Improved Pore Space Utilisation

Australia & United Kingdom Co-lead

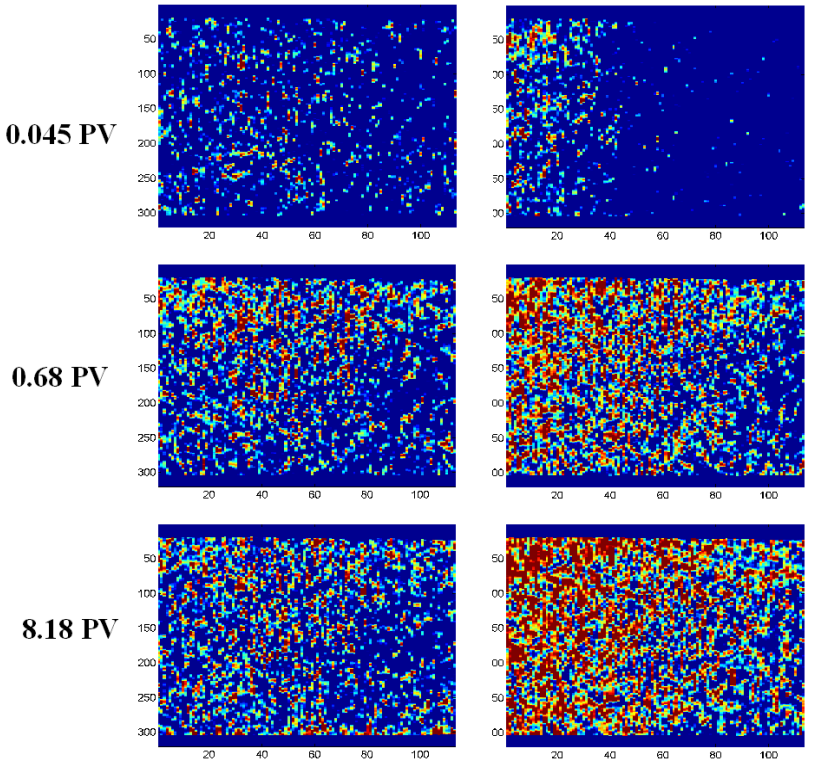
- Purpose is to:
  - Discuss concept of improved utilisation of geological storage space resource to increase CO_2 storage capacity.
  - Review the current state of processes and technologies that enhance the utilisation of the storage space
  - Highlight key techniques recently emerged internationally
  - Provide a (possibly ranked) set of options for stakeholders to develop into their storage projects.

- Members/Input from:

  Australia, United Kingdom,

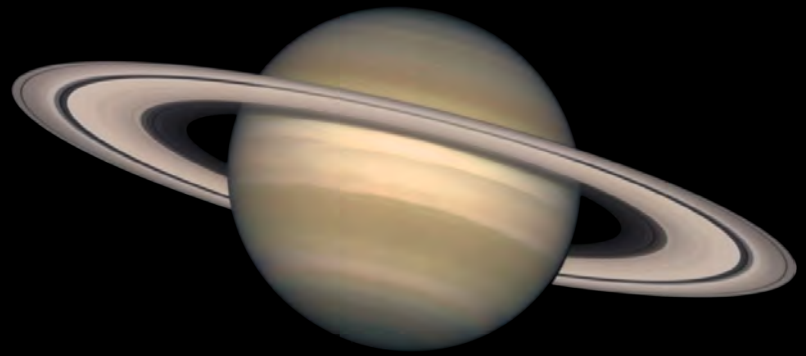
  IEAGHG, France, Japan, Norway,

  United Arab Emirates

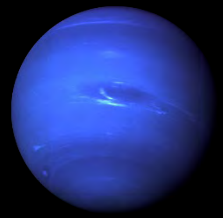


X-ray CT images of Brine-Saturated Cores:
Right: Microbubble CO_2 Injection
Left: Normal-size Bubble CO_2 Injection

