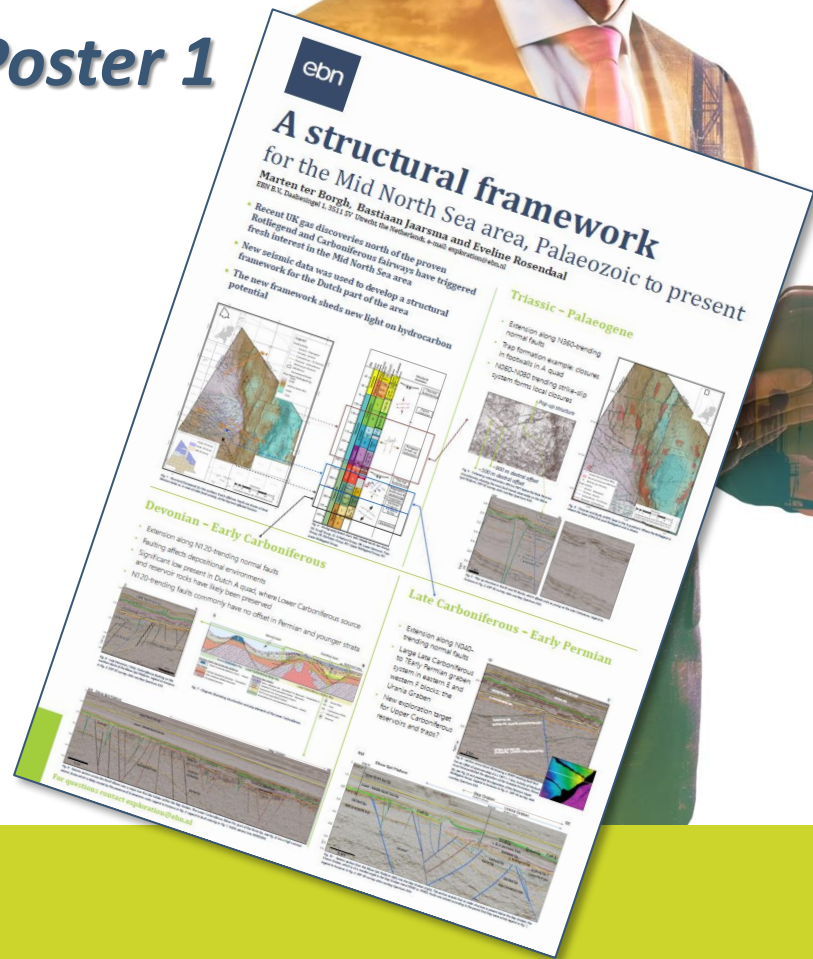


Poster 1



A Structural framework for the Dutch northern offshore

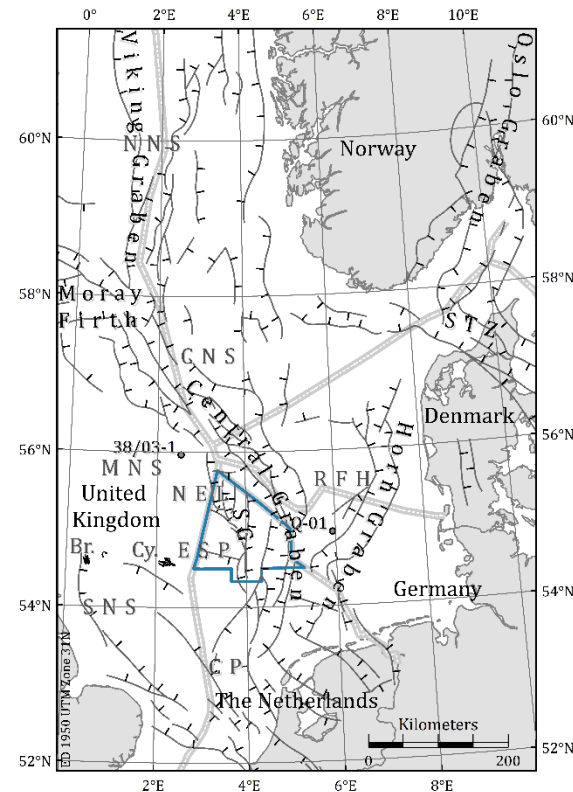
Implications for exploration
Dutch Exploration Day, May 23, 2016

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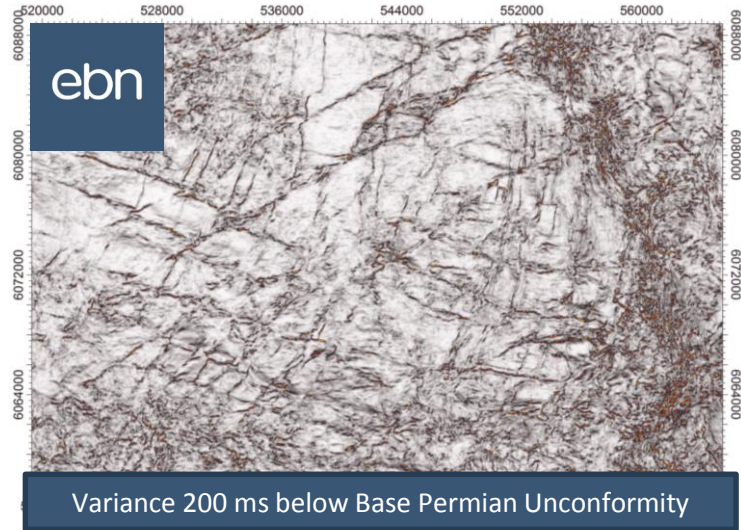
Introduction

- Recent UK gas discoveries north of the proven Rotliegend and Carboniferous fairways have triggered fresh interest in the Mid North Sea area.
- As part of the DEFAB project we developed a structural framework.
- Newly available data: DEF 3D seismics, regional NSR 2D survey.
- The framework helps predict reservoir and source rock distribution, SR maturation and trap formation.
- This presentation provides an overview, more detail in presentations and posters focussing at individual plays.

