Storage Overview

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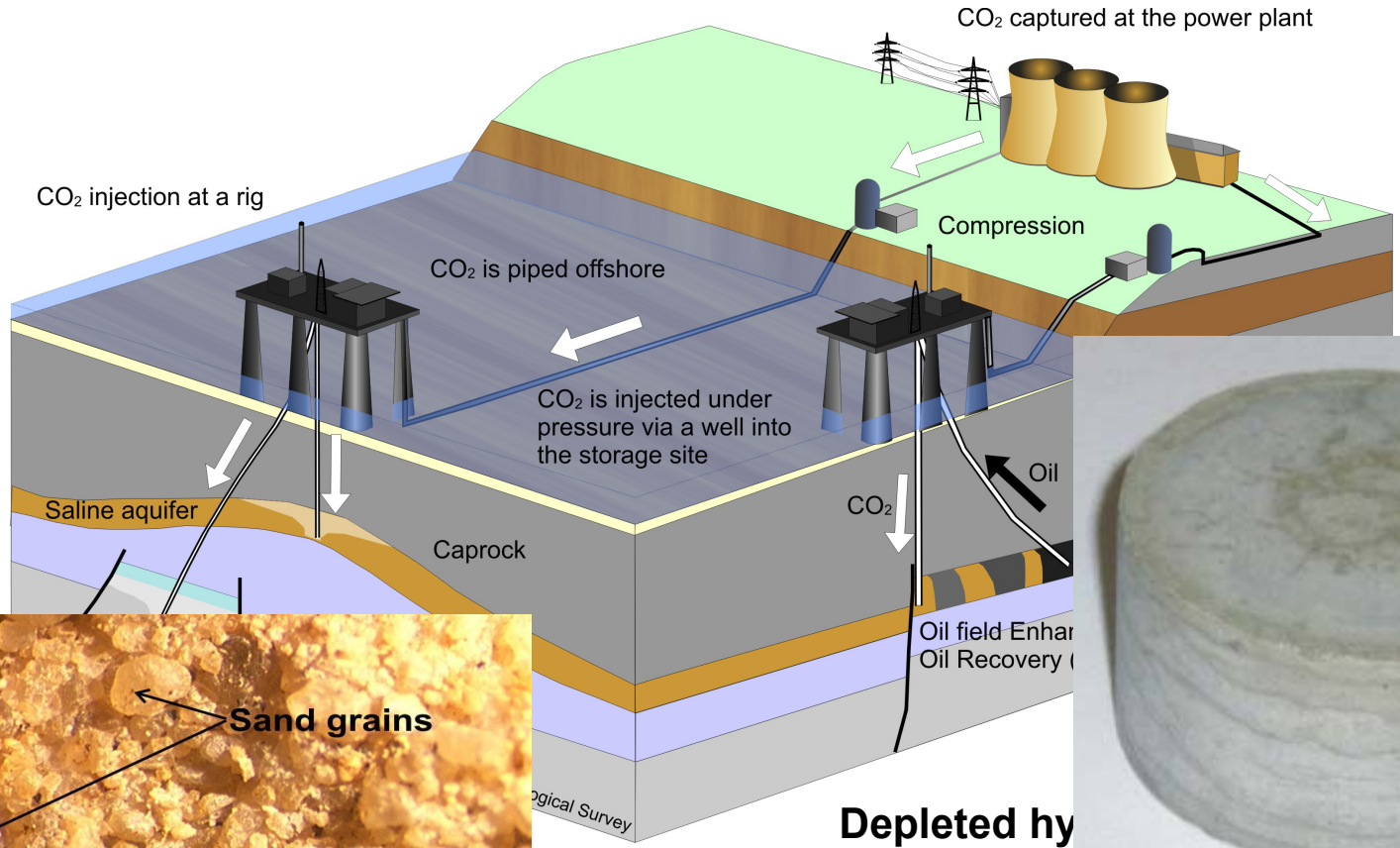
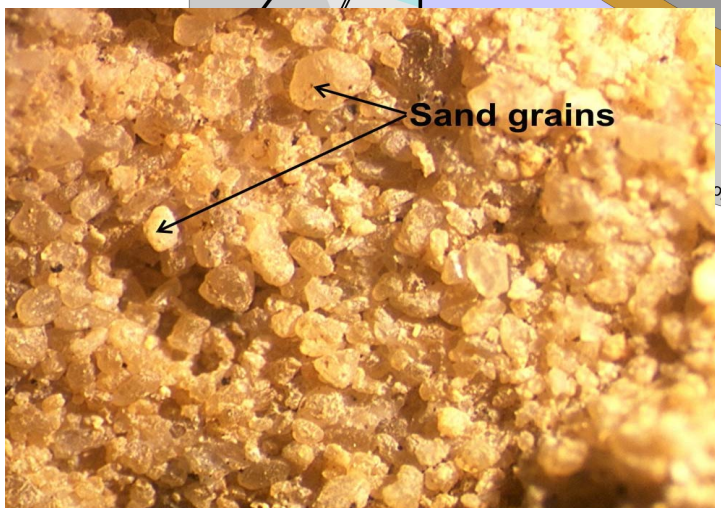
Storage concept





CO_2 is a mobile and buoyant fluid in underground reservoirs

Storage worldwide

[courtesy of Scottish Centre for Carbon Capture & Storage]

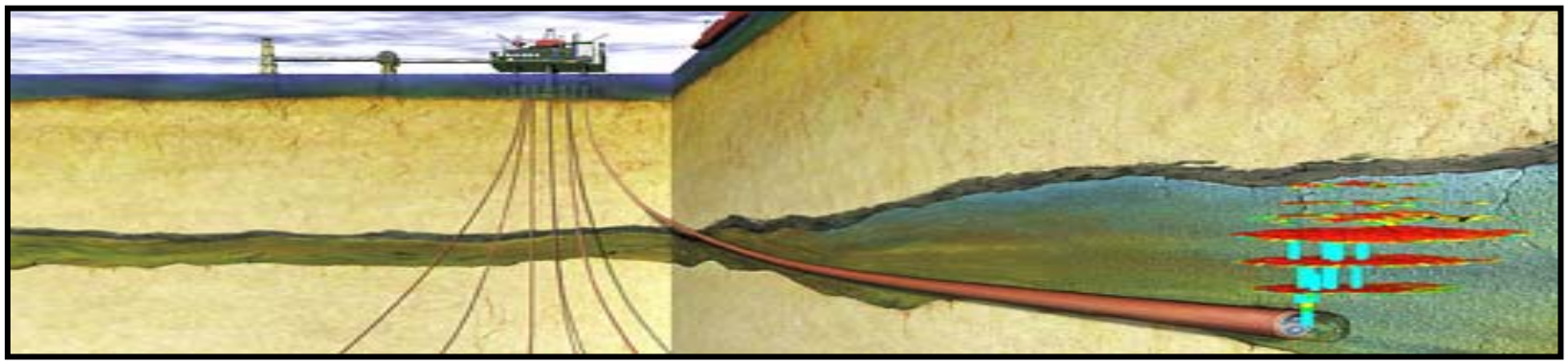
Sites which are currently injecting CO_2

