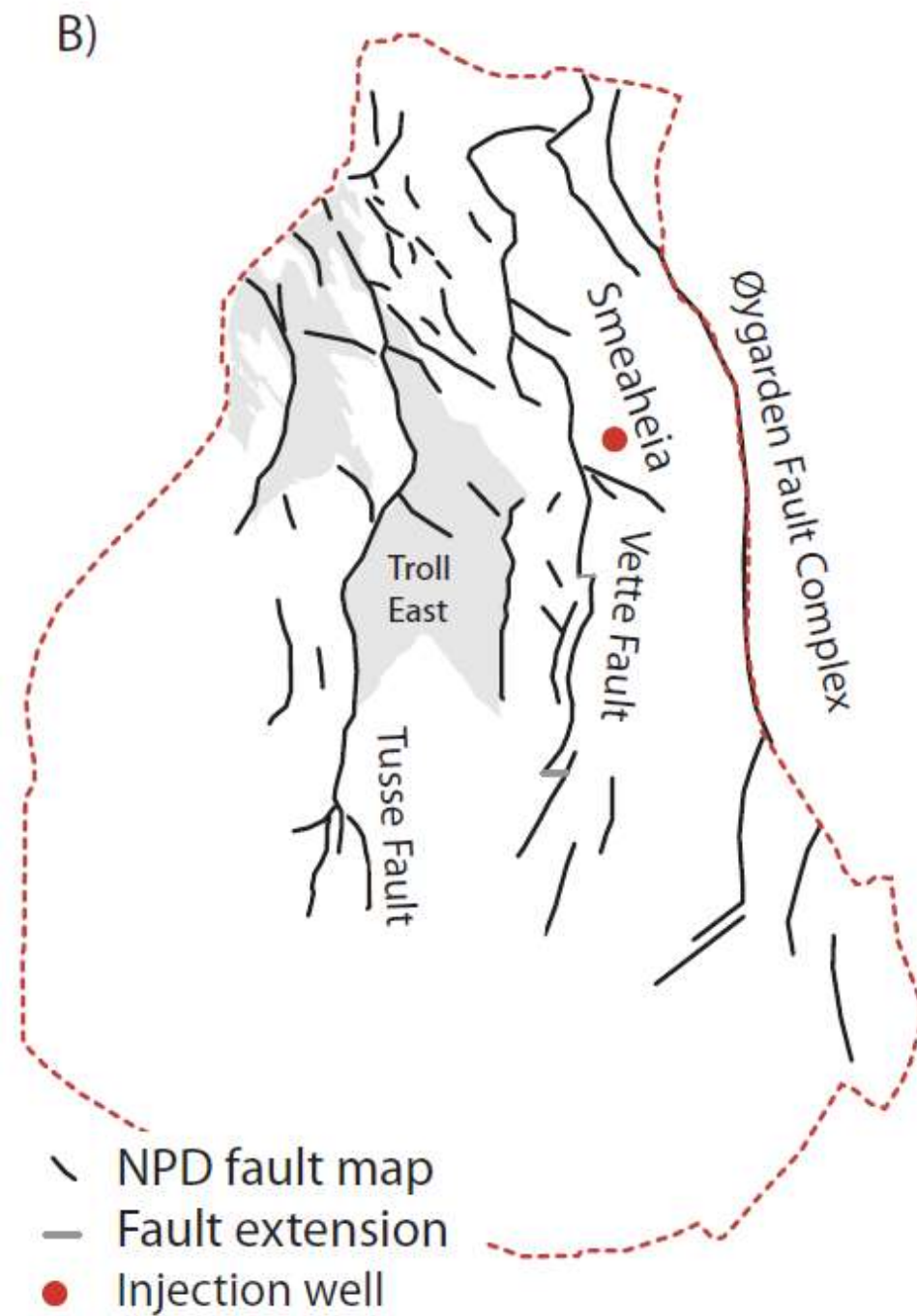
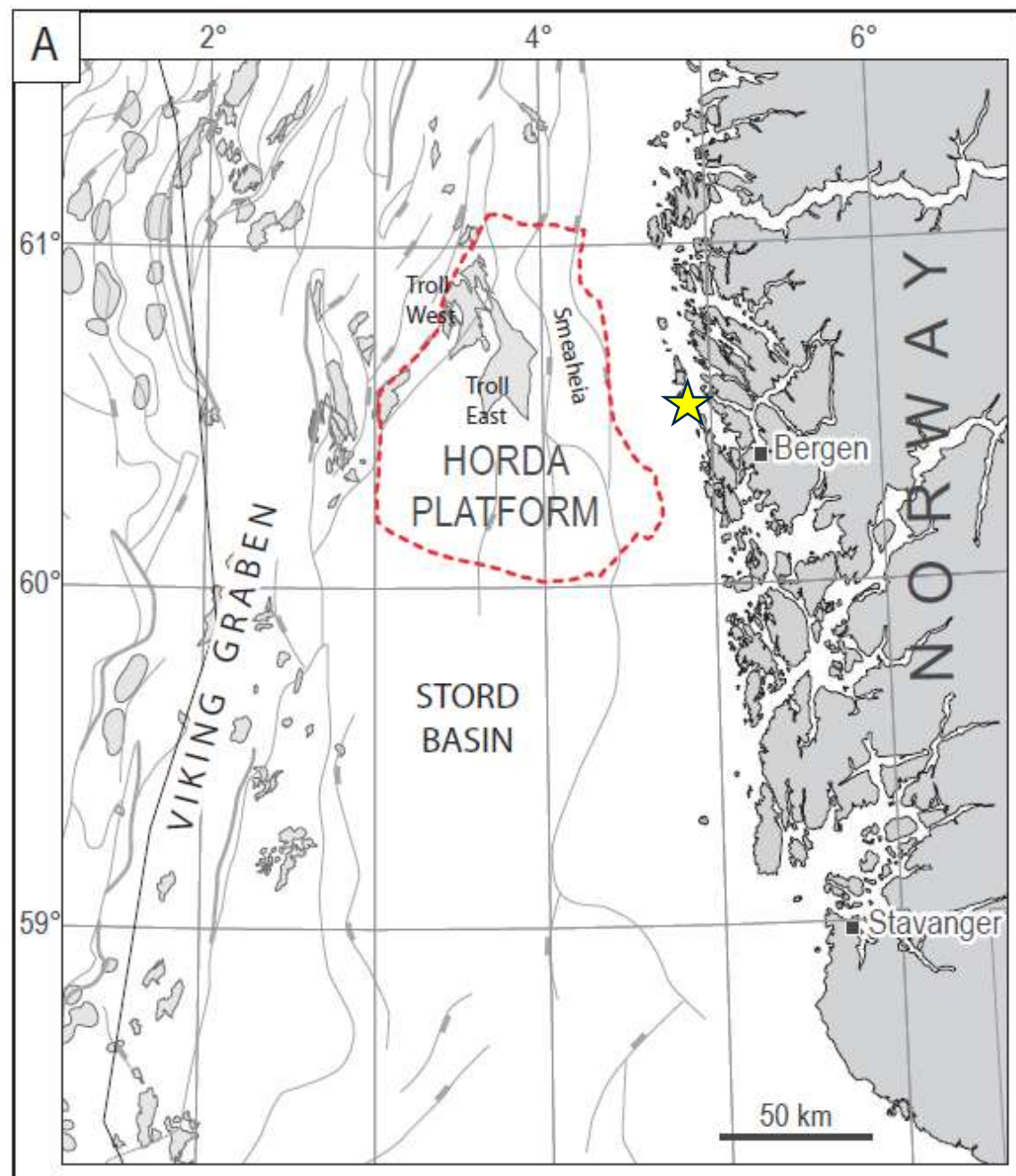


