Monitoring challenges for CO_2 storage

Opportunities to work together

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Applied geoscience for our changing Earth

Introduction to carbon capture and storage (CCS)

At BGS we research the ways in which CO_2 can be stored in rocks under the ground.

Carbon capture and storage (CCS) is one of the ways that Britain and the world can maintain electricity supplies and economic growth while not changing the atmosphere and the climate.

CCS involves capturing carbon dioxide (CO_2) from large emission sources and then transporting and storing or burying it in a suitable deep geological formation. CCS can also mean the removal or scrubbing of CO_2 from the open atmosphere followed by storage in a deep geological formation.

What is carbon capture and storage (CCS)? — Animation: capture, transport and storage.

Why do we need to store carbon dioxide?

Learn about the causes of climate change and the greenhouse effect, and how mankind is accelerating the process as a result of a rapid rise in world population and the need for energy to power our homes, for transport, and industry.

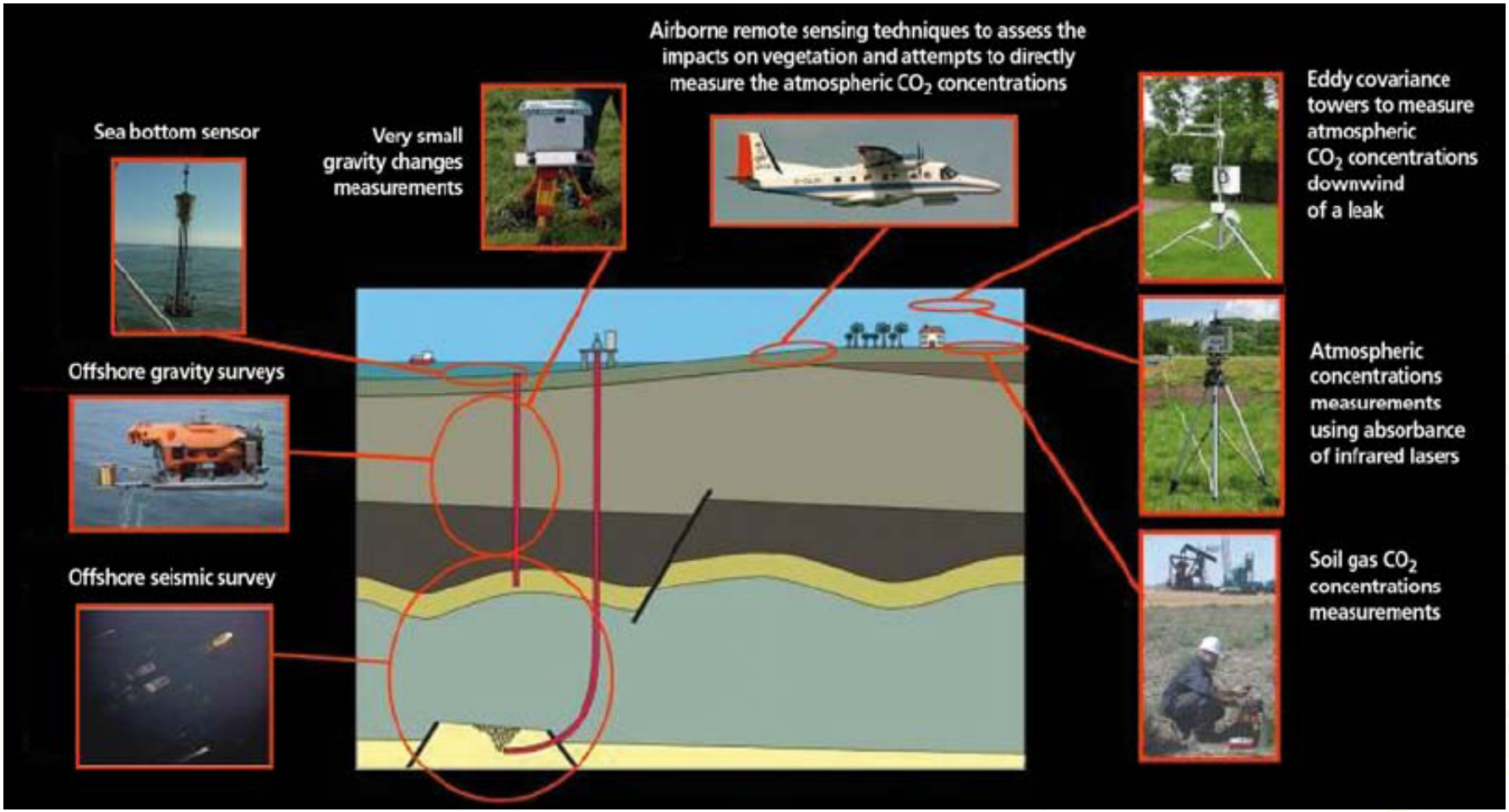
- What is climate change?
- How does the greenhouse effect work?
- Human influence on climate change
- How do power stations capture CO_2?

