CO2 Capture & Storage (CCS) – 14 Years of Storage Experience

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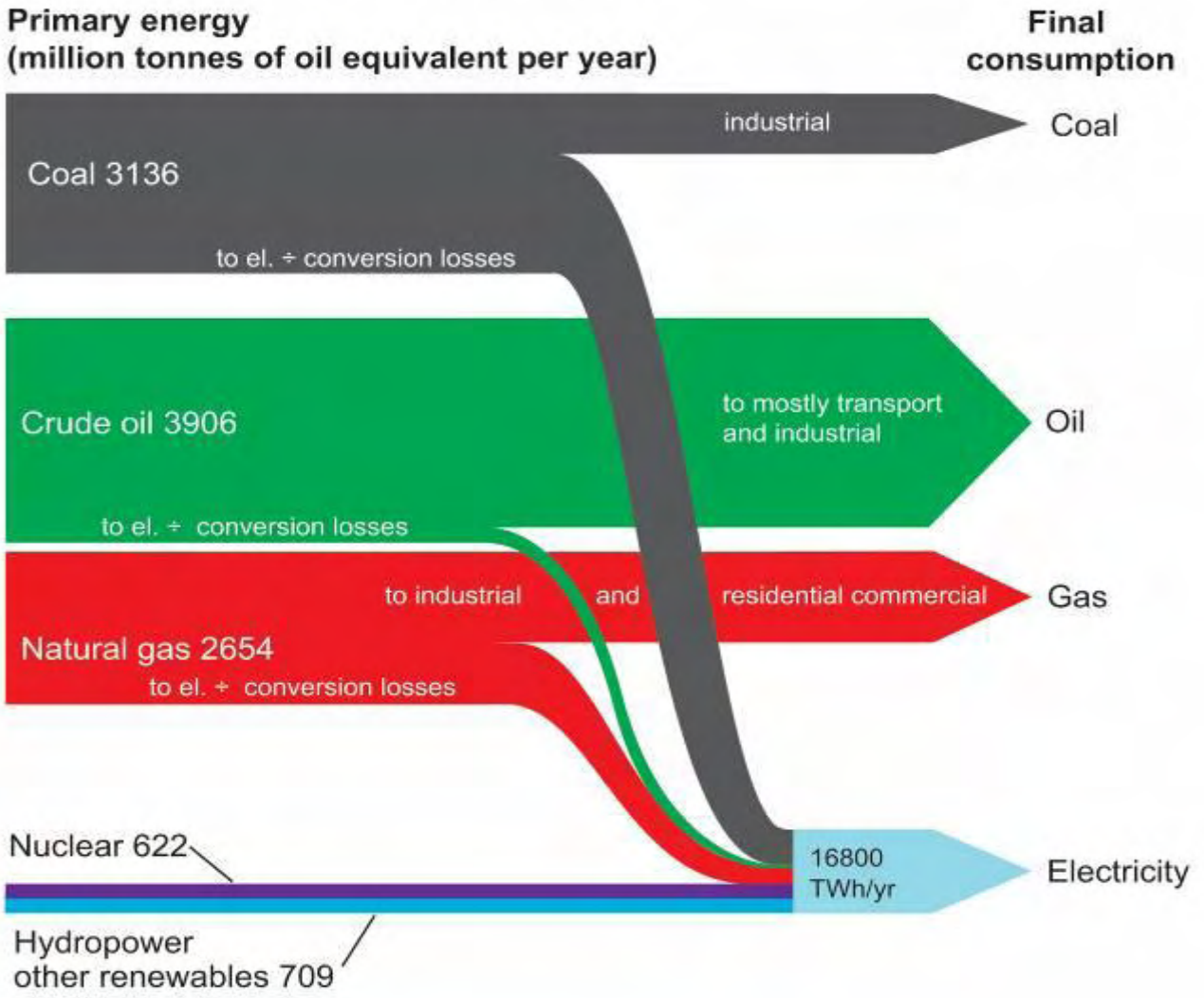
14 Years of Storage Experience

CONTENT:

- Challenge, Vision & History
- Sleipner, In Salah & Snohvit
- Ketzin, Longyear & Svelvik
- Legal Framework

Challenge, Vision & History

Simplified global energy flows 2007



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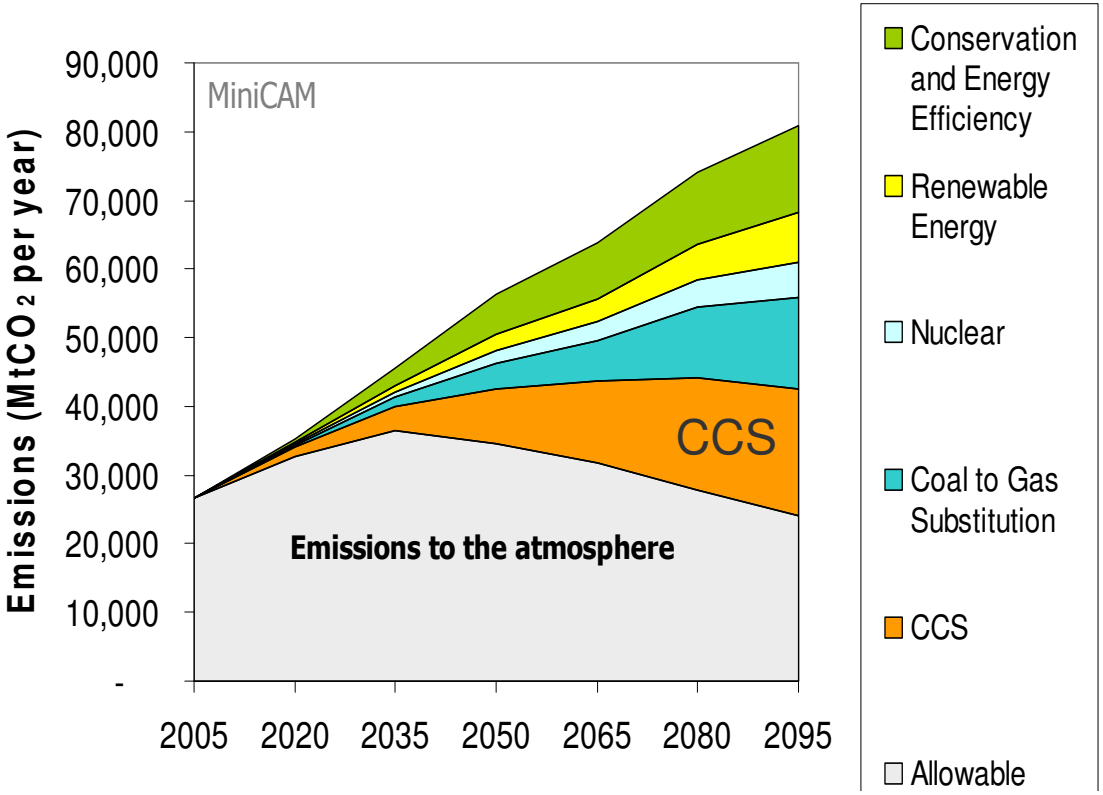
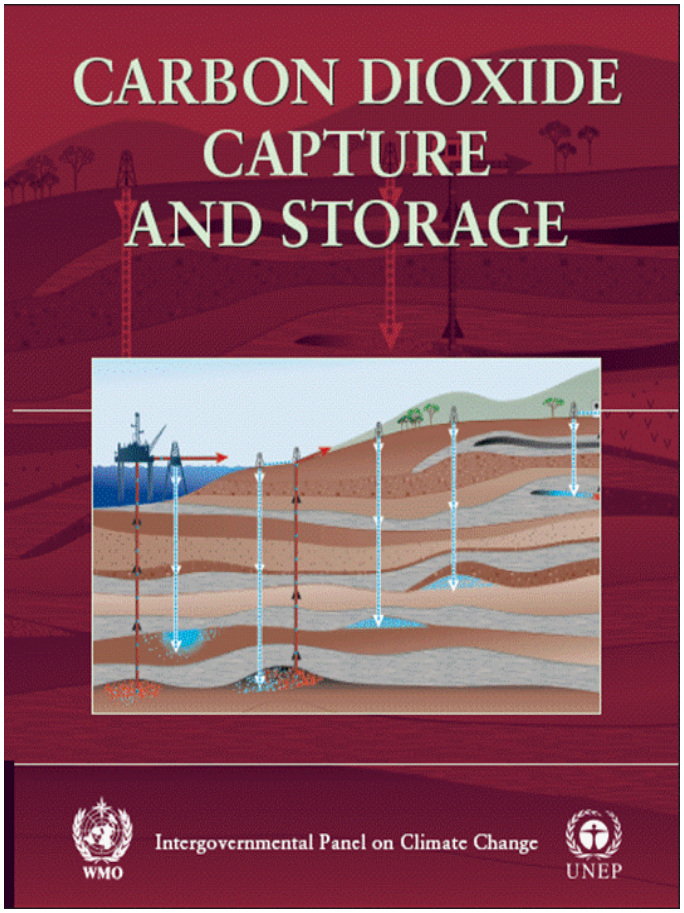
Potential for CCS – Power and Industry



Source: IEA



Source: IPCC - Special Report on CCS (2005)

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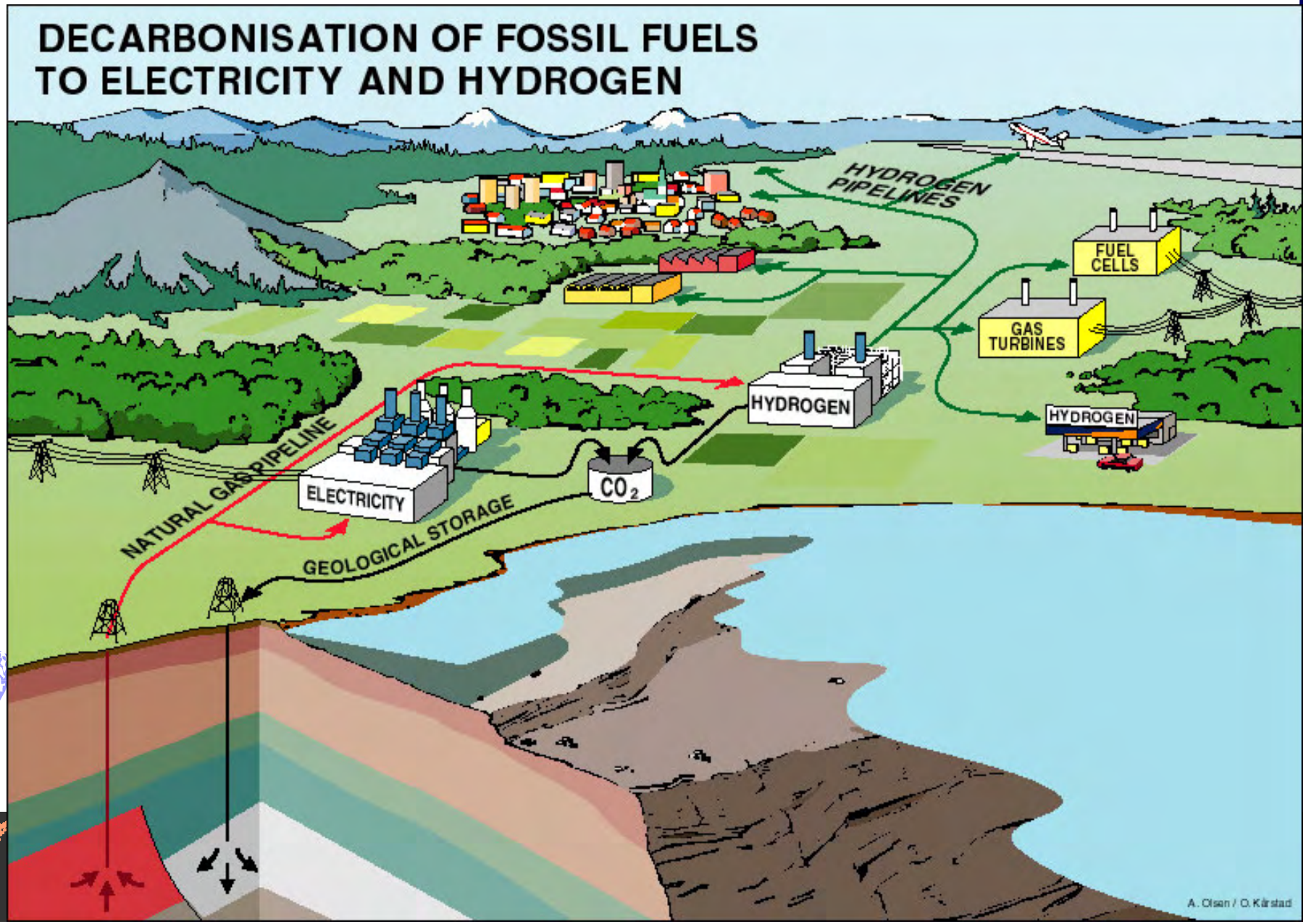
Worst case scenario
is business as usual!
Need to get started now!

