

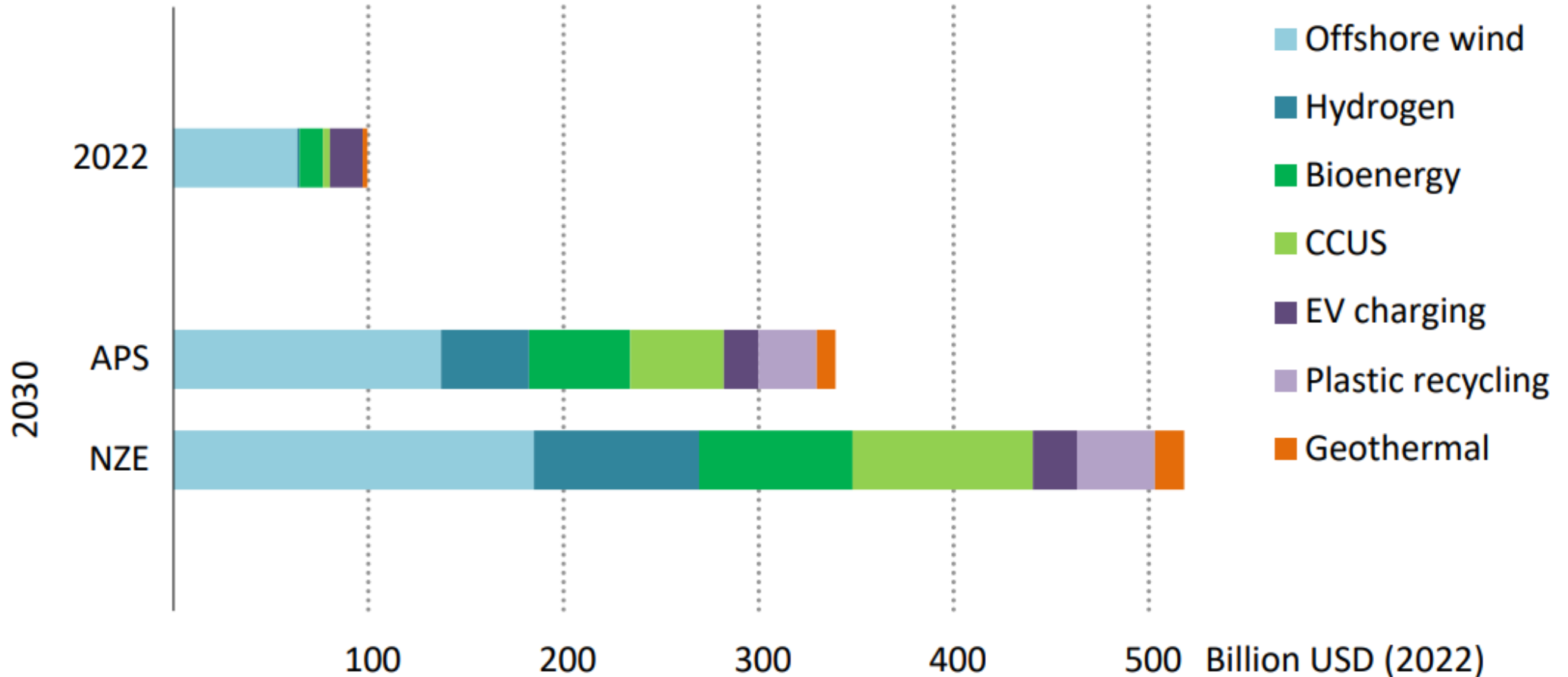
Dados sísmicos de alta resolução:  
Planejamento, desenvolvimento, operação  
eficiente e segura para armazenamento de CO2

Juliana Santos  
Geoscientist at PGS

# Restating the opportunity in CCS & the Energy Transition



Annual investment in technologies that share synergies with the skills and expertise of the oil and gas industry

