Challenges of understanding CO2 plume dynamics

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Equinor R&T - Future Value Chains

The CO_2 plume dynamics challenge … or cloud computing ☺

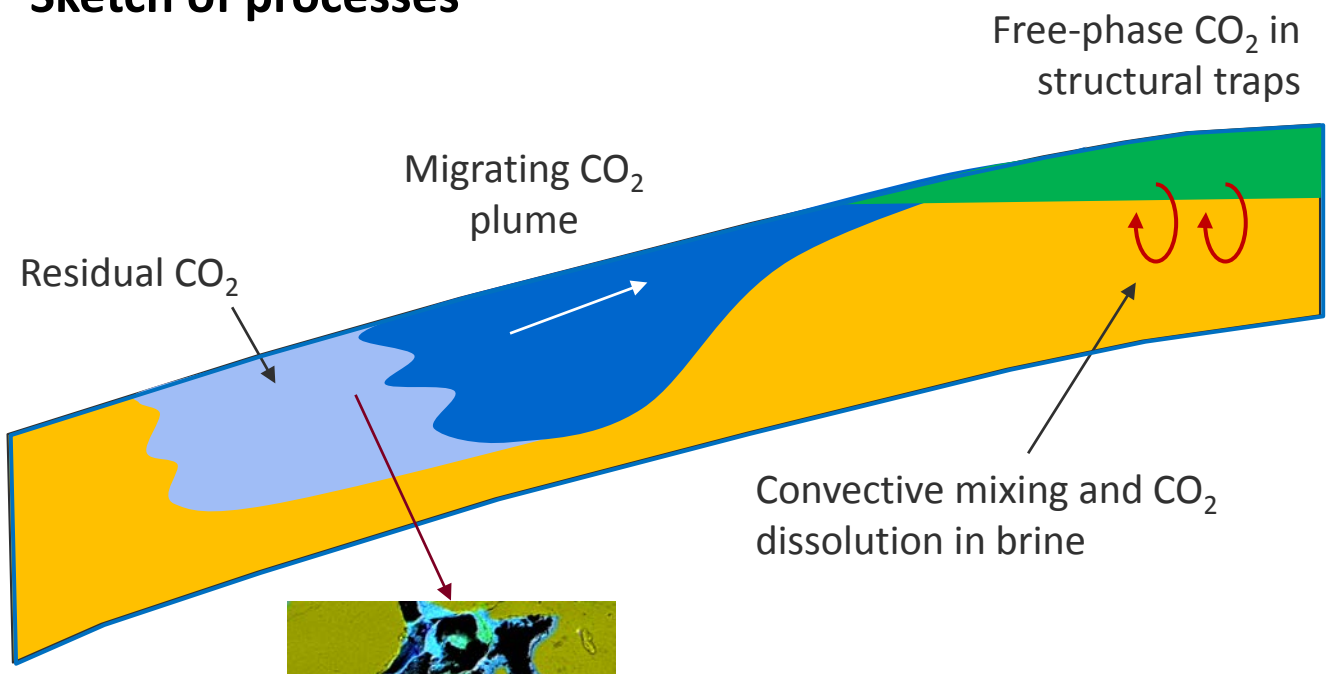
- CO_2 storage regulations require plume conformance and containment assurance
- Emerging projects (incl. Northern Lights) have challenges to predict long-term plume development:
  - Especially in the case of an inclined aquifer (e.g. Aurora and Quest)
  - Some processes still poorly modelled/calibrated (e.g. dissolution)

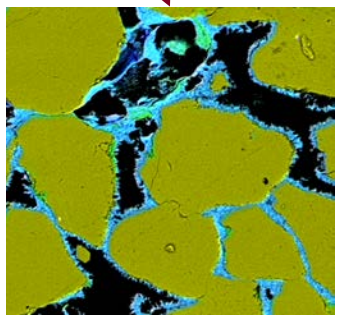
To address this challenge Gassnova has proposed a new initiative:

- New project call on 'History-matching the CO_2 plume at Sleipner'
- Seed funding to stimulate Norwegian Participants
- International participants may participate (own national seed-funding schemes?)
- Timeline – May/June 2019 through to Spring 2020
- Workshop to report findings (around Spring 2020)

