Understanding the composition and distribution of a multi-layered salt-prone stratigraphy, and its role in rift basin development: Insights from the Slyne and Erris basins, offshore NW Ireland

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Research Rationale

- Salt tectonics poorly understood offshore Ireland
  - Salt proven in several wells
  - Salt plays key role in gas discoveries on Irish Atlantic margin (excellent seal)
  - Regional distribution and composition uncertain

- Societal impact
  - Future gas discoveries (energy security)
  - Possible CO₂ storage sites (climate change)
  - Relevance to mining onshore (critical metal supply)

![Diagram showing electricity generation in Ireland by fuel type in 2019 (SEAI, 2020)]
Two main layers proven to date:
- Upper Triassic **Uilleann Halite Member** (part of Currach Fm.)
- Upper Permian **Zechstein Group**

Salt also encountered locally in Mississippian and Lower Jurassic
Mapping the distribution of salt

▲ Well Data
- Few well penetrations
- Average of 55 km separation per penetration in Permian section

▲ Seismic Data
- Salt acts as décollement and will mechanically detach sub- and supra-salt sections
Southern Slyne: Reactive diapirs
Seismic data confidential
Southern Erris: Influence of the neighbouring Rockall Basin

Zechstein Group (Permian):
- Salt-dominated
- Mixed salt-clastic
- Clastic-dominated
- Permian section absent
- Permian section not reached

Gurranche Formation (Triassic):
- Ulliean Halite Member

Mesozoic Basin
- Carboniferous Basin
- Palaeozoic & Pre-Cambrian Basement

Image quality degrades beneath Eocene volcanics

Evidence of significant rift-shoulder uplift and erosion along margin of Rockall Basin

Numerous salt rollers, evidence of Ulliean Halite Mbr
Southern Erris: Transition to clastic dominated
Northern Erris: Clastic-dominated, basement-involved faulting
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Zechstein Group (Permian):
- Salt-dominated
- Mixed salt-clastic
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Carrach Formation (Triassic):
- Ulleneen, Hallie Member

Mesozoic Basin
Carboniferous Basin
Palaeozoic & Pre-Cambrian Basement

Thicker Carrach Fm. with significant sandstone content
Sub-metre-scale anhydrite stringers encountered in well
Salt Distribution: a better understanding

▸ Zechstein Group:
  - Salt-prone in Slyne and southern Erris basins
  - Clastic & carbonate-prone in northern Erris Basin

▸ Currach Formation:
  - Mudstone prone throughout the study area, with thin anhydrite stringers
  - Uilleann Halite Mbr. developed in the northern Slyne and southern Erris basins

▸ Implications?
  - N. Slyne and S. Erris are the most prospective areas for both gas exploration and future CO₂ storage
The Corrib gas field: how does it work?

- Sub-commercial 'Corrib North' gas discovery
- Reactive diapir in footwall of delamination fault
- Gas accumulation in Lower Triassic sandstone
- Fold axis of salt-cored fold parallel to diapir

Northern Slyne Basin

A) Corrib Sandstone Fm.
B) Corrib Fm.
Impact of post-rift tectonics on hydrocarbon prospectivity

Evidence of post-rift fault movement in Cretaceous and Cenozoic

Northern Slyne Basin

Gas charge preserved in Lower Triassic due to delamination fault breaching overlying Upper Triassic salt

Post-rift movement on main delamination fault breaches oil accumulation in Upper Jurassic sandstones

Triassic gas accumulation in 4-way dip closure

Breached Jurassic oil charge in tilted fault block sealed by main delamination fault
Evolution of the Corrib structure

1. Initial Zechstein pillow formation due to sub-salt basement faulting

2. Overburden at crest of anticline becomes unstable, delamination faults form, soling out in Uilleann Halite Mbr.

3. Additional loading in flanking synclines drives further growth of salt pillow

4. As extension continues, reactive diapir forms in footwall of main delamination fault, parallel to the axis of the salt-cored fold

5. Post-rift extension during Cretaceous and Cenozoic indicates post-rift growth of salt-pillow
**Conclusions**

▲ Salt distribution better understood offshore NW Ireland
   • Northern Slyne and Southern Erris areas most prospective for gas exploration and future CO₂ storage
   • Implications for Permian paleogeography and early Atlantic rifting

▲ Multi-layer salt interaction driven by mechanism of positive feedback
   • Zechstein Gp. halokinesis driven by regional extension
   • Uilleann Halite Mbr. halokinesis is (predominately) reactive to the topography formed by Zechstein Gp. salt movement

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