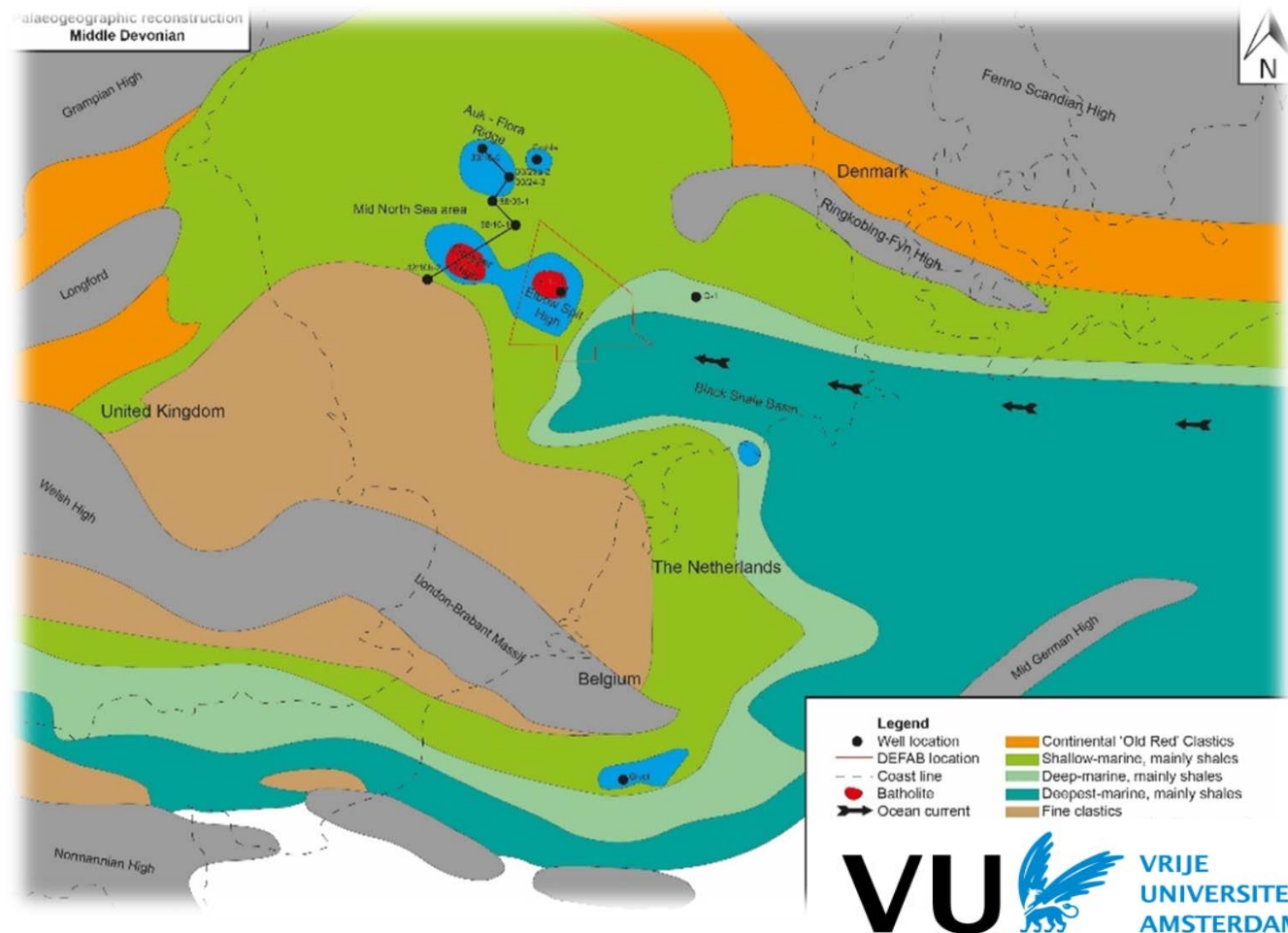


Assessing the petroleum potential of Devonian Carbonates in the Mid North Sea area



Koos de Jong¹,

Bastiaan Jaarsma²,

John Reijmer¹,

Marten ter Borgh²

1 Vrije Universiteit, De Boelelaan 1085,
1081 HV Amsterdam, the Netherlands.

2 EBN B.V., Daalsesingel 1, 3511 SV
Utrecht, the Netherlands

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Assessing the petroleum potential of Devonian Carbonates in the Mid North Sea area

Why?

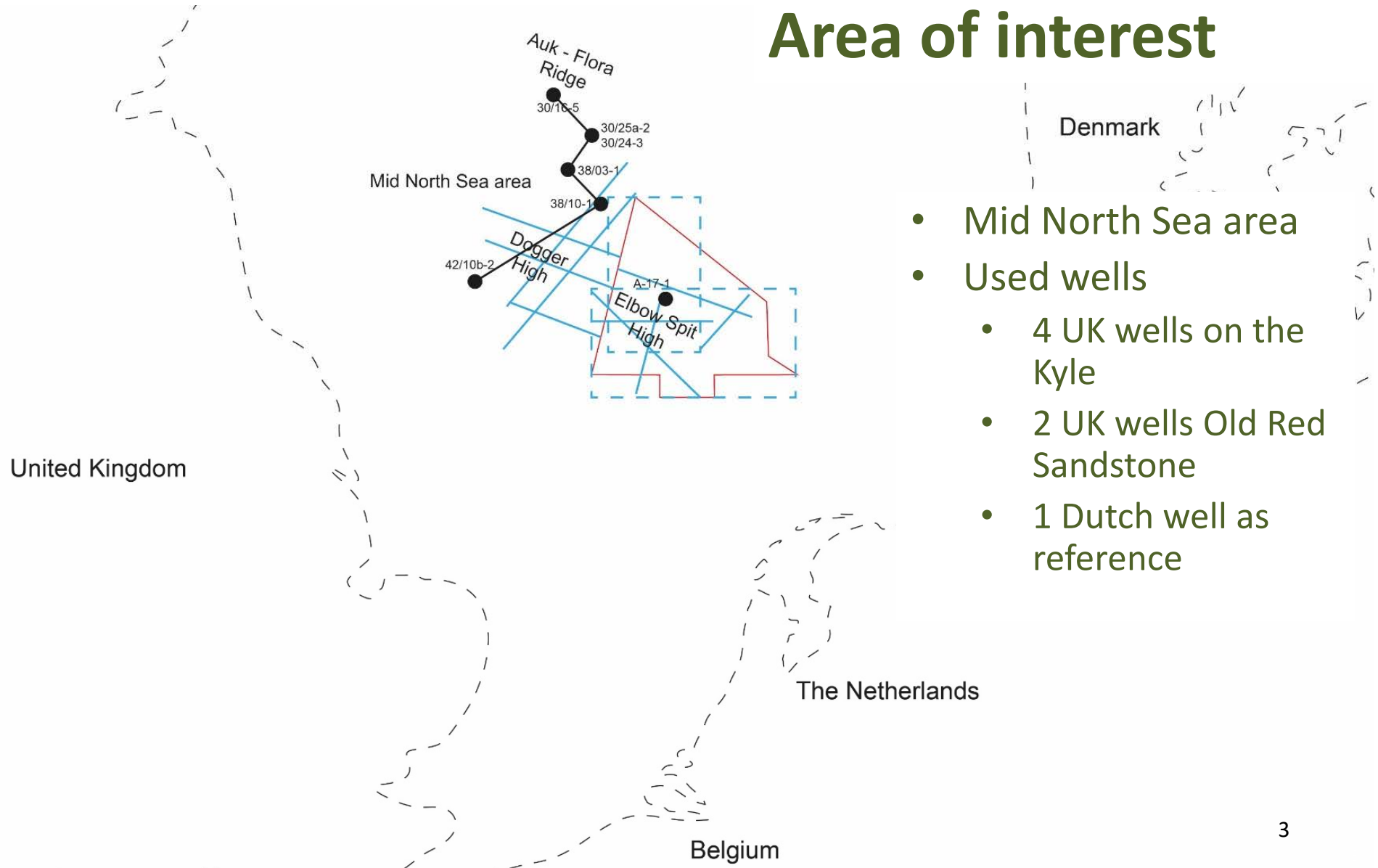
Under-explored area → Primarily Mesozoic Petroleum plays

- Producing analogues in Canada and Australia.
- Newly acquired 3D seismic (DEF survey)