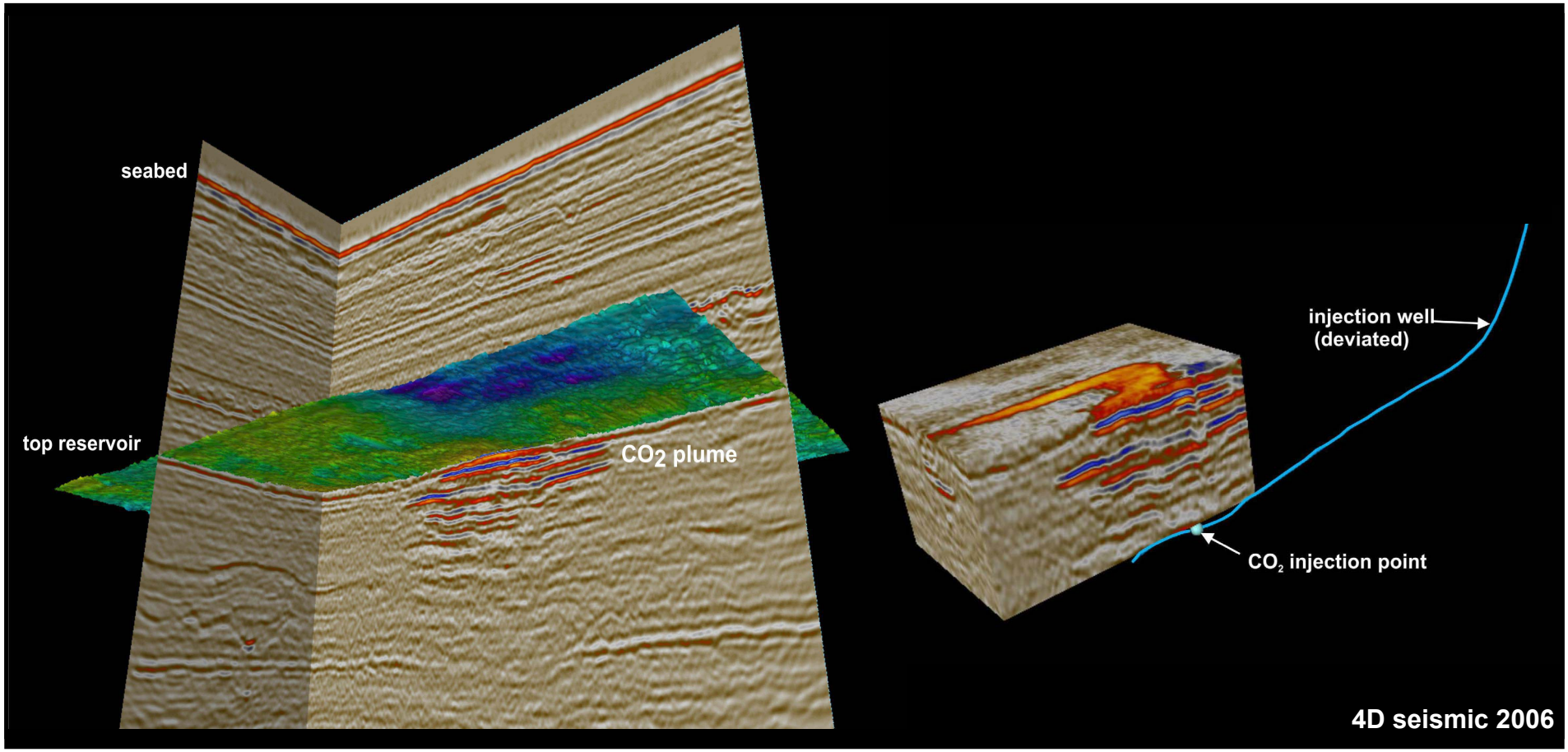
Planned CCS sites. Generally plan on injecting at least 700,000 tonnes CO_2 per year.

Sites which have been cancelled or have completed injection.

