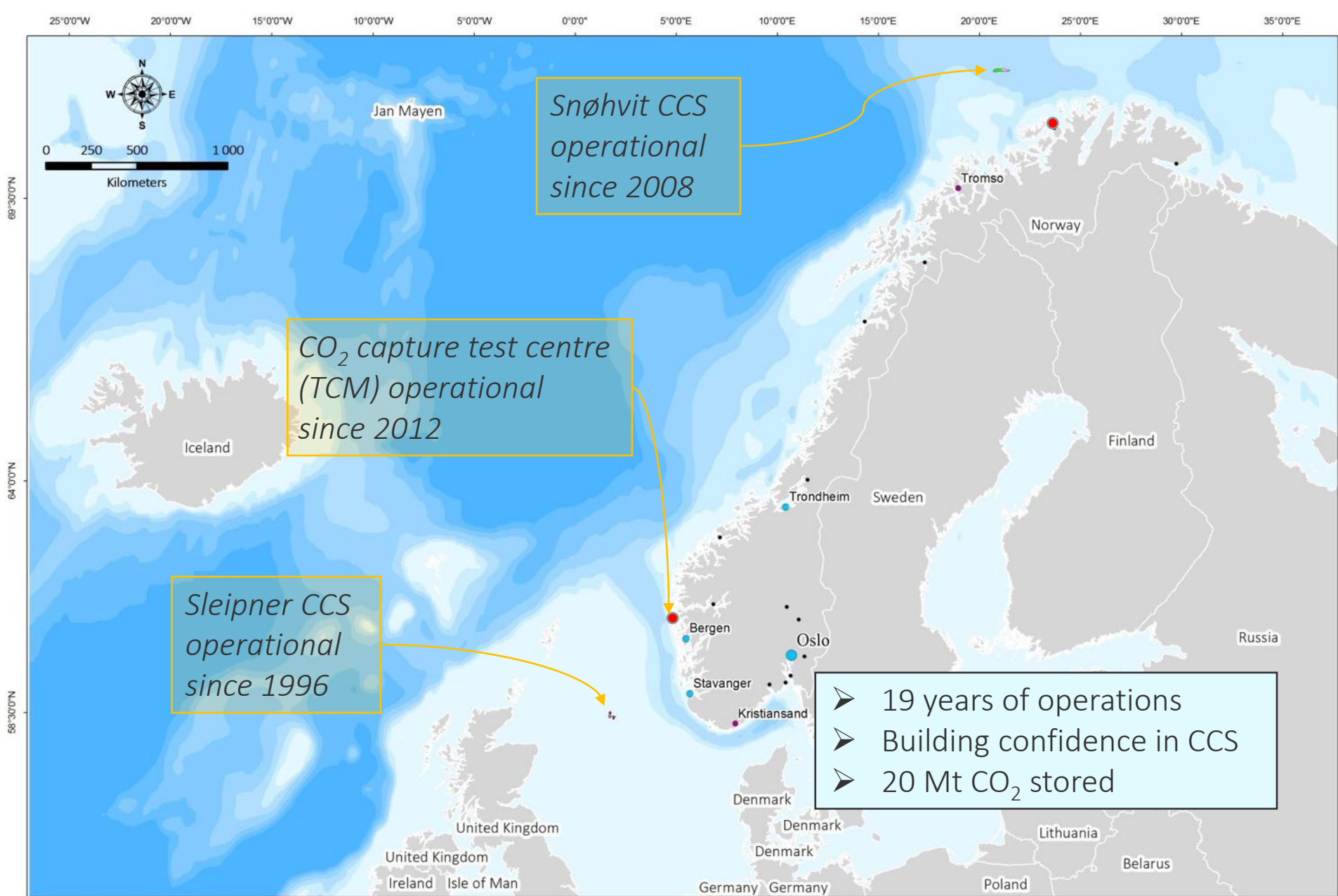


# 19 years of Offshore Operations in the North Sea Region



COP-21 Side-event on Carbon Capture and Storage (CCS):  
Achievements and Opportunities for Developing Country Involvement

