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Natural Environment Research Council

MOET Managing the Offshore Energy Transition

BGS British Geological Survey

Structural controls on pressure communication across the Bunter Sandstone Formation, UK Southern North Sea

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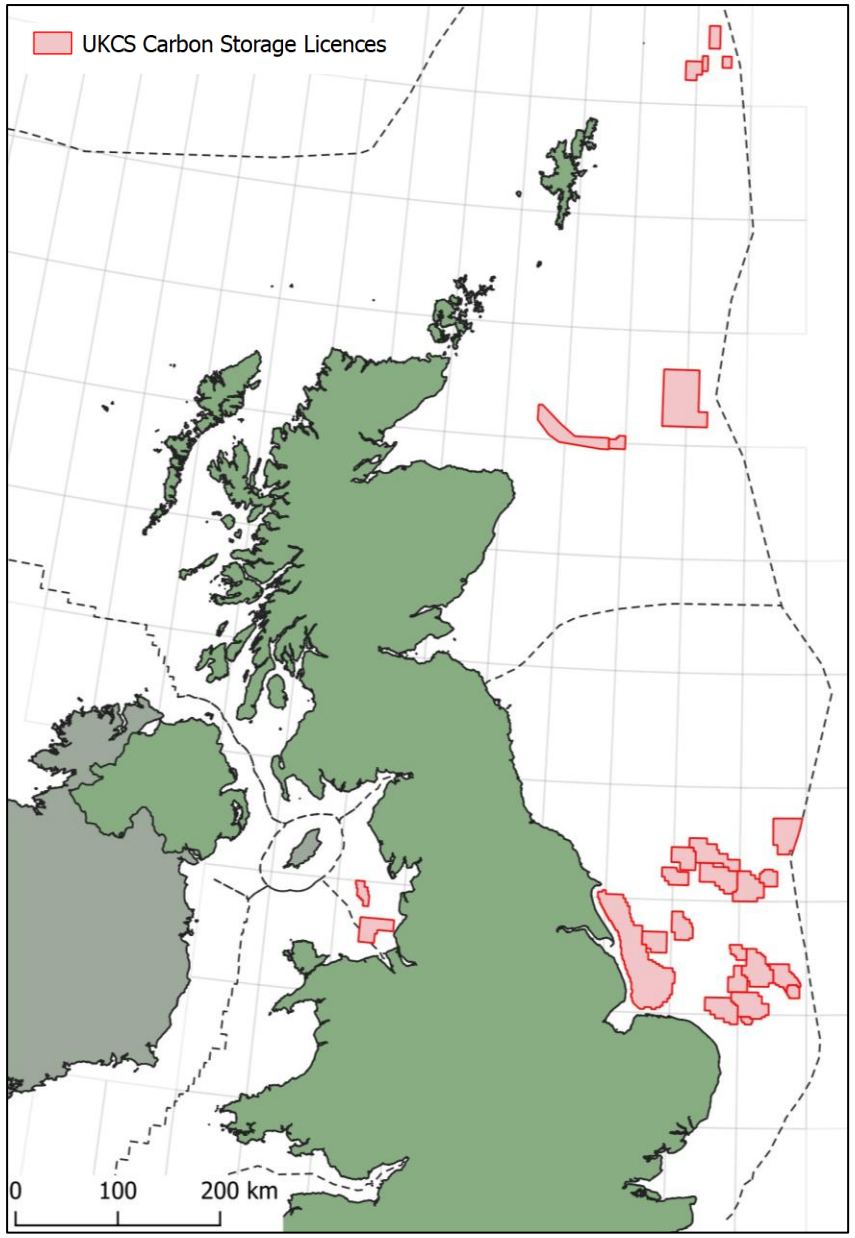
CCS in the UK

- The Lower Triassic Bunter Sandstone Formation of the Baton Group is one of the UK's principal targets for carbon capture and storage
- Two thirds of the UKCS Carbon Storage Sites are located in the Southern North Sea Basin
- It is primarily a saline aquifer with several anticlinal closures which make it an ideal reservoir for CO2 storage



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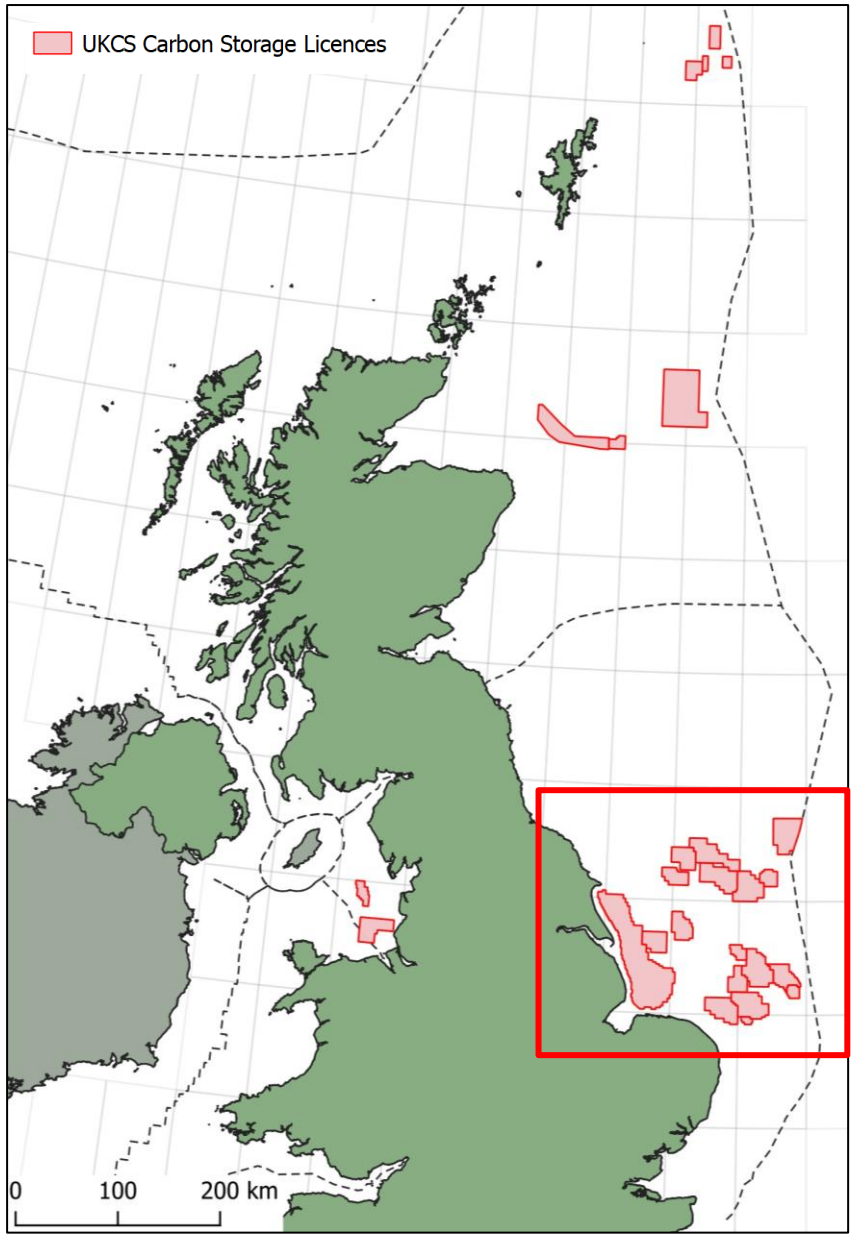
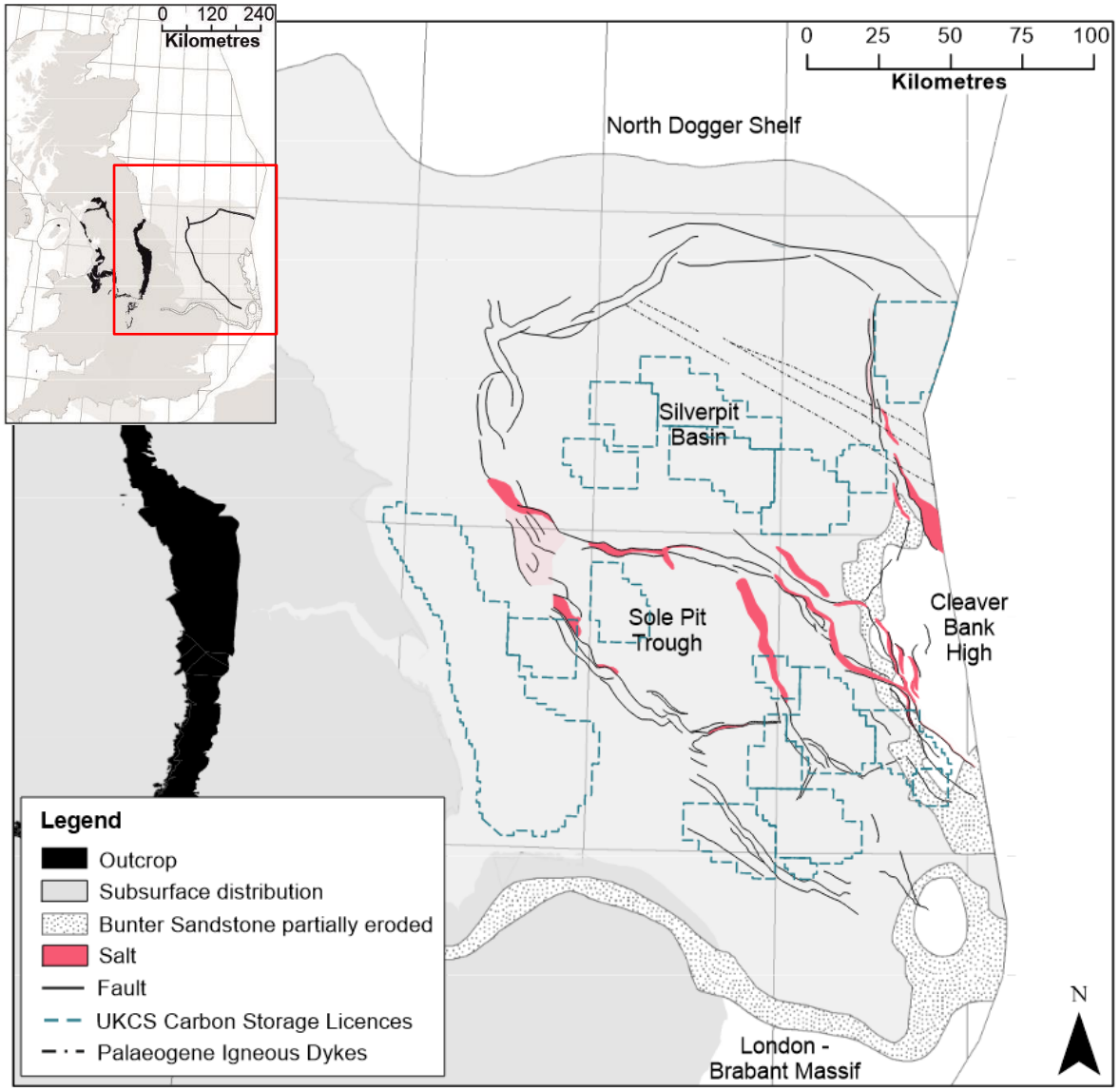


