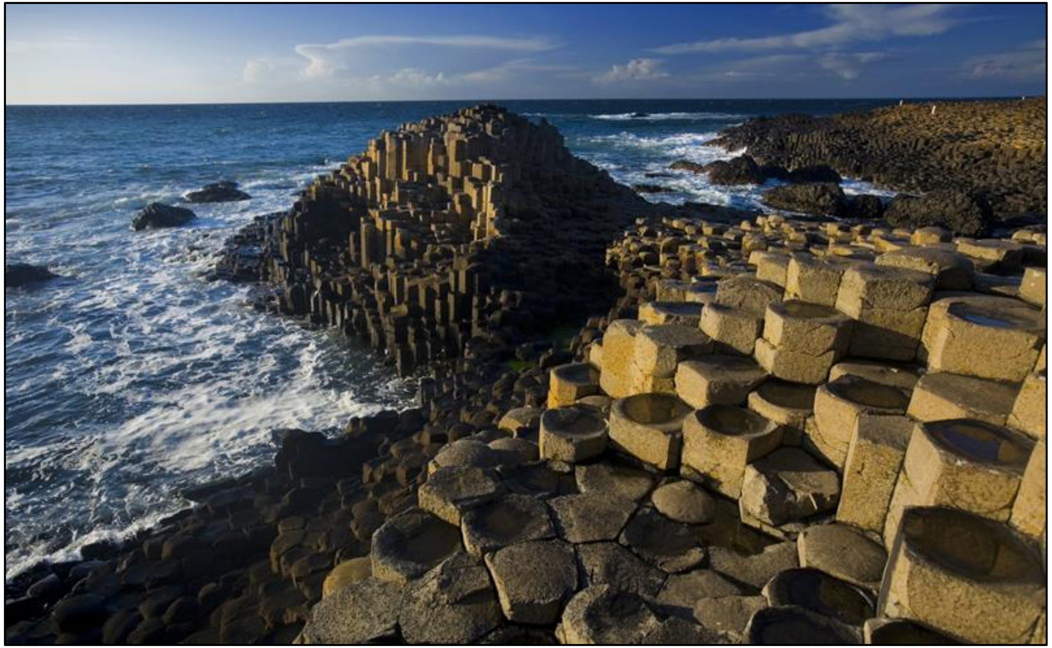
Petroleum System Insights from Evaluation of Volcanic Reflectors, Irish Rockall Basin