Presented by Philip Ringrose  
Statoil ASA, Norway



# Projects in brief



Sleipner

- Gas/condensate field in the North Sea (operational in 1996)
- Discovered 1974
- Statoil (operator), ExxonMobil and Total
- CO<sub>2</sub> content of 4-9%
- Pioneering decision to apply CCS
- Approaching 16 Million tonnes CO<sub>2</sub> stored

Snøhvit  
(Melkøya)

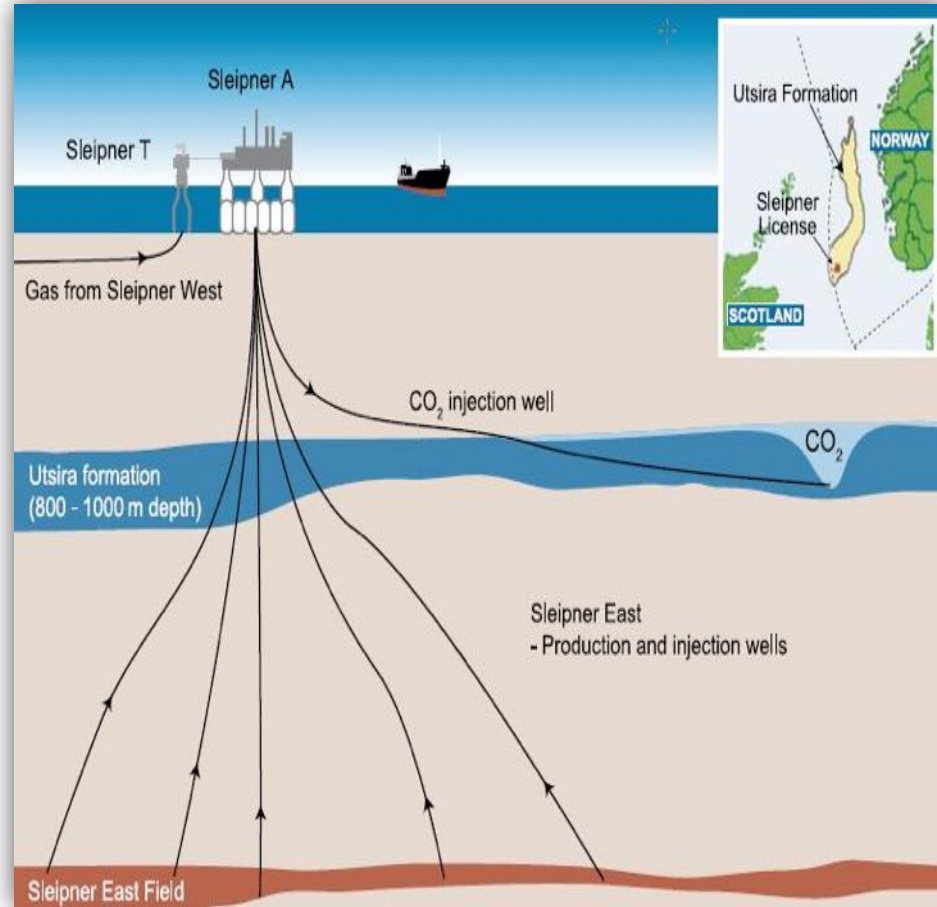
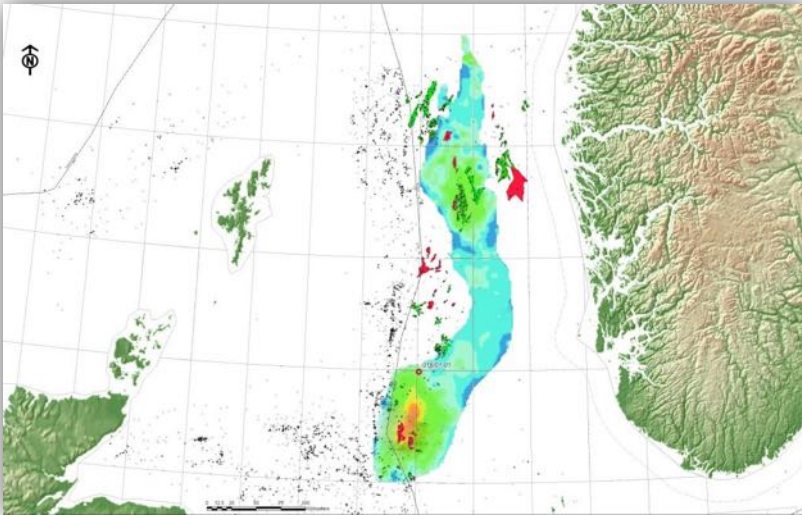