Structural Map of the UKSNS – Top Bunter

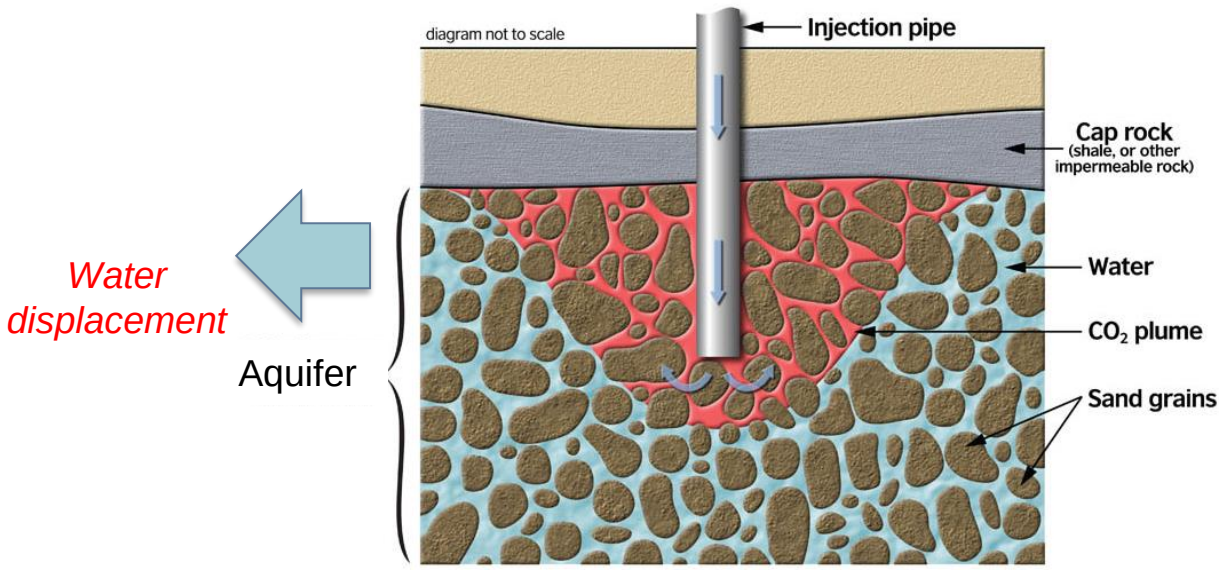


- The Bunter Sandstone Formation is regionally divided by recognised fault systems and salt walls
- The structural division is primarily controlled by movement of the underlying Permian Zechstein Salt
- The SNS has experienced multiple periods of extension, inversion and compression, making these boundary zones highly complex structures

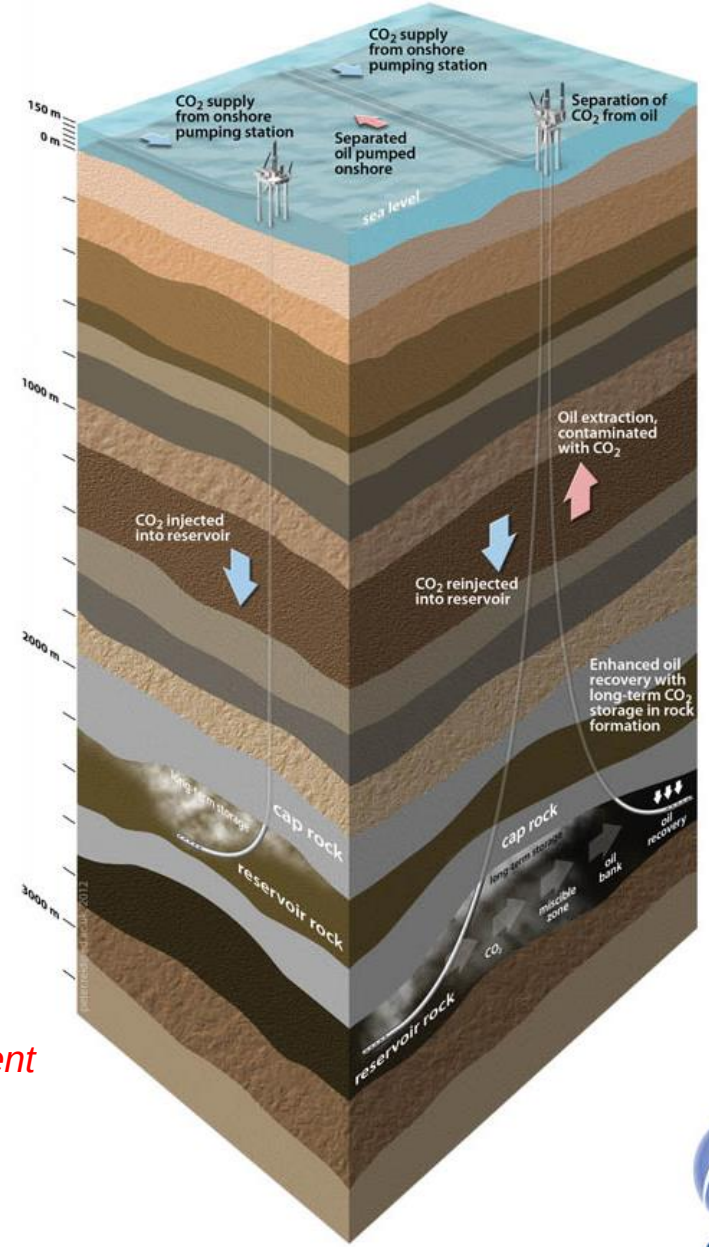
Structural map of the Southern North Sea

CO_2 Storage

- CO_2 is stored in the pore space of rocks and displaces the brine (salt water) currently present in the aquifer
- If the aquifer is confined, then pressure will build up



Water displacement



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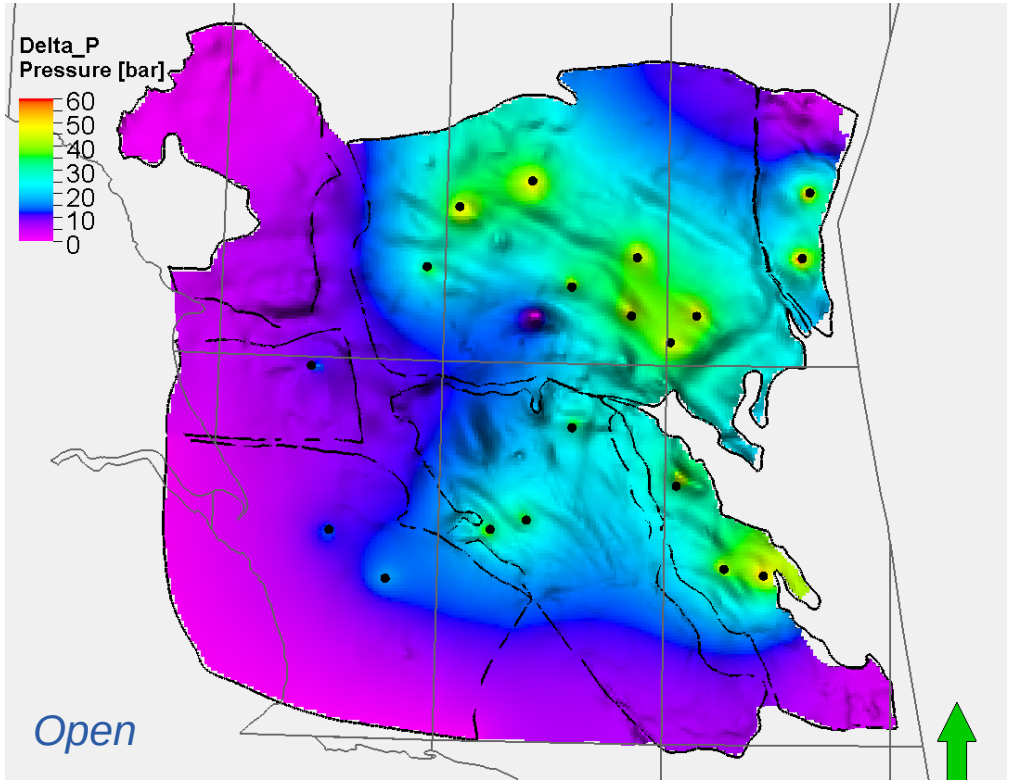
Numerical Modelling of Injection

