

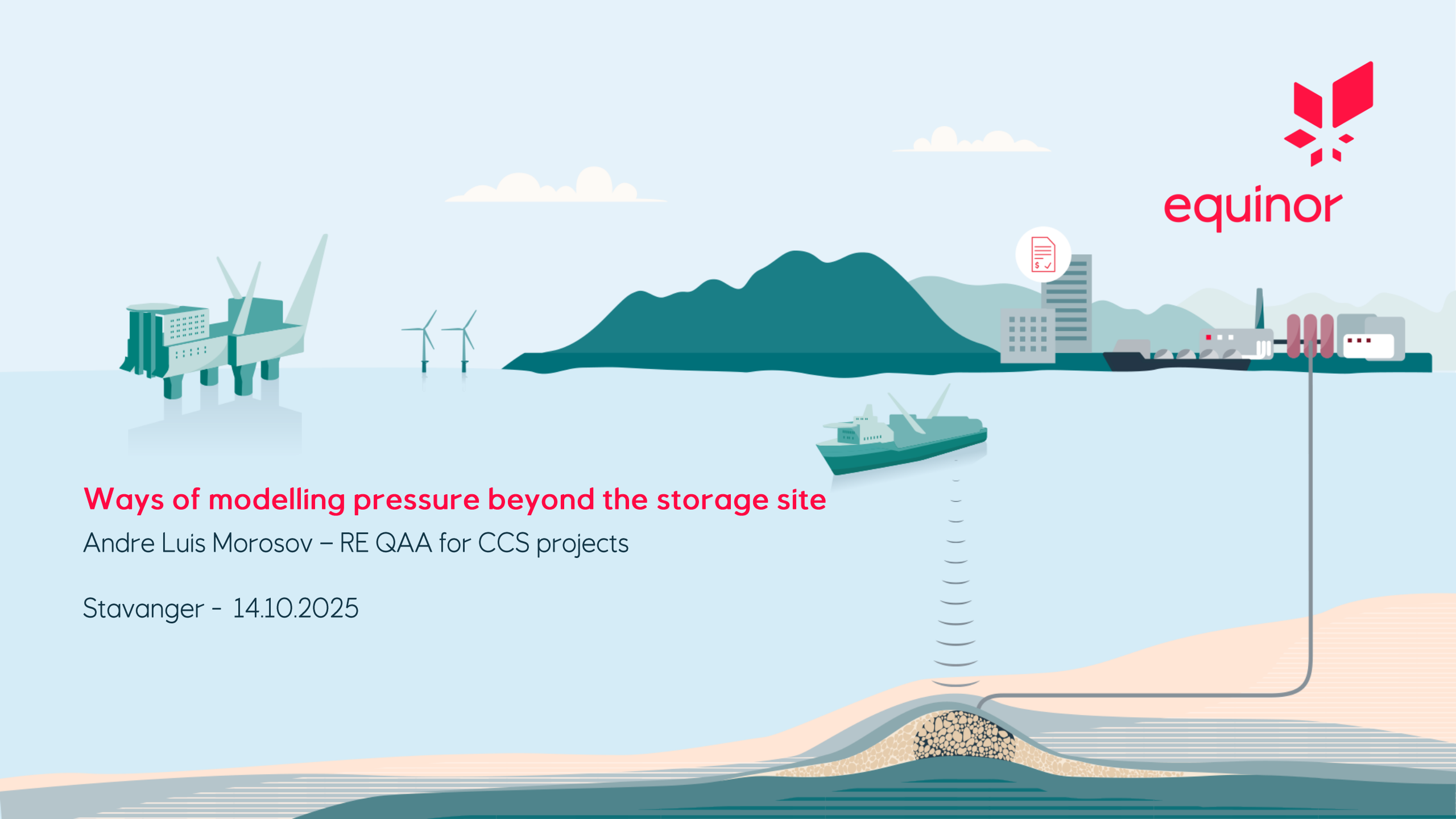


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Ways of modelling pressure beyond the storage site

Andre Luis Morosov – RE QAA for CCS projects

Stavanger - 14.10.2025



PART1

Connected pore volume and pressure response in CO₂ storage.

Pore volume and pressure

$$\Delta V_{CO_2}[m^3] = Pore\ Volume[m^3] * compressibility\ [\frac{1}{bar}] * \Delta Pressure[bar]$$