Challenges of understanding CO_2 plume dynamics

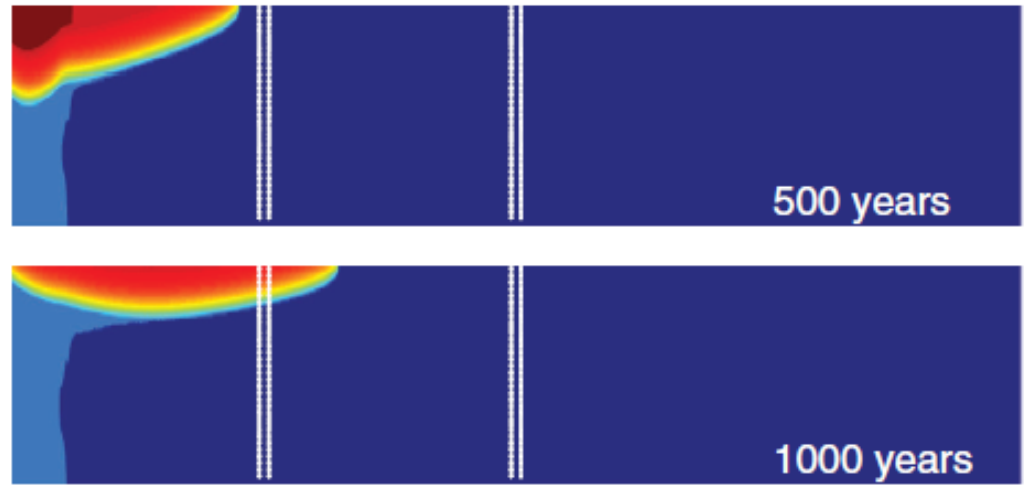
Sketch of processes





Mineral/pore-space reactions

Models CO_2 saturation in sloping aquifer



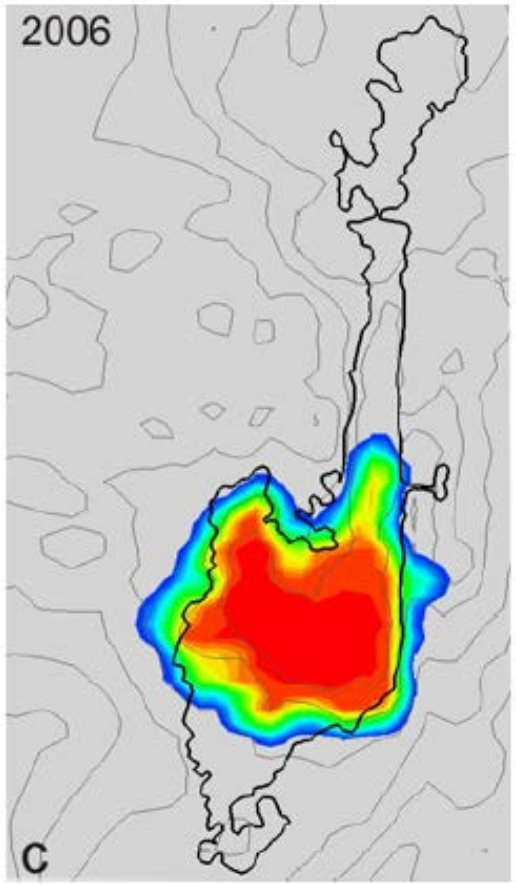
Elenius et al. (2015) Interactions between gravity currents and convective dissolution, WRR