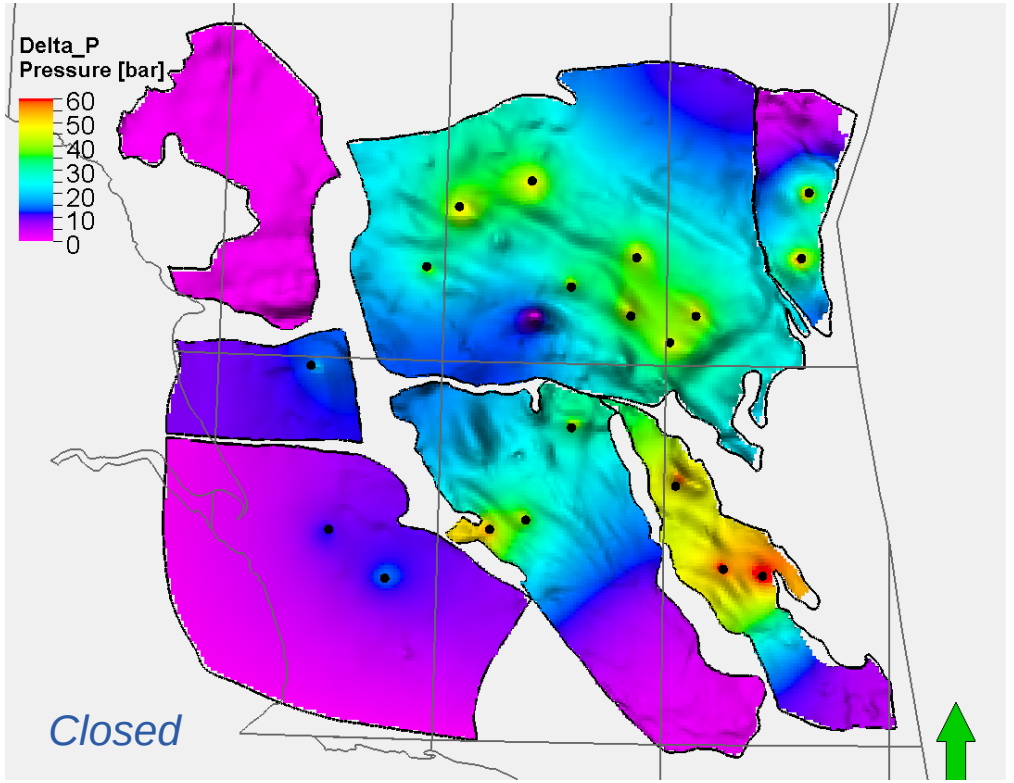
- Numerical simulation studies show industrial scale CO2 storage can result in widespread pressure build up in the aquifer.

- Understanding the potential for pressure communication is important for pore pressure management, as injection activities at one site could potentially impact negatively on operations elsewhere.

Regional pressure modelling due to CO_2 Injection

- Regional modelling completed based on Bunter Sandstone Formation Zones as defined by the CO2Stored database





Pressure increase above hydrostatic conditions after 30 years of injection at a rate of 2 Mt/yr CO2 for cases with faults closed (top) and open (right). Cells representing fault boundaries are removed from the model when closed and have the properties of Zone 4 when open. Injection wells are marked with black circles.

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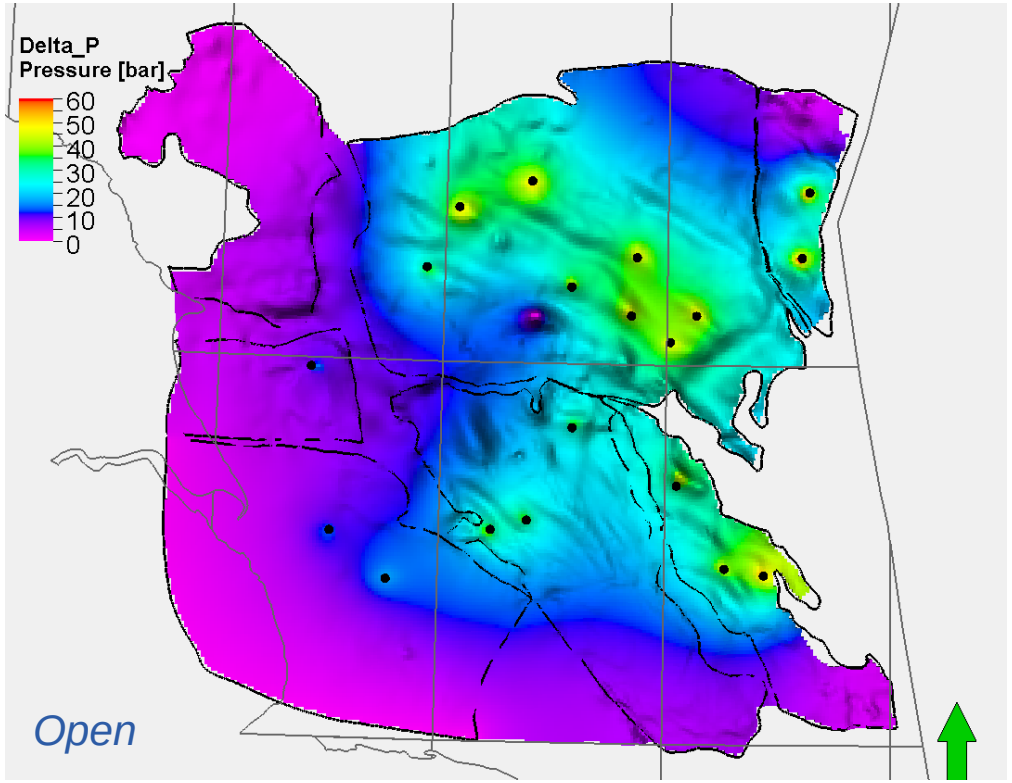