- Gas/condensate field in the Barents Sea (operational in 2007)
- Discovered 1984
- Statoil (operator), Petoro, Total, GDF Suez, DEA
- CO<sub>2</sub> content of 5-8%
- A subsea development with onshore gas processing (LNG) at Melkøya
- First offshore CO<sub>2</sub> transport pipeline (150 km)
- Approaching 4 million tonnes CO<sub>2</sub> stored

# The Sleipner CO<sub>2</sub> injection project

- CO<sub>2</sub> from the Sleipner West field is stored in the Utsira Formation, North Sea
- CO<sub>2</sub> capture facilities installed on the Sleipner T platform (Sleipner East)
- Utsira storage unit at 800-1100 m depth
- One horizontal CO<sub>2</sub> well injecting at ~1012m (36 meter perforation)

Areal extent of the Utsira Formation



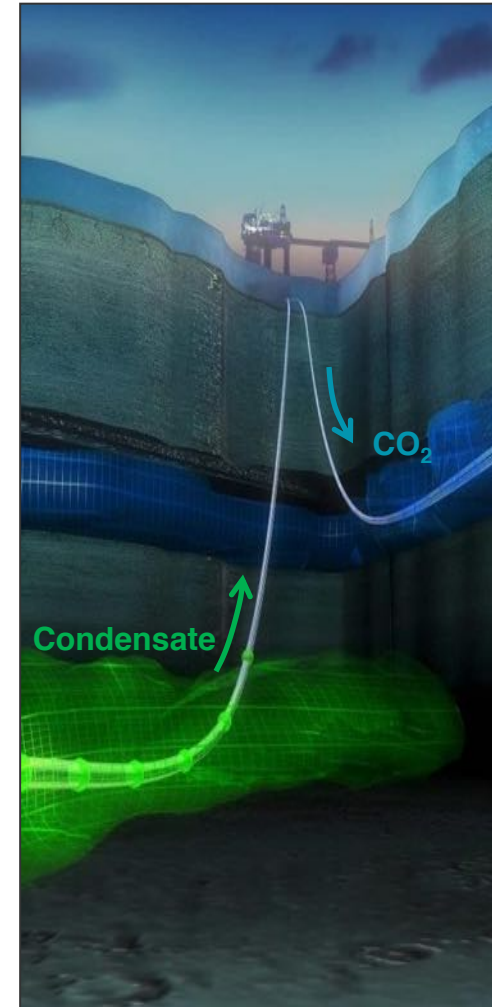
# Operating the Sleipner CO<sub>2</sub> project