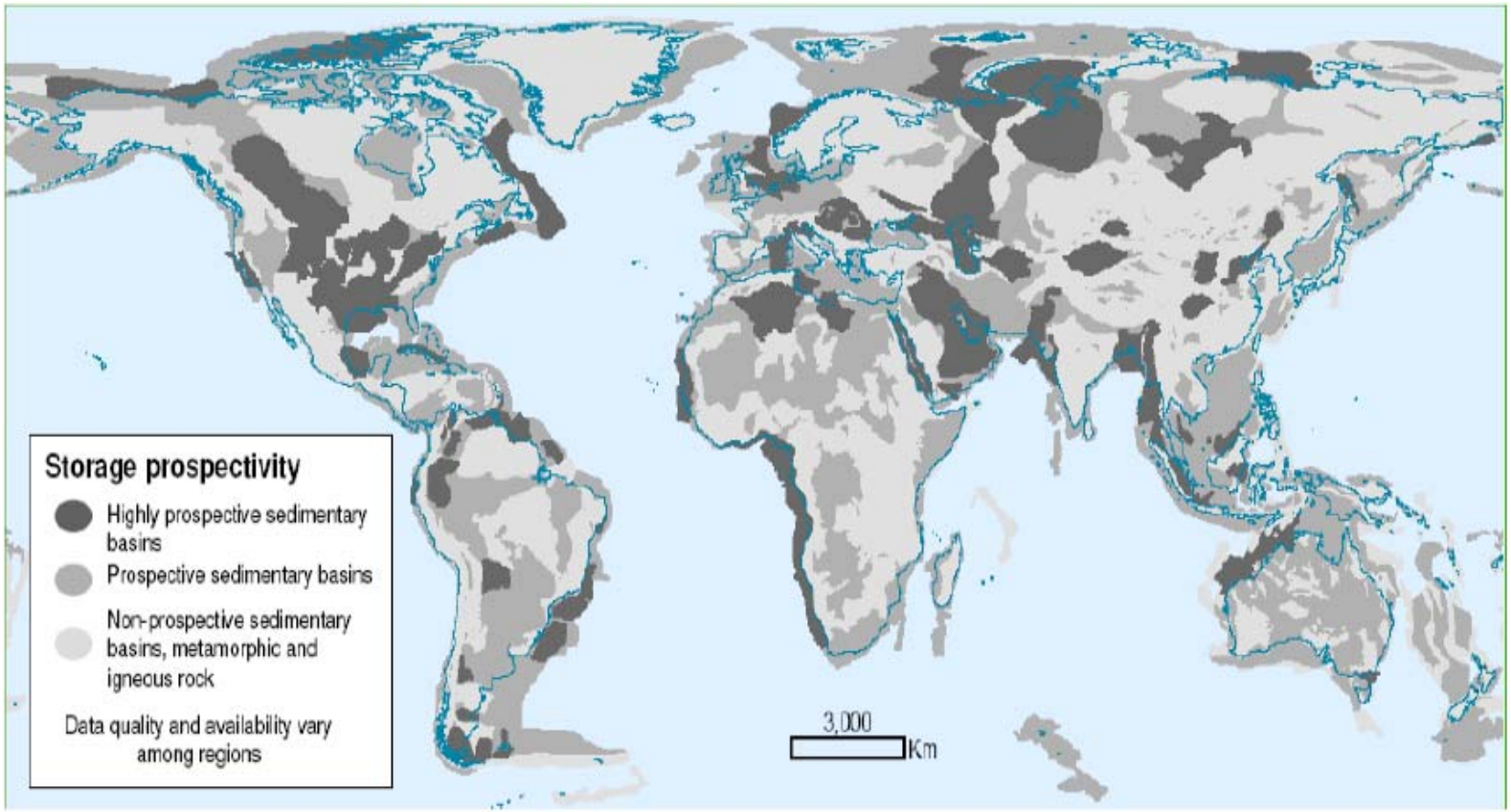
~ 30 Mt of CO_2 stored so far at 4 main industrial sites
(3 pure storage, 1 CO2-EOR)

Storage example: Sleipner





Global CO_2 Storage Capacity



Storage Option	Global Capacity - Gt CO_2
Depleted gas fields	690
Depleted oil fields/CO2-EOR	120
Deep saline aquifers	400 - 10 000
Unminable coal seams	40

Source: IPCC (2007)

[Courtesy of IEAGHG]

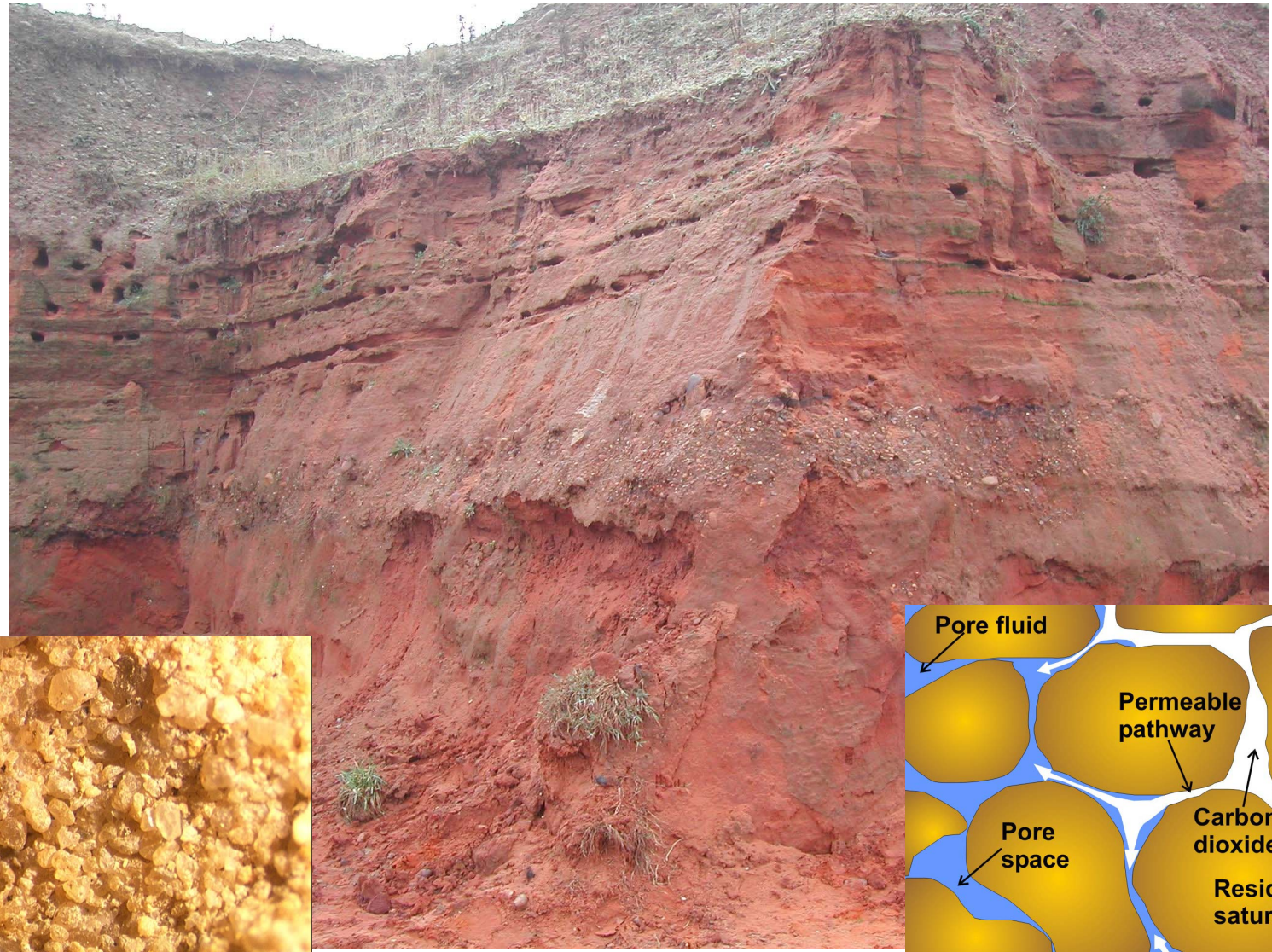
Storage in depleted hydrocarbon fields

- ‘Low-hanging fruit’
- Geology well known
- Structure contained oil or natural gas
- Can refill with CO_2 up to original pressure with little risk
- Main long-term containment risk is wellbores