www.bgs.ac.uk/education/carboncapture/

Monitoring aims

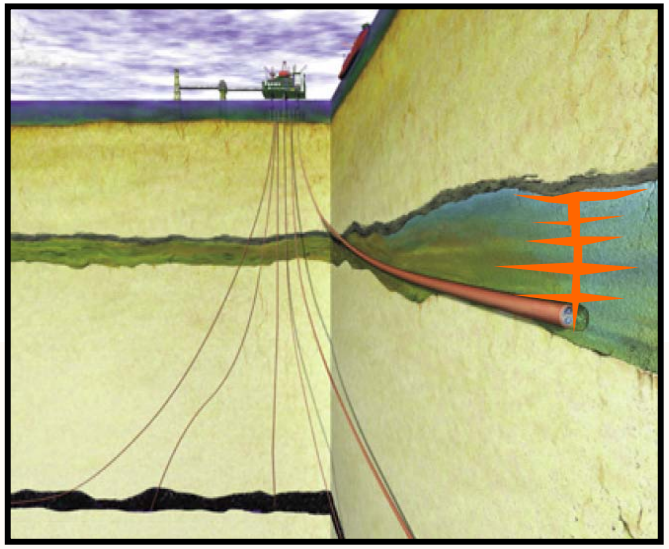
- Site performance: current and future (EC Directive)
  - Image/measure CO2 in the reservoir
  - Monitor containment risks
  - Performance monitoring
  - Constrain predictions of long term site behaviour
- Enable site closure

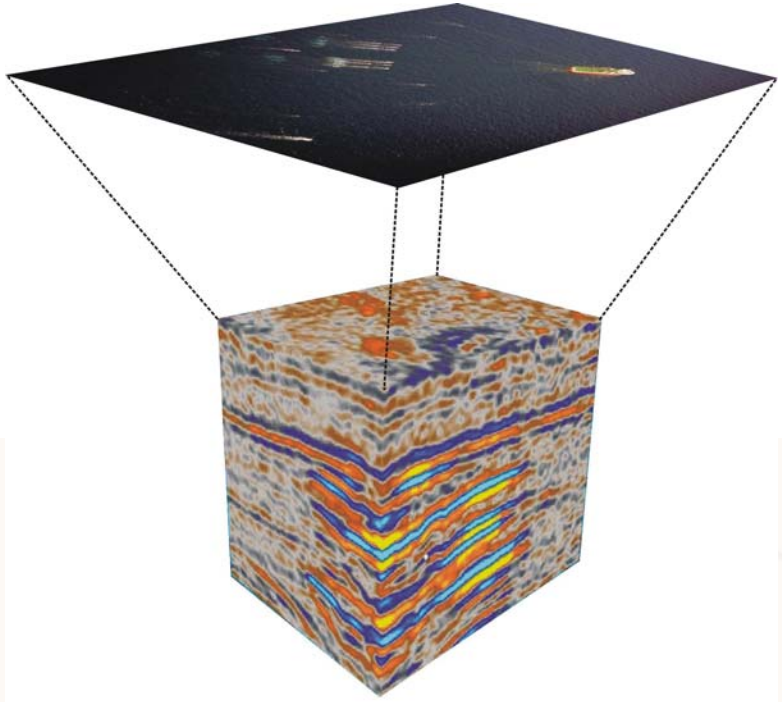
Monitoring technology



see: IEA selection tool
http://www.co2captureandstorage.info/co2monitoringtool/index.php