Brief history of CO_2 plume modelling at Sleipner

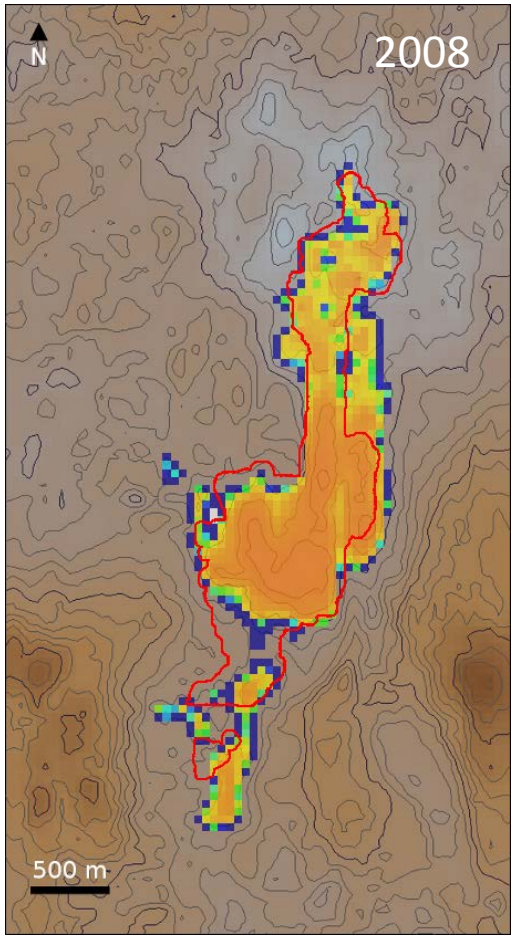
Layer 9 models

Early 5-layer model

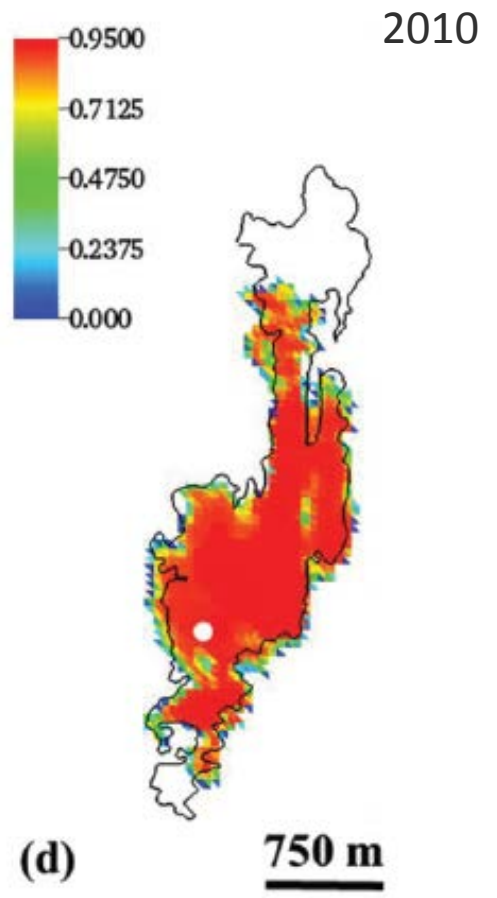
Lindeberg et al. 2000



Chadwick & Noy (2010)