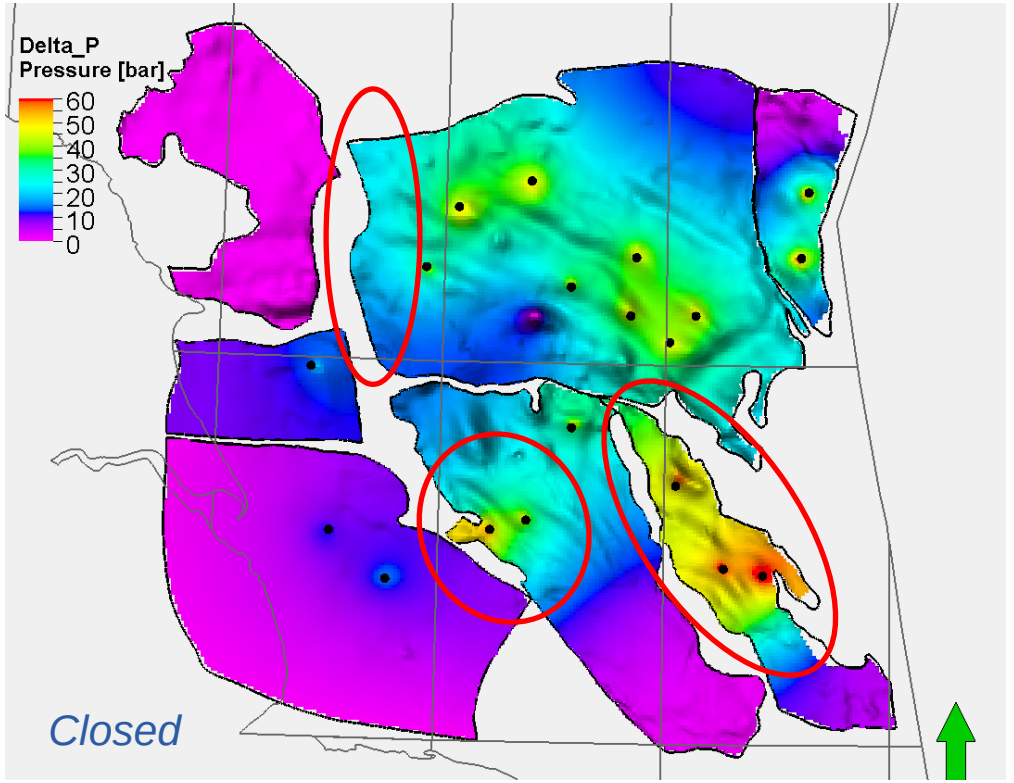

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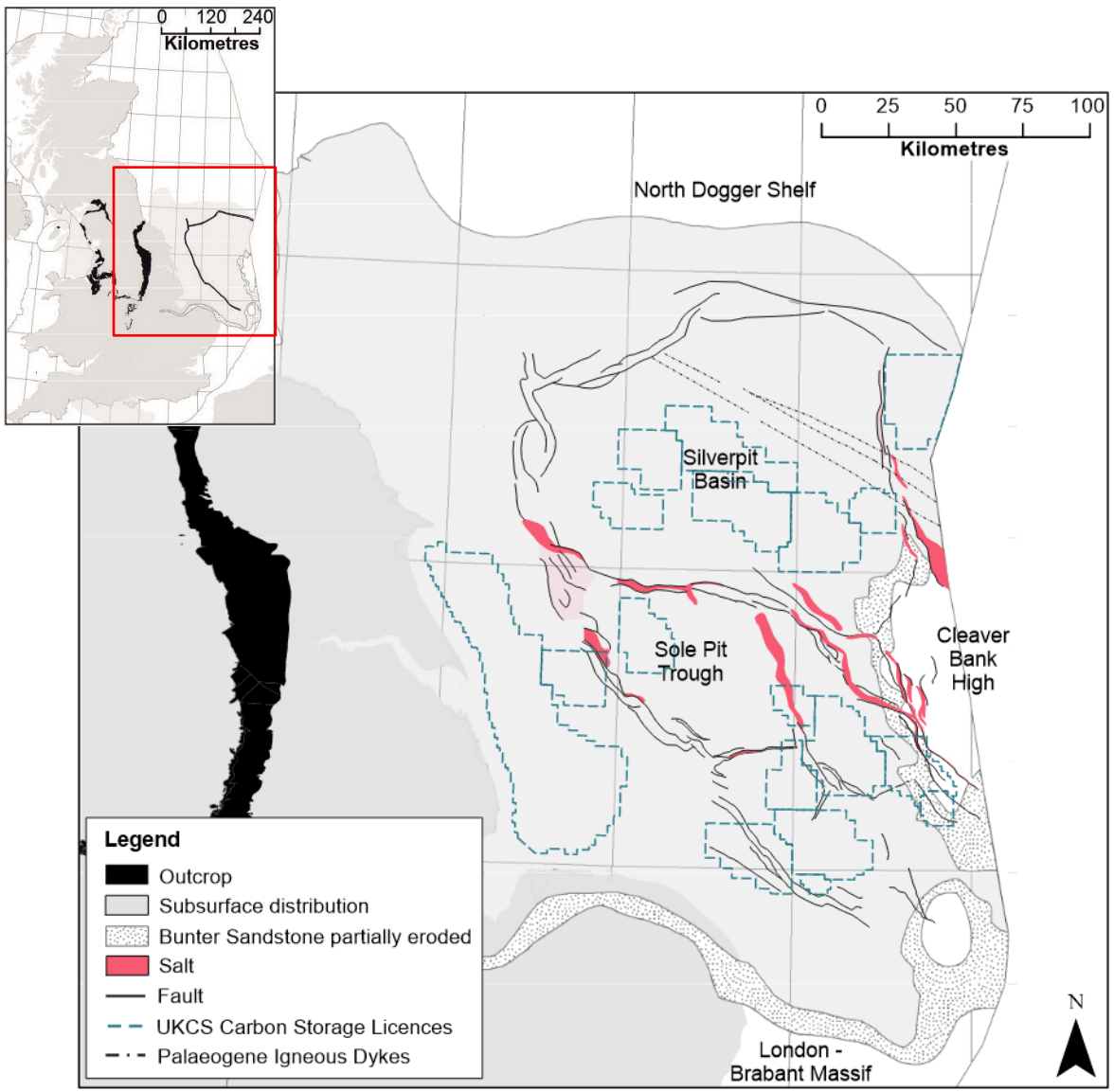
Research Questions

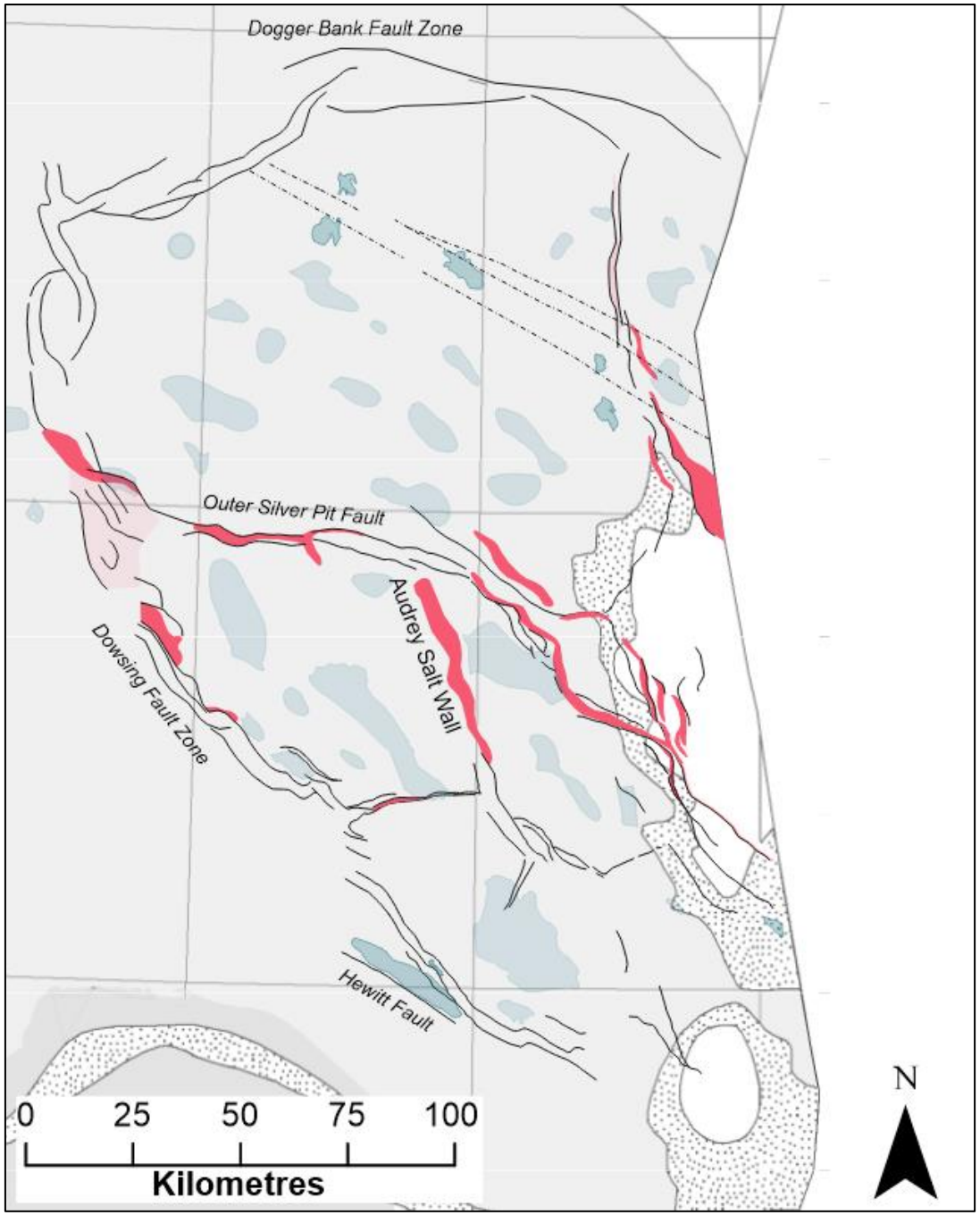
- What are the main structural boundaries that affect the Bunter Sandstone Fm?
- How do the structural boundaries impact pressure communication
- How can this be translated into inputs for further pressure modelling?

Methods

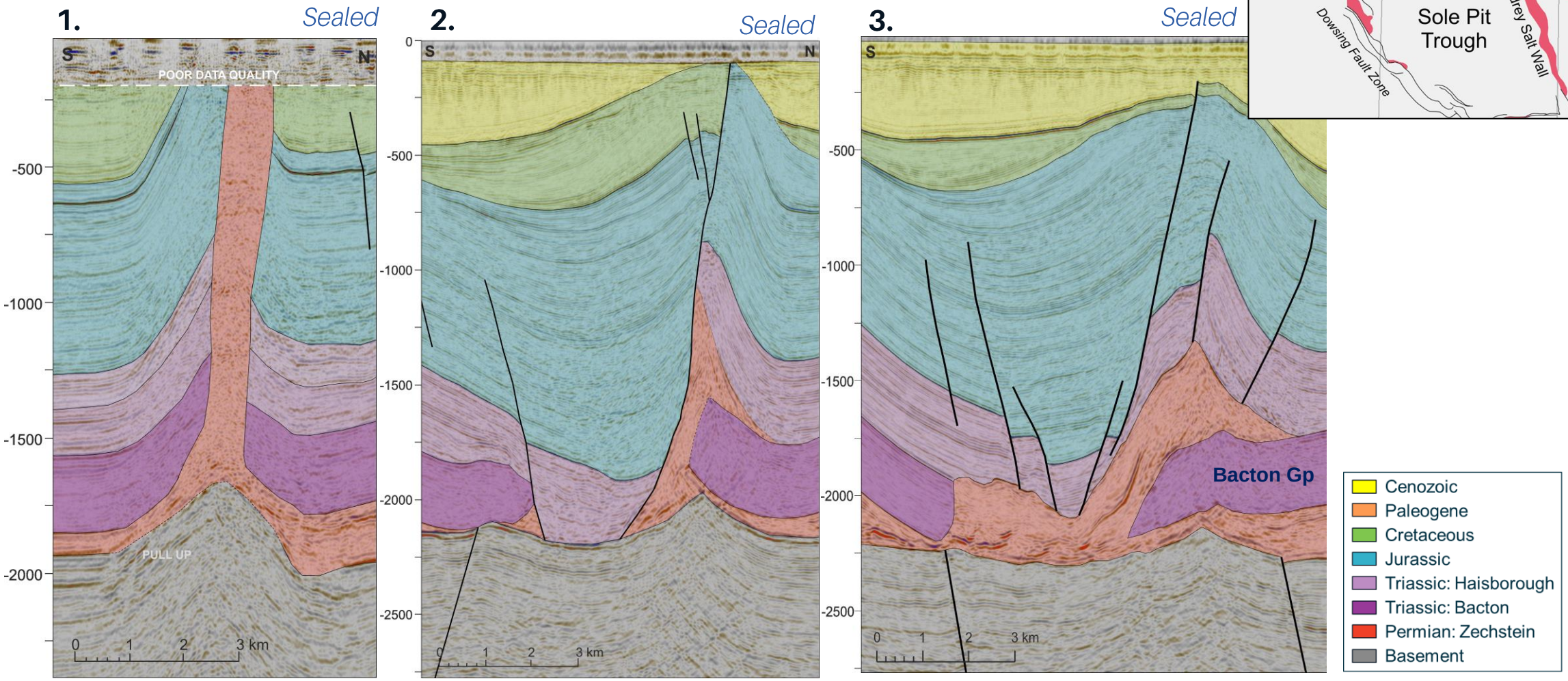
- *A structural study was conducted to inform future pressure modelling activities:*
  - *Seismic interpretation of the Bunter Sandstone Formation*
  - *Creation of a structural map at Top Bunter level*
- *A new classification scheme was developed to map structural variation and connectivity*