- LIMITED STORAGE CAPACITY

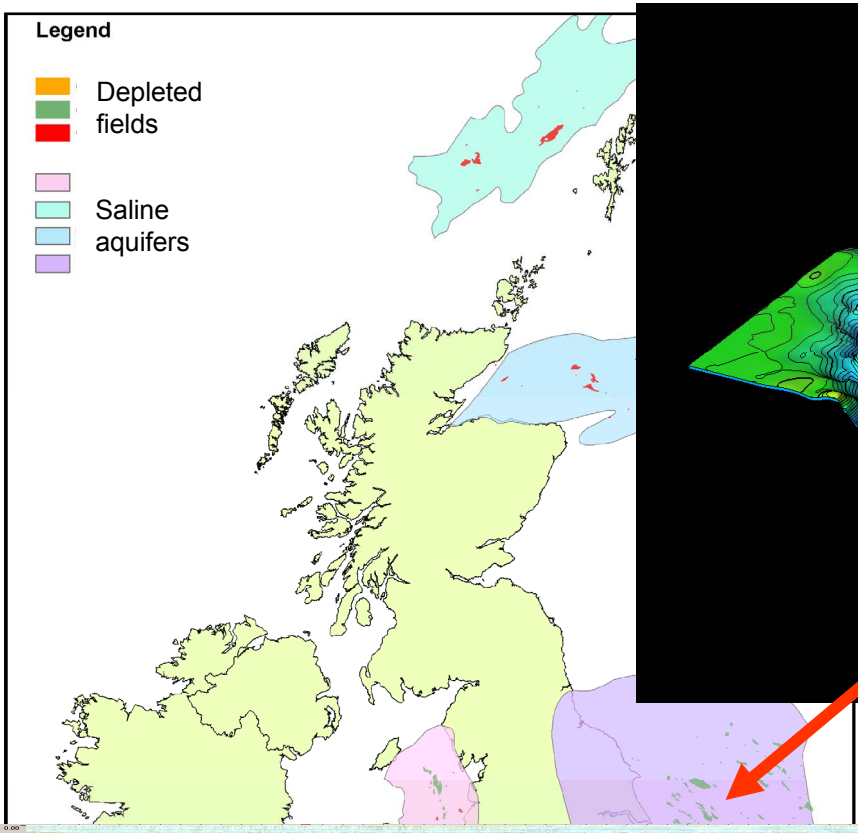
- Aquifer storage likely to be required

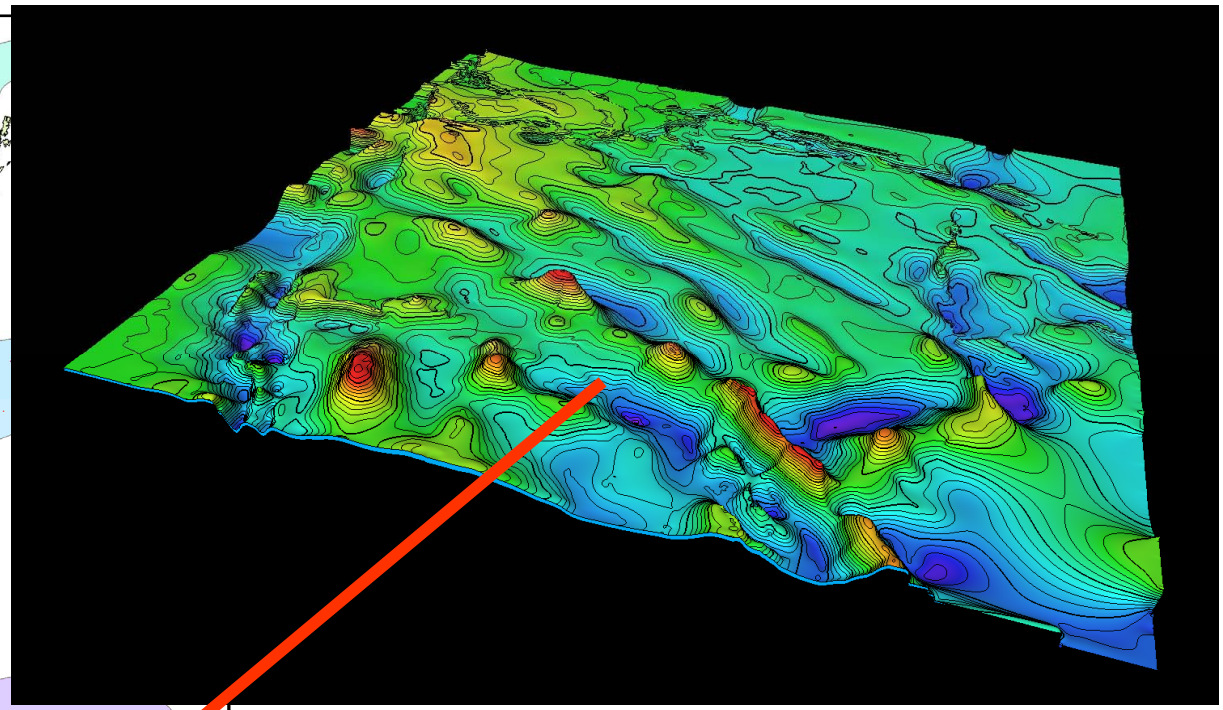
Storage in aquifers



Storage in an aquifer – UK example

