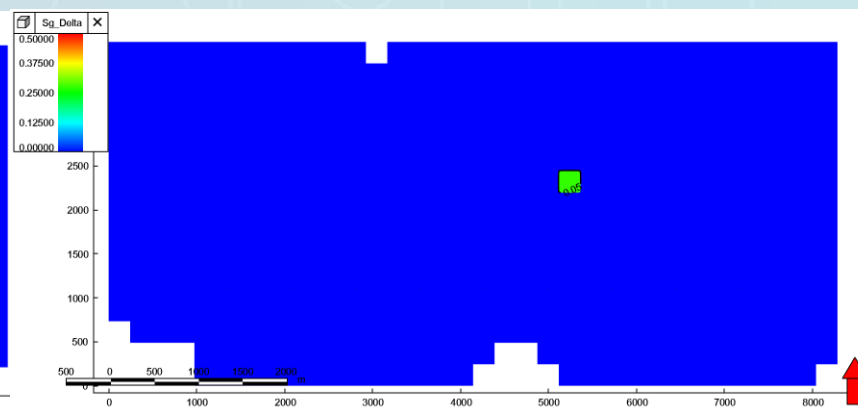
25 yrs post-injection

50 yrs post-injection

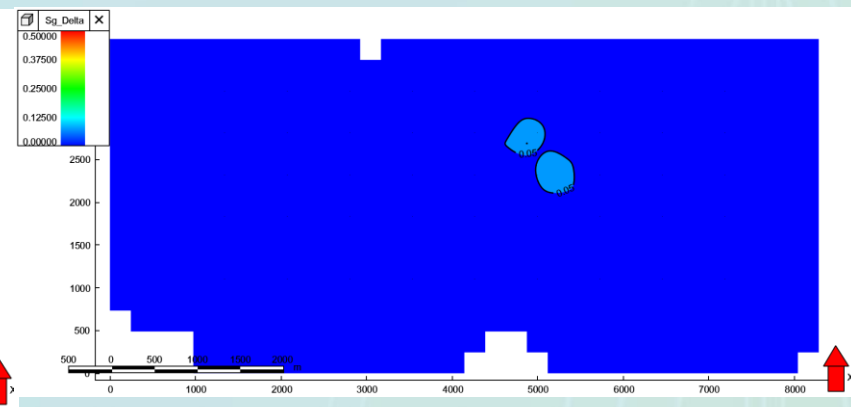
Scenario 4: CO₂ Plume Difference Prior to CO₂ Injection (Top view)



