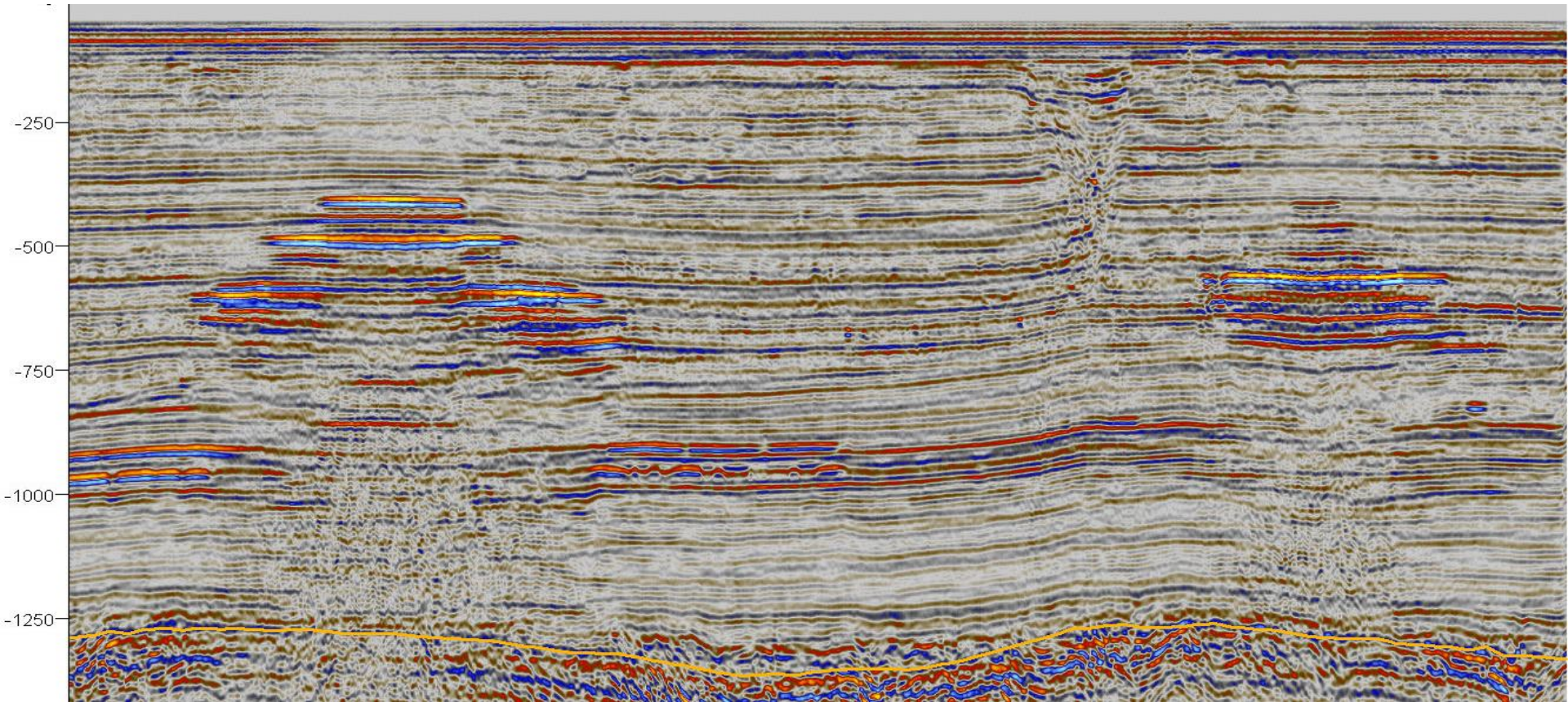


Derisking Shallow Gas as Exploration Target by Seismic Characterisation



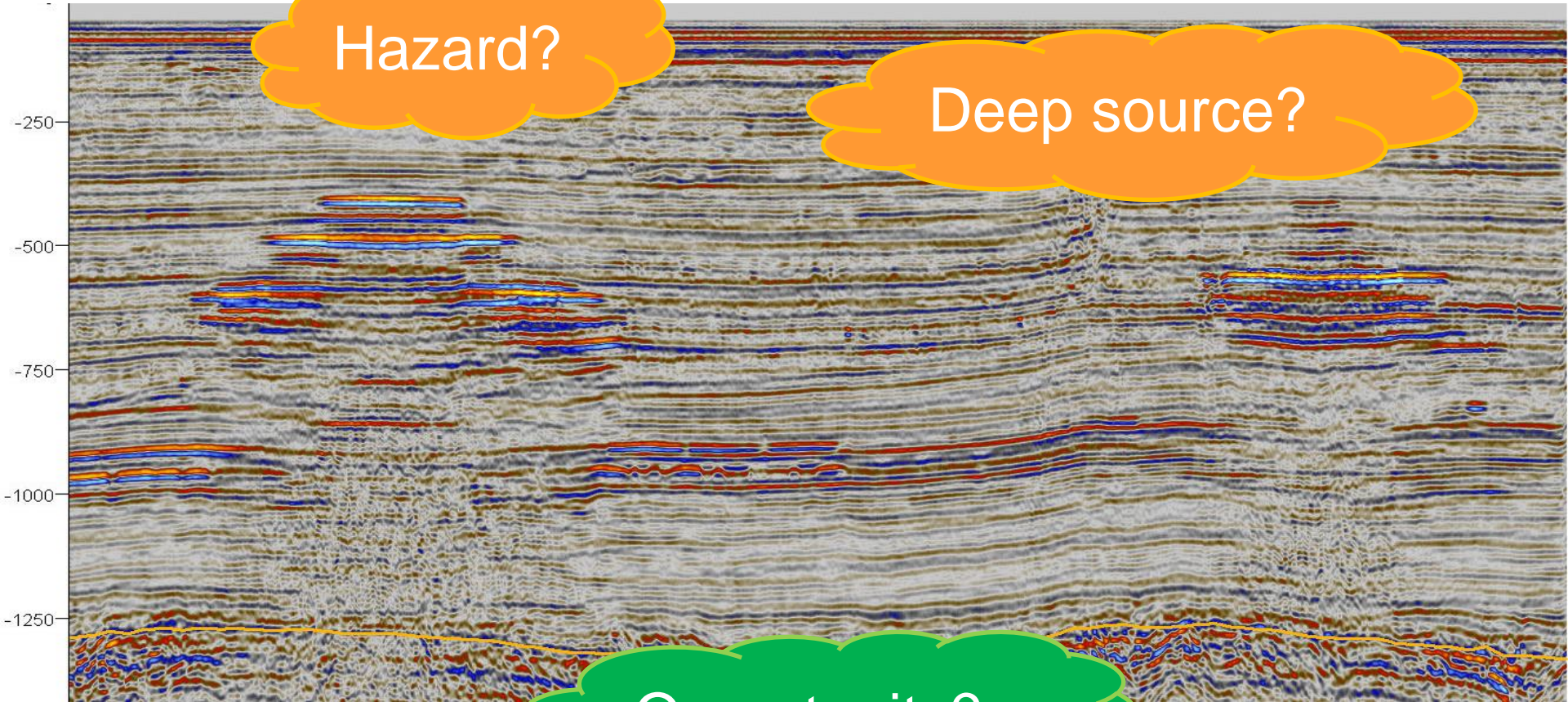
Mijke van den Boogaard & Guido Hoetz (EBN)

Shallow Anomalies Workshop 2014
Indications or prospective petroleum systems?

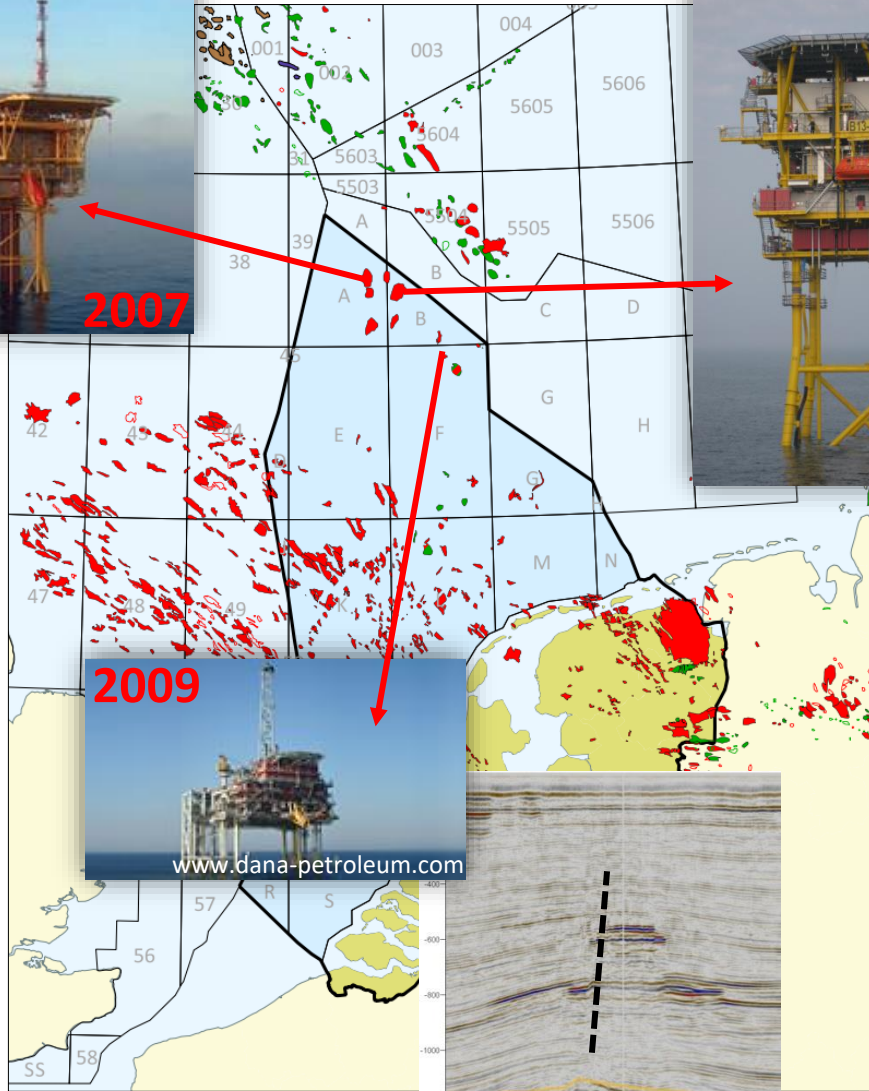
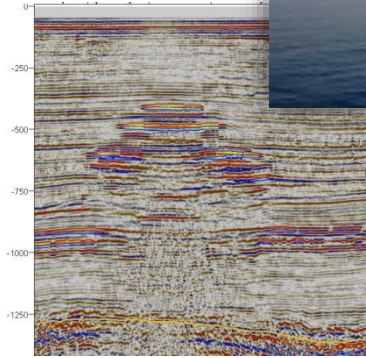
Hazard?

Deep source?

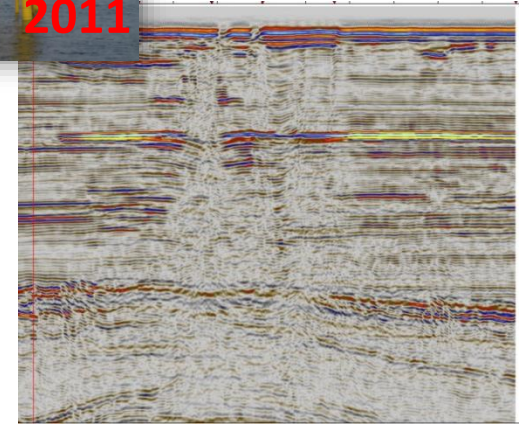
Opportunity?



Shallow Gas Pays Off!