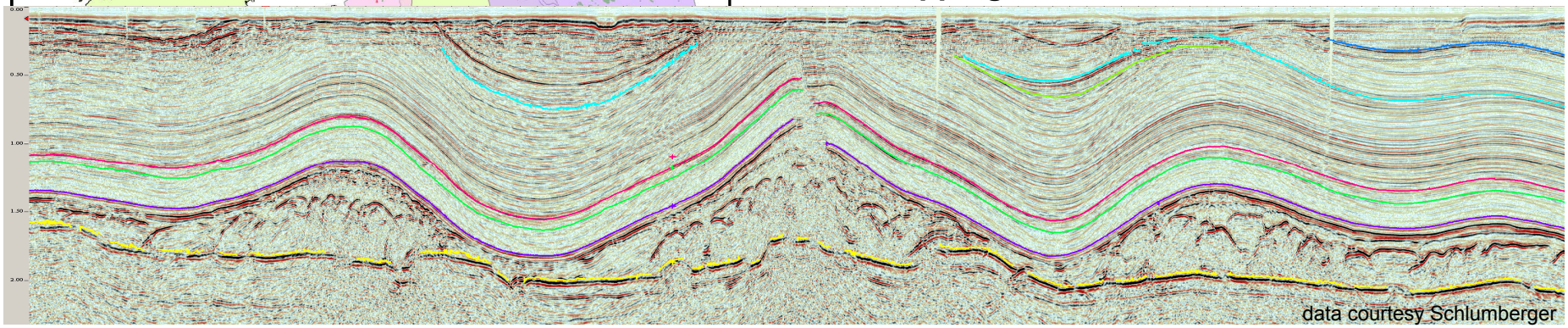
Static modelling





3D reservoir model

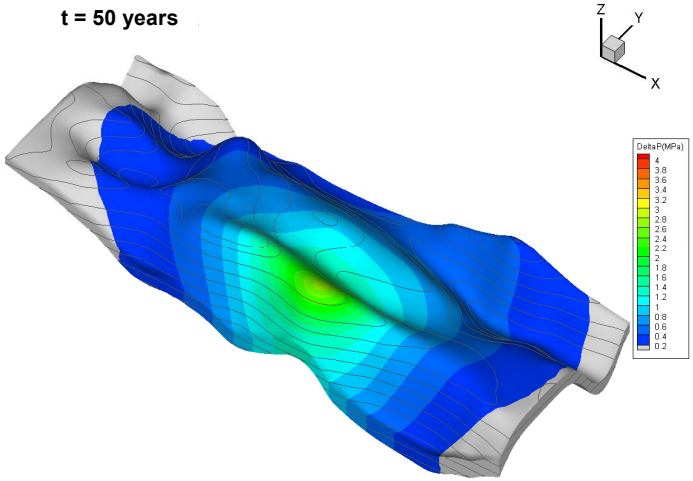
Seismic mapping



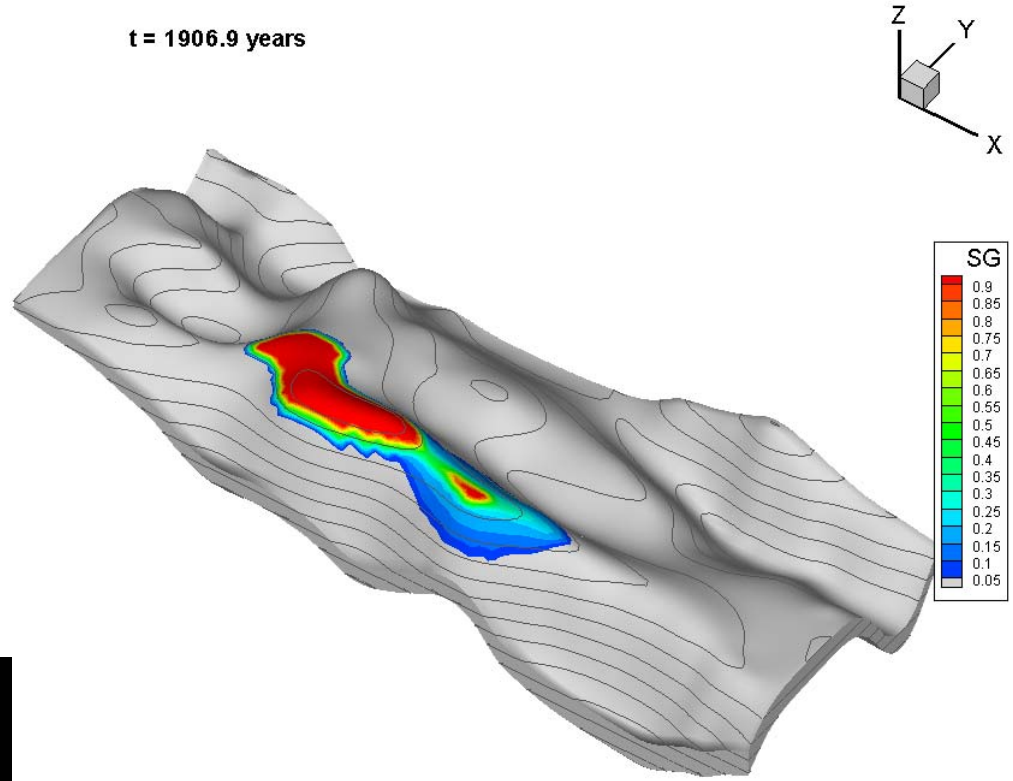
data courtesy Schlumberger