CSLF TRM recommended
storage rate for 2035
>2.4 Gigaton



Total Stored 2016



Gorgon

Otway

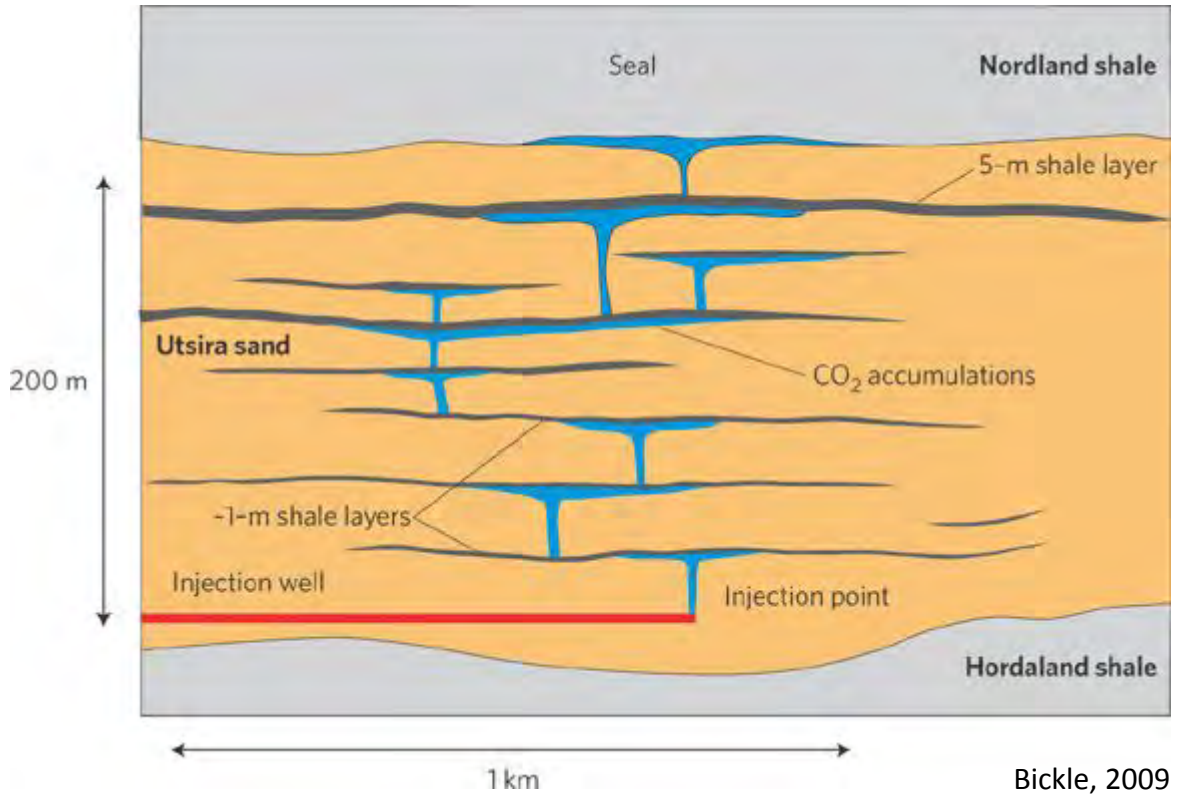
EOR 2016

Stored & in Construction

Storage Utilisation

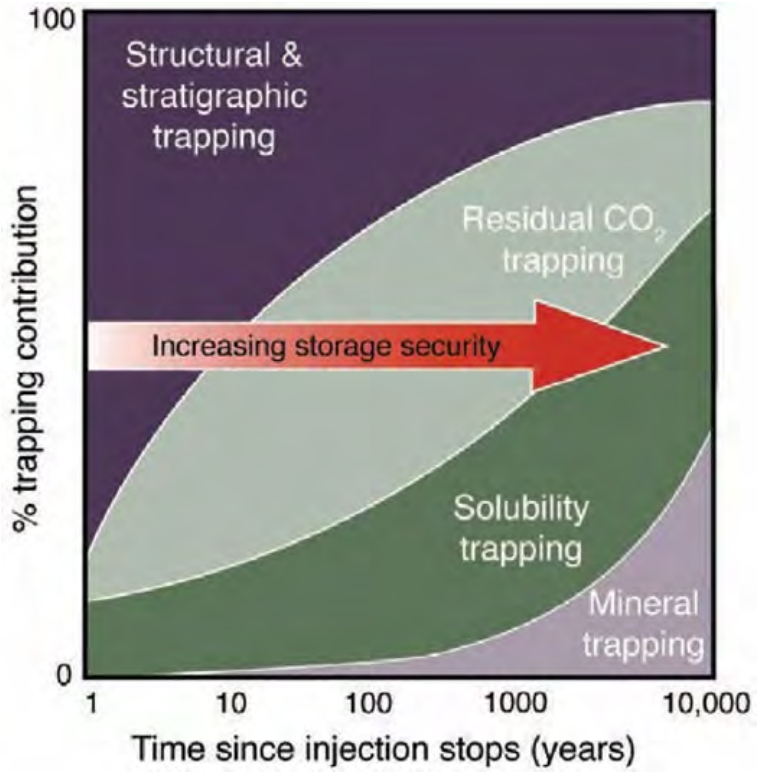
Economies of scale

- Cost to characterise
- Cost to transport
- Cost to operate
- Cost to monitor