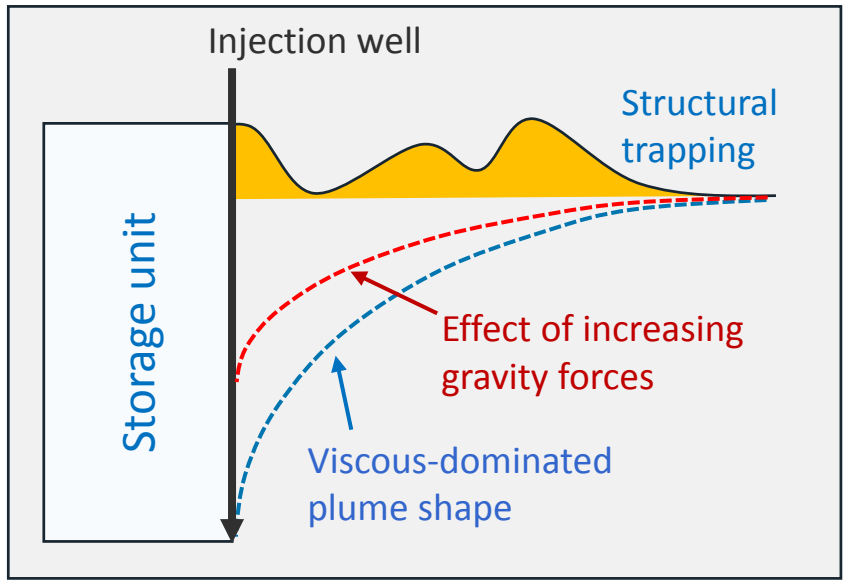


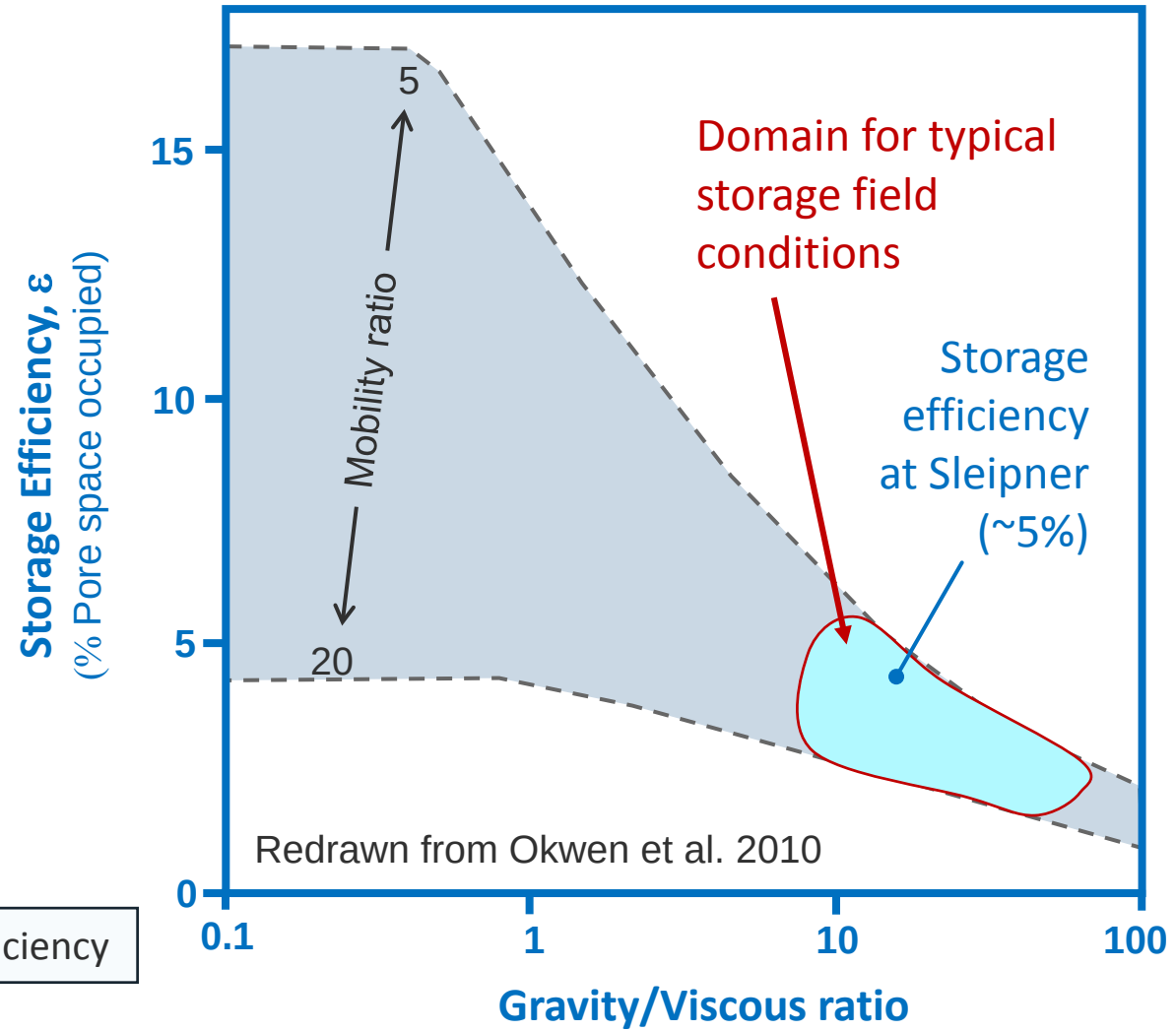
Cavanagh (2013)