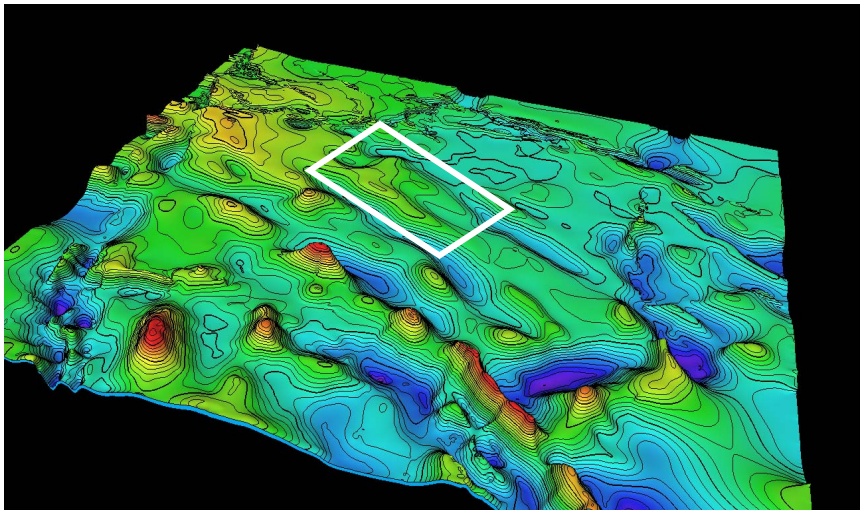
Storage in an aquifer – UK example

Dynamic modelling



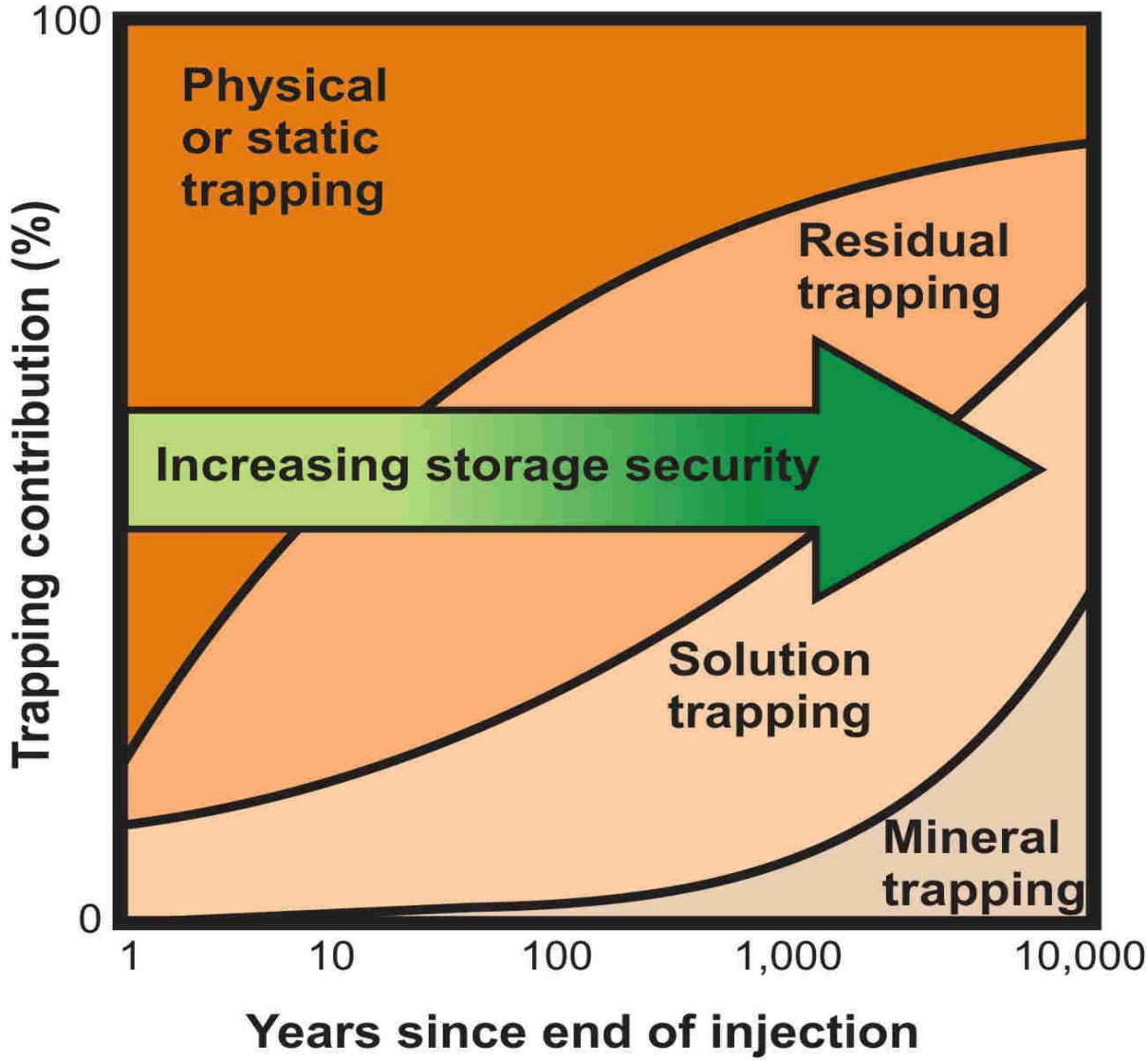
pressure footprint (250 Mt)



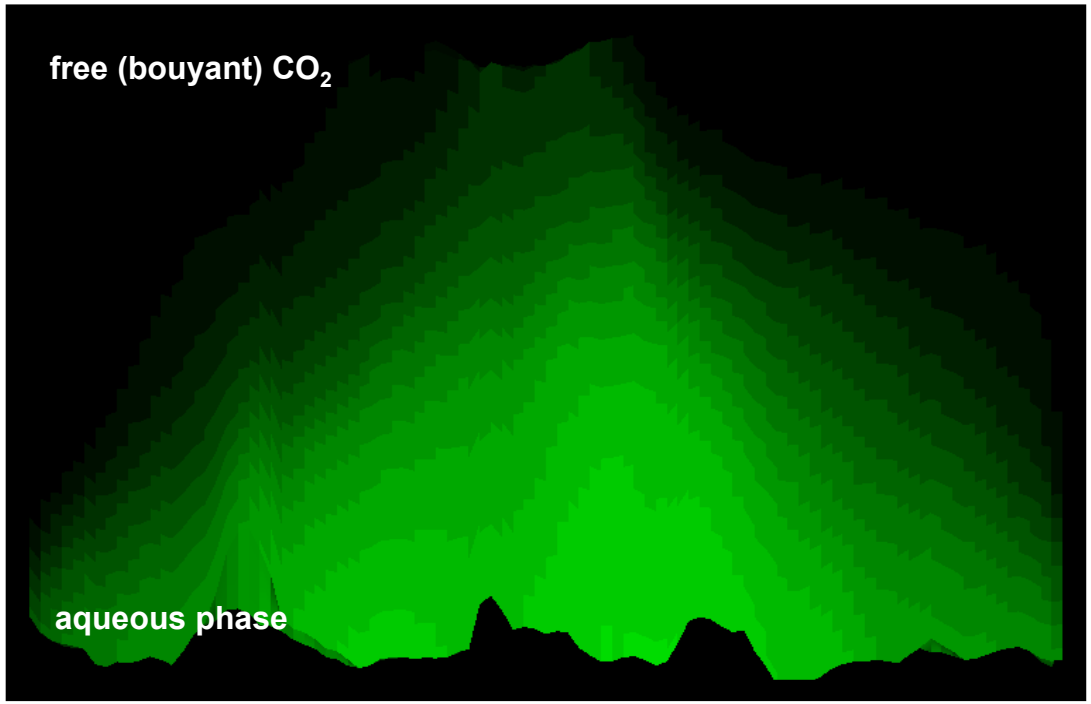


post – injection (250 Mt)

