

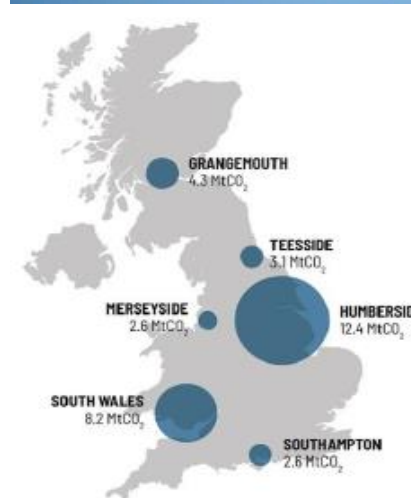


Progressing Phase 1 at Endurance (and beyond) to support the decarbonization of the UK's East Coast.

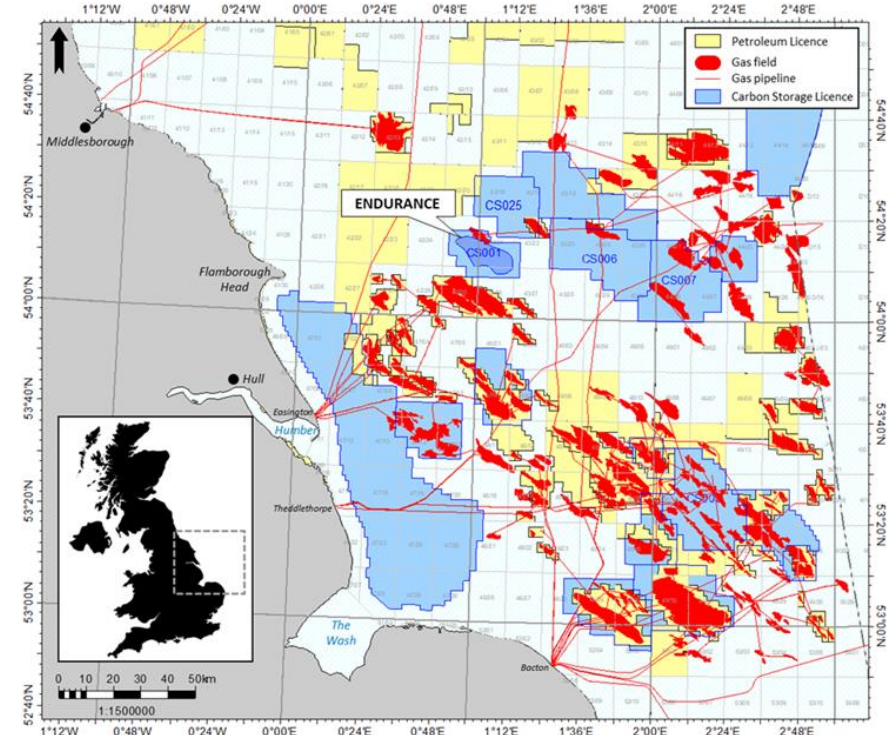
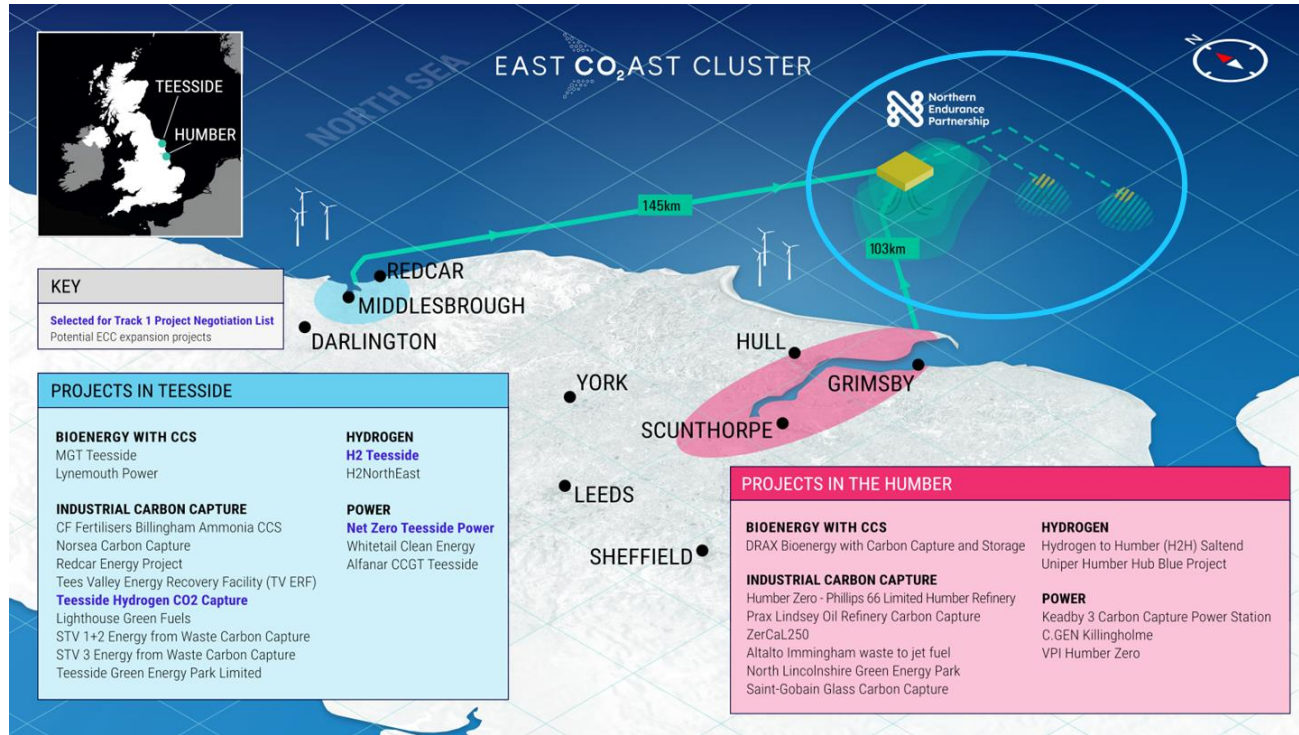
Nicolas Bouffin, bp