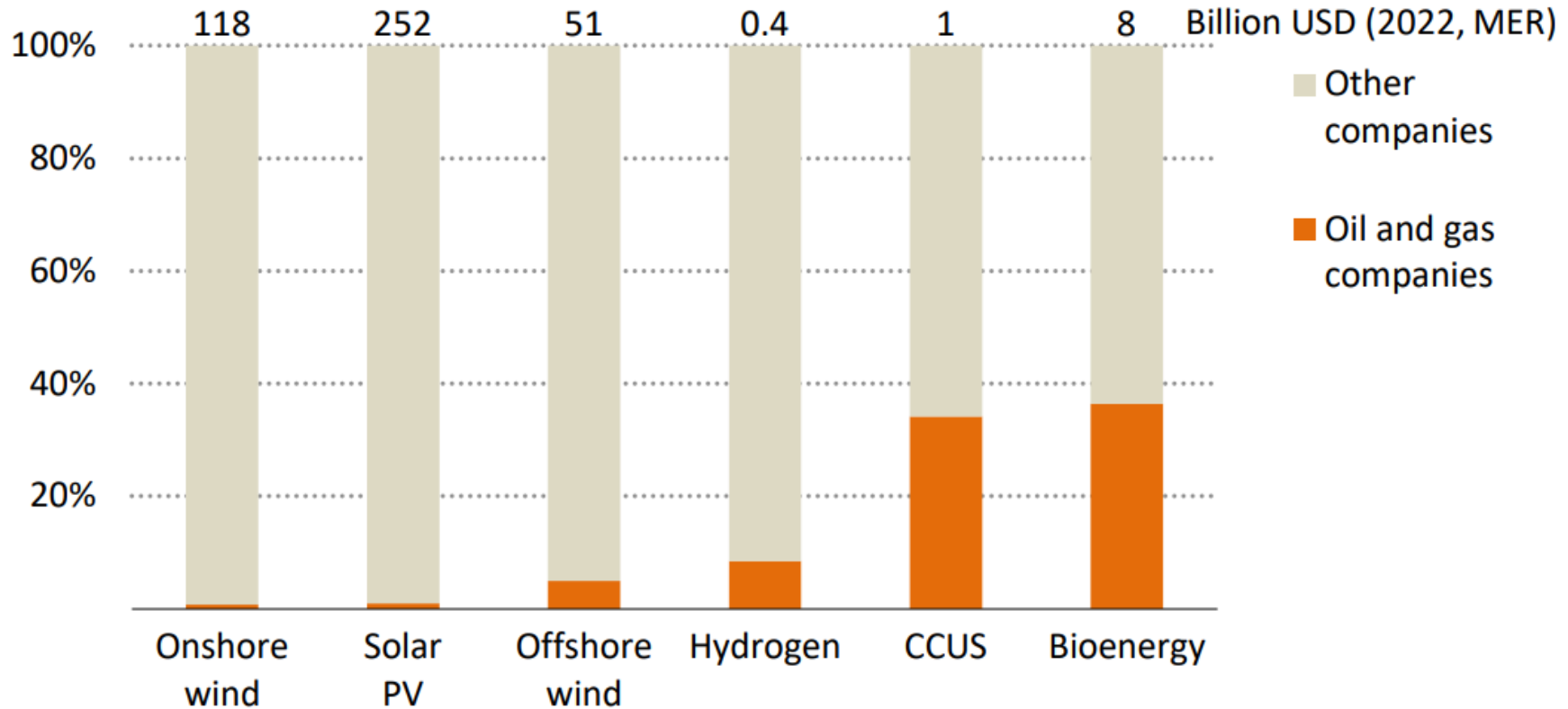


APS = Announced Pledges Scenario  
NZE = Net Zero Emissions by 2050 Scenario

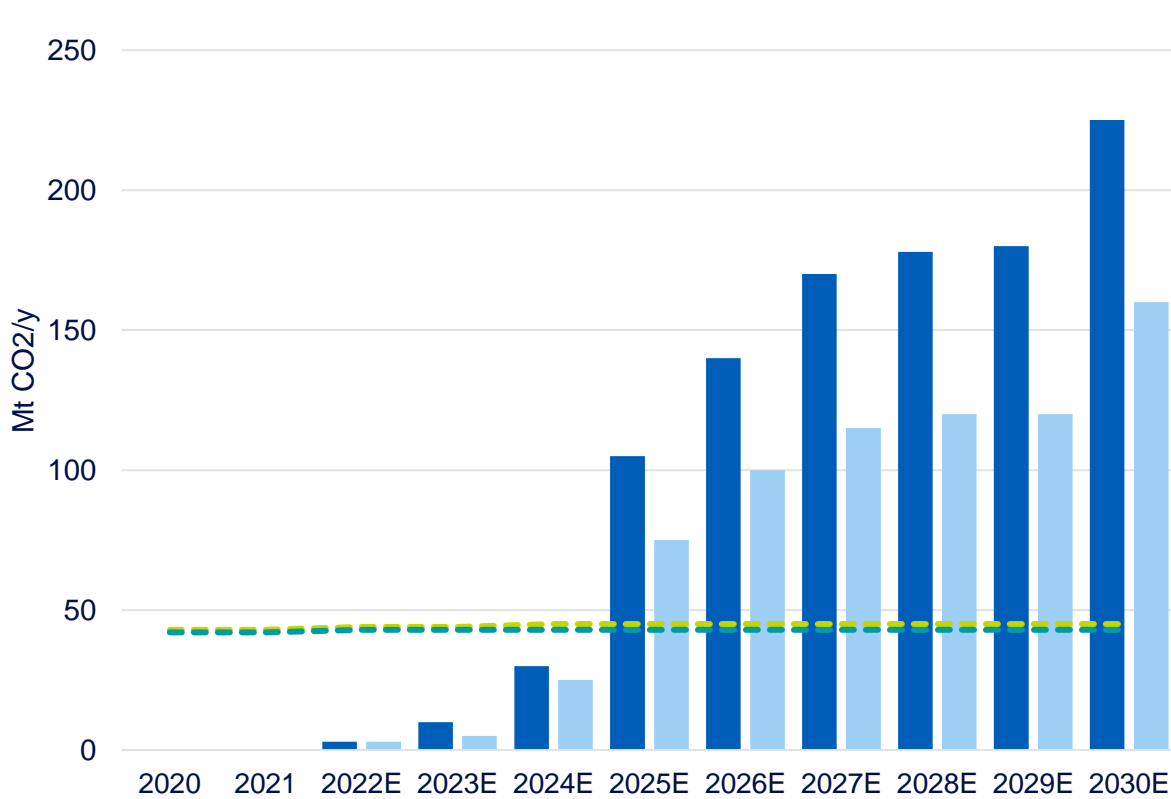
# Investment is lagging...massively

Average annual investment in clean energy technologies, 2019-2022

IEA (2023)

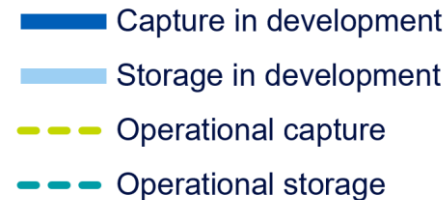


# The Capture/Storage Gap



Source: IEA, Fearnley Securities

- Urgent need for more CO2 storage development