Long-term processes (1)



Long-term processes (2)



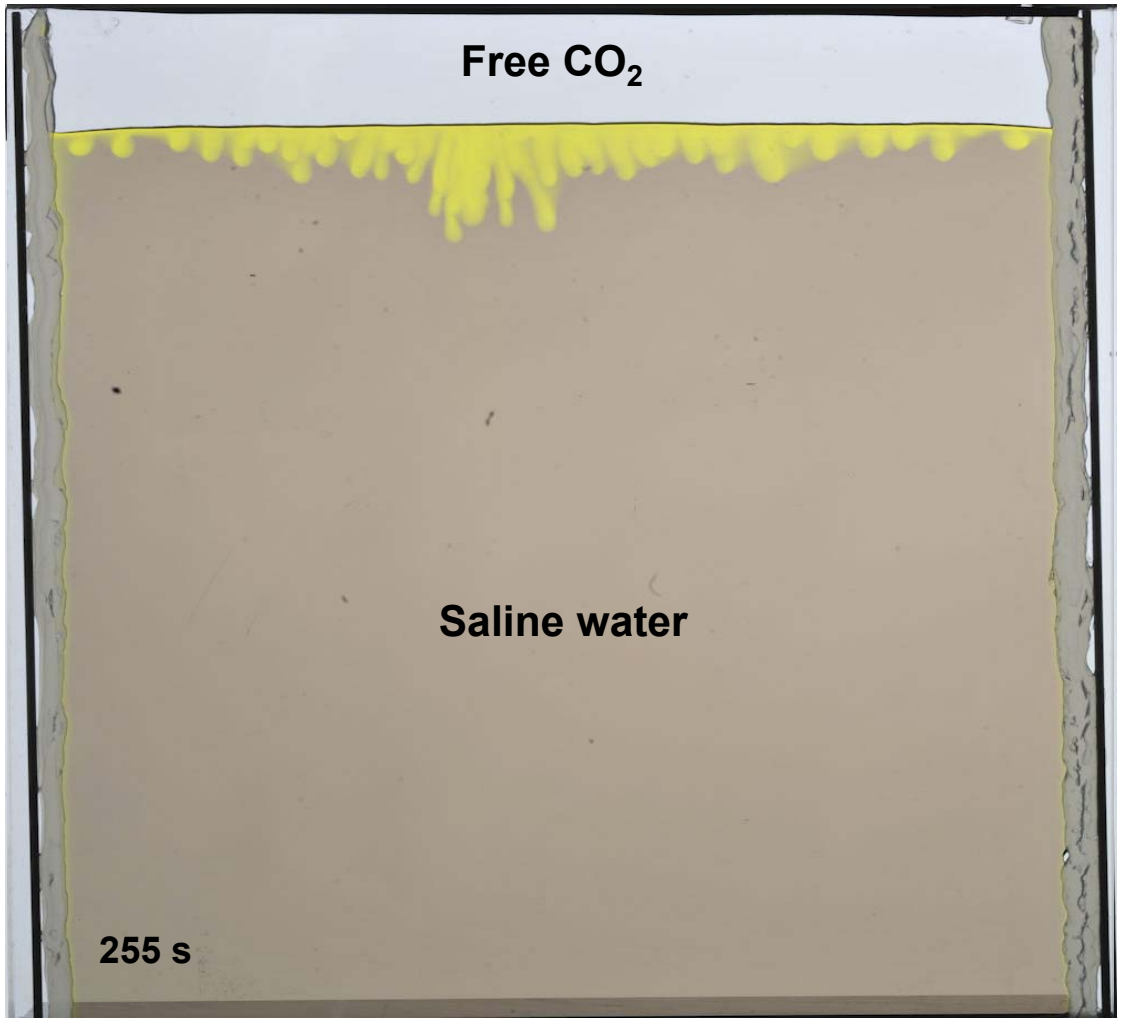
Sleipner simulation:

0 to ~200 years: free CO_2 spreads laterally at top reservoir

> 100 years: CO_2 in aqueous phase sinks in reservoir

with onset of gravitational stabilization

Long-term processes (3)



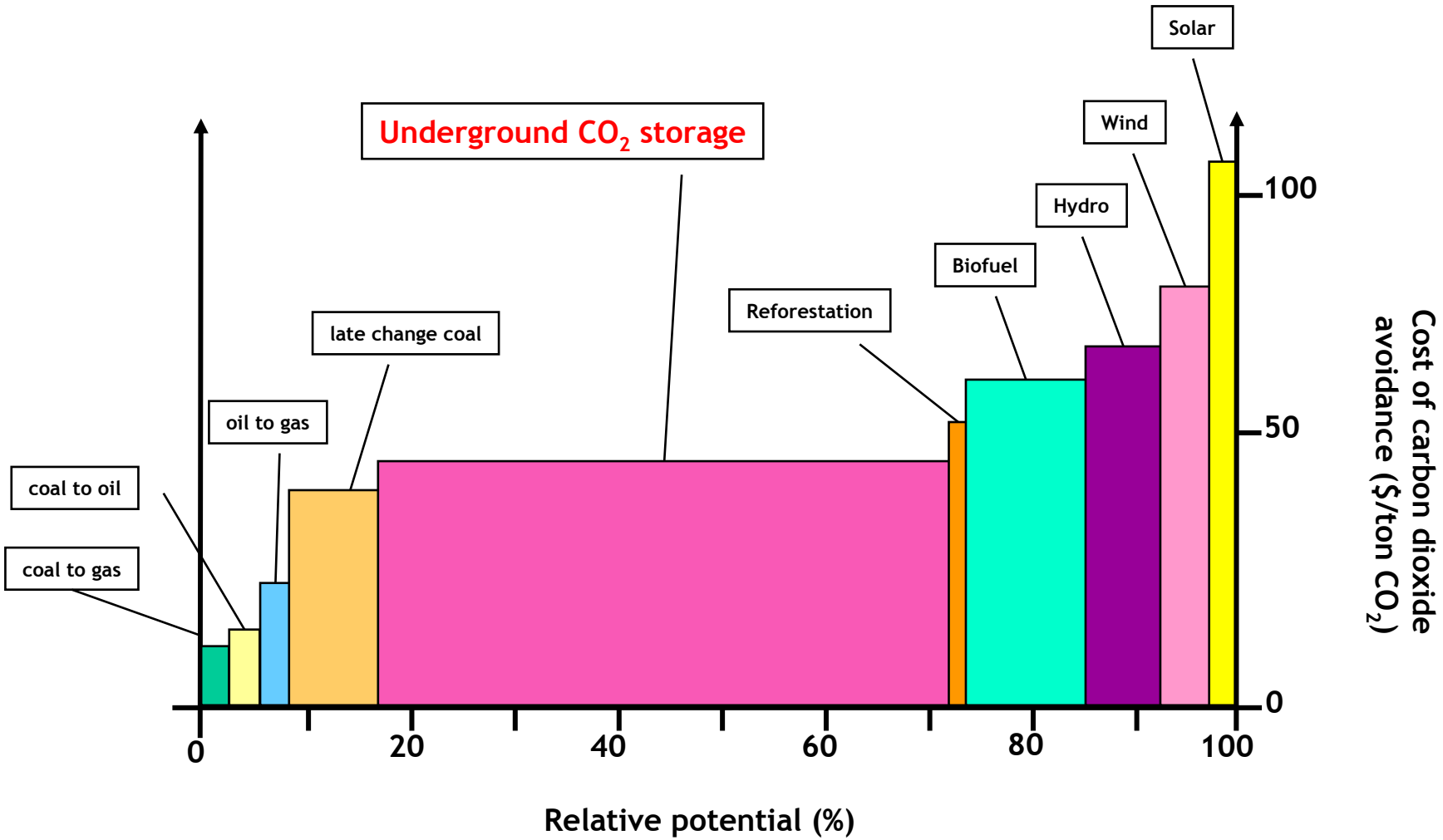
[BGS Hydrothermal Laboratory]