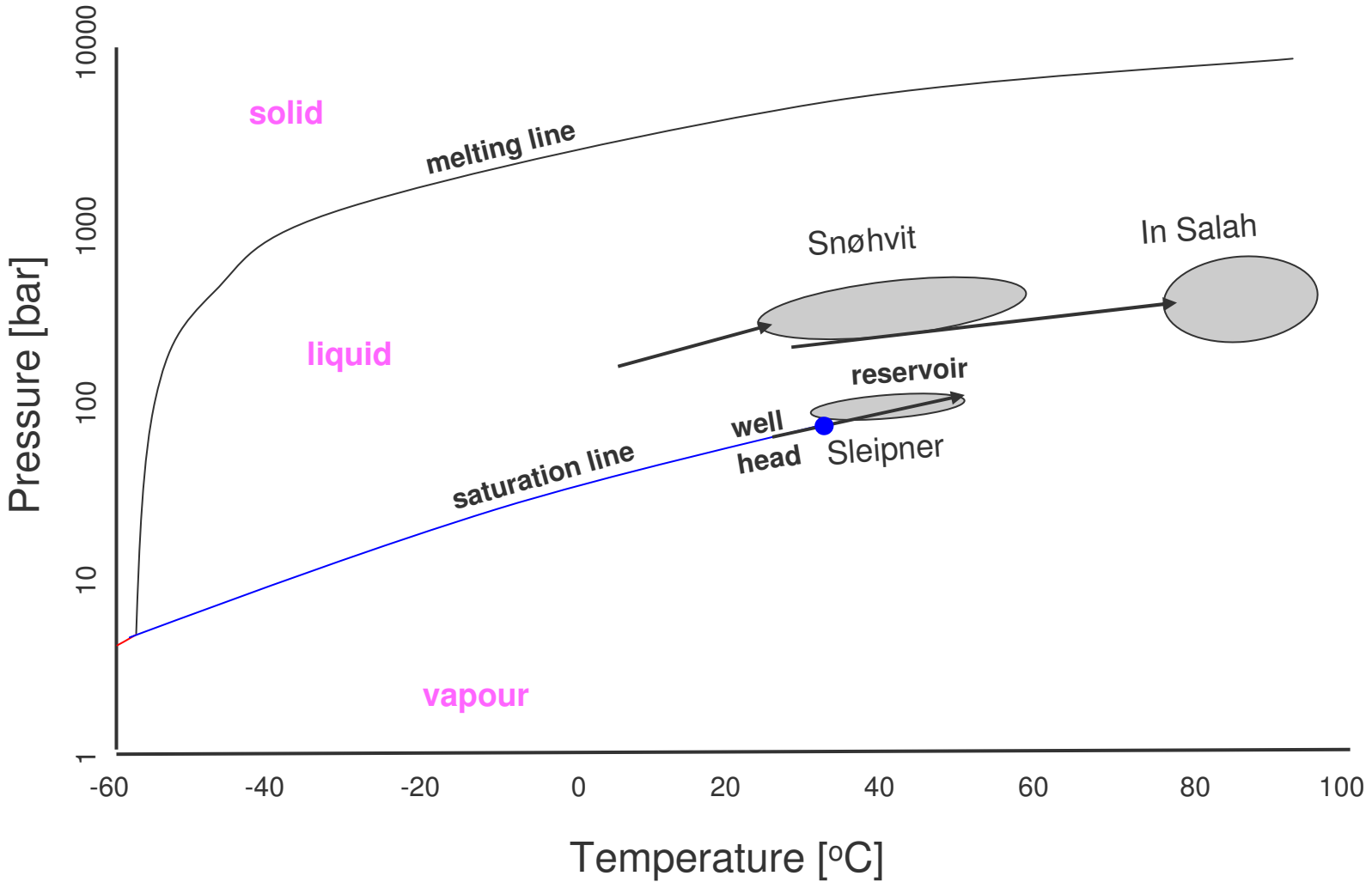
Vision

STATOIL



Sleipner, In Salah & Snohvit

– Industrial sites


Pressure [bar]
10000
1000
100
10
1
solid
melting line
liquid
Snøhvit
In Salah
reservoir
well
head
Sleipner
saturation line
vapour
-60
-40
-20
0
20
40
60
80
100
Temperature [°C]

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SUSTAINABLE ENERGY TIME NEXT

DRILL TEAM This North Sea rig may hold the future of cleaner extraction

Putting the World on a LOW CARBON DIET

The oil and gas industry has come up with a novel way to cut harmful CO_2 emissions: put them back in the ground By Matthew Yeomans

ON THE SURFACE, IT LOOKS LIKE ANY other weather-beaten offshore rig, with its towers of scaffolding, heavy-duty cranes and helicopter landing pad. Located in the North Sea's Sleipner West field, some 230 km off the Norwegian coast, the facility has pumped about 35 billion standard cubic meters of natural gas for Statoil, Norway's state oil company, over the past eight years. But beneath this particular rig lies what could turn out to be a cost-effective technique for fighting global warming.

Traditional drilling for fossil fuels like natural gas and oil releases millions of tons of carbon dioxide (CO_2) into the atmosphere. CO_2 is a greenhouse gas that is both naturally present in oil and gas fields, and is injected into the ground to boost the extraction process. Along with emissions from cars, fossil-fuel power stations and industry, oil and gas drilling contributes to the earth's rising temperatures. Beginning in 1996, Statoil has deployed a new method called carbon sequestration to stop the CO_2 escaping: Statoil engineers remove the CO_2 from the rising column of natural gas and send the greenhouse gas back into the ground, all in one continual process. So far the firm has stashed some 7.5 million tons of CO_2 in a kind of emissions tomb known as a saline aquifer 1,000 m beneath the ocean floor. Statoil estimates there's room for 392 billion tons more, the equivalent of the CO_2 emissions from all the power stations in Europe for the next 600 years. Canada's EnCana is also putting CO_2 back into the ground, and BP and Gaz de France will be trying the technique soon. "Carbon storage is suddenly catching on," says Tore Torp, head of Statoil's CO_2 research program. "Sleipner will not be a lone lighthouse for much longer."

Carbon storage and capture is not what environmentalists would call a green technology; its raison d'etre is to sustain and even increase the use of fossil fuels like oil, gas and coal (this TIME Next report also explores new developments in wind, solar and hydroelectric energy). But sustainable energy solutions—even imperfect ones—are needed in a world addicted to fossil fuels, and carbon sequestration could help the transition to clean, renewable fuels over the next 30 years. One reason for carbon sequestration's newfound popularity in Europe is that, starting in 2005, the E.U. will cap carbon emissions as part of its commitment to the 1997 Kyoto agreement on global warming. Installations will be assigned a carbon emis-

TIME, MAY 17, 2004

Sleipner CO_2 injection:

- Decided in 1992
- In operation since 1996
- 1 million tonne CO_2/år

Time Magazine, 17. May 2004

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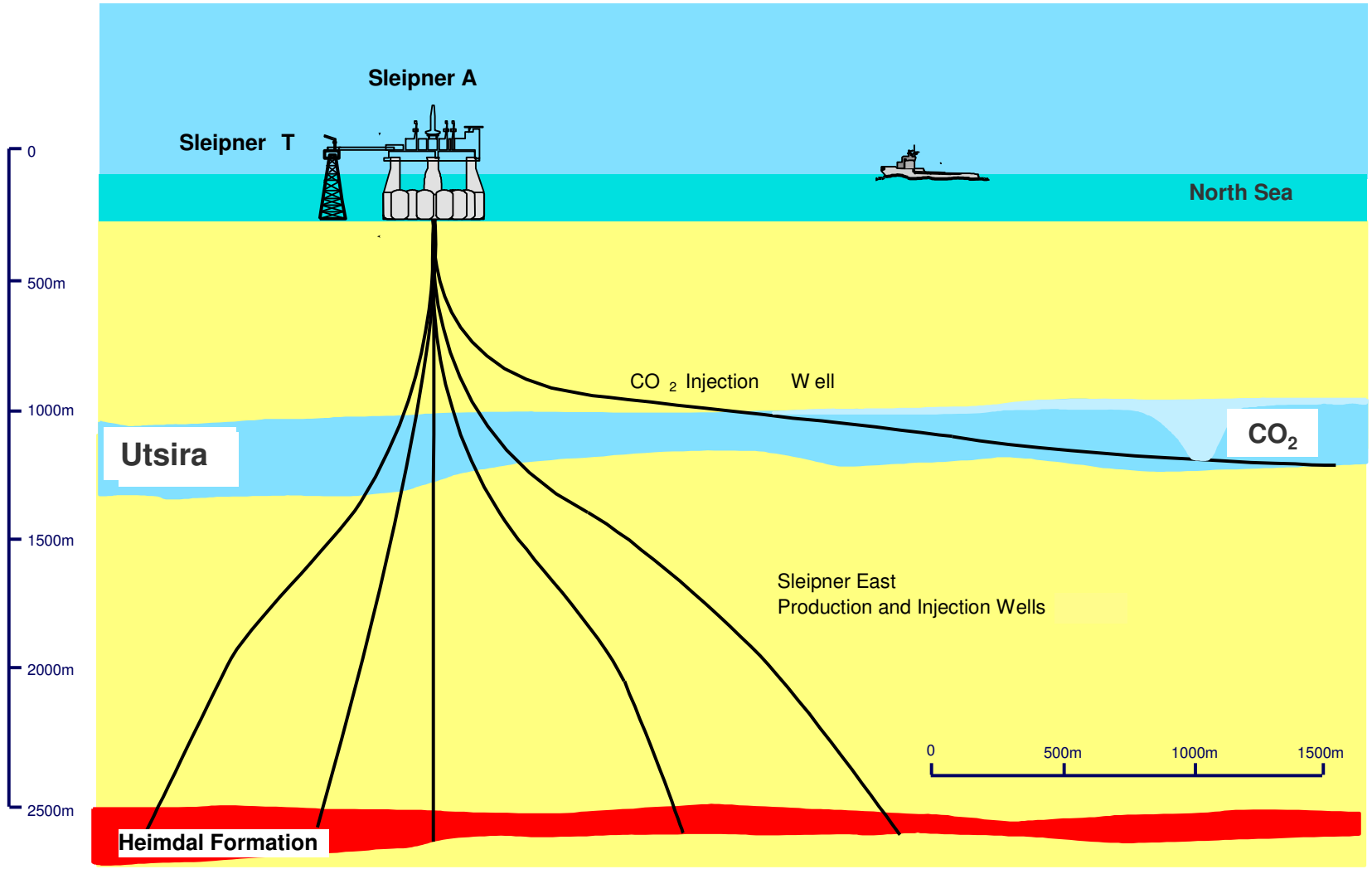
CO_2 Injection well in "Utsira"