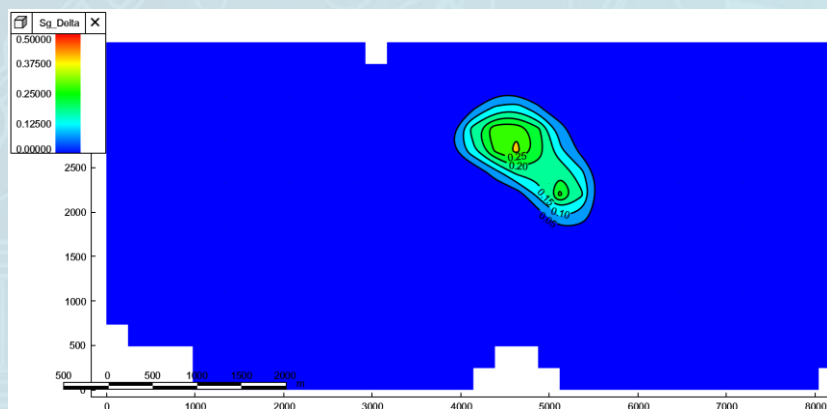
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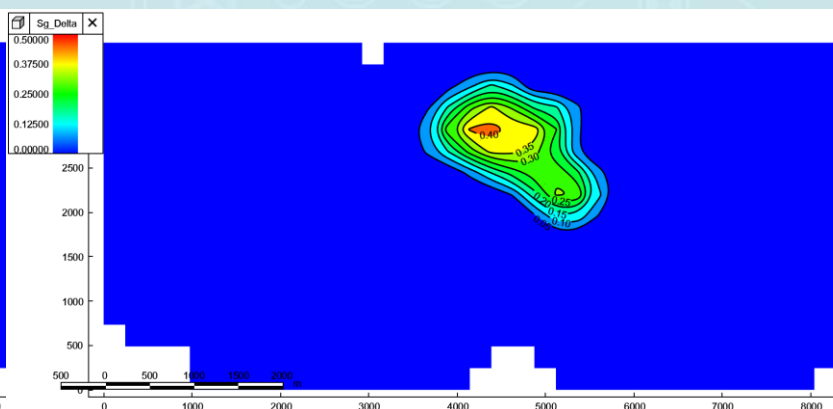
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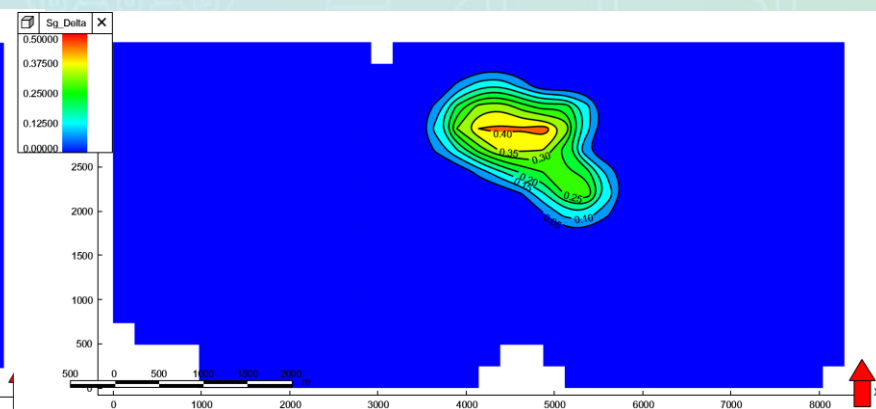
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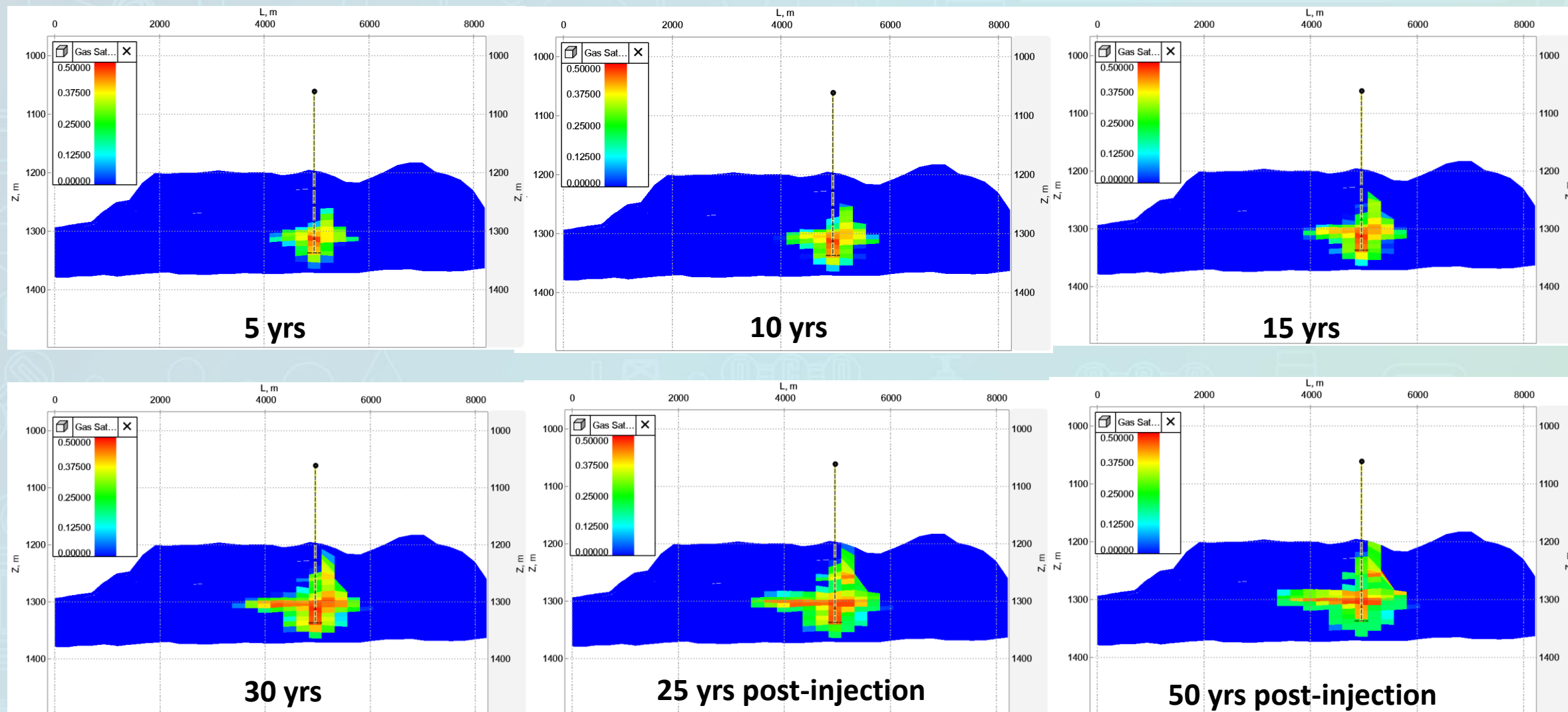