$$\Delta V_{CO_2} = PV * (c_w + c_r) * \Delta P$$

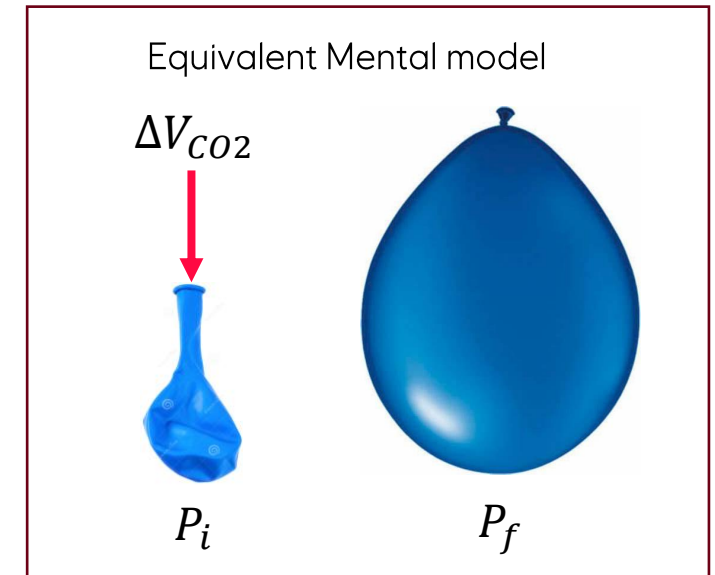
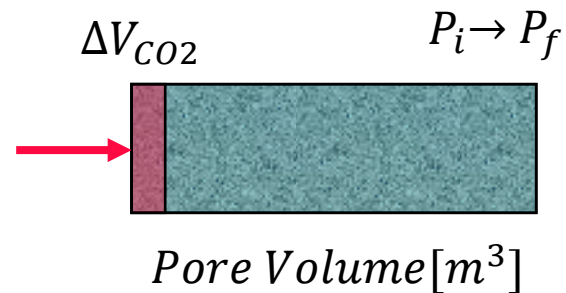
Order of magnitude:

$$c_w \cong 4 * 10^{-5}[1/bar]$$

$$c_r \cong 6 * 10^{-5}[1/bar]$$

$$c_t \cong 10^{-4}[1/bar]$$

$$c_t \cong 0.01[\%/bar]$$



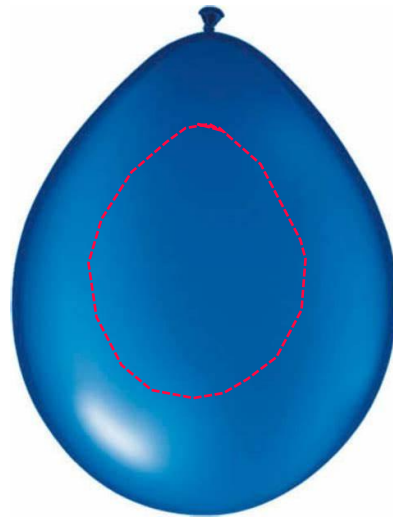
$$\Delta Mass_{CO_2}[Mt] = \Delta V_{CO_2}[m^3] * density_{CO_2}(P_f, T) \left[\frac{kg}{m^3} \right] * 10^{-9}$$

Total connected pore volume

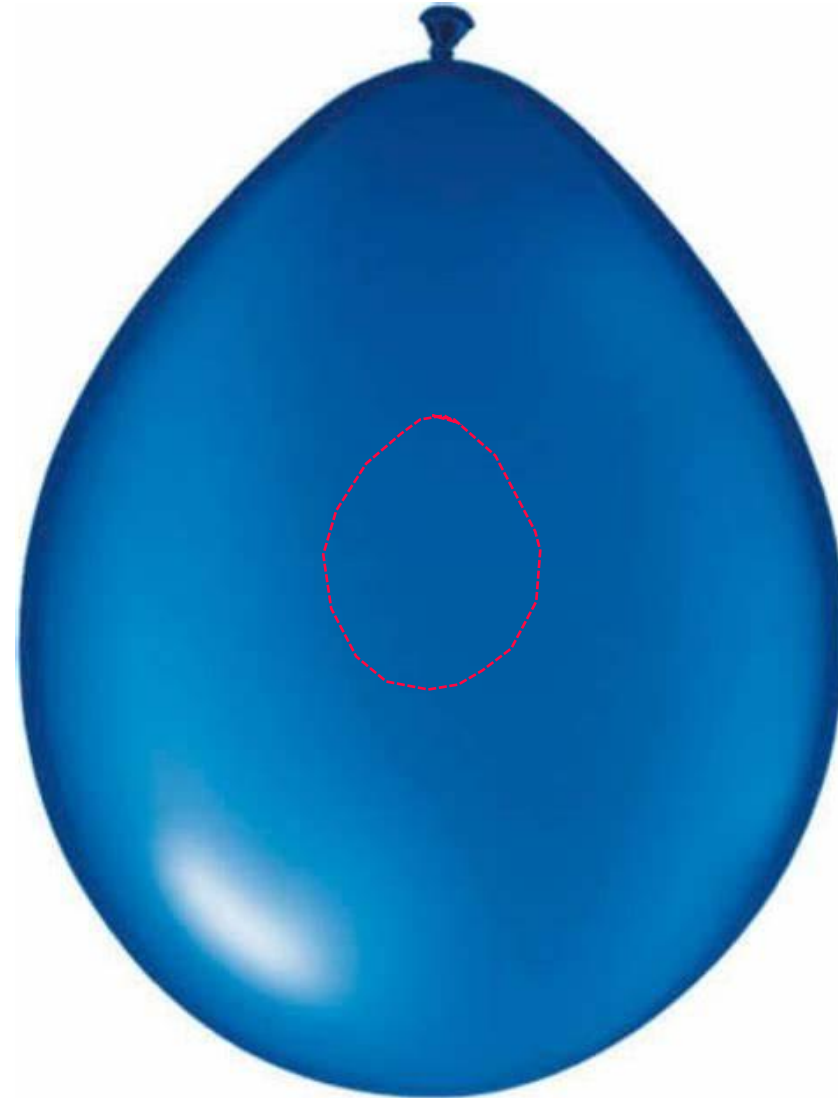
$$\Delta Mass_{CO_2} = PV * c_t * \Delta P * density_{CO_2}$$