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P&J Live, Aberdeen**

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East Coast Cluster (ECC) carbon capture and storage project: overview

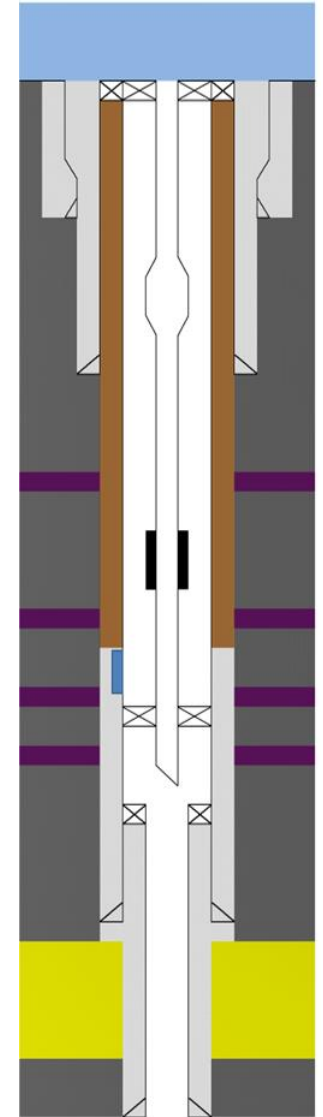
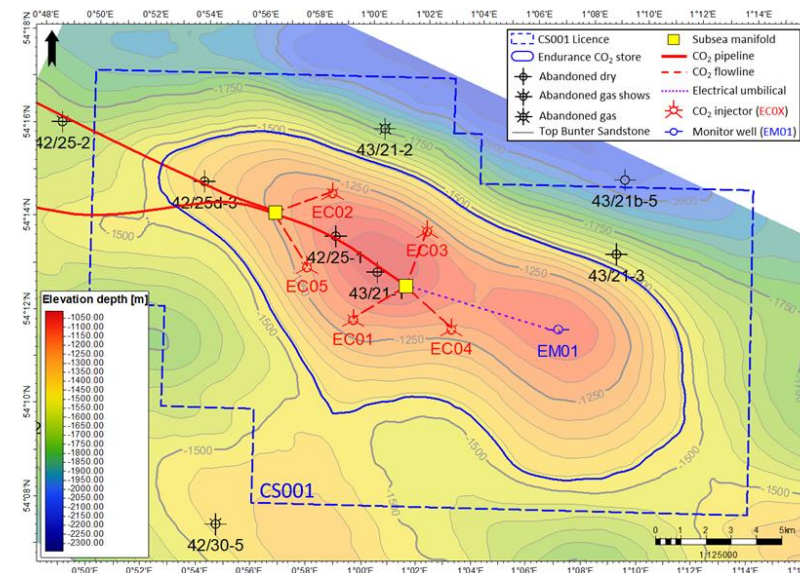
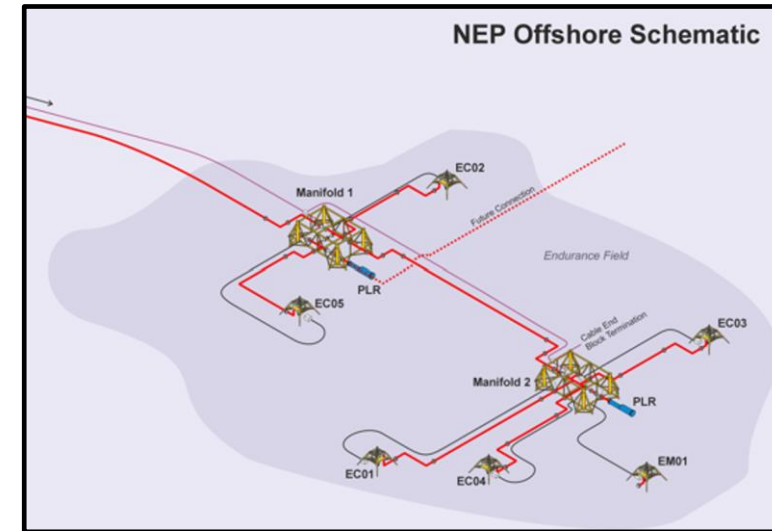