## Operational performance

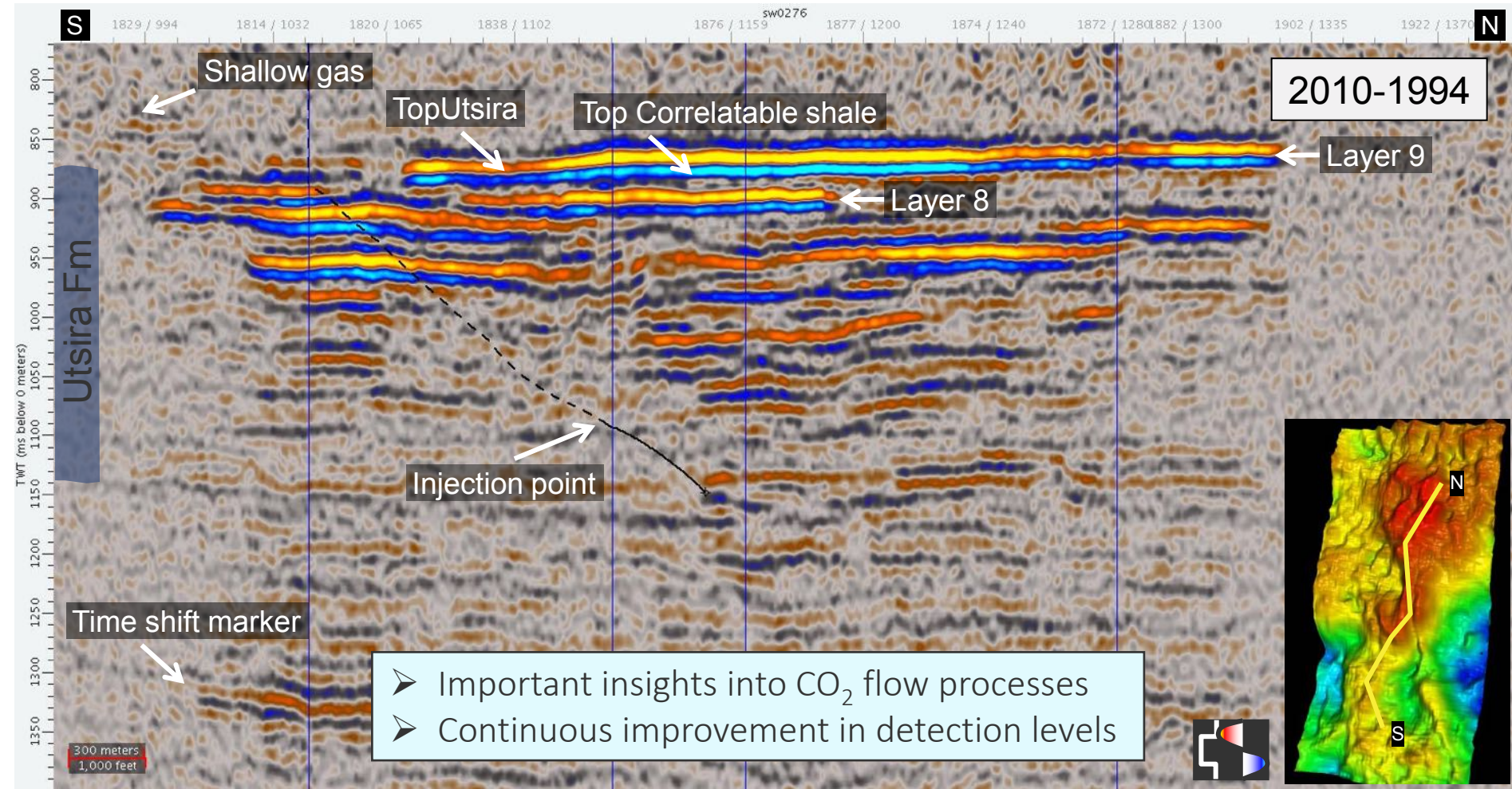
- Injected gas is ~98% CO<sub>2</sub>
- Stable wellhead pressure (65bar) and temperature (25°C)

## Monitoring data

- Wellhead pressure and flow rate is monitored continuously
- Gas composition samples are taken intermittently
- Eight time-lapse (4D) seismic surveys
- Three repeat gravimetric surveys
- Electromagnetic survey
- Sea bottom surveys
  - Side scan sonar and multi beam echo-sounding 2006
  - Synthetic aperture sonar 2011