  - Storage development lags capture development
  - NZ-2050 requires 1,500 Mtpa CO2 stored by 2030
  - Operational capture & storage under capacity



- Liberating CCS prospectivity from library 3D data
- Developing and applying high end subsurface workflows
- Providing acquisition & processing solutions for identification, development & monitoring

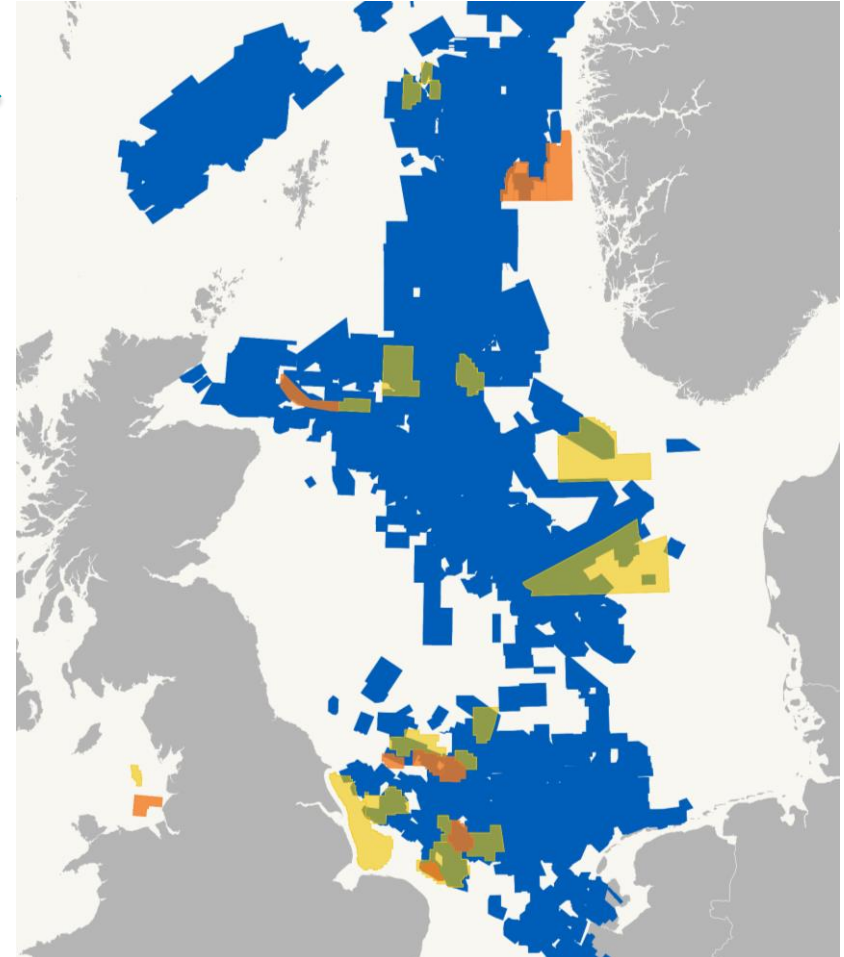
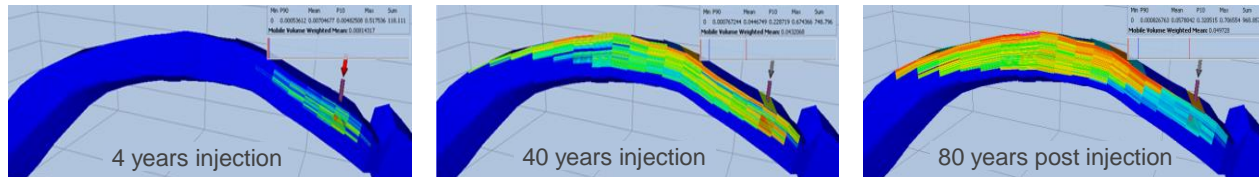
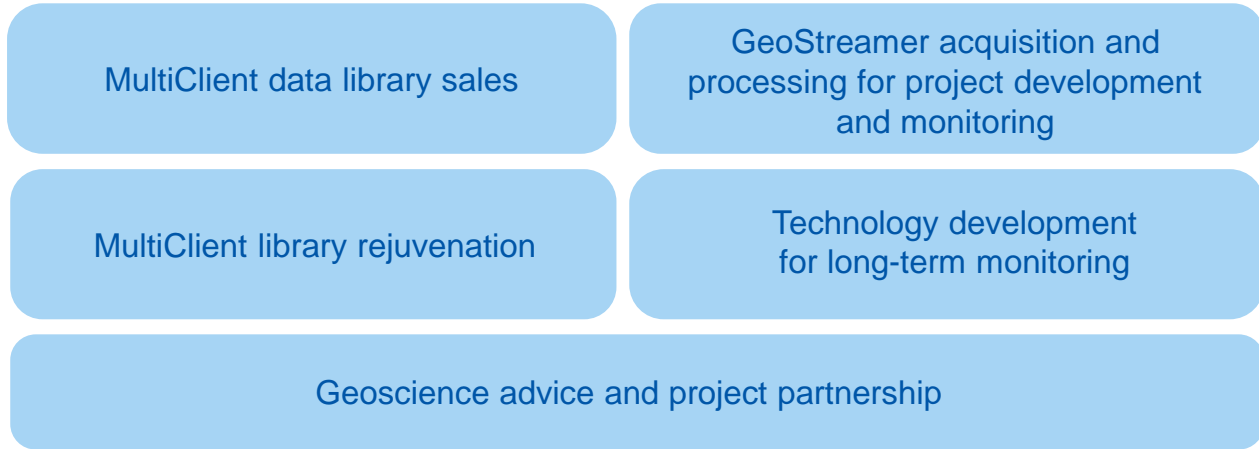