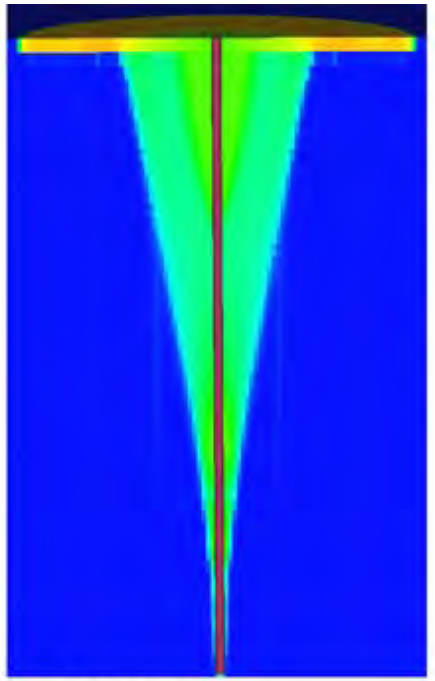


Bickle, 2009

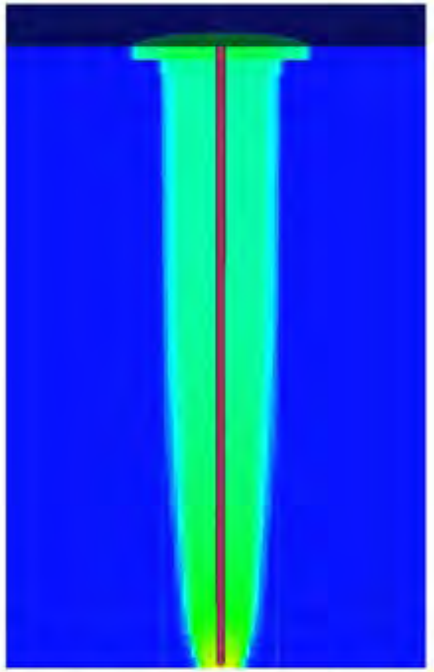
Fundamental to Improved Pore Space Utilisation



IPCC special report 2005



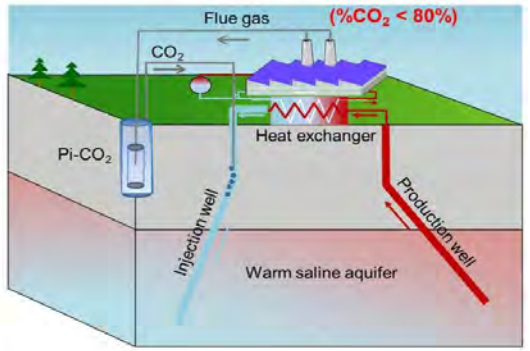
- Poor sweep
- Considerable CO_2 at top seal



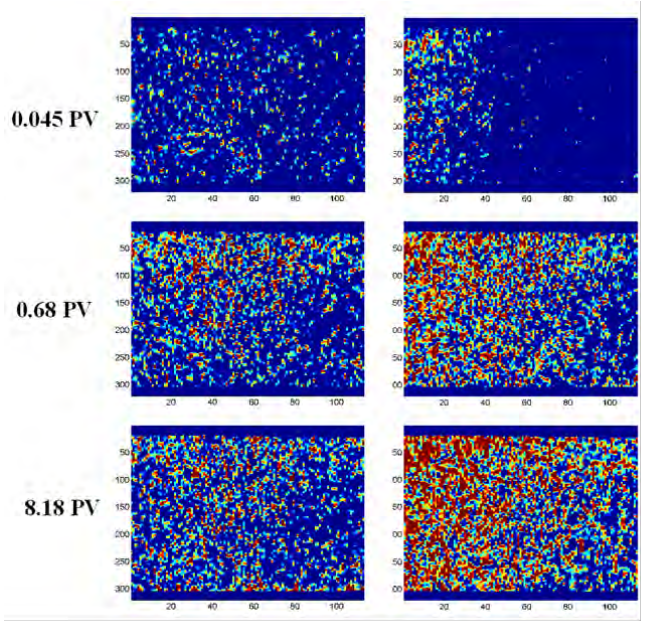
- Improved sweep
- Less CO_2 at top seal