Williams & Chadwick, 2017

Effects of buoyancy on capacity





Sleipner CO_2 storage metrics

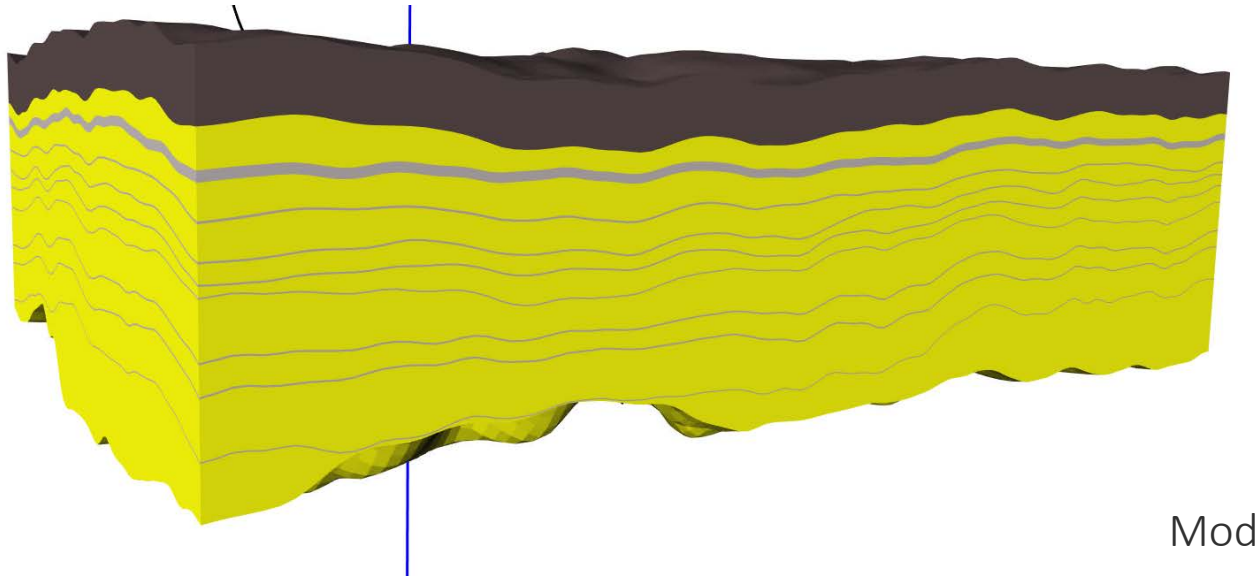
(as of 2010 seismic survey)

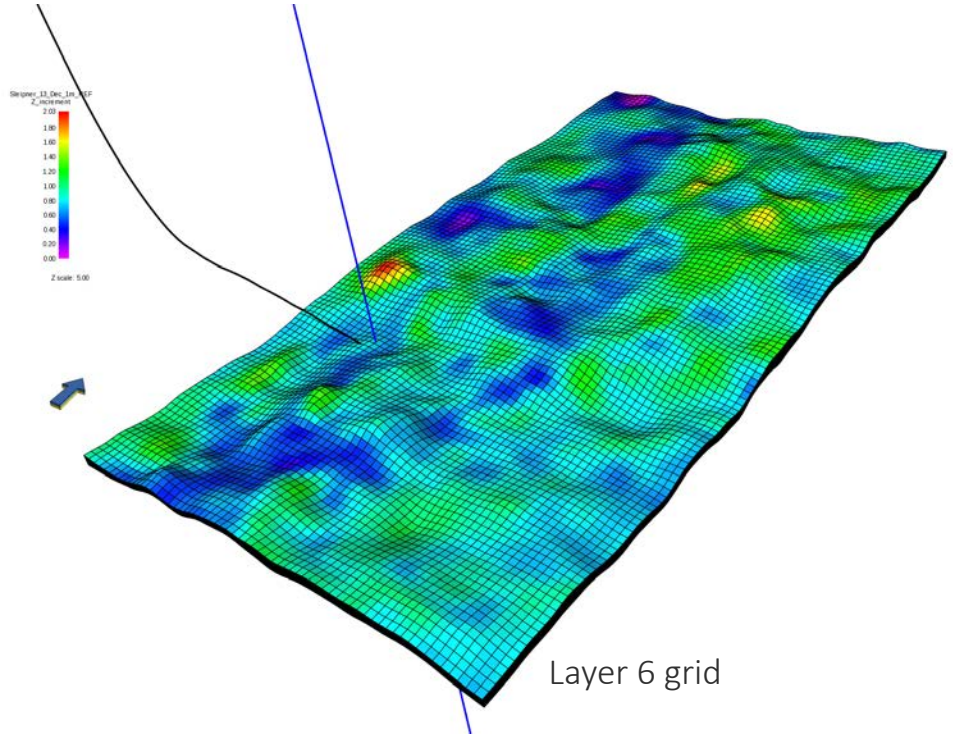
	Mass (Mt)	Fraction of pore space occupied (ε)	
Total injected	12.18	0.048	~5% efficiency
Free phase	11±0.5	0.044	
Dissolved phase	1.2±0.5	0.004	~10% dissolved

Ringrose, 2018

New Sleipner Reference Model - 2019

- New Sleipner Reference model grid covers 3.2 km x 5.9 km x ~300 m
- 50x50m grid gives a total of ~2 million cells (64 x 118 x 263)
  - ~2m-thick cells for sandstone layers and caprock (5 m)
  - ~0,5m-thick cells for shales (~1m thick, at least 2 cells)
- Planned to be shared via the CO2 data share (CSDC) project





Layer 6 grid

Model built by Andrea Callioli Santi (Equinor/Sintef)

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