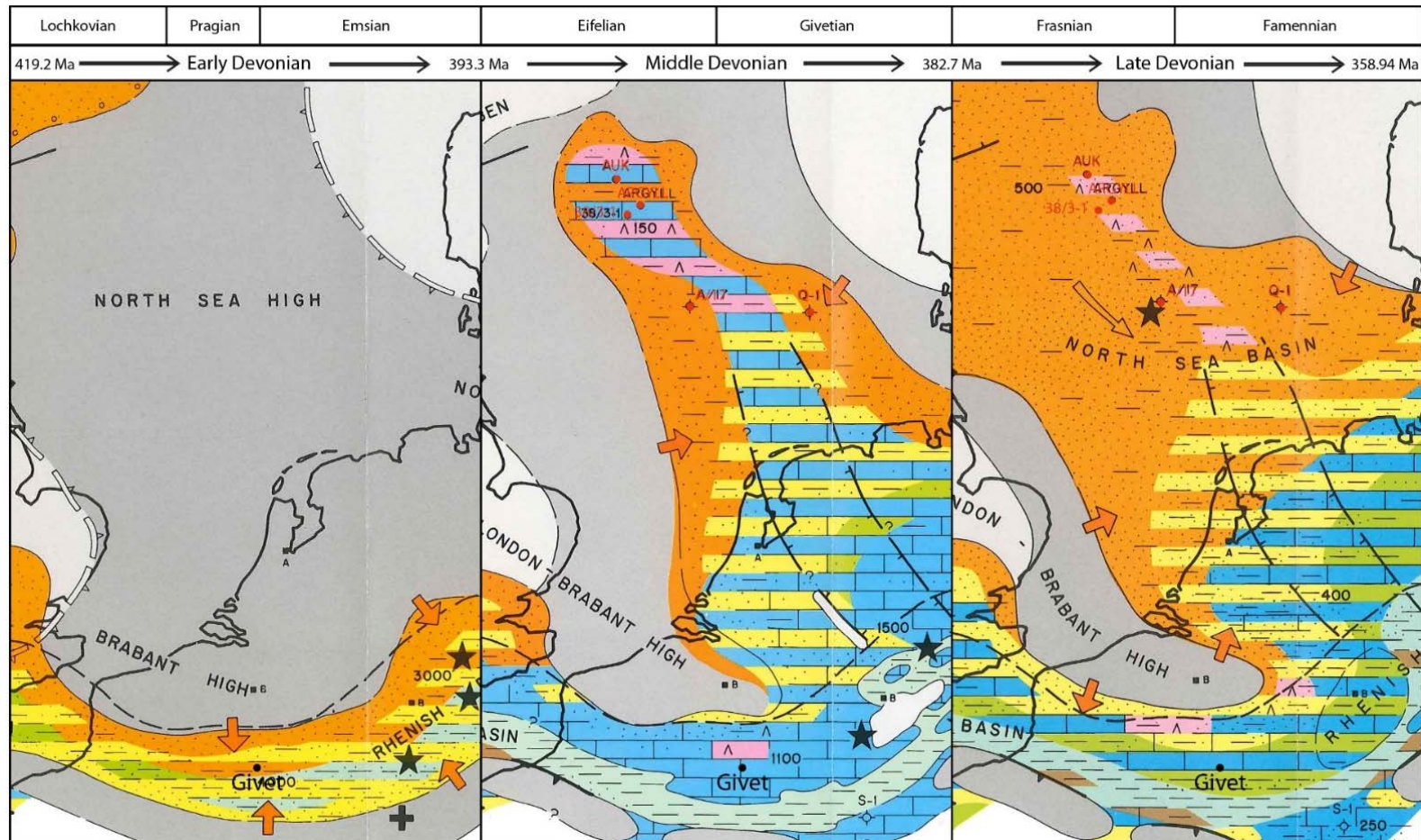
Key messages

- Trap as fault dip closures and stratigraphic traps
- Source intra shales
- Reservoir limestone (karstified / dolomitized / fractured)
- Seal as shales on top

Area of interest



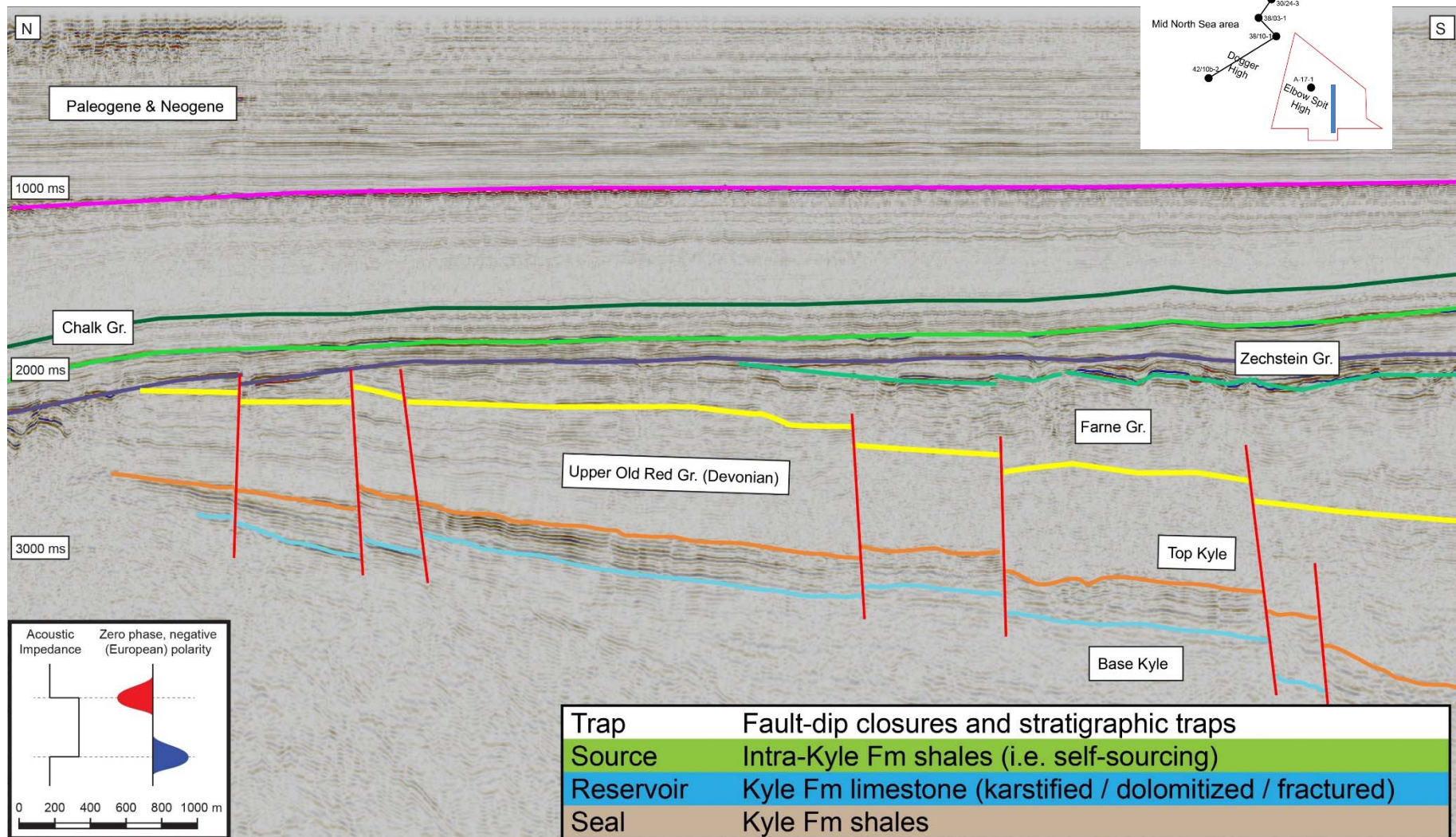
Distribution of the Mid to Upper Devonian



Edited after: Ziegler (1990)

Sea inlet?

Location of the Devonian

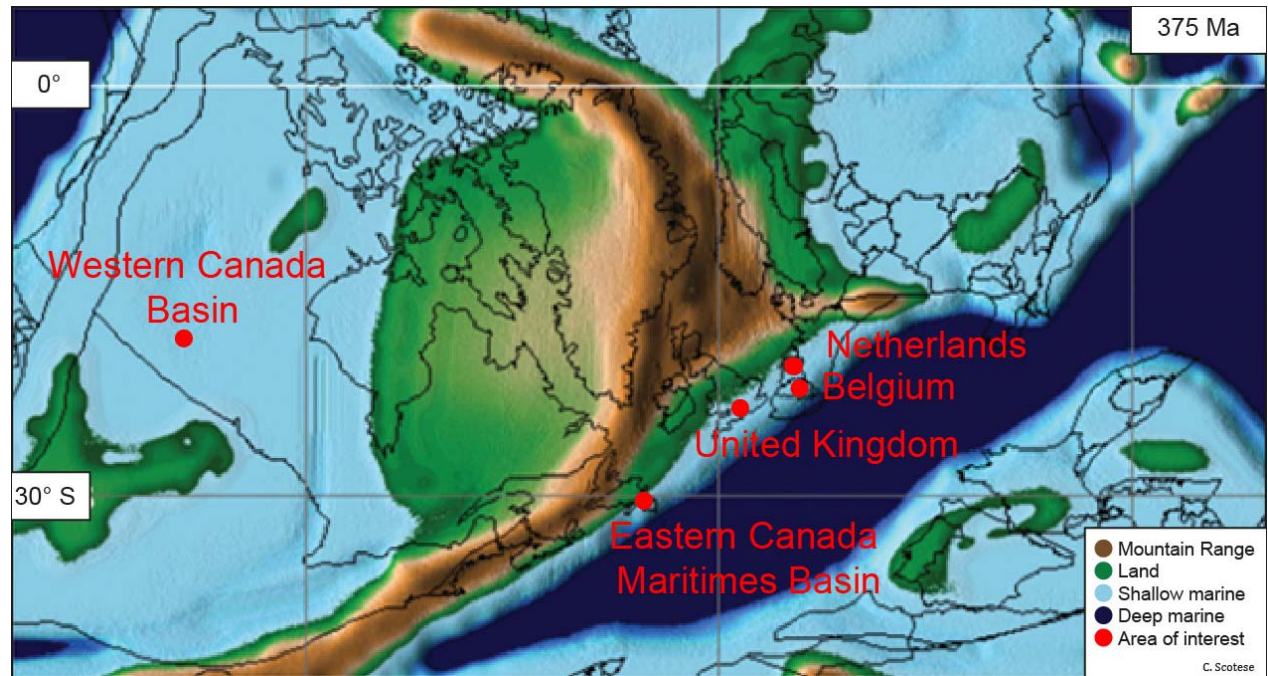


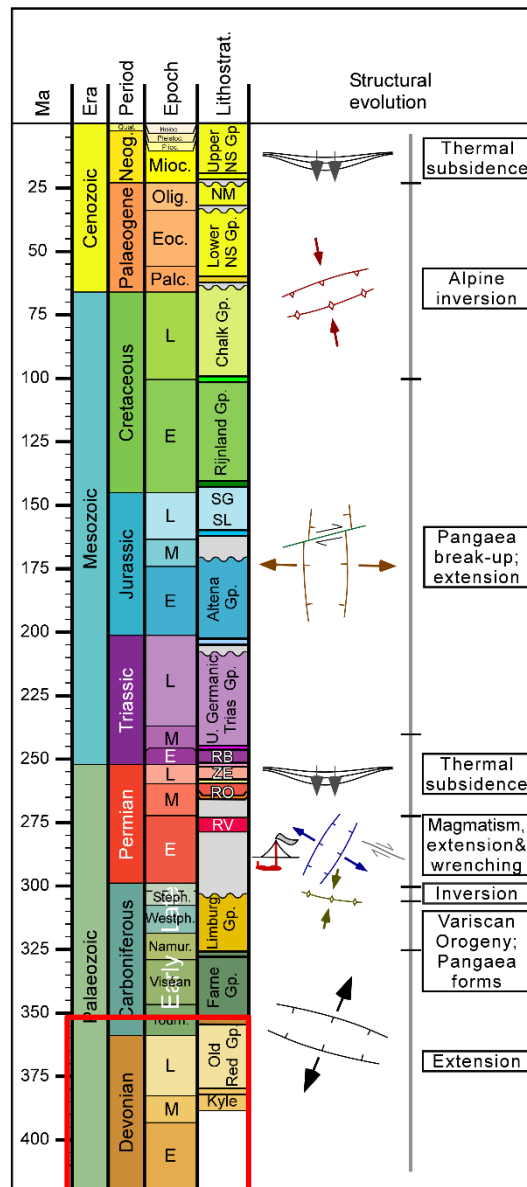
Seismic data courtesy of Spectrum ASA

Favorable conditions for carbonate systems

- Warm Climate
 - 25 °C
- 21.1% to 27.4% O₂
- Shallow marine environment

Orcadian basin to the North



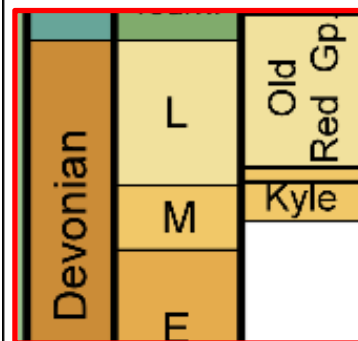


Structural overview

Most important for the Kyle:

- Early Carboniferous extension
- Early Permian magmatic extension

High heat flow



Source: Ter Borgh et al. (2016)

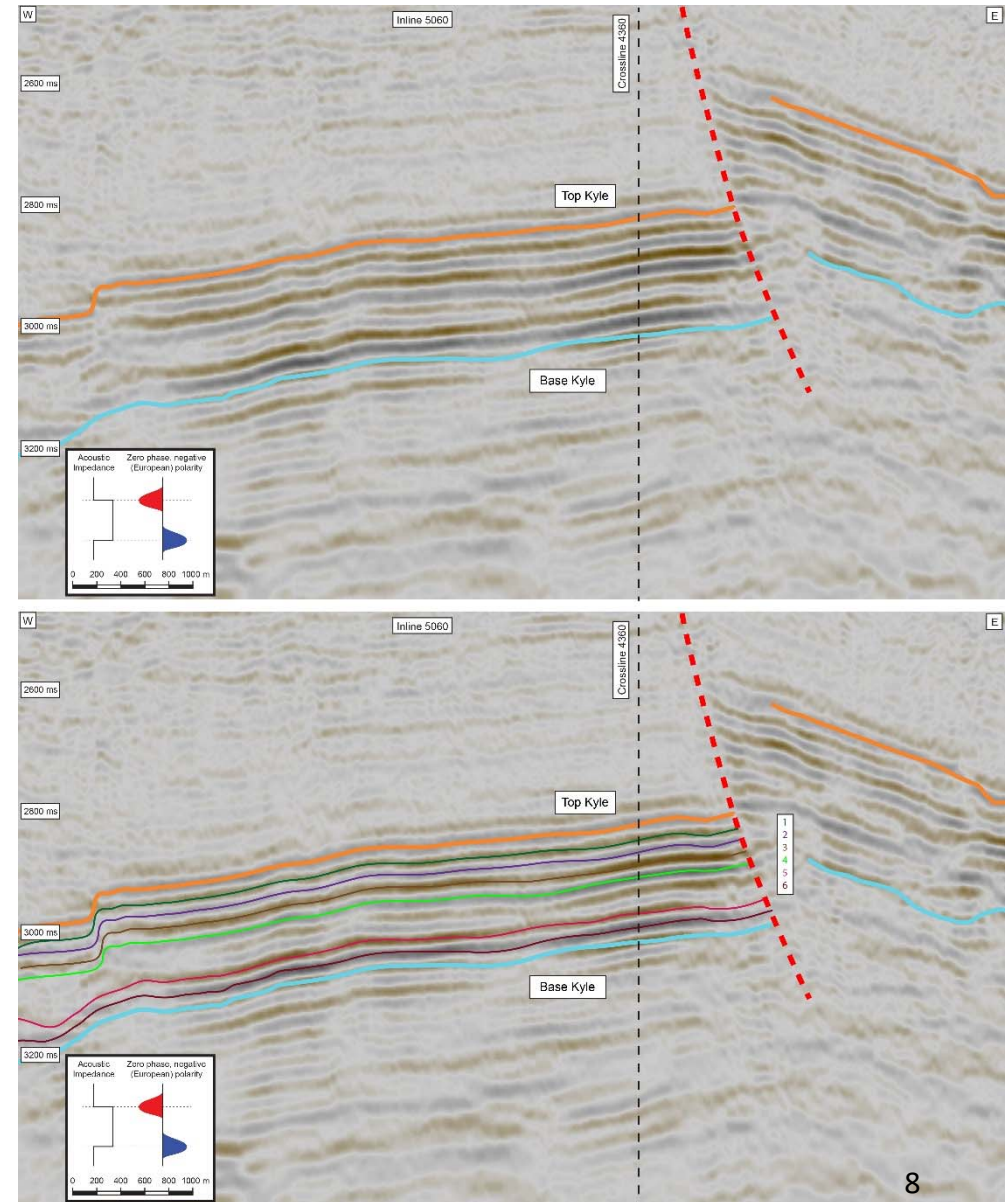
Addition information on the poster of Ter Borgh

A Structural framework for the Dutch northern offshore

Methods

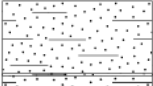
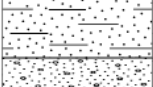
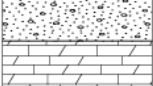
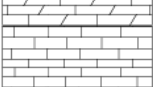
- Synthetic / forward modelling
- Seismic
 - 3D-DEF Survey (NL)
 - 2D-TGS NSR Survey (NL/UK)
- “Conventional” and “Advanced” interpretation
 - PaleoScan®

Seismic data courtesy of Spectrum ASA
PaleoScan, Trademark of Eliis



Literature research synthetics

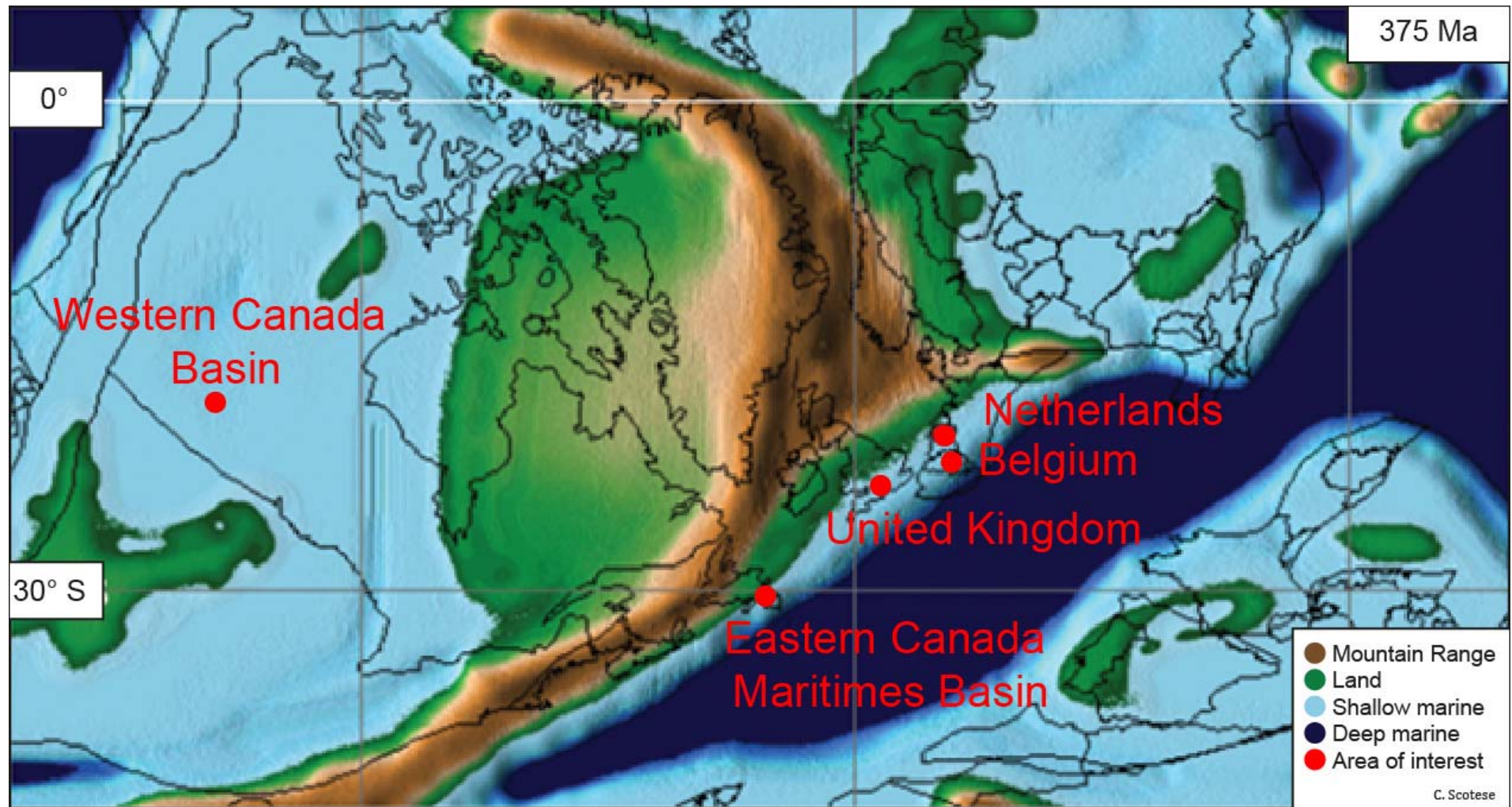
- Acoustic velocity
- Density

Legend		Density (g/cm ³)	Acoustic Velocity (m/s)
	Mudstone	2.50	2400
	Anhydritic Mudstone	2,73	4225
	Sandstone	2,65	6040
	Dolomite	2,87	6960
	Limestone	2,71	6530

Bourbie et al. (1987), Miller (1943), Koga et al. (1958), Mason (1943) and Simmons (1964)

Seismic signal ⇐ ⇒ Synthetic seismic

Analogue Description



Results of the analogues

- Several time equivalent platforms
 - Stromatoporoid reef systems
- Western Canadian Basin
 - Large unconventional petroleum play
- Several reservoirs in UK wells up to Devonian
 - Thickening Kyle along hanging walls
- Several sea-level variations

Results of the analogues

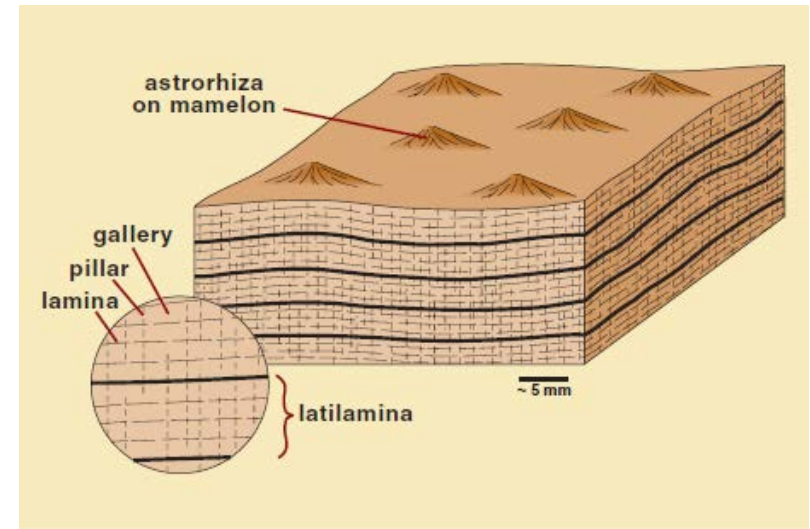
Cairn formation
stromatoporoids



Tabulate corals



Stromatoporoids



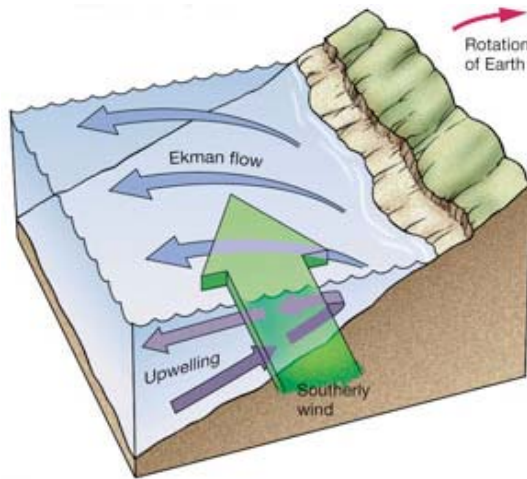
Coquina beds

Scholle and Scholle (2003)

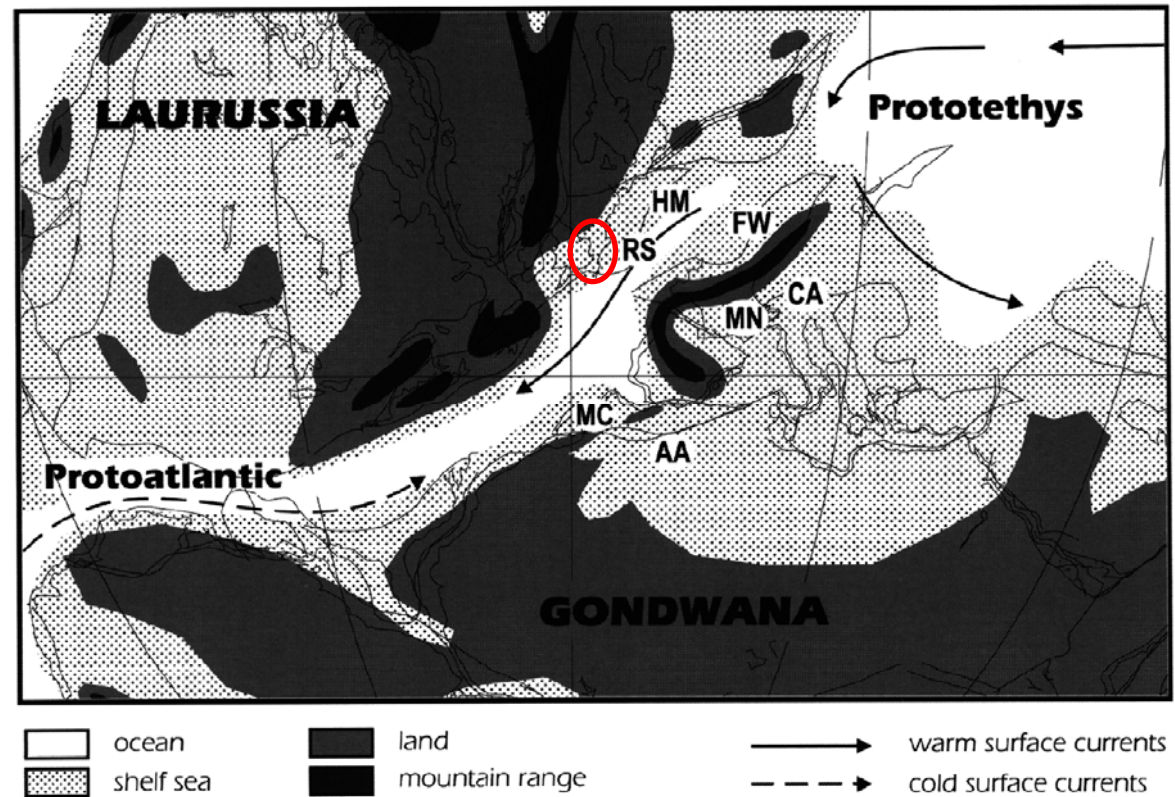


Devonian ocean circulation

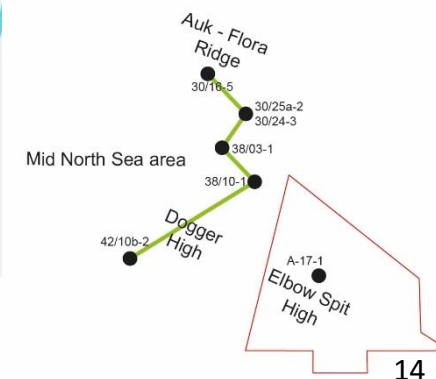
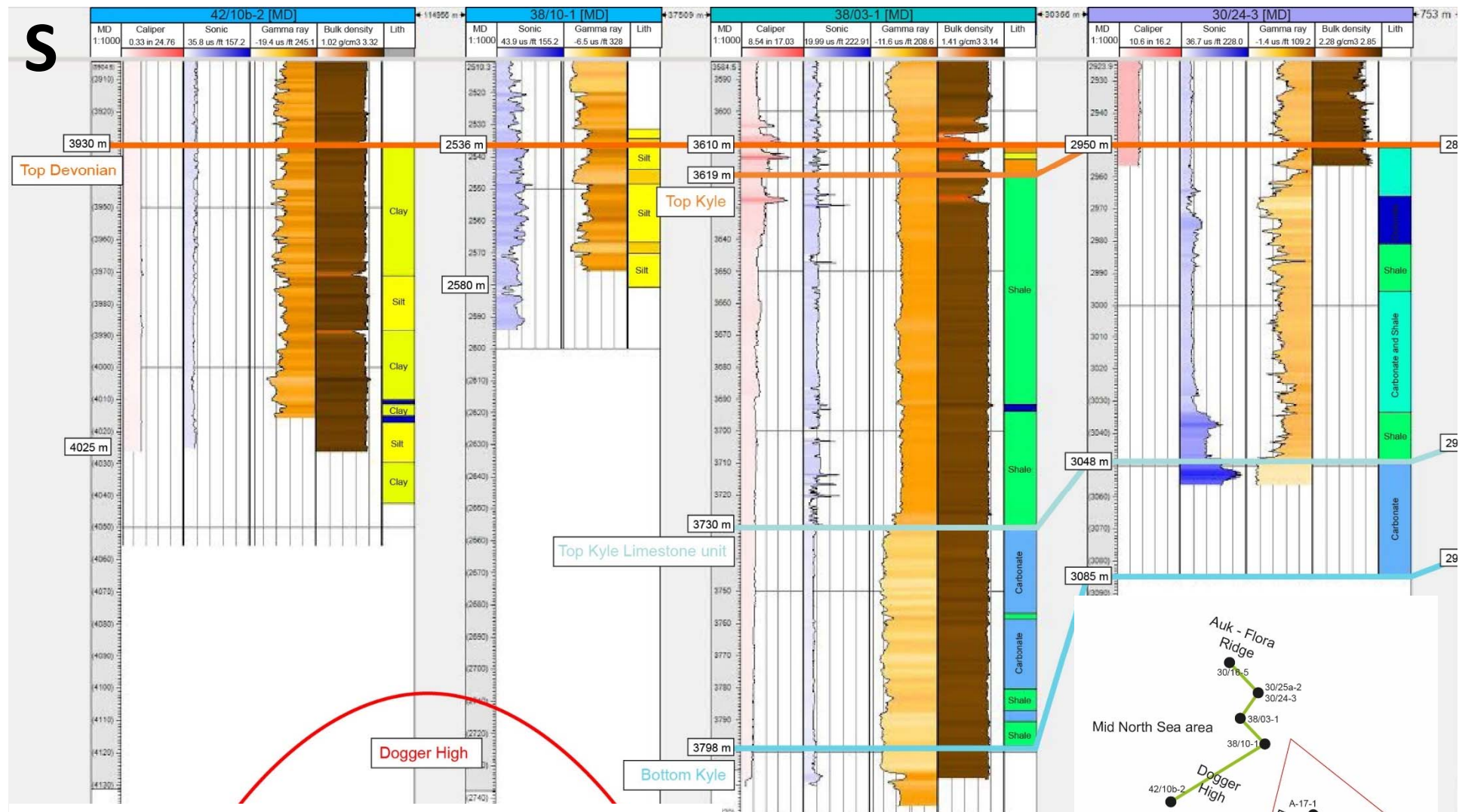
- Paleo current reconstruction
- Based on:
 - Phosphorites deposition areas
→ Nutrient rich areas



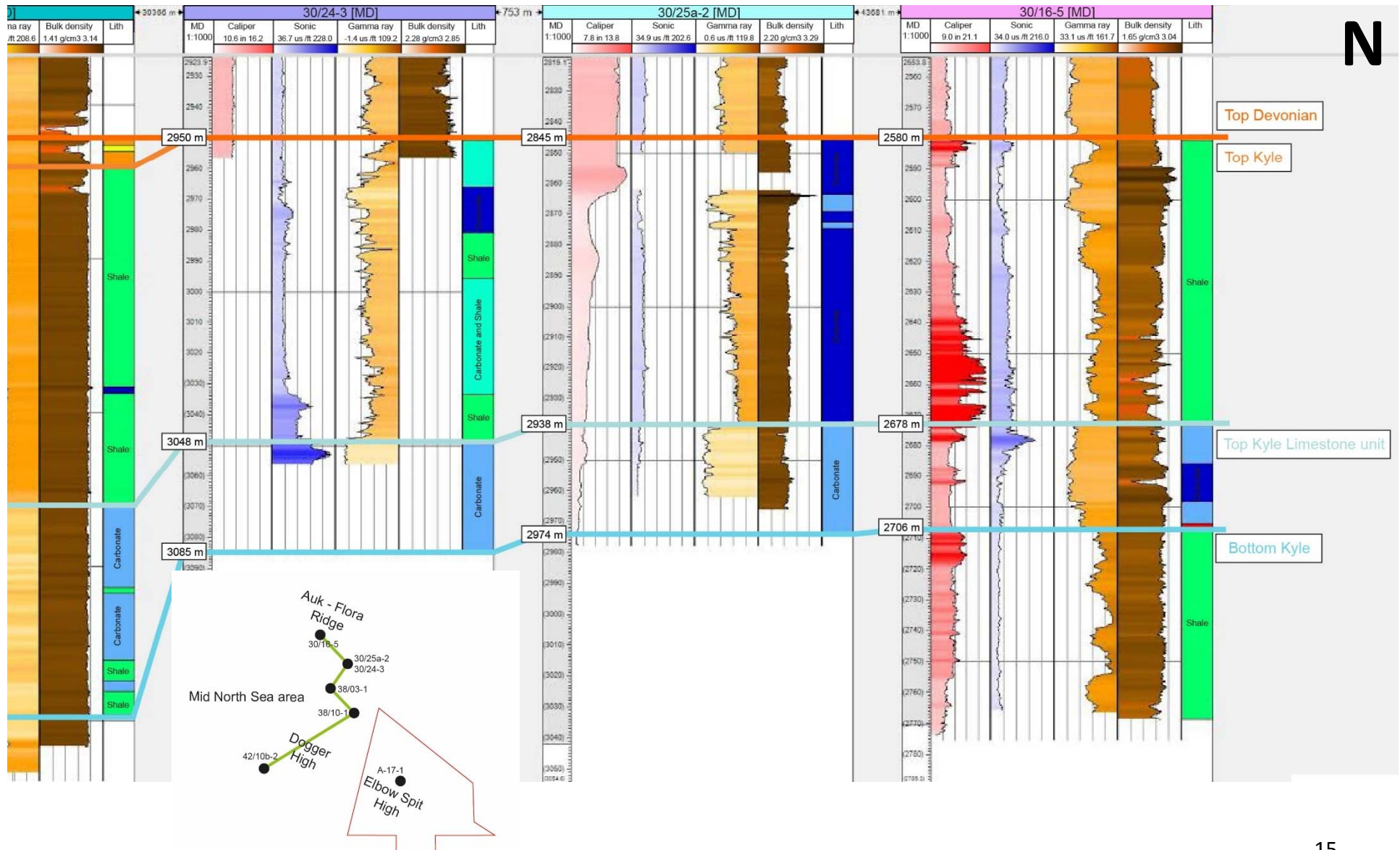
Source: Pearson Prentice Hall, 2004



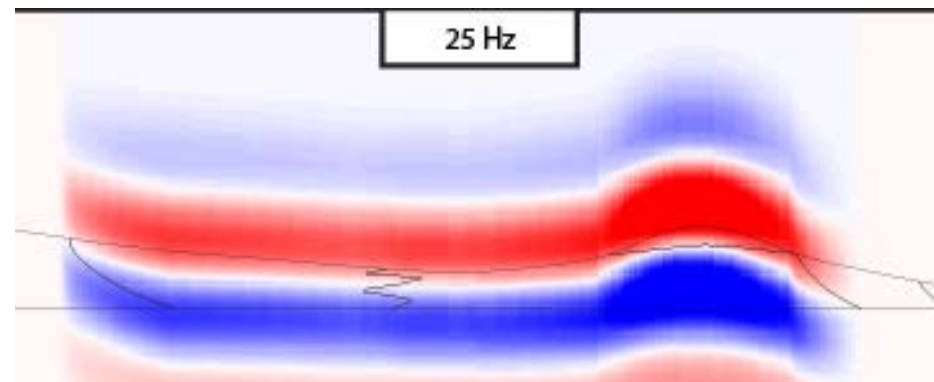
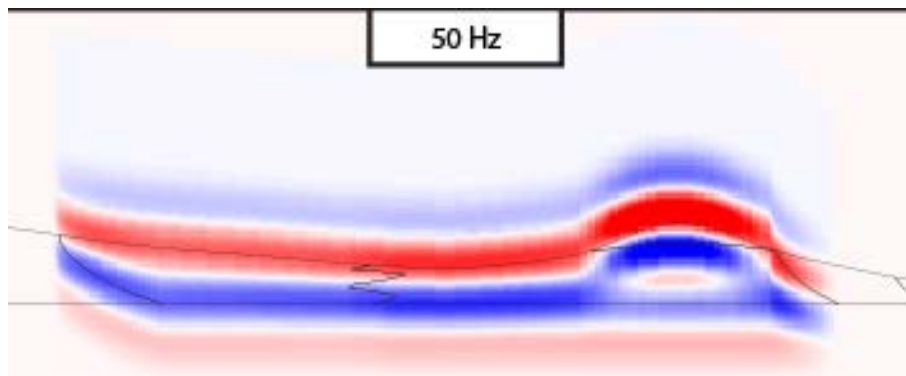
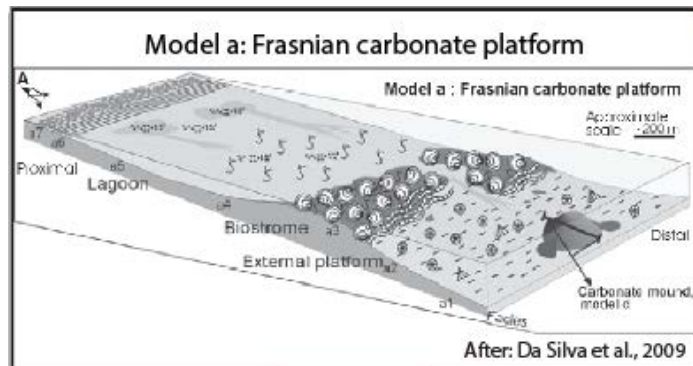
Source: Hüneke (2007)



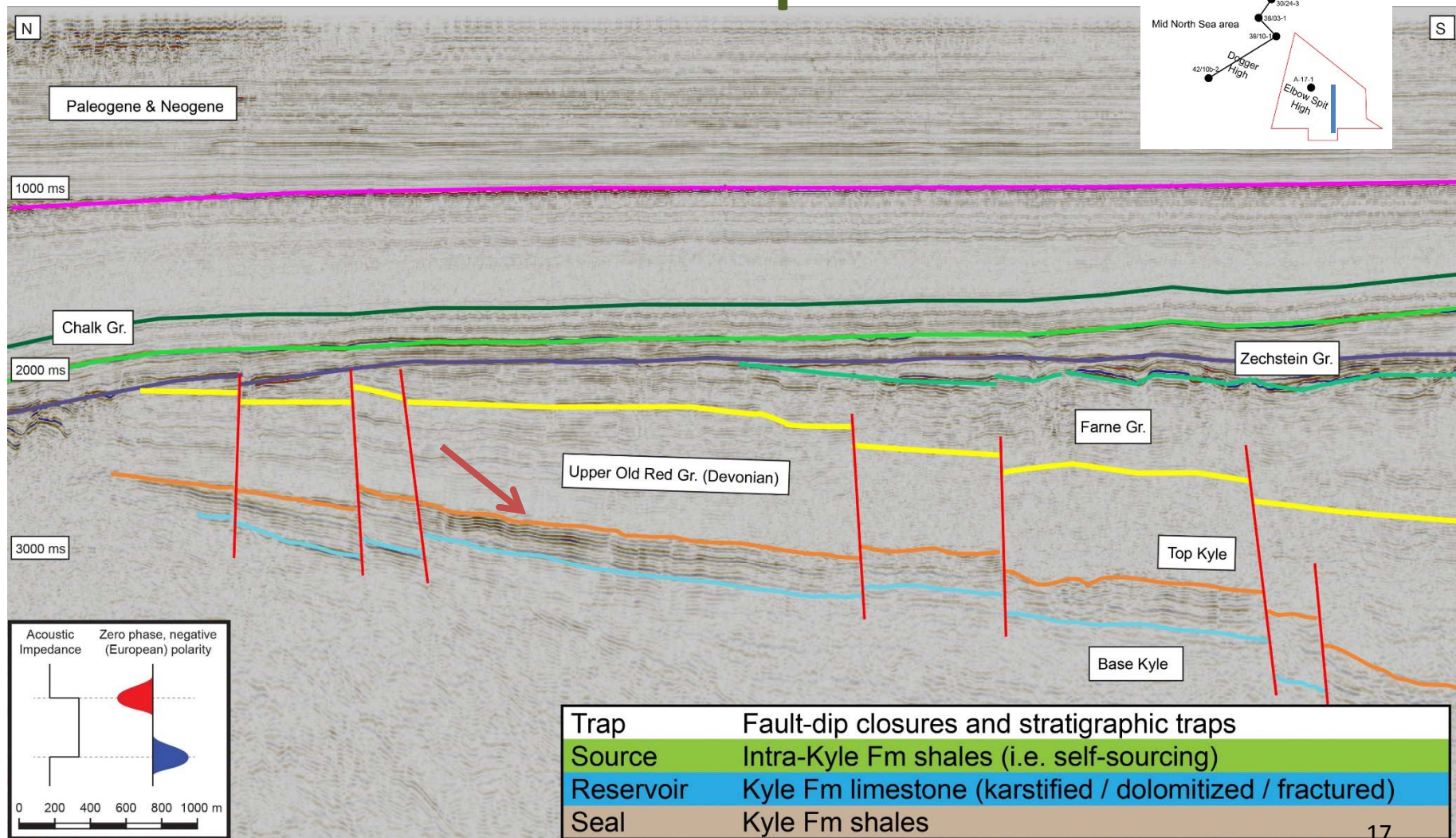
Well correlation panel



Synthetic Frasnian carbonate platform



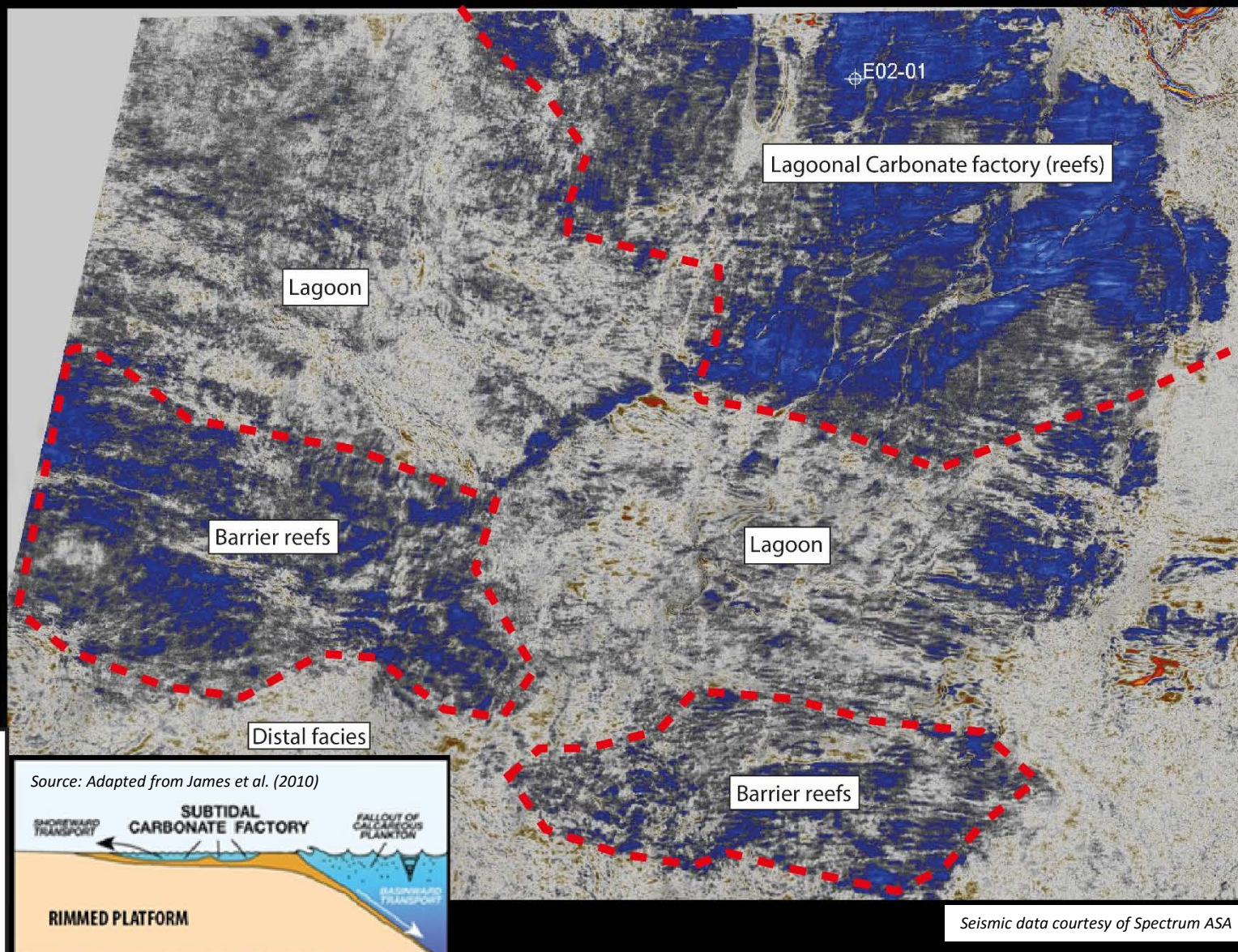
Seismic interpretation



Seismic data courtesy of Spectrum ASA

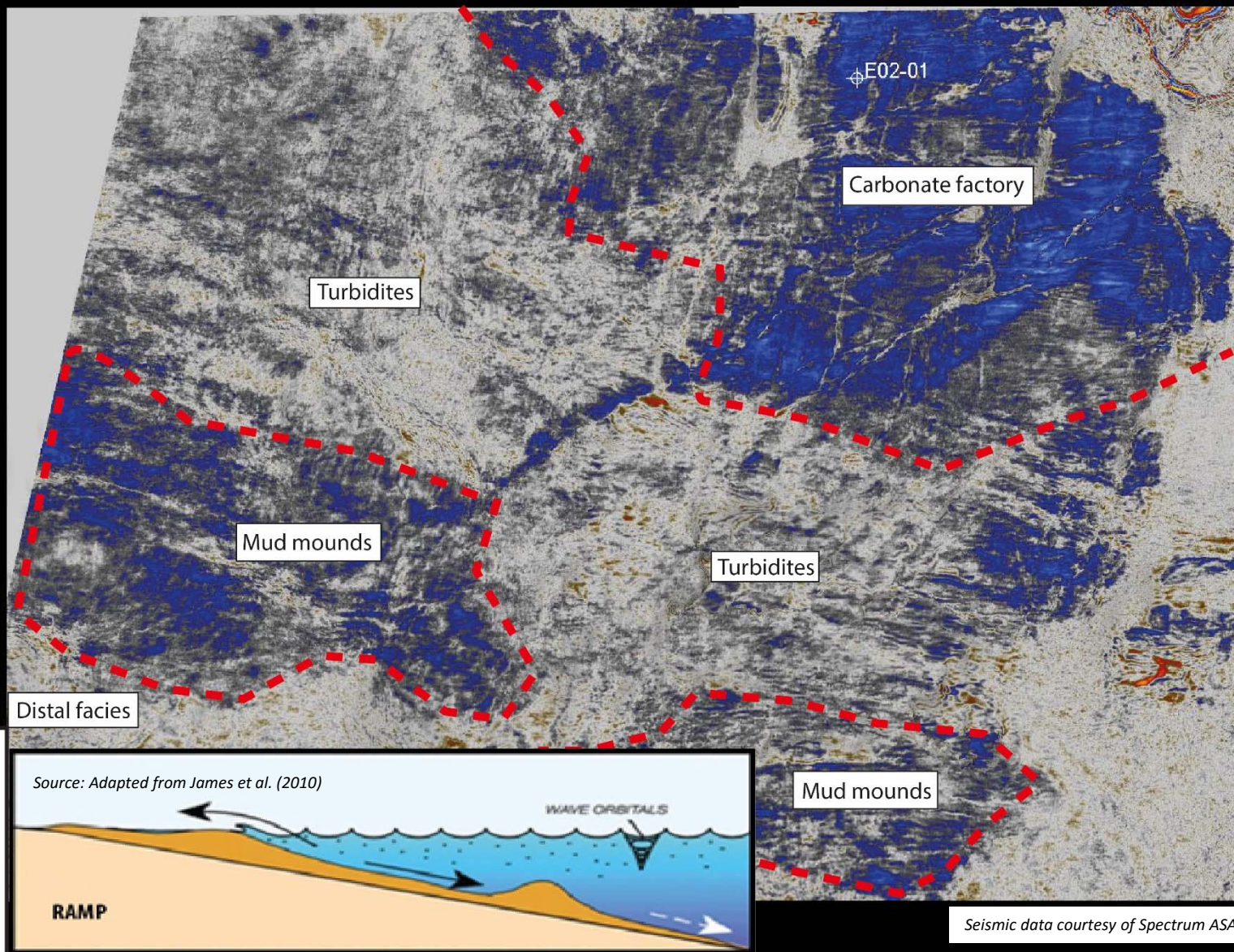
A

Rimmed Platform



