Unraveling Zechstein 3 Anhydrite Structuration and possible implications for Geo-Drilling Hazards

by means of detailed seismic mapping in the Dutch offshore

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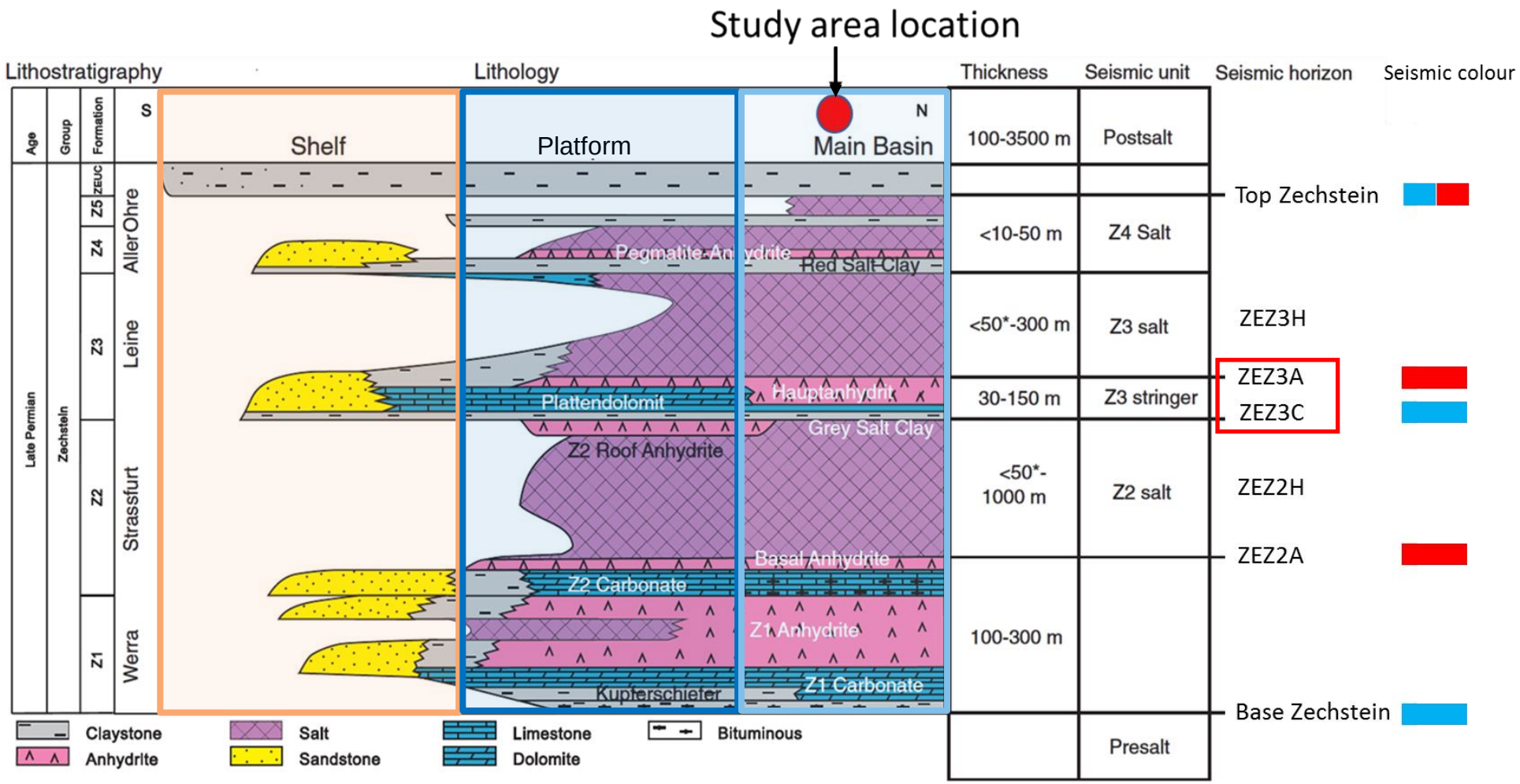
Introduction