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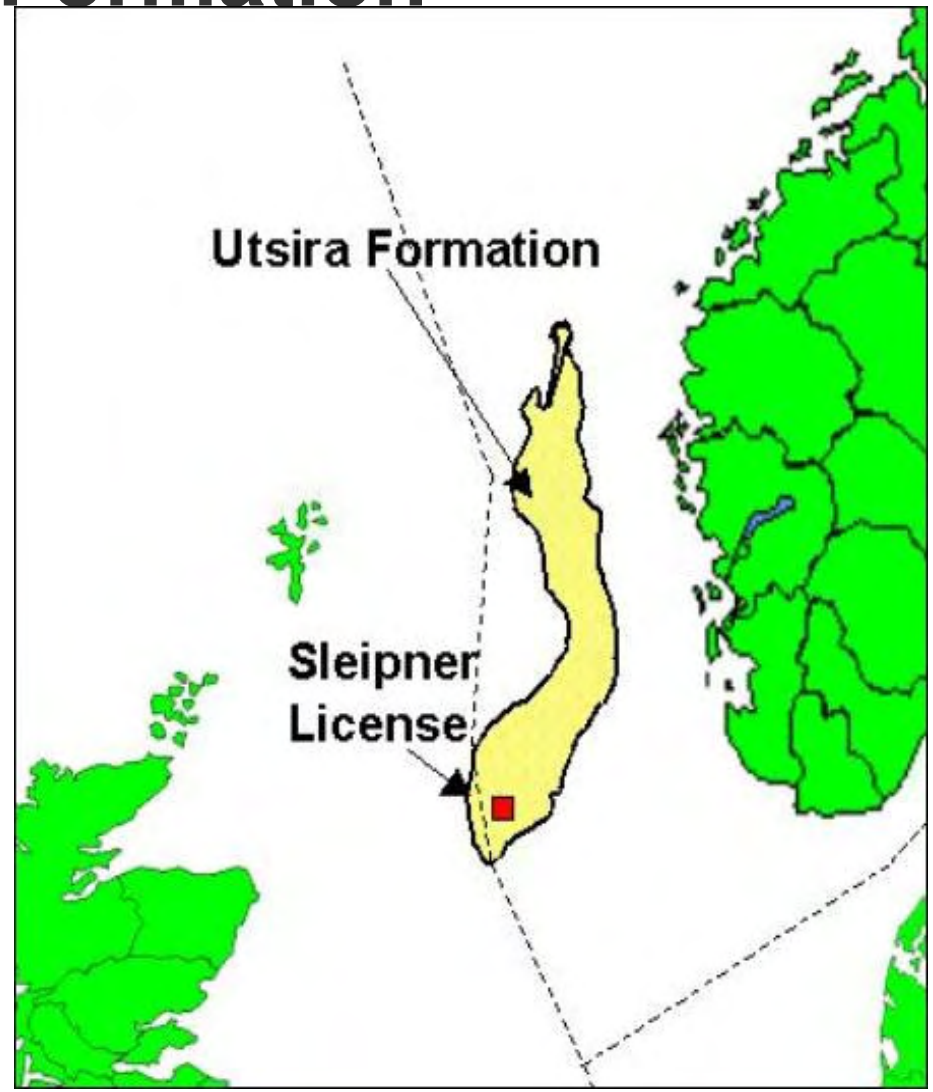
The Utsira Formation



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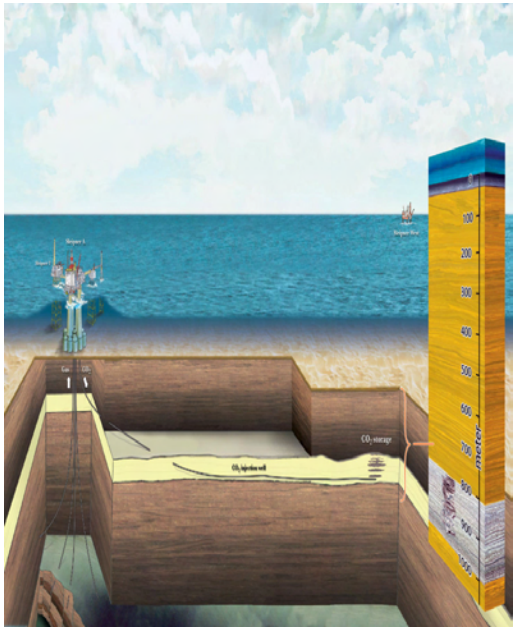
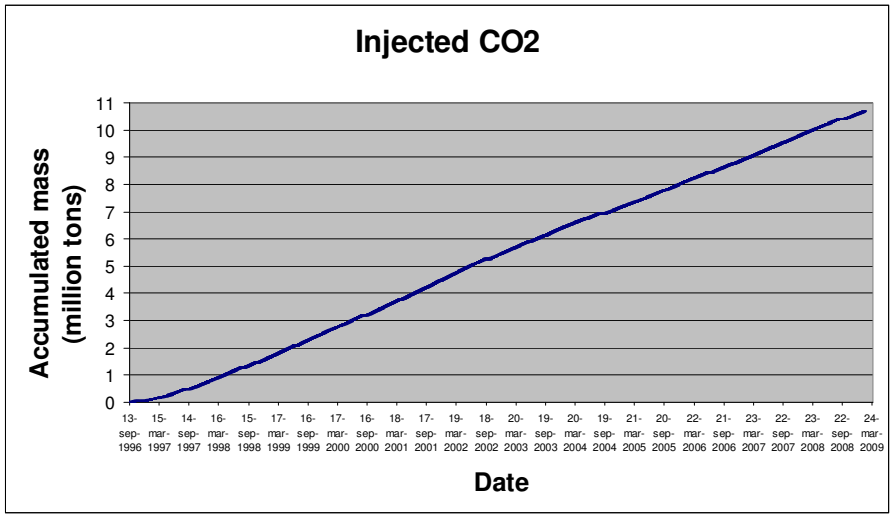
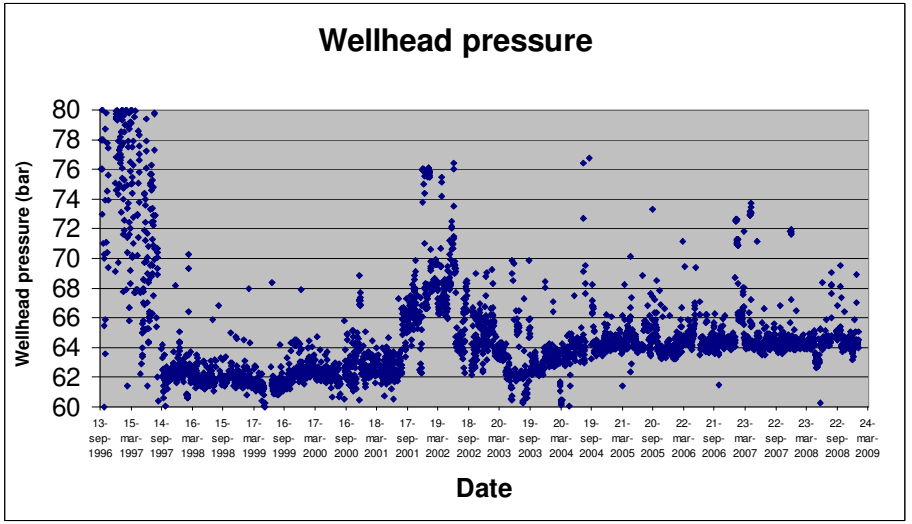
CO_2 Injection

- 10,2 mill. tons injected as of 2008 seismic data acquisition (May-June)
- 13 mill. tons injected as of New Year 2010
- Wellhead pressure stable at ~ 64 – 65 bar
- Wellhead temperature set at 25 °C







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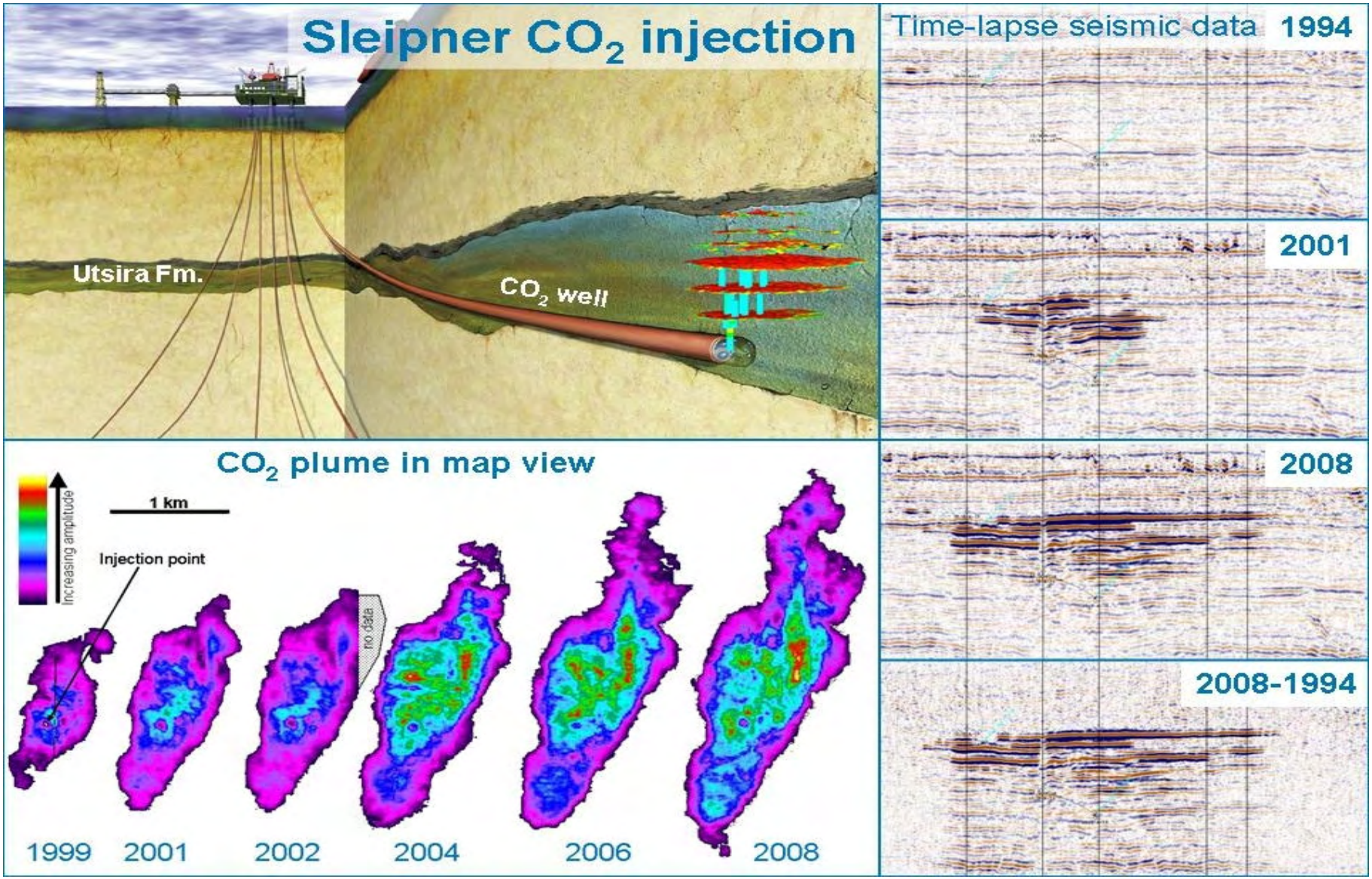
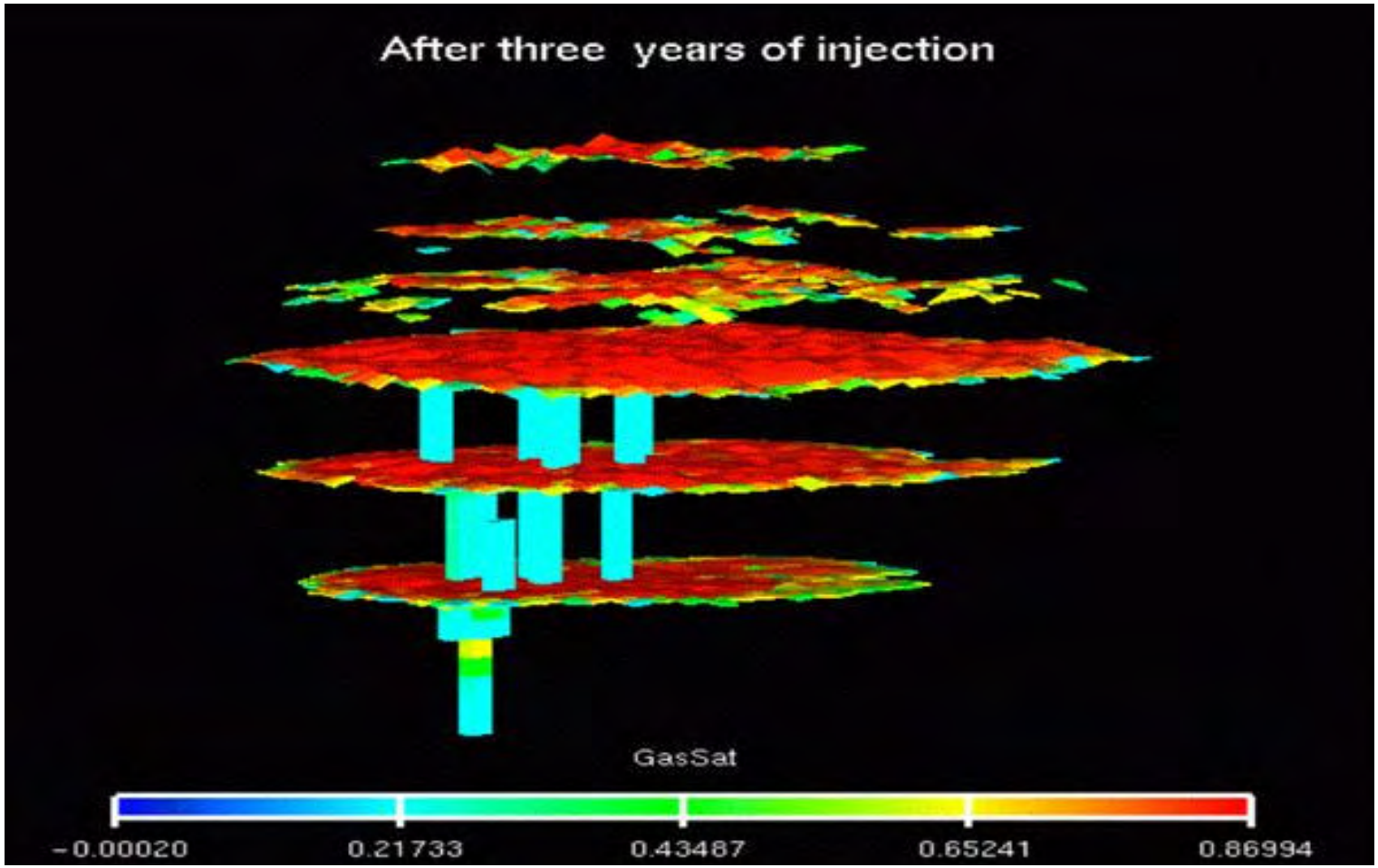