A 'Track 1' CCS cluster, Phase 1 will store 100 MtCO₂ at Endurance over 25 years, captured from Teesside and Humber industrial hubs:

- Northern Endurance Partnership (NEP) is the CO₂ transportation and storage provider for the ECC.
- Captured CO₂ will be injected into the Endurance saline aquifer in the Southern North Sea.
- Nearby structures are being appraised for future expansion (CS006, CS007, and CS025).

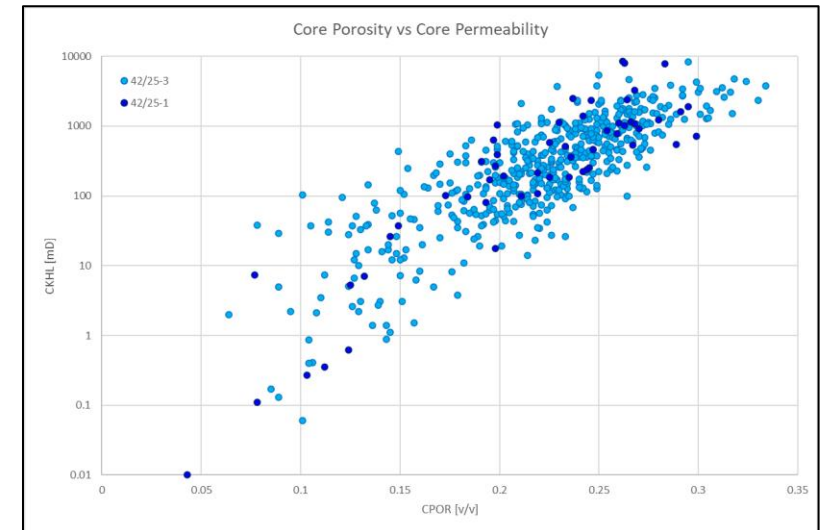
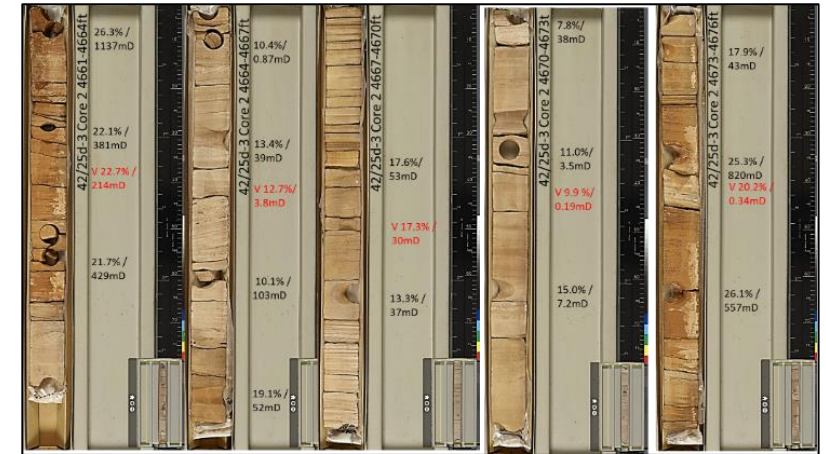
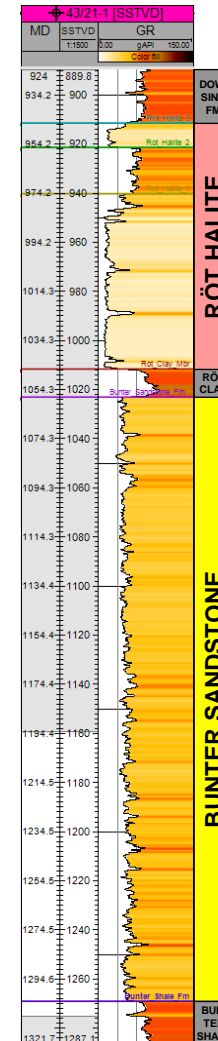
Endurance – Phase 1 development overview