Just store PV
(no aquifer)



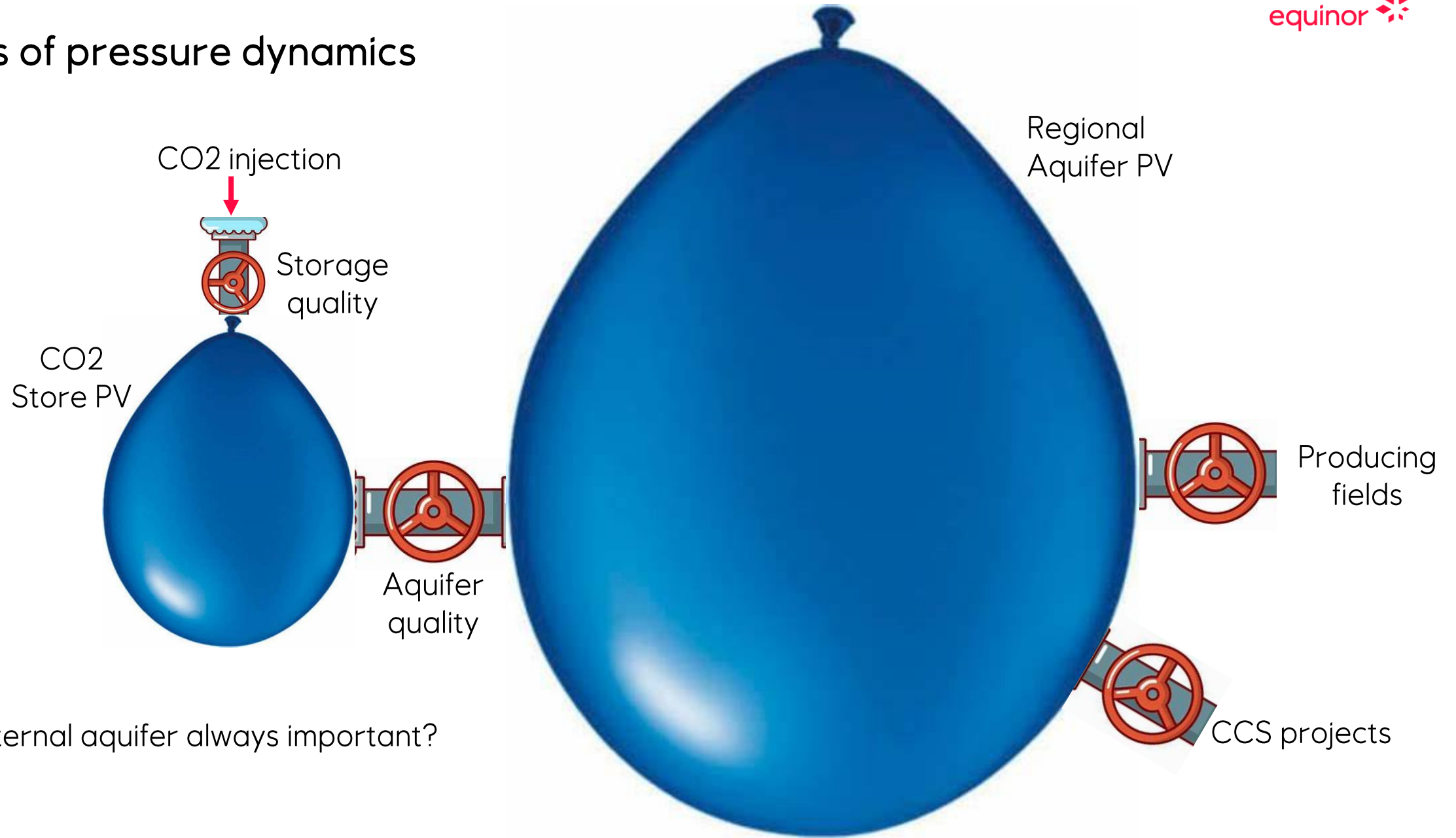
Store with aquifer PV
(small)



Store with aquifer PV
(large)