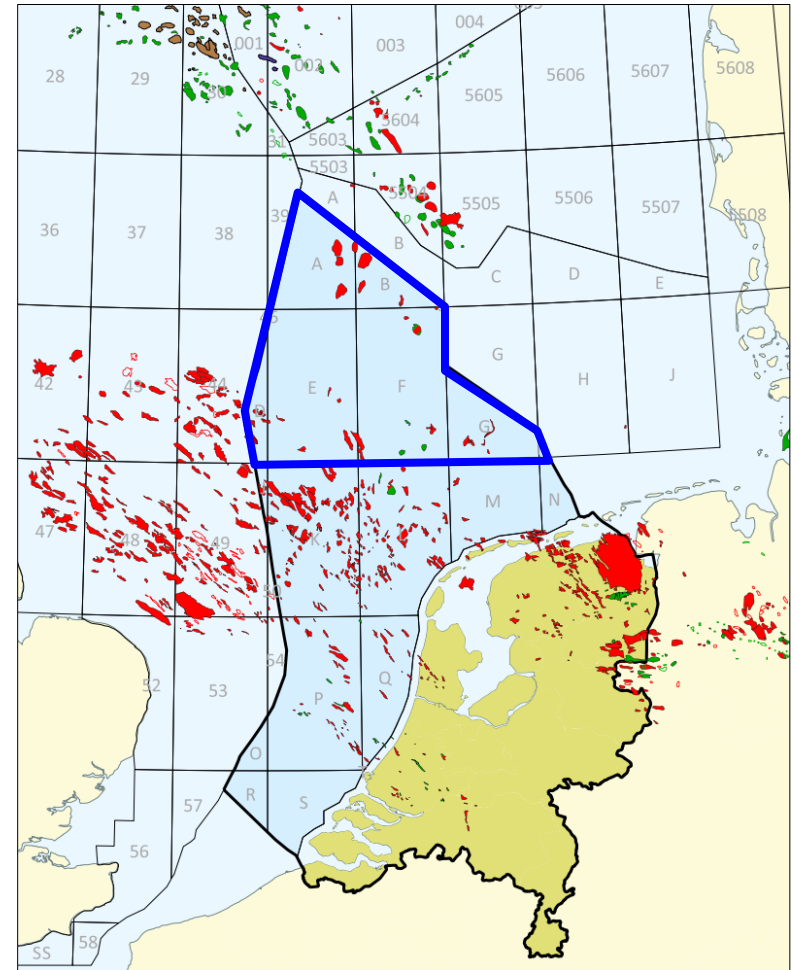


2009



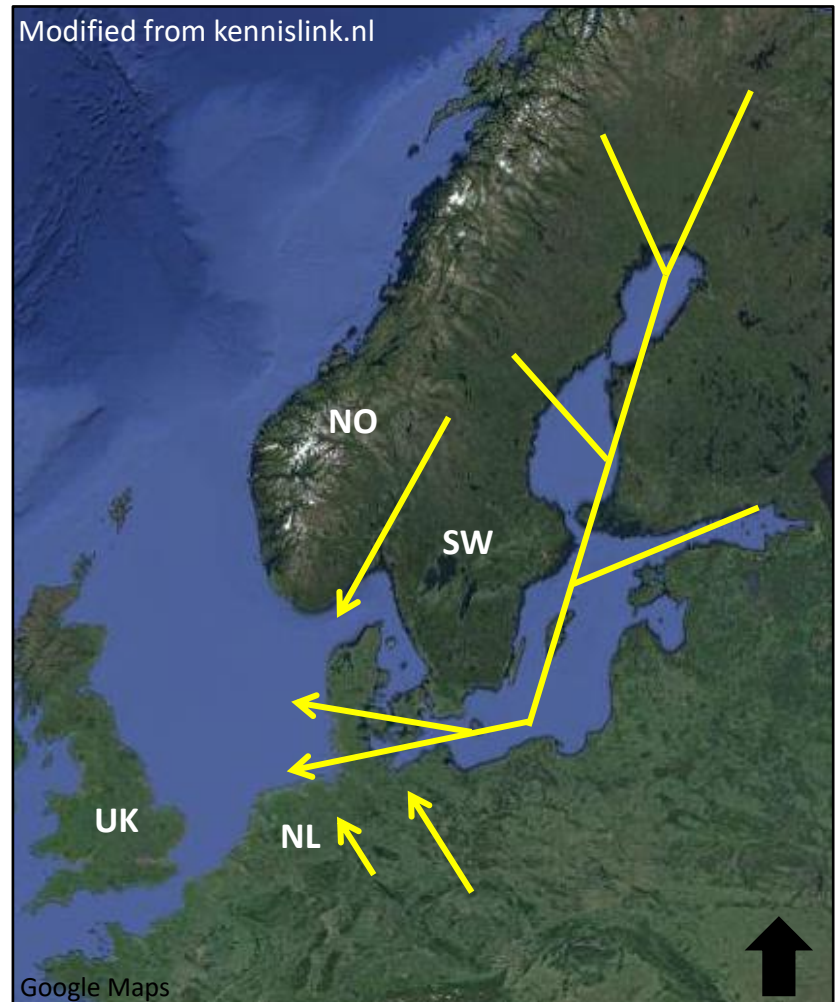
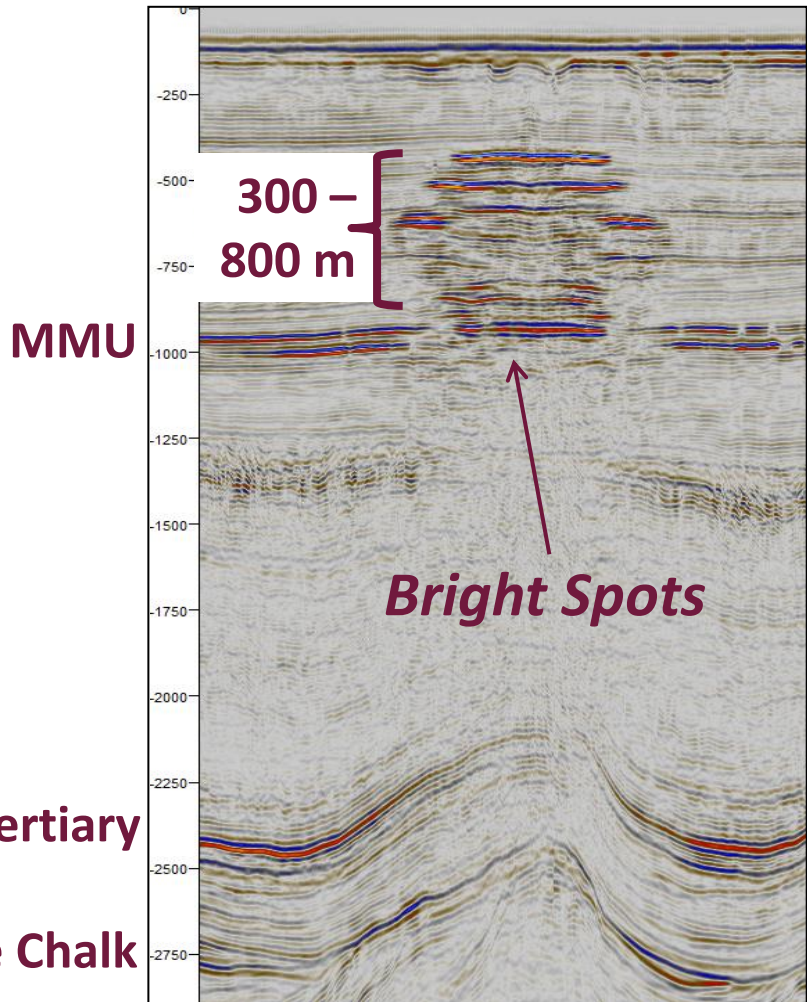
Today ~8 bcm gas produced

1. Introduction
2. New play rather than hazard
3. Seismic characterisation
4. Case study
5. Summary

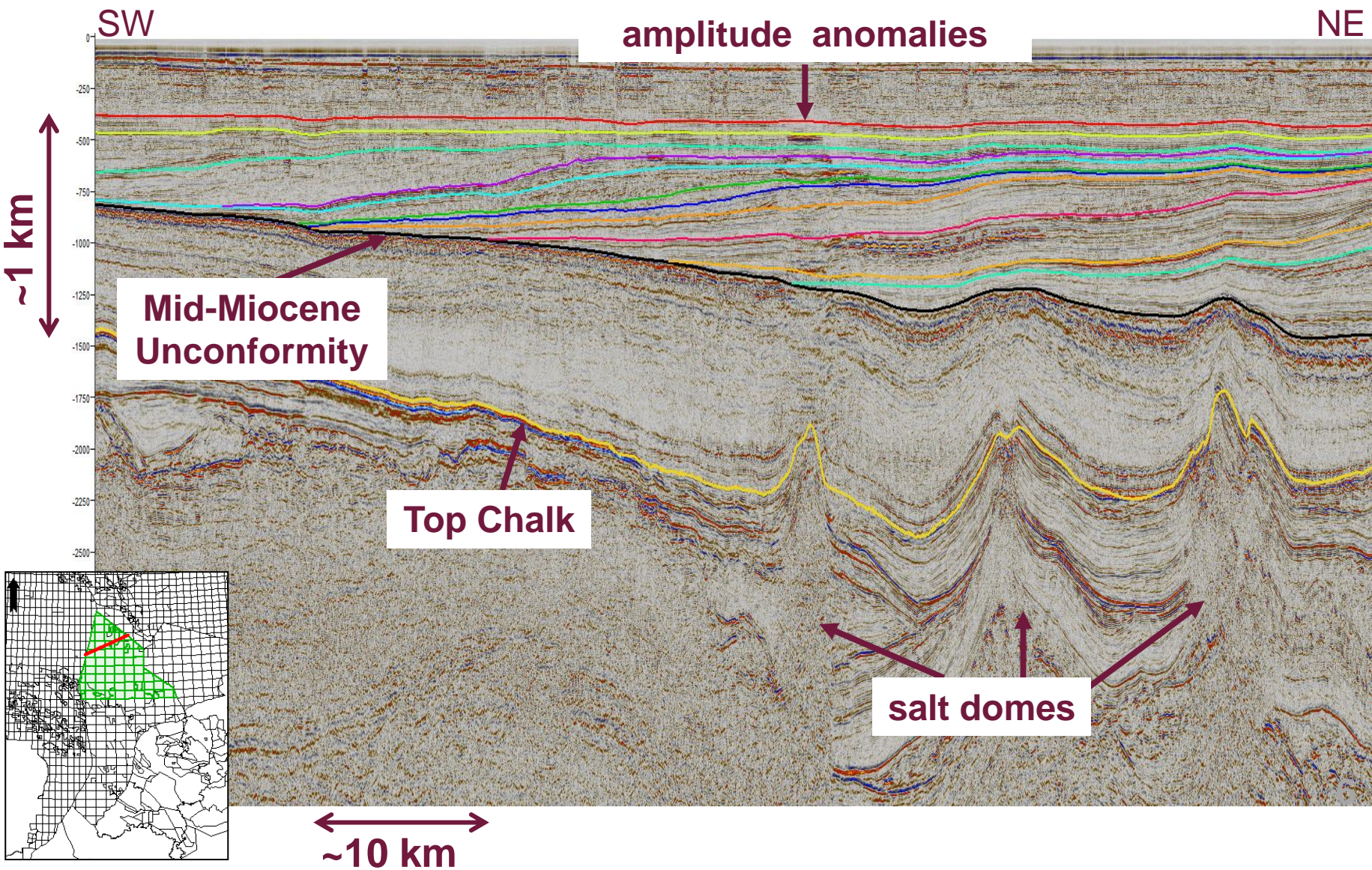


Geological Setting

Shallow Gas (SG) = gas in unconsolidated, Miocene-Pleistocene sands

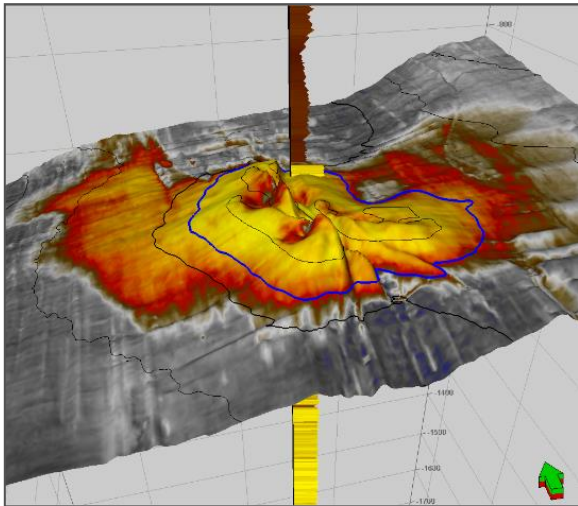
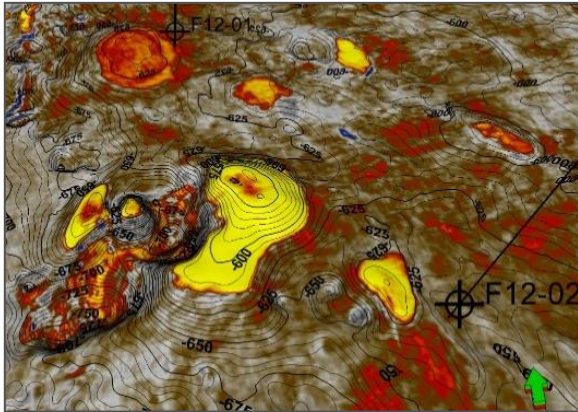