WHAT'S NEXT? STORAGE RESOURCES FOR FUTURE EUROPEAN CCS DEPLOYMENT; A ROADMAP FOR A HORDA STORAGE HUB, OFFSHORE NORWAY

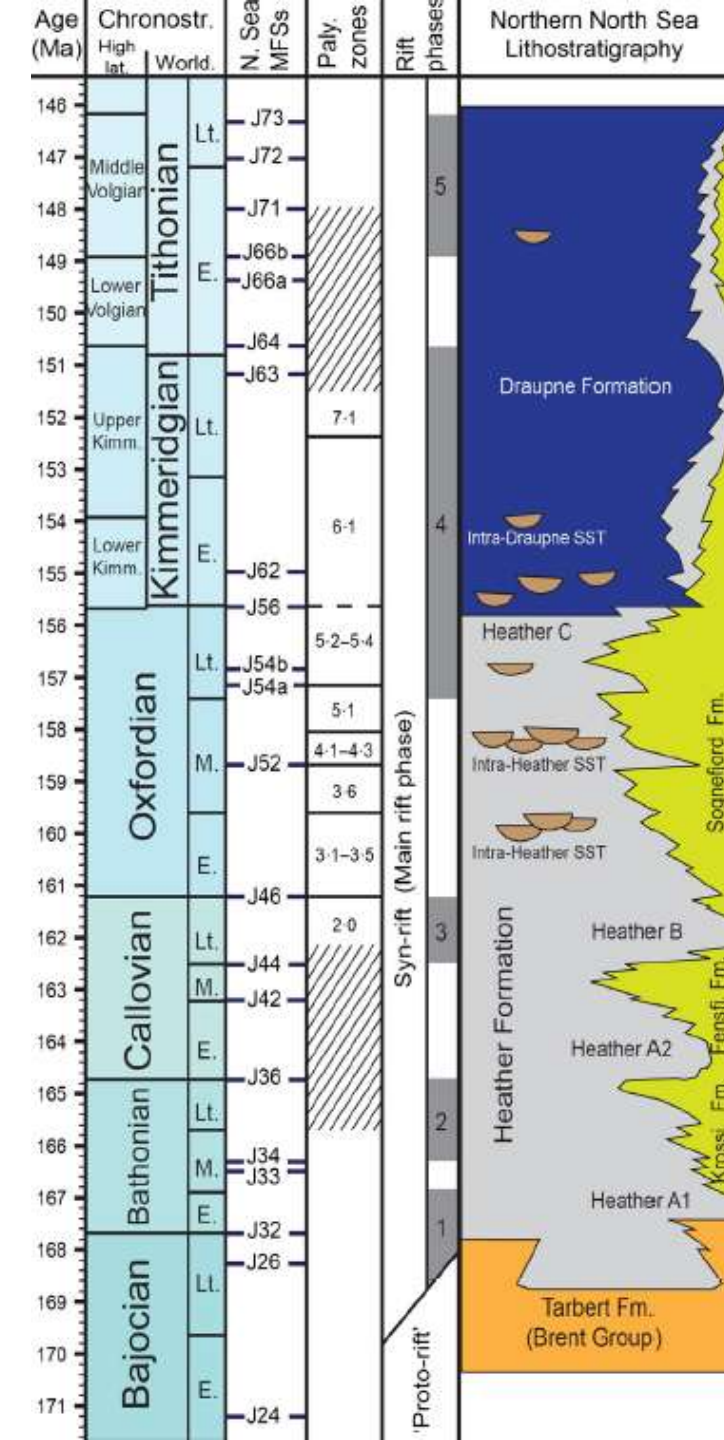
Ane Lothe, Alv-Arne Grimstad & Per Eirik S. Bergmo

TCCS-10, 19th of June 2019



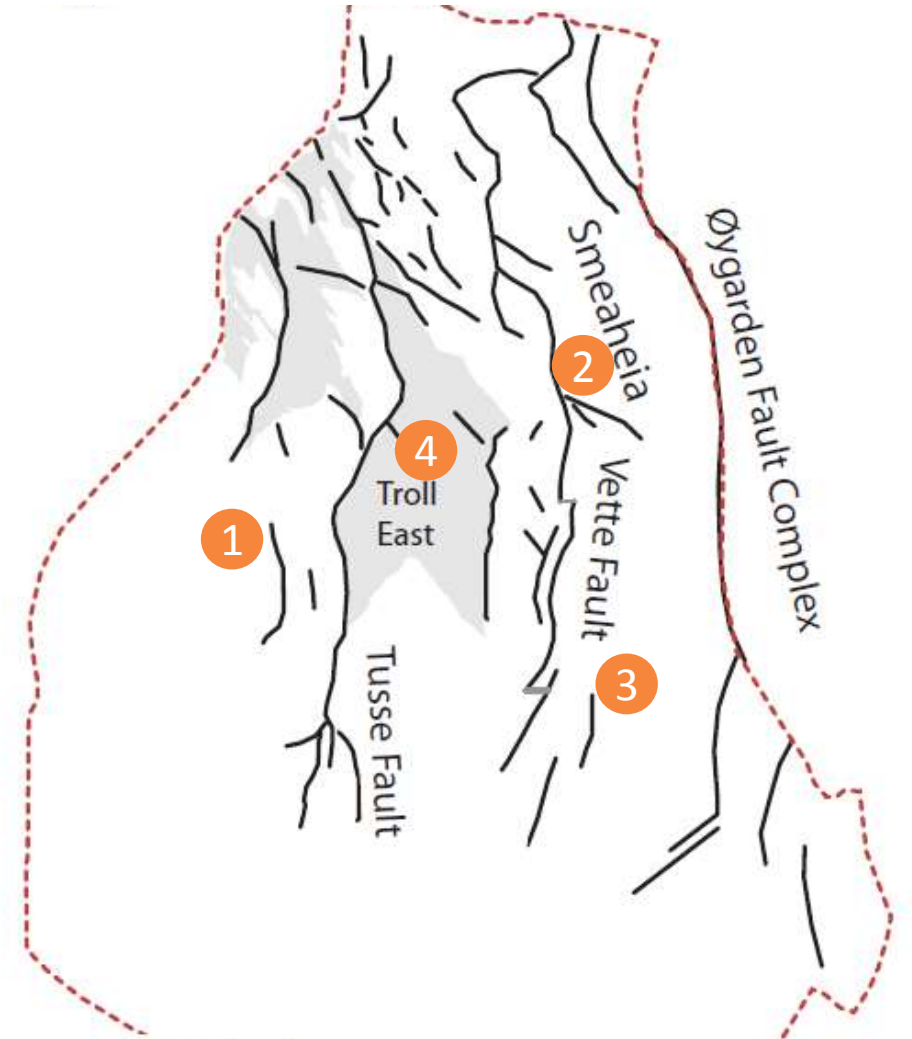
Stratigraphy

- Three coastal shallow marine sands that interfingers with shales
- Thickness 400-500 m
- The Sognefjord Formation:
 - permeability 1-20 D, porosity between 19-34 %
- Thin clay layers and calcite layers