25 yrs post-injection

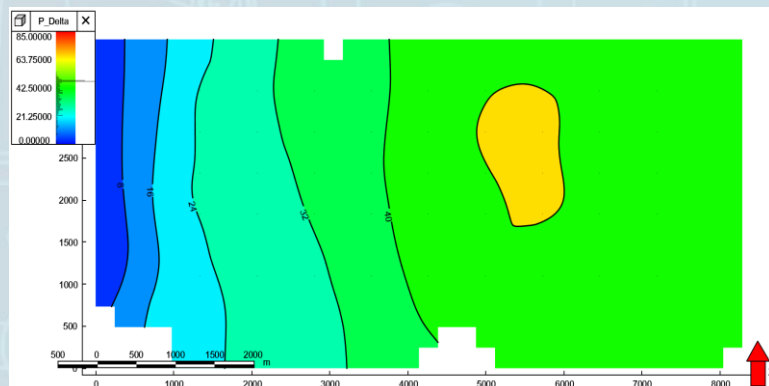


50 yrs post-injection

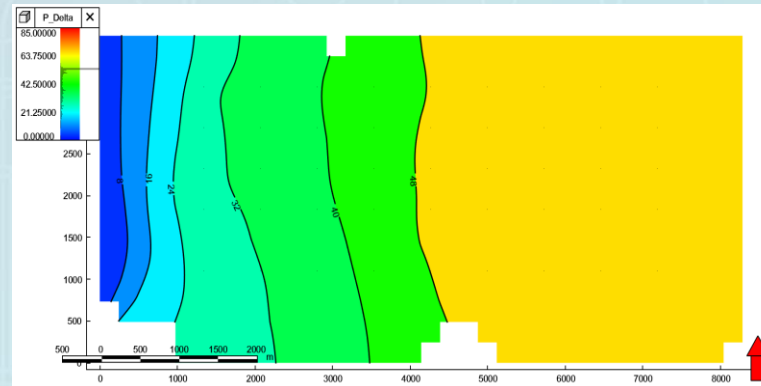
Scenario 4: CO₂ Plume (Cross-sectional view)