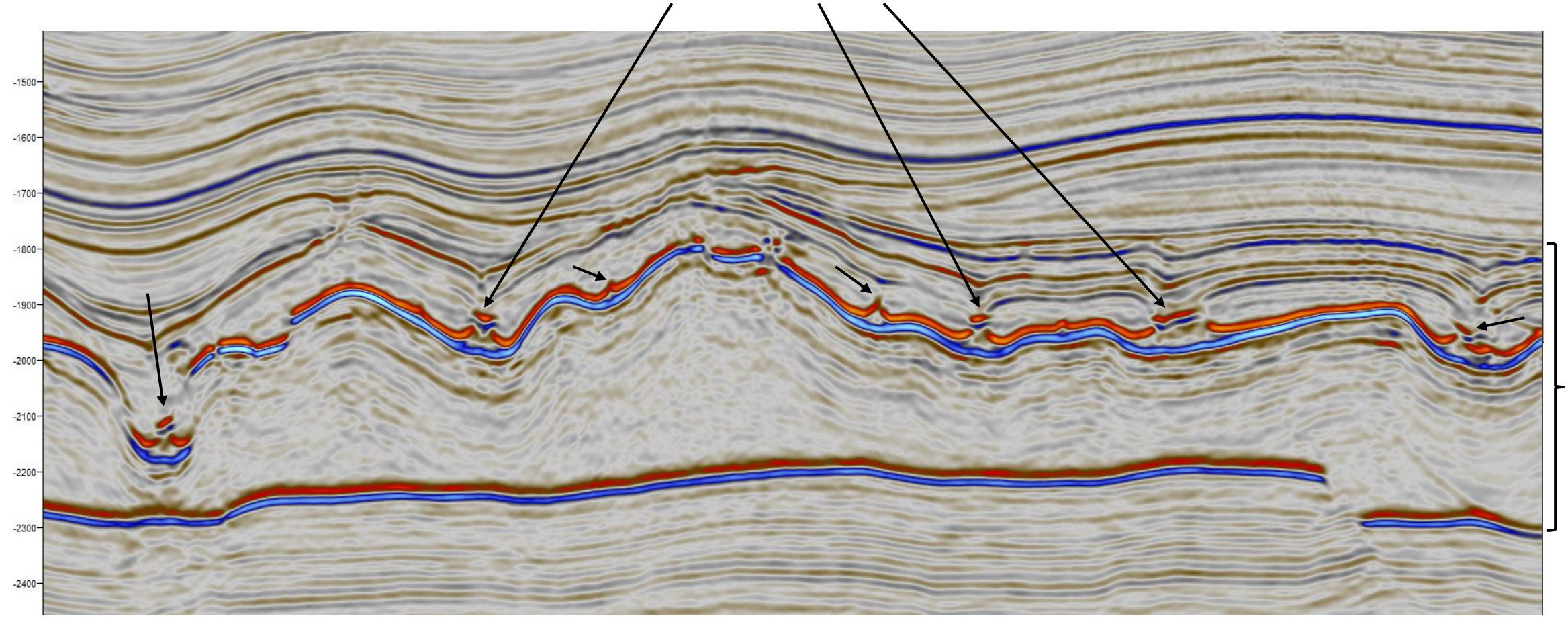
- Research Topic & Question
- Geo-Drilling Events
- Seismic Observations
- “Thickened zone” Analogue?
- Kicks Observed in Anhydrite Domes
- Conclusions