Spectrum



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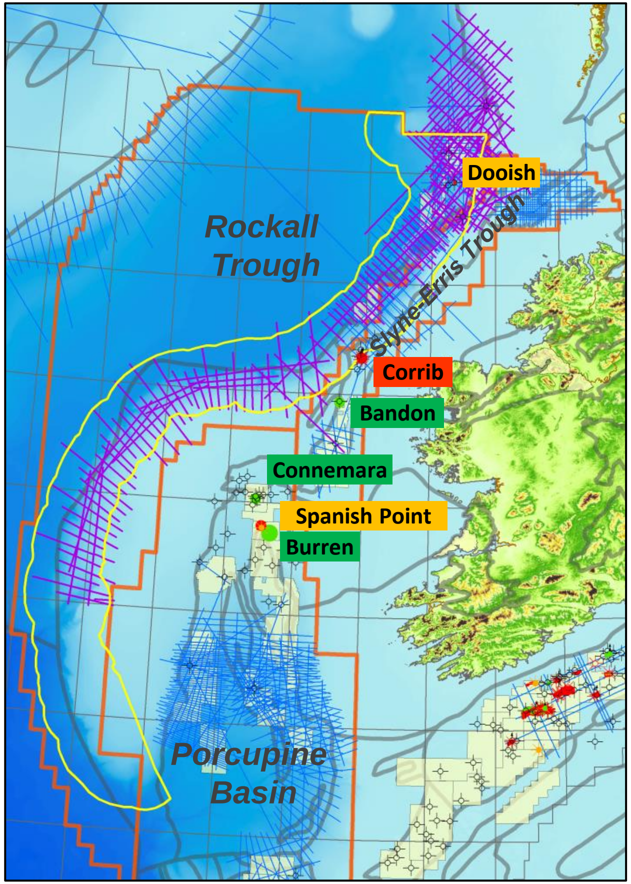
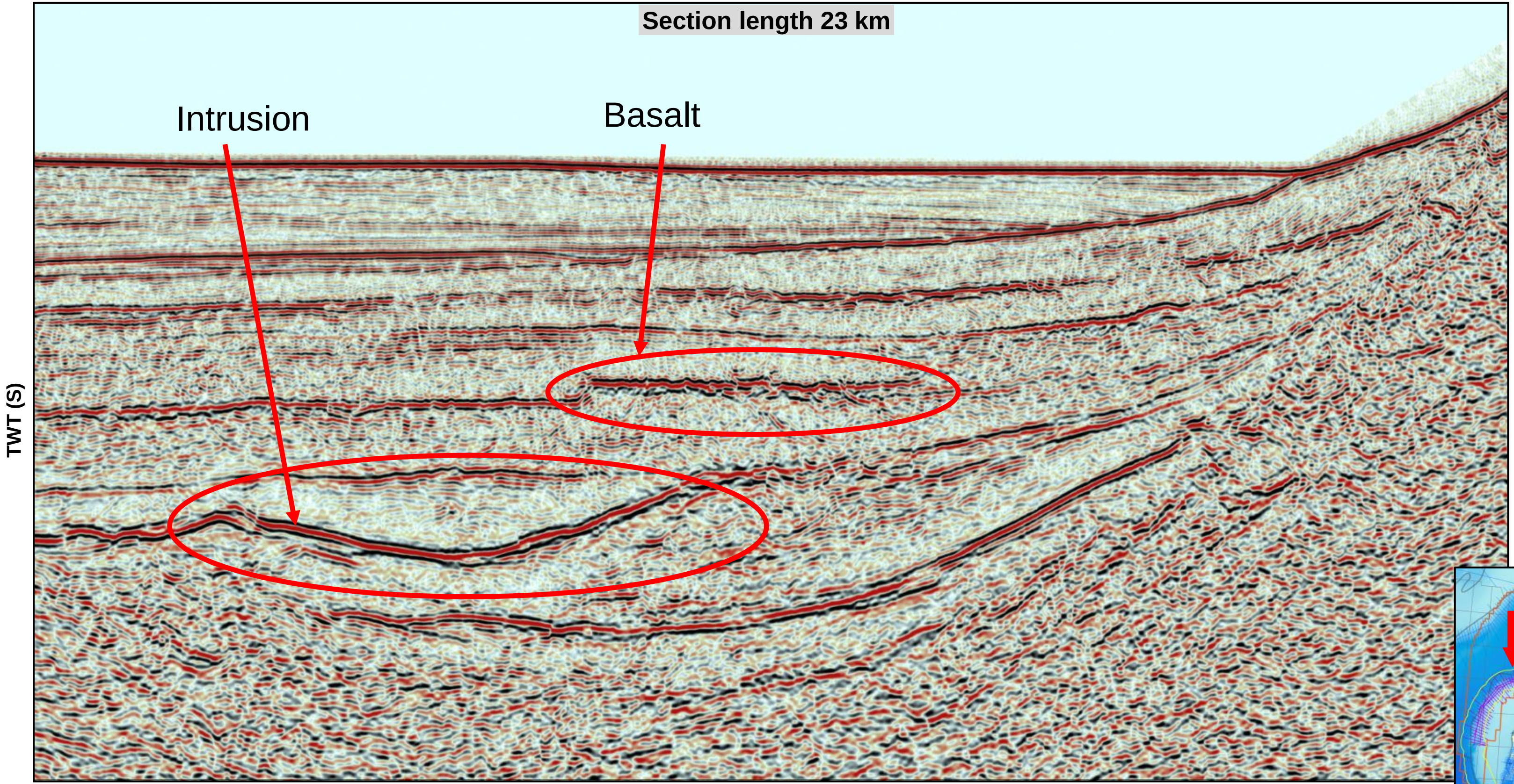
Atlantic Ireland 2015

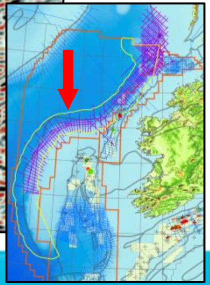
Introduction

- Proven petroleum system; Dooish, Corrib and Bandon discoveries in Rockall & Slyne-Erris Trough
- Analysis of 11,000km reprocessed legacy 2D seismic lines (purple)
- Data cover Rockall eastern margin ‘Area of Environmental Sensitivity’
- Until recently, the influence of Palaeogene volcanism on the petroleum system in Rockall has been largely overlooked