Sleipner CO_2 injection
Utsira Fm.
CO_2 well
CO_2 plume in map view
1 km
Increasing amplitude
Injection point
no data
1999
2001
2002
2004
2006
2008
Time-lapse seismic data
1994
2001
2008
2008-1994



Simulated picture of the distribution of CO_2 after three years. Radius of largest bubble 800 m and the total plume 200 m high.

Ref: SINTEF Petroleum 2001

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CO_2 finnes ”lagret” naturlig i undergrunnen.

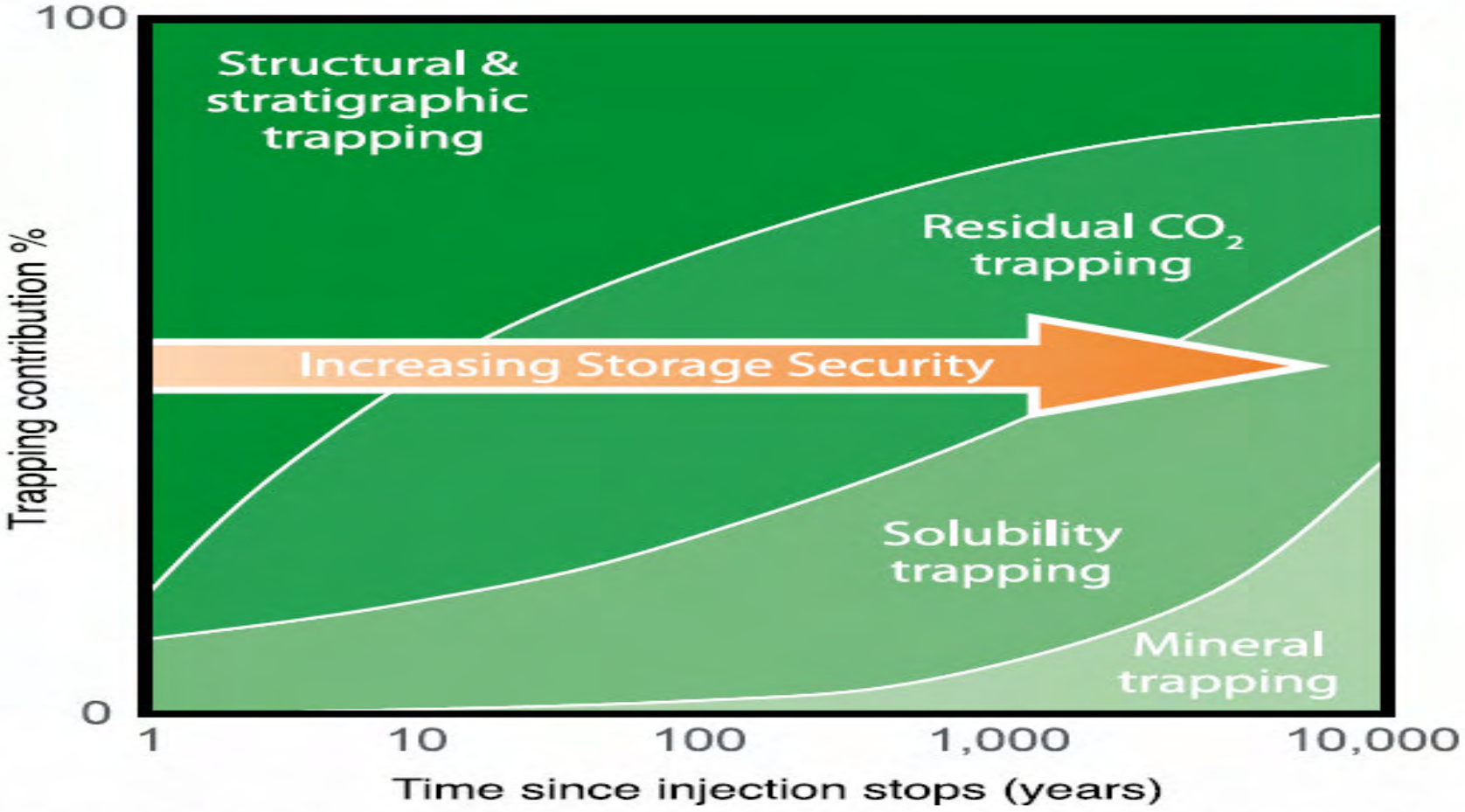

Figure 5.9 Storage security depends on a combination of physical and geochemical trapping. Over time, the physical process of residual CO_2 trapping and geochemical processes of solubility trapping and mineral trapping increase.

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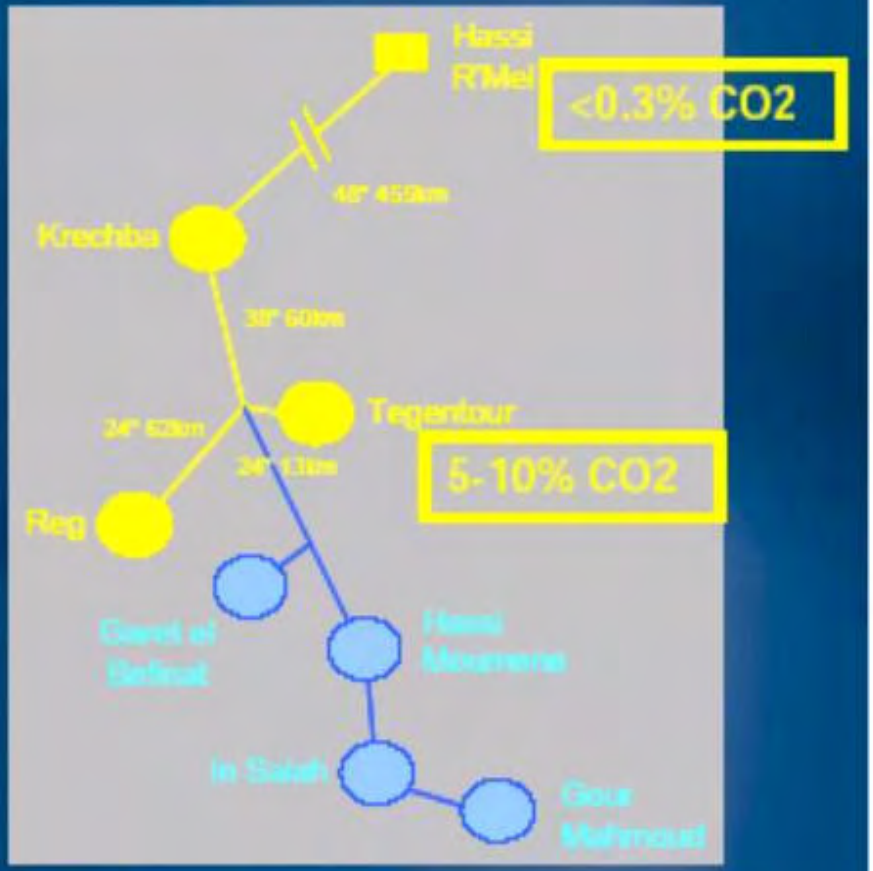
In Salah Gas Project Location, Algeria