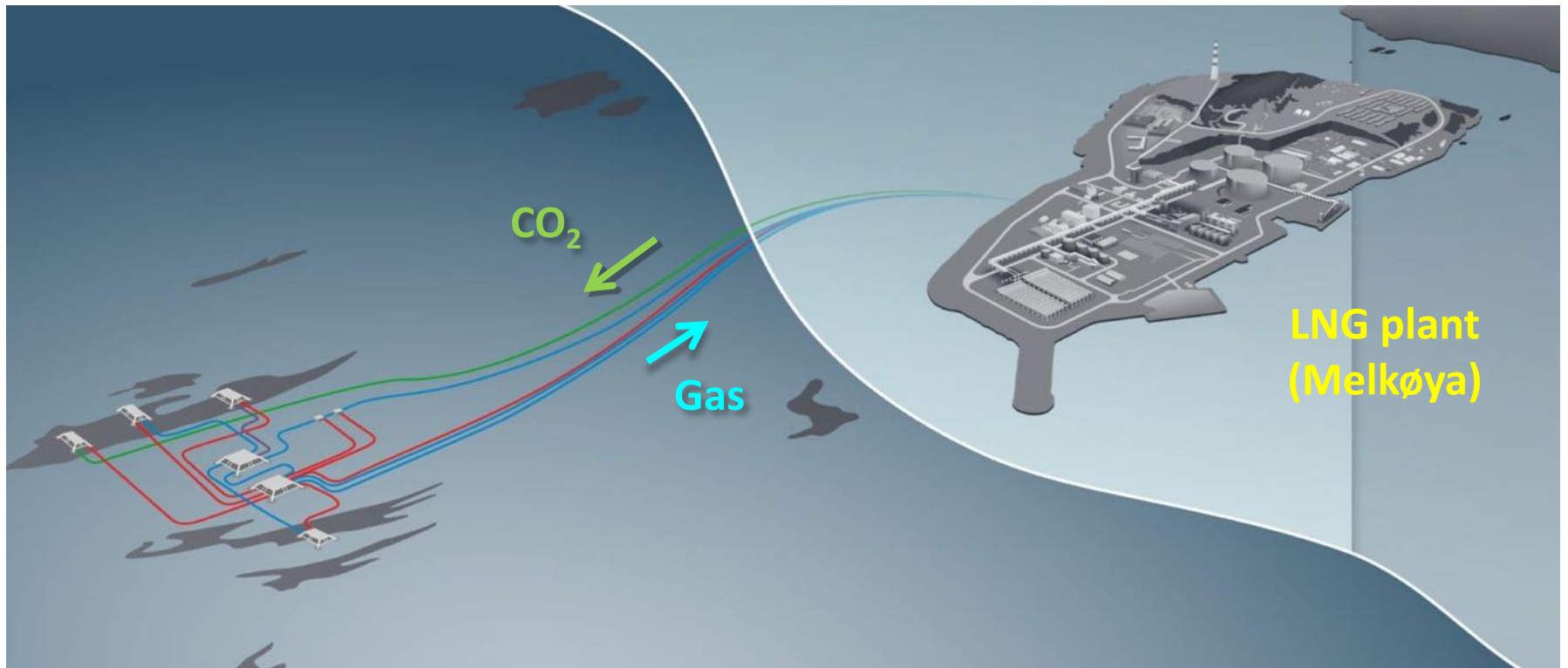


# Sleipner: Time-lapse seismic data



# The Snøhvit CO<sub>2</sub> injection project

- CO<sub>2</sub> from the LNG processing facility
- Storage in the Tubåen and Stø Fm.
- 150km CO<sub>2</sub> transport pipeline
- Reservoir units at 2000 - 2500 m depth
- CO<sub>2</sub> stored initially in the Tubåen Fm. (2008-11) and then in the Stø Fm. (2011-)
- Stable injection of ~1800 ton/day