Research Topic



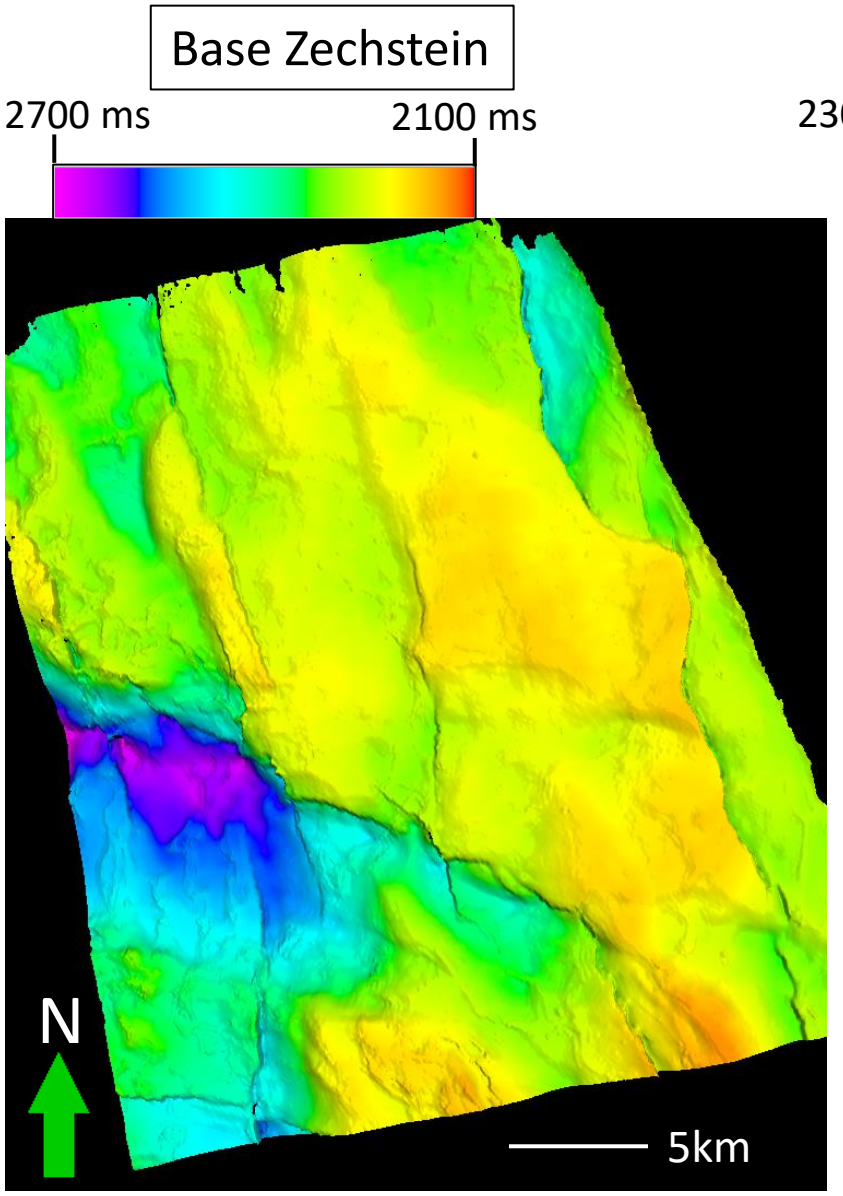
The Question!