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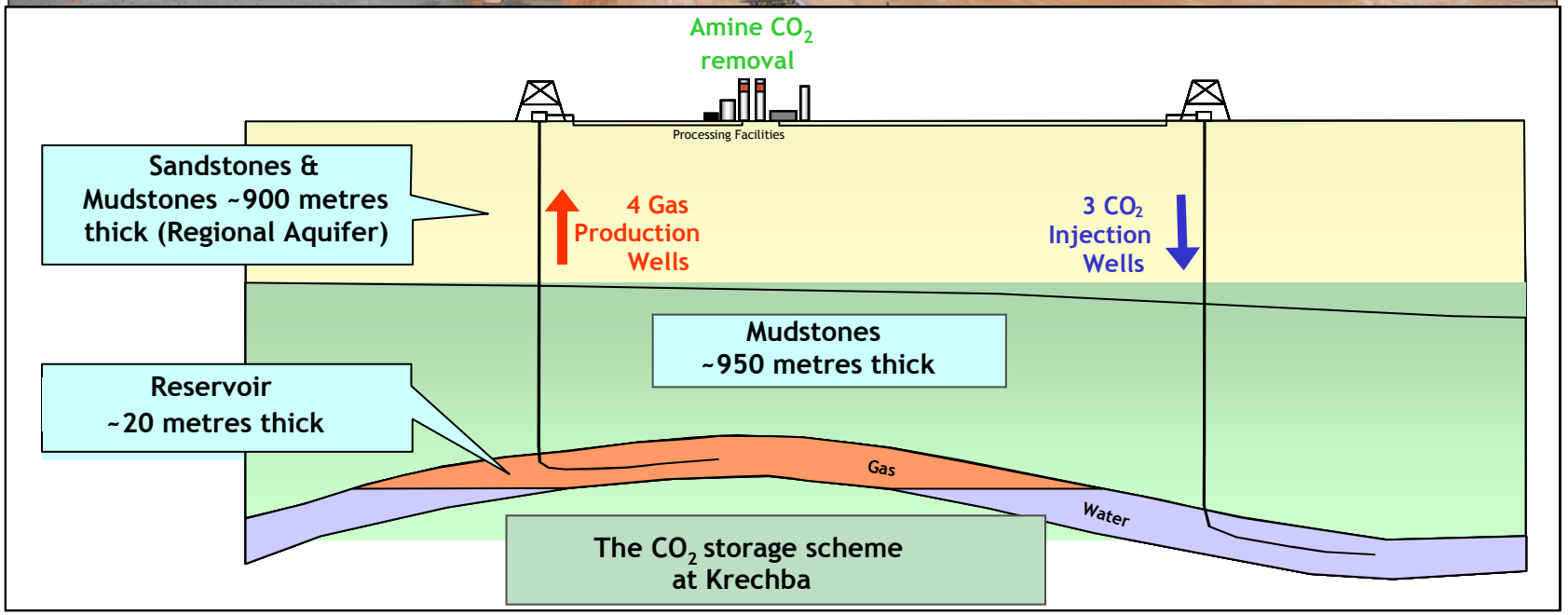
In Salah in Algeria



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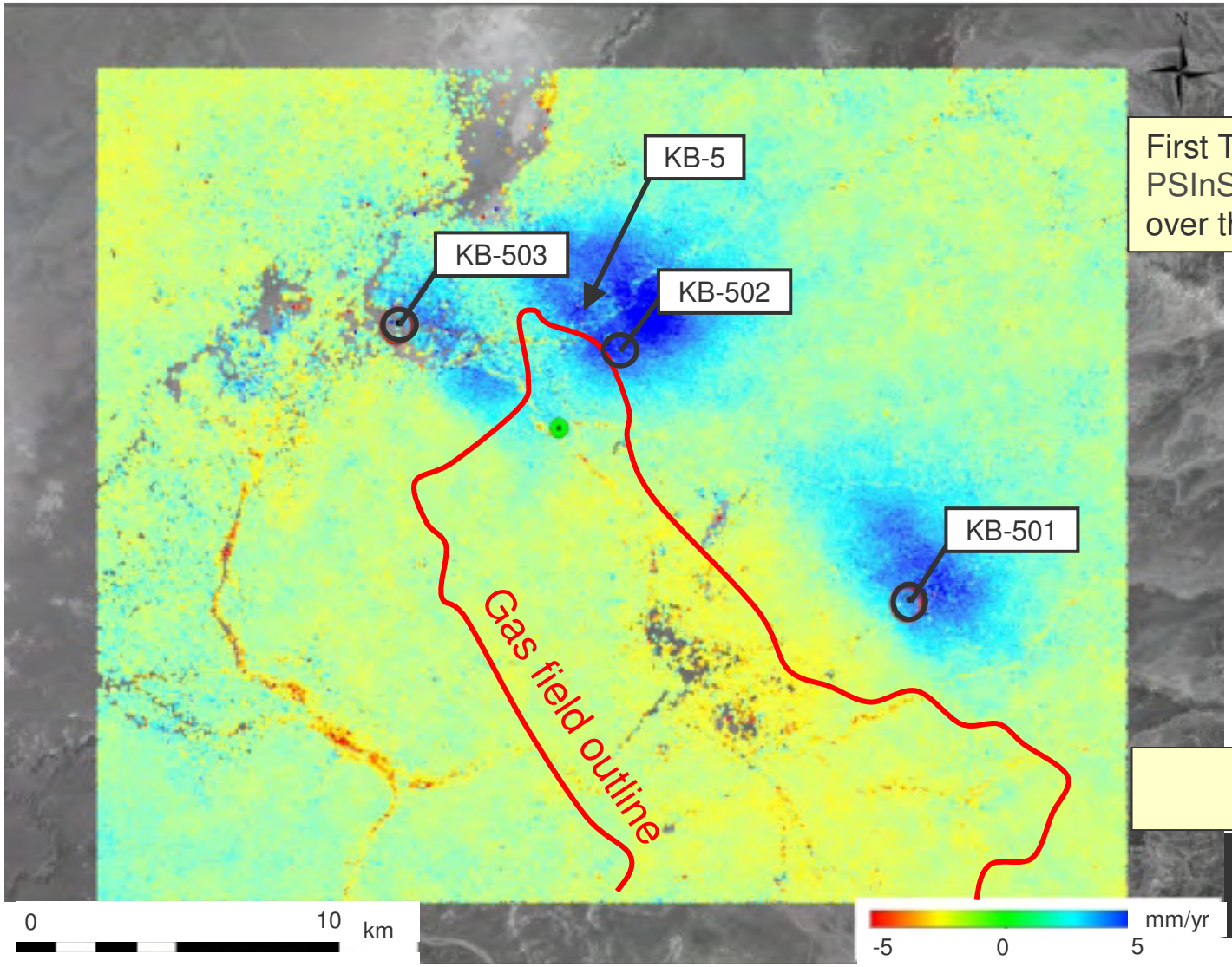
In Salah Satellite Monitoring



First TRE dataset (2003-2007) PSInSAR™ revealed ~5mm uplift over the CO2 injectors

Vasco et al.
Geophysics Journal, Vol. 73, 2008

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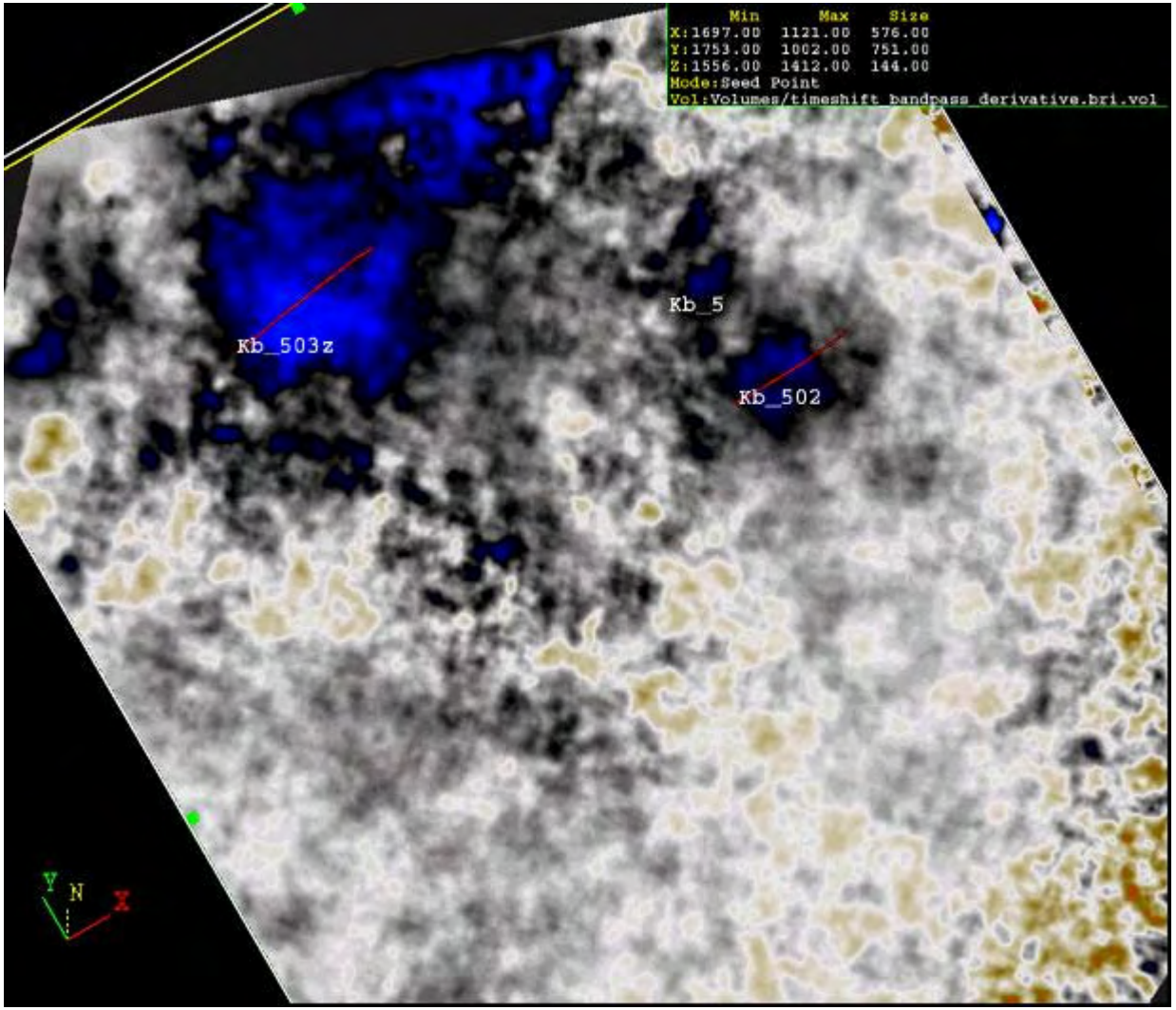
In Salah 4D seismic amplitude changes at reservoir level



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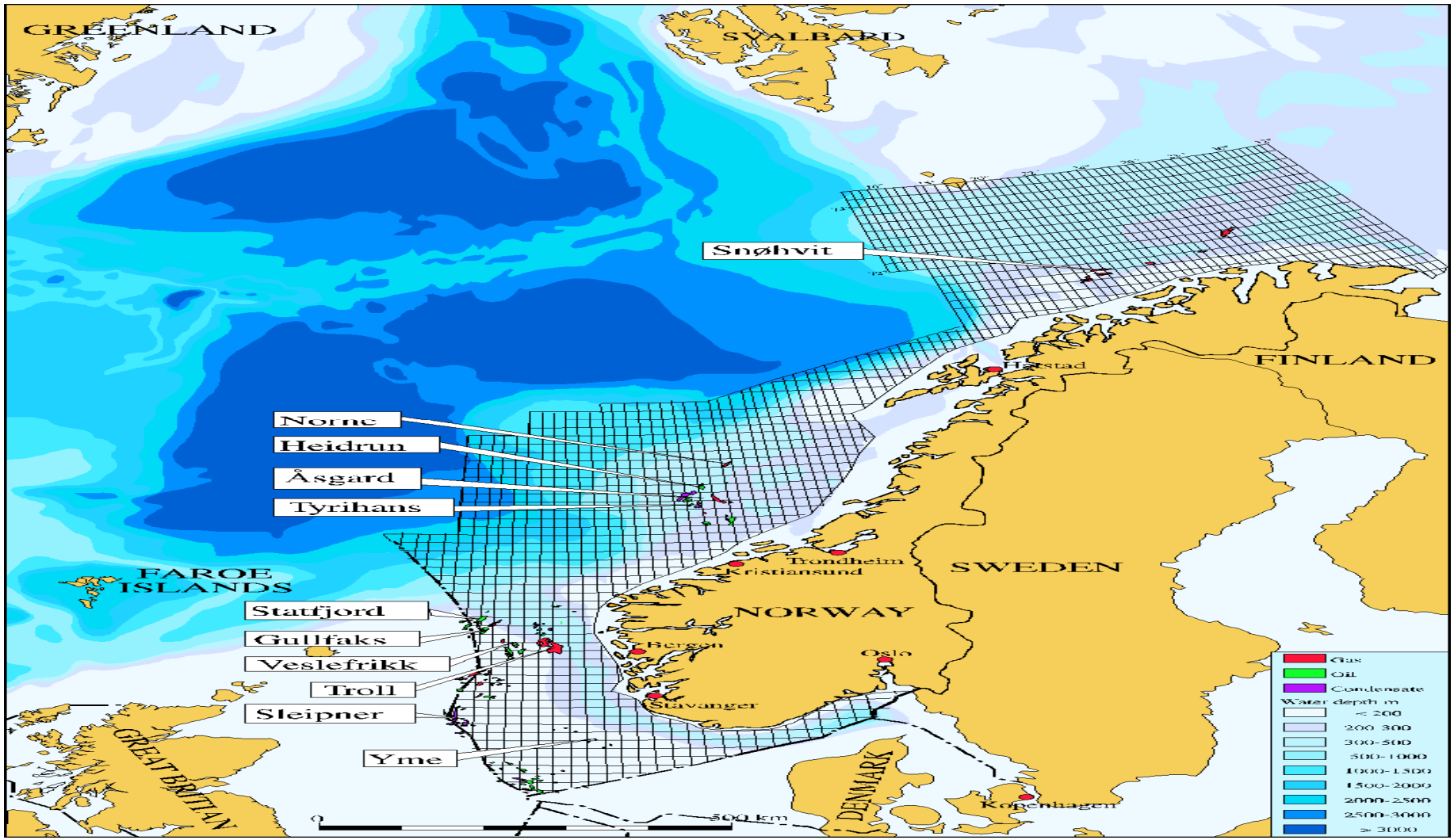
Snøhvit, implement CO_2 storage offshore in North Atlantic