# Northwest Europe Leading the Way in Carbon Storage License Award Process

## CCS Cycle



## PGS Products and Services

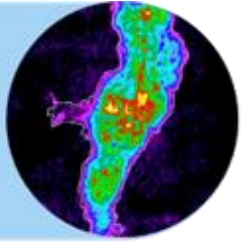


# CCS Demands for advanced geophysical solutions



**Smeaheia**  
3D High Resolution  
Development Survey

**Snøhvit and Sleipner**  
Acquisition and Processing  
CO<sub>2</sub> Monitor Surveys

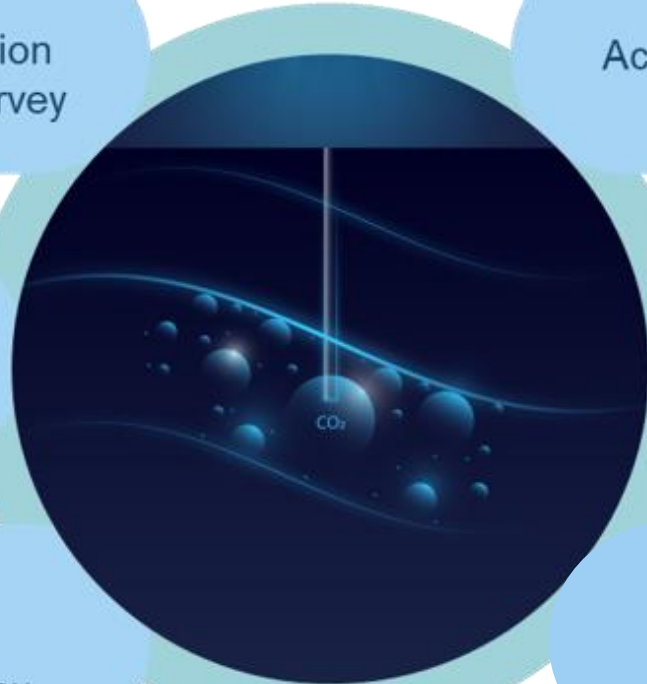


**Northern  
Endurance  
Partnership**  
3D High Resolution  
Development  
Survey

Lol to Develop  
Carbon Storage  
Offshore Australia



**Northern  
Lights**  
4D High  
Resolution  
Baseline Survey

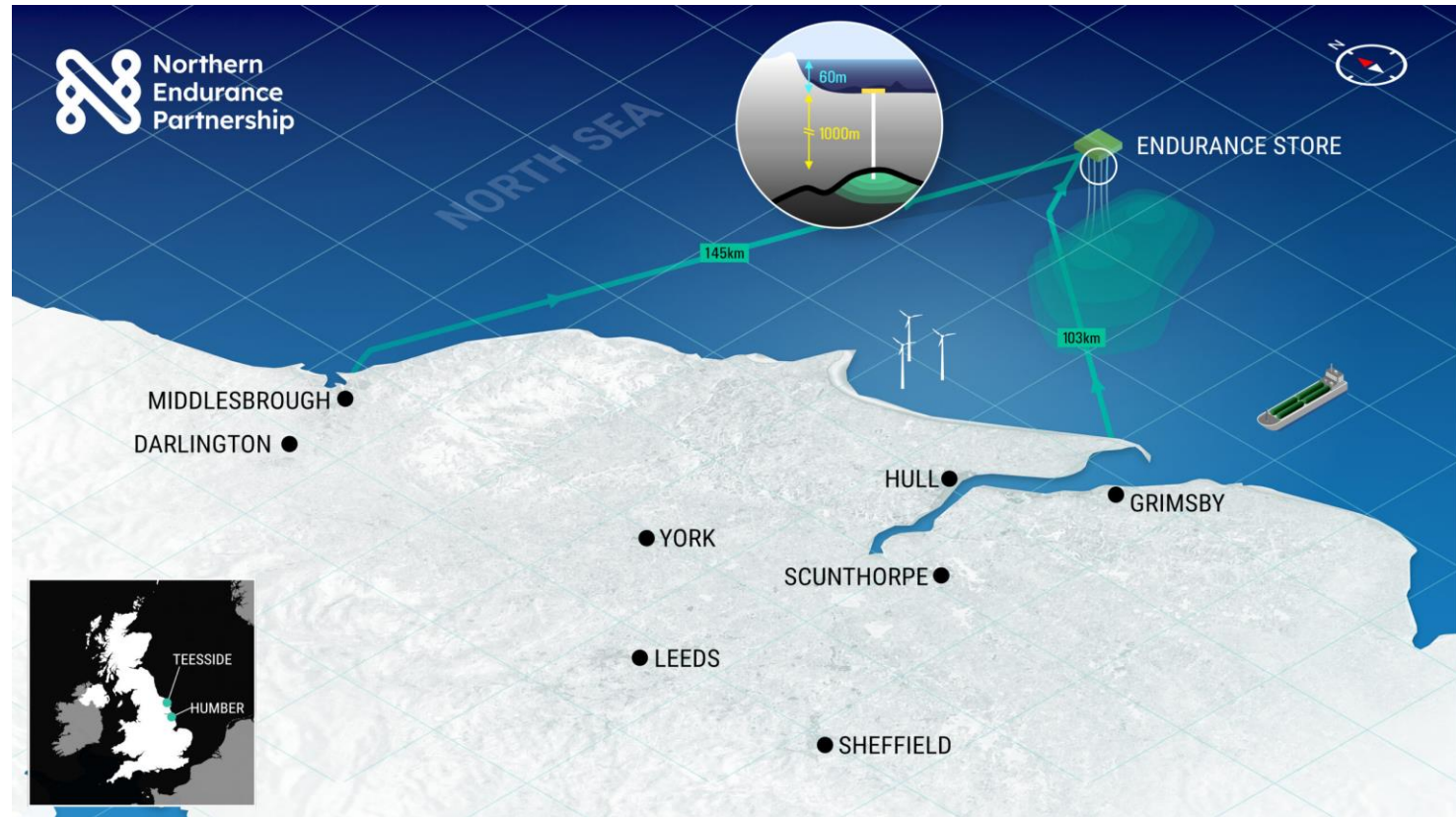


**Vault and Poseidon**  
3D High Resolution  
Development Survey



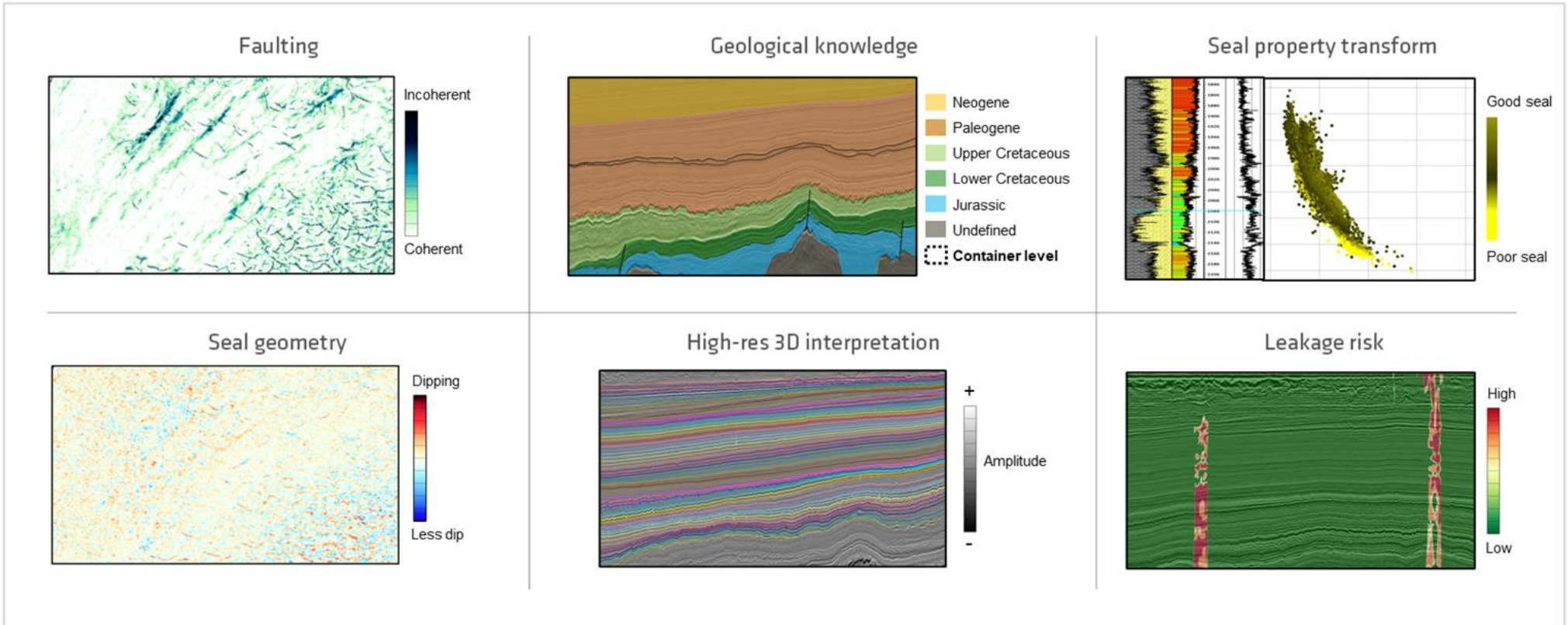
# Northern Endurance survey (Operated by BP)

- NEP - Reduction of onshore emissions by 1/3
- Quantification of CO2 storage capacity - Saline aquifer formation structural trap
- Assess integrity of the seal
- Detect shallow hazards
- Injection well planning
- Establish a baseline dataset for future seismic monitoring
- Water depth of 20m





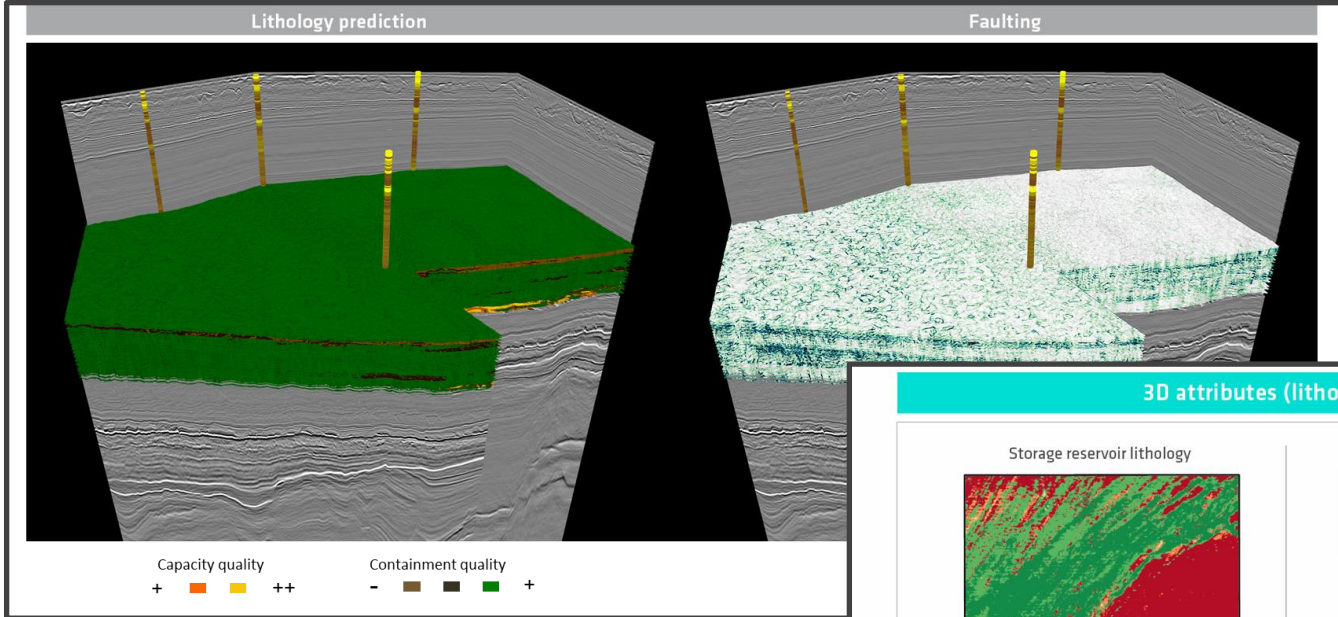
# Reservoir & Elastic Property Integration Drives subsurface risk identification and storage complex definition



G&G Integration for

CO<sub>2</sub> Containment Assessment

# Common risk assessment



SPECIAL TOPIC: MODELLING / INTERPRETATION

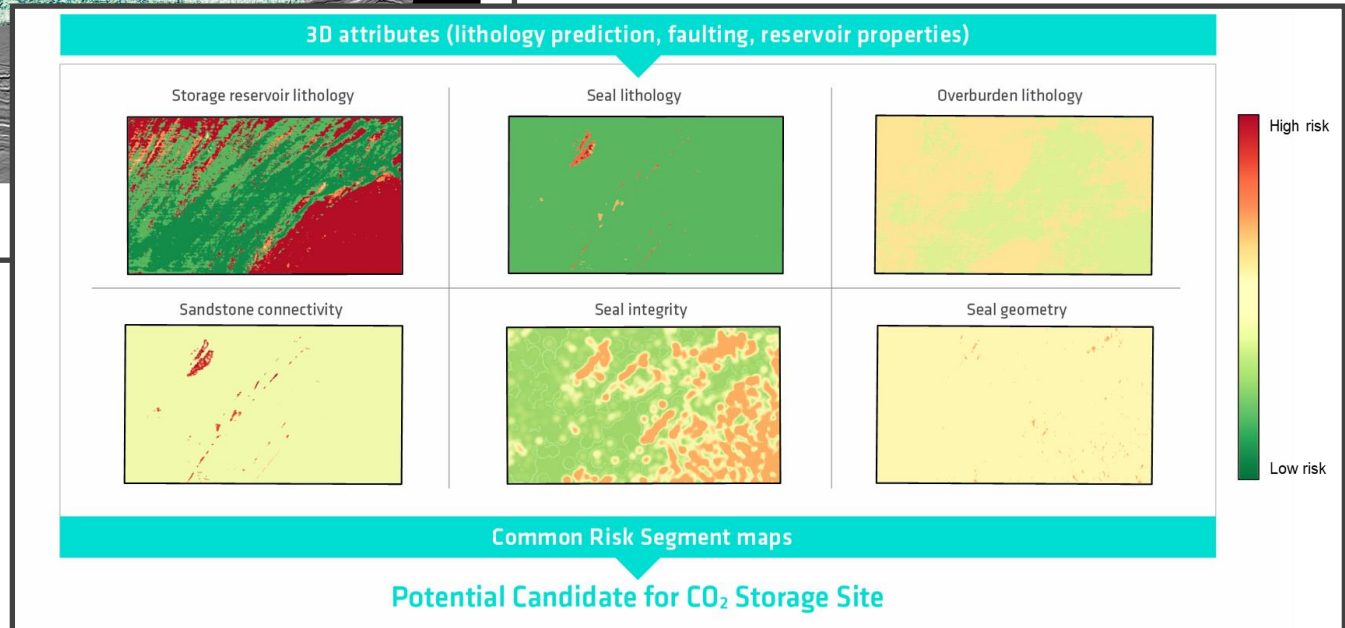
## Ranking and evaluation of CO<sub>2</sub> storage sites using an advanced workflow

Cyrille Reiser<sup>1</sup>, Noémie Pemin<sup>1</sup> and Nick Lee<sup>2</sup> describe a CCS workflow over a proof-of-concept area to assess CCS storage capacity and containment at a candidate saline aquifer site and highlight elements of the workflow to move towards automation.

### Abstract

The world is in urgent need of carbon capture and storage (CCS) sites/facilities to achieve ambitious net carbon dioxide (CO<sub>2</sub>) emission reduction goals. After CO<sub>2</sub> capture and transport, storage is the third step of the CO<sub>2</sub> journey. Accessing and utilizing regional seismic information is a significant part of any workflow attempting to identify and characterize proposed subsurface CO<sub>2</sub> storage sites. In this paper, we have developed and implemented a workflow over a proof-of-concept (PoC) area to assess CCS storage capacity and containment at a candidate saline aquifer

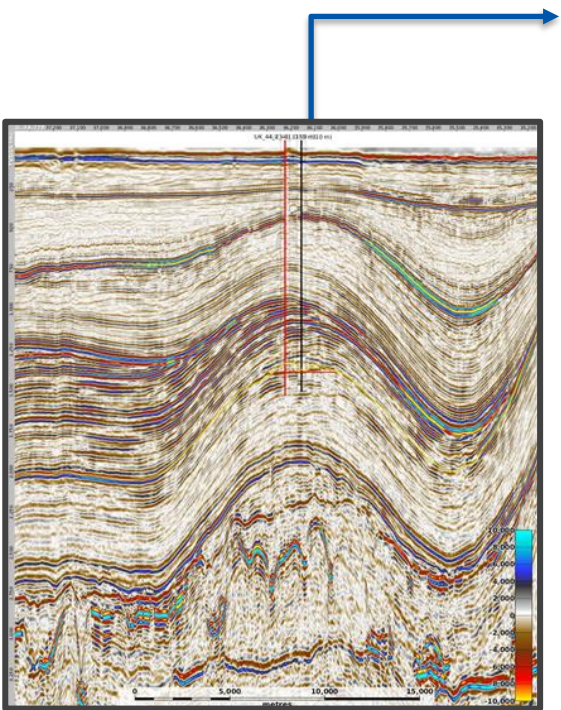
(Wood McKenzie, 2021). Their analysis points to less than 1 Gt of planned storage currently within the planning pipeline for 2030, with this needing to grow by eight times for the target to be met. Against this backdrop there is an urgent need to identify viable carbon storage sites that meet the cost and efficiency imperatives of this growing sector. PGS has a stated a strategic ambition to play a role in supporting the delivery of the energy transition alongside technical subsurface capabilities to deliver the necessary maturation of carbon storage sites. In practice, this means accessing and integrating a wide range of data,



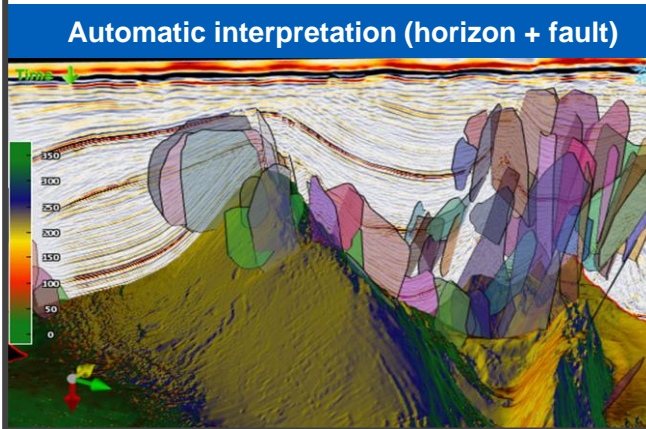
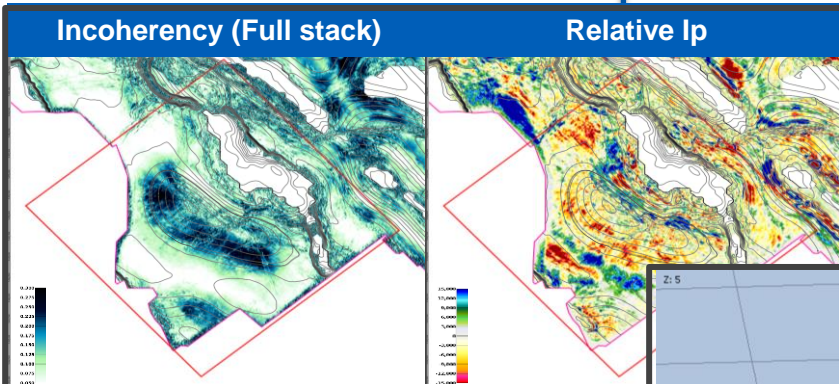