Image/measure CO2 in the reservoir: Sleipner 1





CO_2 injection commenced 1996

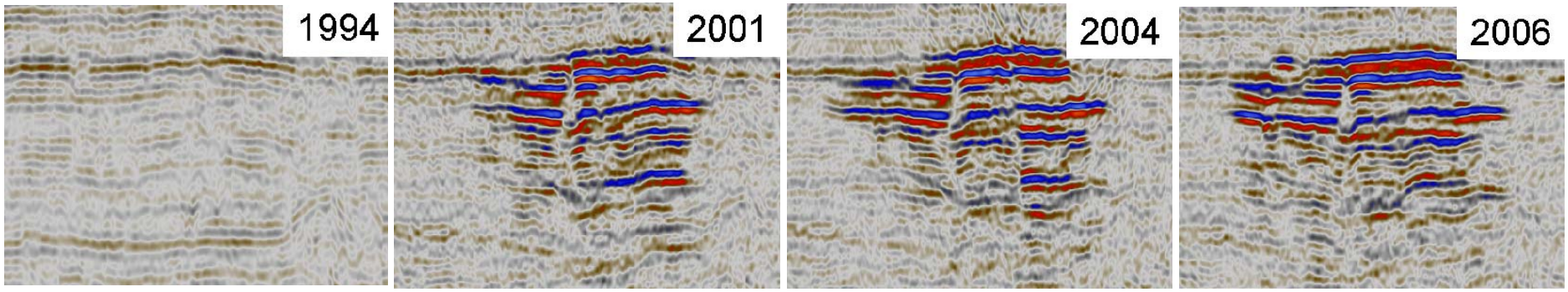
~ 1 Mt CO_2 injected per annum

> 11 Mt currently *in situ*

Timelapse (4D) seismic monitoring programme

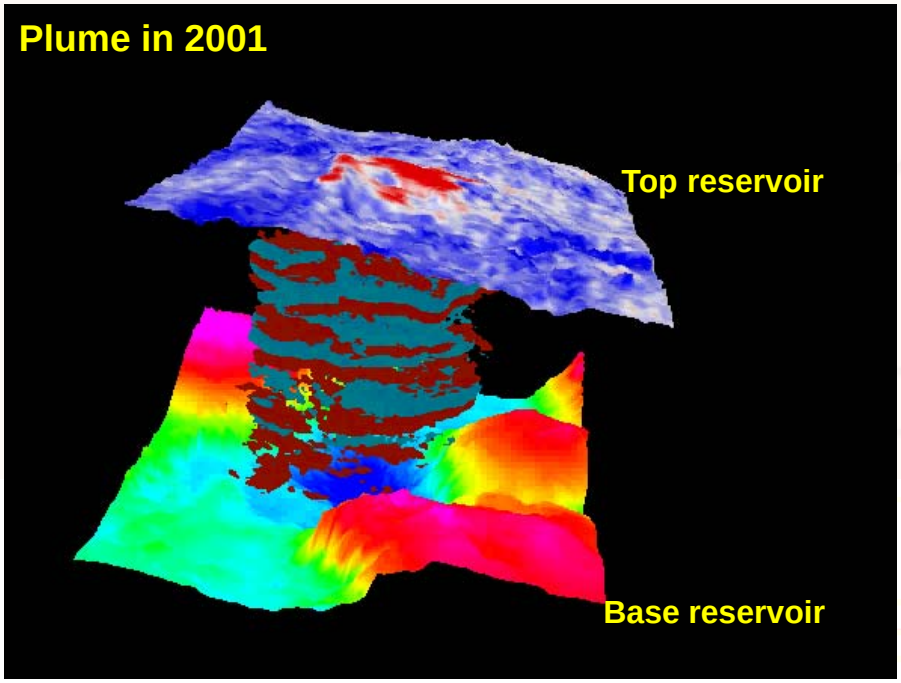
1994	3D baseline
1999	3D
2001	3D
2002	3D
2004	3D
2006	3D (+ hi-res 2D)
(2008	3D)

Image/measure CO2 in the reservoir: Sleipner 2

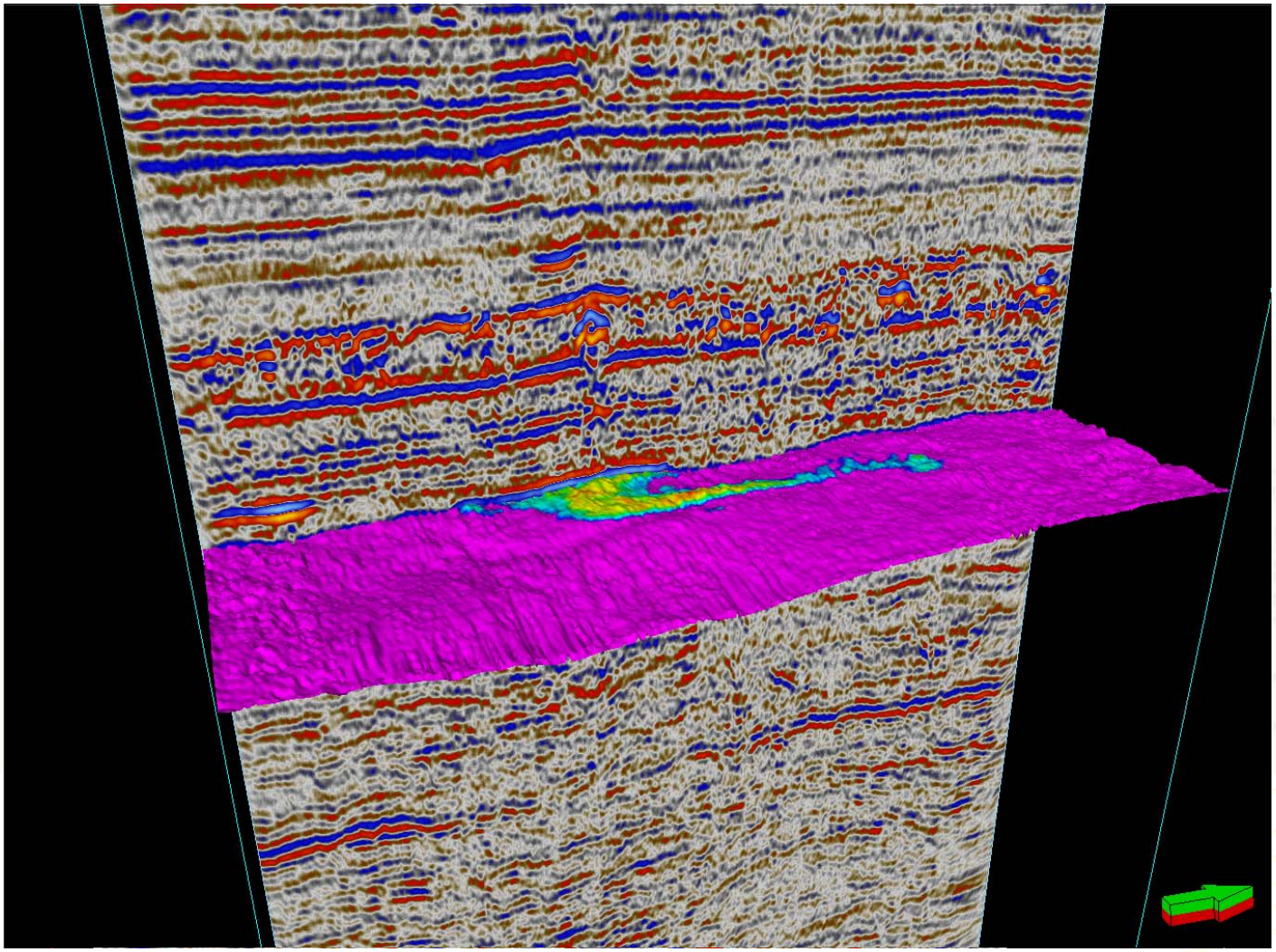


vertical sections (2D)