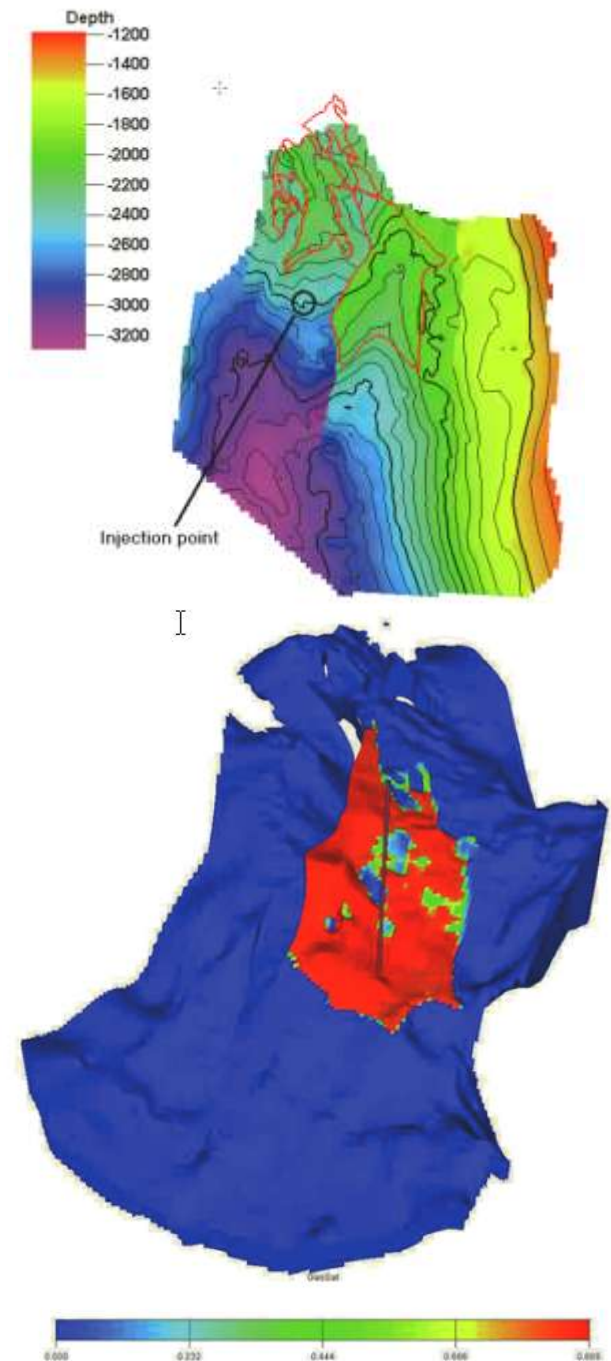
Roadmap for CO₂ Storage Smeaheia Hub

- 1) Aurora structure (Johansen Fm.)
- 2) Smeaheia (Alpha structure)
- 3) Smeaheia south (Gamma structure)
- 4) Post Troll



1) Aurora structure (Johansen Fm.)

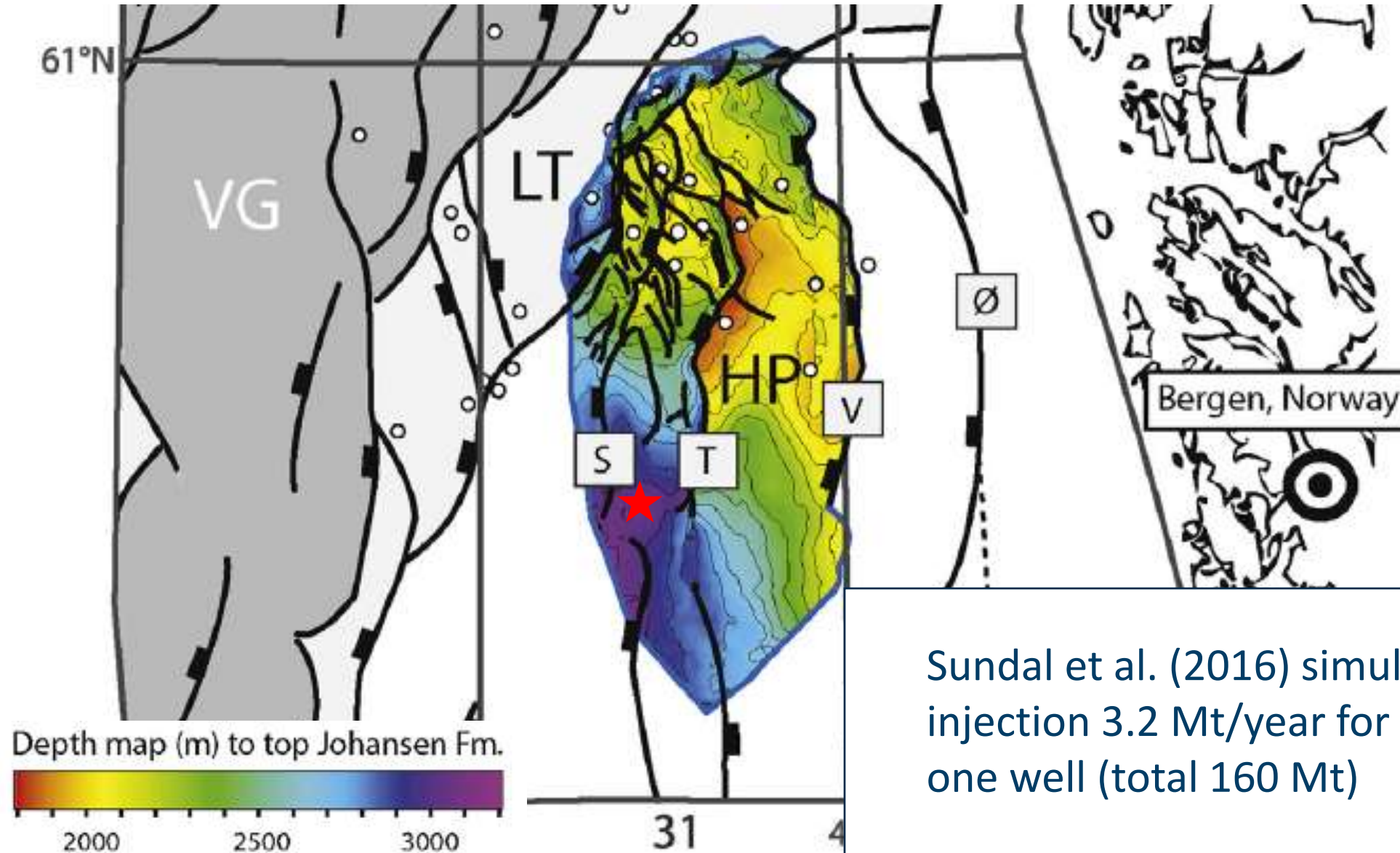
- Bergmo et al. (2009) simulated 3 Mt/year storage over 110 years (330 Mt totally)
- The injected CO₂ will migrate into Troll (in worst case after 150 years of injection)



Base case CO₂ saturation in the Johansen formation after the injection period (110 years)

Bergmo et al. (2009)

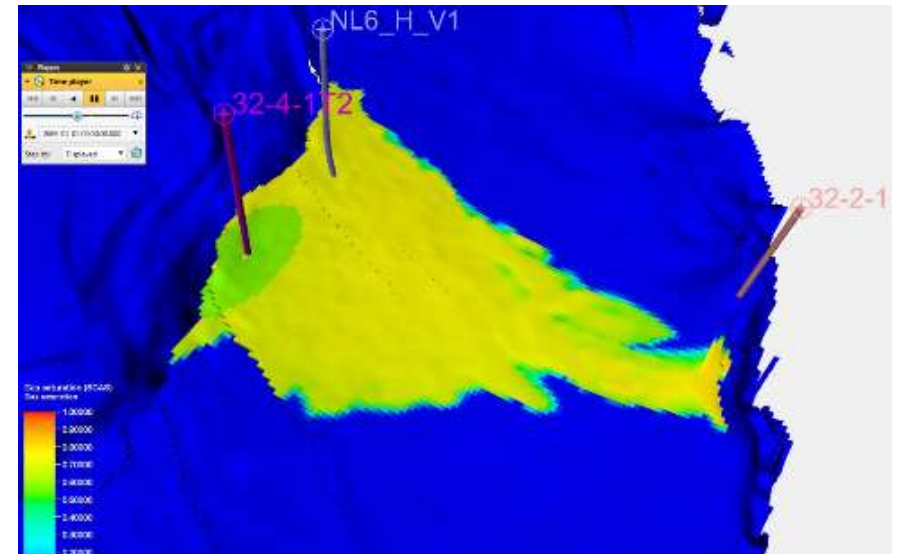
1) Aurora structure (Johansen Fm.)