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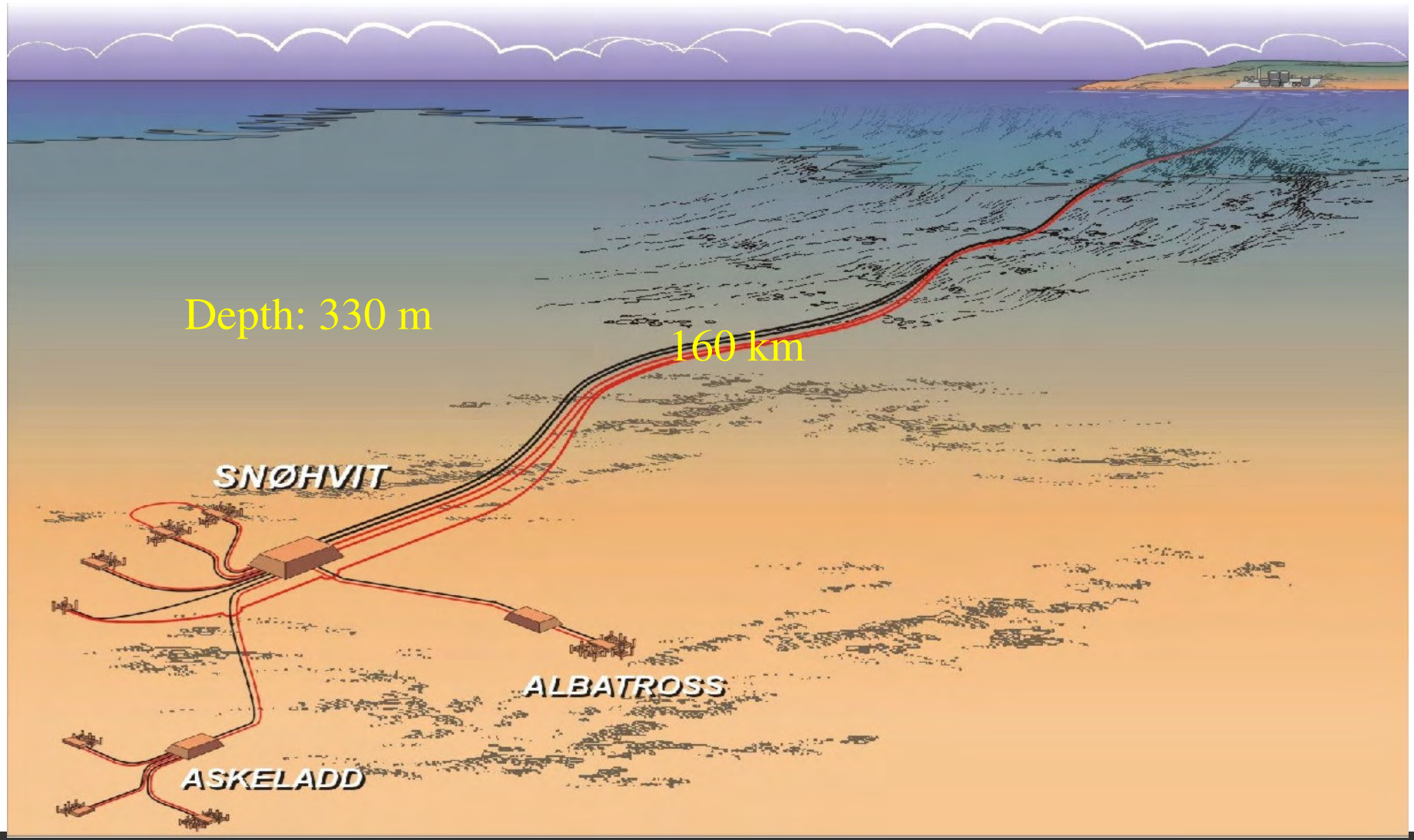
Snøhvit – All subsea



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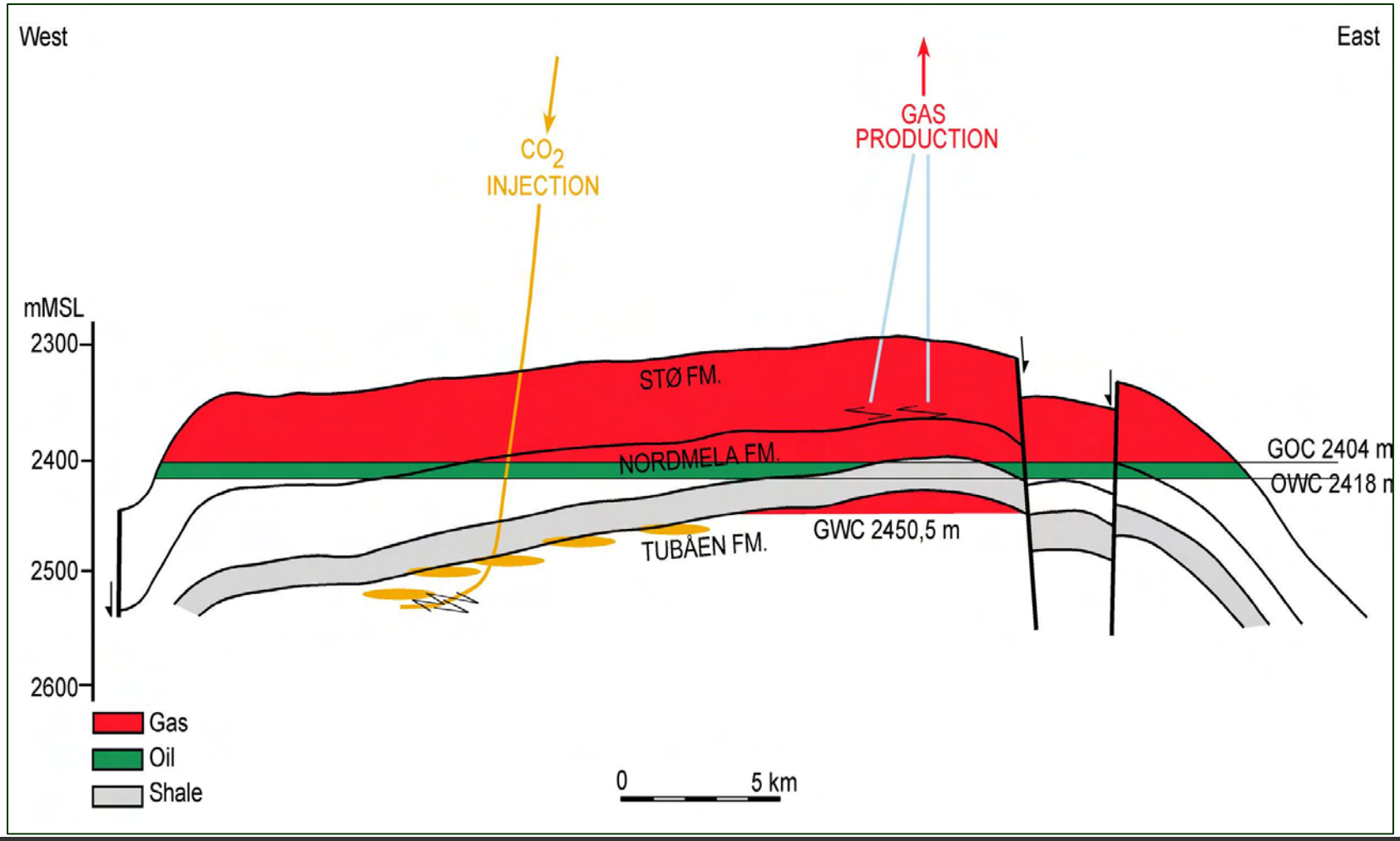
Snohvit CO_2 Injection