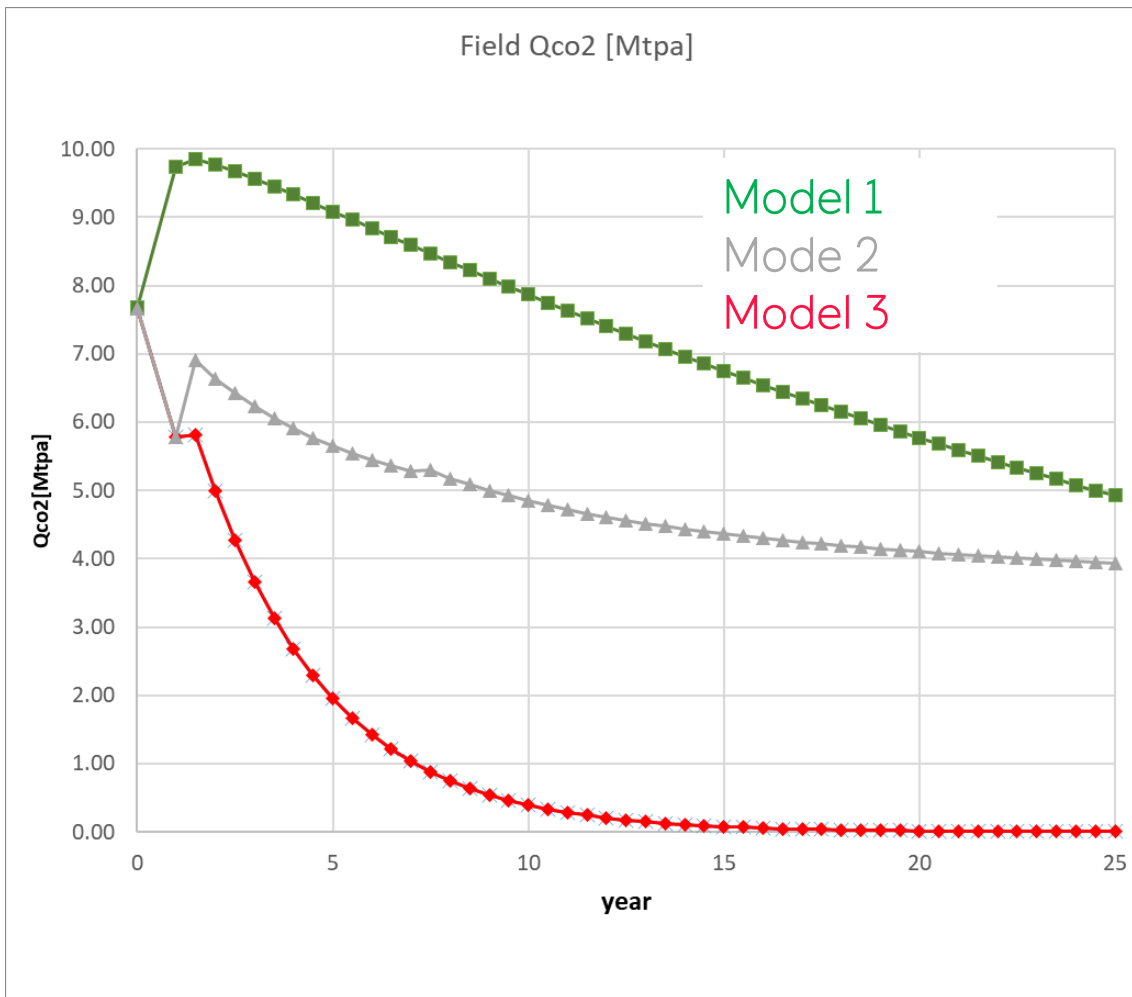
Larger connected PV is needed* to store more CO₂ (considering the same pressure buildup)

Effects of pressure dynamics



Is the external aquifer always important?

Injection potential vs Maximum sustainable constant rate



What controls the first earlier part of the profile?

- Well connection
- Number of wells
- Storage quality
- Storage heterogeneities

What controls the later part of the profile?

- Total PV connected
- Regional connectivity of the aquifer
- Producing fields
- Neighboring projects and

- ✓ The relative importance is **case-dependent**
- ✓ Modeling choices must be **good enough**