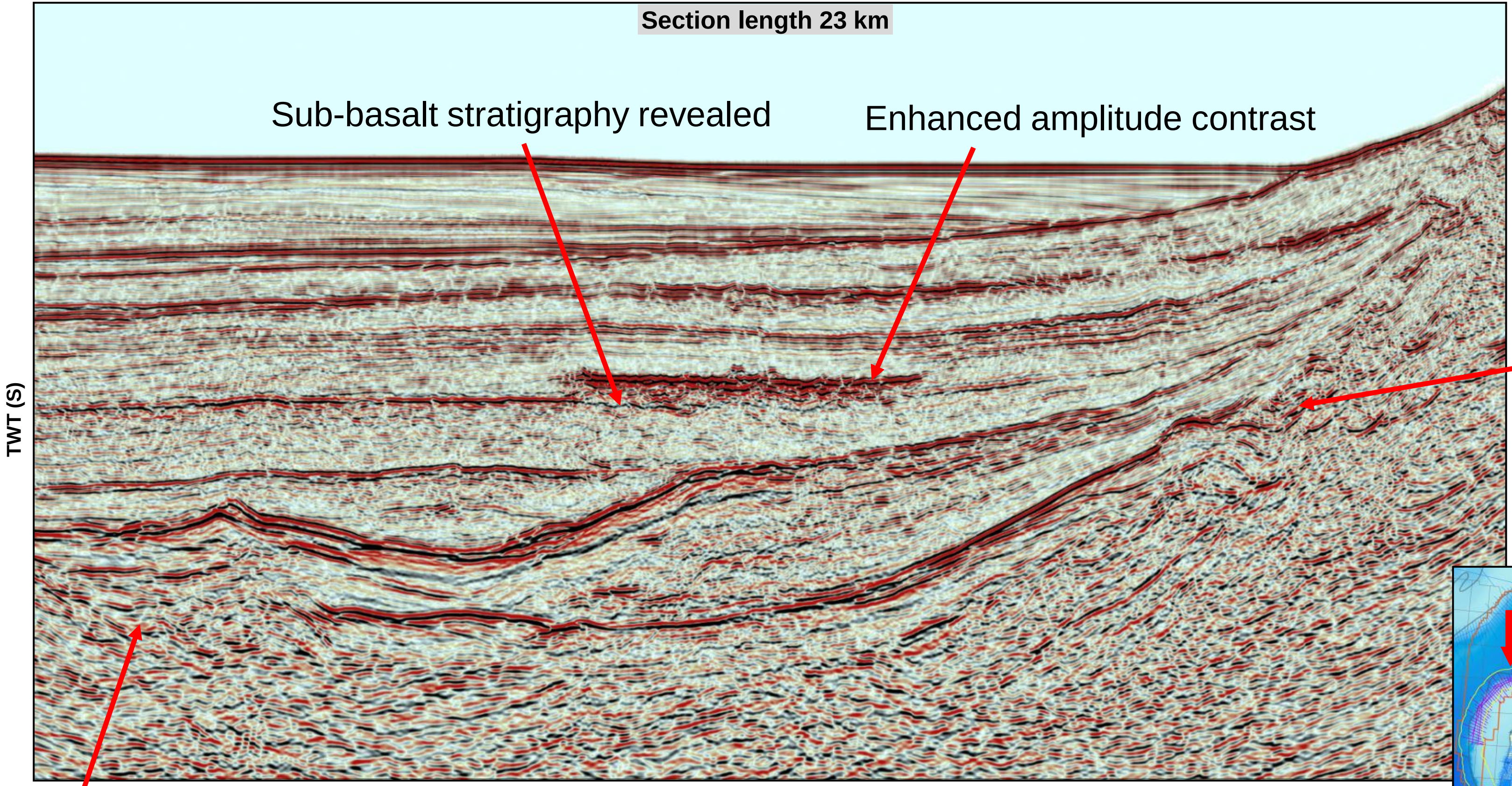


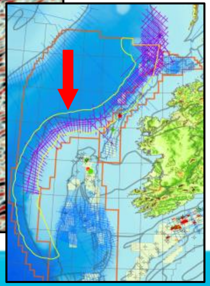
Example Line – Original Mig. 1996





Example Line – Repro 2014





Increased frequency content

Tectonic Evolution

- Rockall Trough – failed rift arm following opening of North Atlantic
- Main rift Late Jurassic to Early Cretaceous
- Highly stretched continental crust – multiple rifting events?
- **Palaeogene transient epeirogenic uplift and igneous activity – 'British Palaeogene Igneous Province' (BPIP)**