Long-term processes (4)

Sleipner materials
Reservoir
Caprock
Wellbore steel
Wellbore cement

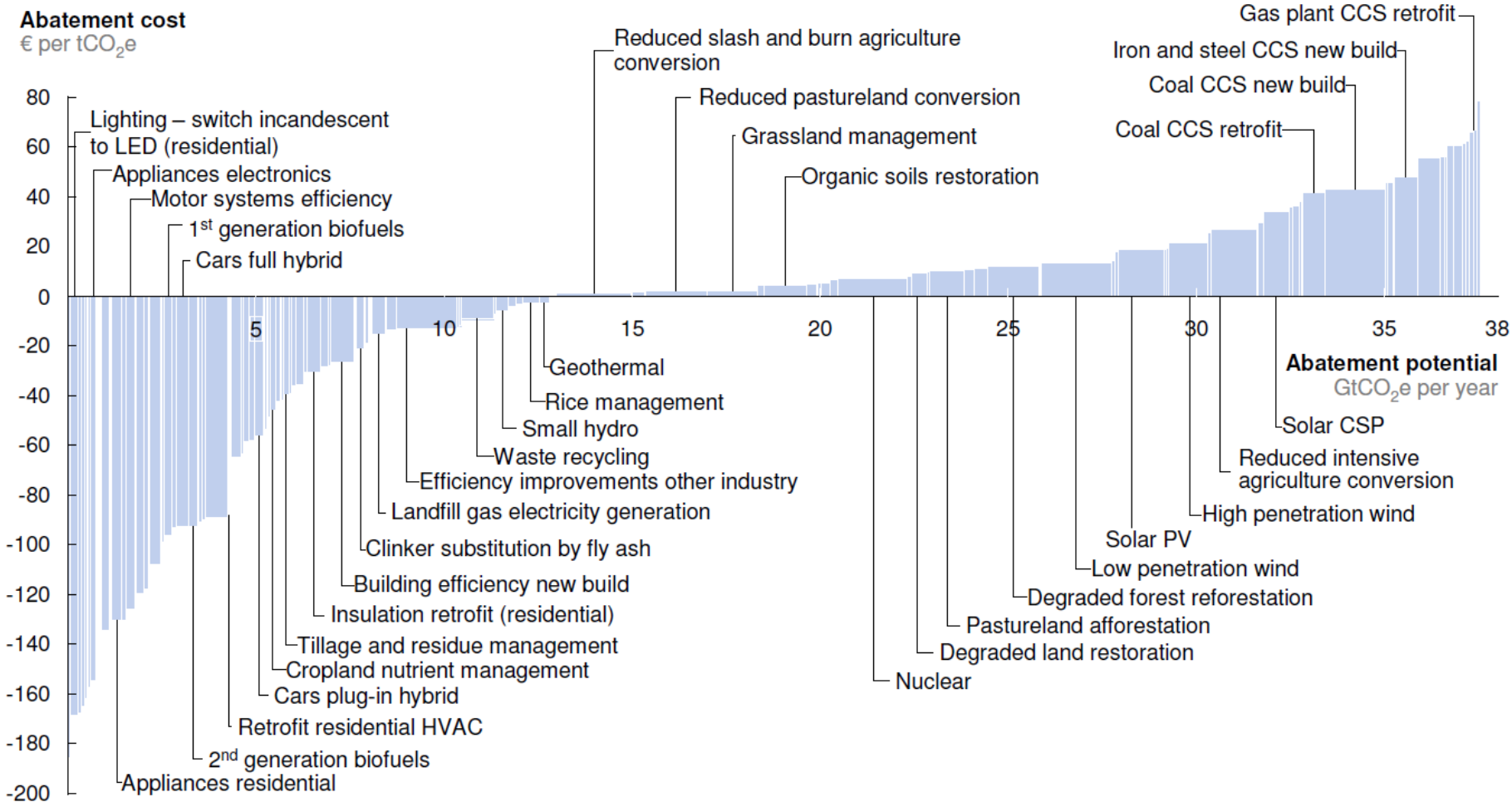
> 5 years at reservoir P & T (longest running experiments in world?)

Costs (1)



[Adapted from Stromberg 2001]

Costs (2)



[Adapted from McKinsey 2010]

Costs (3)

Flu-gas desulphurisation in China

2003: 7 – 8 plants
2005: 46 plants
2006: >100 plants

Price

2000: 800 to 1300 Yuan/kW
2005: 150 to 250 Yuan/kW
2006: 100 Yuan/kW

~ 90% reduction !

CCS has high potential for economies of scale

Conclusions

Global storage potential very high

Hydrocarbon fields suitable for early exploitation

High initial costs are a barrier to implementation