Geological Setting

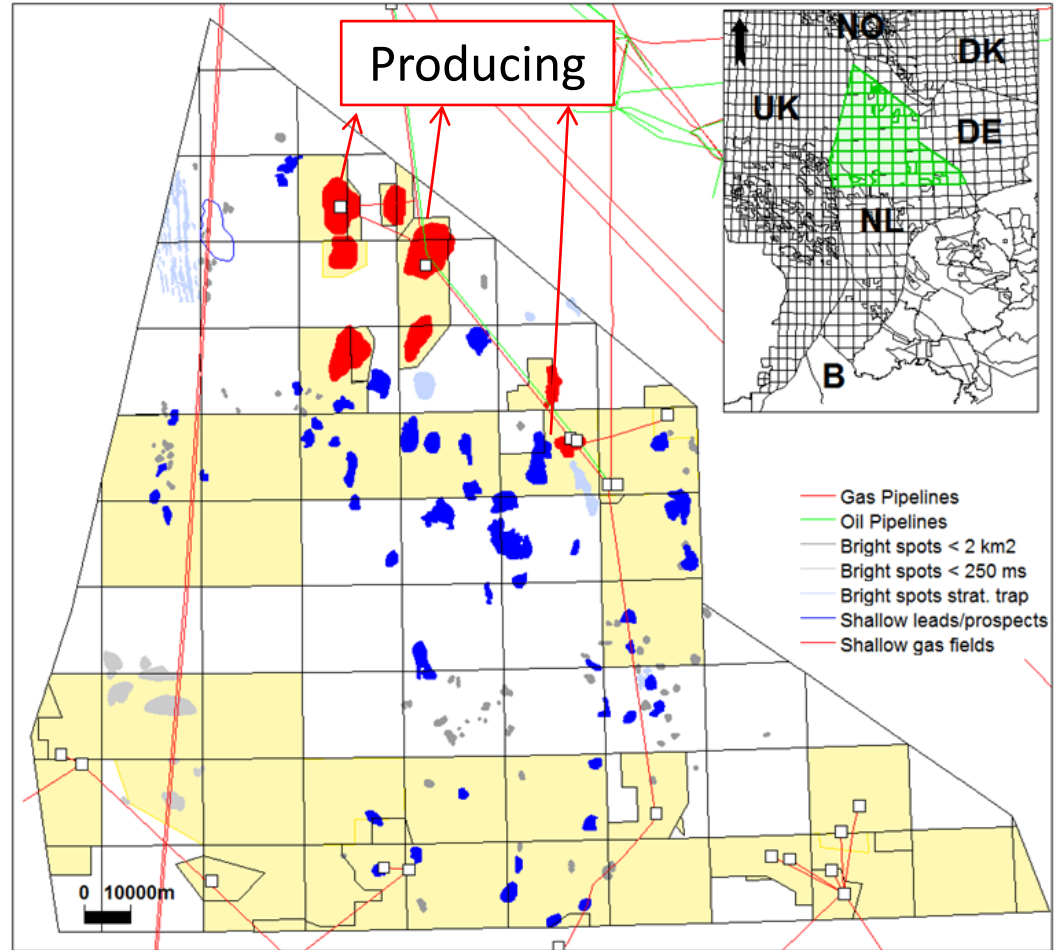


Shallow Gas Portfolio

4-Way dip closures

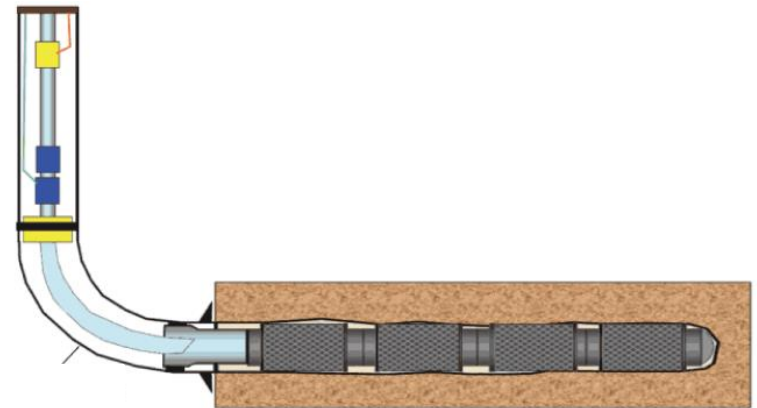


Fault dip closures

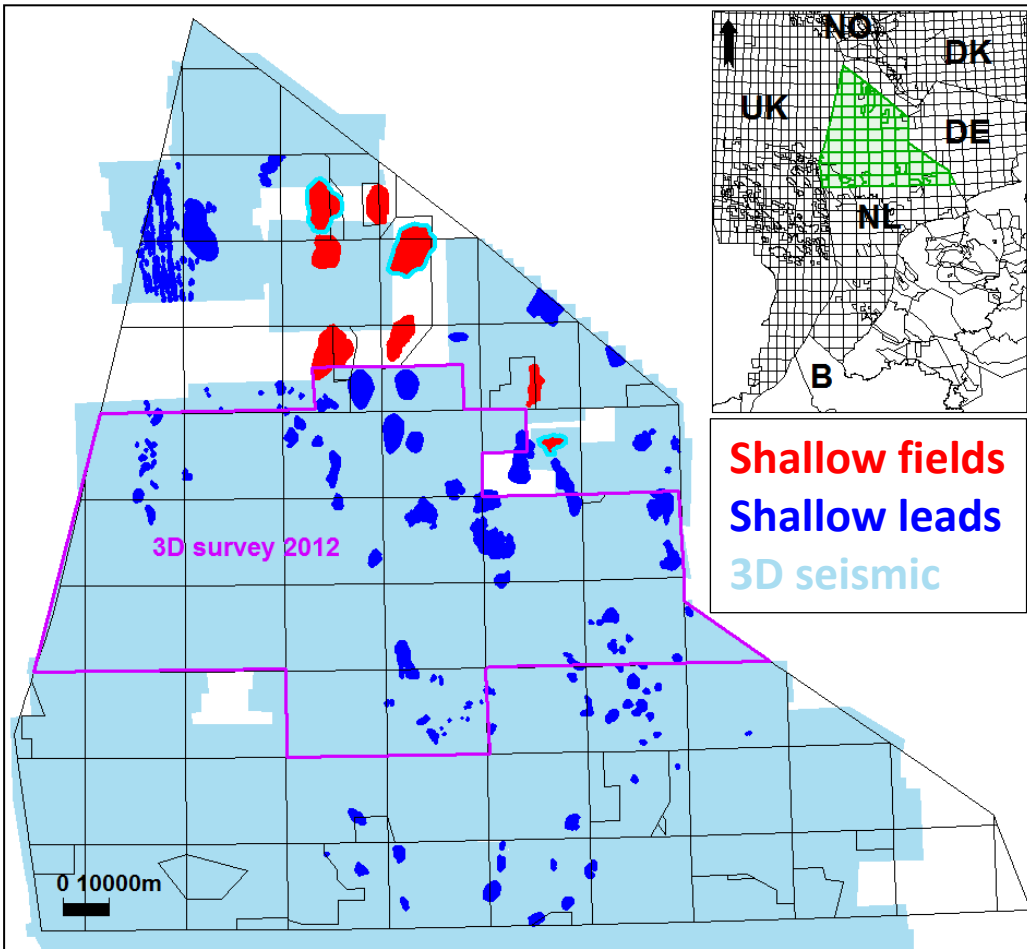


Shallow Gas Production

- Presence shallow gas known since 70's
- Early water breakthrough & sand production expected
→ fields not developed
- Currently 3 successfully producing fields:
 - A12-FA (2007)
 - F02a-B-Pliocene (2009)
 - B13-FA (2011)
- Technical breakthrough
(e.g. sand control in horizontal wells)

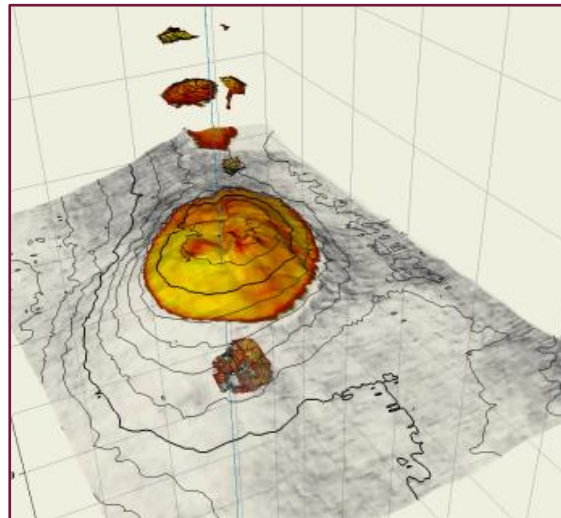
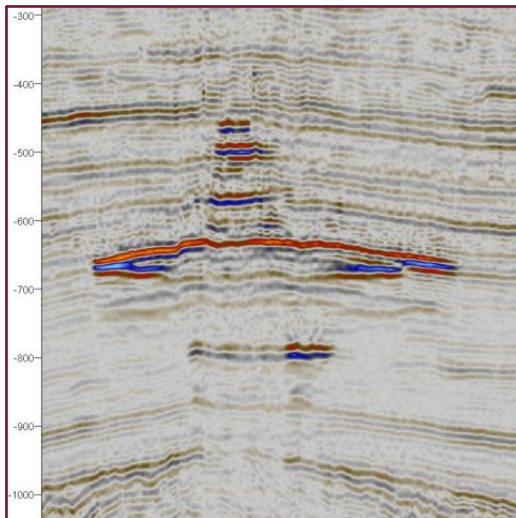
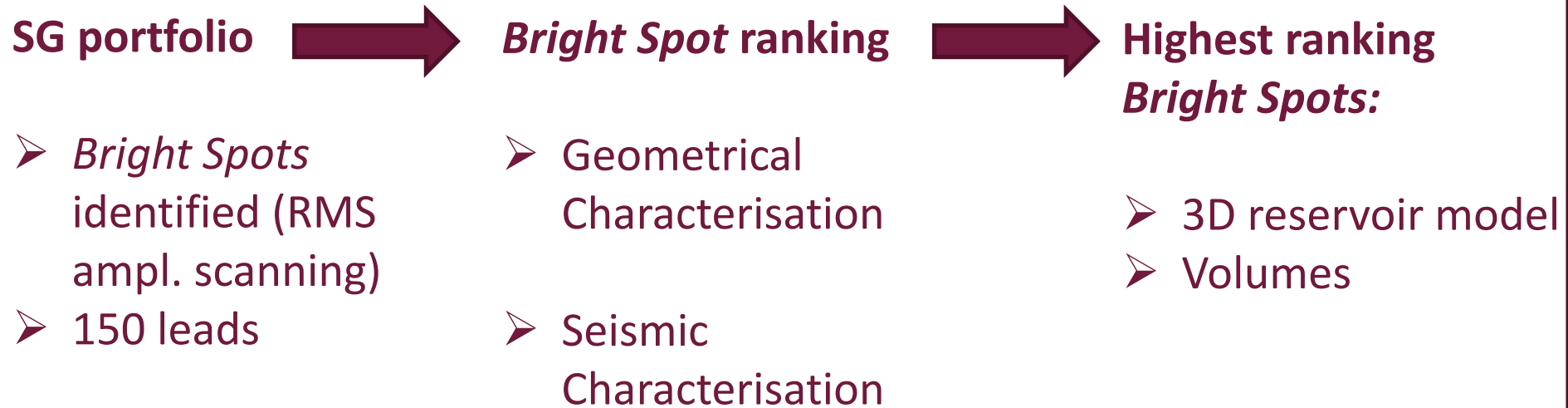


Shallow Gas: new play rather than drilling hazard

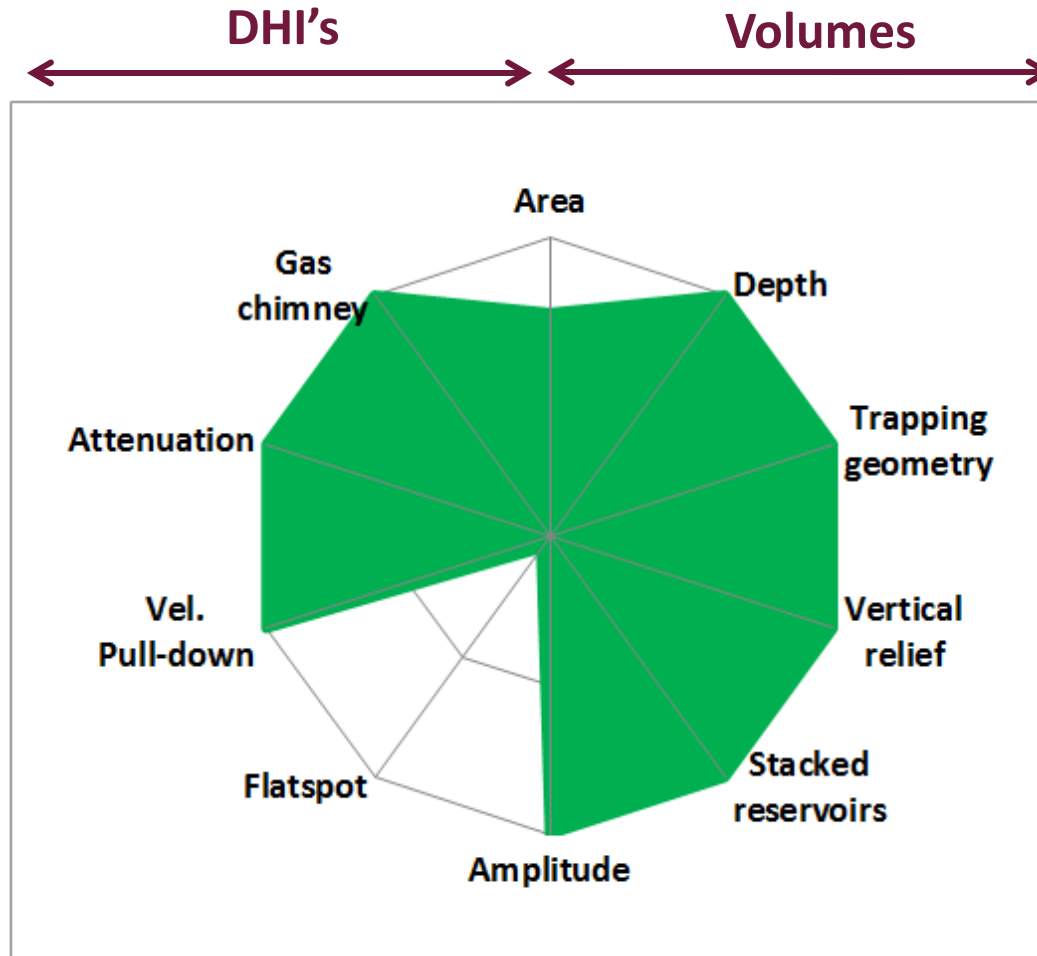


1. New technology proven successful for SG developments
2. New 3D seismic points to more opportunities
3. Small field tax incentive applicable

