Advancing our understanding of the Southern North Sea (SNS) Bunter

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Changing SNS landscape

NSTA responsibility?
Manage Hydrocarbon & Carbon Storage (CS) licences

Why refresh SNS?
Carbon Storage, Exploration, Appraisal, Production and Co-Location

SNS reservoirs?
Focus on Bunter Sandstone Fm (Triassic)
Mostly water wet
Relatively under-appraised

Vast Subsurface Database, Patchy Knowledge

What can we do?
Consolidate regional understanding
Spot the gaps
Influence work programmes
Extensive Wells Database

Extensive, freely downloadable offshore database

UK National Data Repository

Accessible Onshore wells

UK Onshore Geophysical Library
SNS Core

Leman & Carboniferous well understood

Regionally under appraised Bunter
- Gas fields on basin margins
- Very Low number of Cores
  - Almost none near & on shore
  - ~ 2 in overlying top seal
Regionally under appraised Bunter

- Sparse Density Neutron logs
- Rare pressure and fluid samples
- Almost no well tests
Seismic Database

Complete offshore 3D. 2D nearshore / onshore
- Extensive freely downloadable offshore 2D & 3D
- Speculative 2D & 3D seismic vendors
- Onshore 2D & limited 3D
Extensive Detailed mapping

- 800m depth CO₂ supercritical phase
- Bunter outcrops in west
- Numerous structural closures
  - Zechstein salt controlled
  - Some complex overhangs
- Variable seismic imaging
Resultant Bunter closures

Many structural culminations
- Great interest for carbon storage
- Mostly water wet

Gas only at basin margin
- Underfilled structures
- No solid explanation for gas migration

Shallow reservoir amenable to HR 3D

Endurance High resolution seismic trial

Current CS licences
- CS 1st round

Triassic gas field

50km
Bunter Sand thickness

Typically >200m within CS areas
- Eroded/ non-deposition margins
- Thins/ faulted out @ salt ridges
- Thickest in west / onshore
Endurance area porosity

Endurance large 4-way closure
- 3 water wet wells
- Unusually high porosity top

Widespread cemented & low porosity
Impairs:
- Effective net volume
- Injectivity
- CO₂ distribution
Well porosity and seismic polarity

Contrast 2 neighbouring wells

North of Endurance
Cemented = (hard top)

Endurance
High porosity = soft top

Bunter is not a thick, homogeneous tank of sand!
- Large impedance change & seismic polarity flips
- Subtle intra-reservoir reflectivity = porosity change?
Bunter is not an opaque canvas

Mysterious mappable markers?
- Intra reservoir = Porosity
- Seismic Polarity reversal (SPR)
- Inward dipping reflector (IDR)
Bunter Amplitude & Dipping reflector

Polarity & amplitude switching

Inward Dipping reflector (IDR) & Base Bunter sand

Abrupt amplitude/ polarity change
-> porosity decrease?

Structural reconstruction required?
Chase the detail: Bunter facies attribute?

Flattened Bunter seismic

Bunter Amplitude & fluvial channel

Palaeogeography:
Predominantly Fluvial “Some contribution from UK in west”

Fluvial system?
Regional spectral decomposition

Linear features in Bunter -> Channels?
= Vertical wipe-out -> Survey edges?

Bunter regional spectral decomposition

44/17a-5  44/17b-7

Top Chalk
Chalk
Top Bunter/Bunter Shale
Bunter
Top Zechstein/Zechstein
Zechstein
Top Leman/Leman Carb
Leman Carb

Bunter Gas

12.5km

North Sea Sea Transition Authority

3D data
hole
Igneous dykes?

Linear features in Bunter -> Channels?

= Vertical wipe-out -> Survey edges?

Align with magnetic anomalies? Dykes? ❓

Small circular feature: DHI?

Note Undisrupted Larger Circle

Intrusives interpretation

Integrated magnetics

No disruption

3D data hole

Linear features

12.5km

Circular feature

Survey edges? Align with magnetic anomalies? Dykes?
Dykes within the bigger picture

Linear features in Bunter -> Channels?
= Vertical wipe-out -> Survey edges?
Align with magnetic anomalies? Dykes?
Align with structural grain?
Influence methane charge & high CO₂?

Small circular feature: DHI Conformance

Undisrupted Larger Circle in syncline

Intrusives and Bunter depth structure

12.5km
Sole Pit “Meteorite Crater?”

Pros & Cons

“Crater” on Chalk edge map

“Crater” @ top Bunter

Multi survey merge & Data hole

- But, Off-centre 2D line mimics faulting pattern
- Coincident: Bunter syncline & Zechstein thin

Circular Disruption

Major circular disruption

3d data hole

No disruption

3d data hole

Sole Pit "Meteorite Crater?"
Sole Pit “Meteorite Crater?”

Circular Disruption

Diameter vs uplift fits on global crater trend

Chalk

Major circular disruption

BCU

400m

200m

Bunter Gas

12.5km

Top Chalk

Major circular disruption

Chalk outcrop

3d data hole

Domal uplift

Silverpit

SU = 0.0945

Modified from Ostrzalki et al. 2022
Sole Pit “Meteorite Crater?”

3D line through “crater”

Hardband = Slow ROP & lithified claystone

Meteorite floor?

Major circular disruption

Thickening

Destruction

Domal uplift and/or velocity pull up

Or migration swing

Sag /Push down

Minor Scattering

You choose?!
Bunter is (mostly) a great regional CS play

• Very thick & extensive and good reservoir
• Good top seal
• Multiple culminations/ Very large storage capacity
• BUT.......geologically under-appraised

Let’s work the details & understand “mysteries”

• 1990s imaging inadequate/ Reprocessing promising
• New acquisition beneficial
• Are we geophysically up-to-date?

Co-location will be increasingly problematic

• Acquisition options for 3D static or targeted 4D