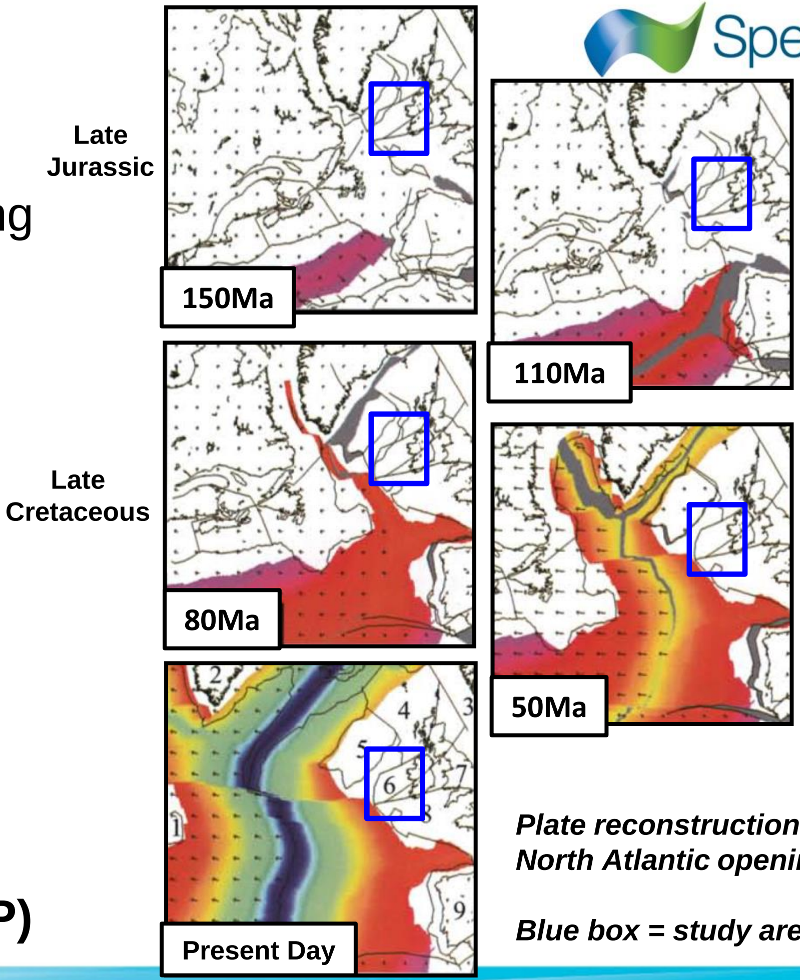
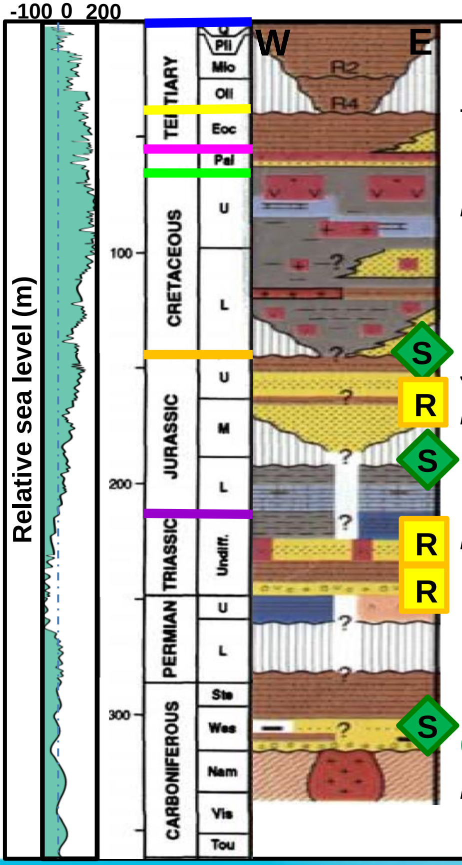


Plate reconstruction of North Atlantic opening

Blue box = study area

Cole & Peachey (1999)

Stratigraphy



Thermal subsidence
Tertiary deep water turbidites
Palaeogene basalt flows
Regional uplift, localised fault inversion, erosion
Palaeogene sills intruded in Cretaceous sediments
Deepwater turbidites
Thermal subsidence
Syn rift – **Lacustrine & shallow marine shales,** shelf sandstones
Main rift – associated with N Atlantic opening

Lacustrine shales
Earlier Triassic rift?

Permian/Triassic evaporites & restricted marine

Continental clastics, coals
Earlier Carboniferous rift?