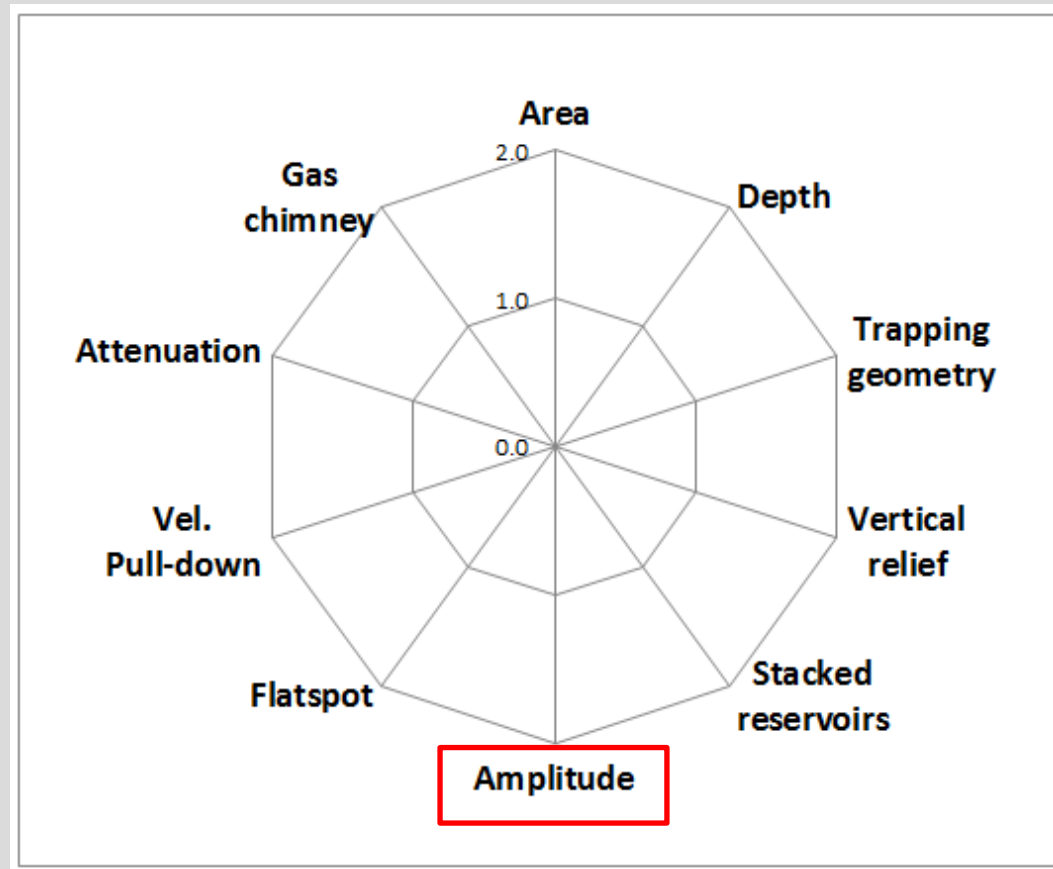
Seismic Characterisation Shallow Gas



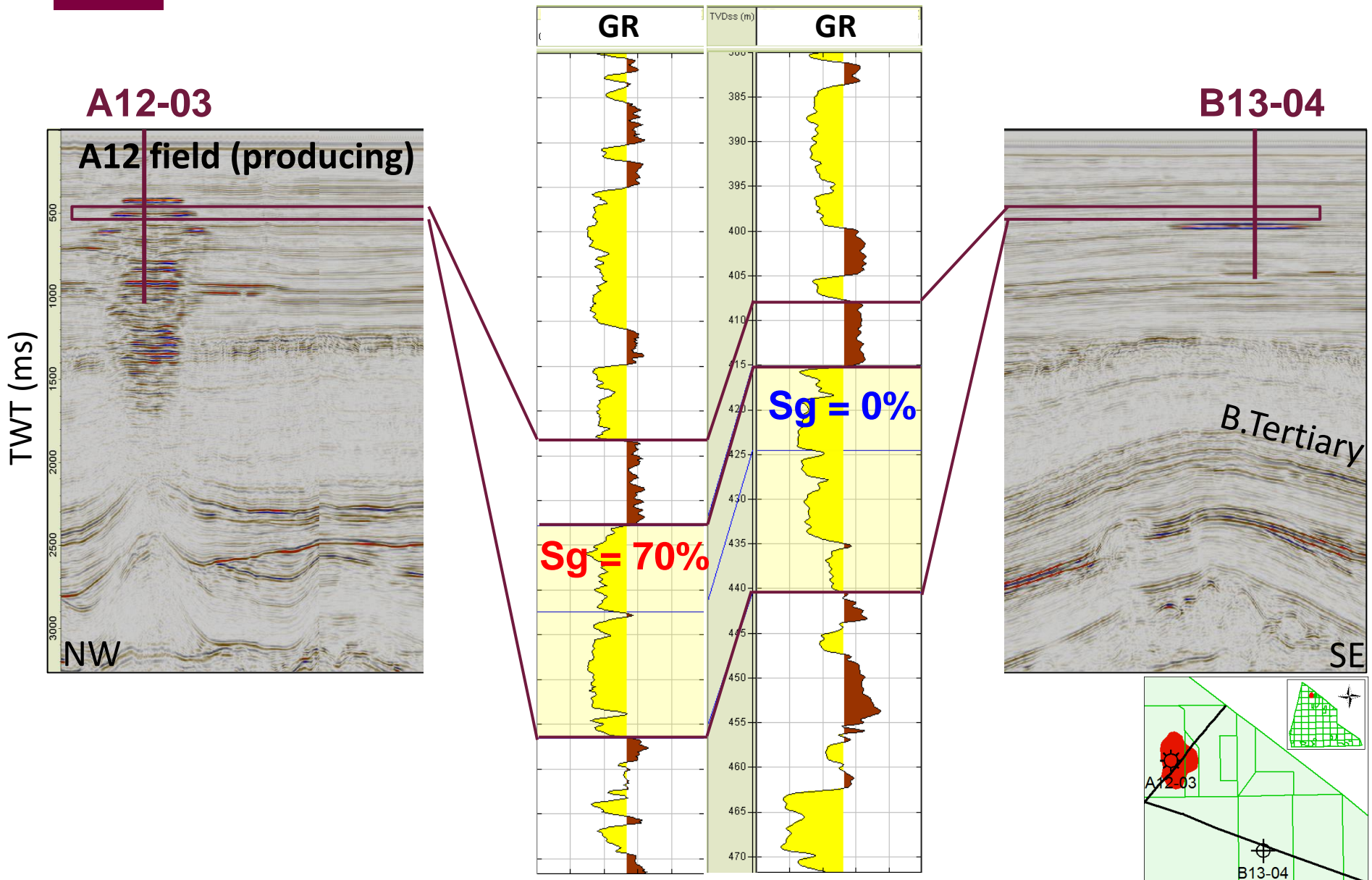
Seismic Characterisation Shallow Gas



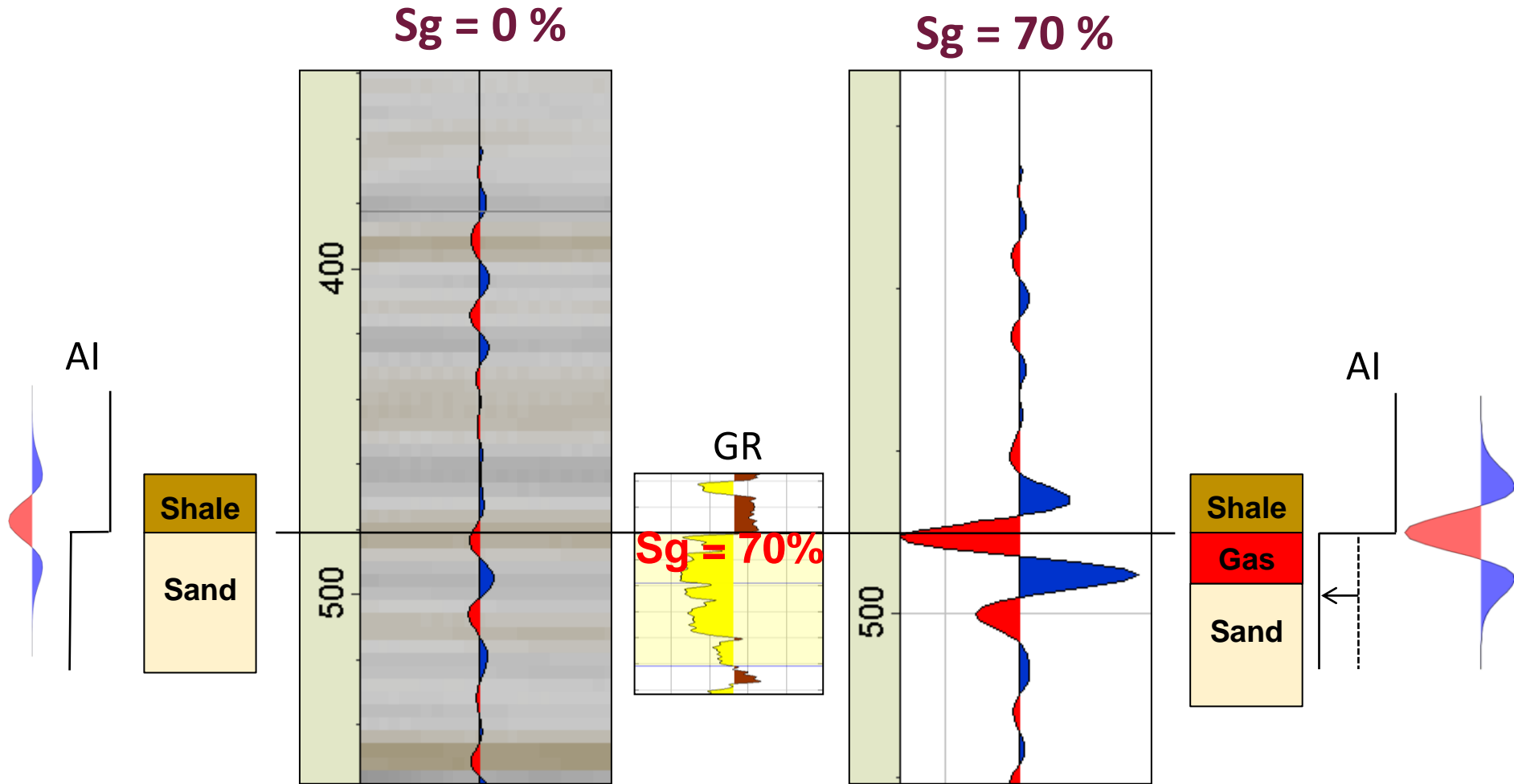
Seismic Characterisation Shallow Gas



Seismic Characterisation - Amplitude

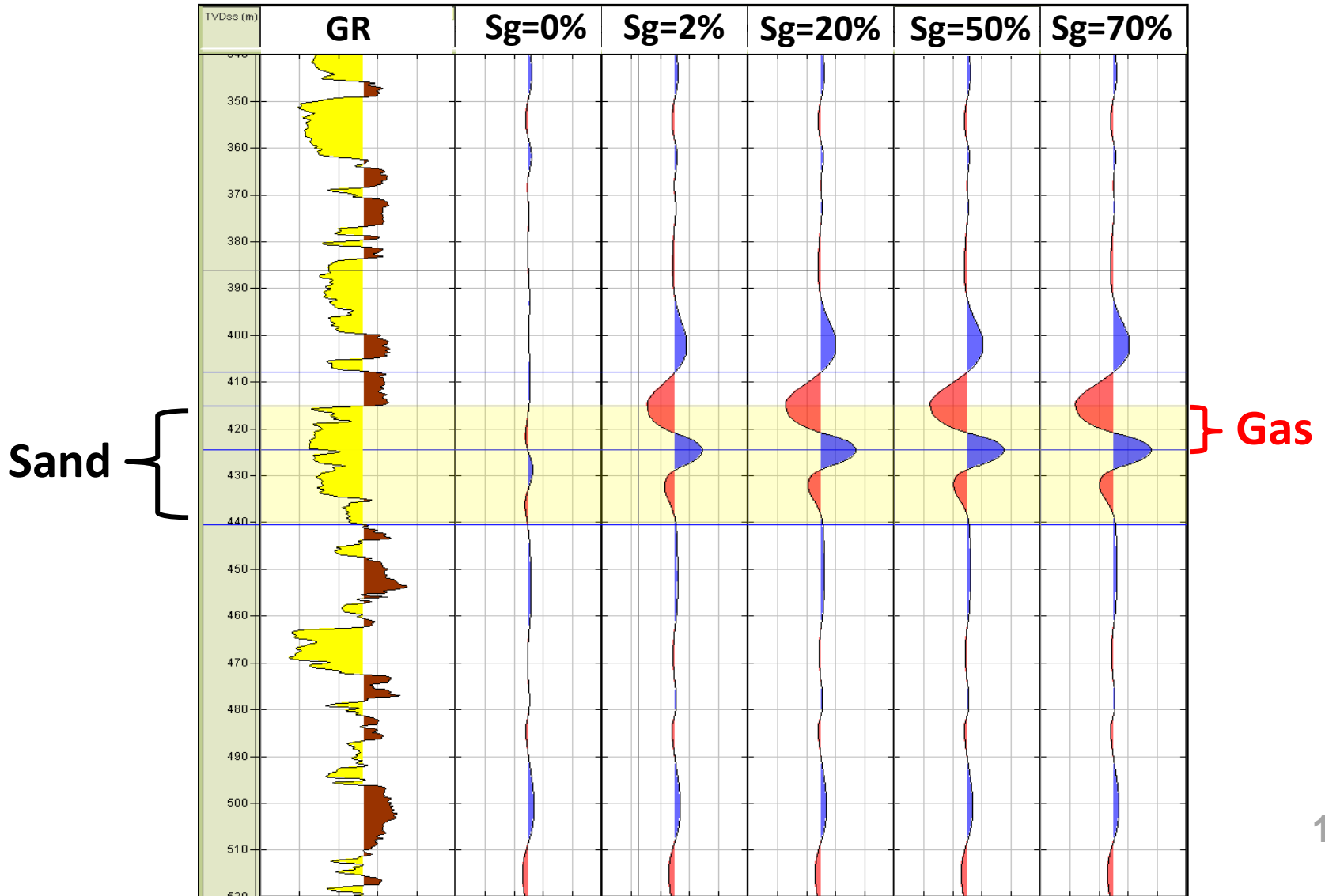


Seismic Characterisation - *Amplitude*



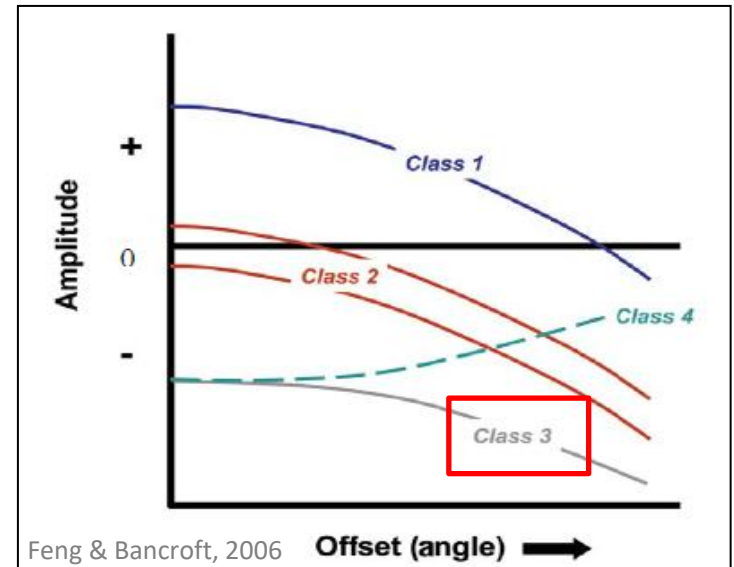