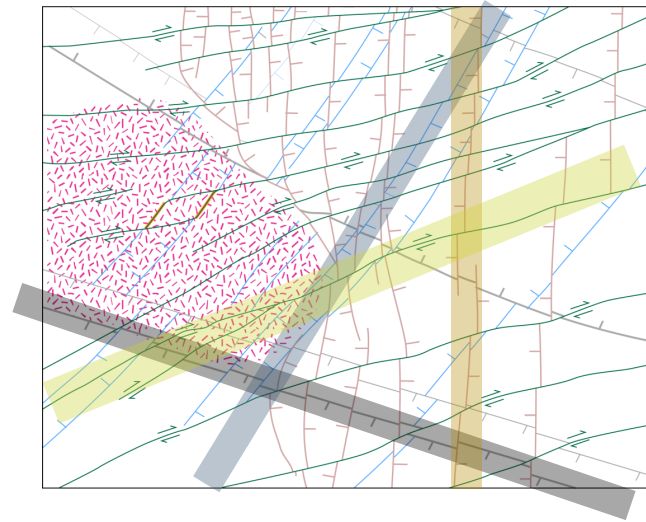


Structural mapping

Method used for identifying fault trends:
coherency cubes

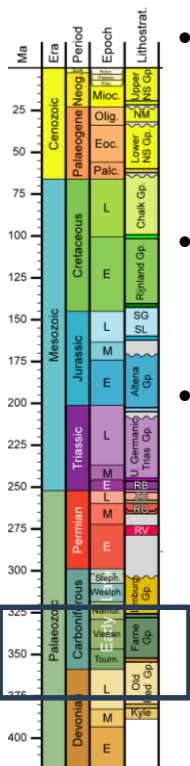


Four important fault trends identified

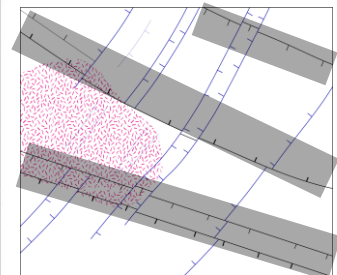
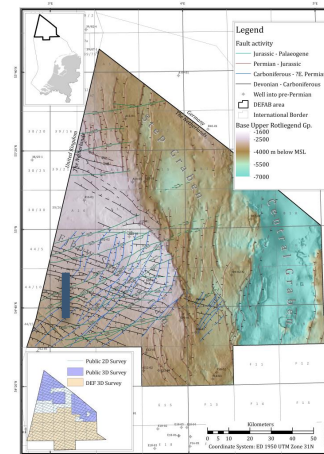
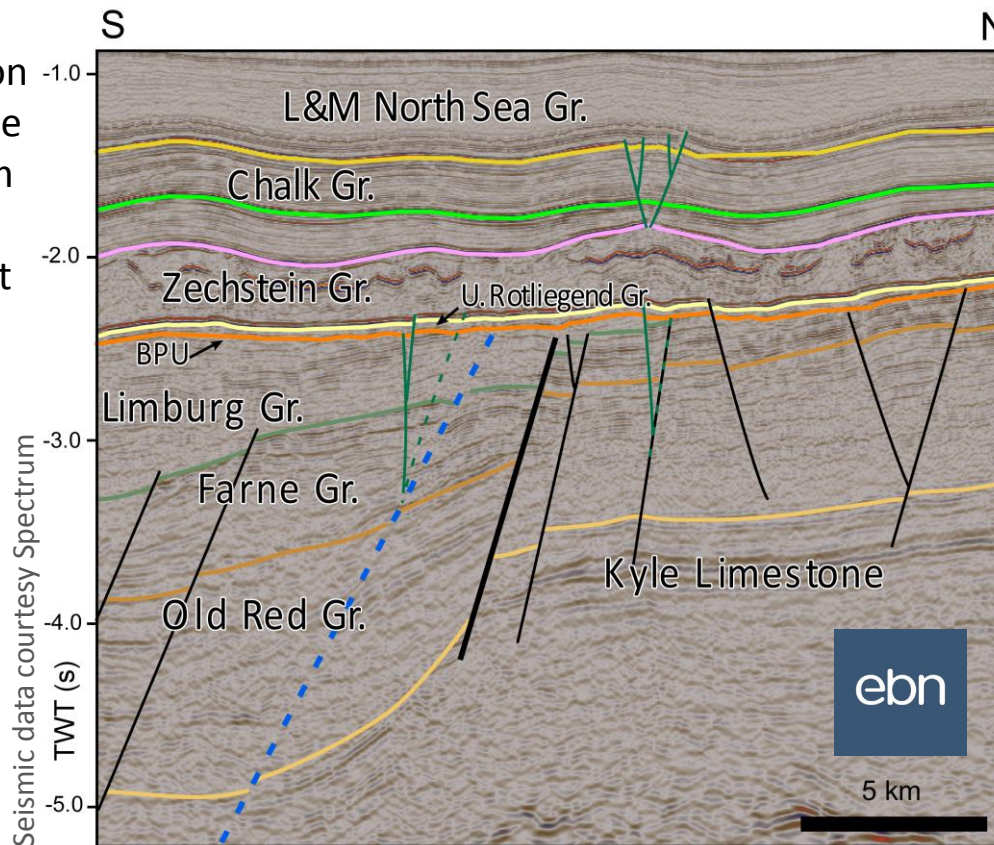


- When were these faults active?
- How do they affect deposition, source rock maturation, trap formation?