- Dense-phase CO₂ injected into the Endurance saline aquifer via subsea manifolds with 5 injection wells and 1 monitoring well
- 4 Mtpa_a for 25 years (100 Mt) at Endurance represents ~3% of the above-spill point volume
 - Storage volumes can be delivered by Phase 1 development for adverse P90/downside subsurface scenarios (confirmed by external SRMS audit)
- Wells designed for CO₂ injection
 - Simple vertical well with intervention capability
 - CO₂ resistant metallurgy
 - 0.8Mtpa_a/20 Mt per well
- Distributed subsea layout provides extra robustness against any (unlikely) reservoir quality variation and/or compartmentalisation
- A storage permit application has been made to NSTA including extensive risk assessments, associated monitoring and corrective measures plans



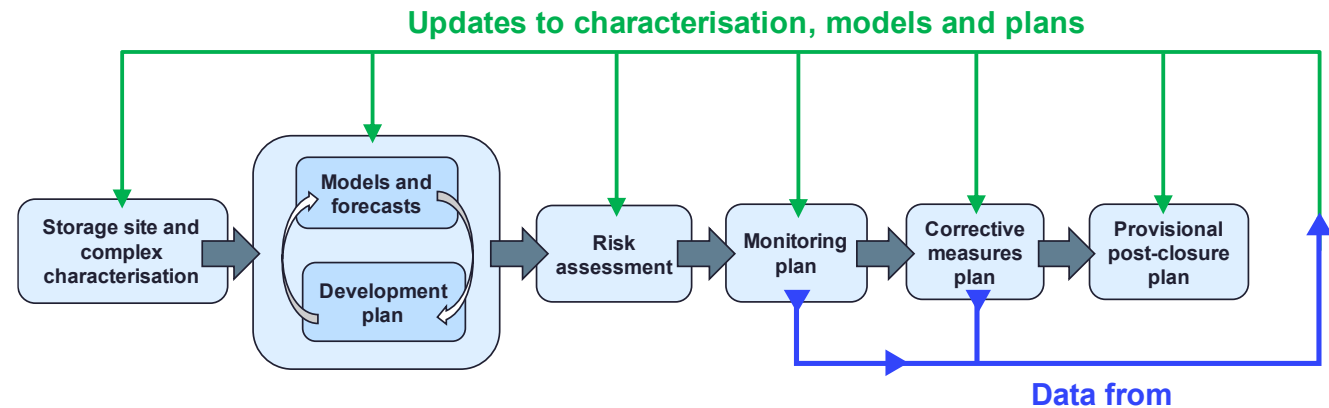
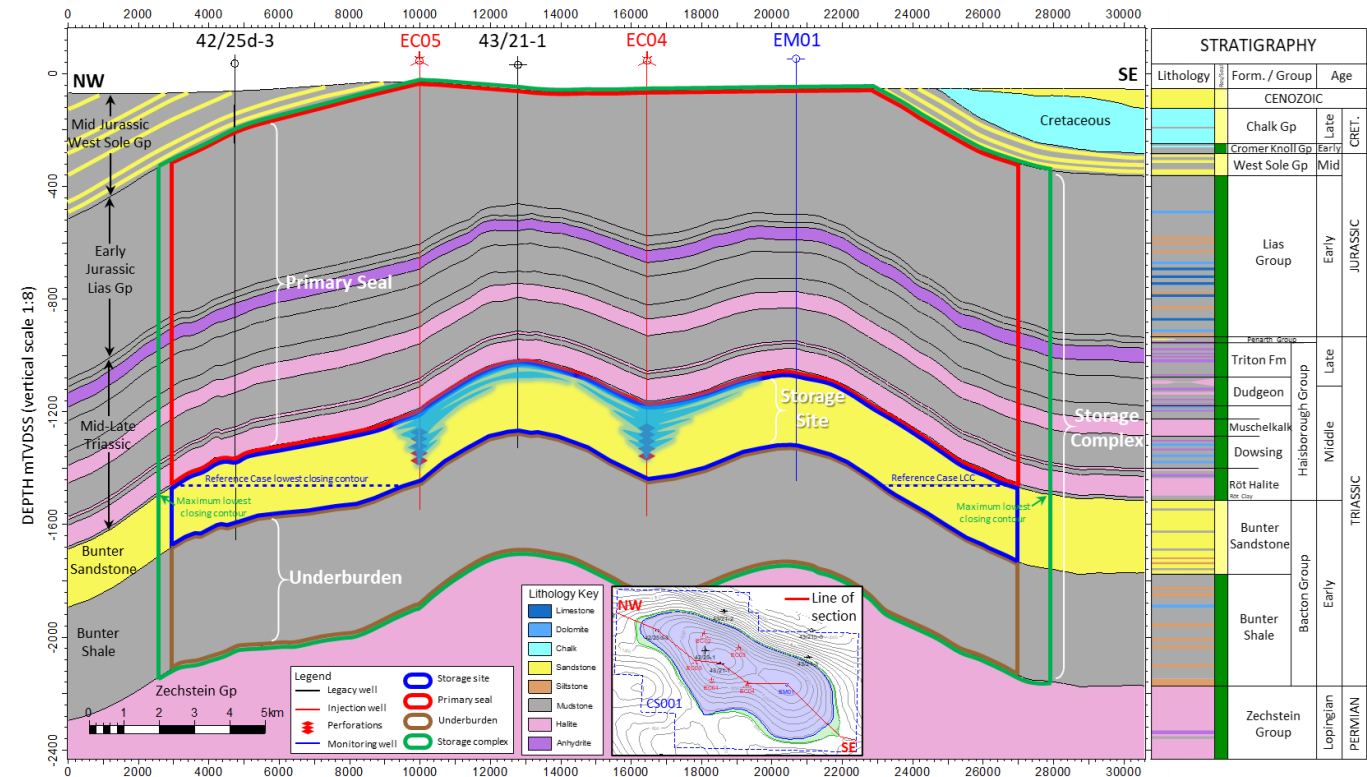
Endurance – Reservoir injectivity

- Bunter Sandstone comprises fluvial-aeolian sands deposited in slowly-subsiding basin under semi-arid climatic conditions
- Bunter Sandstone has good to excellent reservoir quality:
 - 90% net-to-gross
 - 22% porosity and 300 mD average permeability
 - 250m thick
 - Confirmed by DST test in well 42/25d-3 (2013)
- Bunter Sandstone is an extensive reservoir connected to a regional aquifer
- Uncertainties:
 - Baffling potential from cemented or shale layers
 - Compartmentalisation potential from sub-seismic faulting
 - Reservoir properties over unpenetrated eastern part of structure