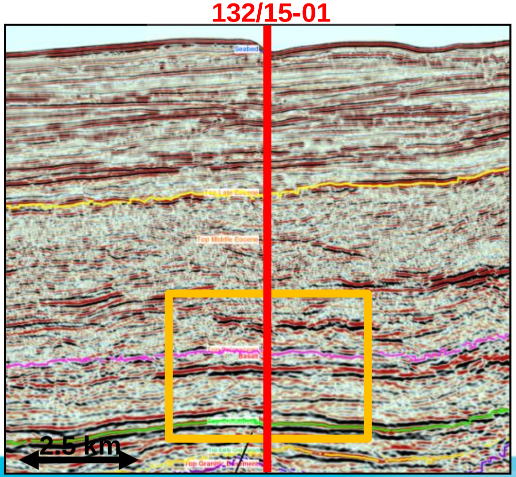
Post-rift
Syn-rift
Pre-rift

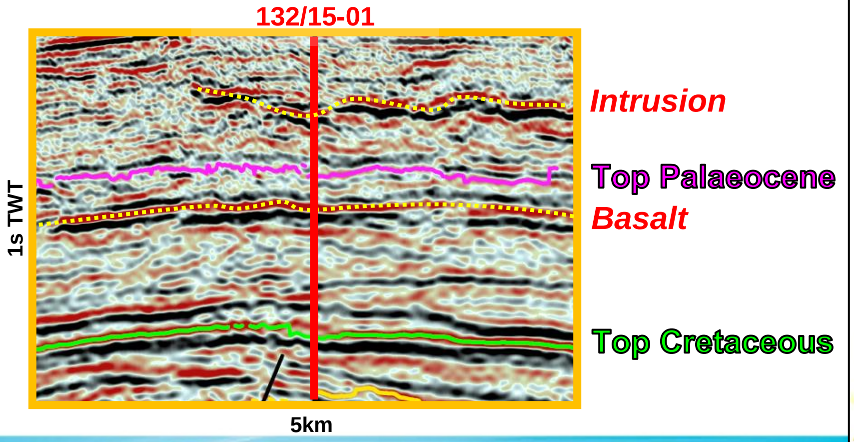
Modified from Tate et al (1999)
Relative sea level curve from Haq (1987)

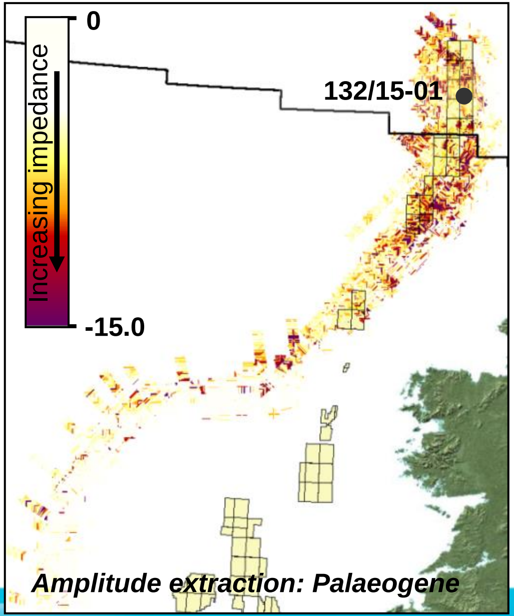
Identification of Volcanic Reflectors

Igneous extrusives:

- Top Basalt – significant increase in acoustic impedance, within Palaeogene strata
- Basalts concentrated in north, close to Igneous Province
- Well 132/15-1 (UK Sector) – 40m thick basalt & tuffaceous mudstone interval, 25ms TWT high amplitude event



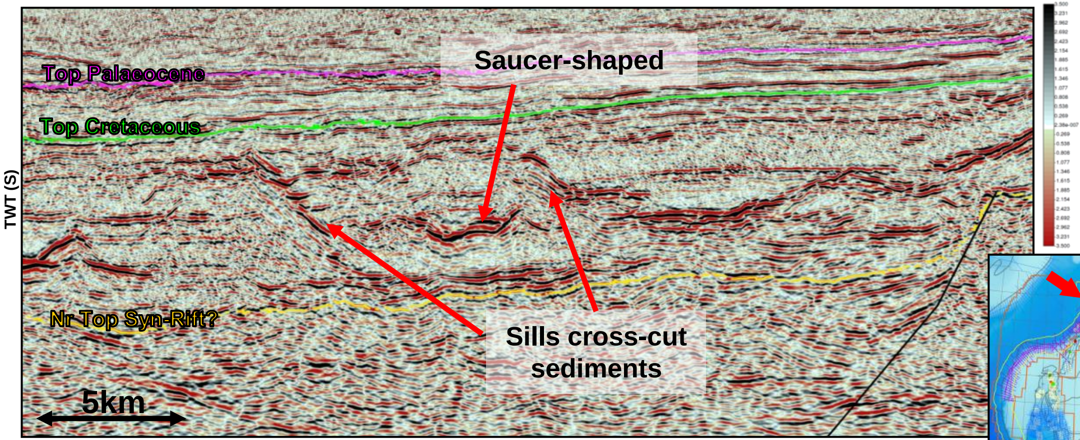


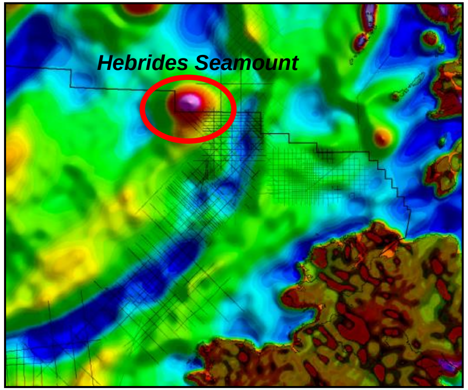


Identification of Volcanic Reflectors

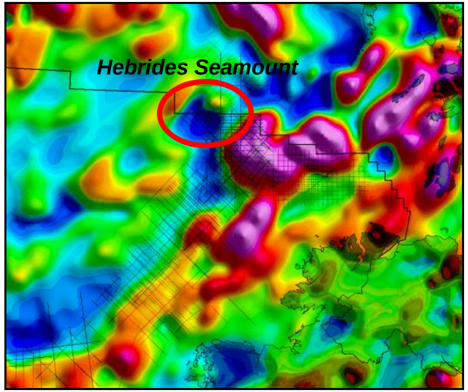
Igneous sills:

- Significant increase in acoustic impedance
- Stratigraphic relationships
- Geometry
- Cross-cutting sediments
- Existing structure & faults
- Gravity & magnetic data can be used to interpret large plutons & volcanoes





Satellite Gravity Grid



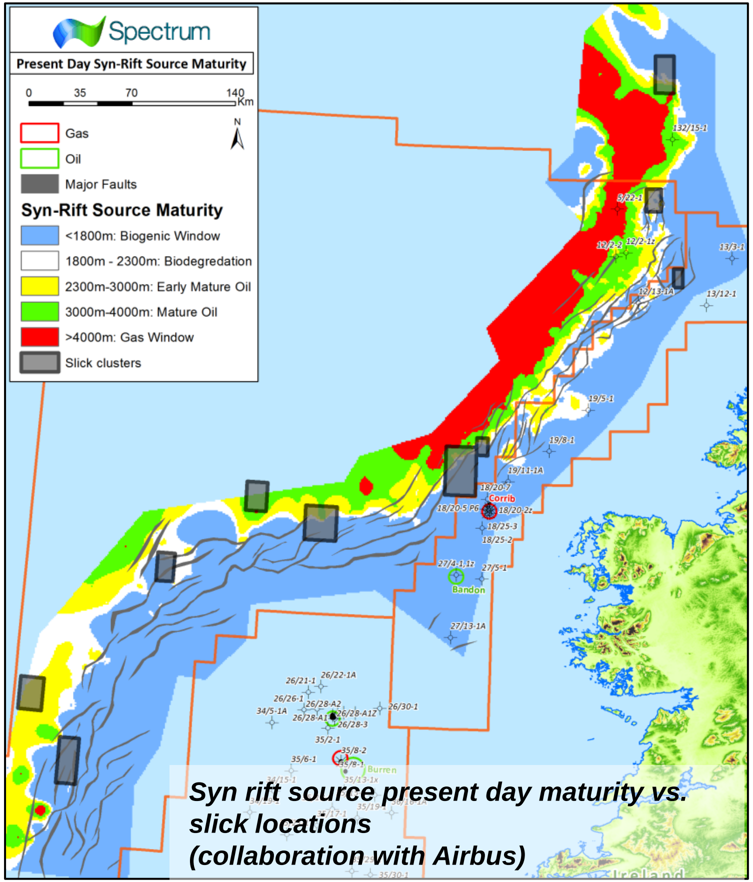
Magnetic Grid

Influence on Source Rocks

- Spectrum satellite slick study – mature Jurassic oil source?

- Direct heating can cause early maturation; oil window shallowed by 1.4km in north Rockall in Early Eocene (Clift, 1999) **however**…

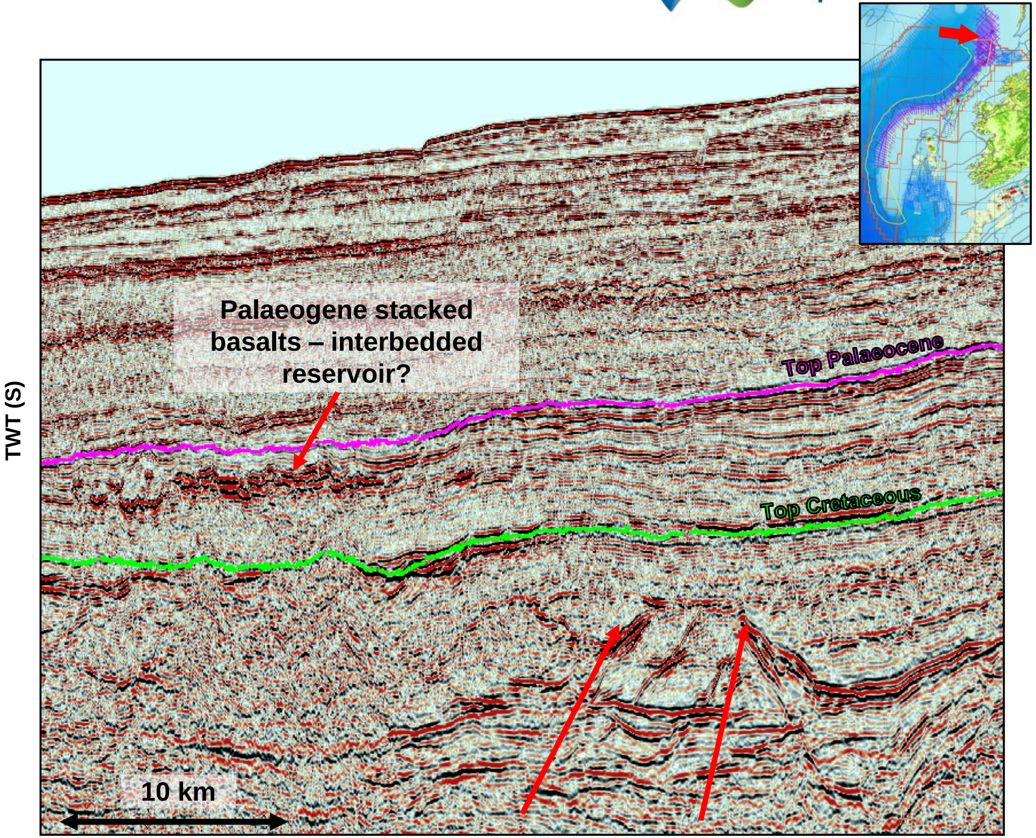
- Limited lasting effect on generation?
  - Peak palaeo-heat flow 70mW/m², progressive underplating
  - Present-day 45-50 mW/m²
  - Thermal effect of sills limited, unless they occur in high numbers (Rohrman, 2007)
  - Majority of sills in Cretaceous sediments;
    Jurassic source probably escaped thermal influence (Davison et al, 2010)