# Integrated CO2 Storage Evaluation

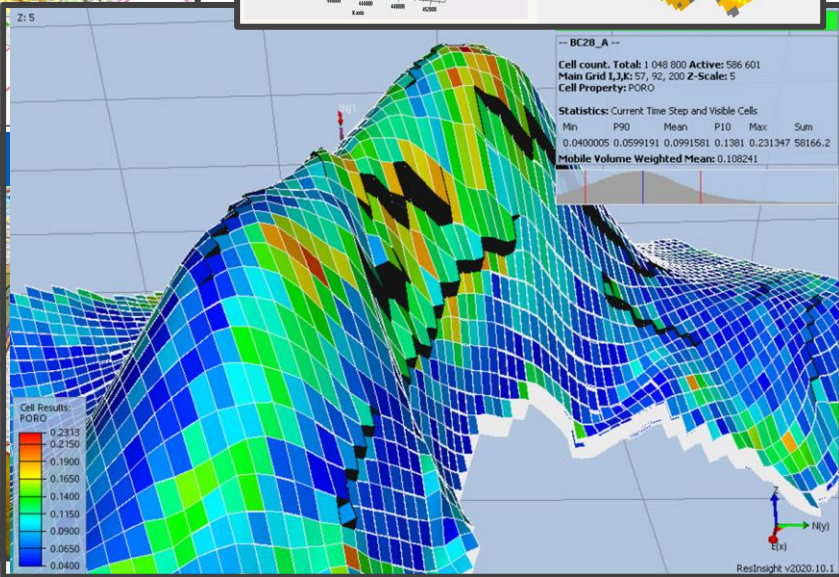
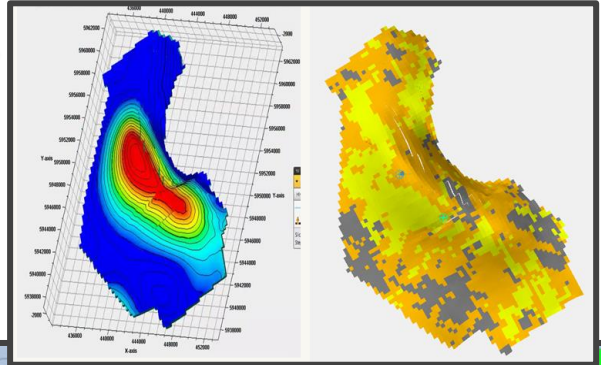
## CCS Play - Closure Evaluation



Store identification



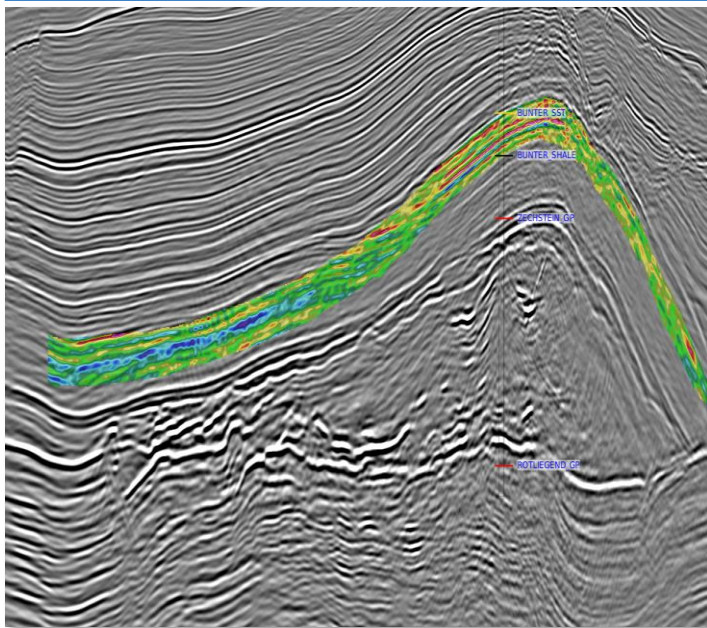
Detailed store mapping, characterisation & risk assessment (+monitorability feasibility)



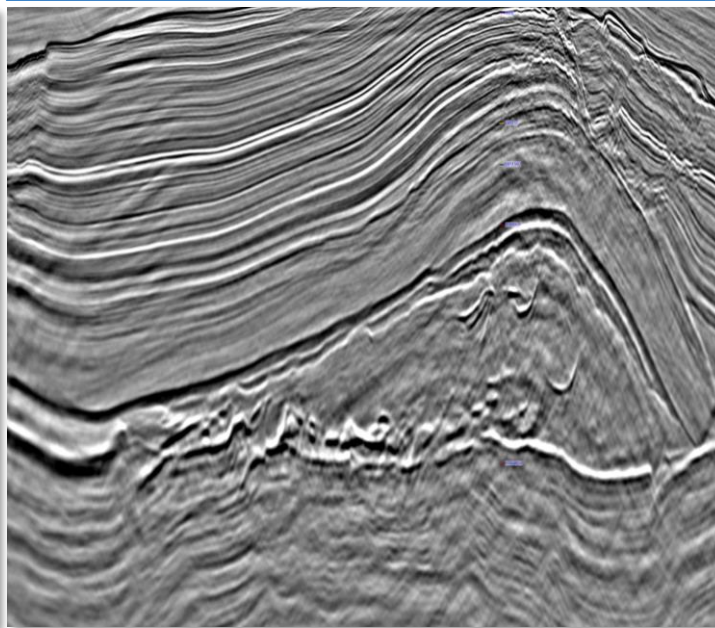
MMV planning, license/acreage capture  
Project execution