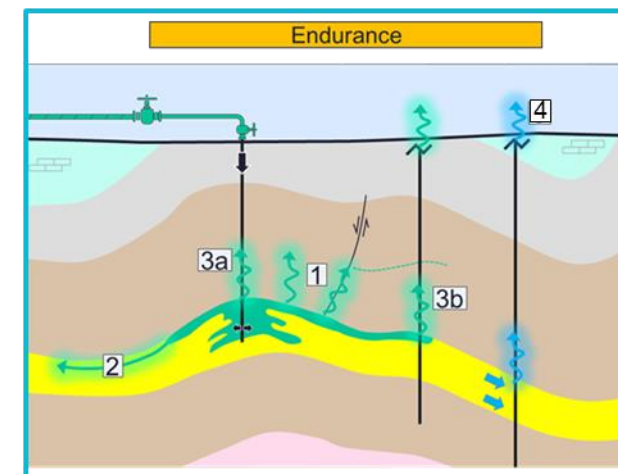
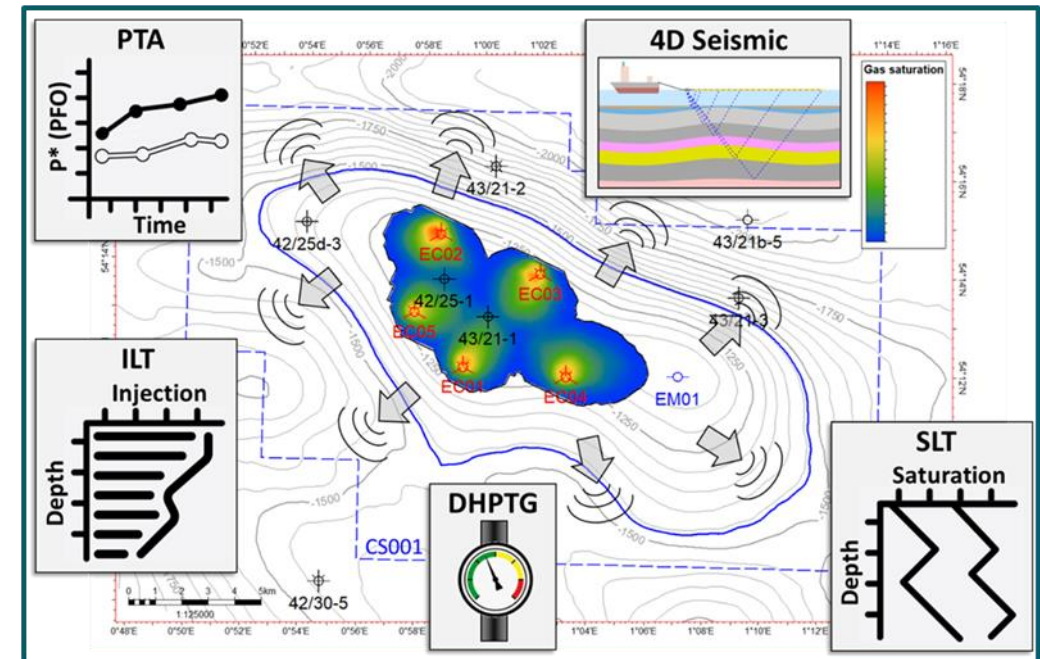
Endurance – CO₂ storage capacity and containment

- Endurance is a very large 4-way structure (equivalent to ~26 billion reservoir barrels in-place above spill point)
 - Circa 1 km of sealing lithology above Bunter
 - Limited overburden faulting
- Injected CO₂ will migrate from mid-flank (residual trapping along the way) to crest due to density difference with in-situ formation water:
 - Formation of a secondary CO₂ ‘gas’ cap (structural trapping)
 - Limited CO₂ dissolution due to high-salinity
- Esmond gas field (regional analogue 50km north of Endurance) suggests a well-connected system for Greater Bunter Aquifer