Syn rift source present day maturity vs. slick locations (collaboration with Airbus)

Reservoir Influence

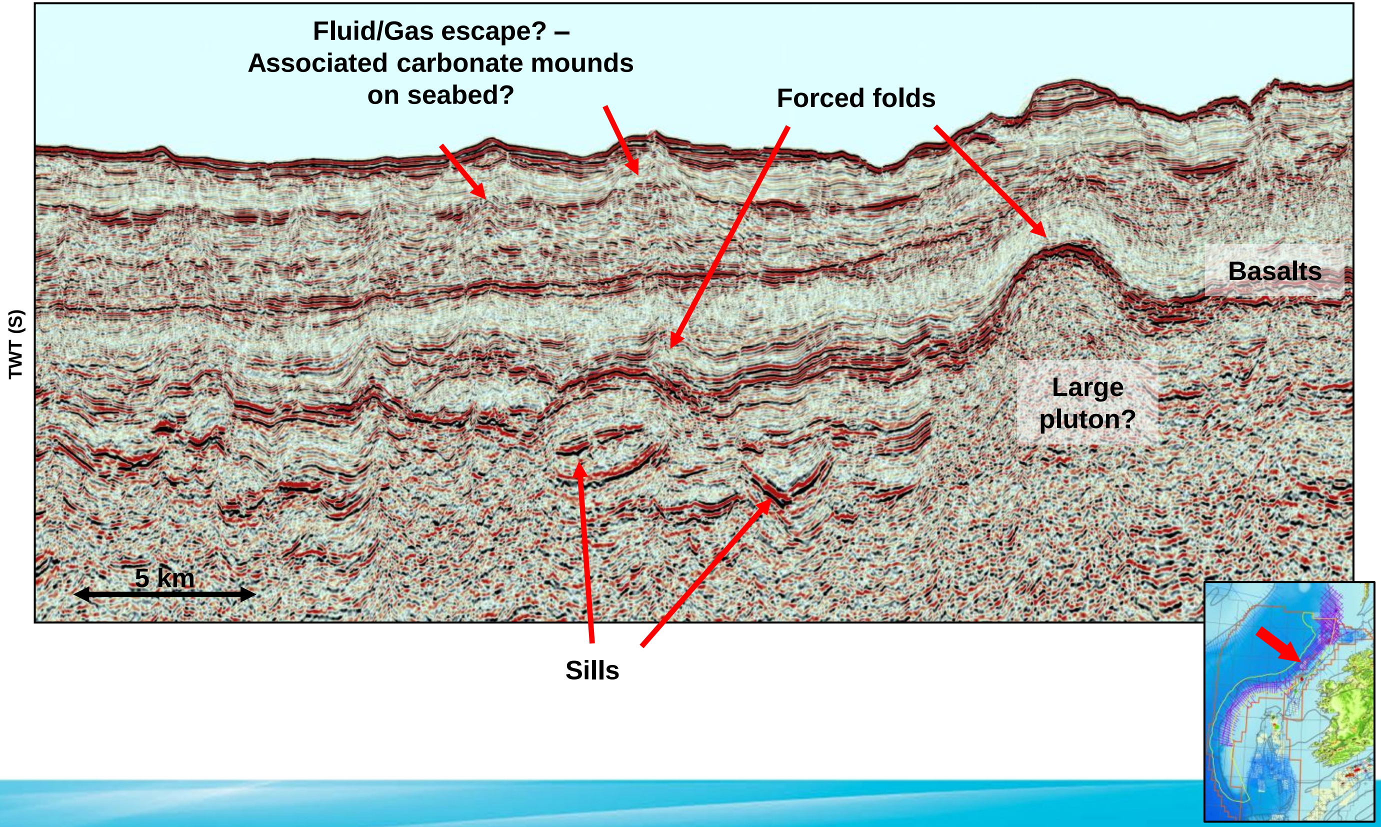
- Sandstones may be present between basalt lavas (Rosebank analogue) – difficult to image
- Hyaloclastites – low porosity, not suitable reservoirs
- Contact metamorphic zone around sills – local recrystallisation may reduce poro-perm
- Sills can compartmentalise reservoirs & create overpressure zones