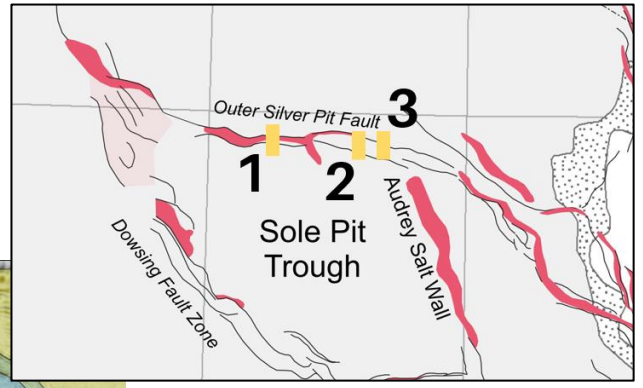
Structural Map – Top Bunter





Variation along the Structural Boundaries





Contains information provided by the North Sea Transition Authority

Variation along the Structural Boundaries

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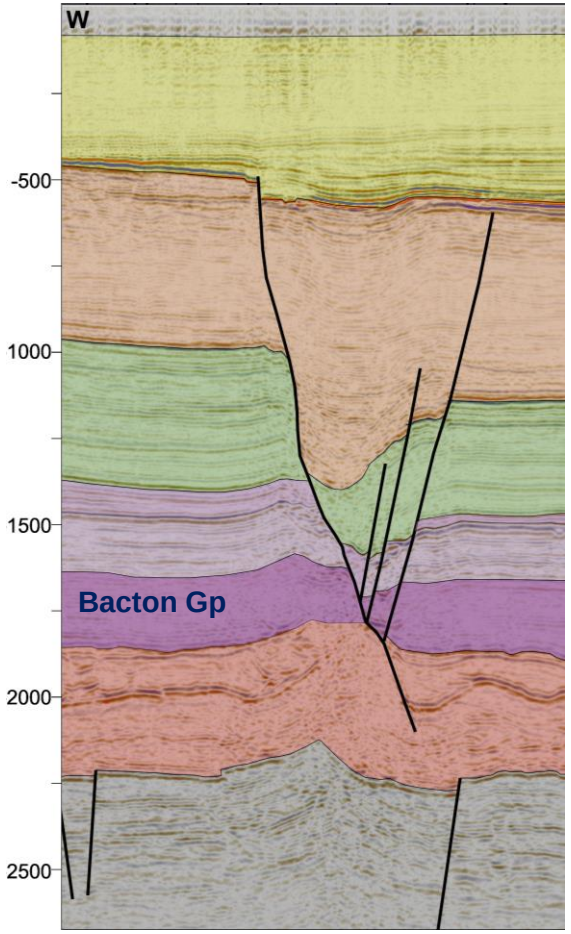
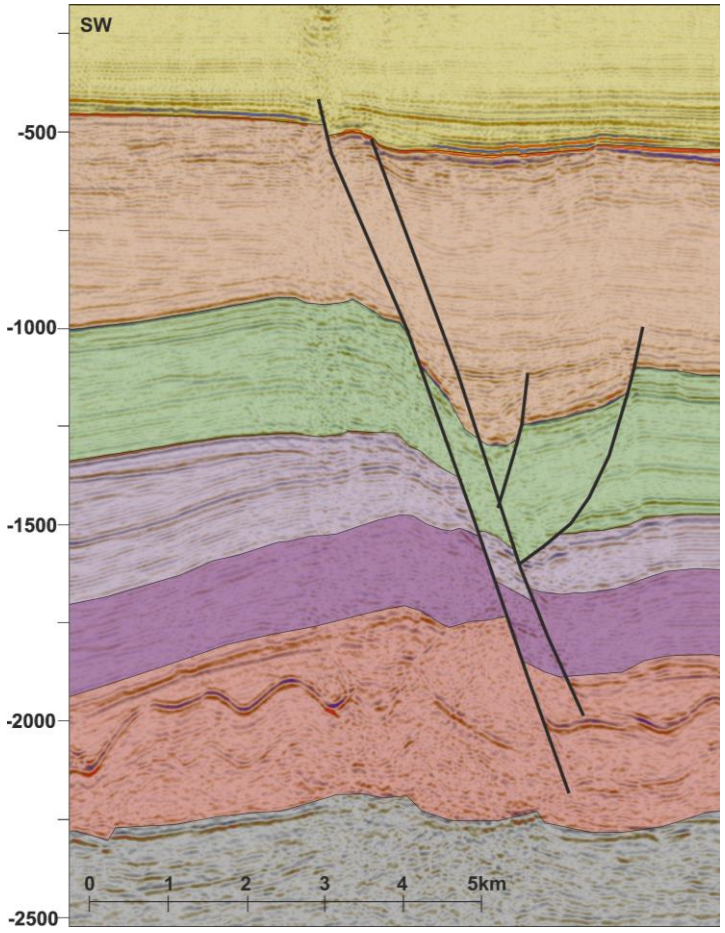
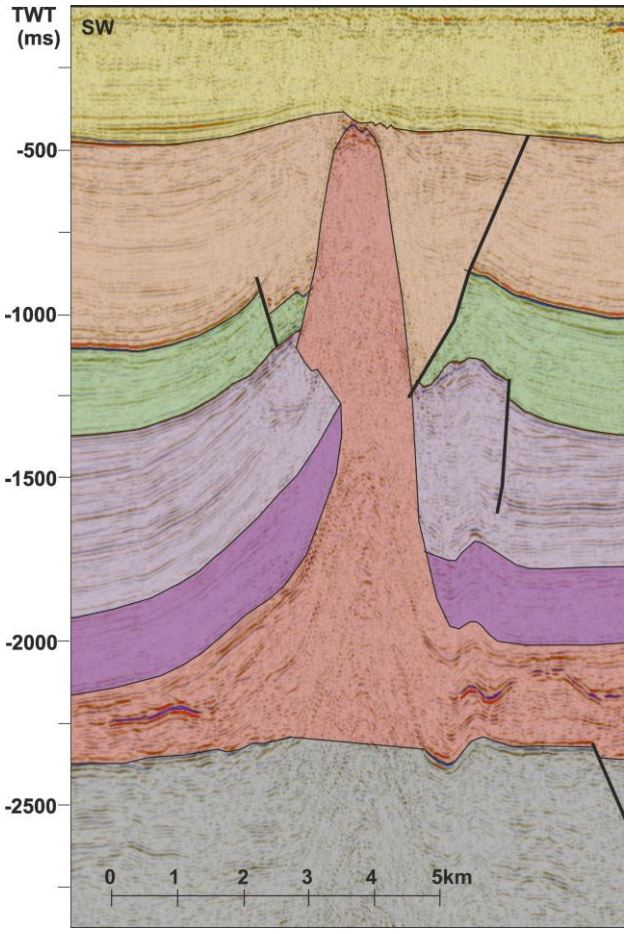
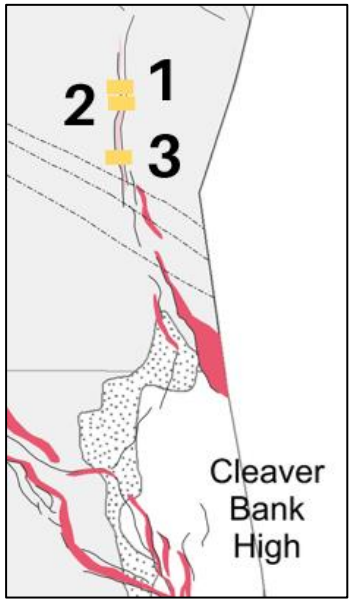