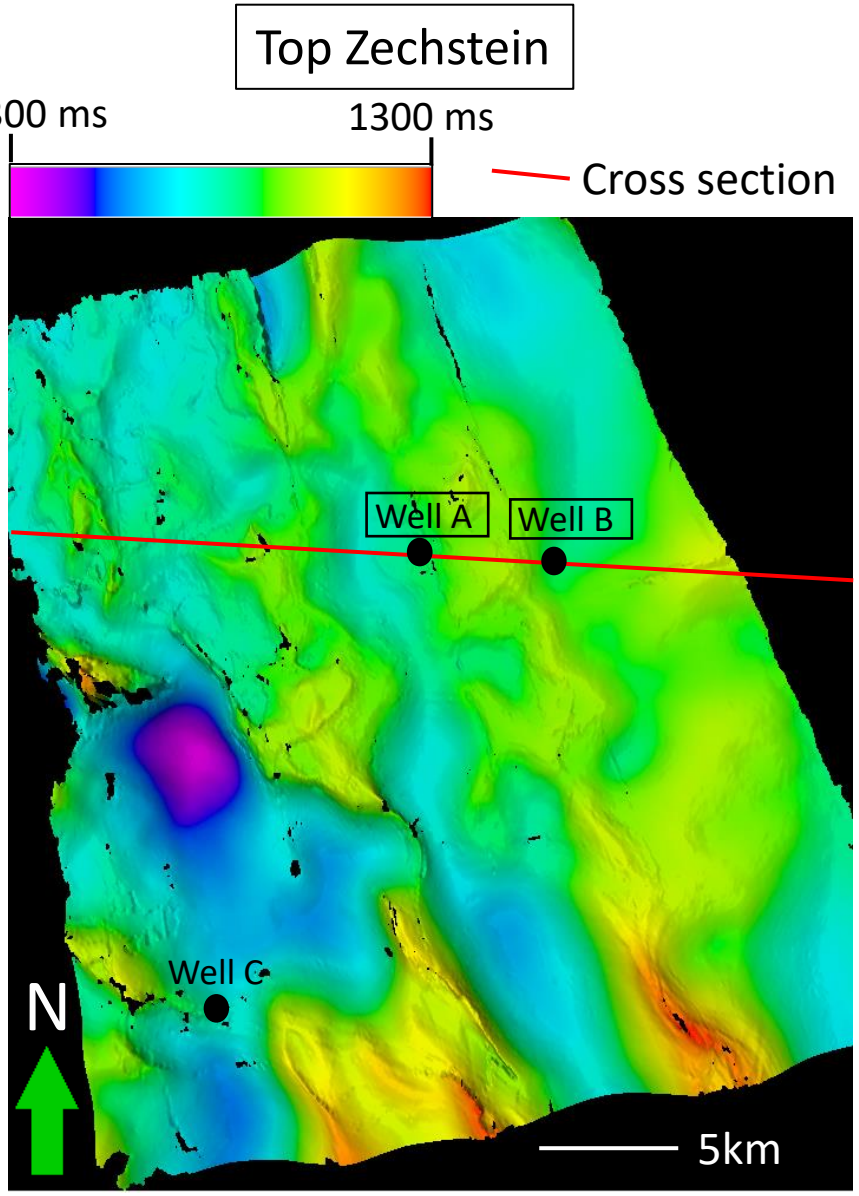
What explains thickness variation in the Hauptanhydrit?