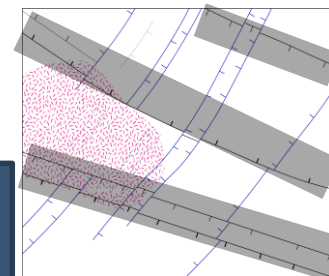
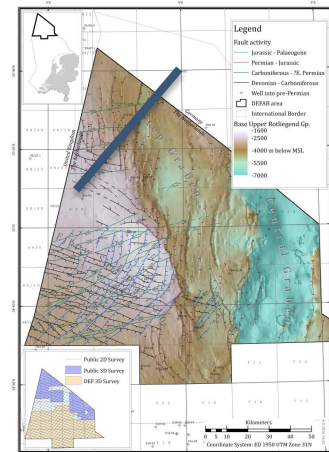
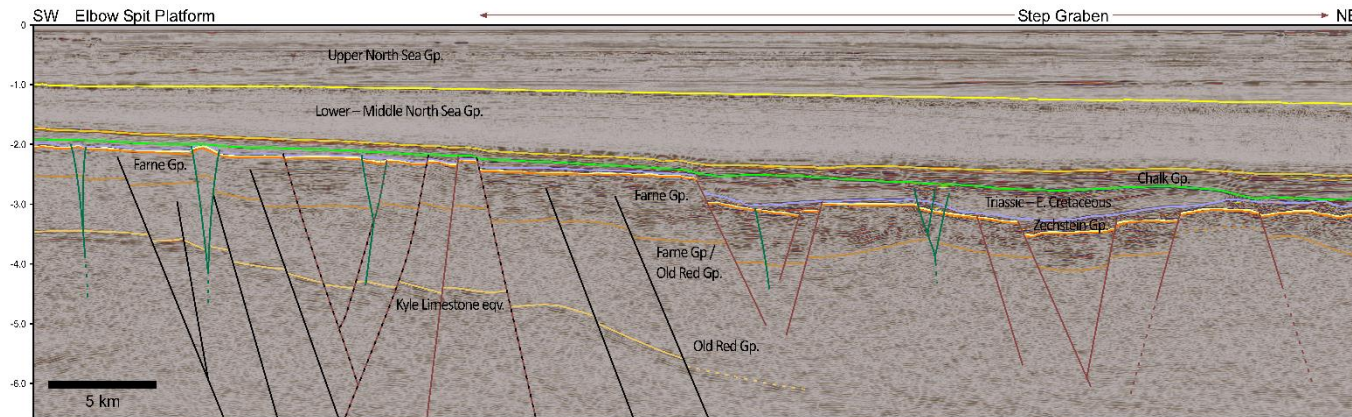
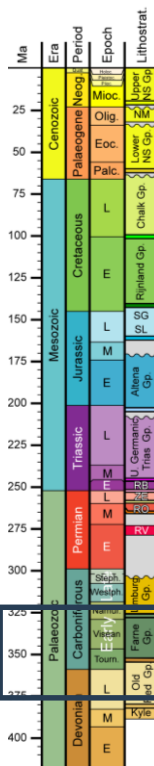
Early Carboniferous & Devonian



- Significant extension on the S flank of the Elbow Spit Platform
- No or little offset at Base Permian level
- Change in seismic facies across fault; faulting affects deposition



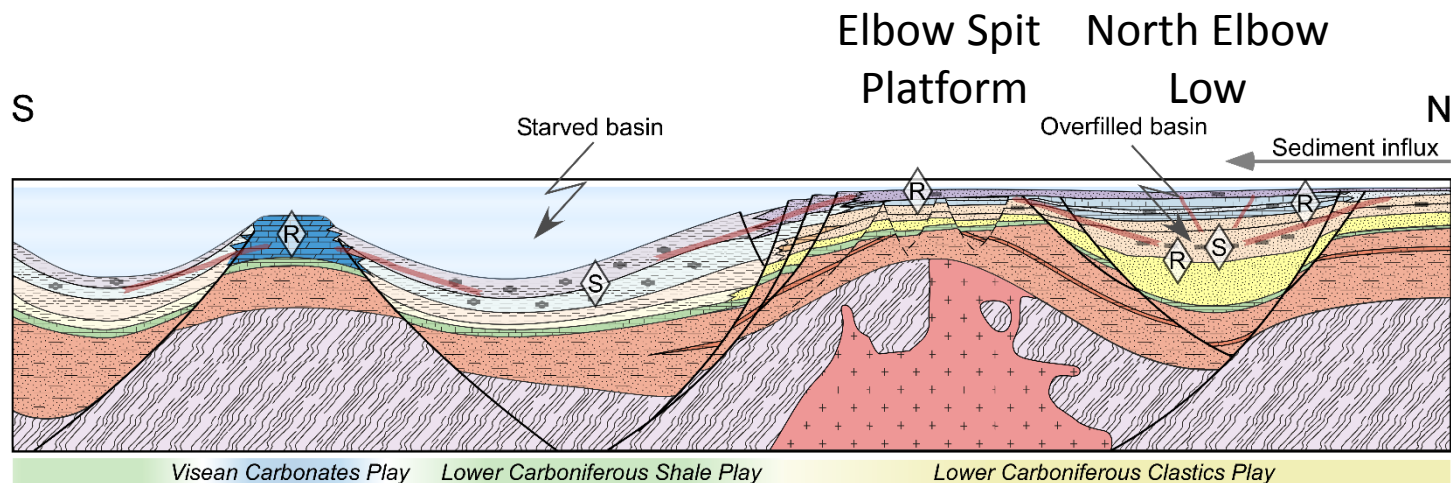
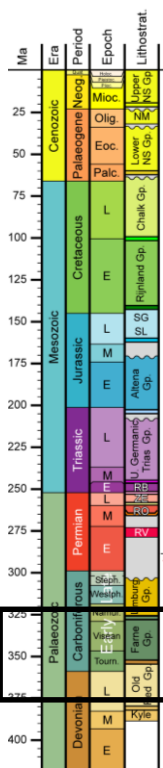
Lower Carboniferous north of Elbow Spit Platform



A major Carboniferous/Devonian low is present north of the Elbow Spit Platform; in line with findings by Milton-Worsell et al. (2010) for adjacent UK sector. Lower Carboniferous deposits preserved!

Summary Early Carboniferous/Devonian

Normal faults with a N100-N125 trend, cause large-scale alternation of highs and lows. Affect deposition.



Southern North Sea Carbonate platforms

Visean Carbonate platforms (Tourn. – Visean)

Pre-Visean

Old Red Sandstone (Devonian – Tournaisian)

Kyle Limestone (Middle Devonian)

Pre-Middle Devonian

Mid North Sea clastics

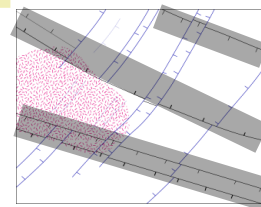
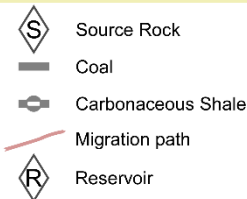
Epen – Millstone Grit – Klaverbank Fm (Namurian – Westphalian A)

Yoredale Fm and equivalents (Visean – Namurian)

Scremerston Fm and equivalents (Visean)