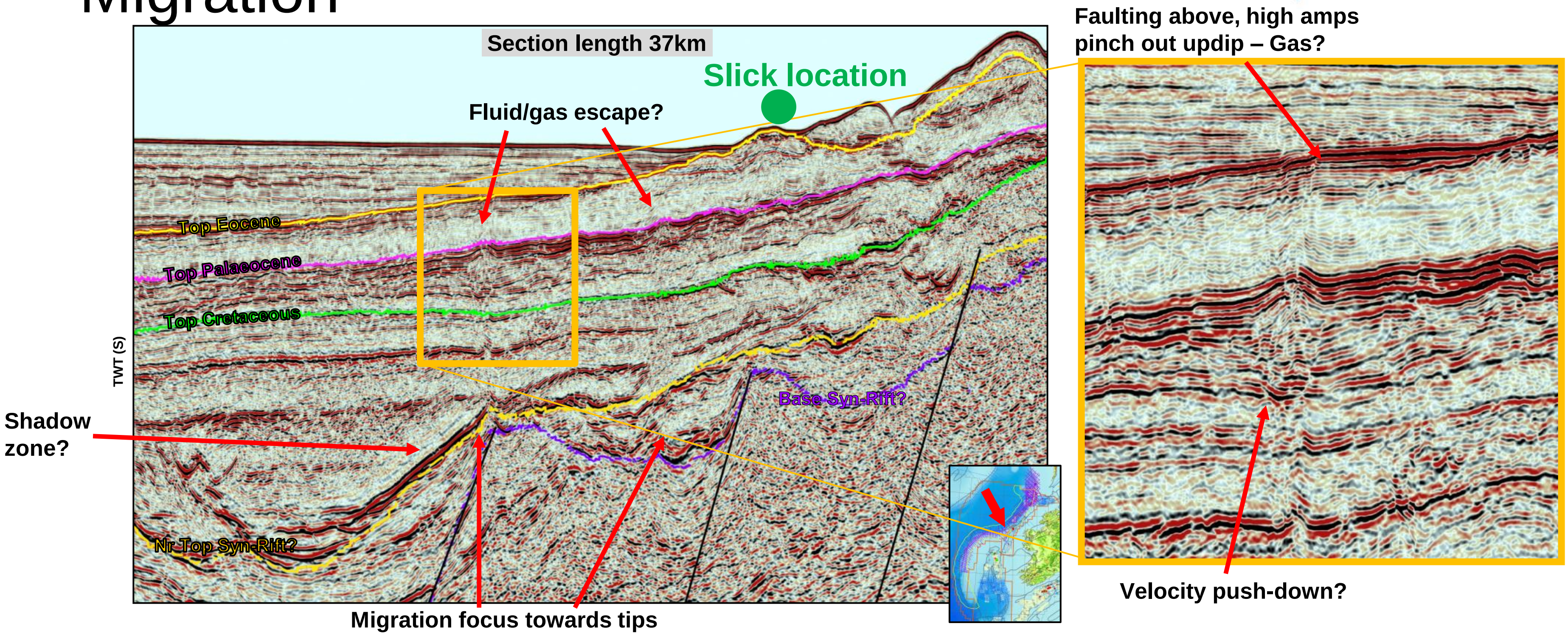
Intrusion networks may compartmentalise reservoirs

Trap Creation & Sealing Efficiency

- Basalt sealing efficiency difficult to predict
- Sills may seal faults
- Sill cooling joints generally do not connect – effective top seals, dykes effective side seals, create stratigraphic traps
- Forced fold anticlines



Migration



- Saucer-shaped sills can act as baffles, barriers or conduits to fluid flow, affecting charge & migration patterns, creating shadow zones above, and fluid concentrations at sill tips (Rateau *et al*, 2013)

Conclusion

- Palaeogene volcanism has previously discouraged explorers
- Limited lasting effects on hydrocarbon generation
- Has restricted impact on reservoir quality, can cause compartmentalisation, influence migration pathways, and create structural and stratigraphic traps
- **Enhanced seismic imaging of volcanic reflectors and underlying sediments is crucial to reducing risk**