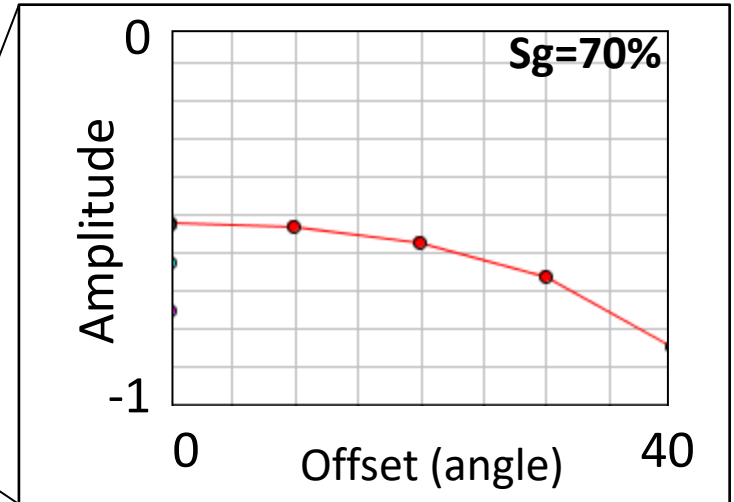
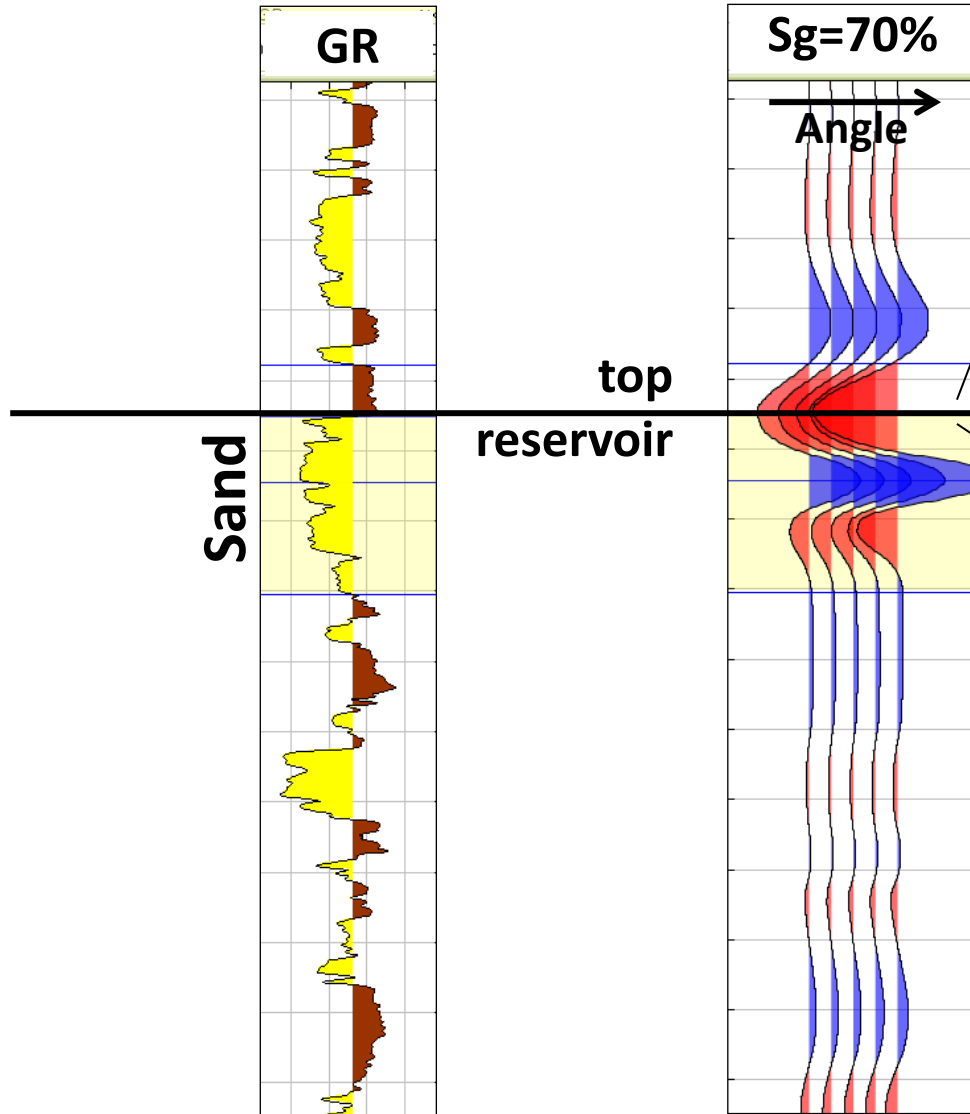
Gassmann fluid substitution approximately valid

Seismic Characterisation - *Amplitude*

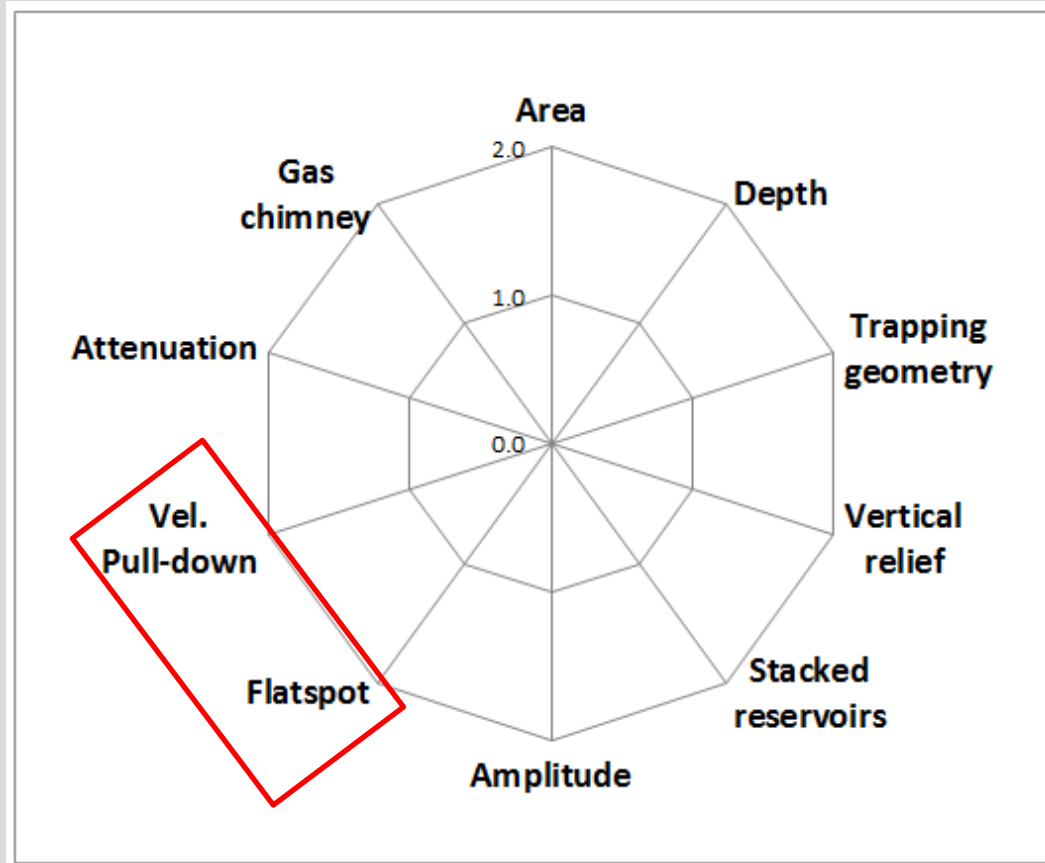


Seismic Characterisation – Amplitude

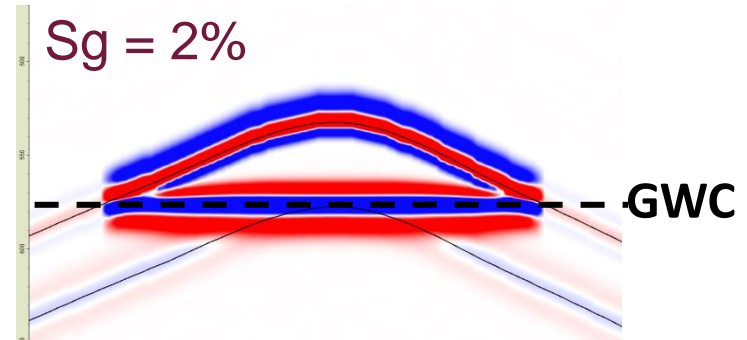
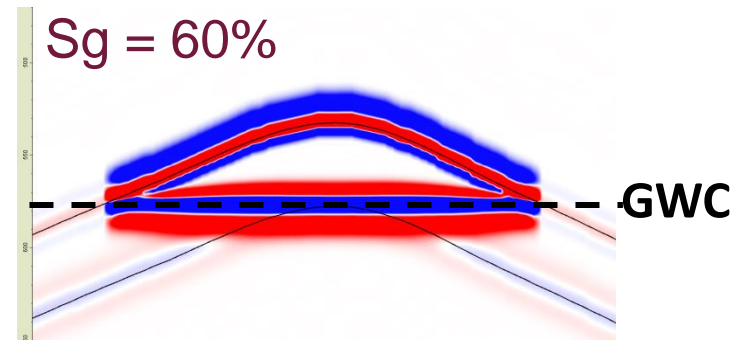
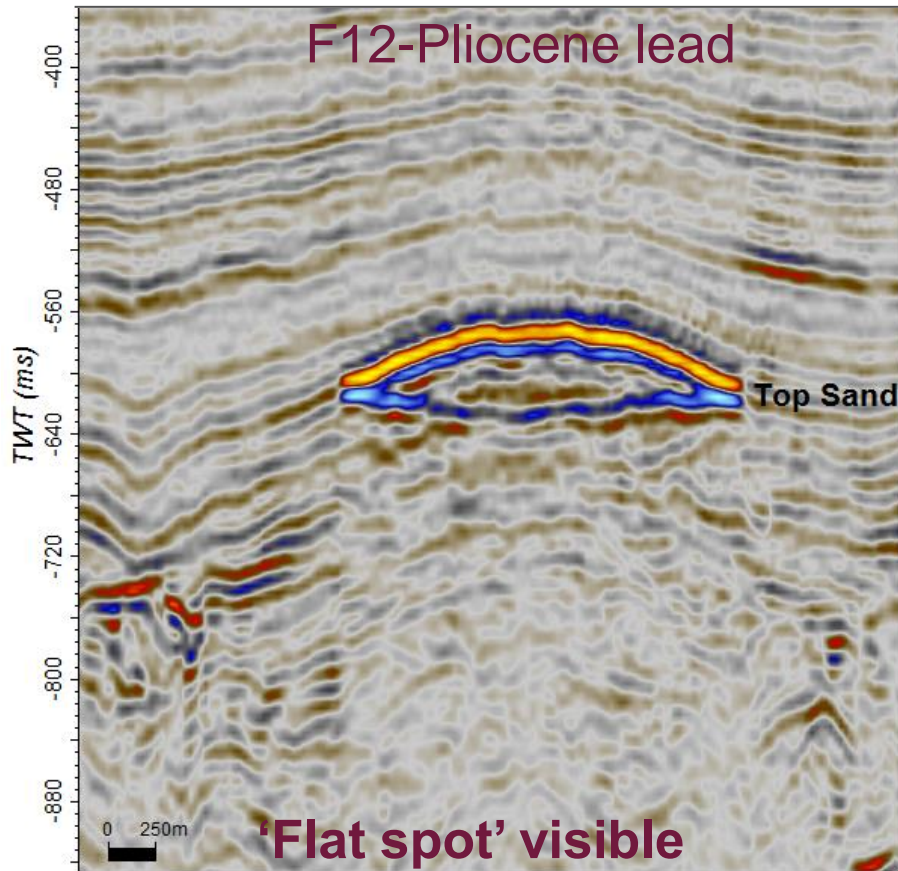
Can AVO help?