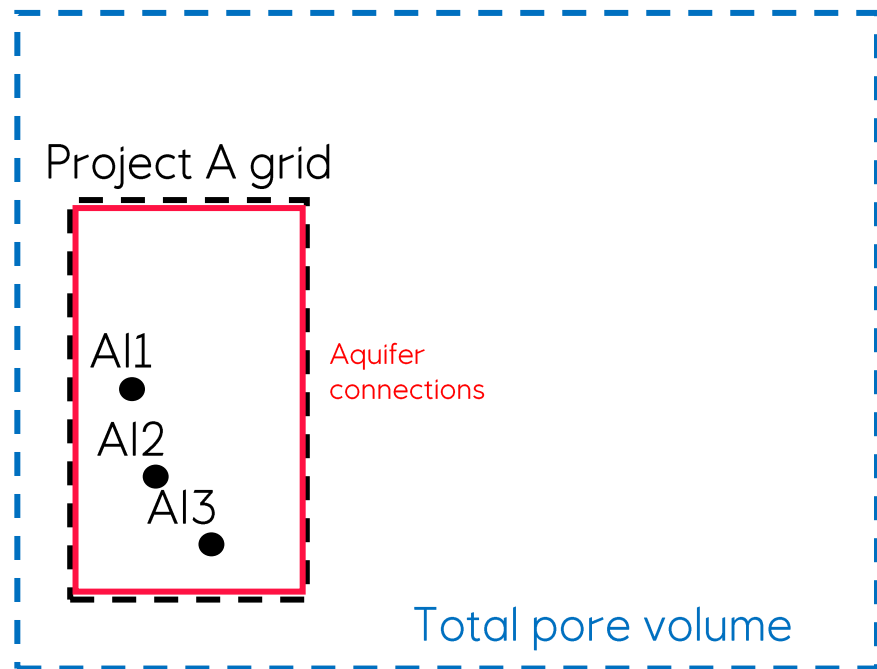


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PART2

Fit-for-purpose modelling in decision making context

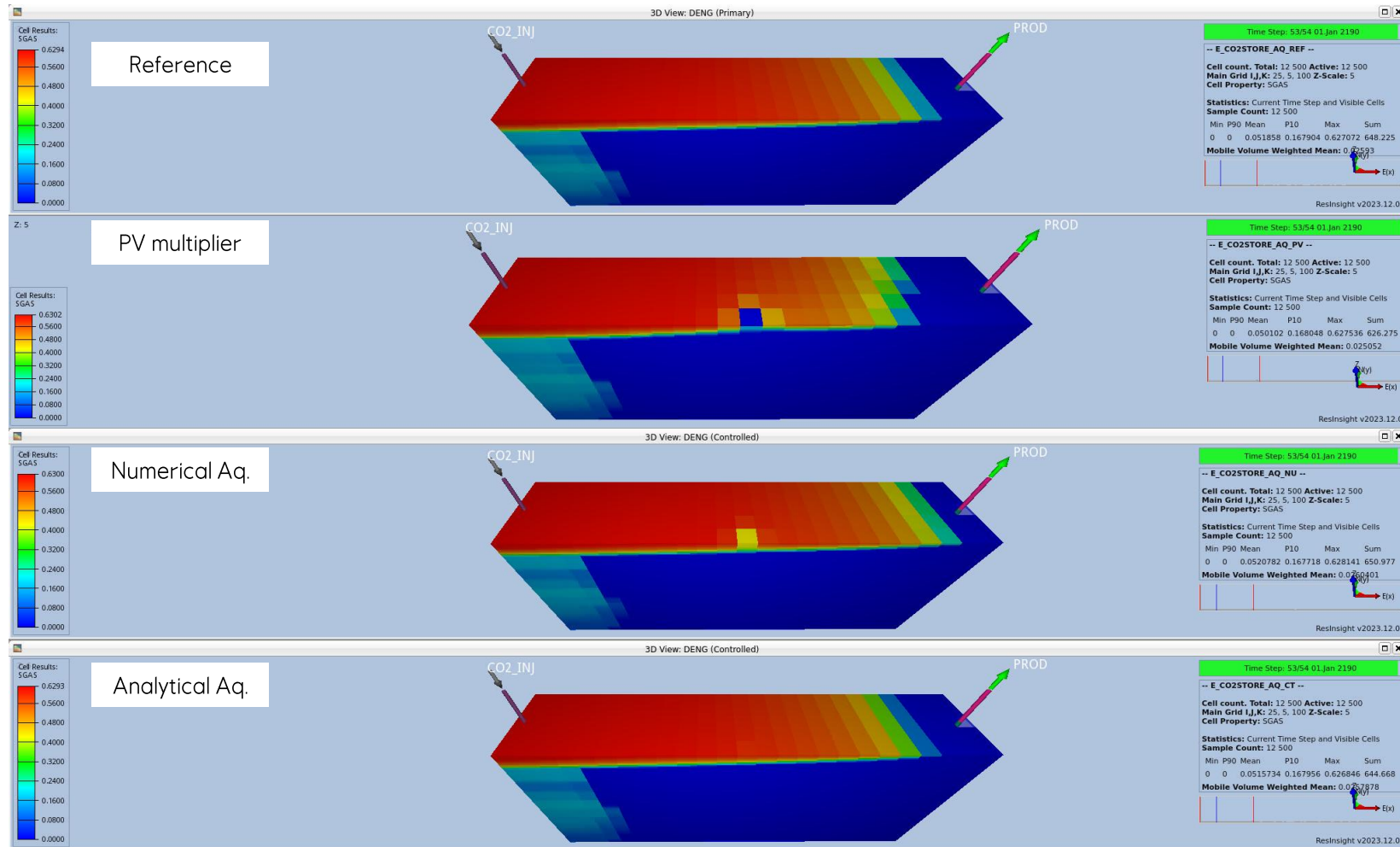
Numerical representation



Possible options:

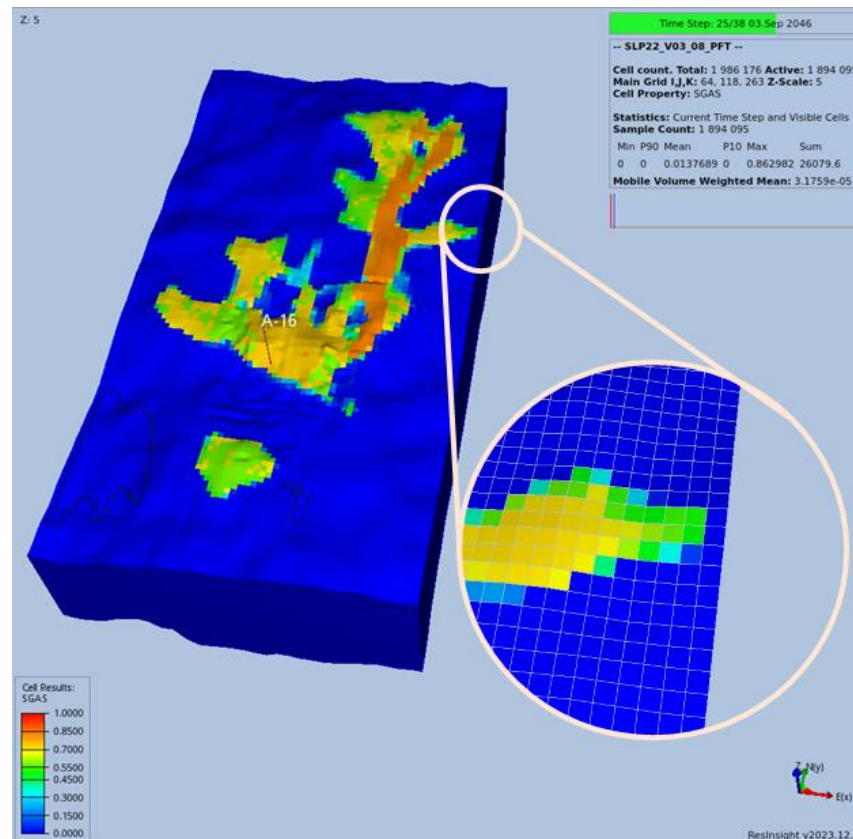
- Analytical aquifers
- Numerical aquifers
- Constant head pressure
- Pore volume multiplier on the edges