Sundal et al. (2016) simulated CO₂ injection 3.2 Mt/year for 50 years in one well (total 160 Mt)

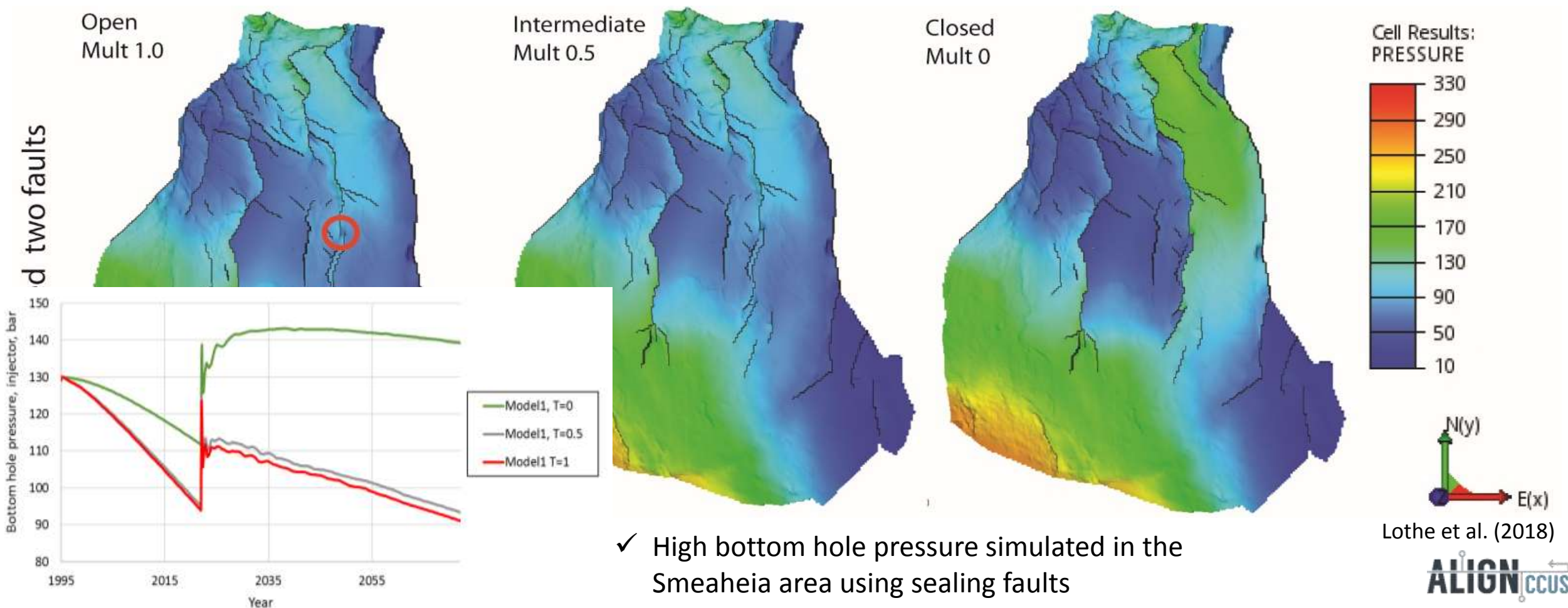
2) Smeaheia (Alpha structure)

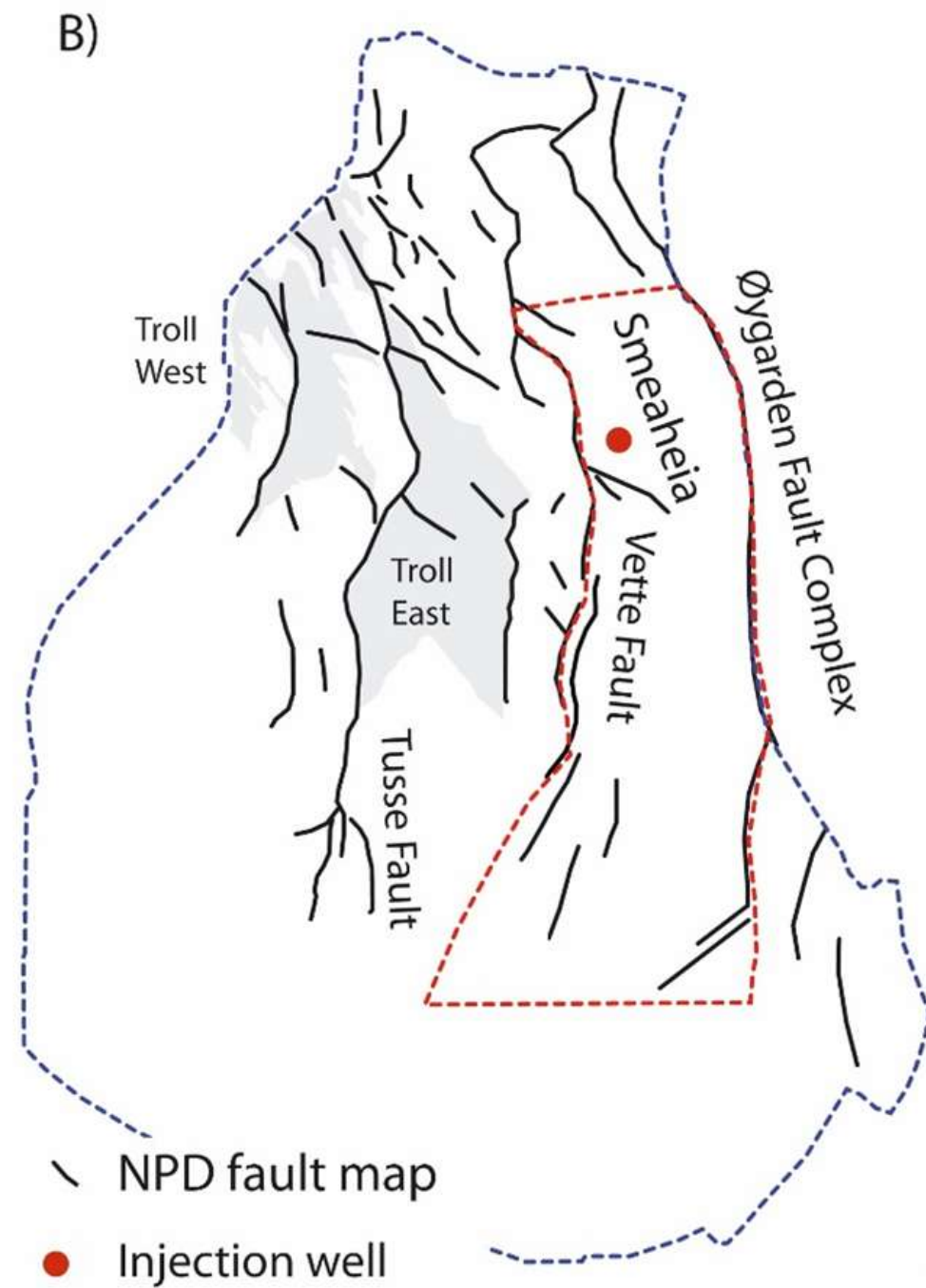
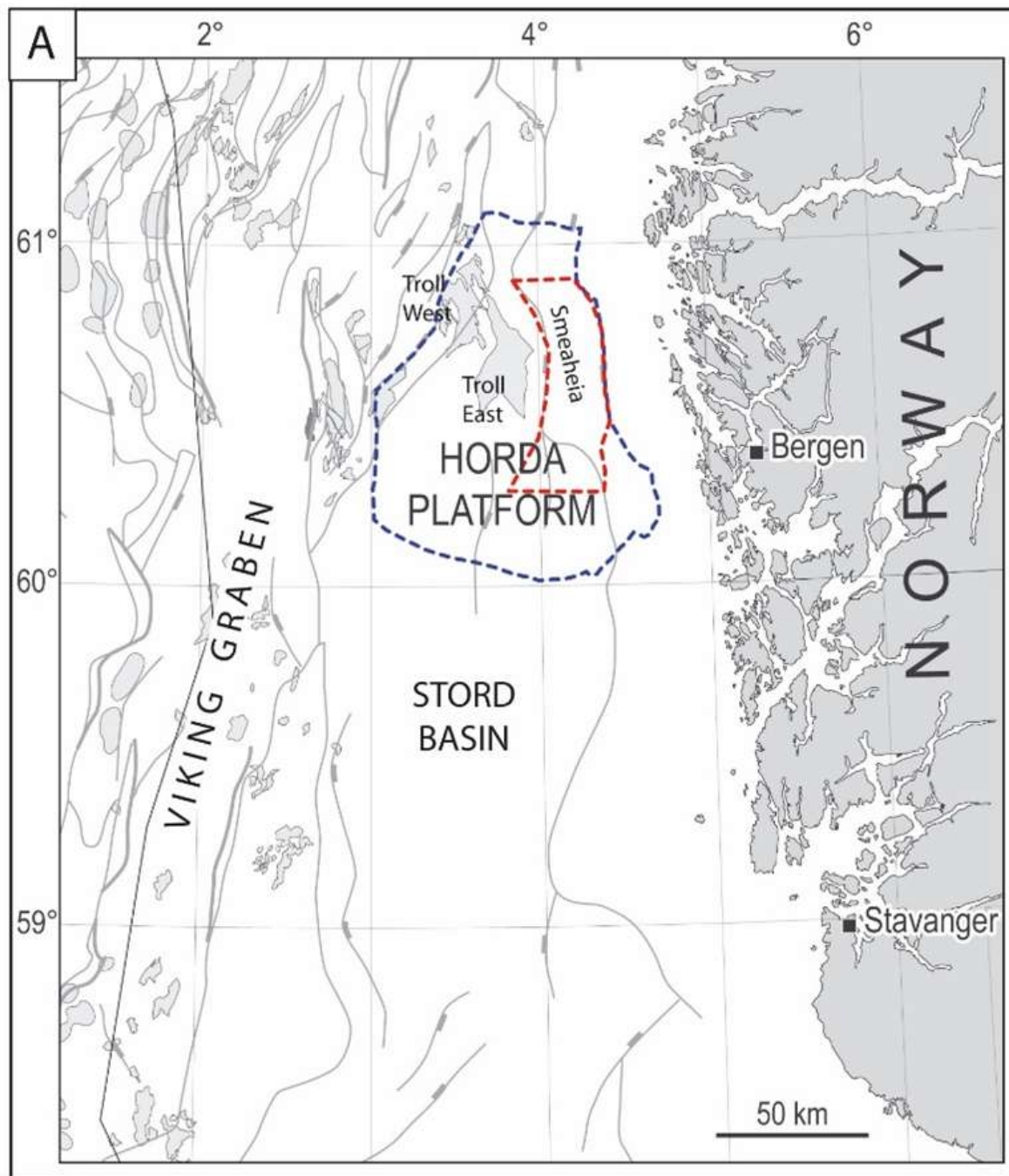
Lauritsen et al. (2018) simulate CO₂ injection in one location, with storage of totally 40 Mt