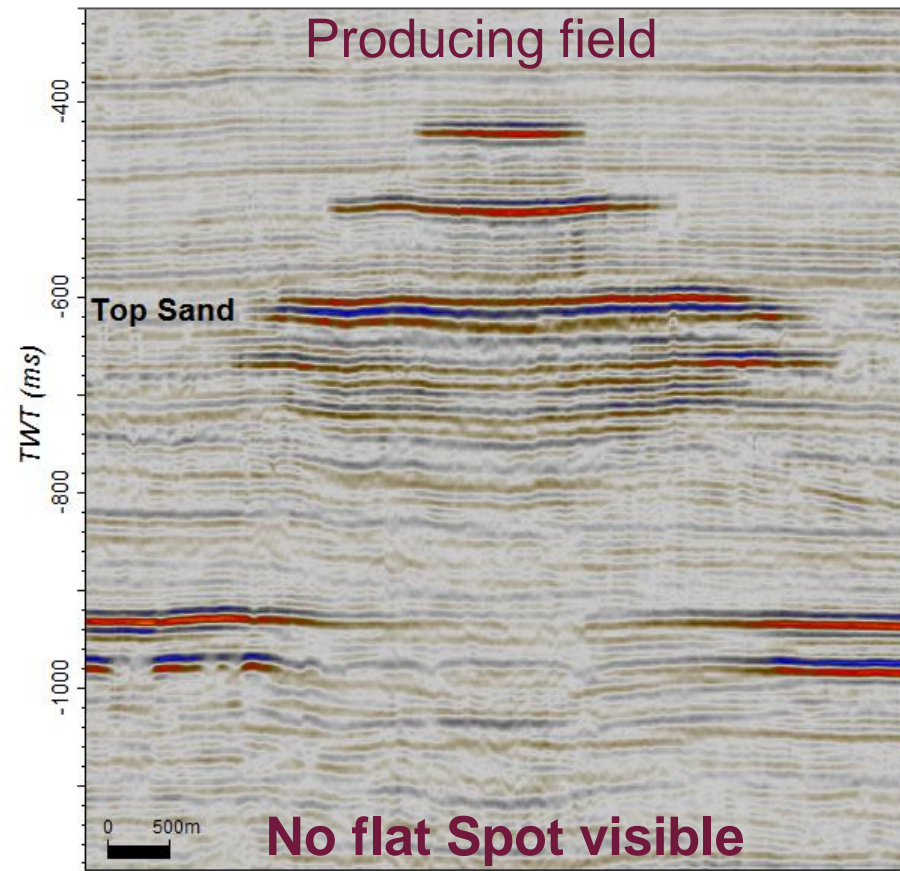
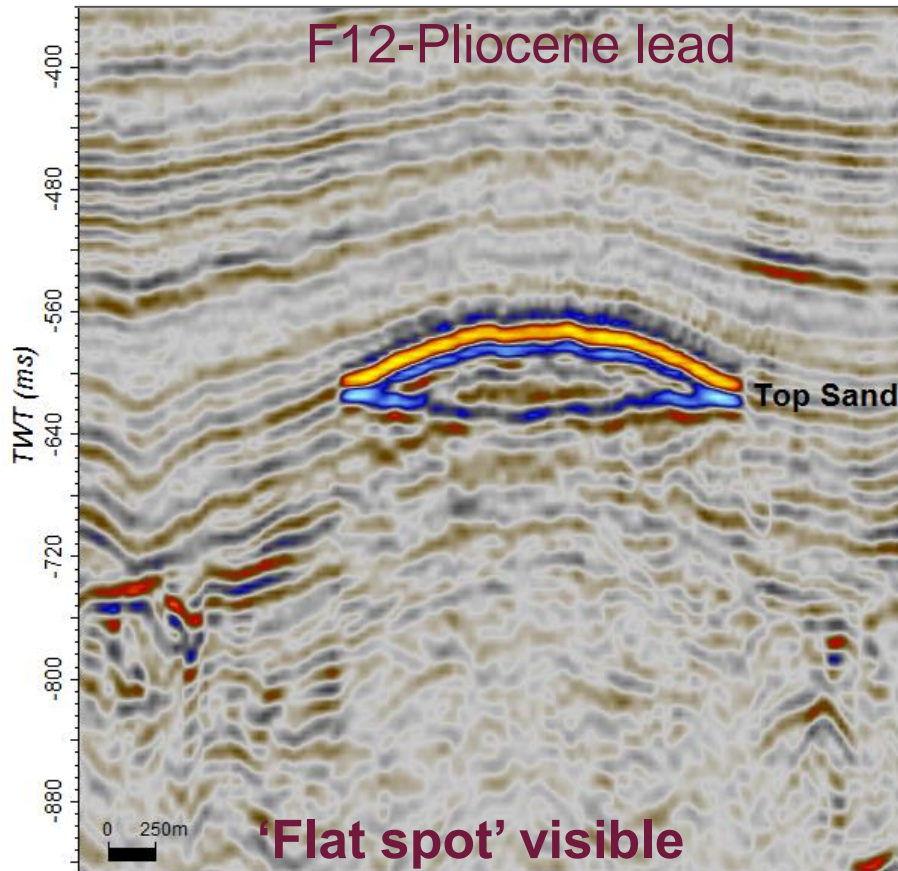
Seismic Characterisation Shallow Gas



Seismic Characterisation - *Flat Spot*



Seismic Characterisation - *Flat Spot*

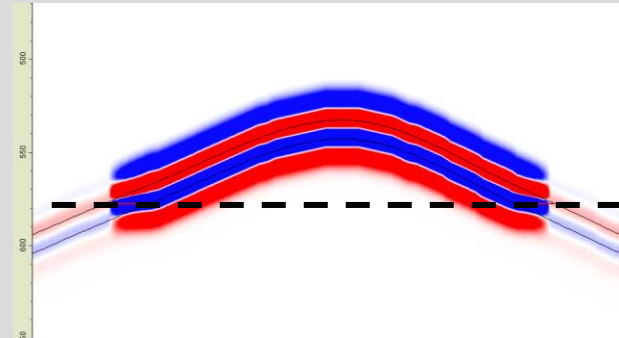
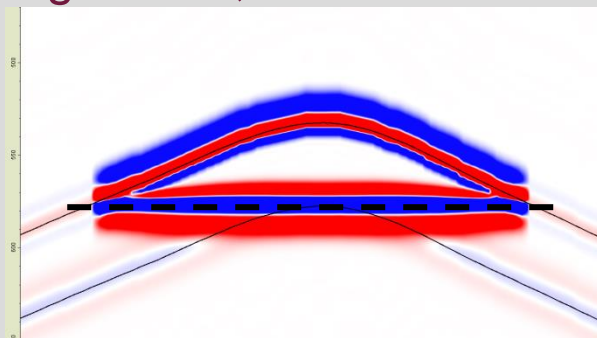
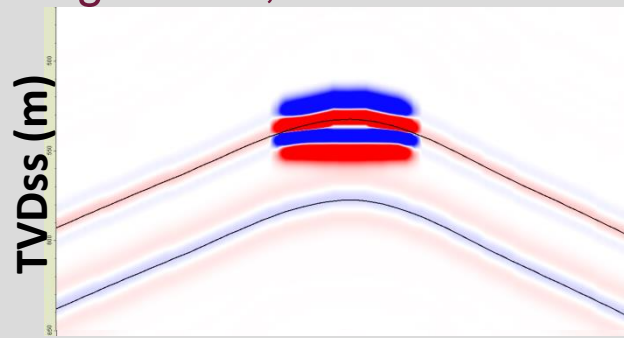


Seismic Characterisation - *Flat Spot*

Reservoir = 50m
Sg = 60%, Column = 10m

Reservoir = 50m
Sg = 60%, Column = 50m

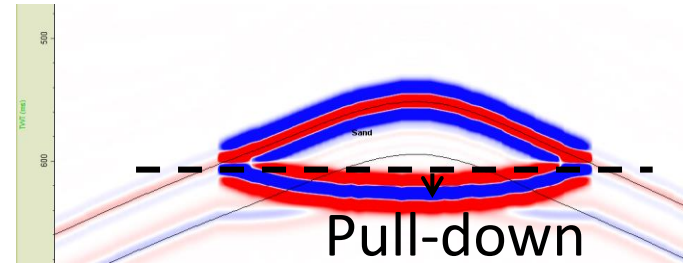
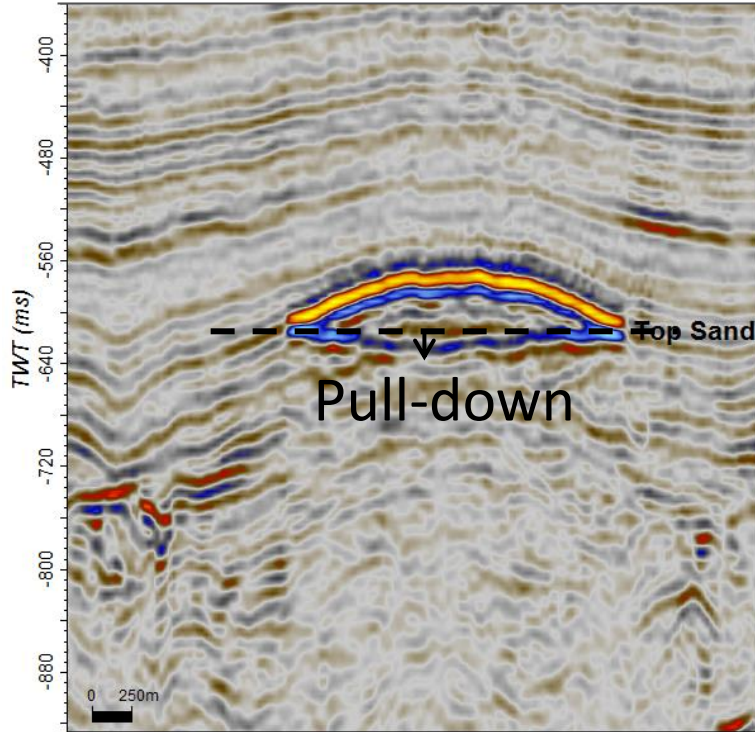
Reservoir = 10m
Sg = 60%, Column = 50m

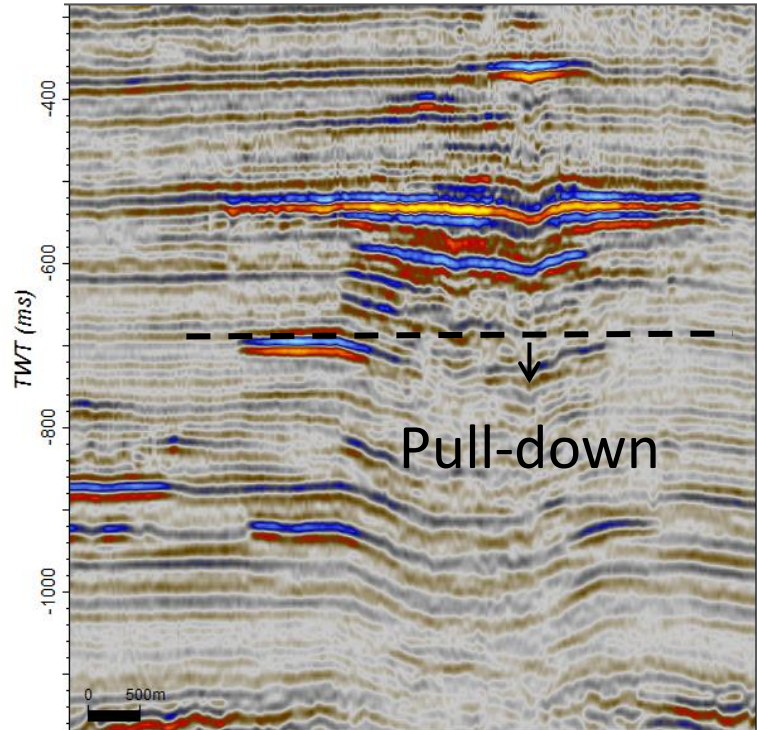
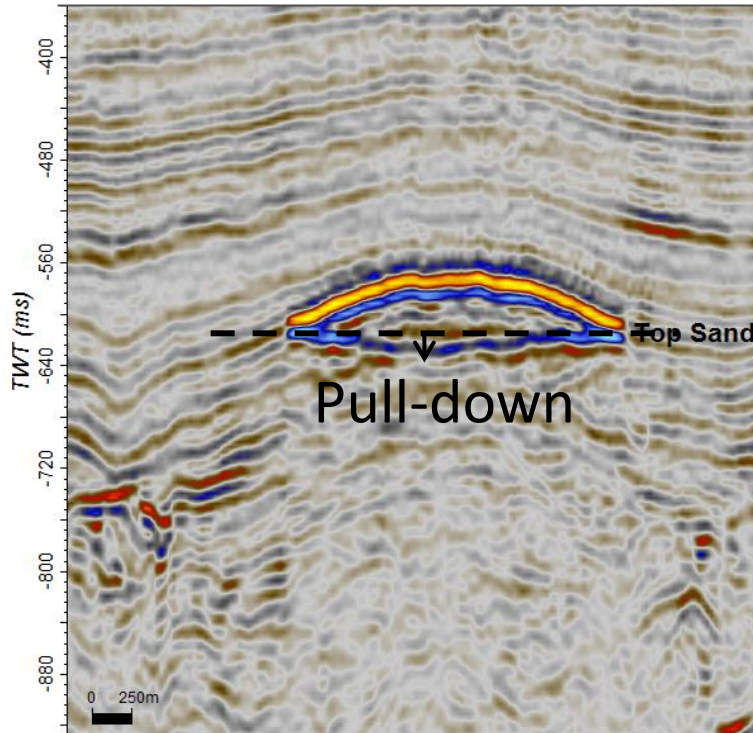