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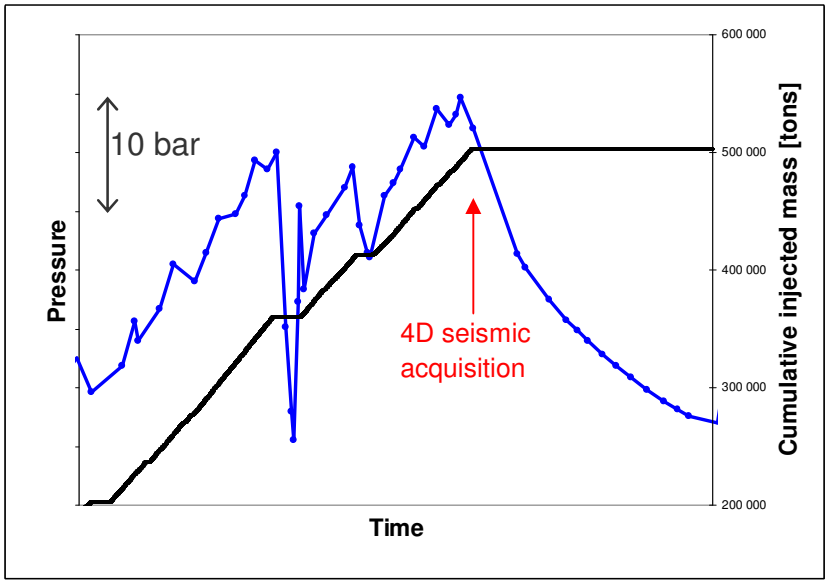
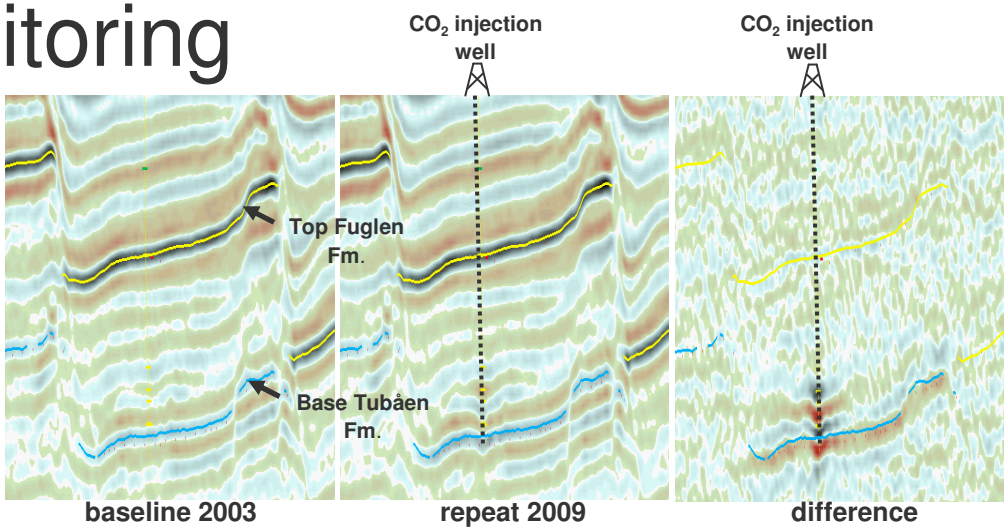
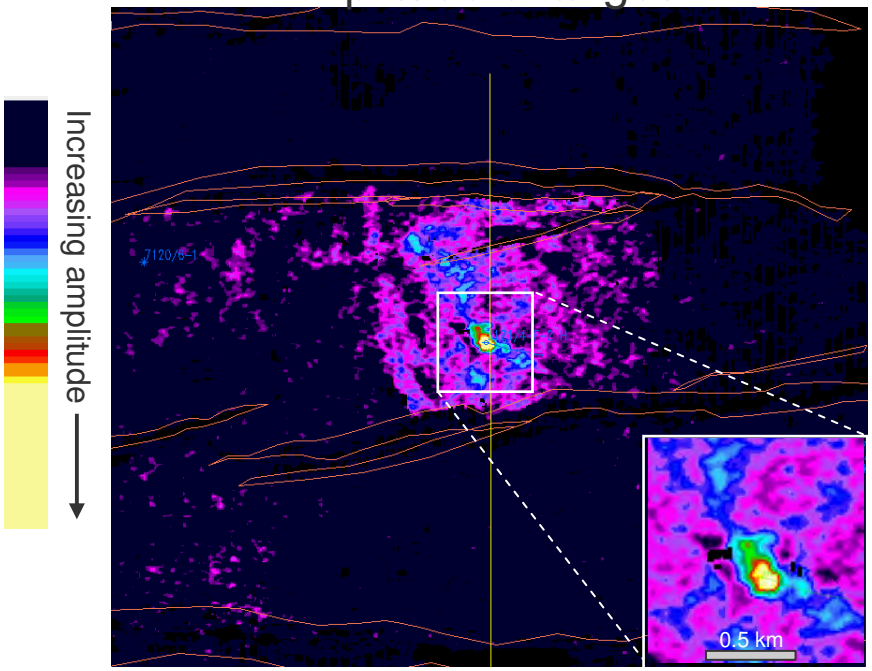
Snøhvit CO_2 monitoring

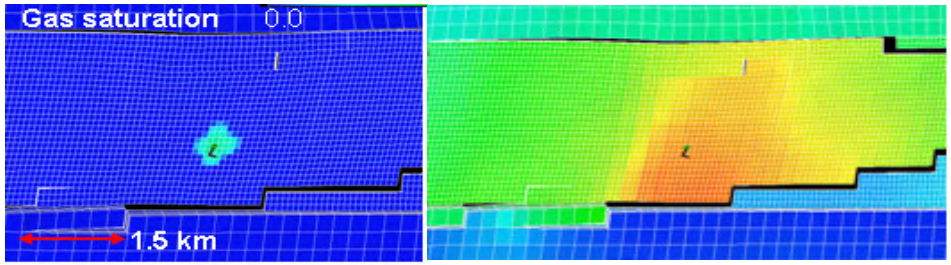




Amplitude changes



Modelled CO_2 saturation and pressure increase



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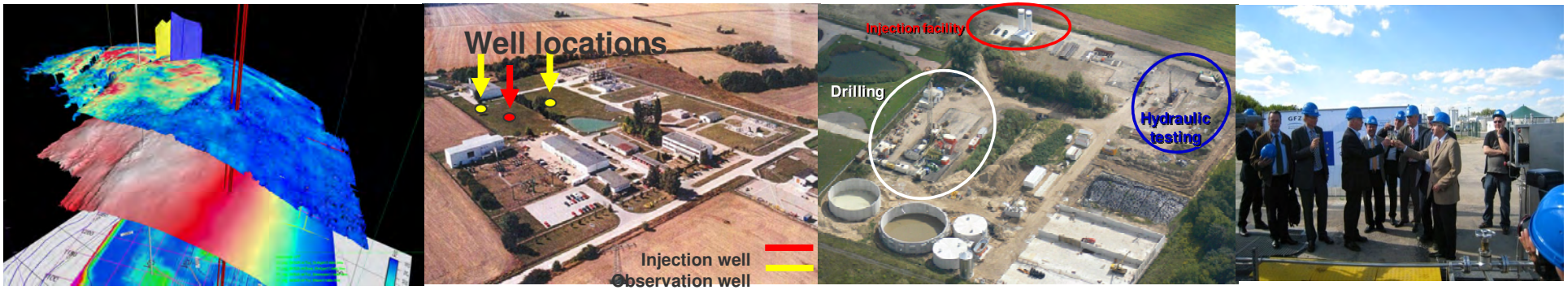
Ketzin, Longyear and Svelvik - Pilot test sites

CO2SINK - First European On-shore CO_2 Storage Project at Ketzin (Germany)



SIXTH FRAMEWORK PROGRAMME

Federal Ministry of Education and Research

Federal Ministry of Economics and Technology

Coordinator: GFZ, Potsdam

Industry: E.ON, RWE, Schlumberger, Shell, Siemens, Statoil, Vattenfall, VNG

Statoil

Ketzin
- Facilities at Wintertime

Source: GFZ, Potsdam

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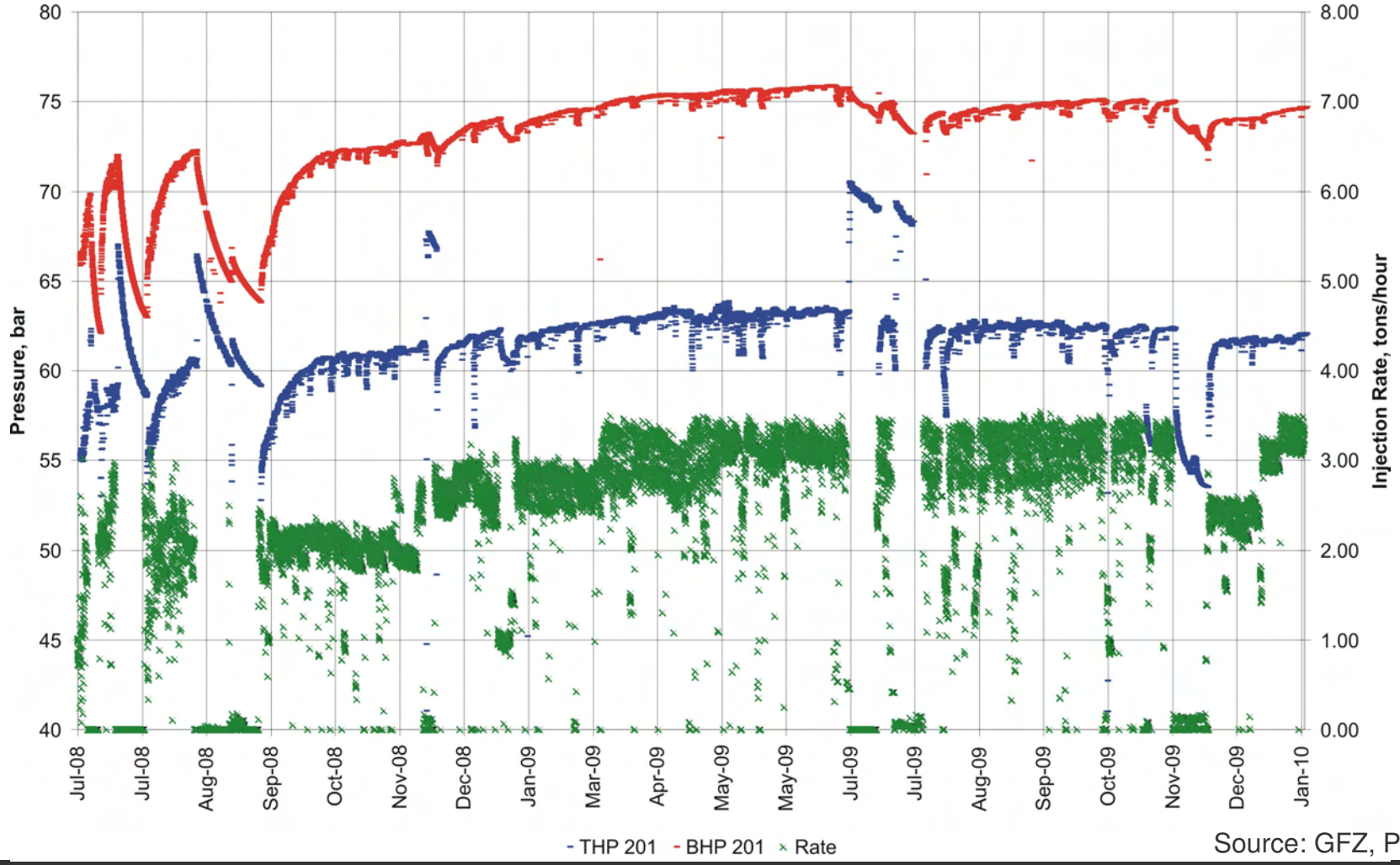
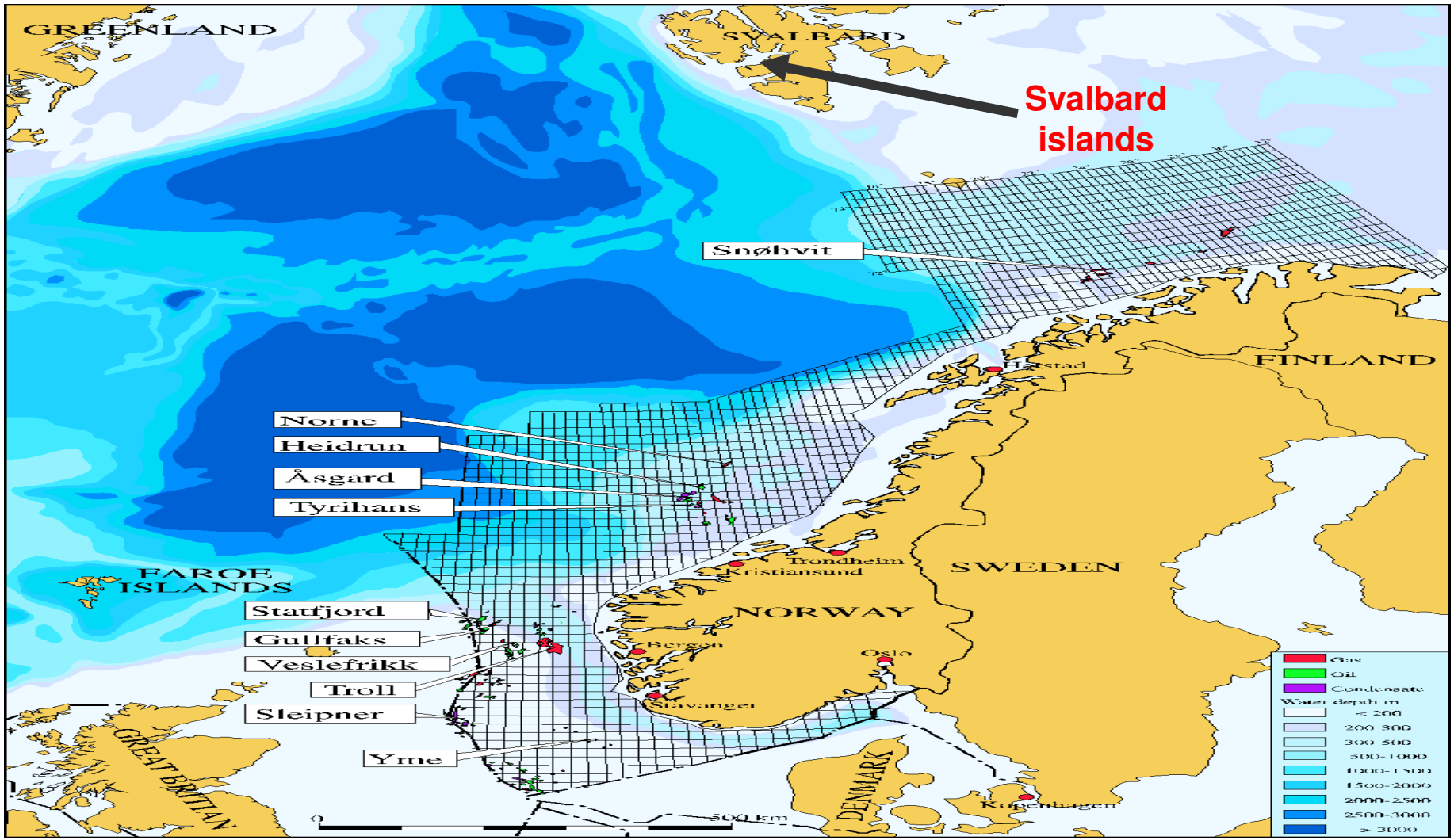
Regular Operations (3)
Rates & Pressures