3D view

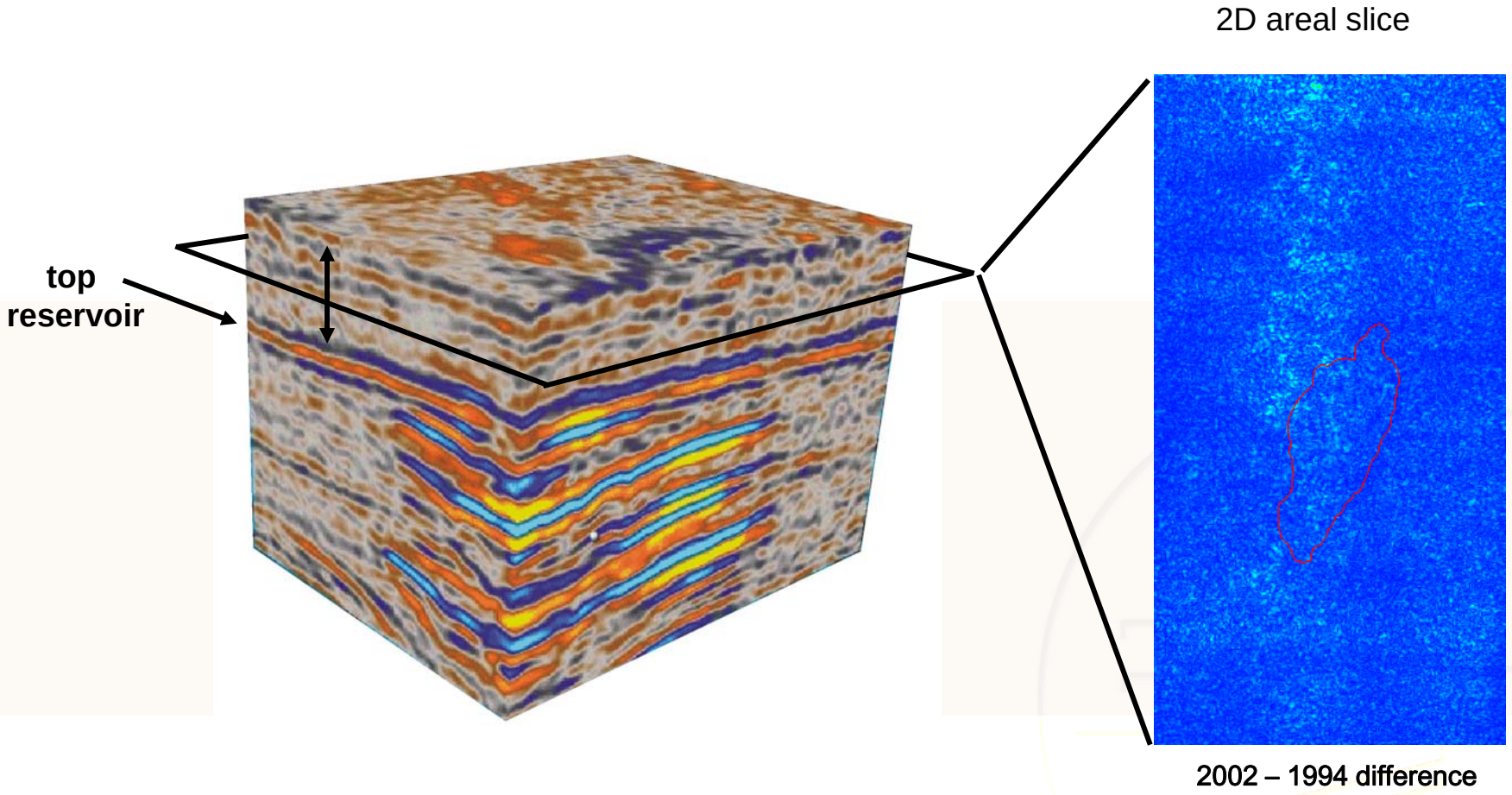


Image/measure CO2 in the reservoir: Sleipner 3



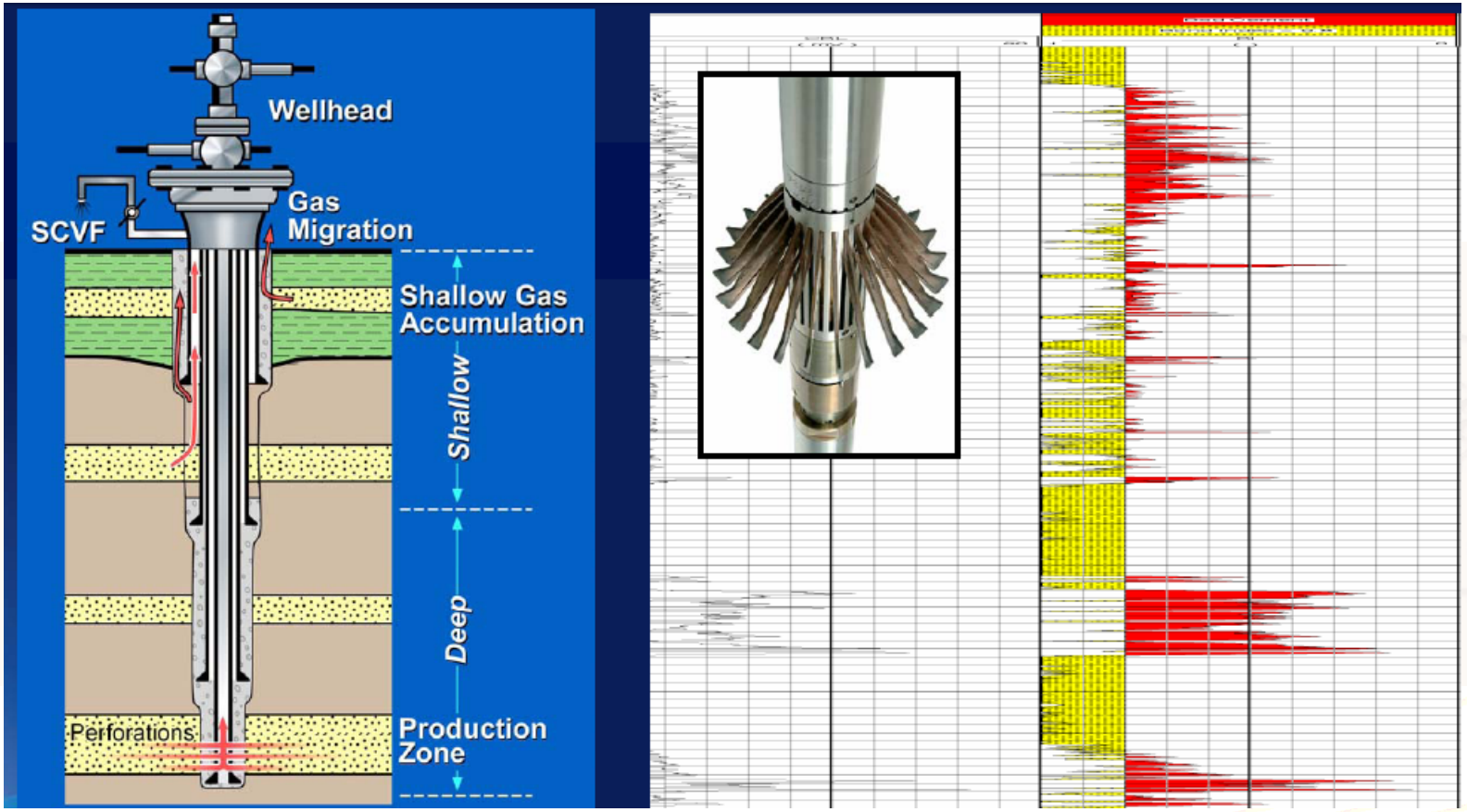
Containment risks: geological seal 1