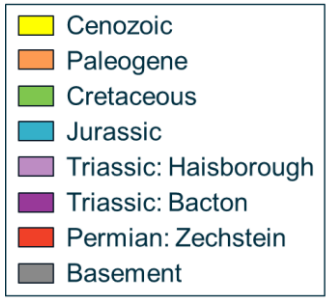
2. *Possible Communication*



3. *Sealed*







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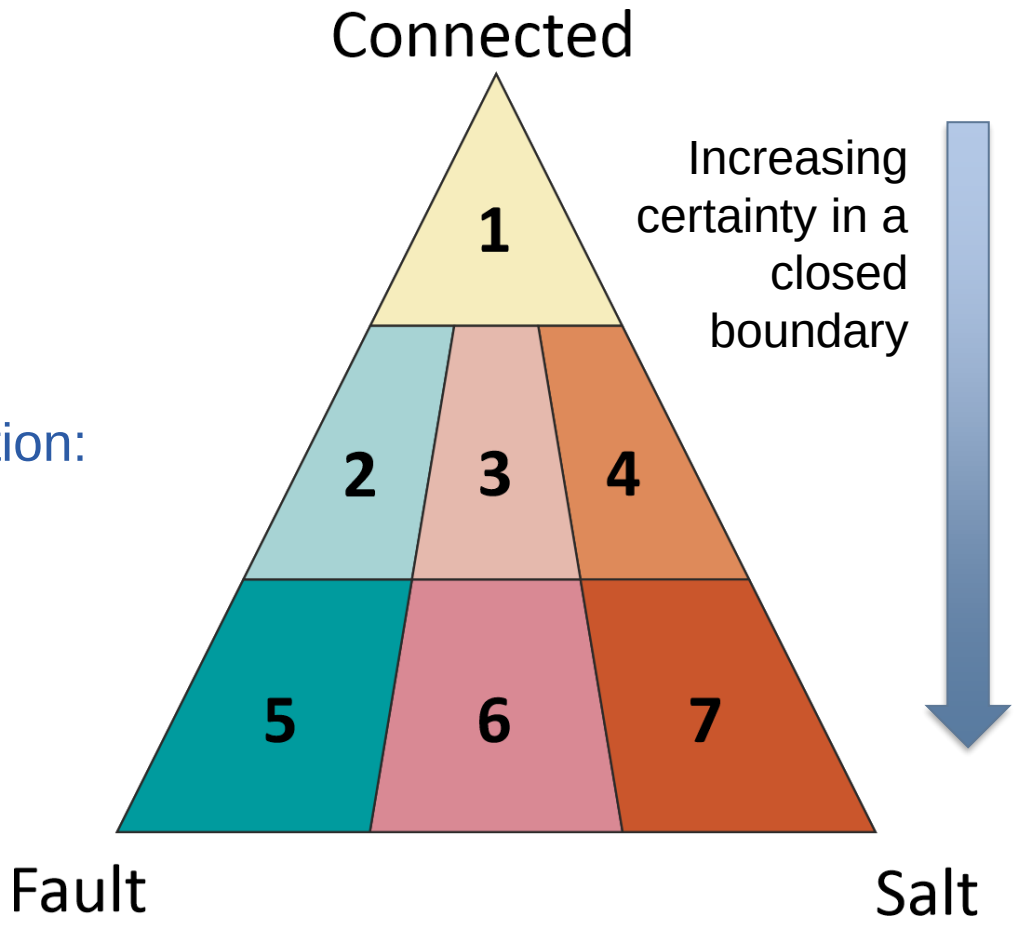
Boundary Classification Scheme

Based on 3 end members:

- Connected: no separation of the Bunter sandstone
- Faulted: complete separation - no juxtaposition
- Salt: complete separation by salt

4 intermediary categories then fall out of this classification:

- 2: faulted with juxtaposition
- 3: juxtaposition despite faulting & salt deformation
- 4: salt deformation with juxtaposition – not seen as faulting, usually occurs with salt deformation
- 6: complete separation by salt and faulting



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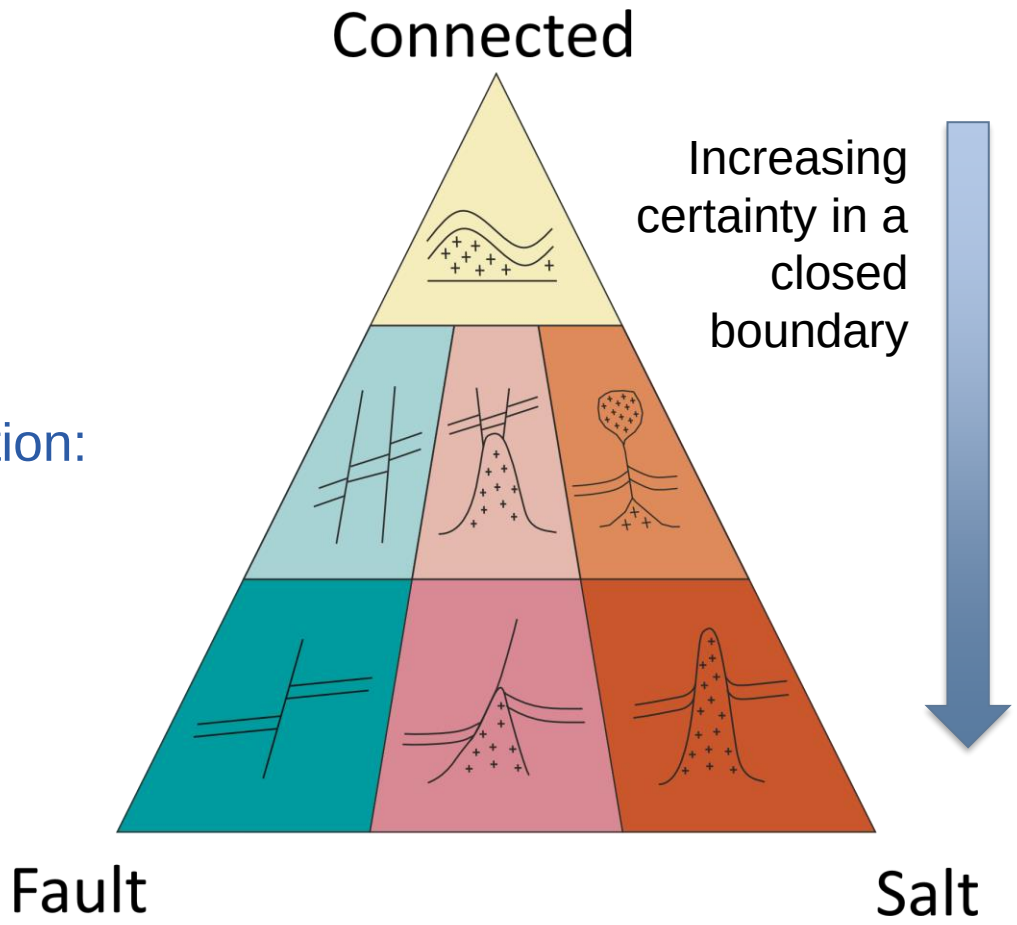