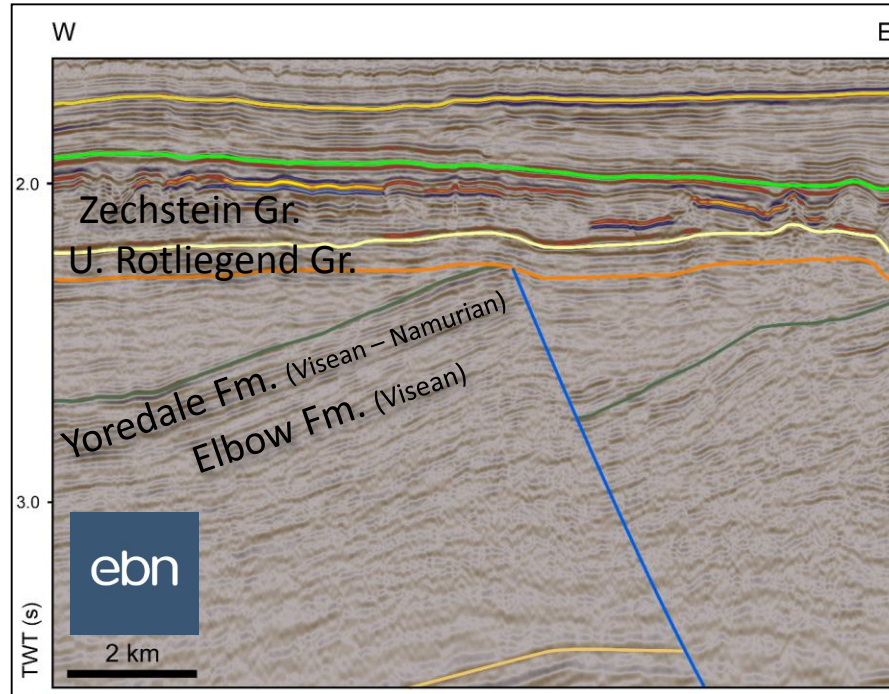
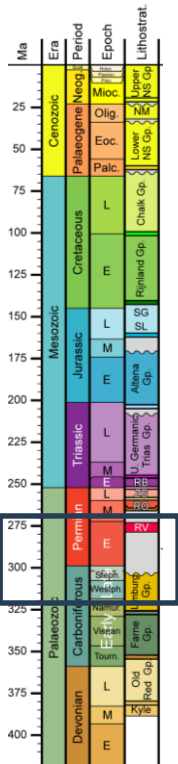
Fell Fm and equivalents (Visean)

Cementstone Fm and equivalents (Tournaisian – Visean)

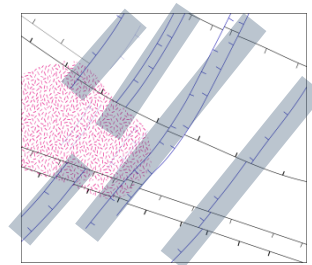
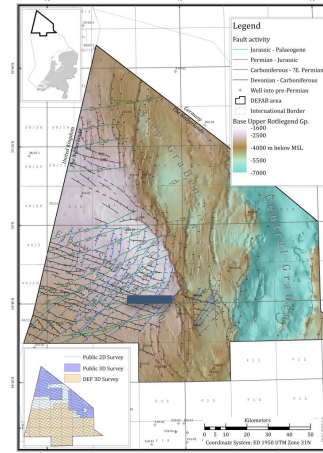


Fault activity Late Carboniferous / E. Permian

Normal faults with N040 to N060 trend. Active during the Late Carboniferous to Early Permian.

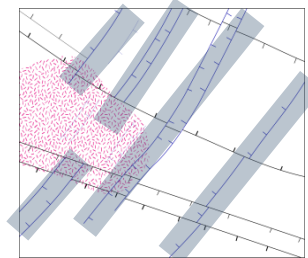
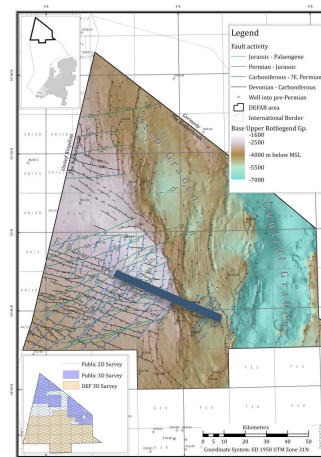
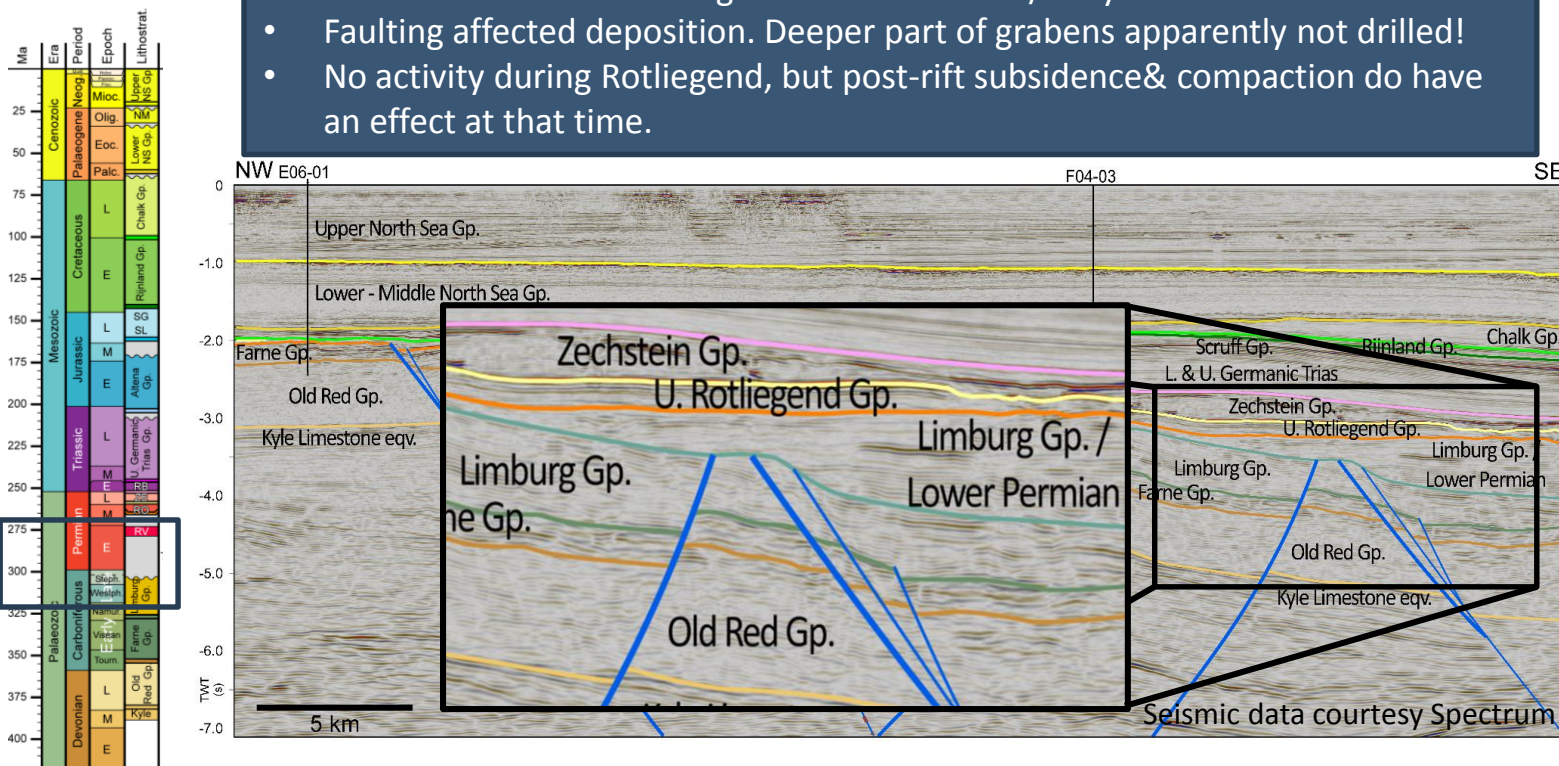


Seismic data courtesy Spectrum

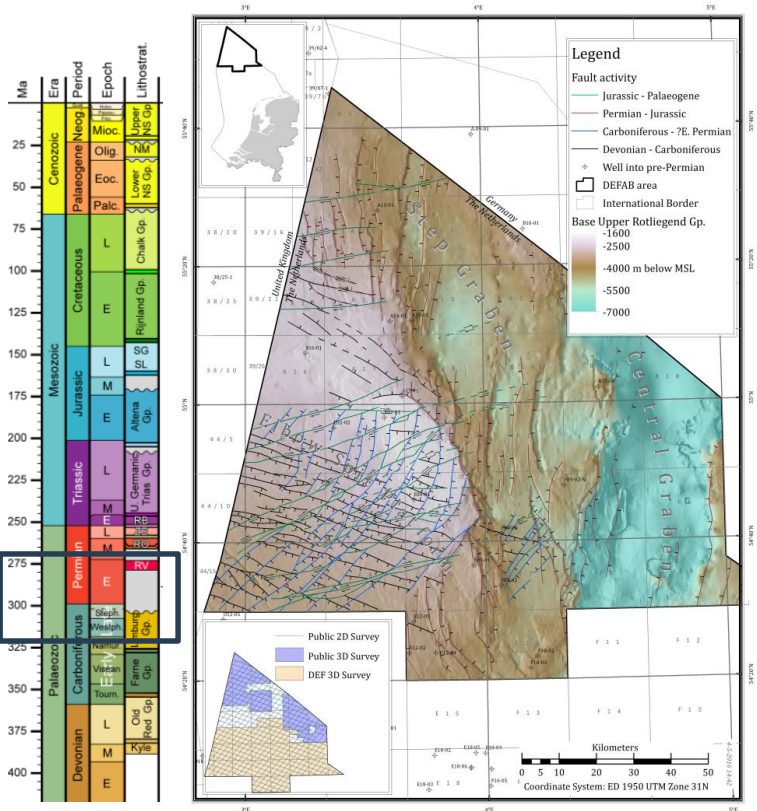


Fault activity Late Carboniferous / E. Permian

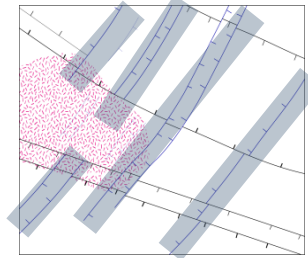
- Normal faults active during Late Carboniferous/Early Permian
- Faulting affected deposition. Deeper part of grabens apparently not drilled!
- No activity during Rotliegend, but post-rift subsidence & compaction do have an effect at that time.



Summary Late Carboniferous / E. Permian

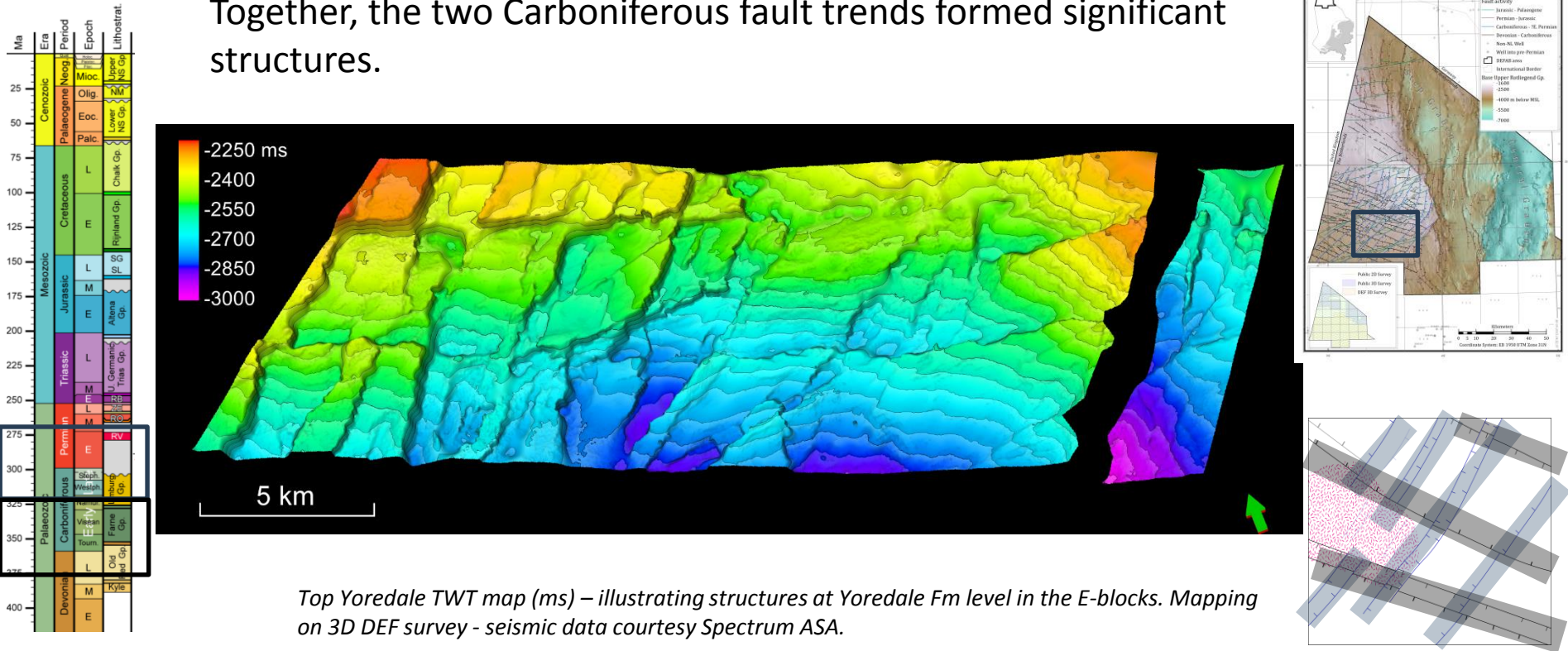


- N040 faults commonly only affect Carboniferous and older units directly; not the Step Graben but an older structure: **Urania Graben**.
- Undrilled Late Carboniferous to Early Permian deposits in Urania Graben.
- Rotliegend thicker above Urania Graben; probably result of compaction, post-rift thermal subsidence.
- What was the effect of these structures on deposition during Late Carboniferous and Permian?

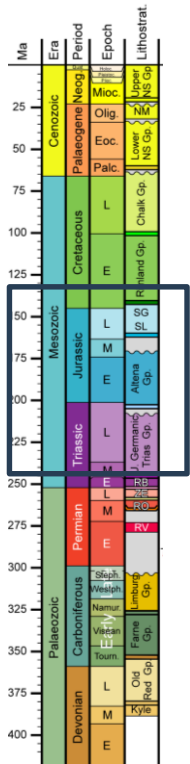


Example: structuration

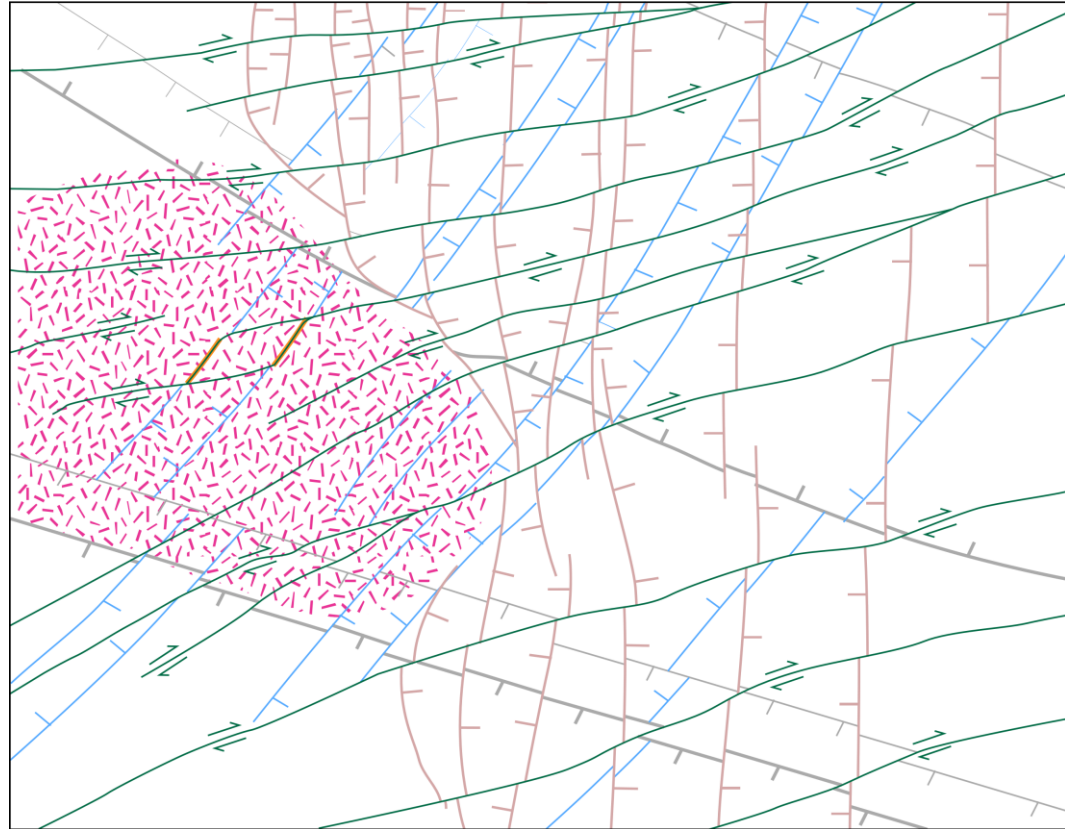
Together, the two Carboniferous fault trends formed significant structures.



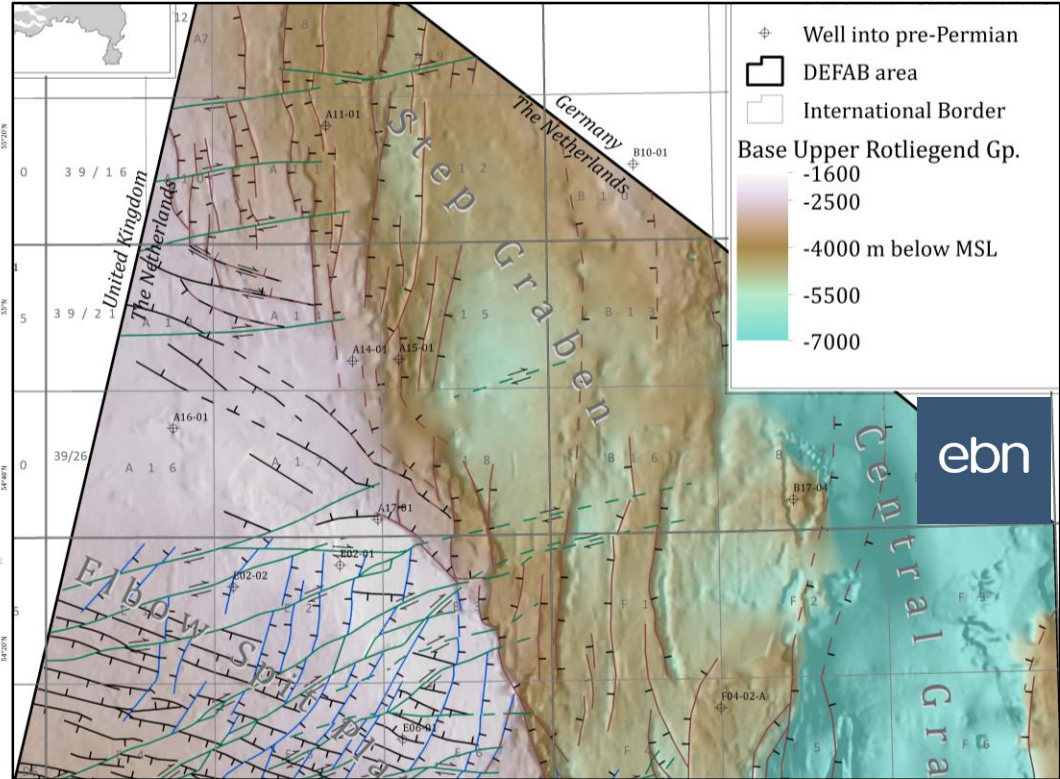
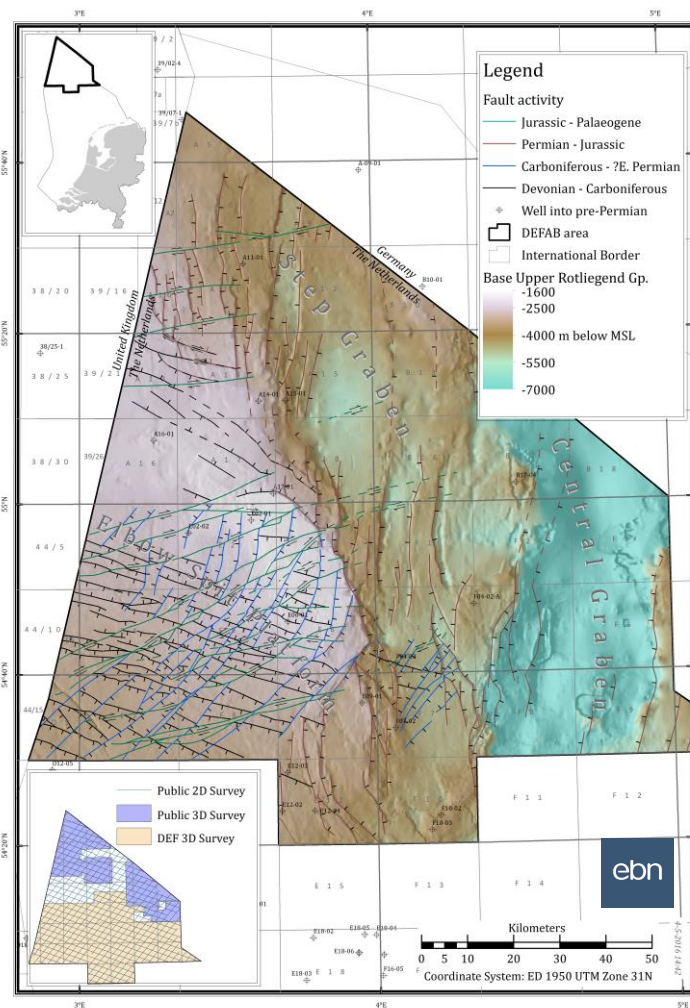
Mesozoic structural development



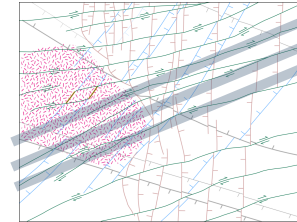
- Opening of Central Graben and Step Graben along N-S trending faults (Triassic – Jurassic).
- Dextral strike-slip faulting along N060-N080 trending faults.
- Salt tectonics discussed in separate presentation.



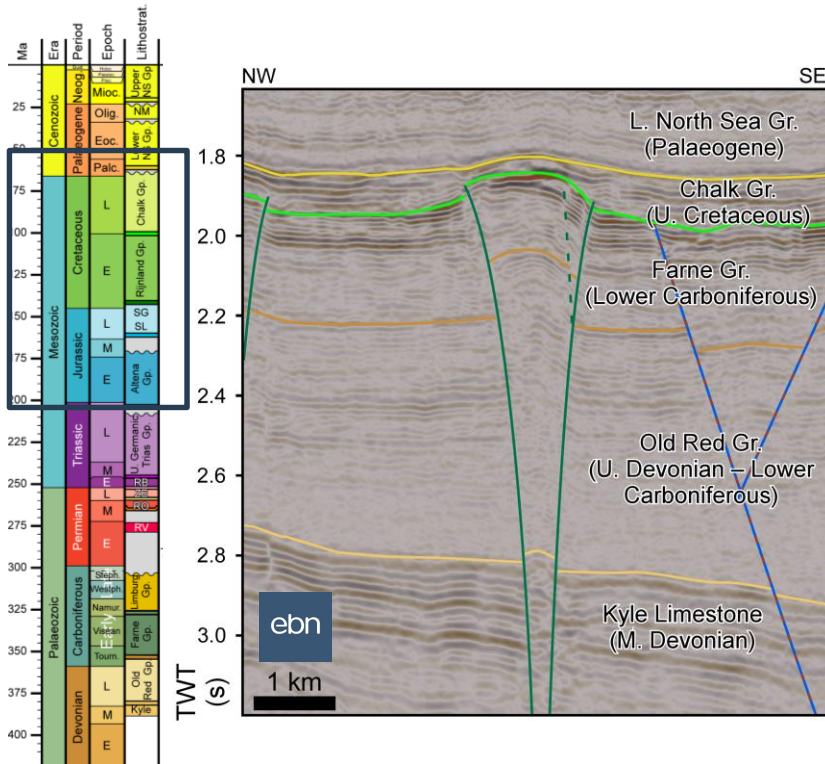
Step Graben



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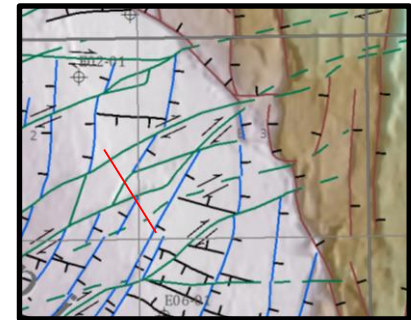
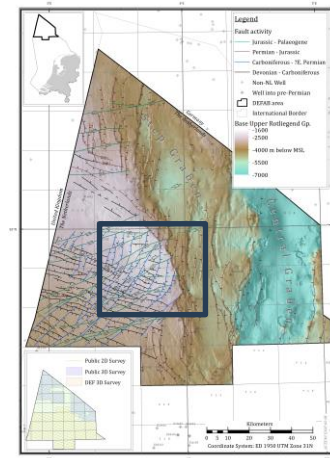