Visibility of flat spot dependent on:

- Dip of reflectors
- Reservoir thickness
- Column height

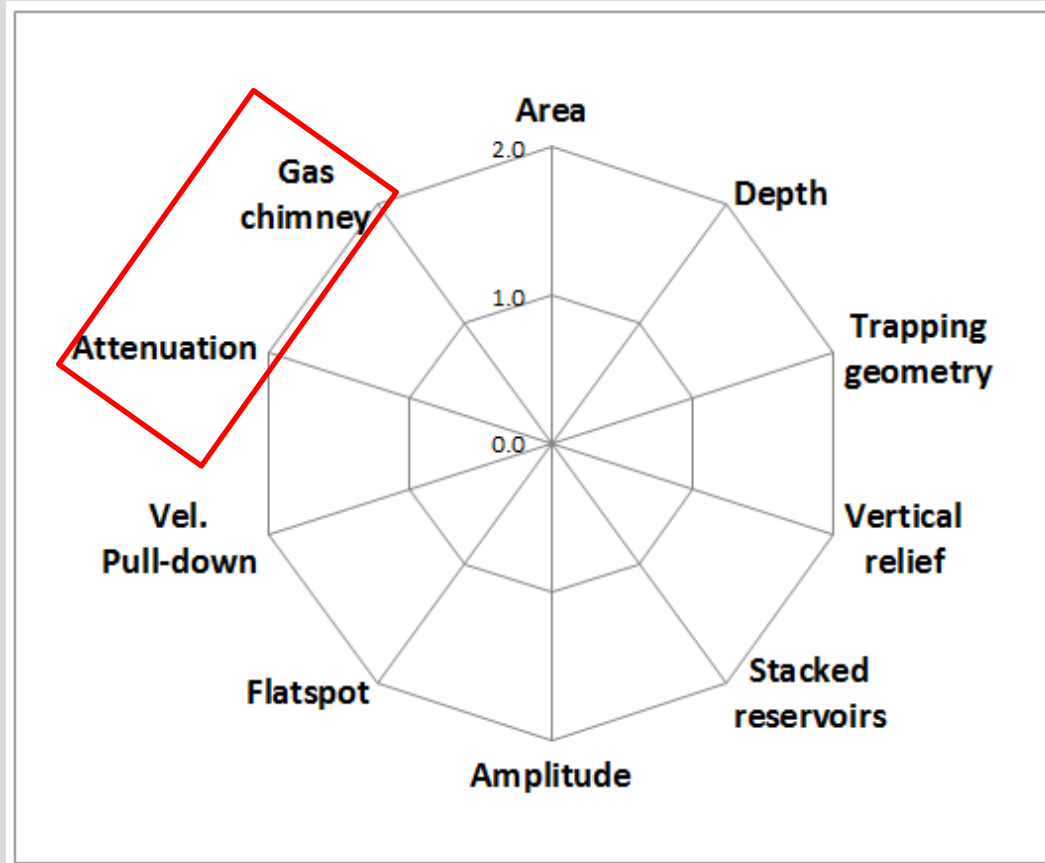
Flat spot indicates reservoir thickness & HC column, not saturation



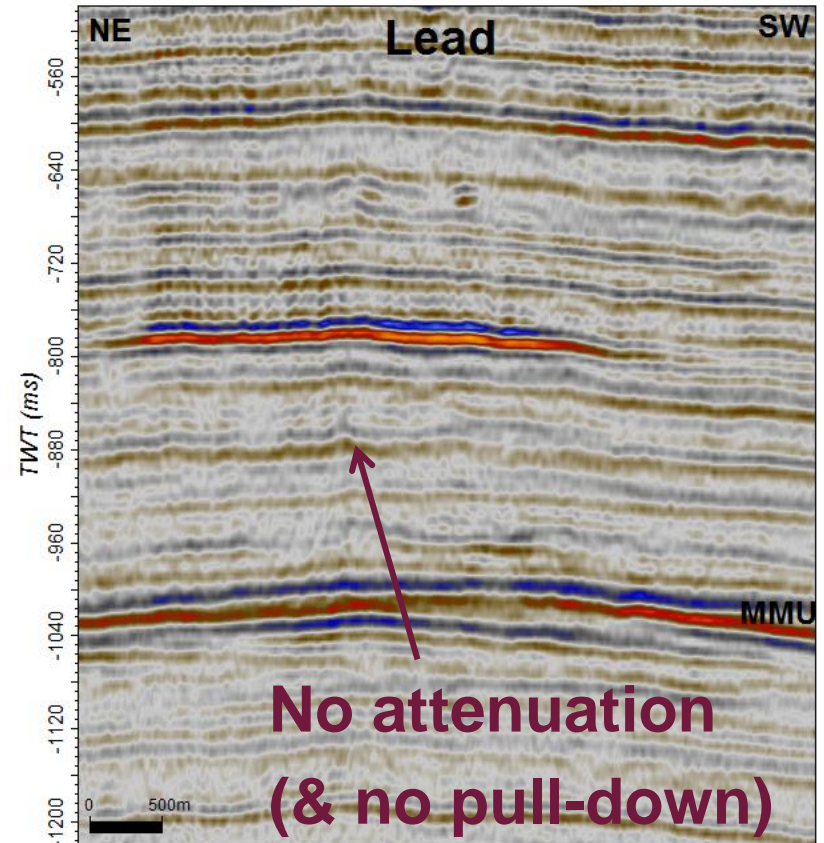
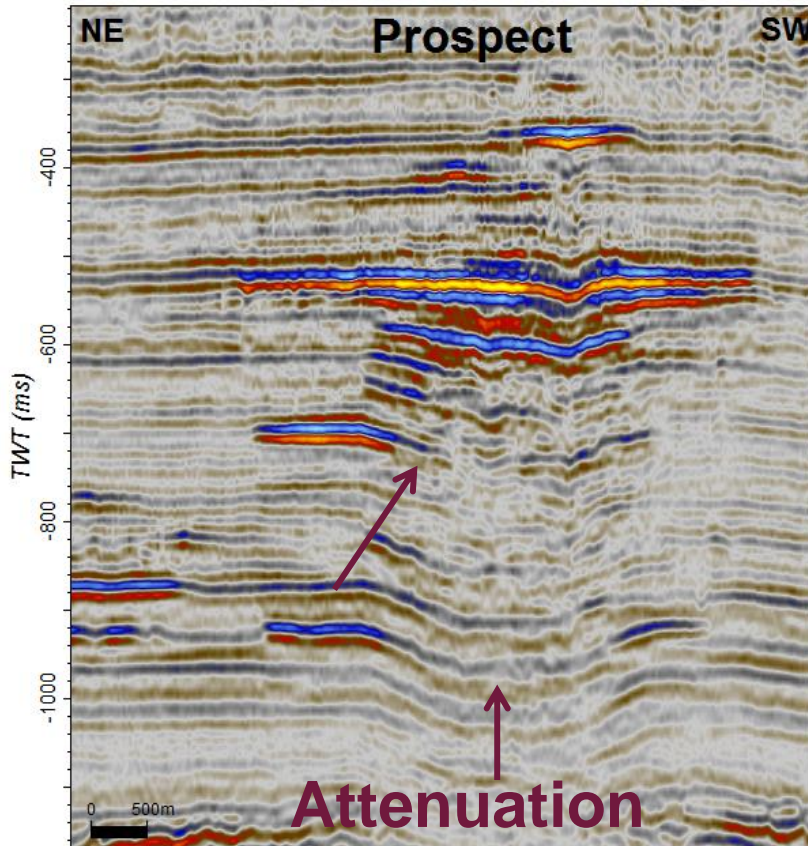


- **Pull-down indicates (total) HC column**
- **Absence pull-down indicates very low saturation**

Seismic Characterisation Shallow Gas

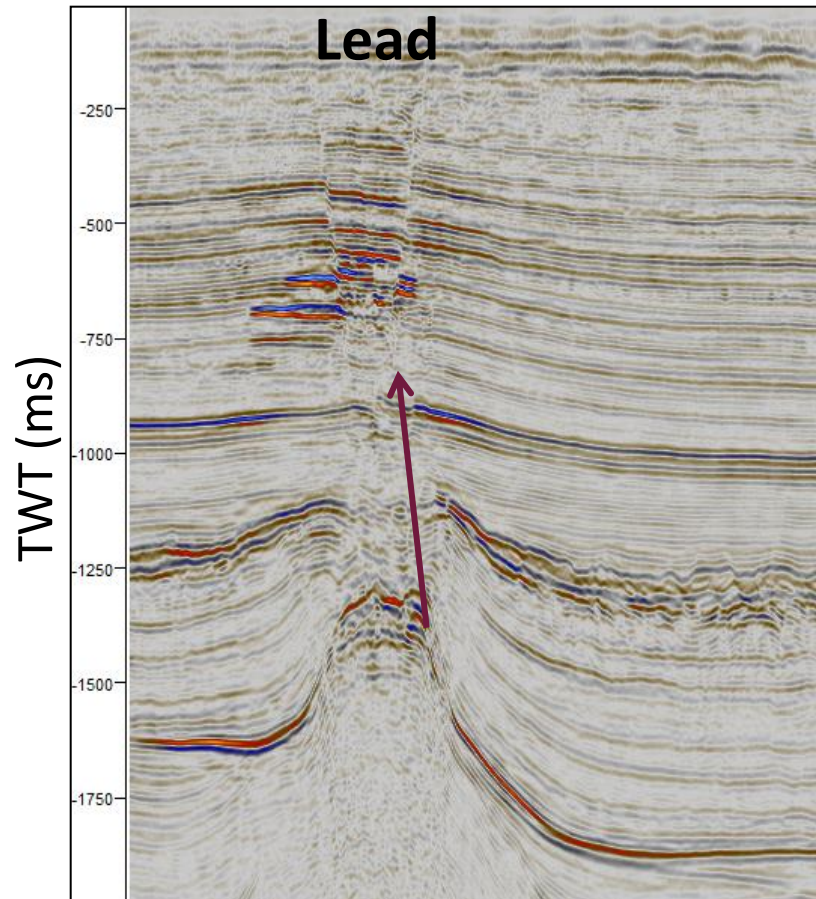


Seismic Characterisation - Attenuation



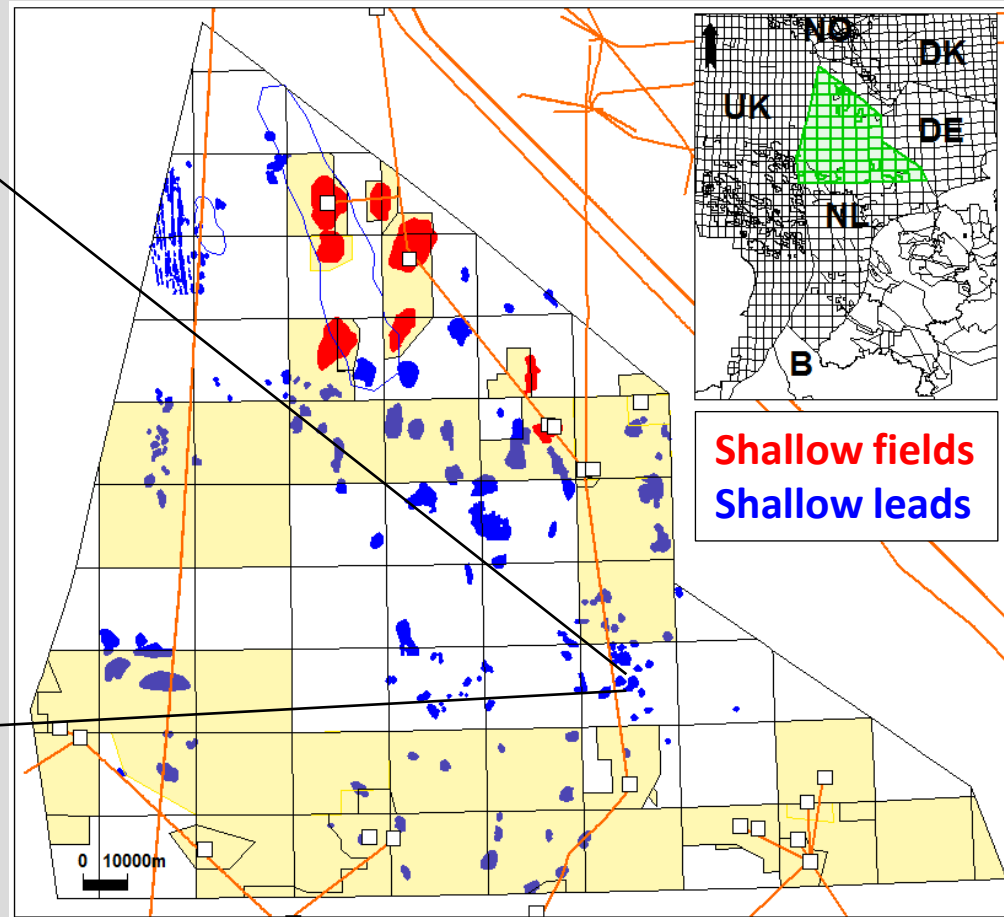
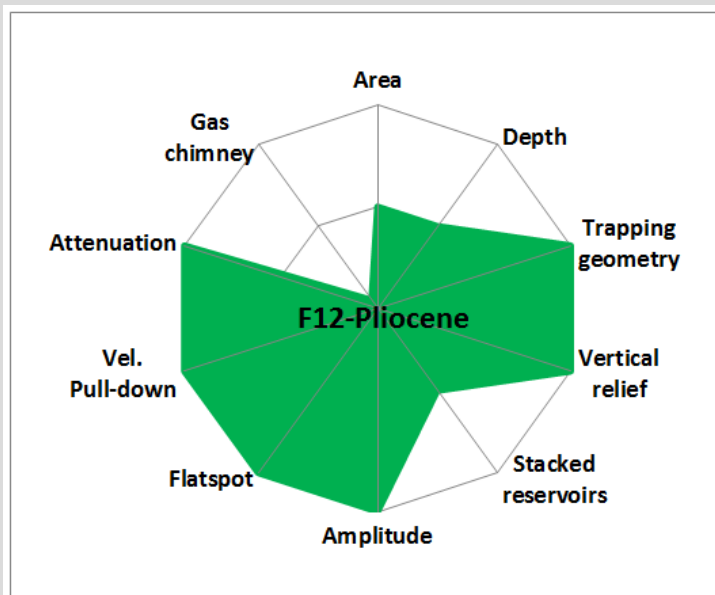
→ Absence attenuation indicates very low saturation