Source: GFZ, Potsdam

Statoil

LONGYEAR CO_2 - Storage on Svalbard



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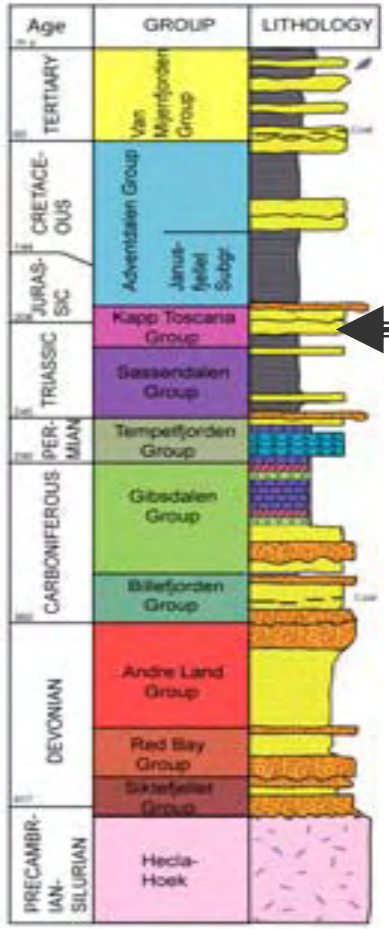
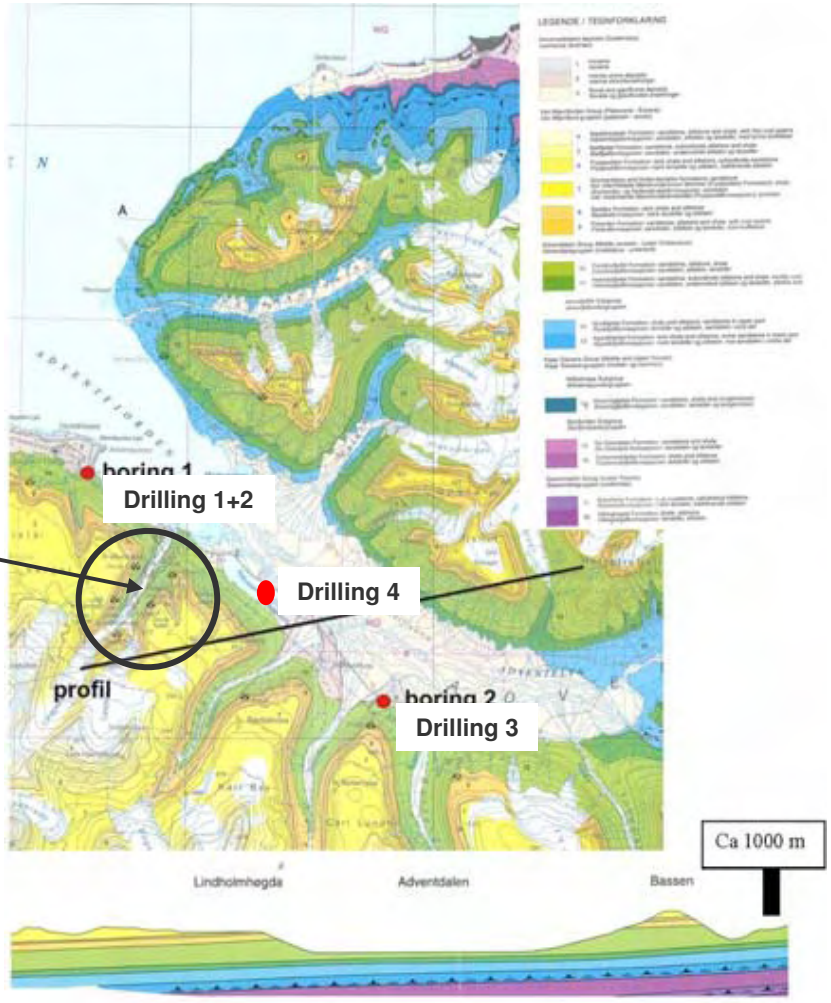
CO2 Storage on Svalbard



Drill hole target – 900 m

Longyearbyen



Source: UNIS, Svalbard

Statoil

Longyear CO2 – Drill rig at winter

Courtesy: UNIS, Svalbard

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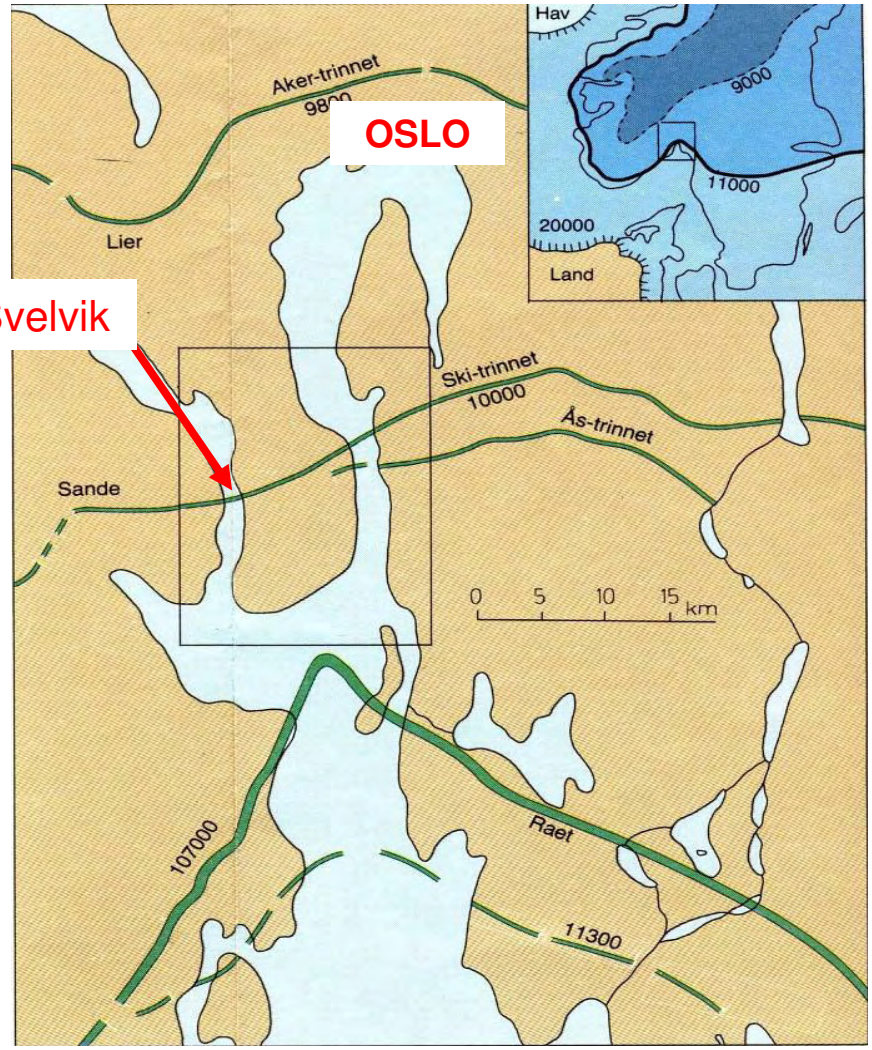
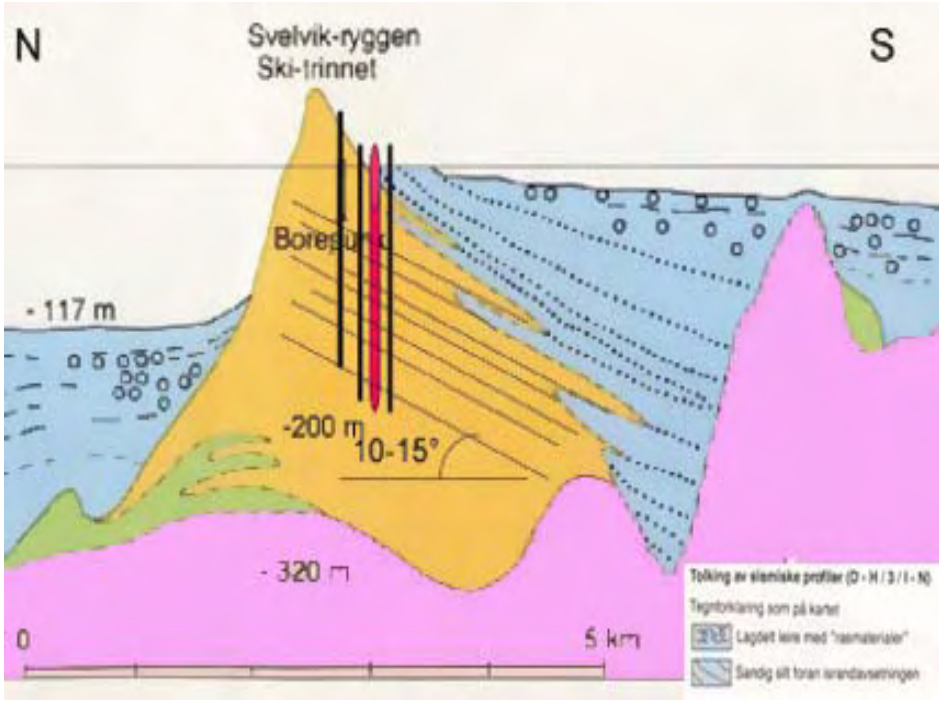
CO2 Field Lab



Objectives:

1. Determine requirements for monitoring of industrial CO2storage
2. Quantify unforeseen migration and leakage into the atmosphere or ocean



Courtesy SINTEF Petroleum

Statoil

CO2 Field Lab – Svelvik site

Courtesy:
SINTEF
Petroleum

Statoil

Legal Framework

Legal Framework – Present status

- **Ownership to site** – Ground owner
  Ownership to subsurface – State*

- **Petroleum law** – Injection of fluids
- **Environmental Protection law** - Emissions to air and sea

- **EU Water Directive** – CO2 excluded
- **EU Landfill Directive** – CO2 excluded
- **EU CCS Directive** – Regulates "from birth to grave"
  Under implementation in Member States and Associated Norway

* USA special – Subsurface owned by ground owner

THANKS for your attention!

QUESTIONS?