Lauritsen et al. (2018)

Large scale pressure simulations

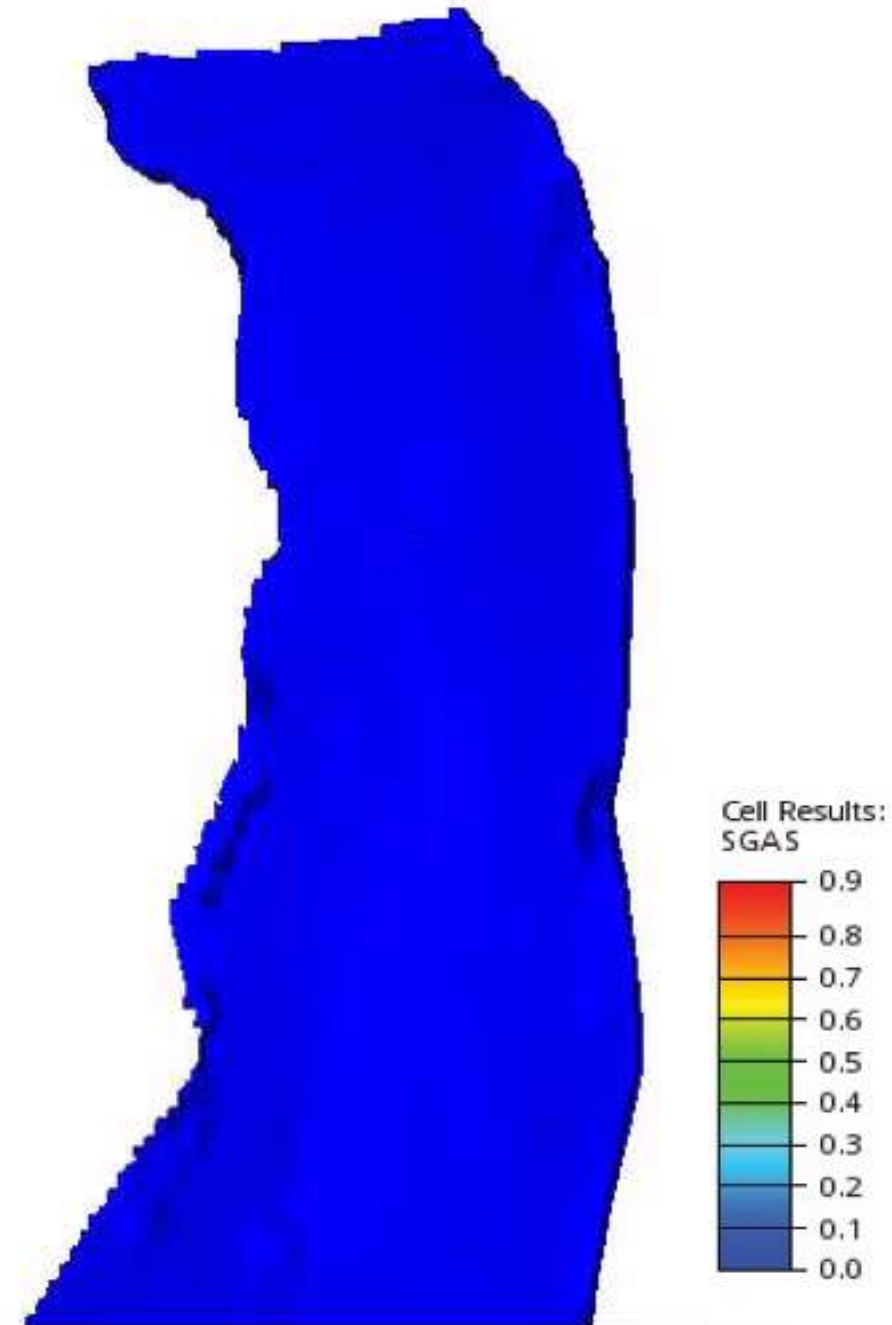




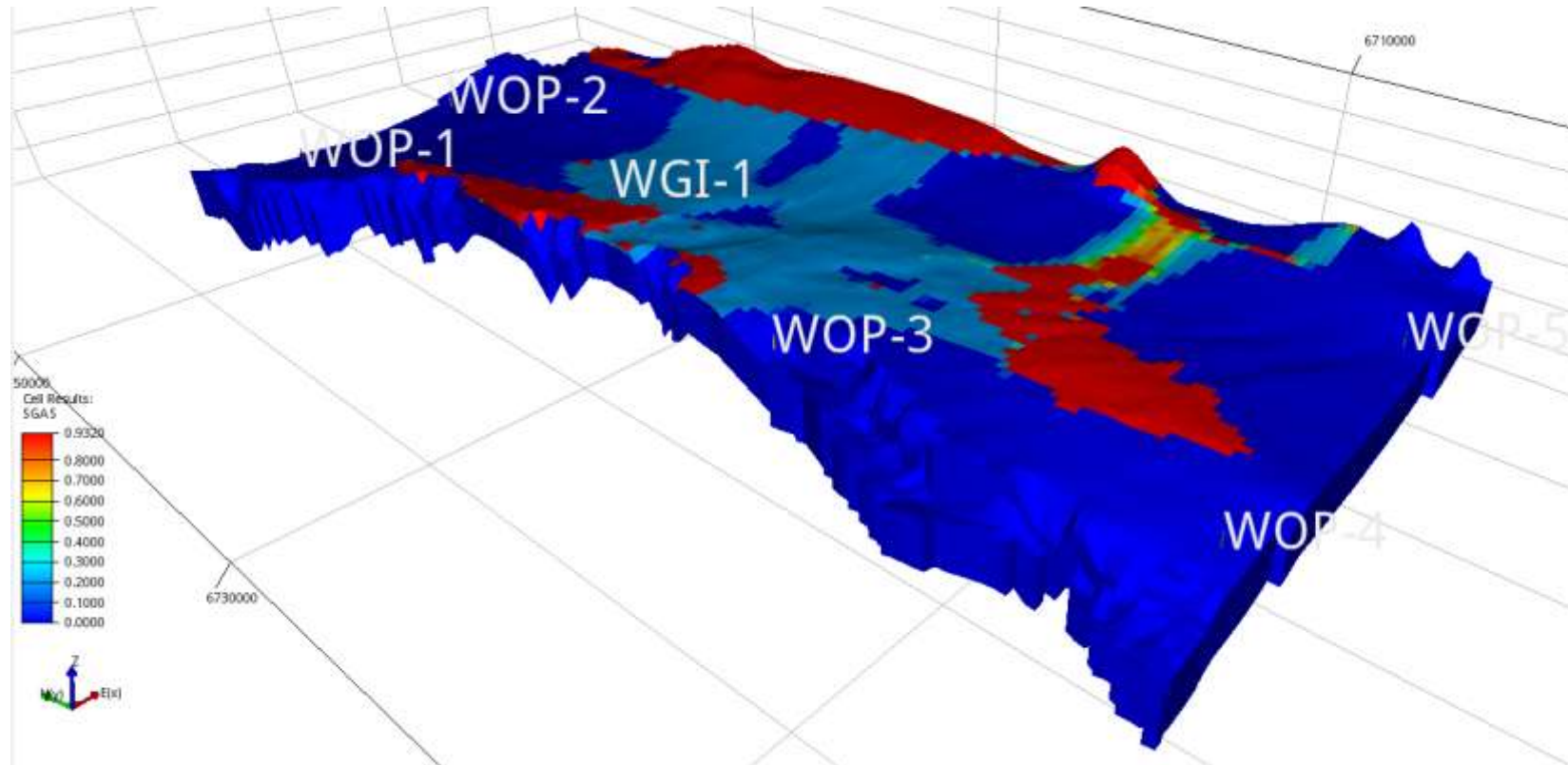
2) Smeaheia (Alpha structure)

- Assume depletion from the Troll Field, and sealing faults
- CO₂ injection rate is constant at 3 Mt/yr for 50 yrs
- Simulate for 1000 years
- Rapid migration into the Øygarden Fault zone