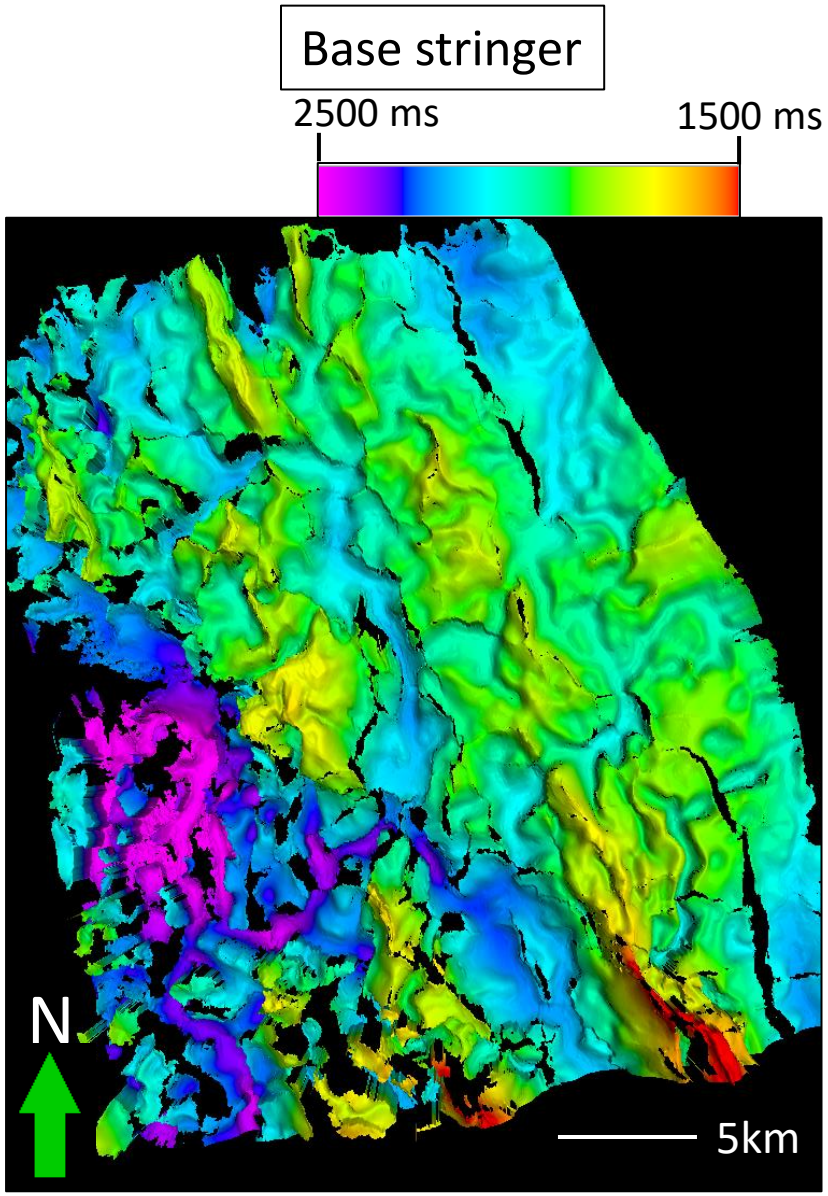


Seismic Observations

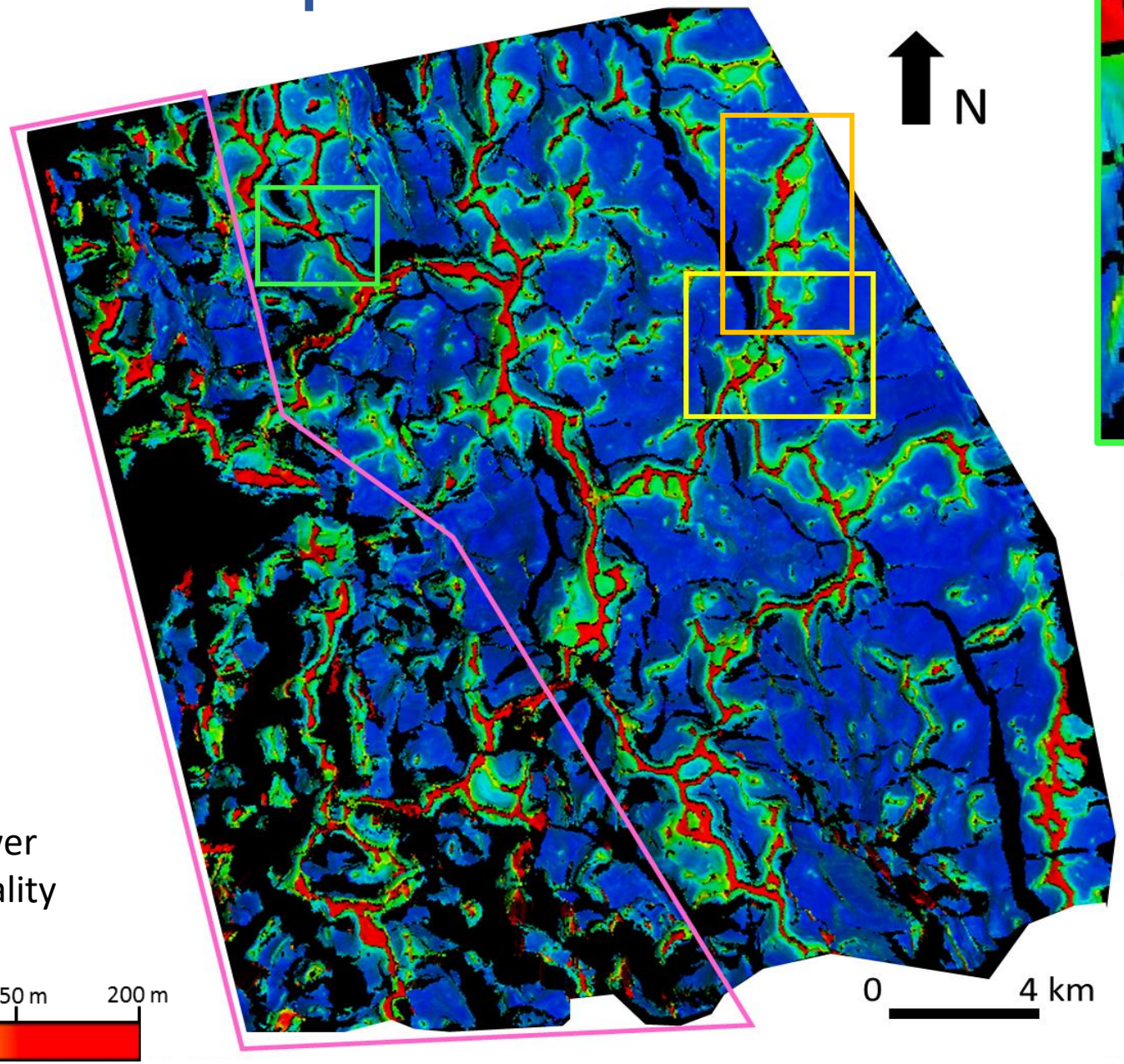
Interpreted horizons (TWT)