Endurance Phase 1 Data and Monitoring

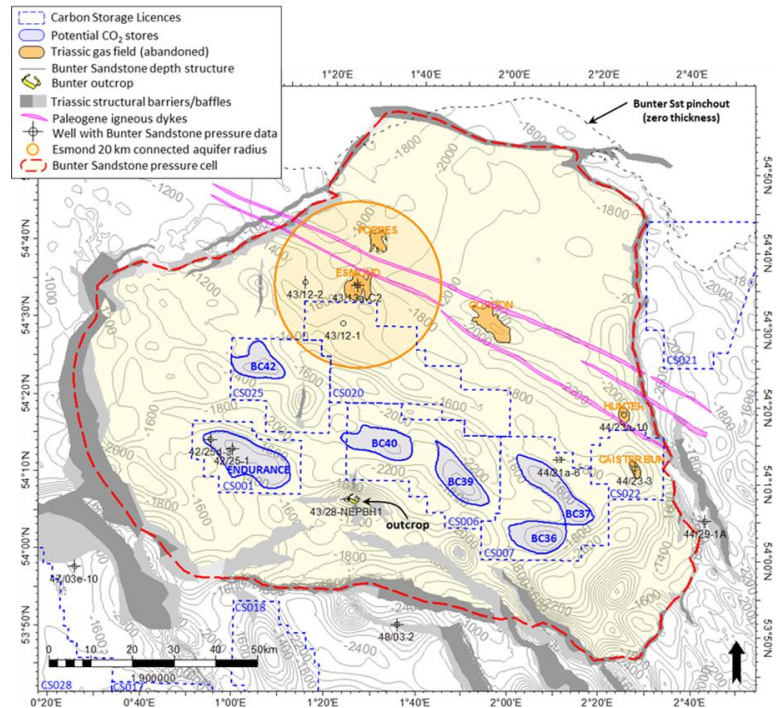
- Key uncertainties:
 - Storage efficiency factor beyond Phase 1 – rate and volume dependent on pressure dissipation driven by
 - Overall connectivity to far-field aquifer
 - On-structure heterogeneities impacting plume migration towards structural crest
- Data acquisition as part of development wells
 - Core, wireline logging, pre-flush
- Monitoring plan designed to manage residual risks
 - Continuous monitoring in wells and on seabed
 - Areal seabed and seismic surveys planned before, during and after injection
 - Dedicated monitoring well EM01 (passive reservoir pressure)
 - Feasibility studies on seabed landers and 4D gravimetry



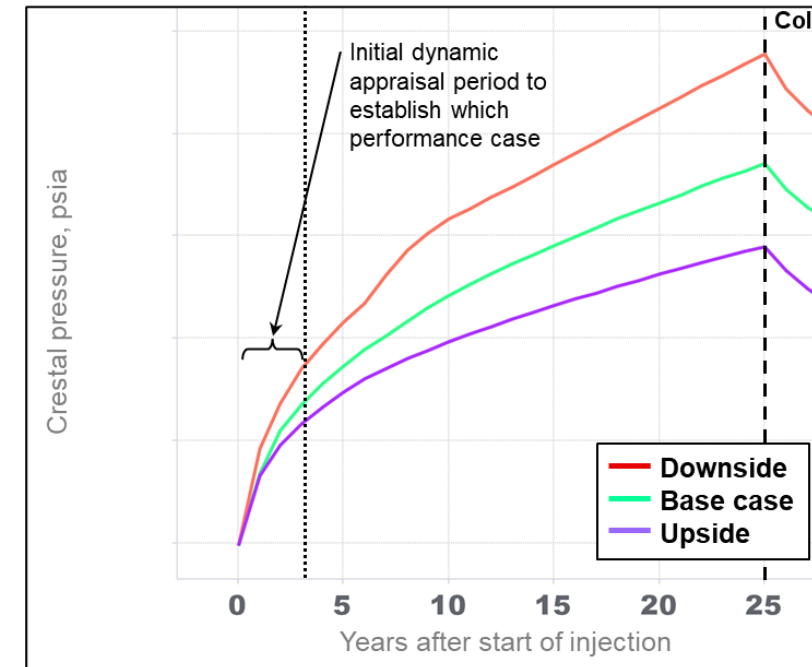
1. Vertical CO₂ migration via geological leak pathways
2. Lateral CO₂ leakage via geological pathways
3. Vertical CO₂ migration via wells (a: operational; b: abandoned)
4. Formation water displacement via well pathways

Storage management plan

Greater Bunter Aquifer Hydraulic Unit



Endurance Simulation model P90-Base-P10 pressure



- Storage site management framework will be an iterative process
 - Integrated with risk management, monitoring & updated site characterisation (containment, injectivity, and capacity)
- Store performance ('dynamic appraisal') over first few years critical
 - Pressure development to determine aquifer connectivity
 - Phase 1 Well performance
 - Potential storage rate and capacity beyond Phase 1 (100 Mt)

Conclusions

- 4 Mtpa_a for 25 years (100 Mt) at Endurance represents ~3% of the above-spill point volume
 - Can be delivered by downside/P90 subsurface scenario
- CO₂ plume: structural trapping expected to dominate in 4-way closure
 - Distributed subsea layout provides extra robustness against any (unlikely) decrease from the observed good reservoir quality and/or compartmentalisation
- Development well data and monitoring planned from 2026+
 - First years of injection will provide dynamic data to inform expected performance and potential for growth beyond Phase 1
- Storage potential beyond Endurance being actively appraised
 - Includes evaluation of hydraulic unit connectivity

Acknowledgements

- Northern Endurance Partnership:

