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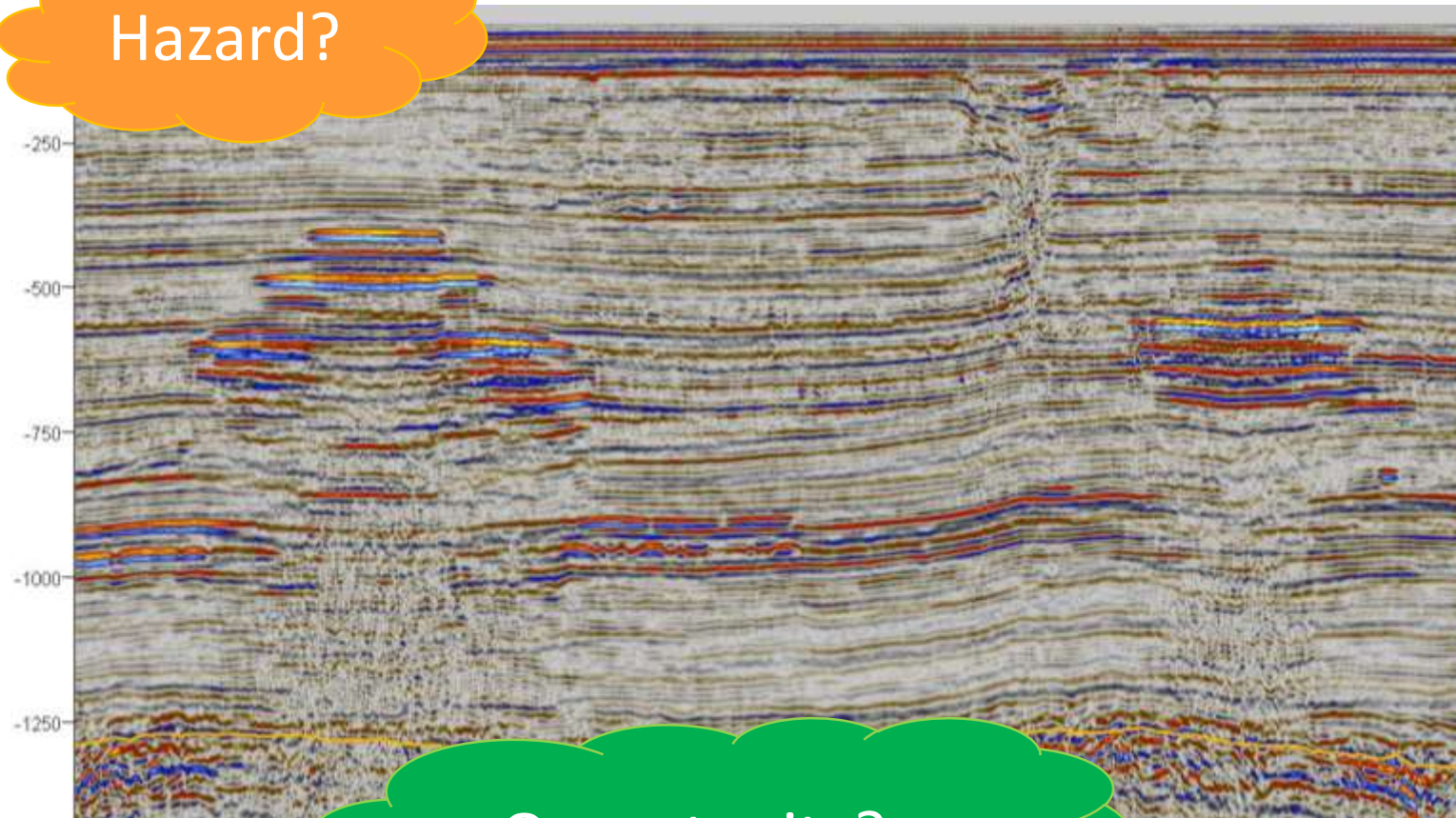
# Shallow Gas: An overlooked resource opportunity – examples of the Netherlands

G. Hoetz, M. van den Boogaard,  
EBN

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# Shallow Gas: An overlooked resource opportunity – examples of the Netherlands

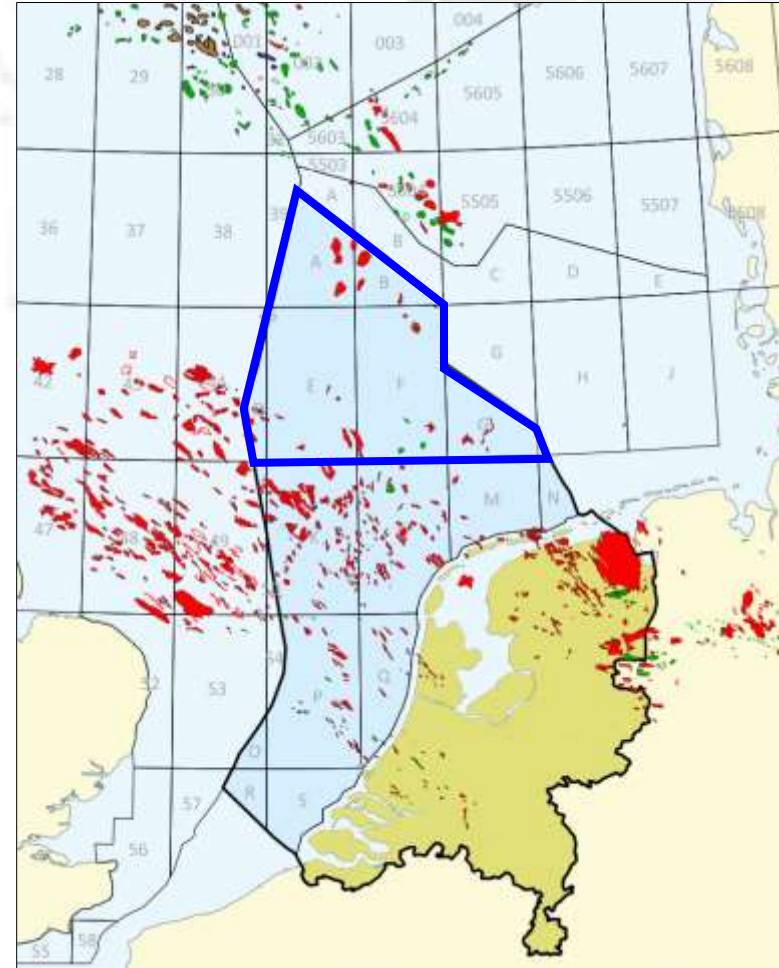
Hazard?



Opportunity?

# Outline

1. Introduction
2. New play rather than hazard
3. Lead characterization using seismic attributes
4. Summary



# Drilling hazard.....

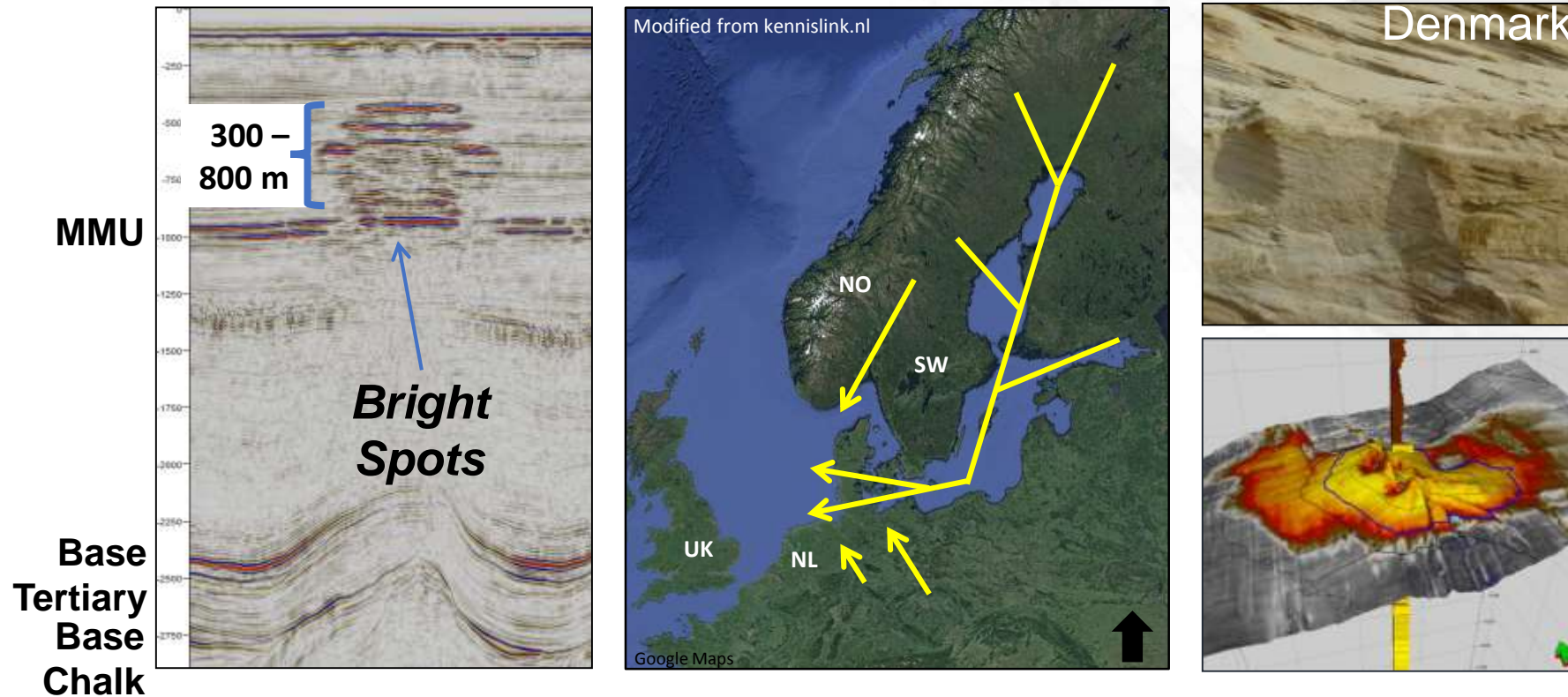
- Blow-out in Het Haantje on 1.12.1965
- No injuries but the drilling rig and portacabins sunk into the ground
- Unexpected gas accumulation encountered at 1950m leading to over-pressures that exceeded mud-weight selection.
- Once pressure exceeded fracture strength of mechanically weaker shallow sediments gas escaped to surface in vicinity of rig.



## Blow-out

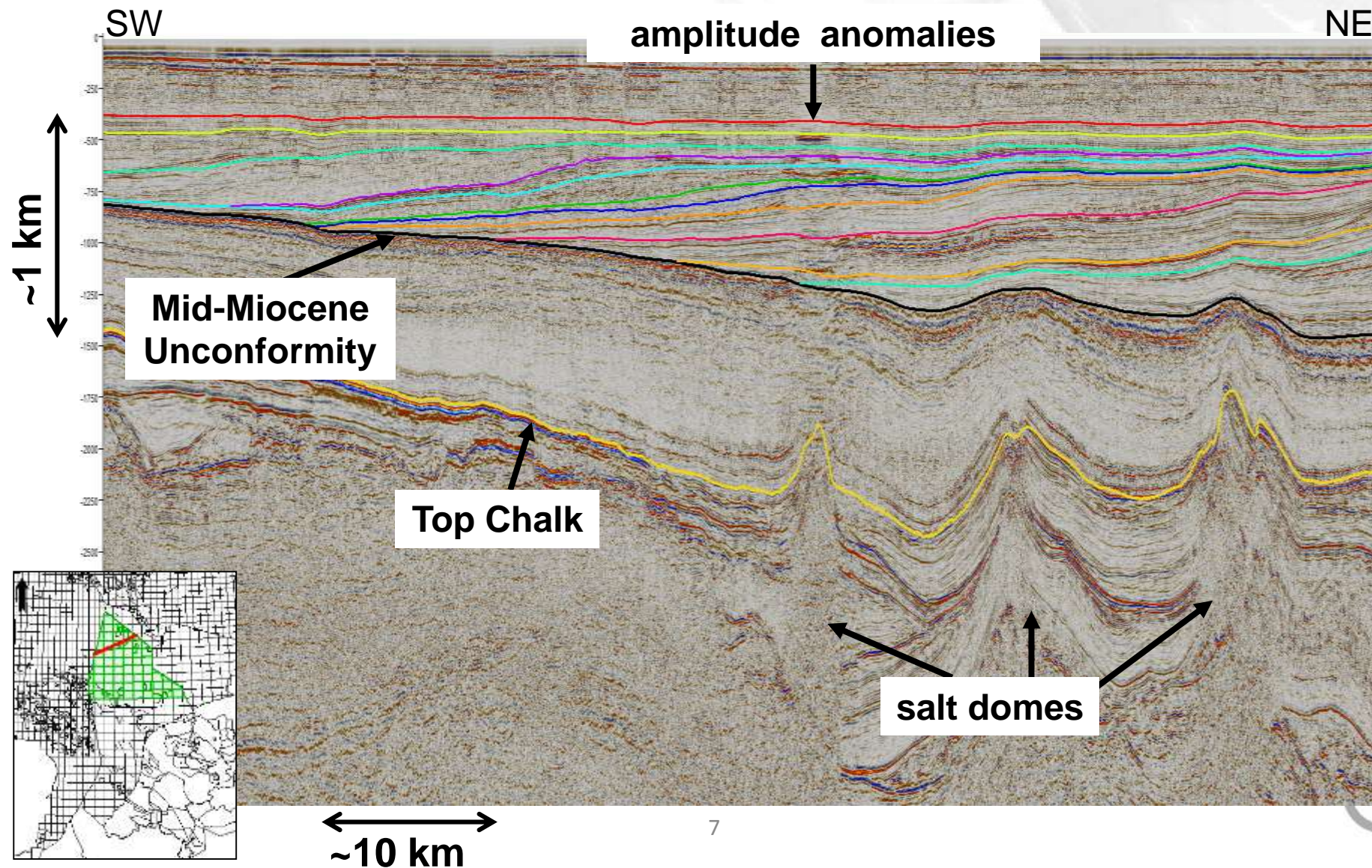


# Geological Setting



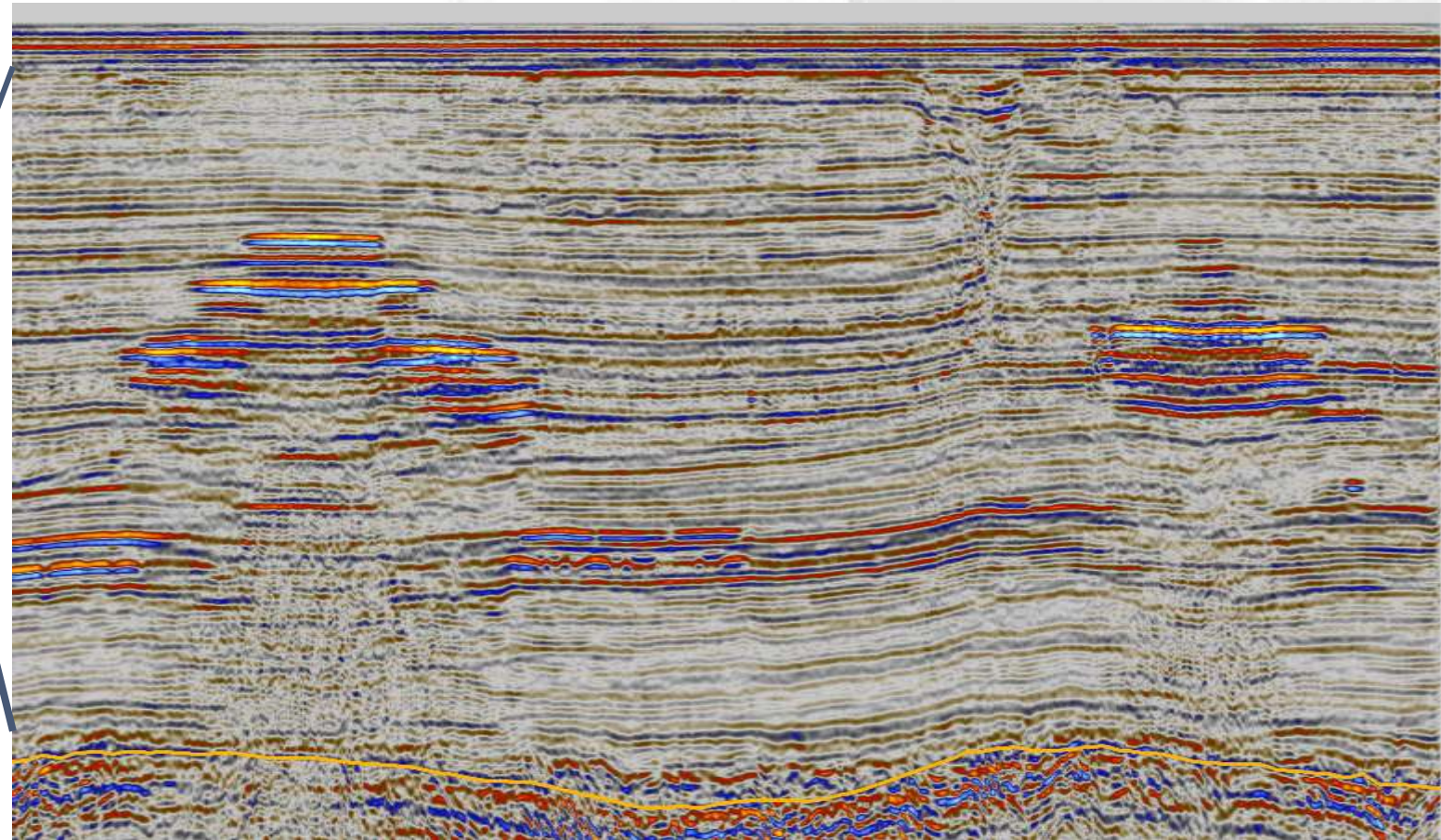
Shallow Gas (**SG**) = gas in unconsolidated, Miocene-Pleistocene sands

# Geological Setting



# Shallow gas: stratigraphy

Cenozoic	Quaternary	Holocene	
		Pleistocene	
	3.6Ma	Neogene	Pliocene
			Miocene
			Oligocene
	Tertiary	Paleogene	Eocene
			Paleocene
Mesozoic	Cretaceous	Late	
		Early	
	Jurassic	Late	
		Middle	
	Triassic	Early	
		Late	
Middle			
Paleozoic	Permian	Early	
		Late	
	Pennsylvanian		
	Mississippian		
	Devonian	Late	
		Middle	
		Early	
Silurian	Late		
	Early		
Ordovician	Late		
	Middle		



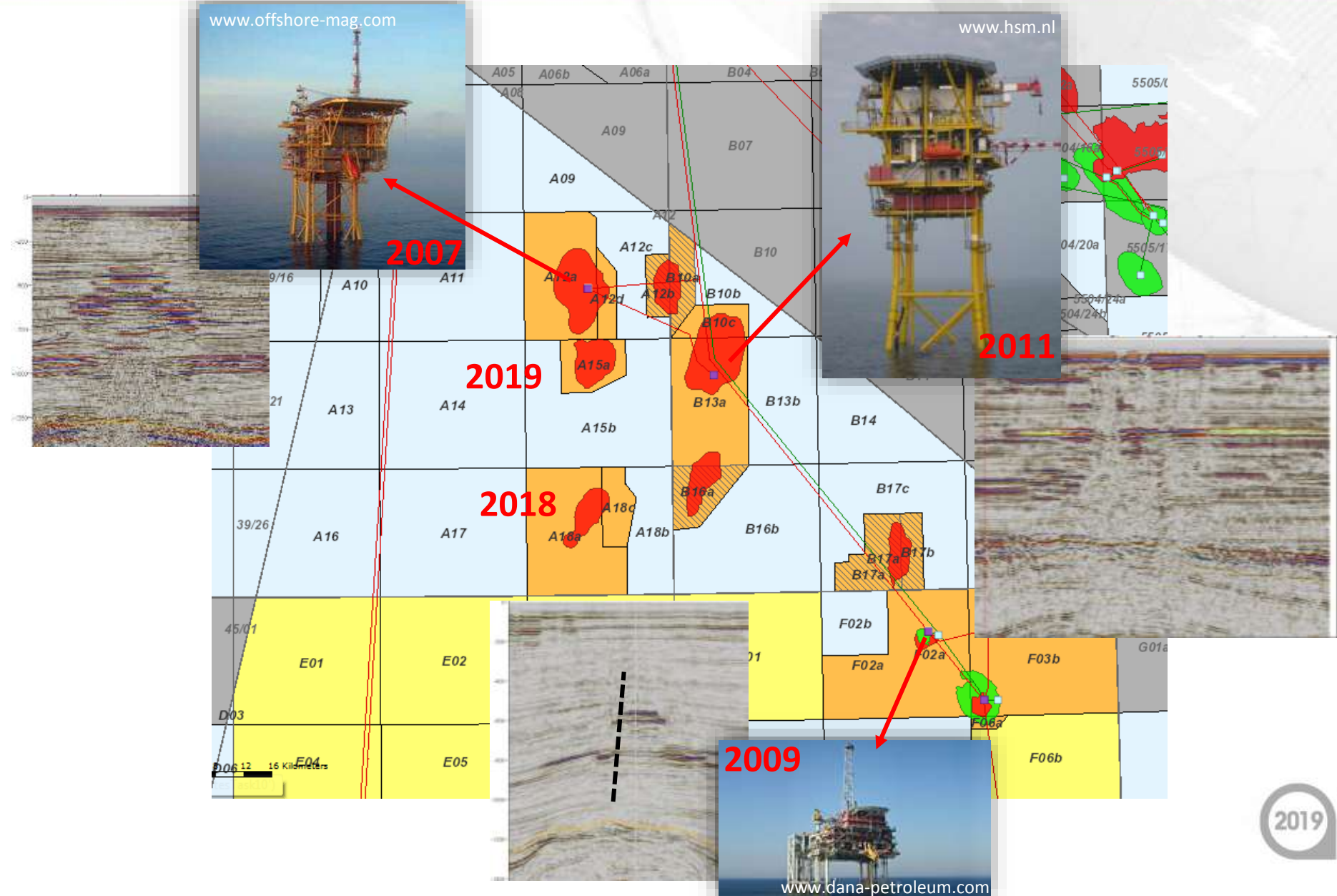
0 ms

1000 ms

SG depthrange: 400-800 m

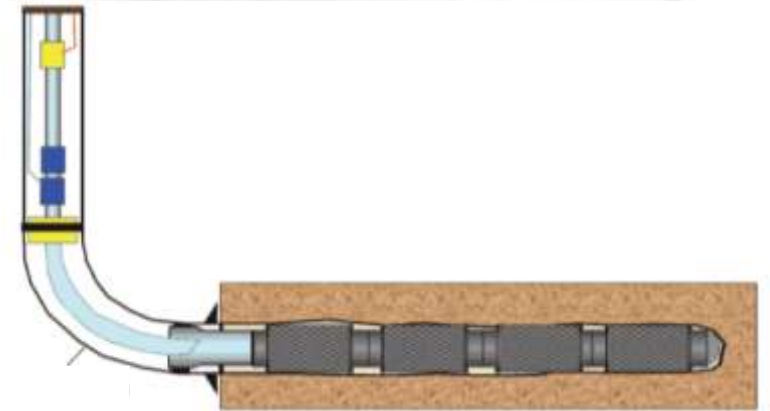


# Shallow Gas Pays Off!

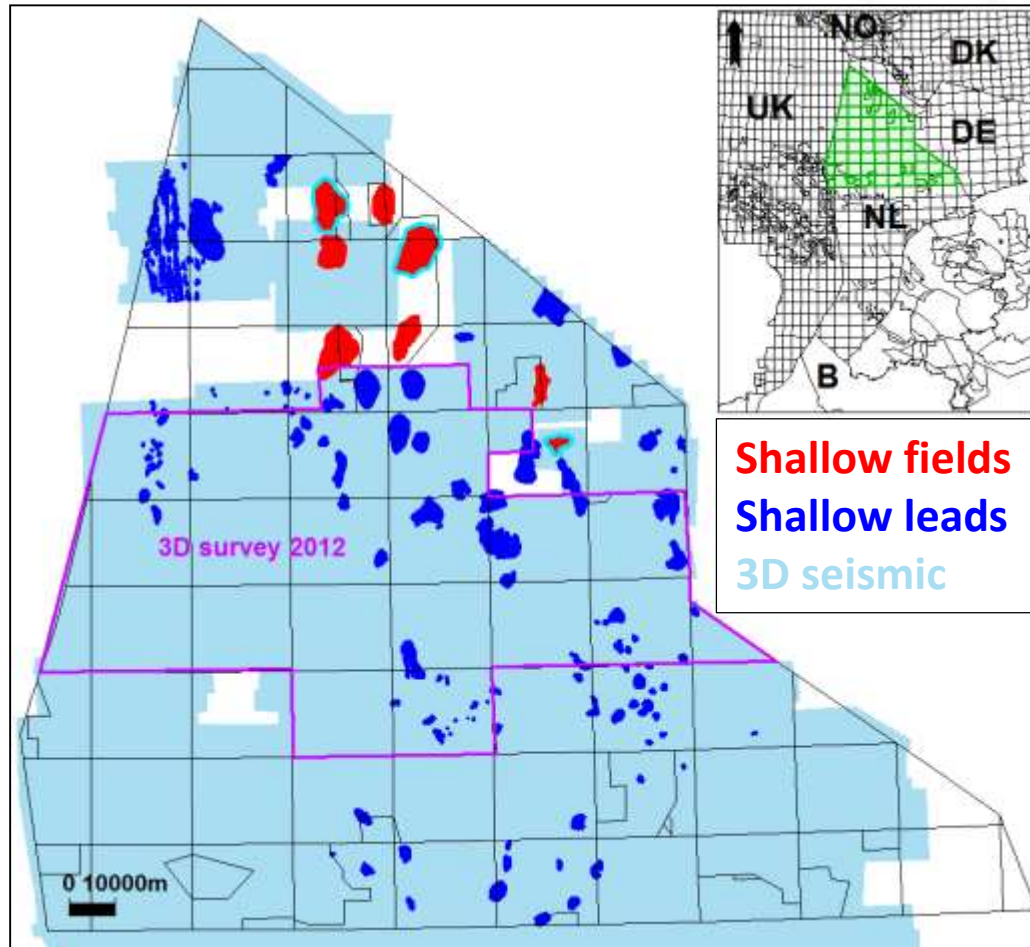


# Shallow Gas: Production

- Presence shallow gas known since 70's
- Early water breakthrough & sand production expected  
→ development considered not feasible
- Technical breakthrough (e.g. sand control in horizontal wells)
- Currently 4 successfully producing fields:
  - A12-FA (2007)
  - F02a-B-Pliocene (2009)
  - B13-FA (2011)
  - A18-FA (2018)
- Despite low pressure, expected RF: 50-70%, today >10 bcm gas produced



# Shallow Gas: new play with upside



1. New technology proven successful for SG developments
2. New 3D seismic points to more opportunities
3. First pass portfolio characterization using pseudo-quantitative approach based on seismic attributes.

# Seismic Characterisation Shallow Gas

**SG portfolio**



***Bright Spot* ranking**

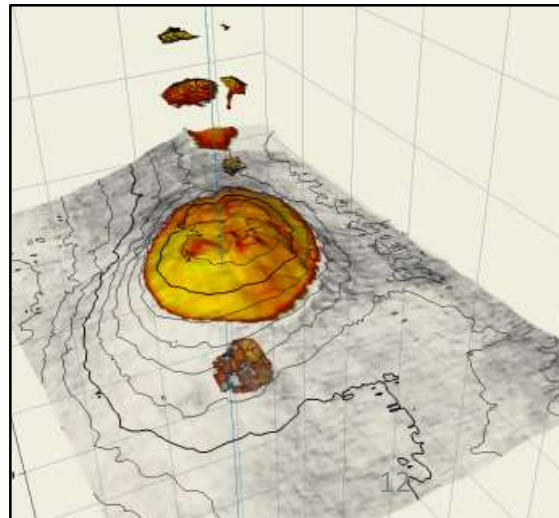
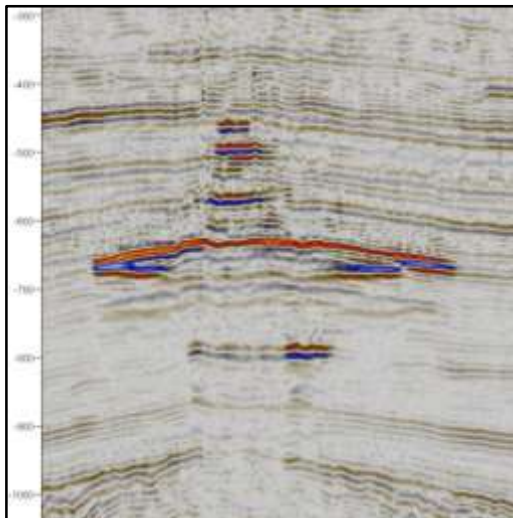


**Highest ranking  
*Bright Spots*:**

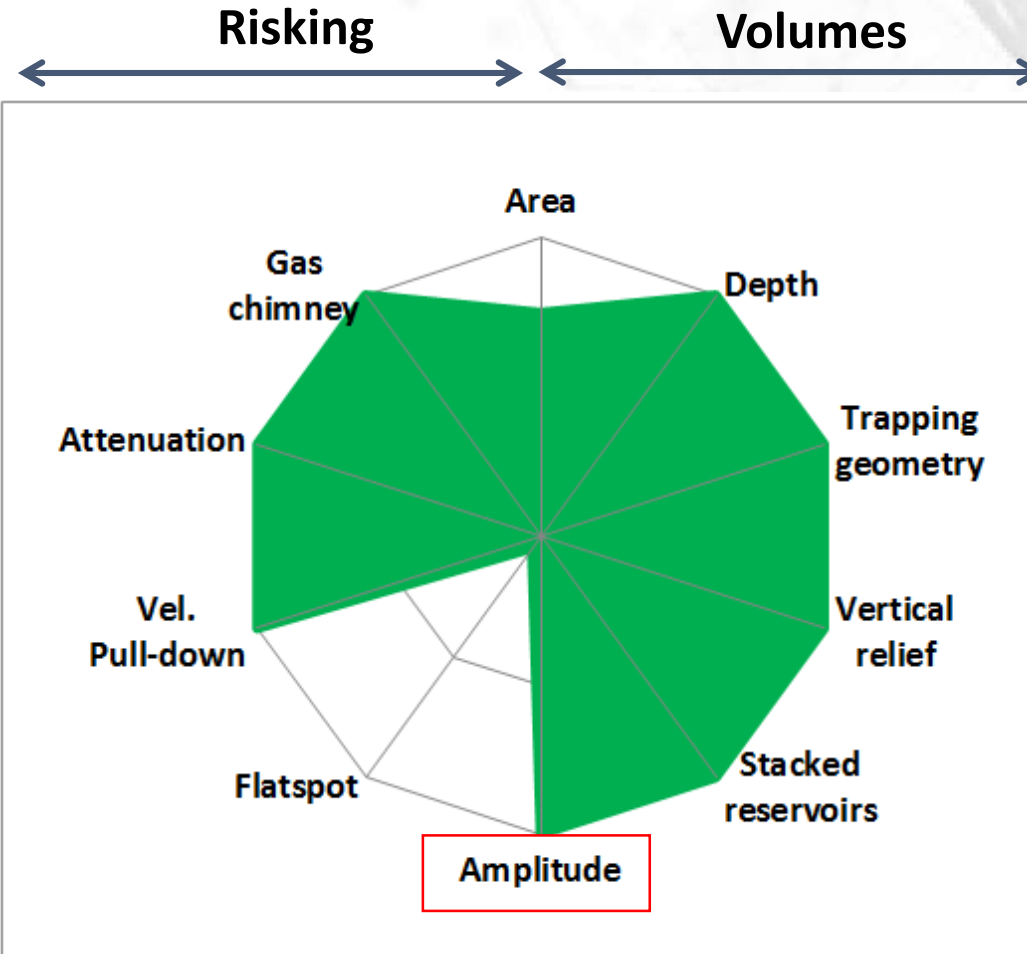
- *Bright Spots* identified (RMS ampl. scanning)
- 150 leads

- Geometrical Characterisation
- Seismic Characterisation

- 3D reservoir model
- Volumes

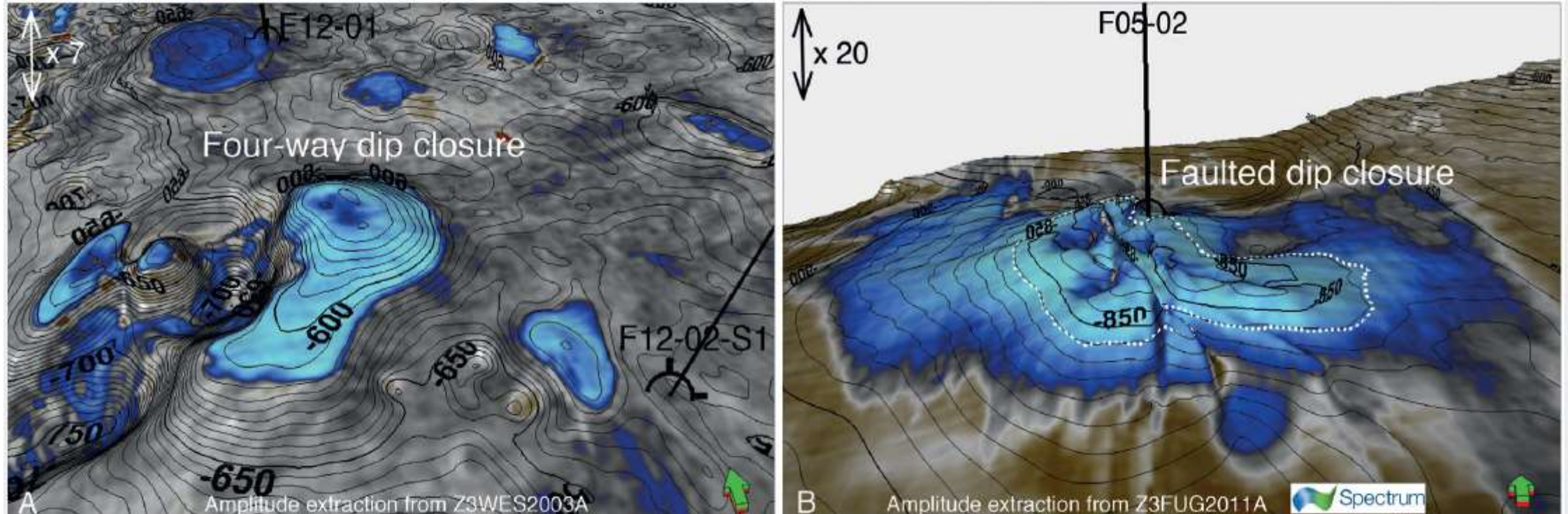


# Shallow Gas: Seismic Characterisation



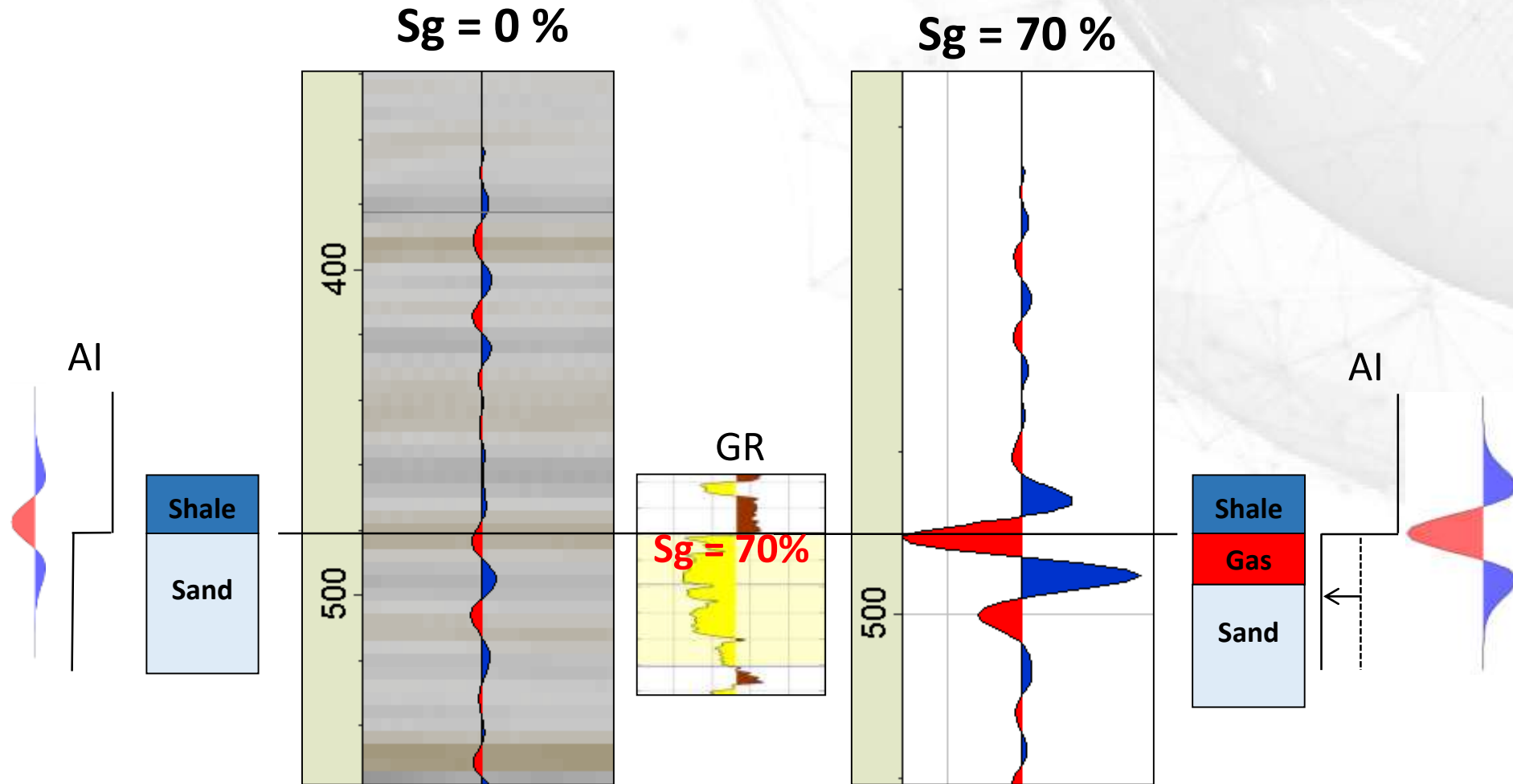
Each SG lead characterized pseudo-quantitatively using *radarplot*

# Amplitudes conform Structure



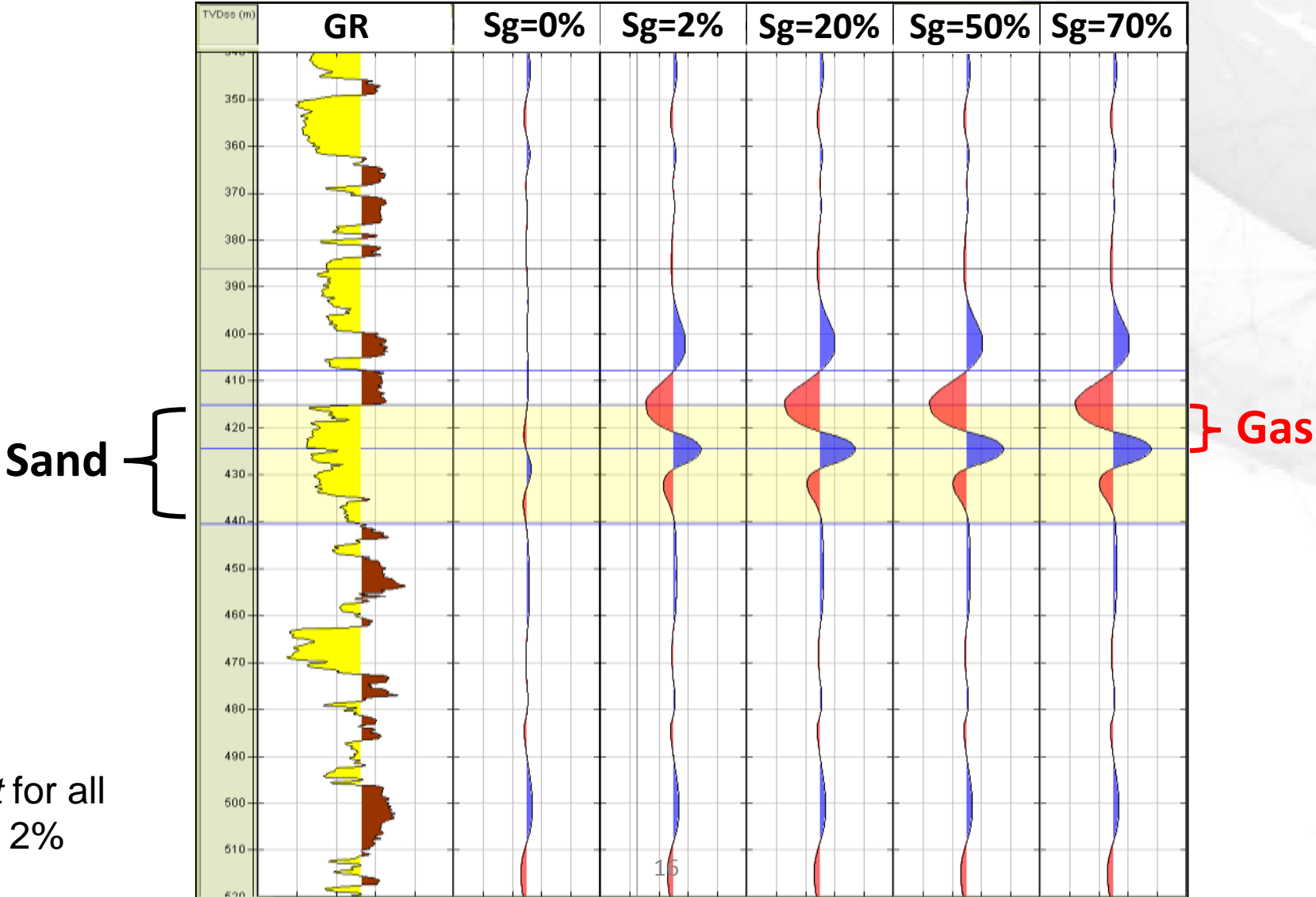
**Figure 4** A) Amplitude extraction plotted on the top reservoir map (TWT) of a four-way dip closure bright spot (area 5 km<sup>2</sup>). B) Amplitude extraction plotted on the top reservoir map (TWT) of a faulted dip closure bright spot (area 40 km<sup>2</sup>). The white stippled line indicates the brightest part of the anomaly that is conforming to structure.

# Seismic Characterisation - *Amplitude*



**Gassmann fluid substitution approximately valid  
(despite unconsolidated sediments)**

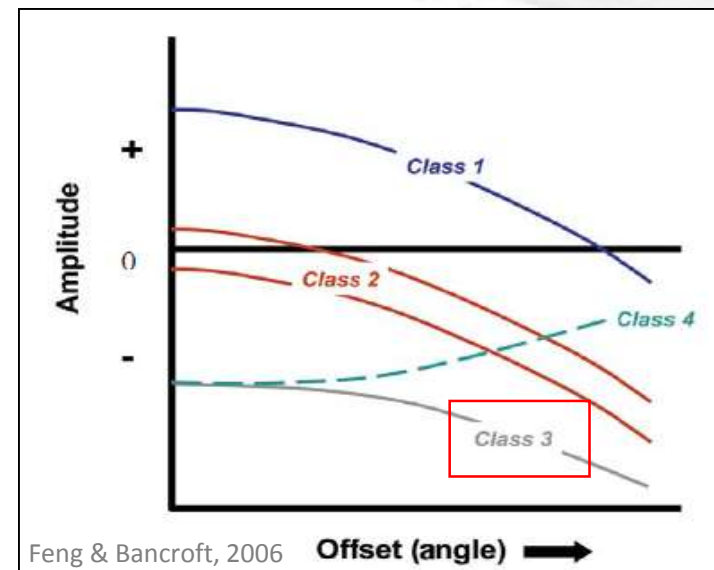
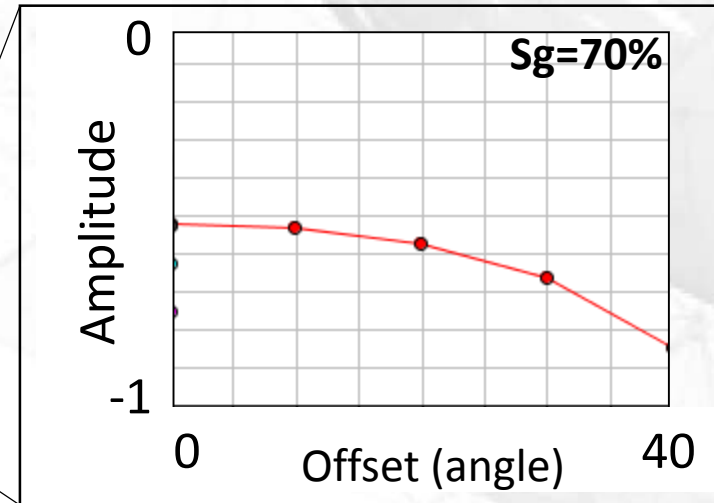
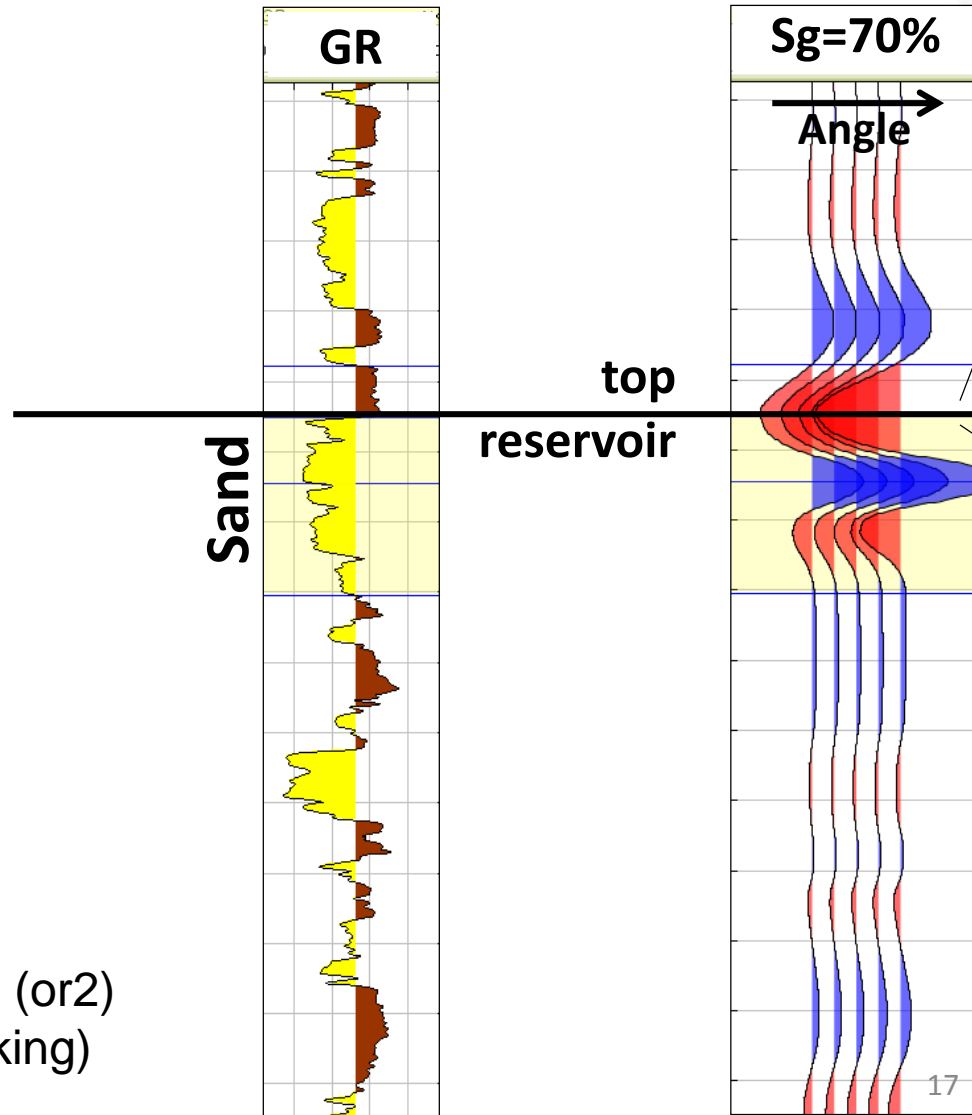
# Seismic Characterisation - *Amplitude*



Amplitudes *bright* for all gas saturations > 2%

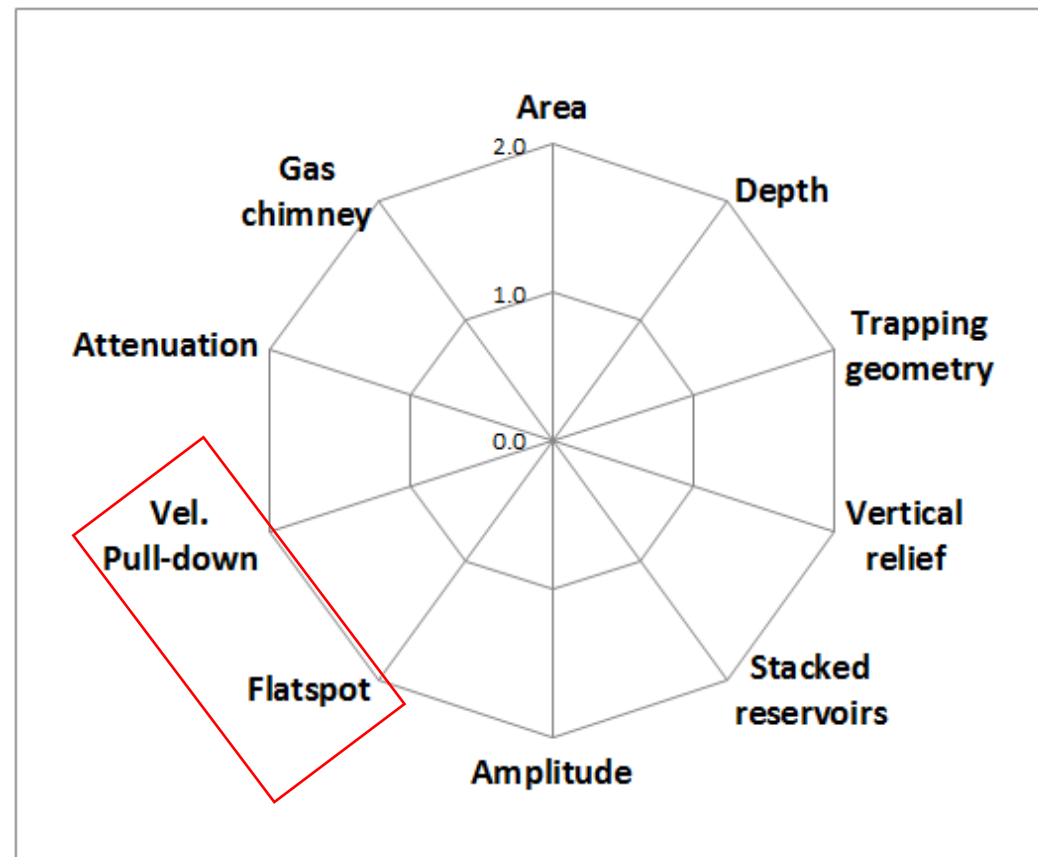


# Seismic Characterisation – AVO

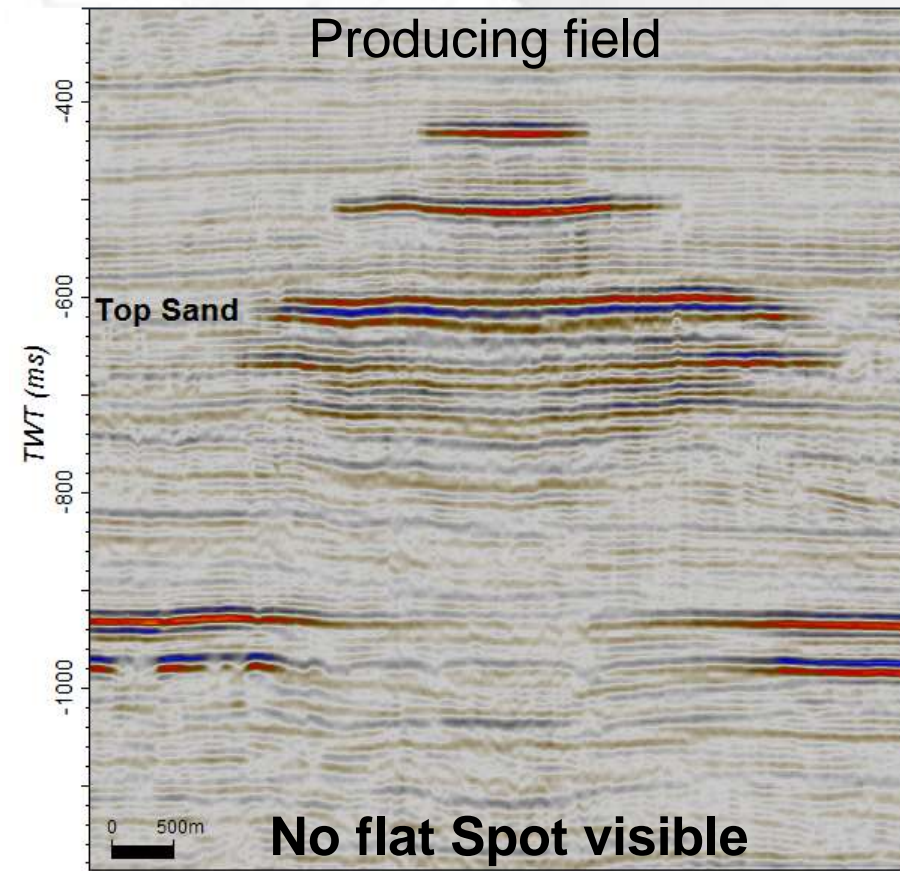
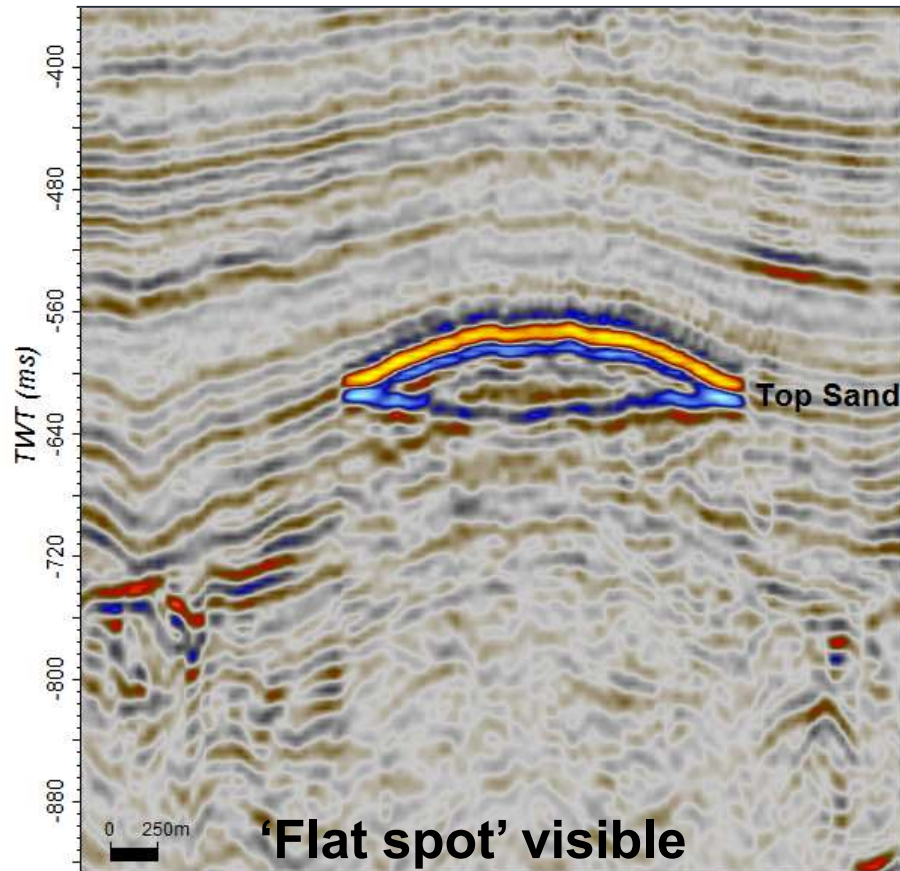


AVO class 3 (or2)  
(Vs logs lacking)

# Seismic Characterisation Shallow Gas



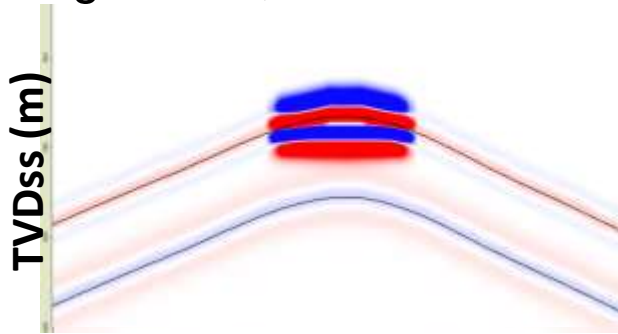
# Flat Spots



# Seismic Characterisation - *Flat Spot*

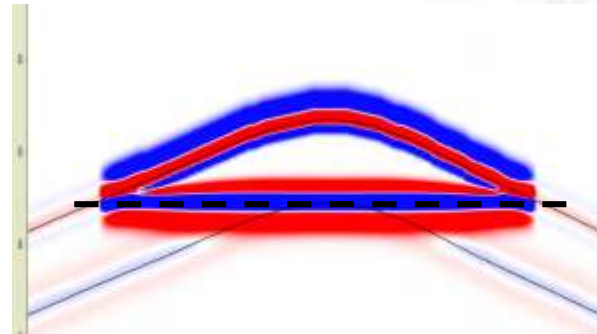
Reservoir = 50m

Sg = 60%, Column = 10m



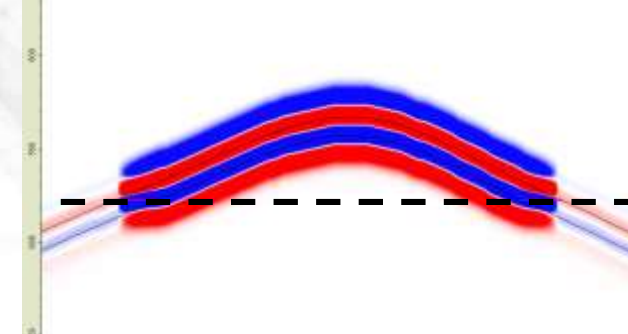
• Reservoir = 50m

• Sg = 60%, Column = 50m



Reservoir = 10m

Sg = 60%, Column = 50m

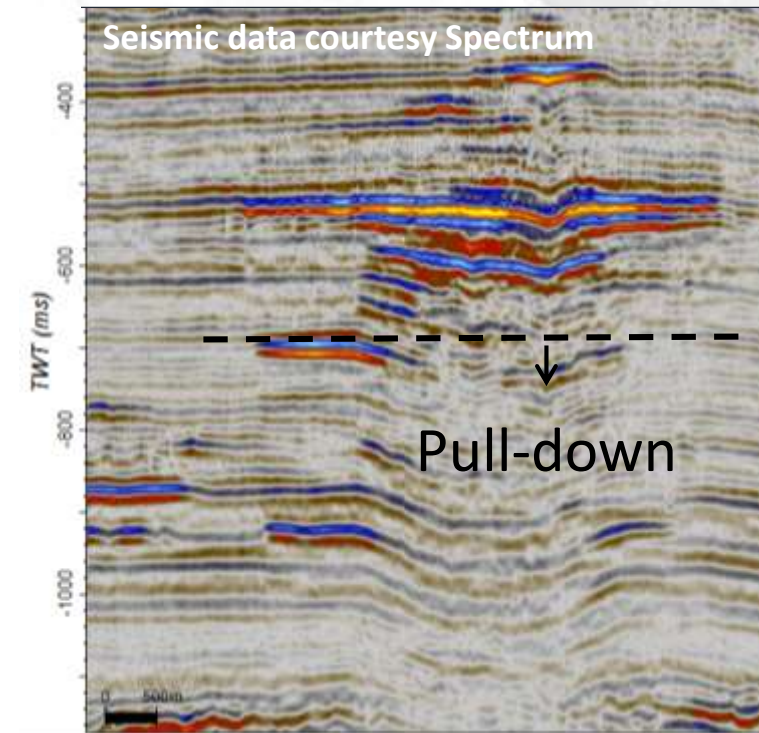
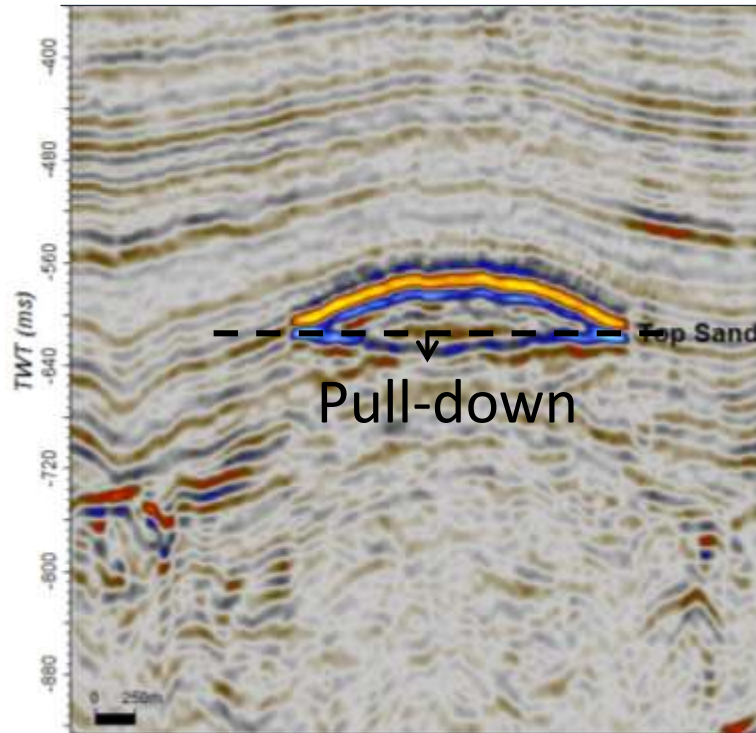


Visibility of flat spot dependent on:

- Dip of reflectors
- Reservoir thickness
- Column height

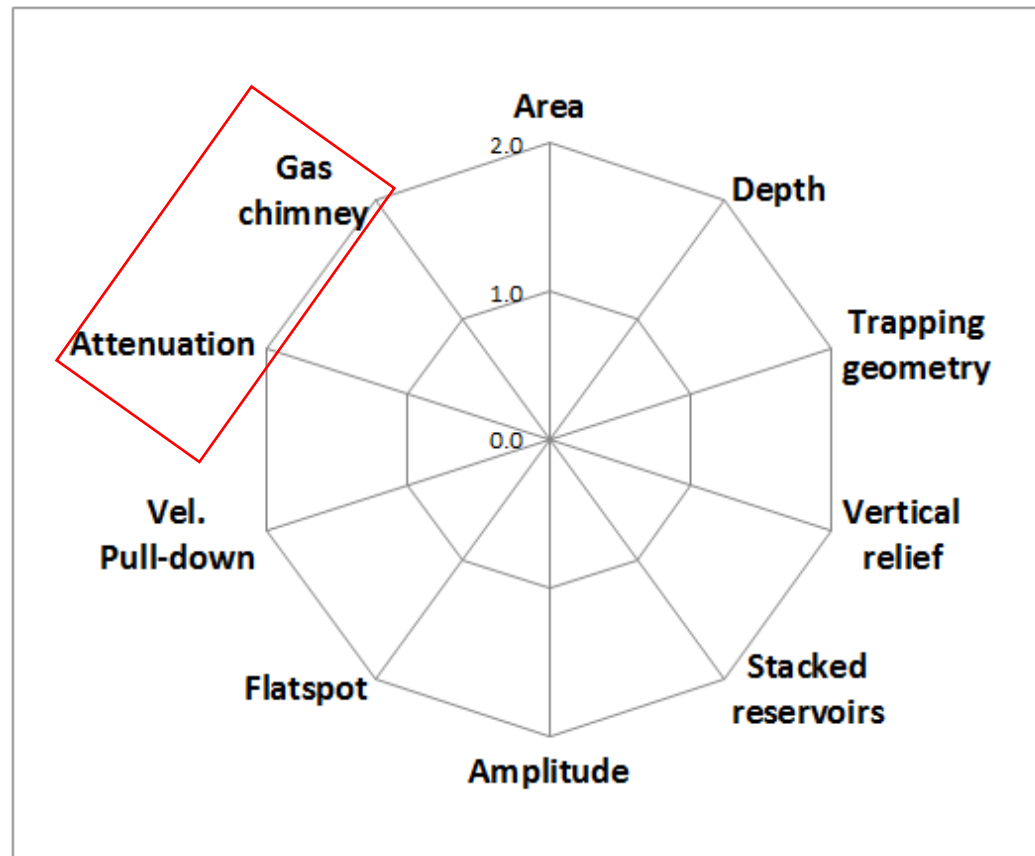
**Flat spot indicates reservoir thickness & HC column, not saturation**

# Seismic Characterisation - *Velocity Pull Down*



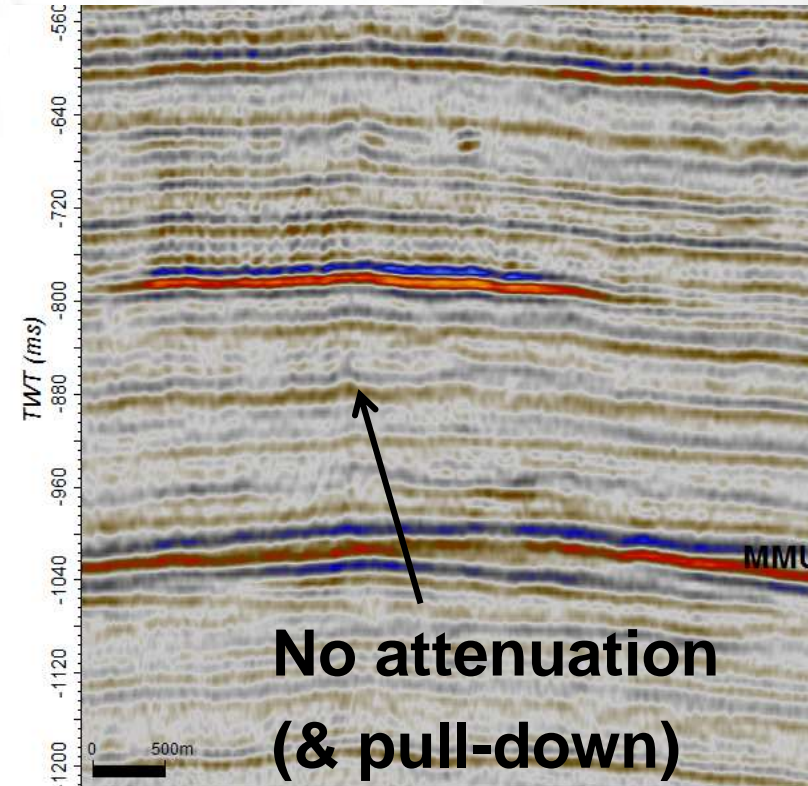
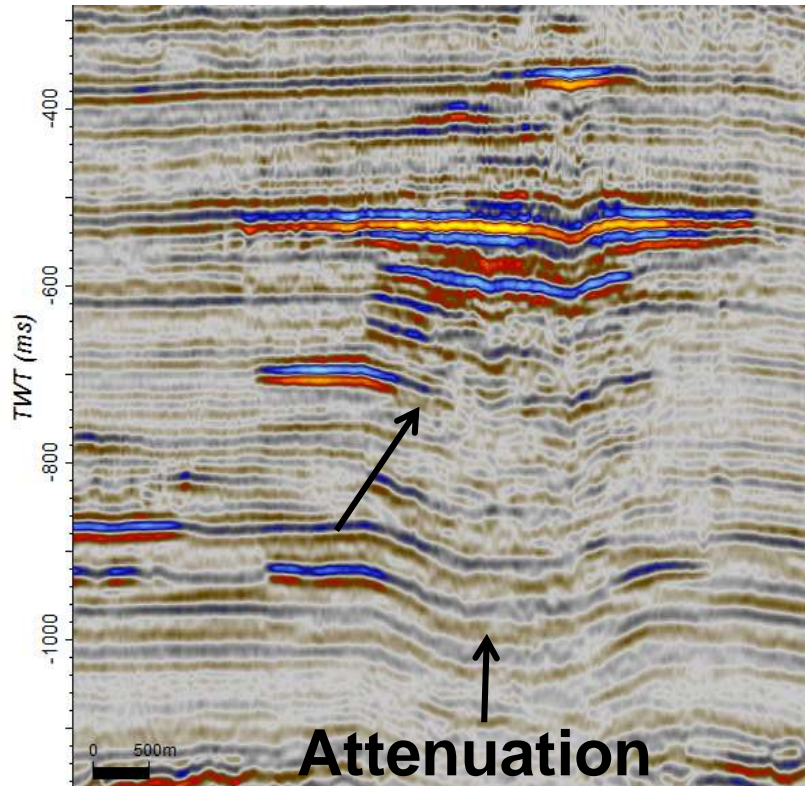
- → Pull-down indicates (total) HC column
- → Absence pull-down indicates very low saturation

# Seismic Characterisation Shallow Gas



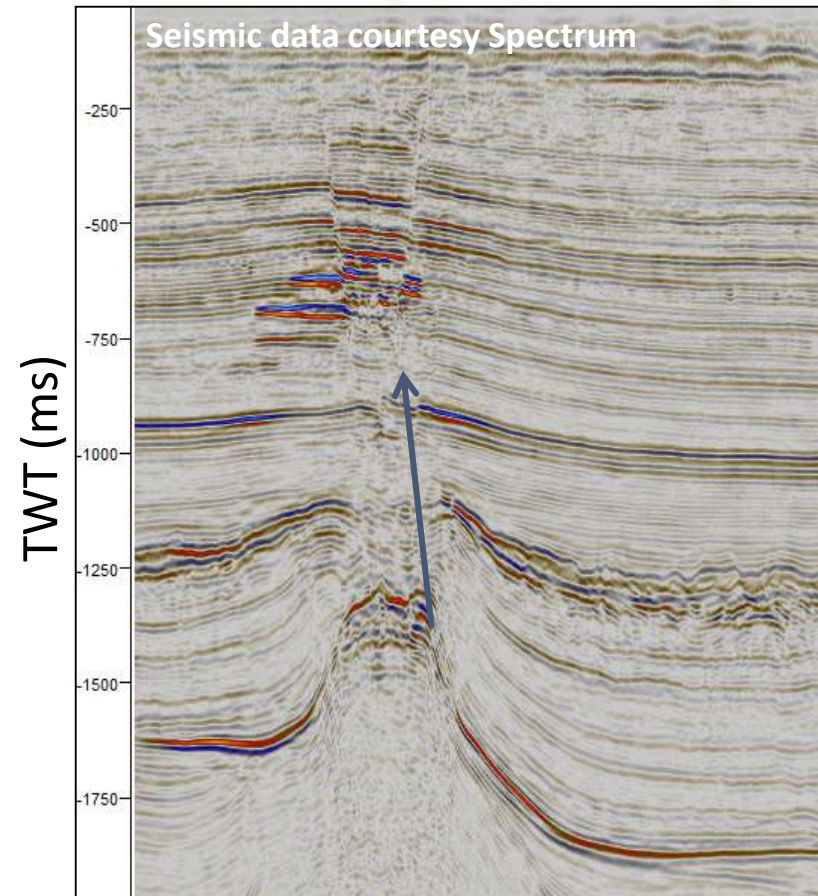
# Seismic Characterisation - *Attenuation*

Seismic data courtesy Spectrum



- → Absence attenuation indicates very low saturation

# Seismic Characterisation - *Gas Chimney*

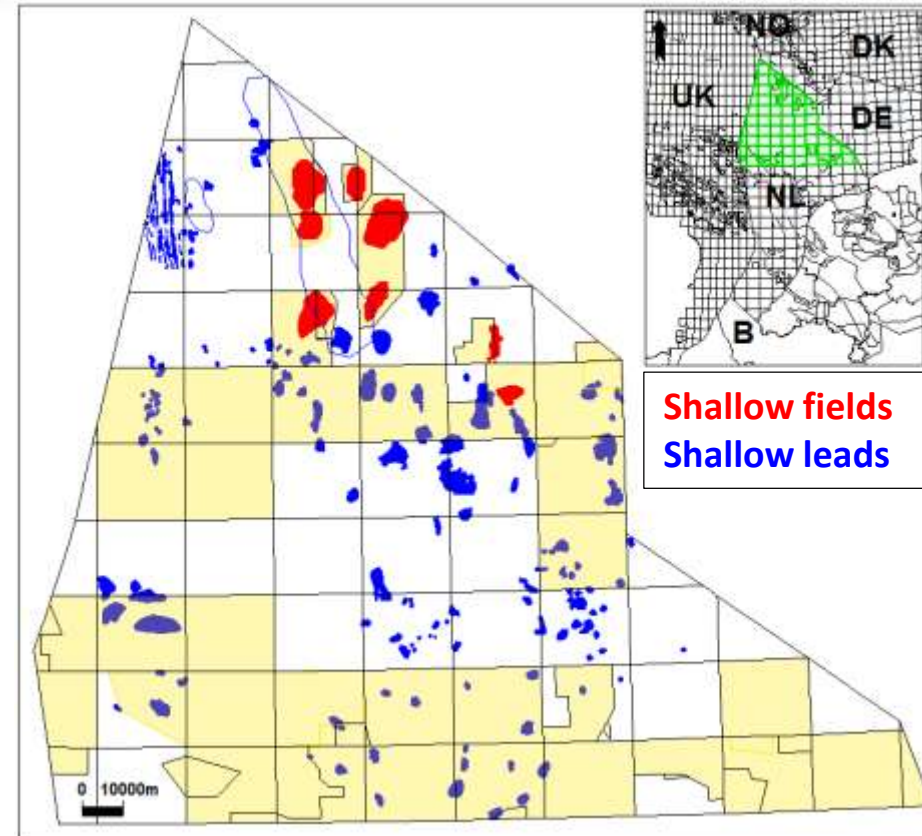


- Gas chimney indicator for gas



# Summary

- Bright spots indicative for Shallow gas.
- Since 1965 no significant SG drilling incidents in NL.
- 4 producing fields.
- > 100 leads in portfolio.
- Pseudo-quantitative seismic characterization useful for first order ranking.
- Ultimate derisking requires the bit?



# Acknowledgements

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- Petrogas (E. Campbell, K. Borowski)
- Spectrum, seismic data courtesy
- TNO
- EBN Exploration team

See also:

**Prospectivity analysis of shallow gas in the Netherlands**

M. van den Boogaard and G. Hoetz

First Break volume 36, Dec 2018

(P47-54, Regional Focus The Netherlands)