Lothe et al. (2019)



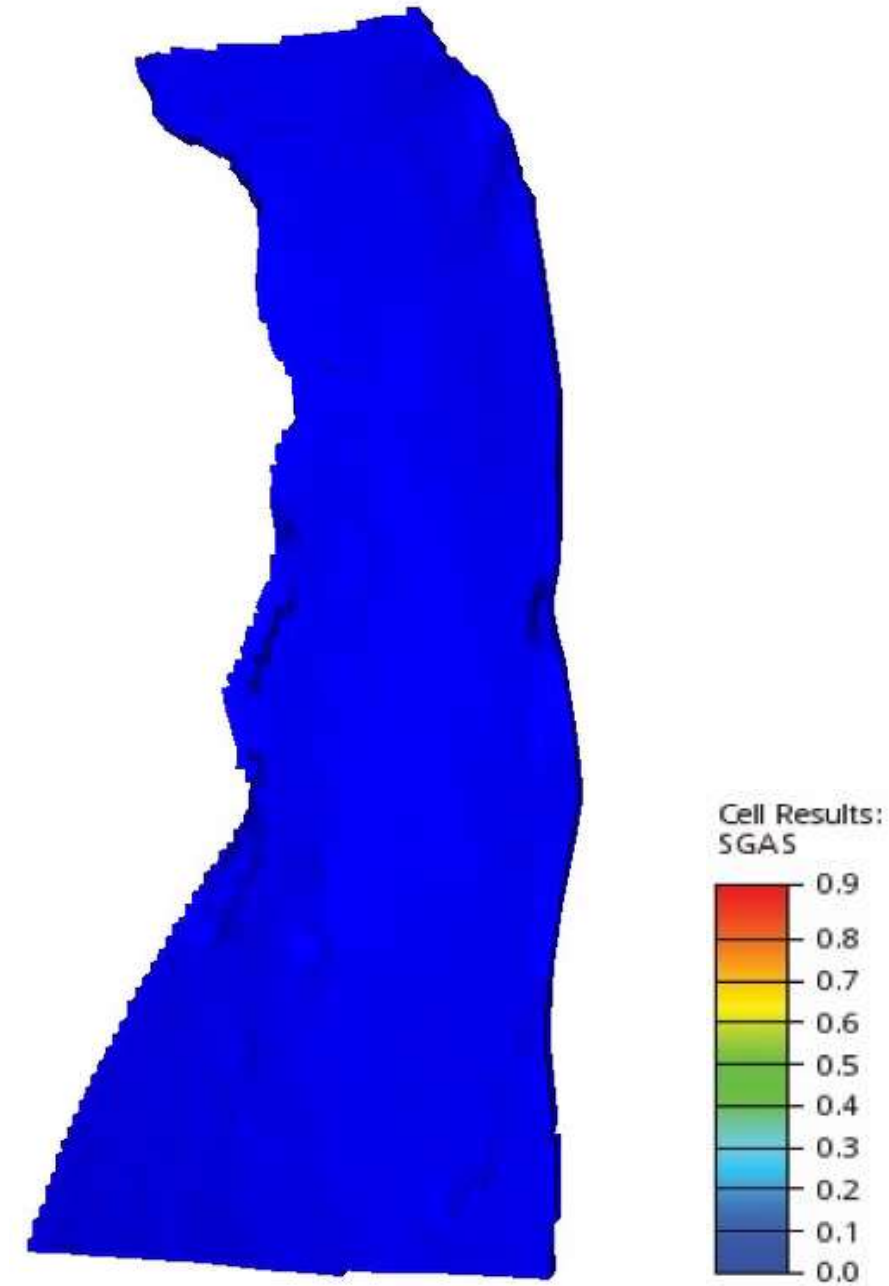
3 Mt/year over 50 years



Result after 500 years

3) Smeaheia South (Gamma structure)

- Assume depletion from the Troll Field, and sealing faults
- CO₂ injection rate is constant at 3 Mt/yr for 50 yrs
- Simulate for 1000 years



3) Smeaheia South (Gamma structure)