Early warning of subsequent leakage



Sleipner 1996 – 2006 no detected migration of CO_2 from the reservoir

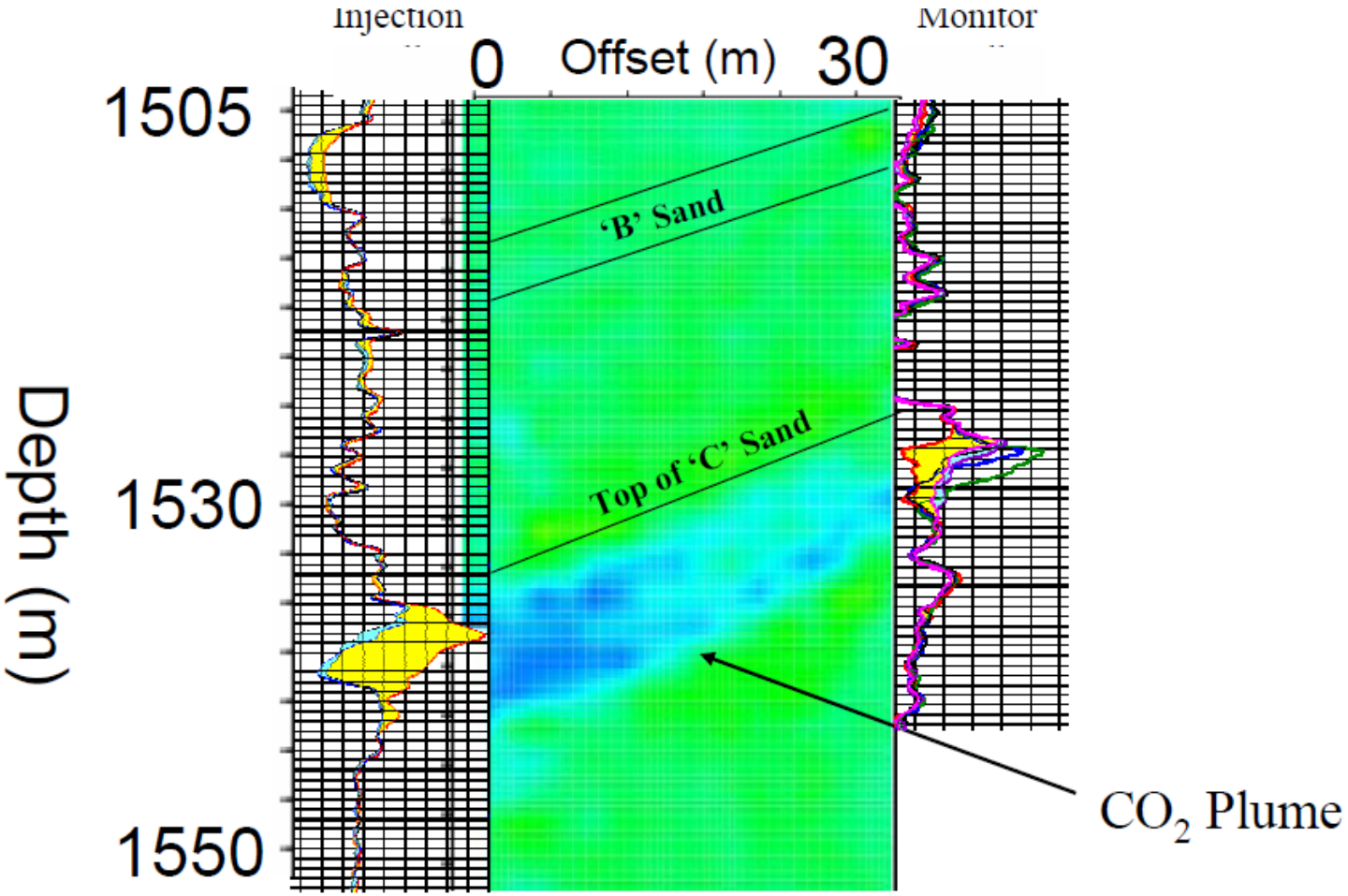
Containment risks 2: man made infrastructure