Improved Pore Space Utilisation Techniques

- Improved Sweep Efficiency techniques from the oil and gas sector
  - Polymers
  - Surfactants
  - Foams
- Pressure Management
  - Relief wells (active and passive)
  - Increased Injection Pressure
- Microbubble CO_2 Injection (Japan)
- CO_2 Saturated Water Injection and geothermal energy (France)
- Compositional, Temperature and Pressure Swing Injection (Norway)



CO_2 DISSOLVED facility



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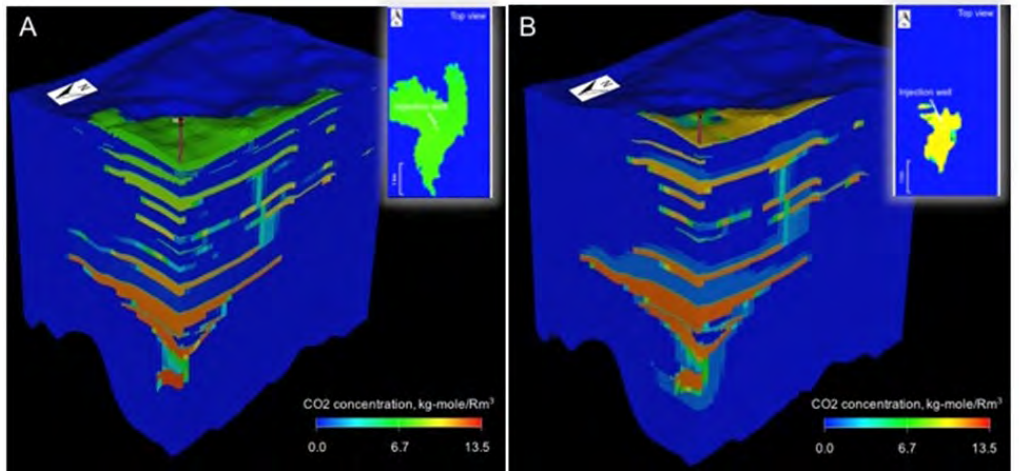

Modelled output of compositional swing injection

P	Technology Type	Prior R&D and application	Technology Readiness Level#	Technology Prospectively	Core Recommended Action
1	Microbubble CO_2 Injection	Laboratory and Modelled, prototype	TRL 4	High potential	Trial at in field research facility
2	Swing Injection	Laboratory and Modelled	TRL 3	High potential	Validate technology at lab scale
3	Increased Injection Pressure	Laboratory and Modelled	TRL 3	High potential	Validate technology at lab scale to assess sweep effectiveness in heterogeneous reservoirs
4	Active Pressure Relief (increase sweep & reduce lateral spread)	EOR, planned for Gorgon CO_2 injection project	TRL 6	High potential	Pressure relief - Key lessons drawn from active commercial project using pressure relief wells as a risk mitigation technique
5	Foams (block high permeability pathways)	EOR	TRL 6	Reasonably well understood	Modelling of application effectiveness prior to Demonstration at commercial scale
6	Passive Pressure Relief	Modelled	TRL 4	Limited effectiveness	Trial at in field research facility. Consideration around long-term fluid management
7	Polymers (increase formation water viscosity)	EOR	TRL 7	Reasonably well understood	Cost effectiveness investigations. Demonstration at commercial scale*
8	Surfactants (reduce residual saturation of formation water)	EOR	TRL 7	Reasonably well understood	
9	CO_2 saturated water injection & geothermal energy	Laboratory and Modelled	TRL 3	Site specific & lower volume	Seek opportunity to trial PI-CO_2 technology at lab scale

Improved Pore Space Utilisation Report Release

- Alignment with key contributors
  - 9th November 2018
- Task Force Members to circulate wider within their countries/organisations
  - 30th November 2018
- Report publication and circulation
  - 1st February 2019