Aquifer implementation

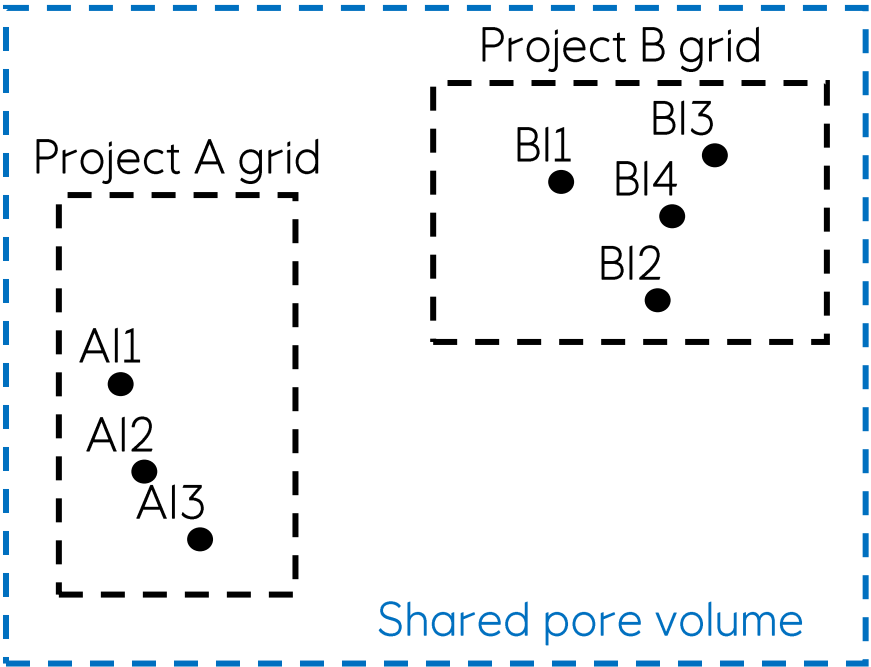


Effect of the boundary

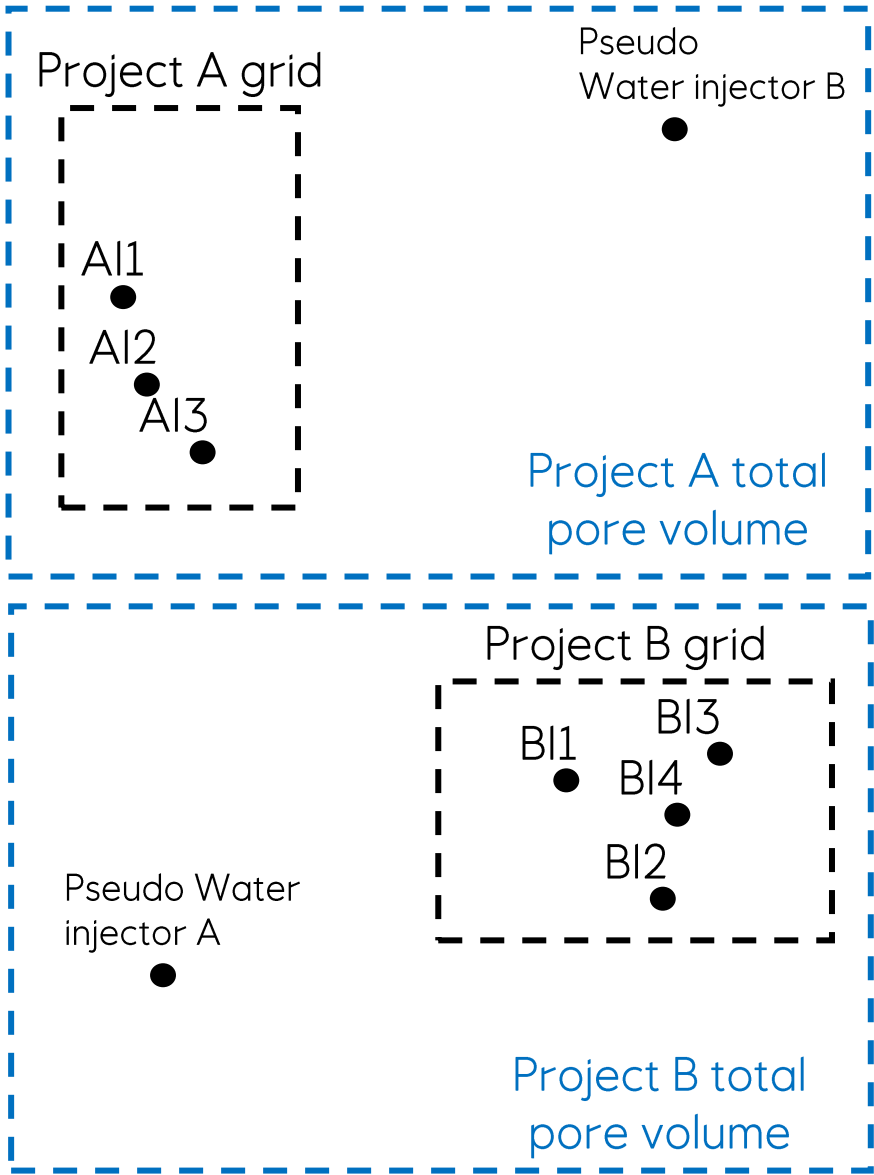
- Be mindful of plume movement
- Plume development is not valid anymore after the saturation front reaches any high pore volume boundary