Strike-slip deformation (2)

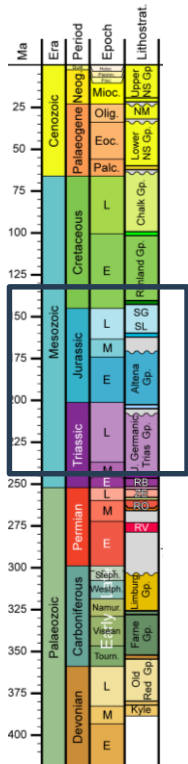


- Activity: main phase during the Jurassic to Early Cretaceous, less intense activity up to Palaeogene.
- Strike-slip faults clearly expressed only below Zechstein salt, or where salt is absent or thin.
- Suggests strongly that decoupling along the Zechstein salt occurred.

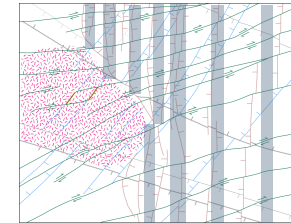
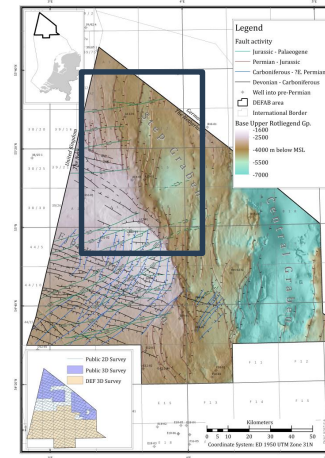
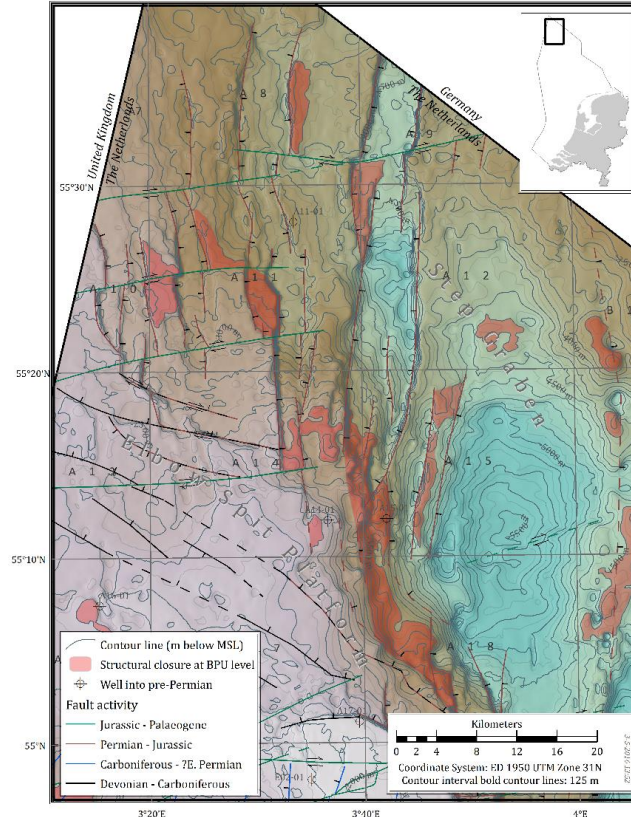
Seismic data courtesy Spectrum



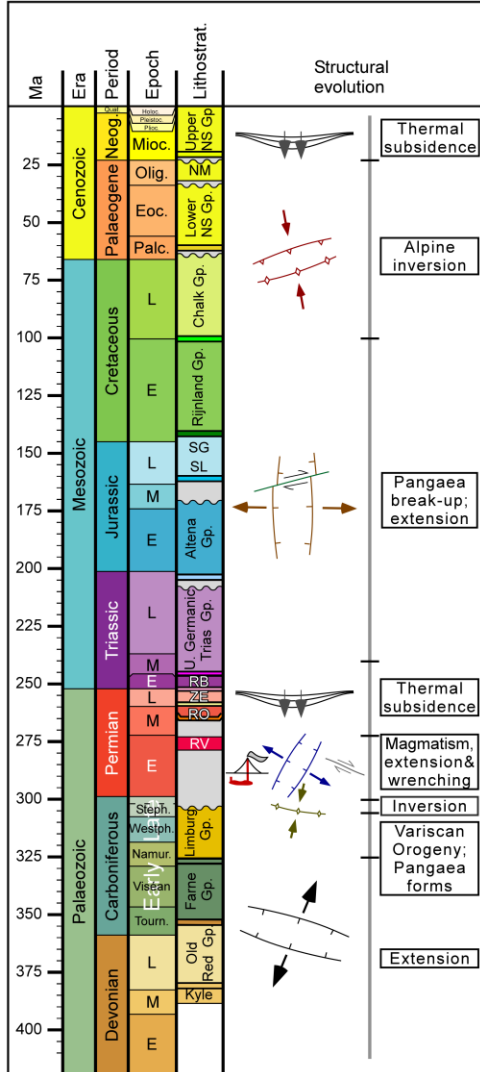
Example: structuration in the A quad



- 4-way and fault-dip closures mapped in Step Graben area at Base-Permian (Silverpit Fm) level.
- Based on vintage seismics.
- Better seismic imaging would further improve mapping of these, and possibly more, structures.



Summary



Better understanding of deformation in Step Graben area; affects trap formation, SR maturation

Significant extension during Late Carboniferous to Early Permian along Urania Graben. Graben infill mostly undrilled.

Better understanding of relationship between faulting and deposition during Early Carboniferous.

Poster 1

Thank you for your attention

More information? Contact us:

exploration@ebn.nl

Acknowledgements:

Fugro and Spectrum ASA, for giving permission to show data from the DEF survey

EBN Colleagues

Tacjana Litwinska-Kemperink