# Improving imaging and reservoir properties predictions

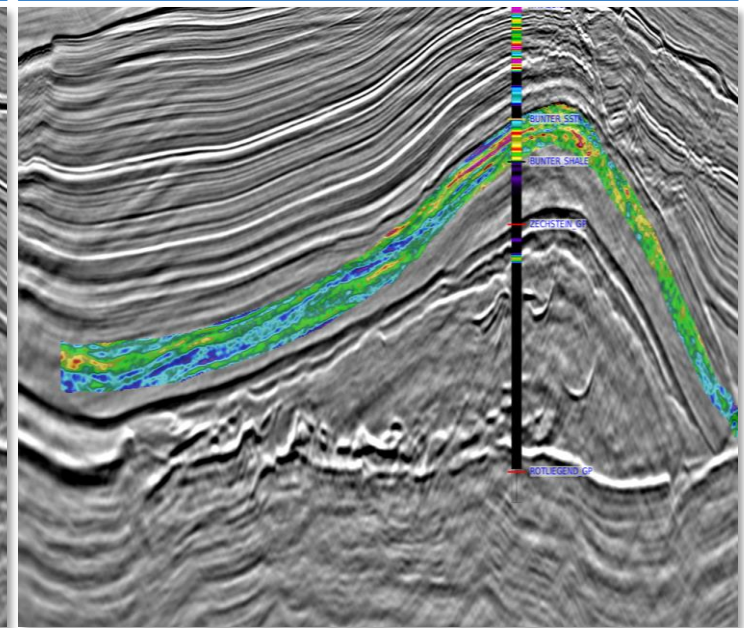
Legacy PSTM Porosity Estimation



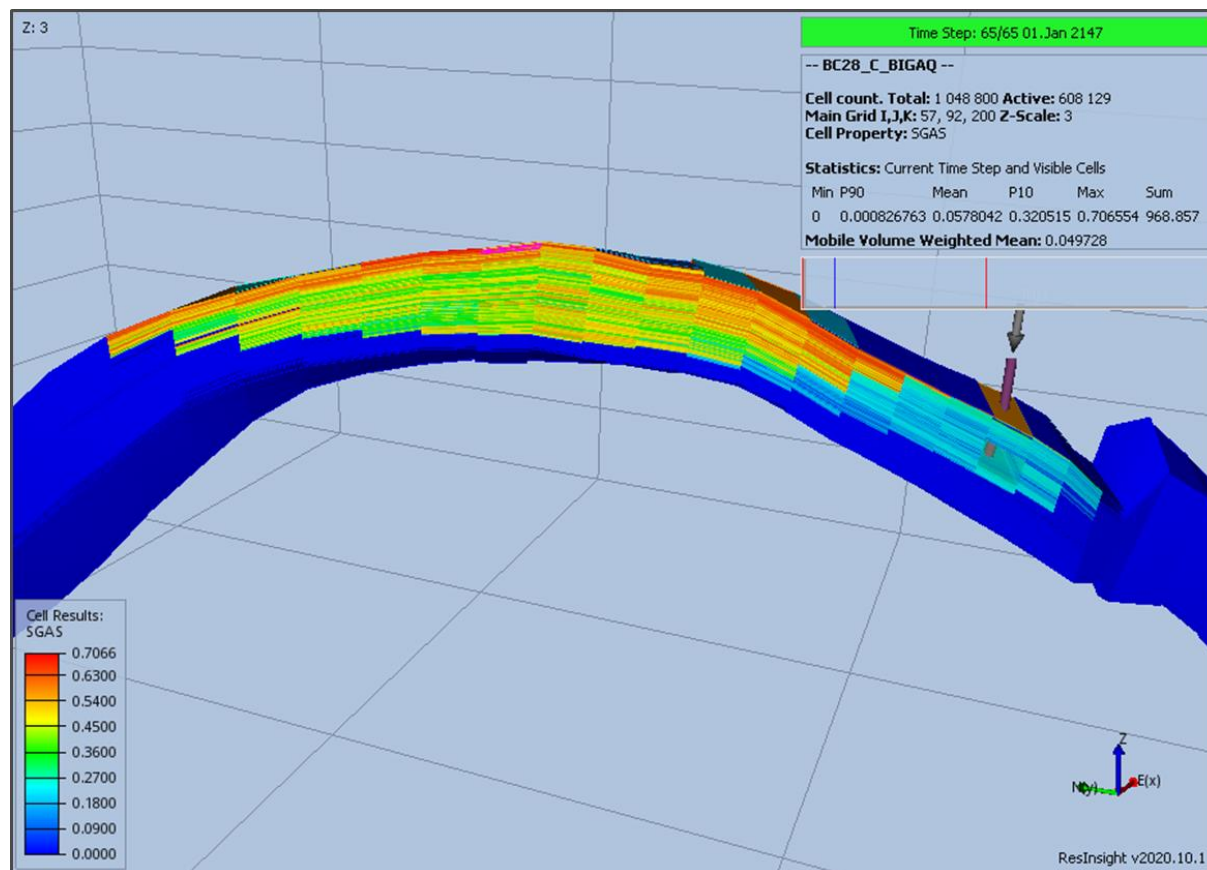
SNS Vision KPSDM (Early Out)



SNS Vision KPSDM (Early Out)  
Porosity Estimation



# Integrated CO2 Storage Evaluation - CO2 Injection 80 yrs after injection ceases – 1<sup>st</sup> January 2147



- Integrate SNSV data and establish benefit to reservoir characterization
- Re-build and re-simulate FFM
- Move into geomechanics domain
  - Coupled flow-geomechanics model
  - Return to seismic domain for MMV assessment

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Modelling the impact of geological heterogeneity on pressure connectivity in the Bunter Sandstone Fm in response to sustained CO2 injection

## Modelling the impact of geological heterogeneity on pressure connectivity in the Bunter Sandstone Fm in response to sustained CO2 injection

OIL AND GAS AUTHORITY  
Published date: 8 November 2023  
Last edited date: 21 November 2023

[Watch this notice](#)

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Closing: 24 November 2023, 1pm

Closed opportunity - This means that the contract is currently closed. The buying department may be considering suppliers that have already applied, or no suitable offers were made

# 4D monitoring – Sleipner

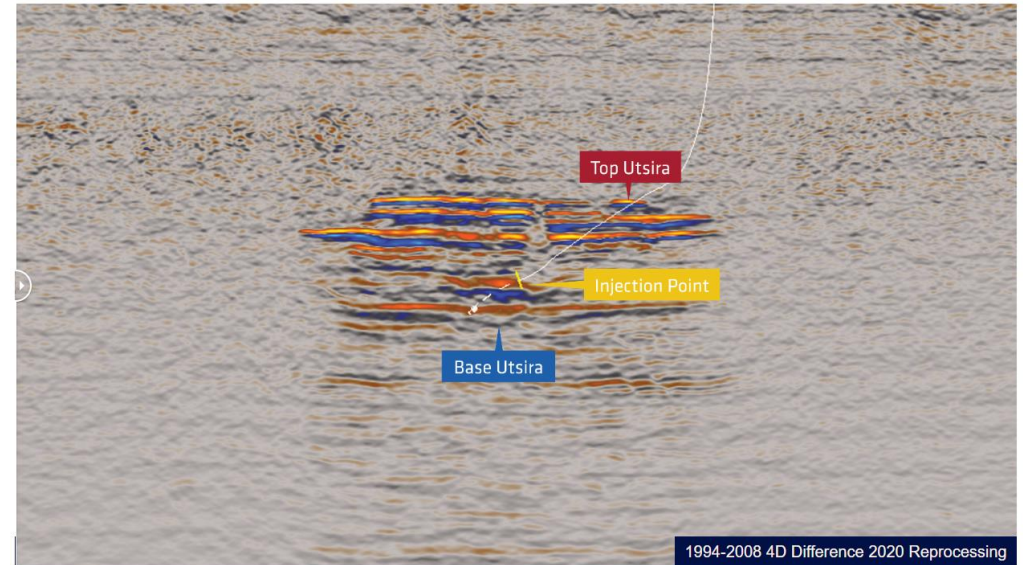
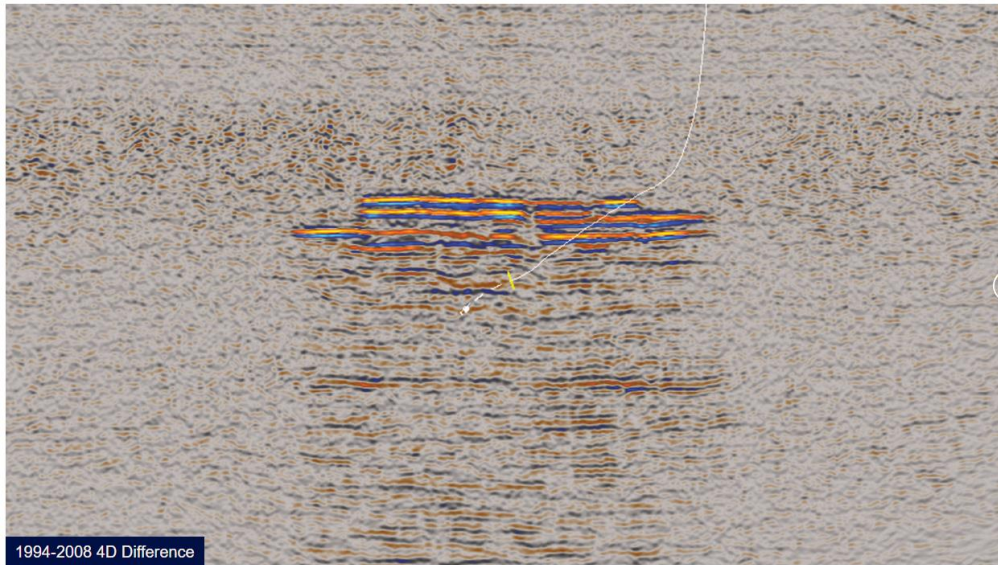
- CO2 stored in 9 layers
- 4DS used for monitoring development and migration of CO2 plume.
- Improved interpretability and base Utsira Fm.