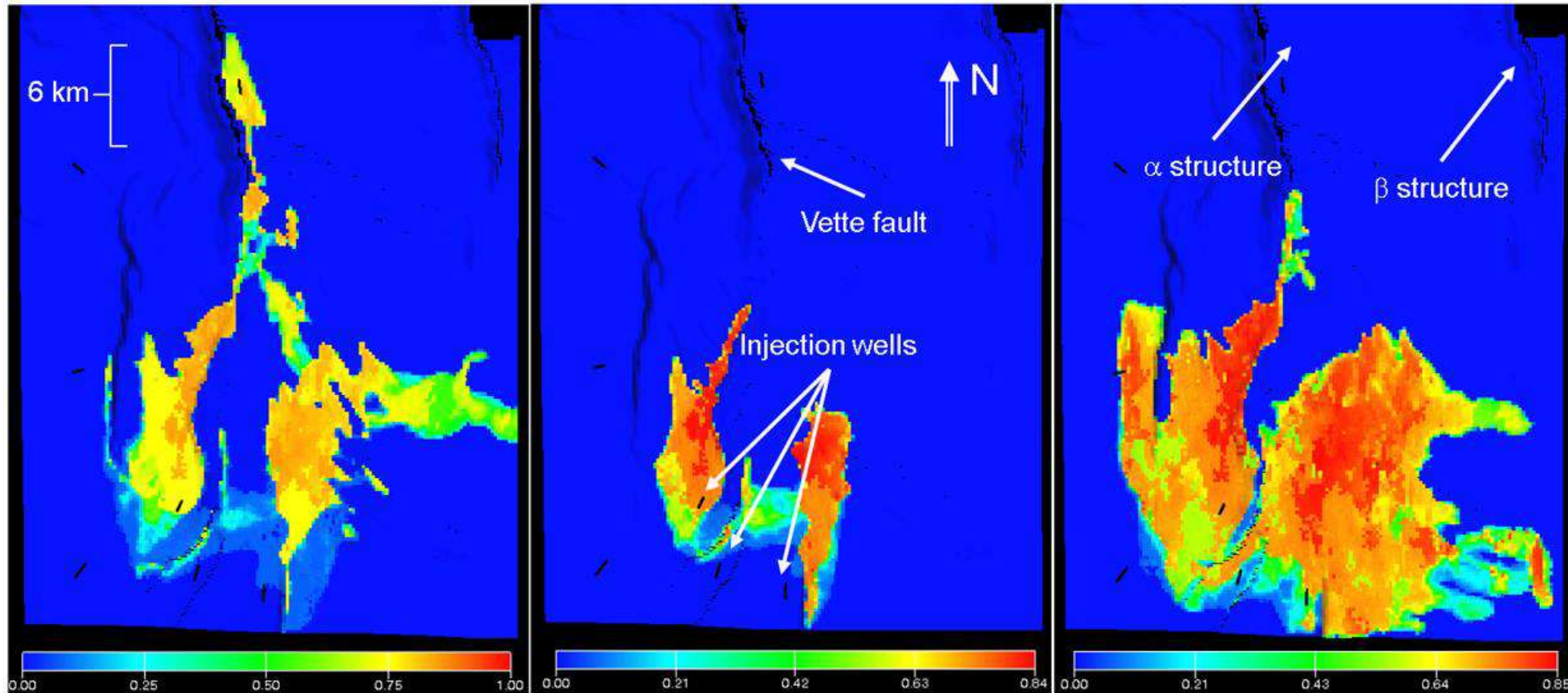
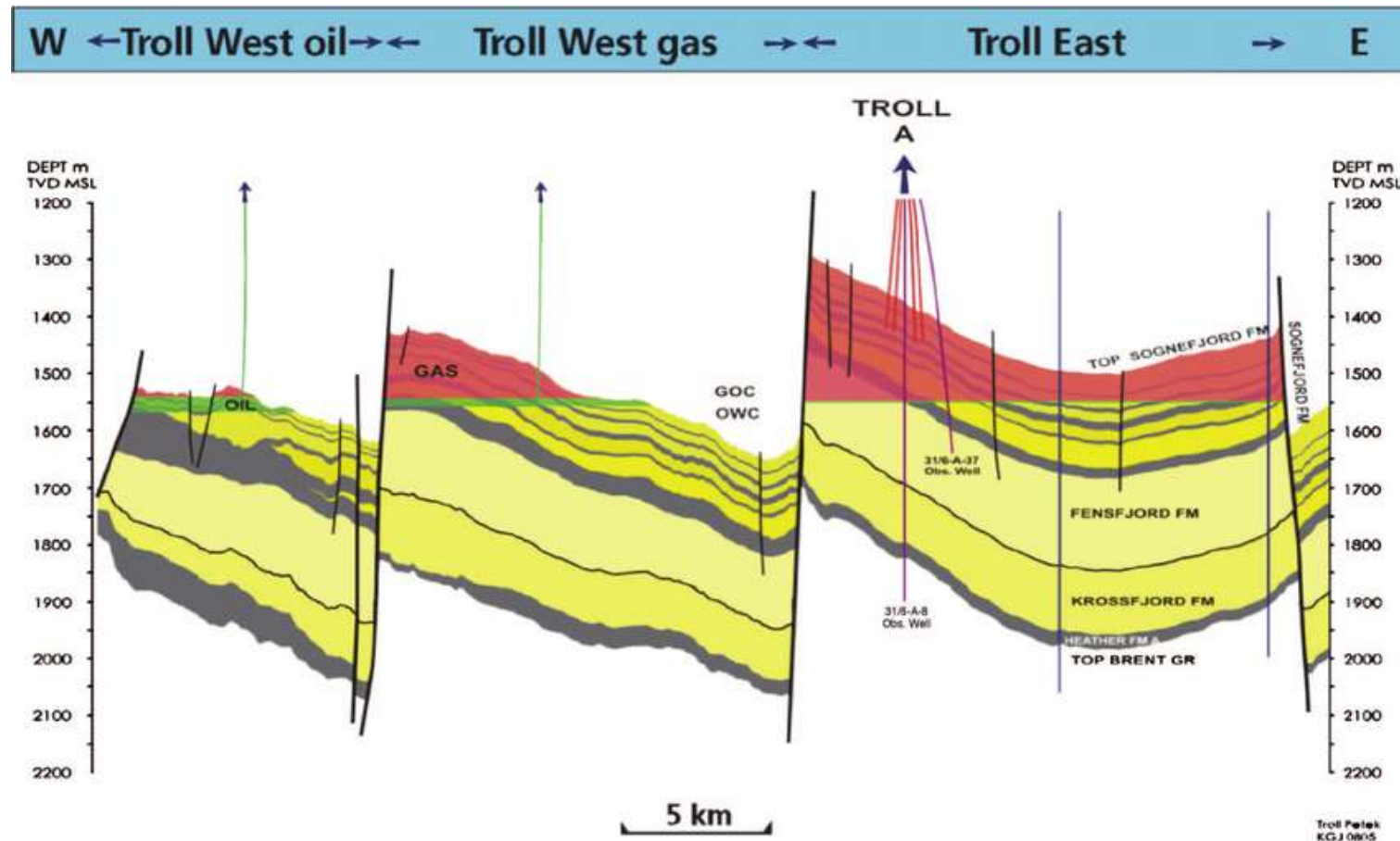
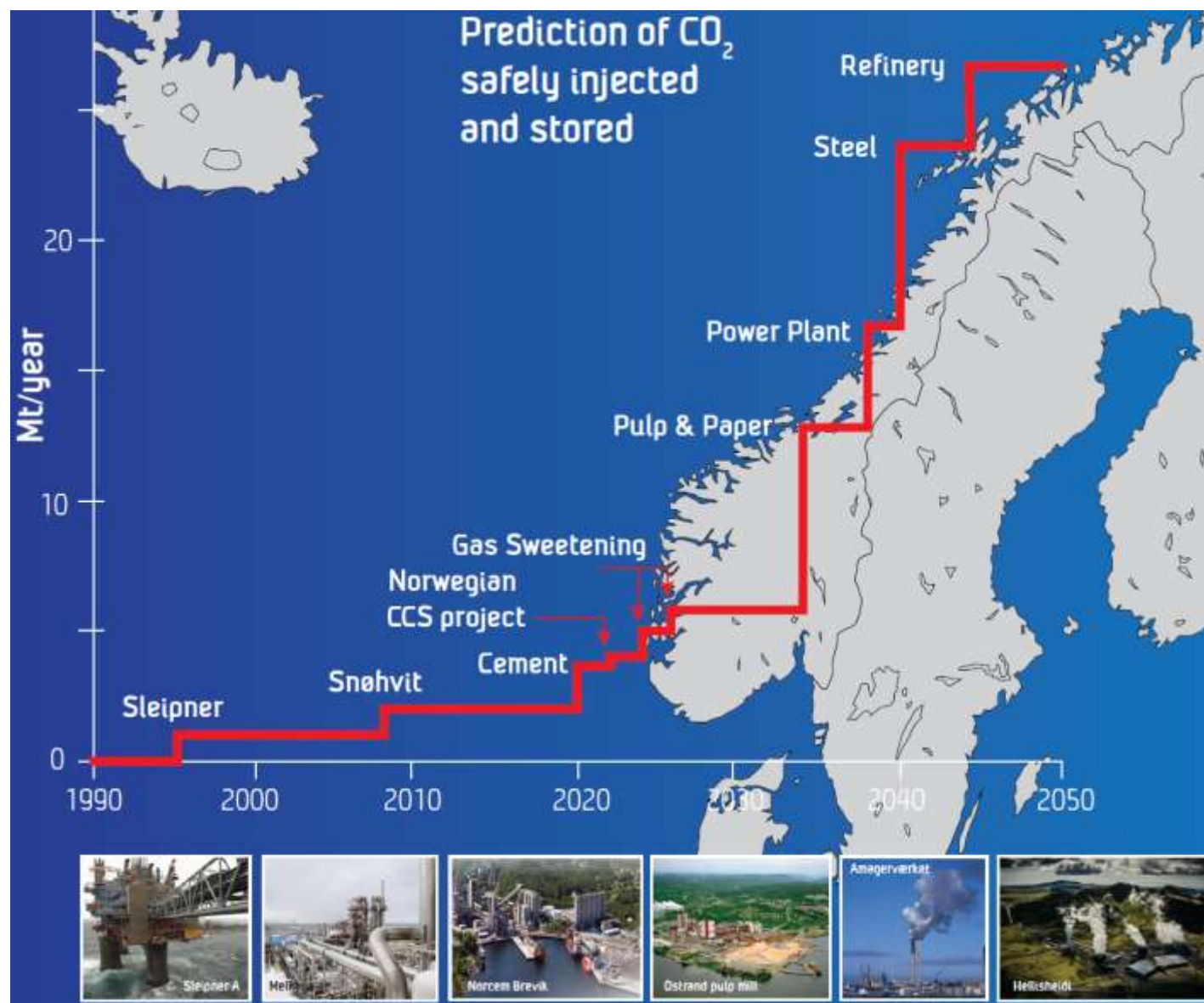