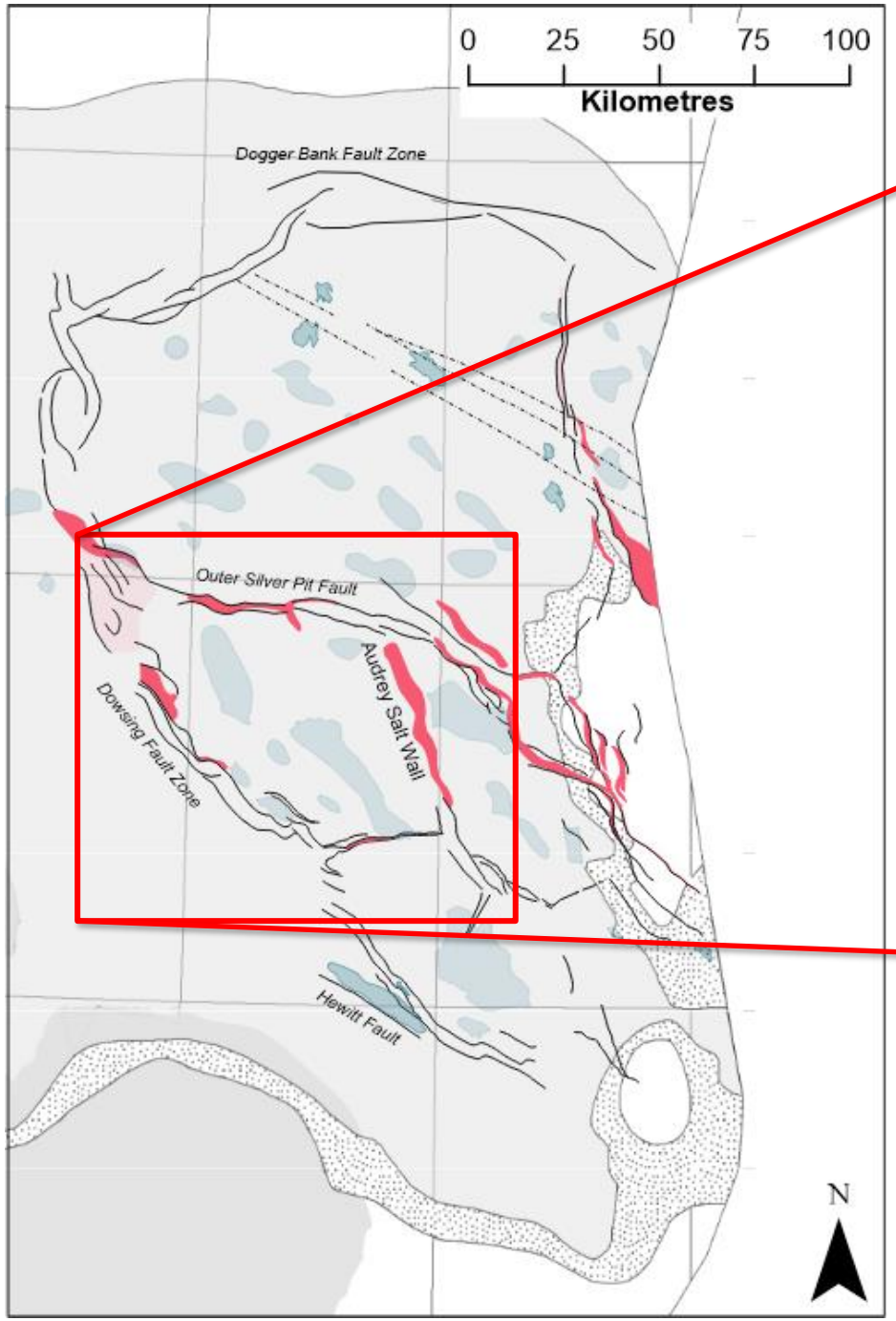

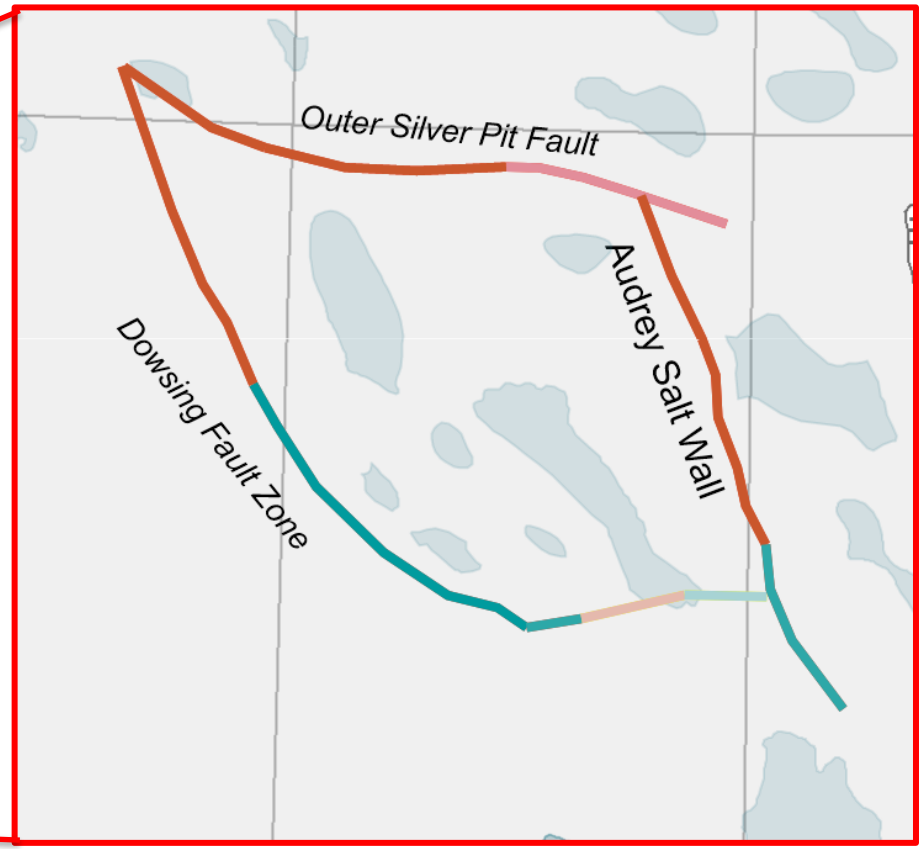

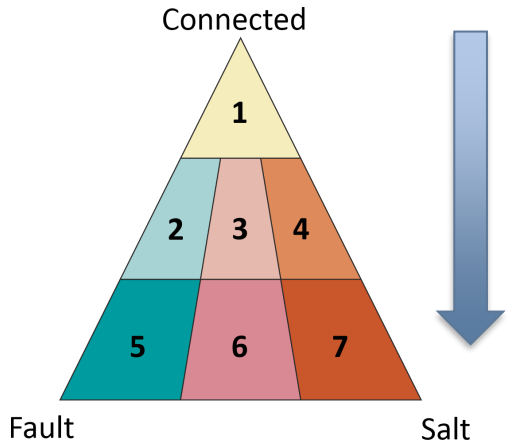

Classified boundaries – note the structure is predominantly sealed except on the southern boundary

Legend

- NSTA Wells
- Outcrop
- Subsurface distribution
- Bunter Sandstone partially eroded
- Salt
- Bunter Sandstone closure
- UKCS Carbon Storage Licences
- Palaeogene Igneous Dykes

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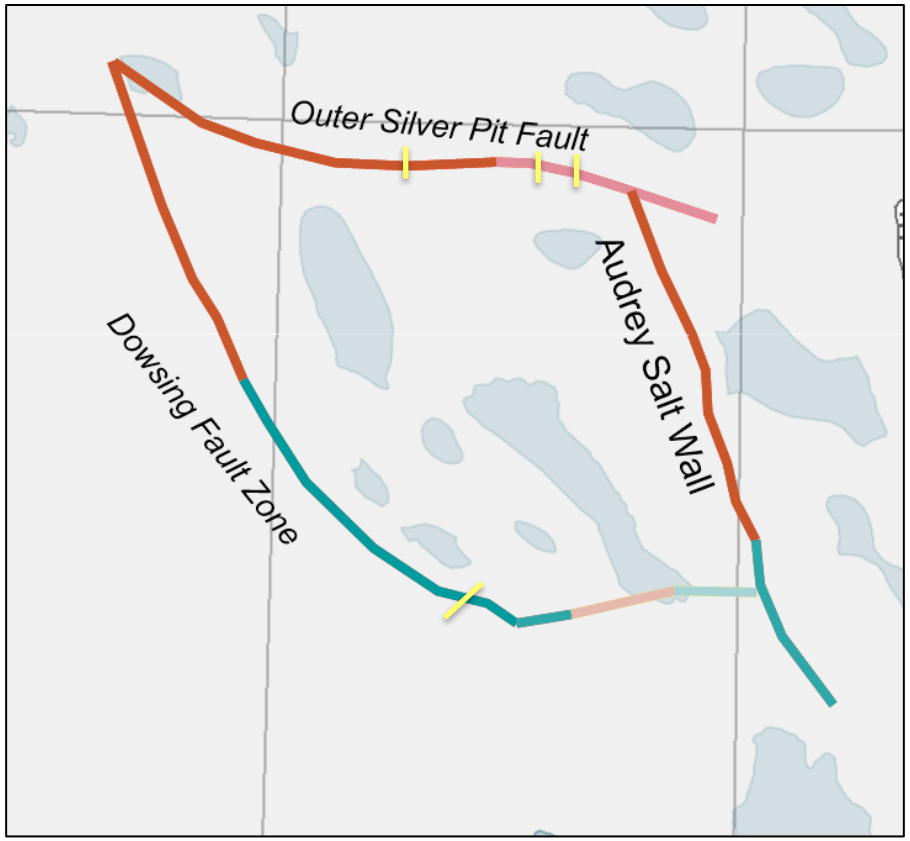