Courtesy CO2Geonet and S Bachu

Integrity monitoring CASTOR Criteria Report

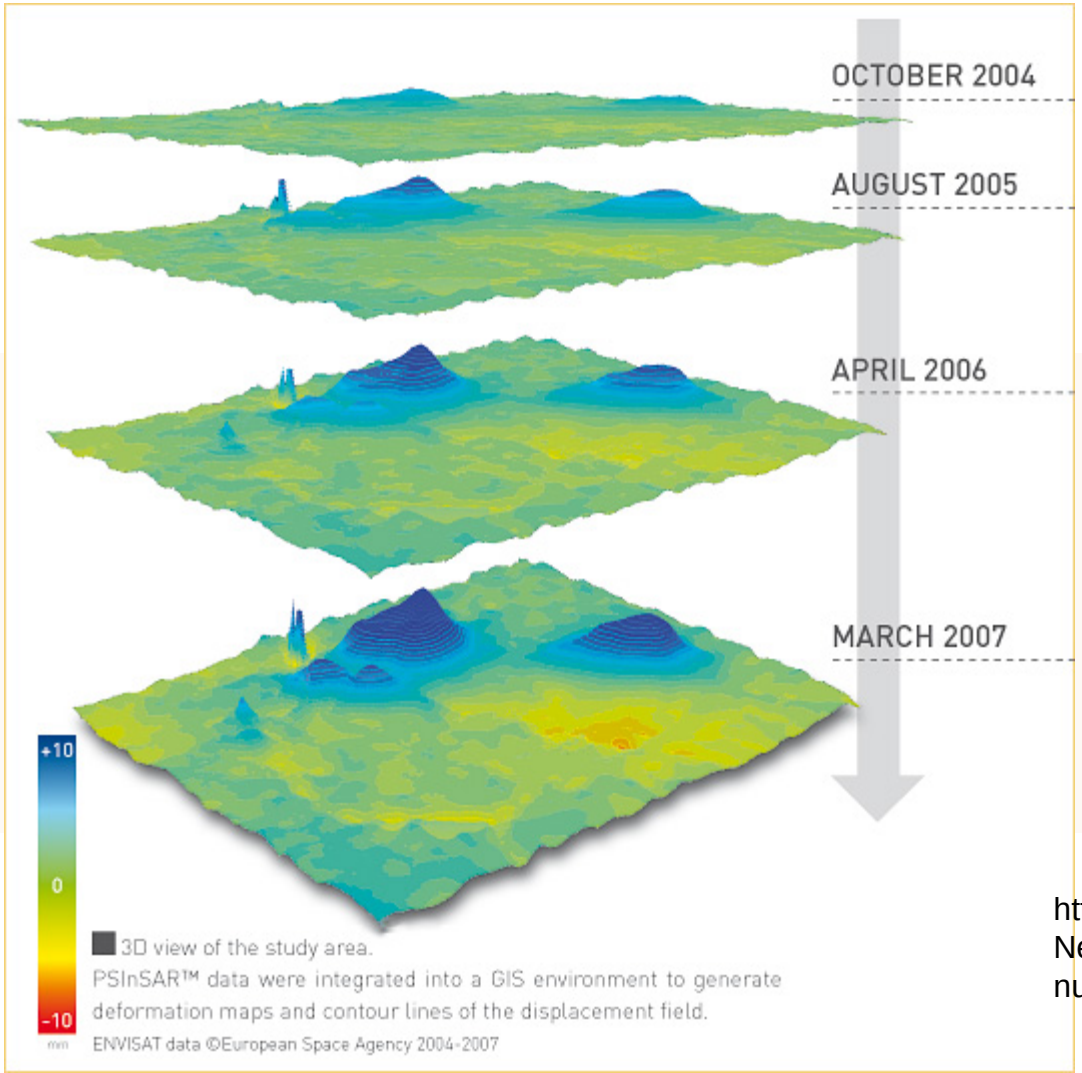
Performance monitoring 1: well logs and cross hole seismic