Figure 3. Left. Top view of CO₂ plume 650 years after injection of more than 600 Mt in a continuously depleted Smeaheia. Middle. 600 Mt CO₂ injected in a non-depleted Smeaheia. Right. 3 Gt CO₂ injected under continuous depletion. CO₂ plume is almost stabilized 650 years after the injection.

Nazarian et al. (2018)

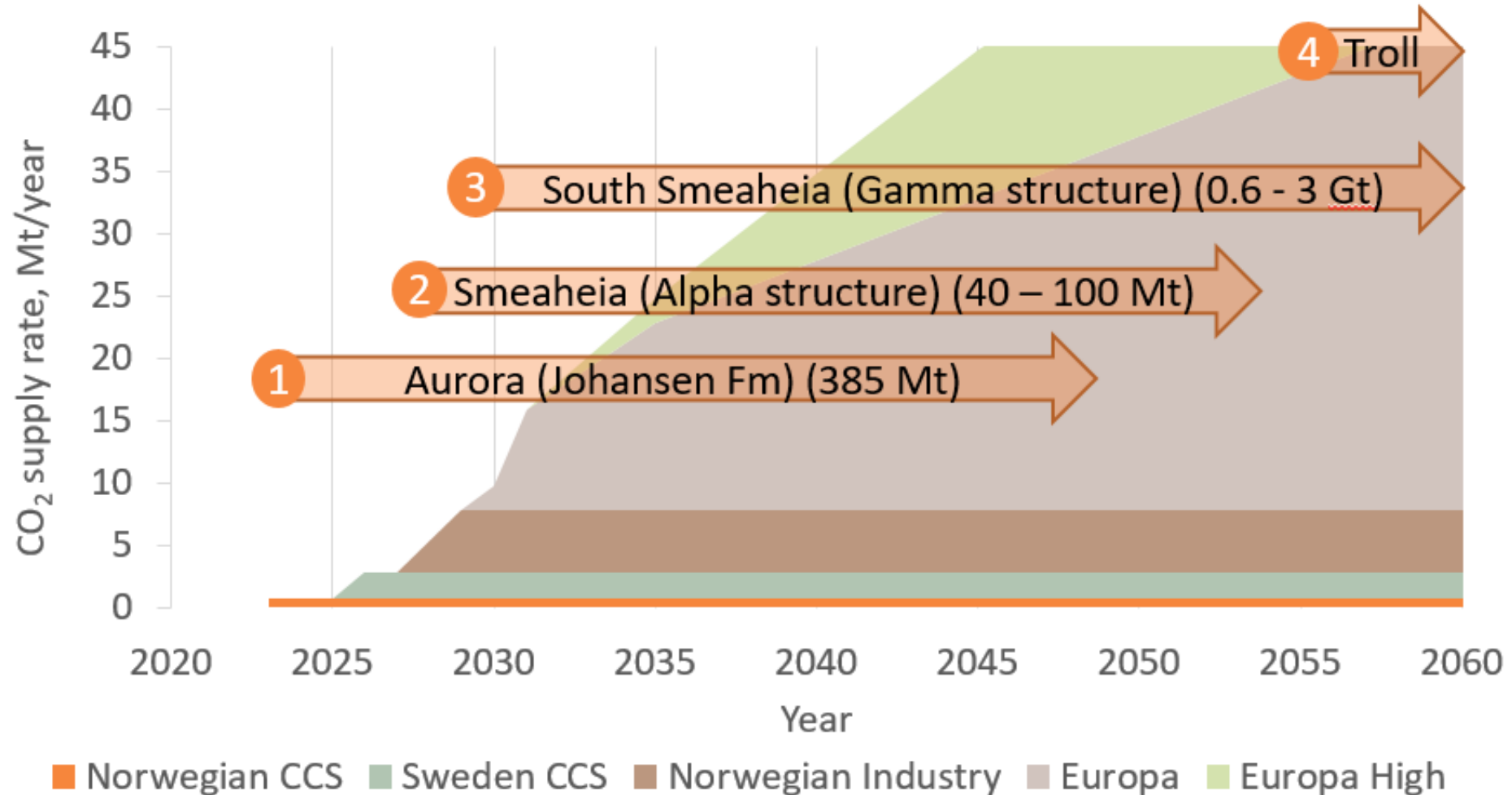
4) Post Troll gas production





Nordic CCS Roadmap (2015)

Horda Storage Hub



Conclusions

- This work show the large potential for gradual increase in the storage capacity in the Horda Platform area to match the expected increasing storage demand from CO₂ sources.
- However, more modelling are needed to quantify the storage capacity with better resolution for the top reservoir map

Acknowledgements

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