**BROADBAND PROCESSING IMPROVES 4D REPEATABILITY AND RESOLUTION AT THE SLEIPNER CO2 STORAGE PROJECT, NORTH SEA**

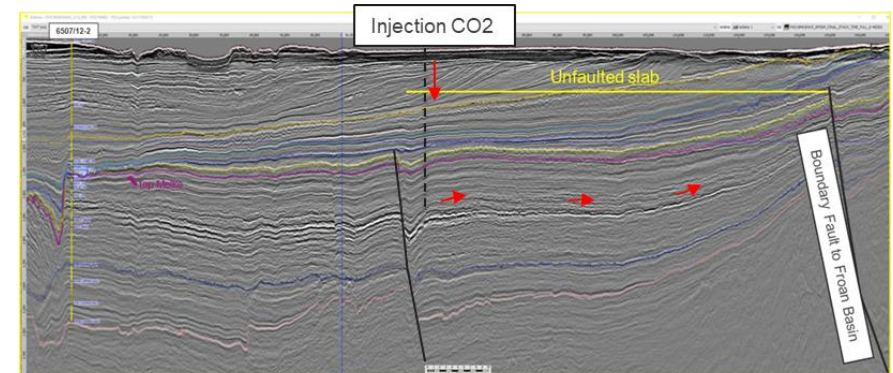
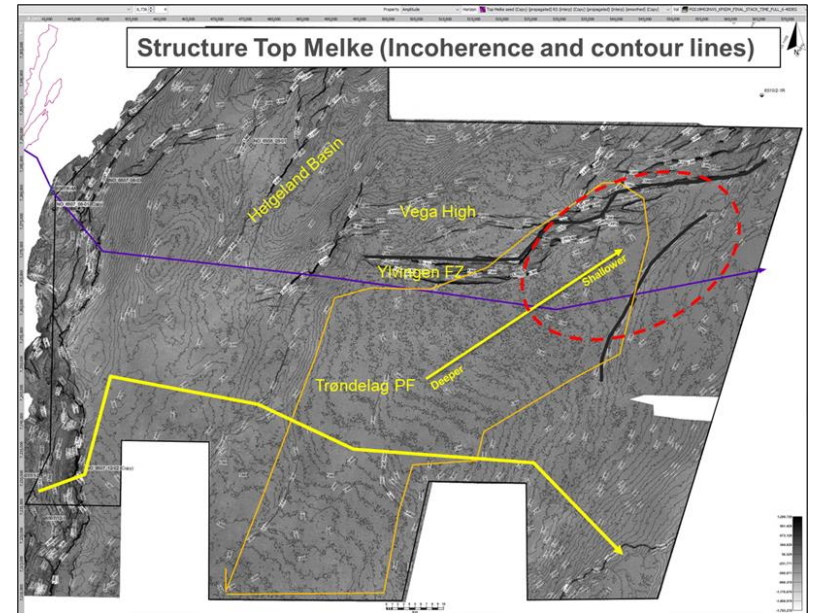
M. Wierzchowska<sup>1</sup>, H. Alnes<sup>2</sup>, J. Oukili<sup>1</sup>, C. Otterbein<sup>1</sup>

<sup>1</sup> PGS; <sup>2</sup> Equinor



# Meeting the challenges of large-scale CO2 storage – combined potential of >4.4 Gt (NPD)

- Large scale storage opportunities in under-explored, low prospectivity regions
  - Proven regional top seals & regional storage units
  - Limited oil and gas development – low well integrity risks
- 2 storage concepts:
  - Open (non-closure) regional sloping aquifer – migration assisted storage
  - Closed (structural) – free-phase storage
- PGS ongoing high quality Geostreamer seismic-simulation project to evaluate storage potential within the AOI



4000 km2 un-fault slab



# Top Melke: Container Height

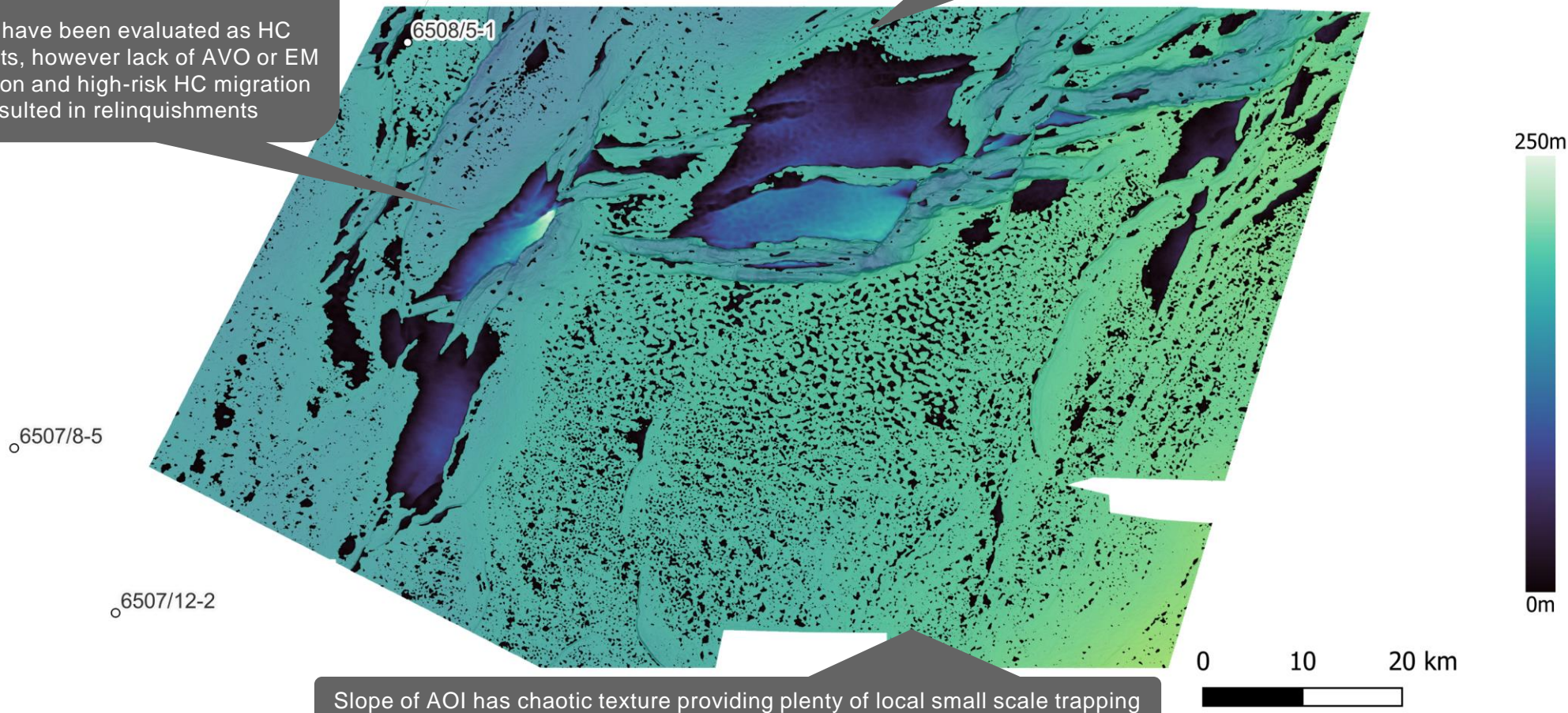
Norwegian Sea Long Distance Migration (residual/capillary & solution trapping) & shallow marine systems



Several structural traps observed across the area

Most have been evaluated as HC prospects, however lack of AVO or EM validation and high-risk HC migration resulted in relinquishments

Structure identified in the NPD Atlas 6510/2-1 R



# Takeaways

- All guidances recognizing the high resolution seismic role
- Importance of specific design for different challenges
- 4D monitoring, how sparse?
- Business models
- Interaction with different agencies





# Obrigada!

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A Clearer Image