- ALSO downhole methods at K12B

http://www.beg.utexas.edu/gccc/bookshelf/Final%20Papers/05-03-Final%20(AGU%20Papers)/05-03c-Final.pdf

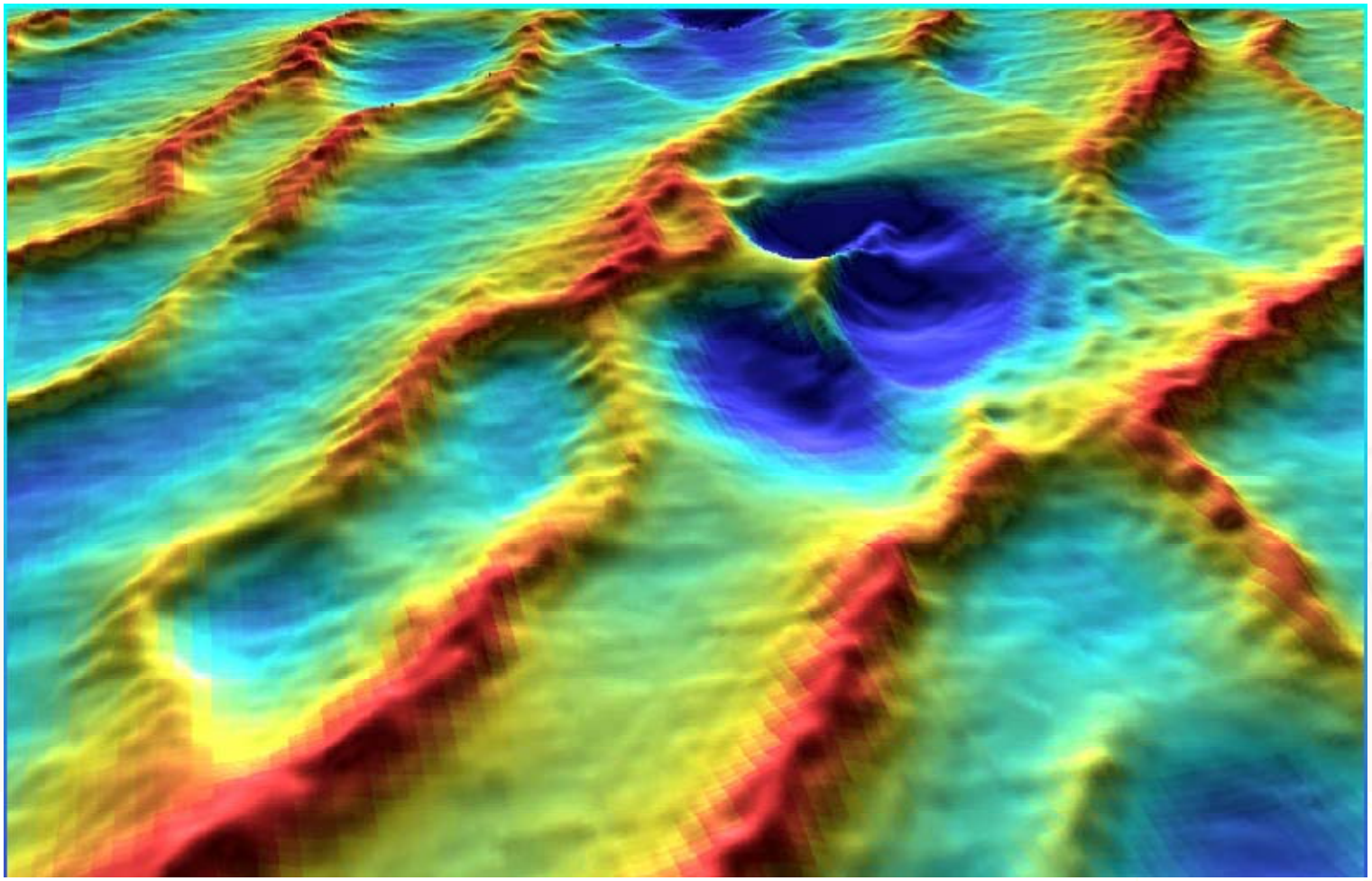
Performance monitoring 2: remote sensing



- Uplift at In Salah

http://www.treuropa.com/HomeTRE/NewsEvents/Newsletter/tabid/195/newsid972/92/Default.aspx#num1