Regional interference modeling



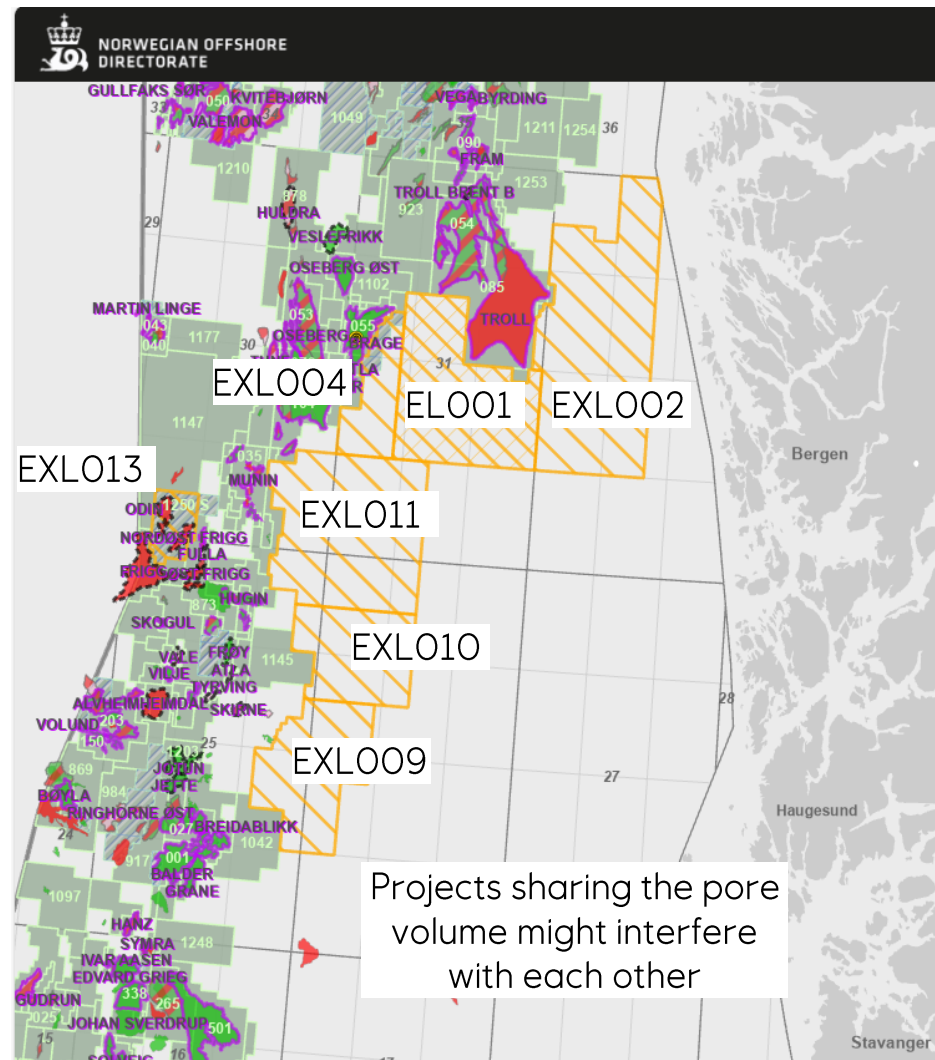
Equivalent
Project A
model



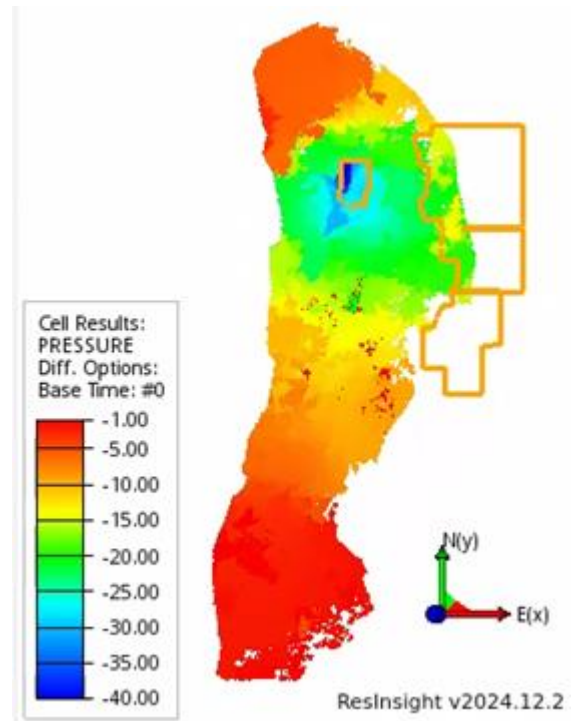
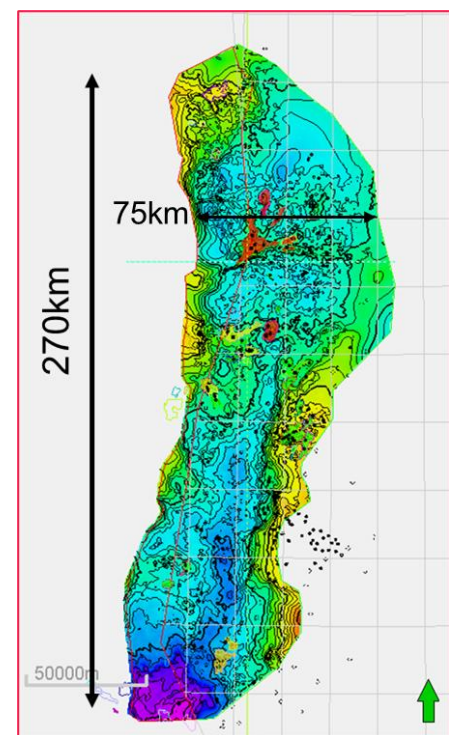
Equivalent
Project B
model



Regional interference modeling example



Frigg-Heimdal aquifer model
 FORCE seminar, May 10th 2023



Norther Endurance Partnership (NEP) in UK

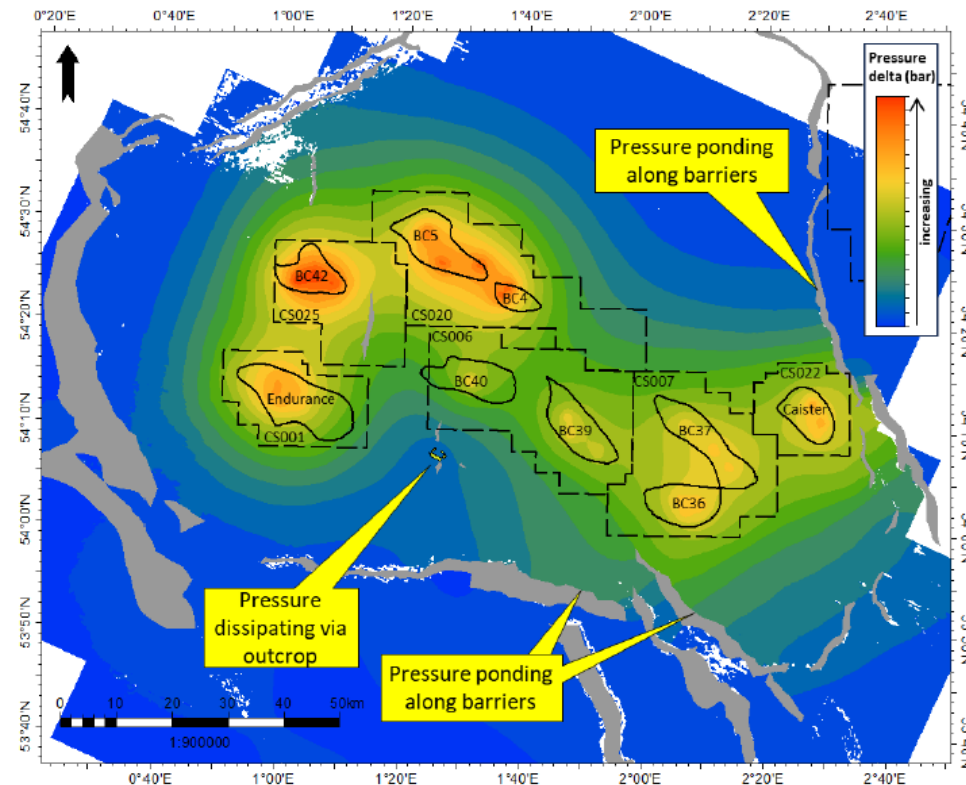


Figure 3 Reservoir pressurisation of the Silver Pit Basin hydraulic unit after 25 years of simultaneous CO₂ injection at multiple CO₂ stores (combined injection rate of 22 Mtpa, 550 Mt injected in total).

Gibson-Poole, C., Tarasewicz, J., Gray, E., Hitchen, K., Bouffin, N., Taplin, M., ... & Buchanan, S. (2025, June). Multi-store Developments within the UK Southern North Sea: Implications for Carbon Storage Pore Space Usage. In *86th EAGE Annual Conference & Exhibition* (Vol. 2025, No. 1, pp. 1-5). European Association of Geoscientists & Engineers.

Take away messages

- Important to have clarity in the physics
- Modeling choices are case-dependent
- Focus on fit-for-purpose modeling



Thank you

Andre Luis Morosov – RE QAA for CCS projects

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