Seismic Characterisation - *Gas Chimney*

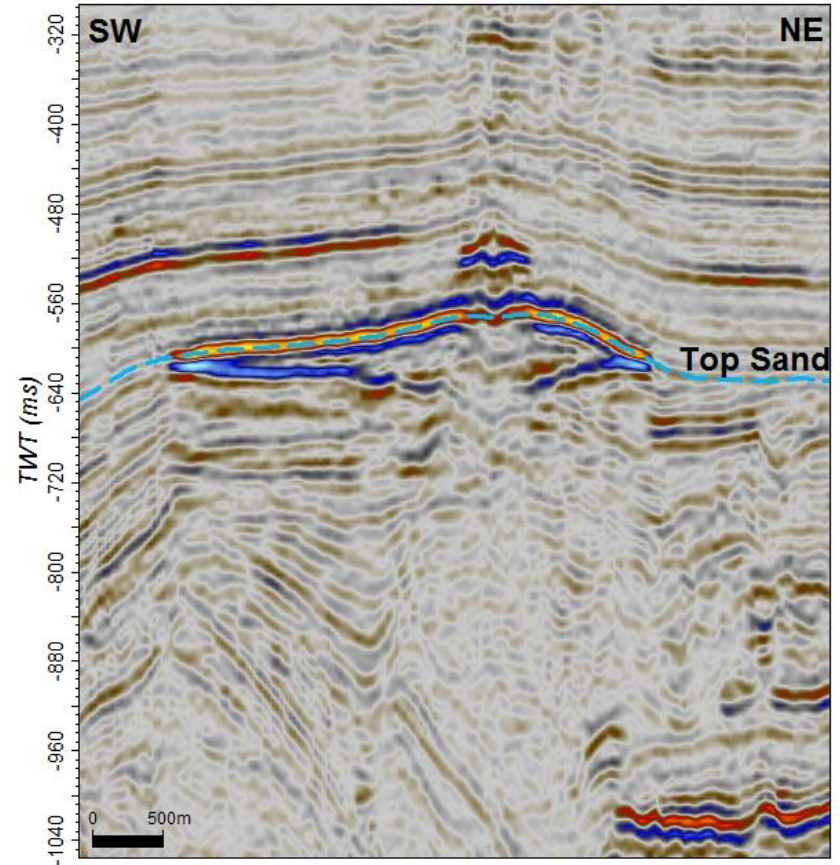
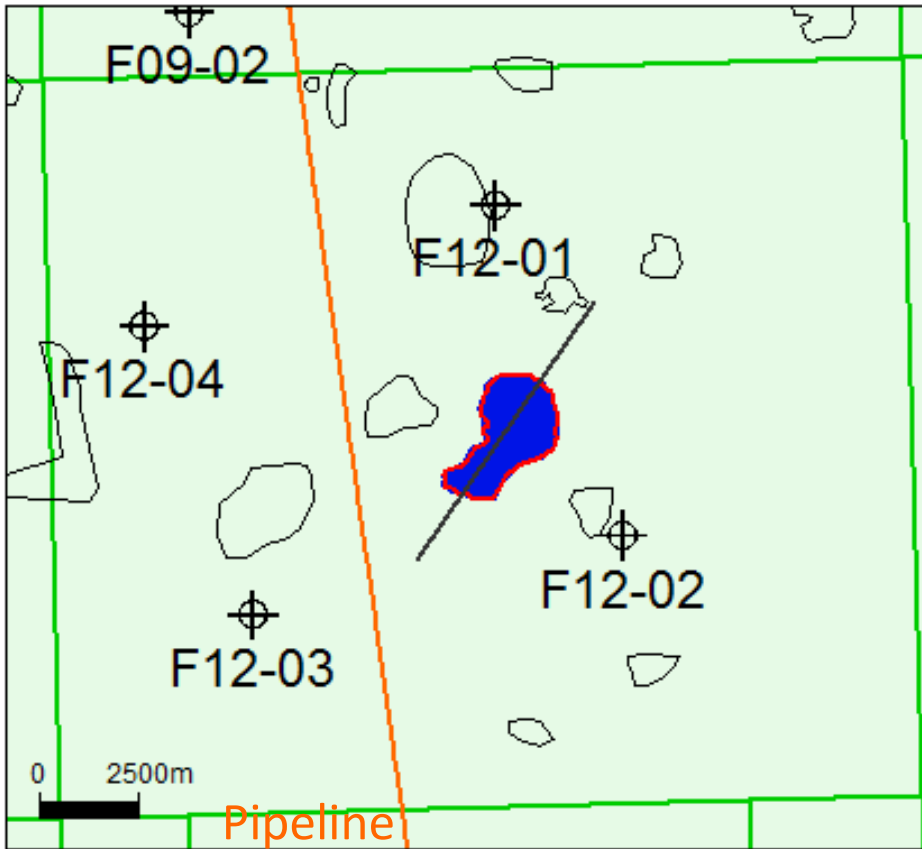


Gas chimney indicator for gas

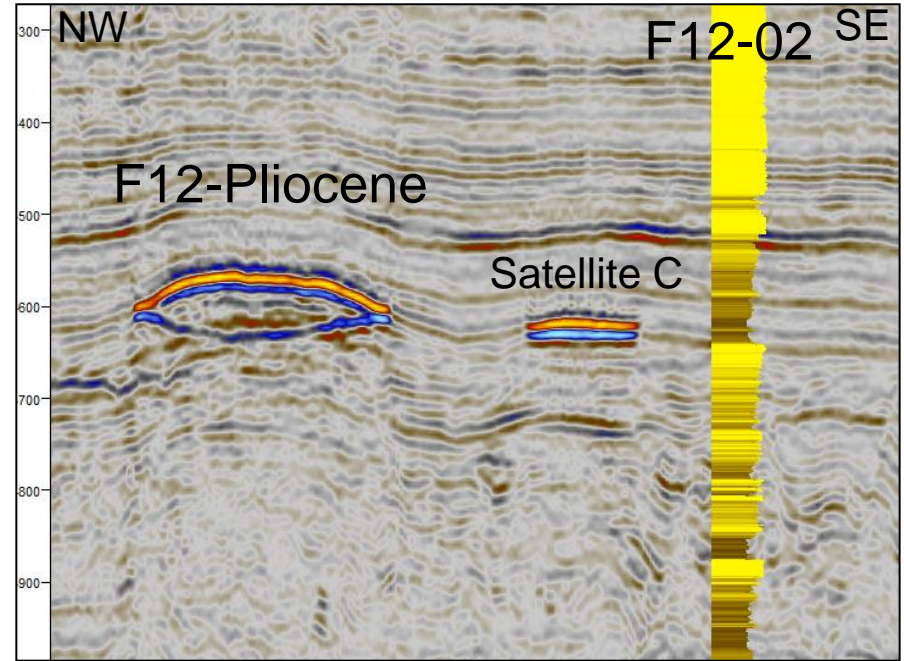
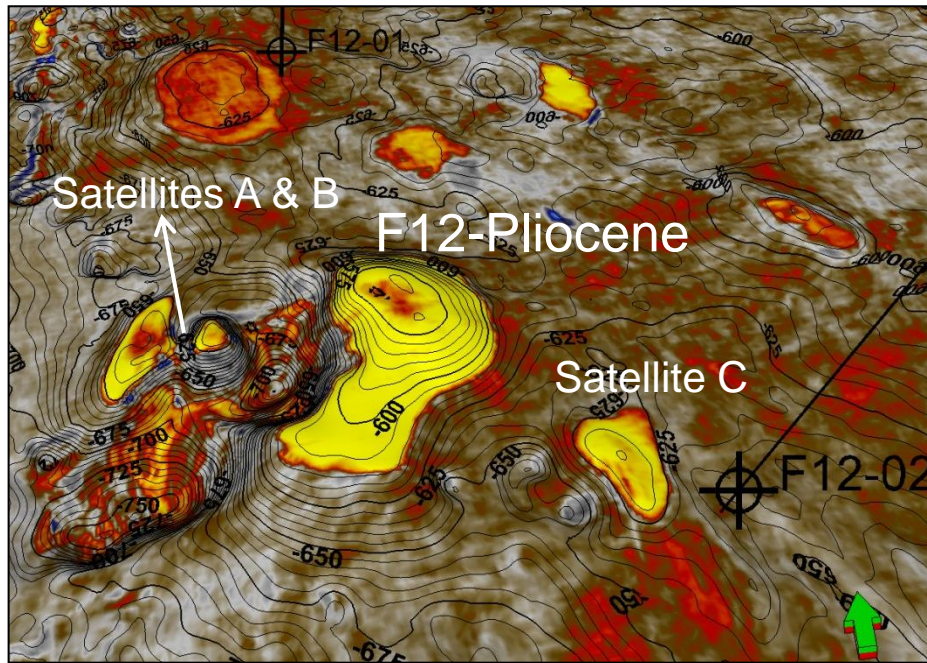
Case Study: F12-Pliocene



Case Study: F12-Pliocene



Case Study: F12-Pliocene



GIIP (bcm*)		
P10	P50	P90
0.6	0.8	1.1

*1 bcm (Nm) \approx 37.3 bcf

Summary

Derisking Shallow Gas as Exploration Target by Seismic Characterisation

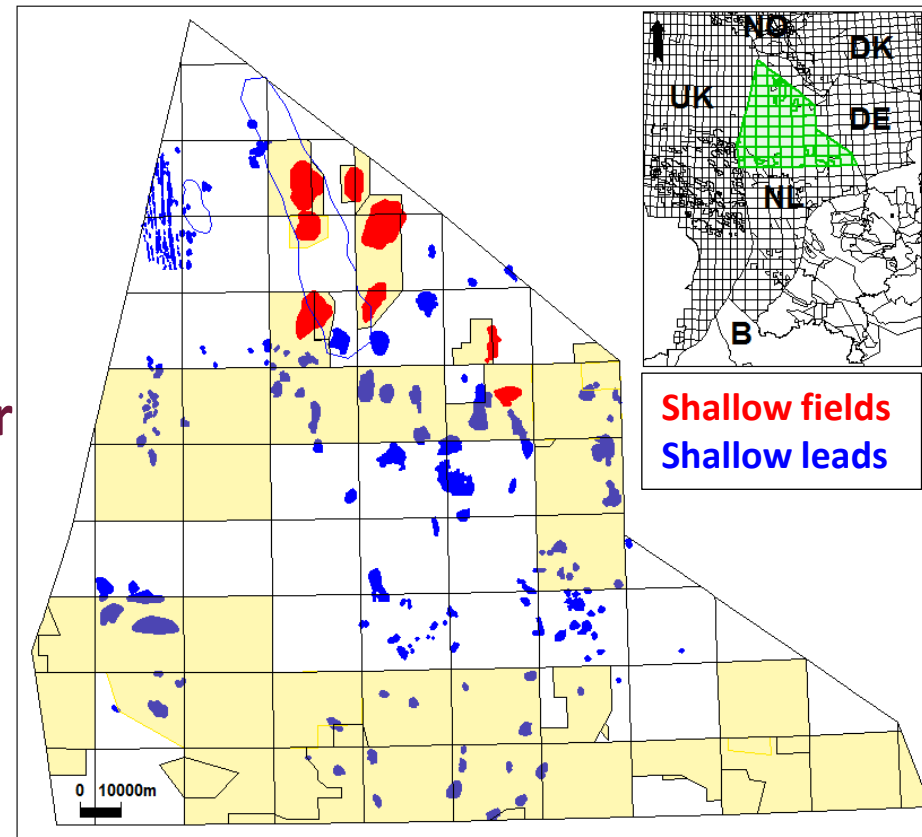
8 fields (wells)

> 150 leads (seismic data)

Semi-quantitative seismic characterization useful for first order ranking

AVO analysis ongoing

Ultimate derisking requires the bit?



→ Find cost efficient solutions

- Rutger Gras (ONE)
- TNO
- Ikon Science
- Chevron (E. Campbell, K. Borowski)
- EBN B.V. (B. Scheffers, E. Rosendaal)

Opportunities?