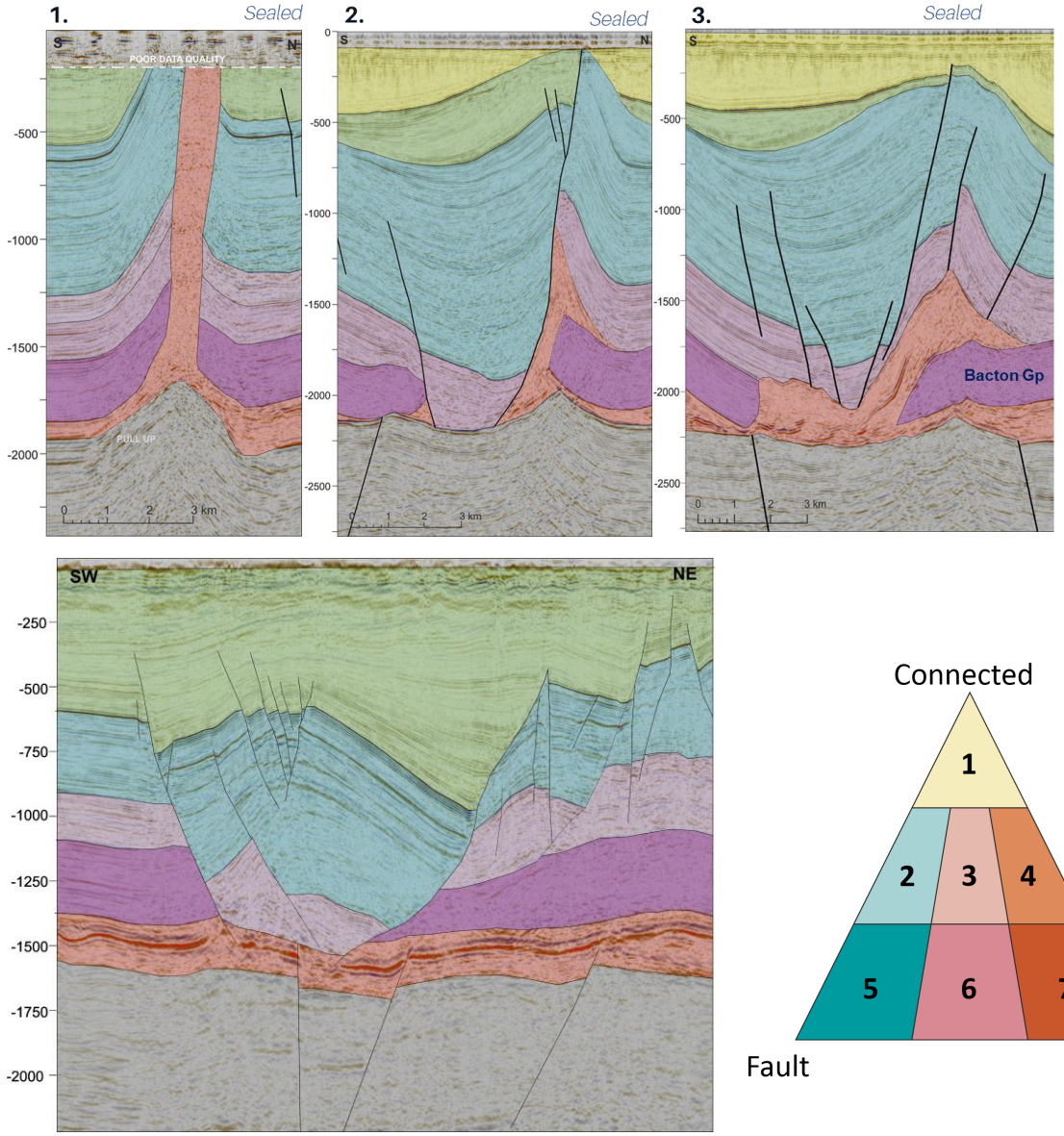

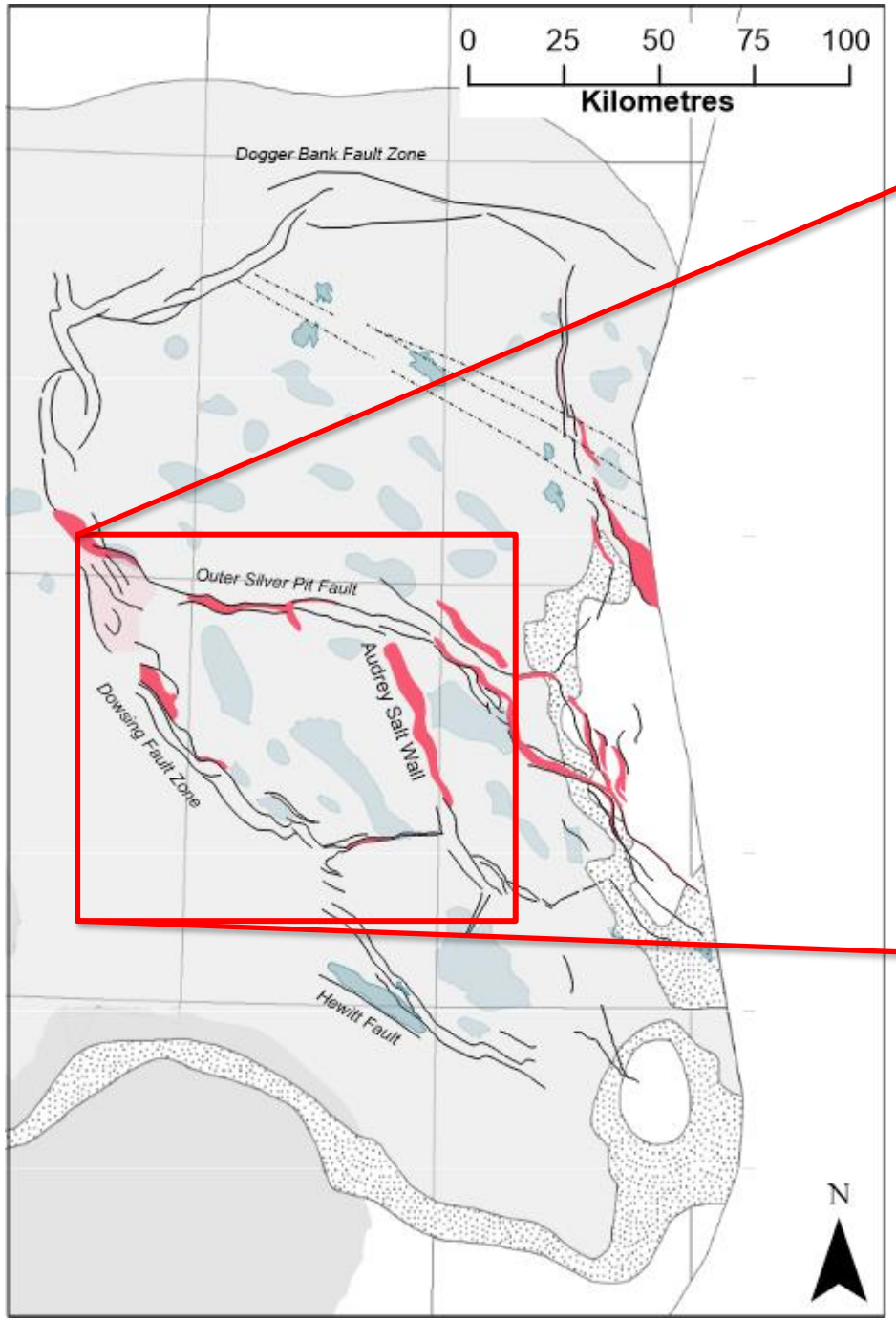

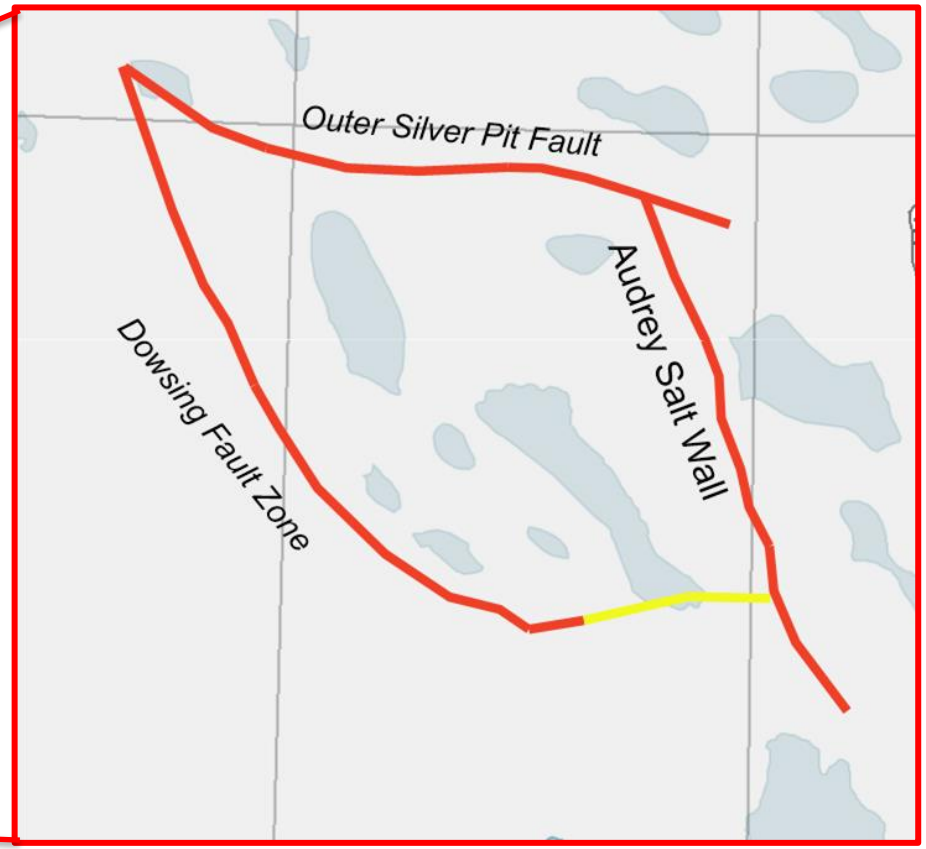

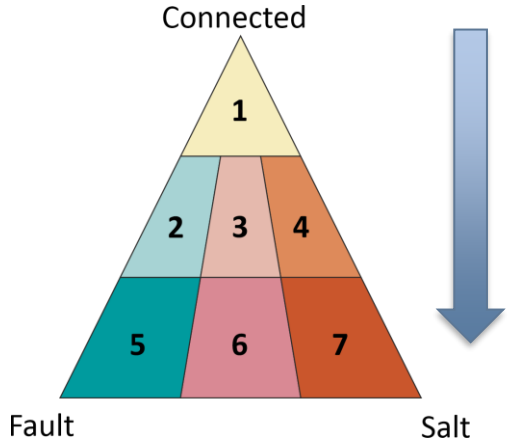

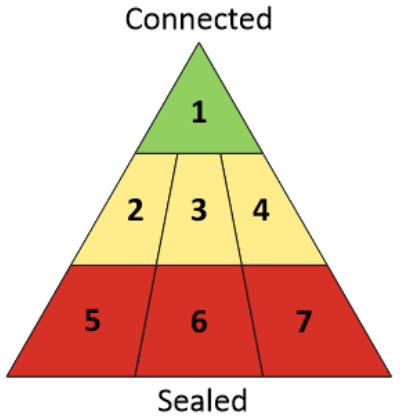

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Emerging Findings

1. The majority of the structural boundaries are considered to be sealed by separation though salt intrusion, faulting or a combination of both
2. Some short sections with potential communication pathways are present. Where there is fault juxtaposition of the Bacton Group the sealing capacity is reliant on that of the fault
3. In transition zones at the ends of salt walls and the intersection of major fault zones, there is a higher degree of uncertainty in the sealing capacity

Acknowledgements

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Thank you