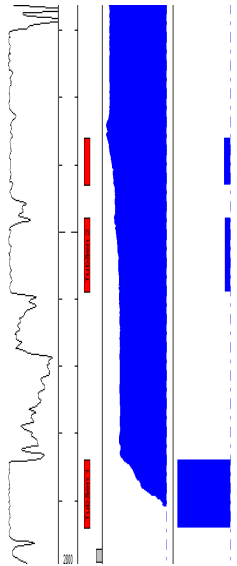


# Monitoring techniques applied at Snøhvit

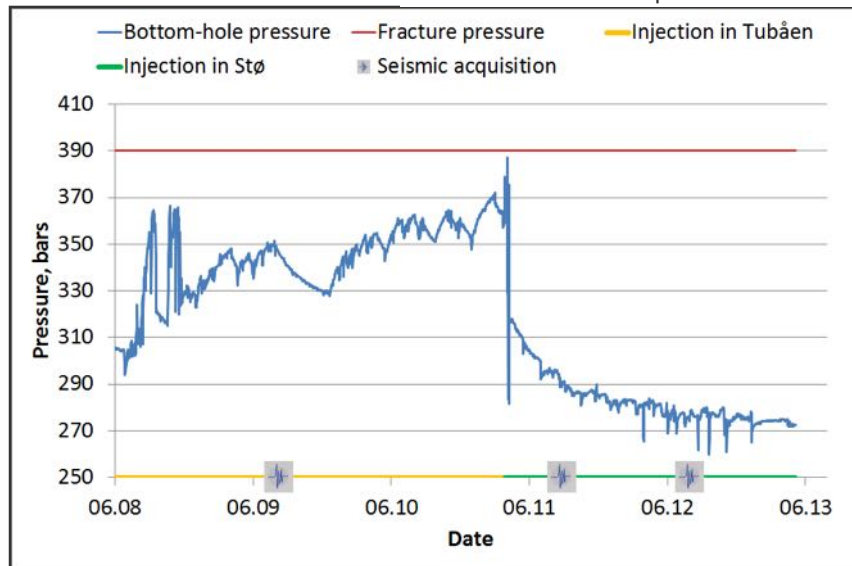


Down-hole data:  
P, T, Q

- Time-lapse seismic
- Downhole P/T gauges and flow logging
- Gravity surveys



Down-hole pressure data

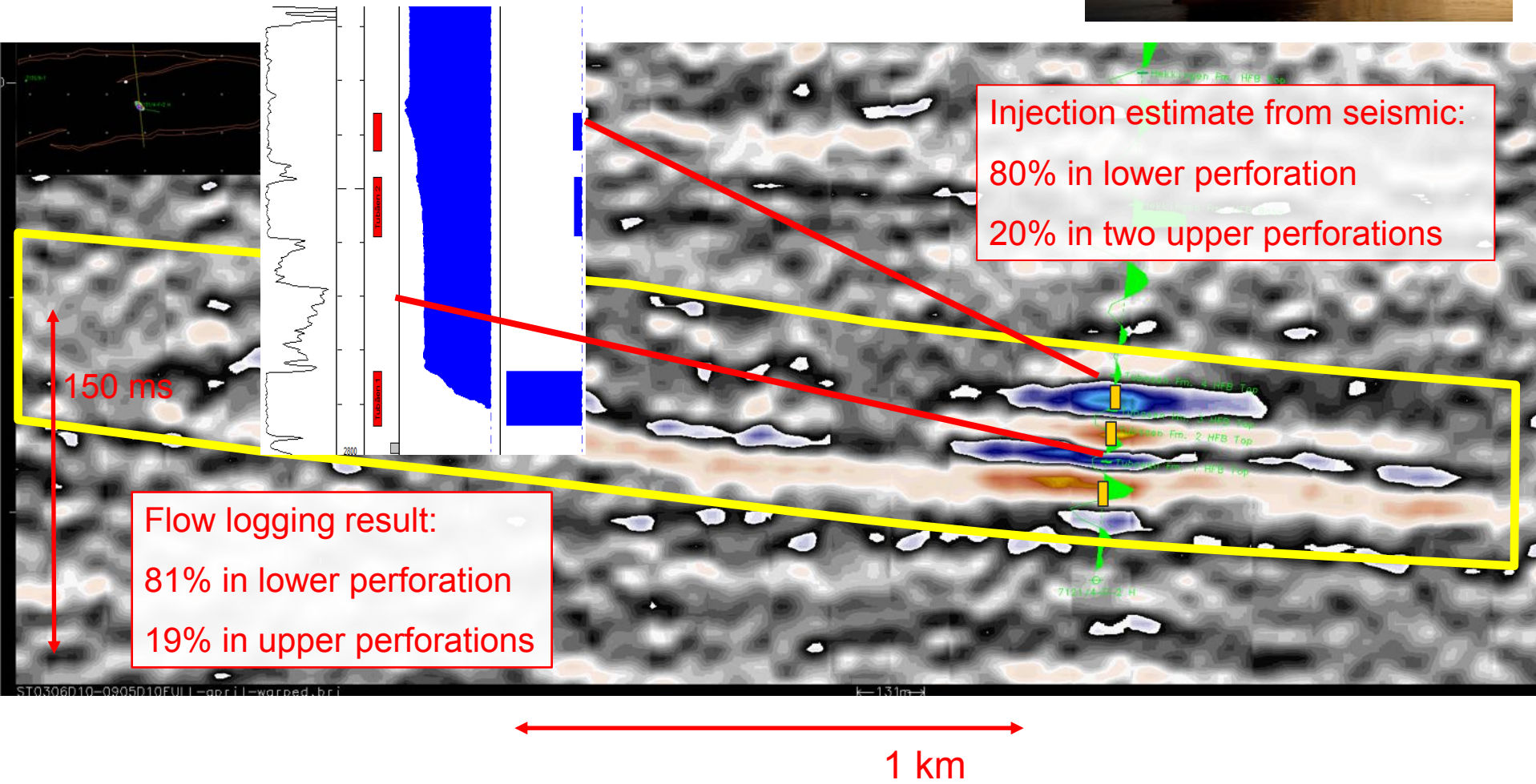




# Monitoring CO<sub>2</sub> injection (Tubåen)



INFLOW LOG



# Summary

- Strong track record in CO<sub>2</sub> storage operations
  - 20 Mt CO<sub>2</sub> safely stored underground
- Geophysical monitoring has proven essential for site management
- Practical learnings about capacity and injectivity from well operations
- Improved understanding of CO<sub>2</sub> storage processes
  - Builds confidence in models and forecasts
- Sharing experience is important for building confidence in CCS
  - Datasets shared with research partners worldwide
- CCS technology ready for use worldwide

# Useful links and references

Statoil New Energy pages (Sleipner and Snøhvit):

- <http://www.statoil.com/en/TechnologyInnovation/NewEnergy/>

Technology Centre Mongstad (CO<sub>2</sub> Capture):

- <http://www.tcmda.com/en/>

Papers summarizing the Sleipner and Snøhvit projects:

- Hansen, H., Eiken, O., & Aasum, T. O. (2005). Tracing the path of carbon dioxide from a gas-condensate reservoir, through the amine plant and back into a subsurface aquifer. Case study: The Sleipner area, Norwegian North Sea. SPE paper 96742 presented at *Offshore Europe 2005 conference, Aberdeen*.
- Eiken, O., Ringrose, P., Hermanrud, C., Nazarian, B., Torp, T. A., & Høier, L. (2011). Lessons learned from 14 years of CCS operations: Sleipner, In Salah and Snøhvit. *Energy Procedia*, 4, 5541-5548.
- Hansen, O., Gilding, D., Nazarian, B., Osdal, B., Ringrose, P., Kristoffersen, J. B., ... & Hansen, H. (2013). Snøhvit: the history of injecting and storing 1 Mt CO<sub>2</sub> in the Fluvial Tubåen Fm. *Energy Procedia*, 37, 3565-3573.