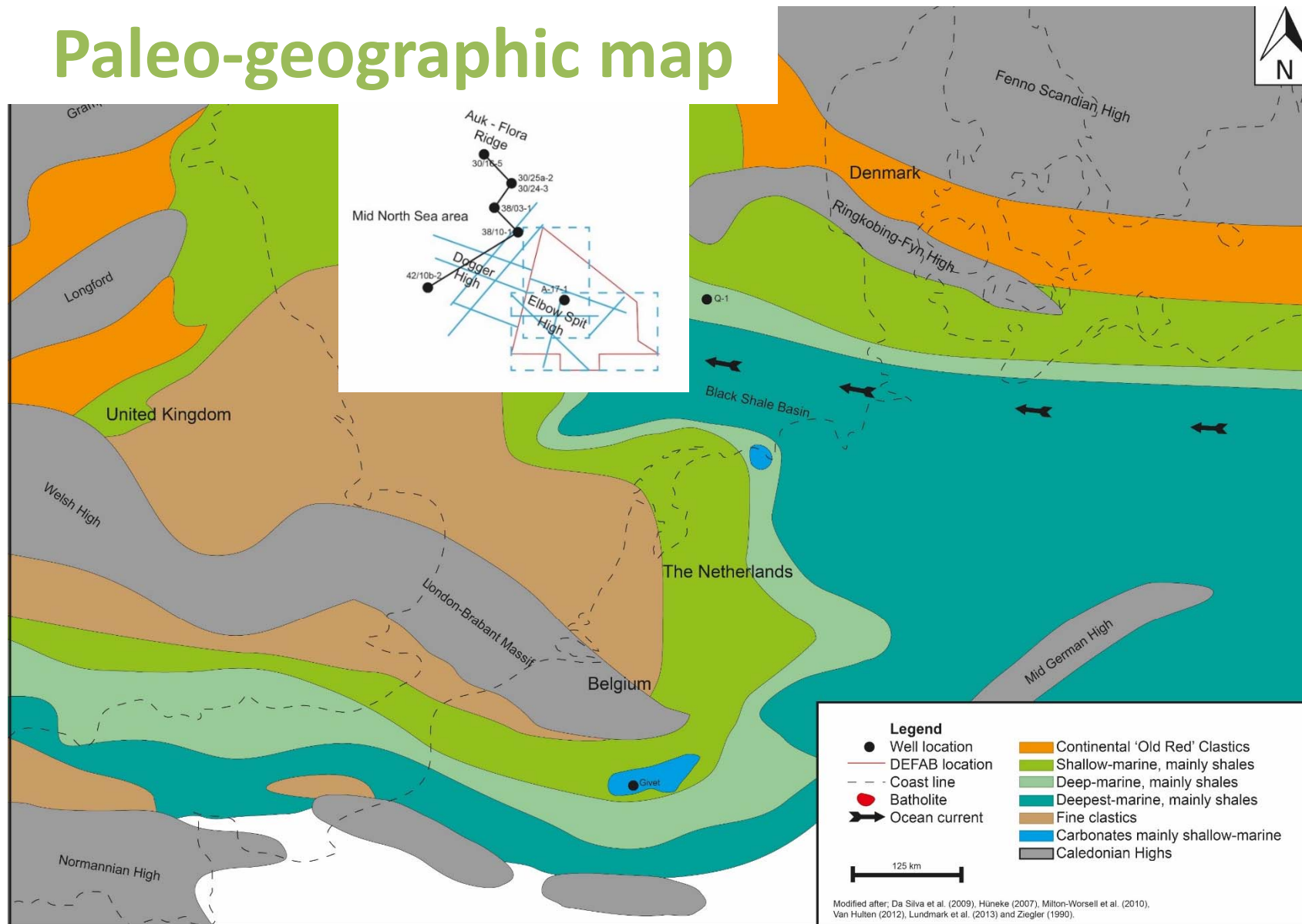
B

Ramp



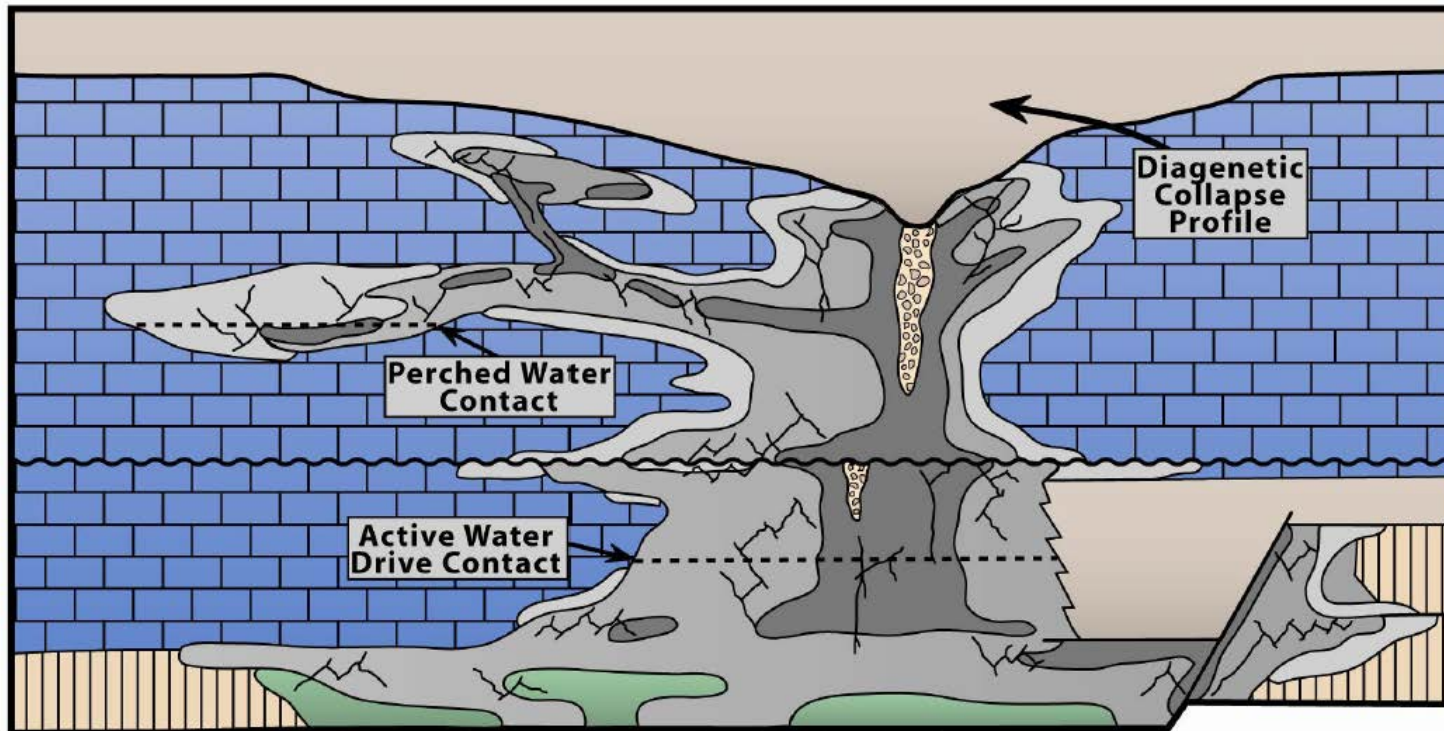
Seismic data courtesy of Spectrum ASA

Paleo-geographic map



Source: Da Silva et al. (2009), Hüneke (2007), Milton-Worsell et al. (2010), Van Hulten (2012), Lundmark et al. (2013) and Ziegler (1990).

Hydrothermal influence



Grammer et al. (2010), Devonian Slave Point reservoir, Canada



Modified from Reimer and Teare, 1991 & 1992

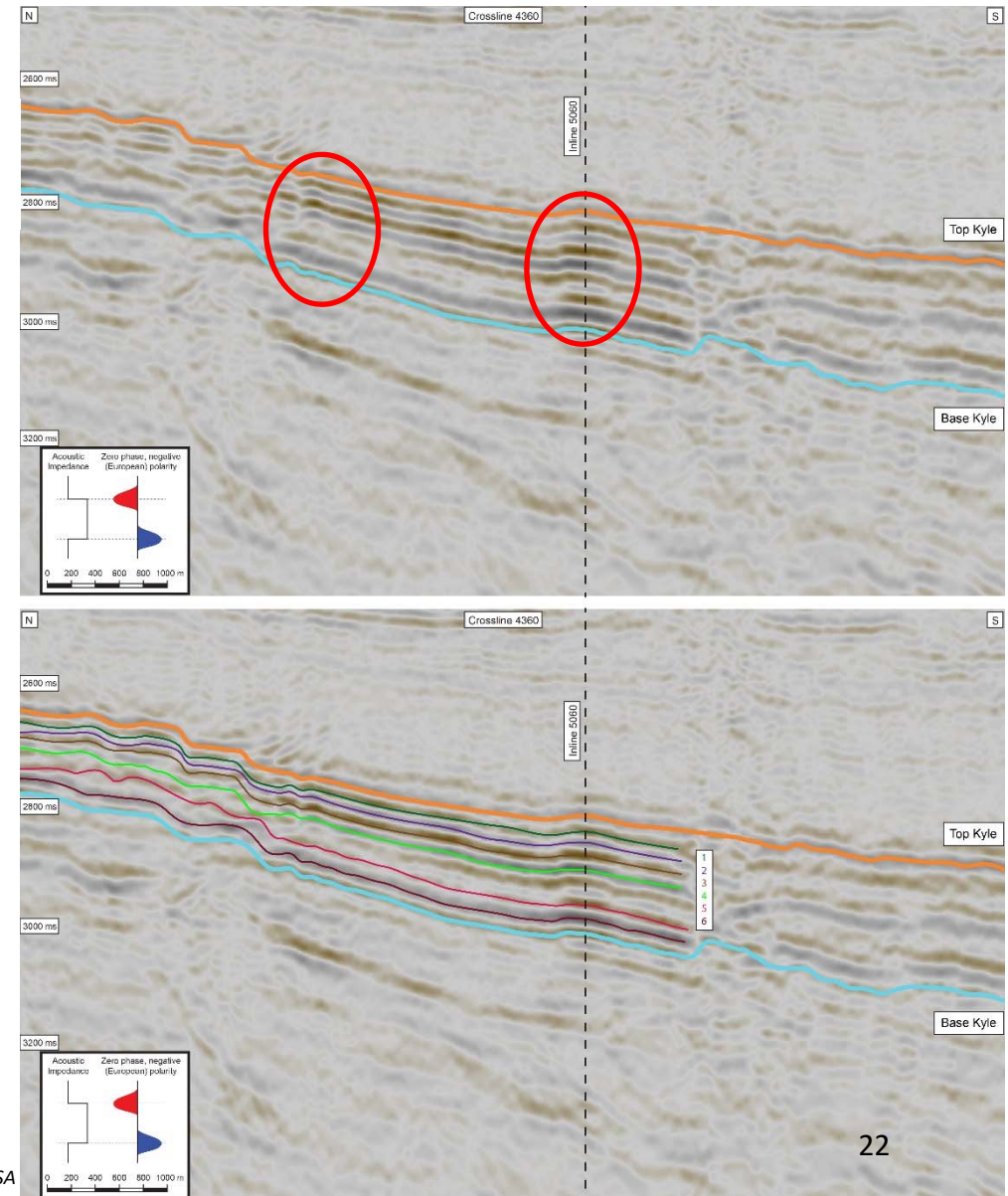
 **Fractures**

----- **Present Gas/Water**

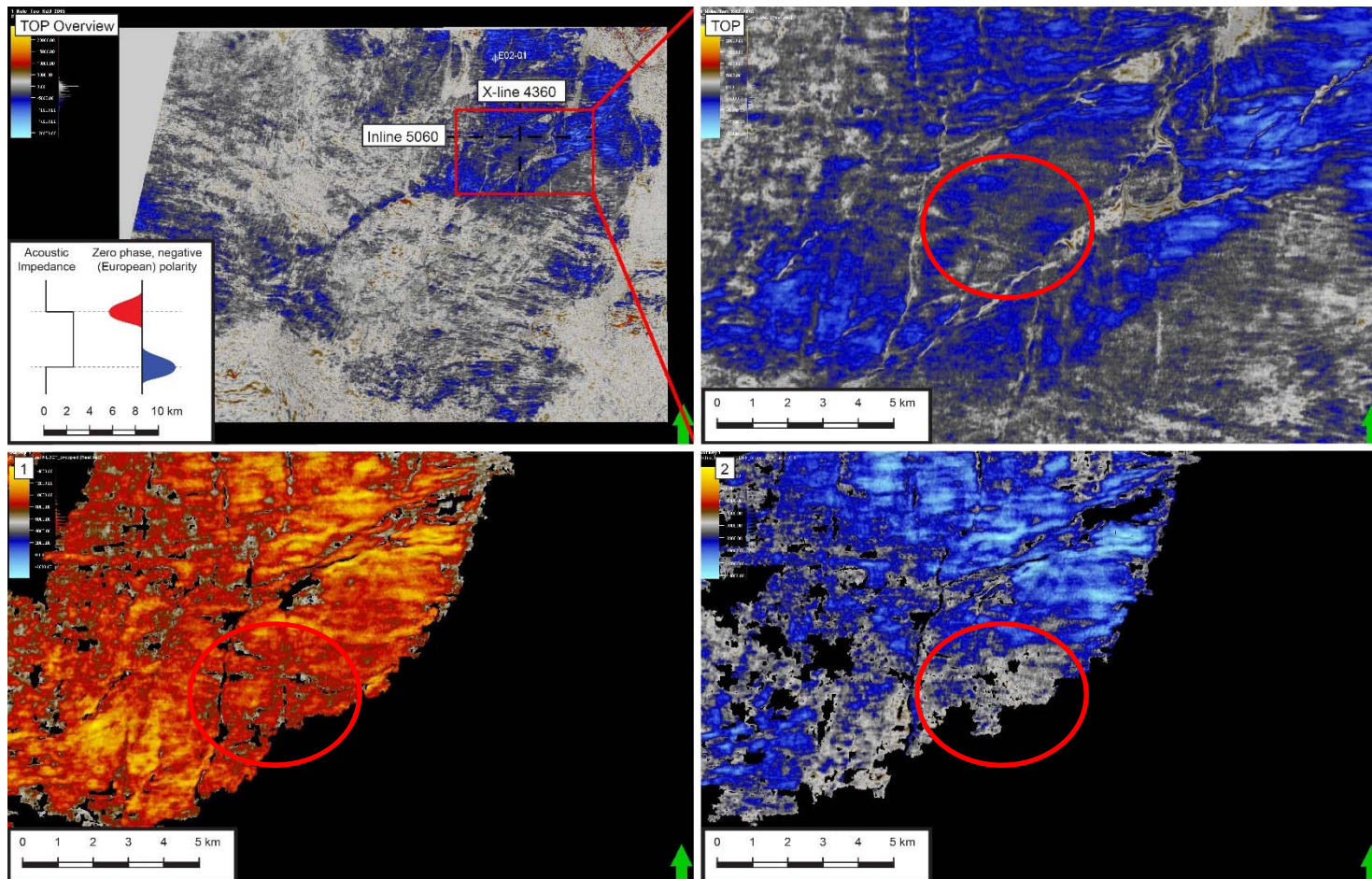
GRD95

Hydrothermal influence

- 3:1 Mg:Ca ratio
- High geothermal gradient
- Contact metamorphism



Seismic data courtesy of Spectrum ASA

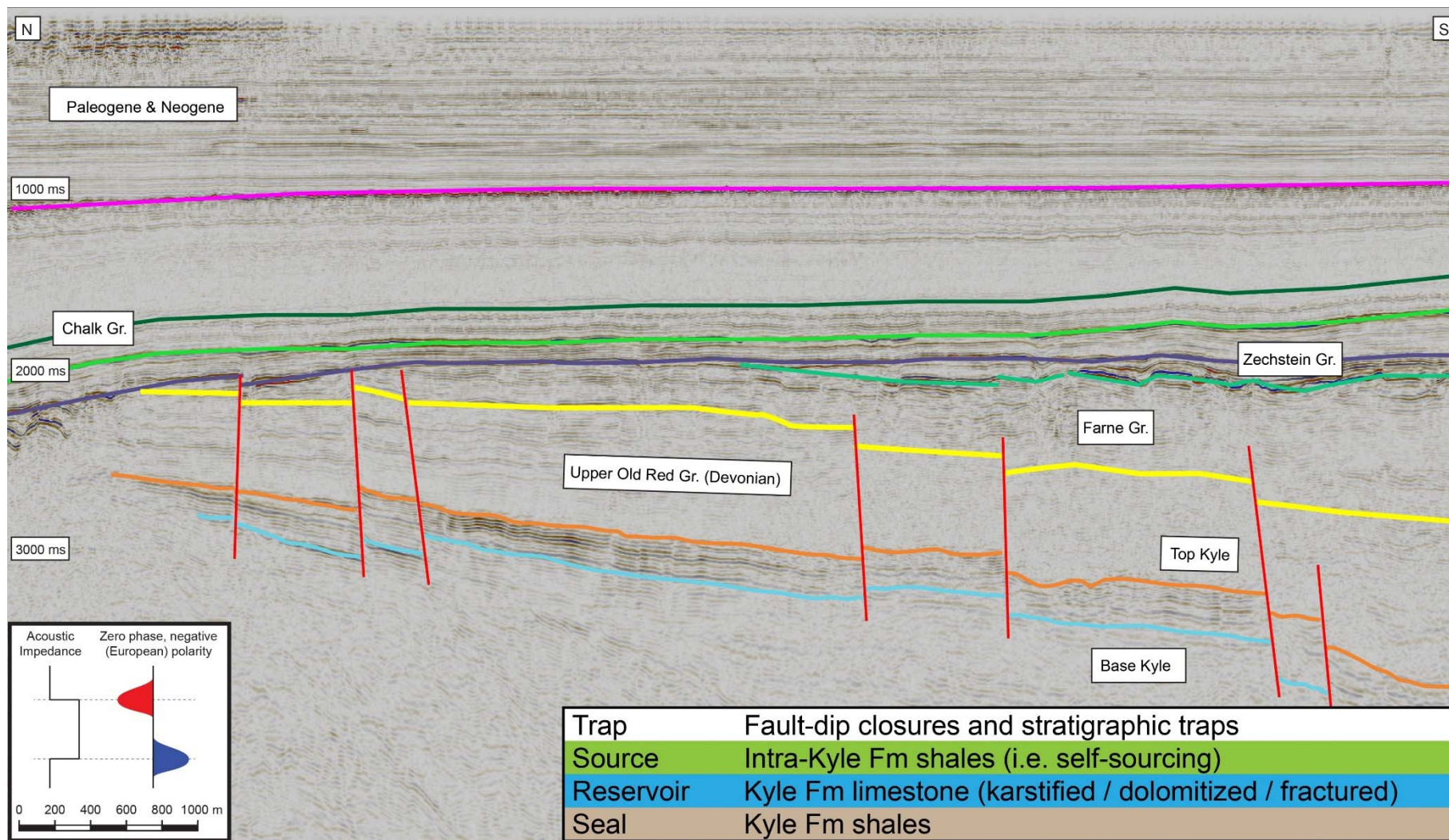


> Dolomitization

> Higher grain density

> Increase in velocity

> Seismic pull-up



Seismic data courtesy of Spectrum ASA

Conclusions

Assessing the petroleum potential of Devonian Carbonates in the Mid North Sea area

- Devonian carbonate systems are found across the globe.
- There are two possible carbonate systems both explaining the observed seismic.
- Correlation to synthetic seismic profiles helps in predicting unknown areas.
- Acoustic anomalies present at the regional fault trend could be induced by hydrothermal dolomitization.

Future work

- Assess source rock potential, timing and maturity
- Timing of higher heat flows (dolomitization) and source rock maturity
- Structural evolution of the Devonian configuration of basins and highs.
- Stratigraphic forward modelling (Dionysos)

Literature

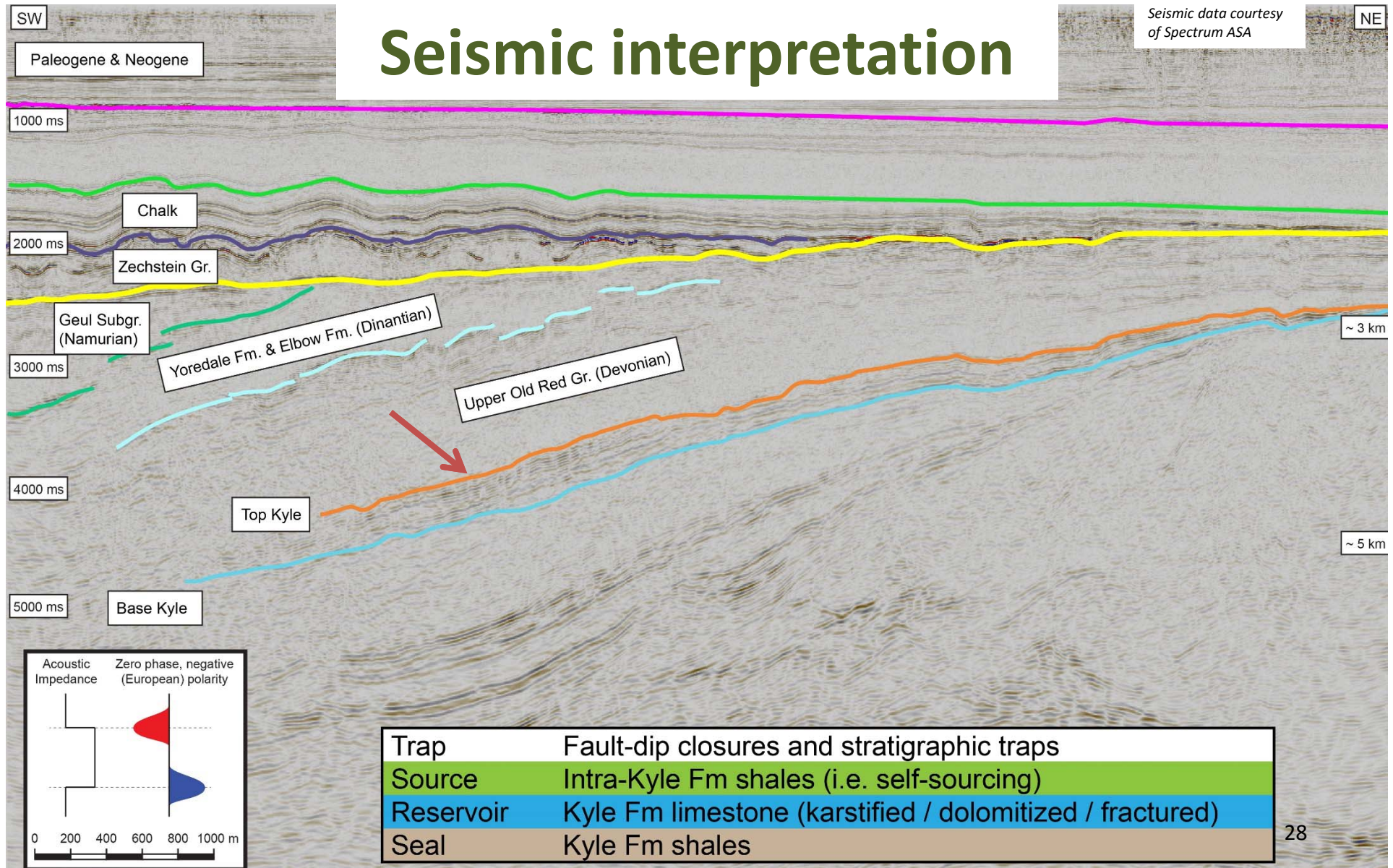
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https://upload.wikimedia.org/wikipedia/commons/5/5c/Stromatoporoid_reef%2C_Cairn_Formation_%28Devonian%29.jpg

Seismic interpretation

Seismic data courtesy
of Spectrum ASA



Location of the Devonian

Seismic data courtesy of Spectrum ASA