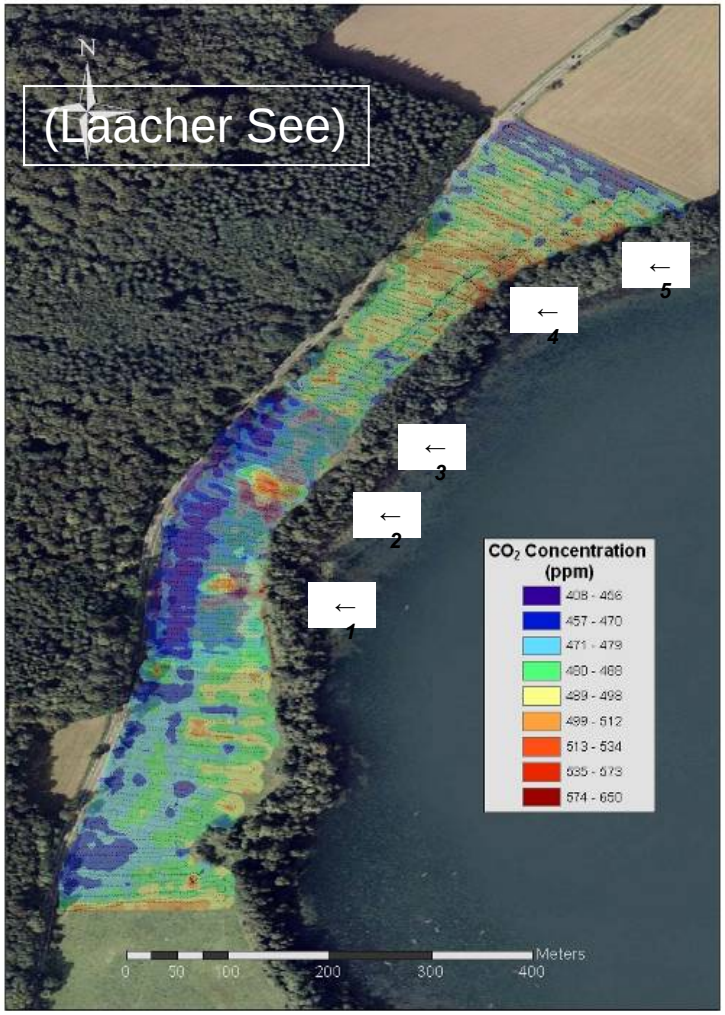
Performance monitoring 3: sea bed survey



(Hoveland, 2007)

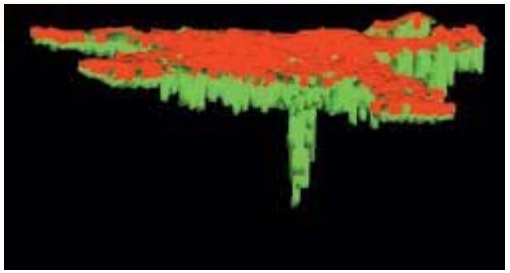
Performance monitoring 4: sea bed survey

- Open path laser gas analysers:
  - Purpose: Rapid surveying
  - Detection limit/sensitivity
    - 5-10 ppm CO_2
    - 0.1-1 ppm CH_4
  - Readings every 1 sec
  - Linked to GPS position

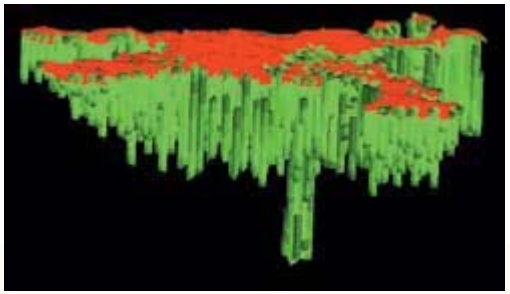


Monitoring can detect CO_2 at very high sensitivities

Long term site behaviour



2021



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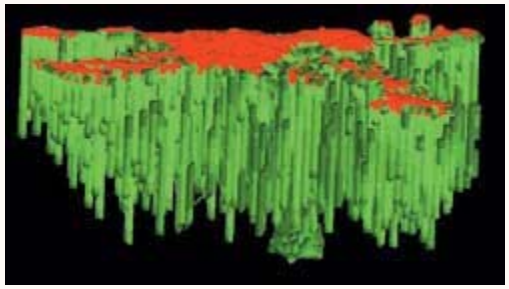

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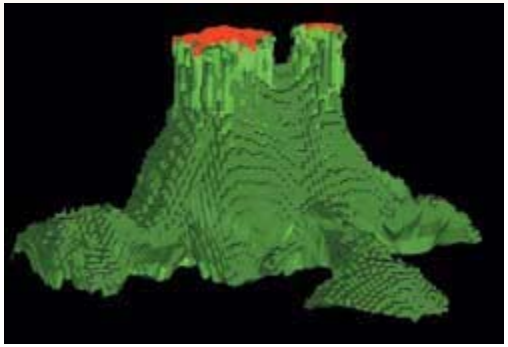

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- Simulation of how injected CO2 disperses and gradually dissolves within a reservoir.
- red zone illustrates free CO2 gas,
- green zone shows dissolved CO2.
- When the gas is injected into the bottom of a reservoir it will rise to the cap rock and spread out like a bubble with a diameter of several kilometres. It will gradually dissolve in the underlying water column, and the images show how this CO2 solution eventually removes all the CO2 from underneath the rock seal and stores it like carbonated mineral water at the bottom of the formation. In this simulation it would take about 5000 years for all the CO2 to dissolve.

Courtesy Erik Lindeberg: http://www.ntnu.no/gemini/2005-01e/basicallygood.htm

Conclusions

- Need to monitor, measure and predict in line with regulatory requirements
- Monitoring tools provide different and complementary information
- Key challenge: develop site specific, cost effective monitoring strategy using correct blend

Opportunities to work together

- GCCSI
  - Just announced Aus $ 50 m/yr
    - Address generic barriers to global CCS
    - Assist projects to operation
- UK-US FCO funded colaboration
  - 1-2 week visits UK/US CCS experts
  - Deadline 13 Dec
- 2011 FP7 Cooperation Programme Theme 6
  - International research colaboration US, China, India, Russia, Latin America

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