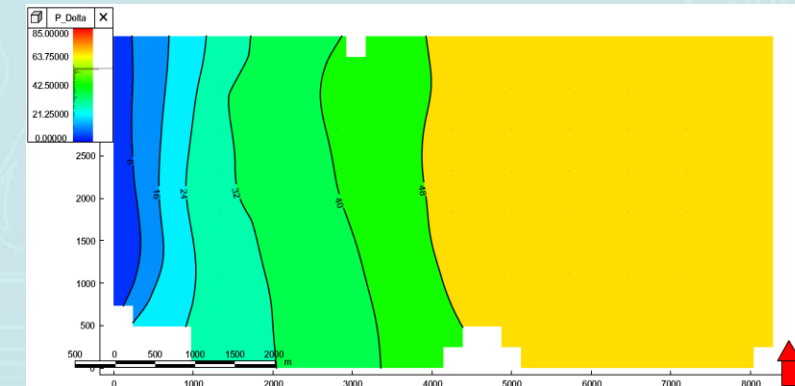
Scenario 4: Pressure Difference Maximum 85 bar, 1233 psi (Top view)



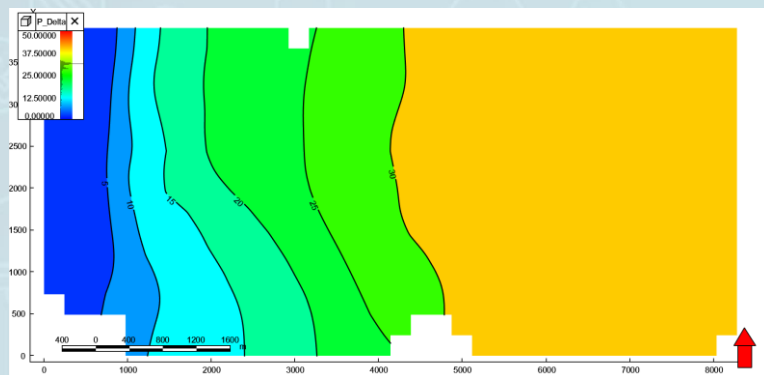
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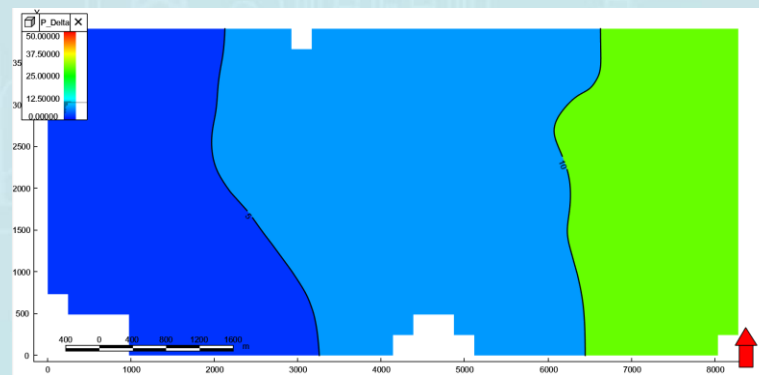
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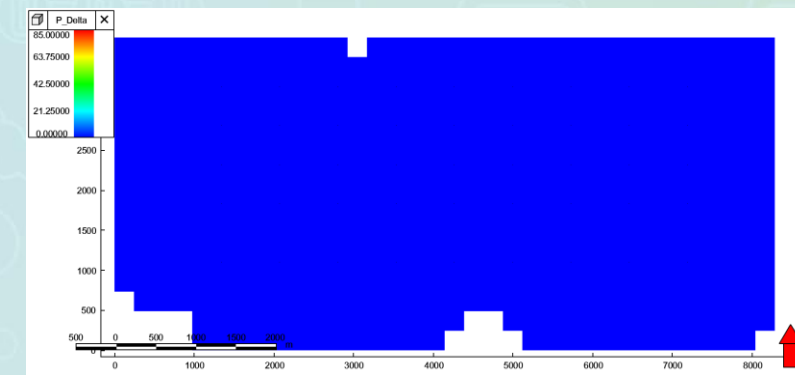
15 yrs



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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