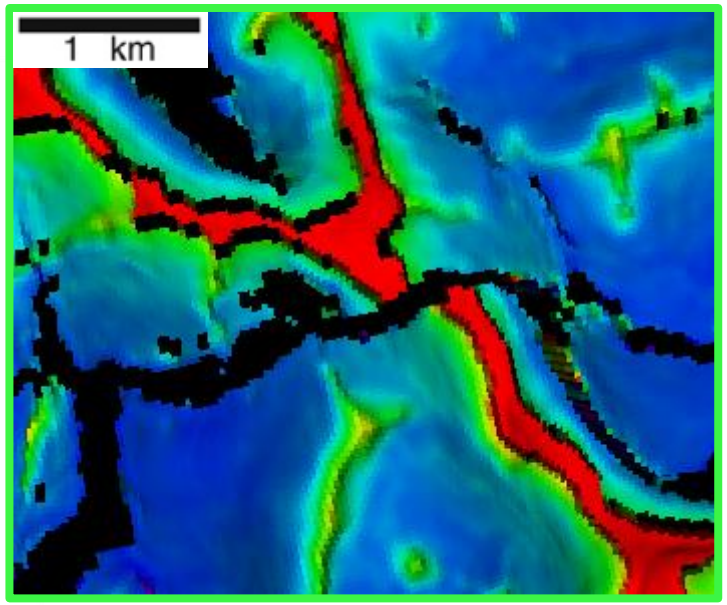




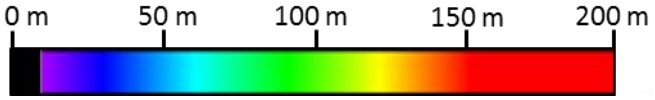


Stringer Thickness Map

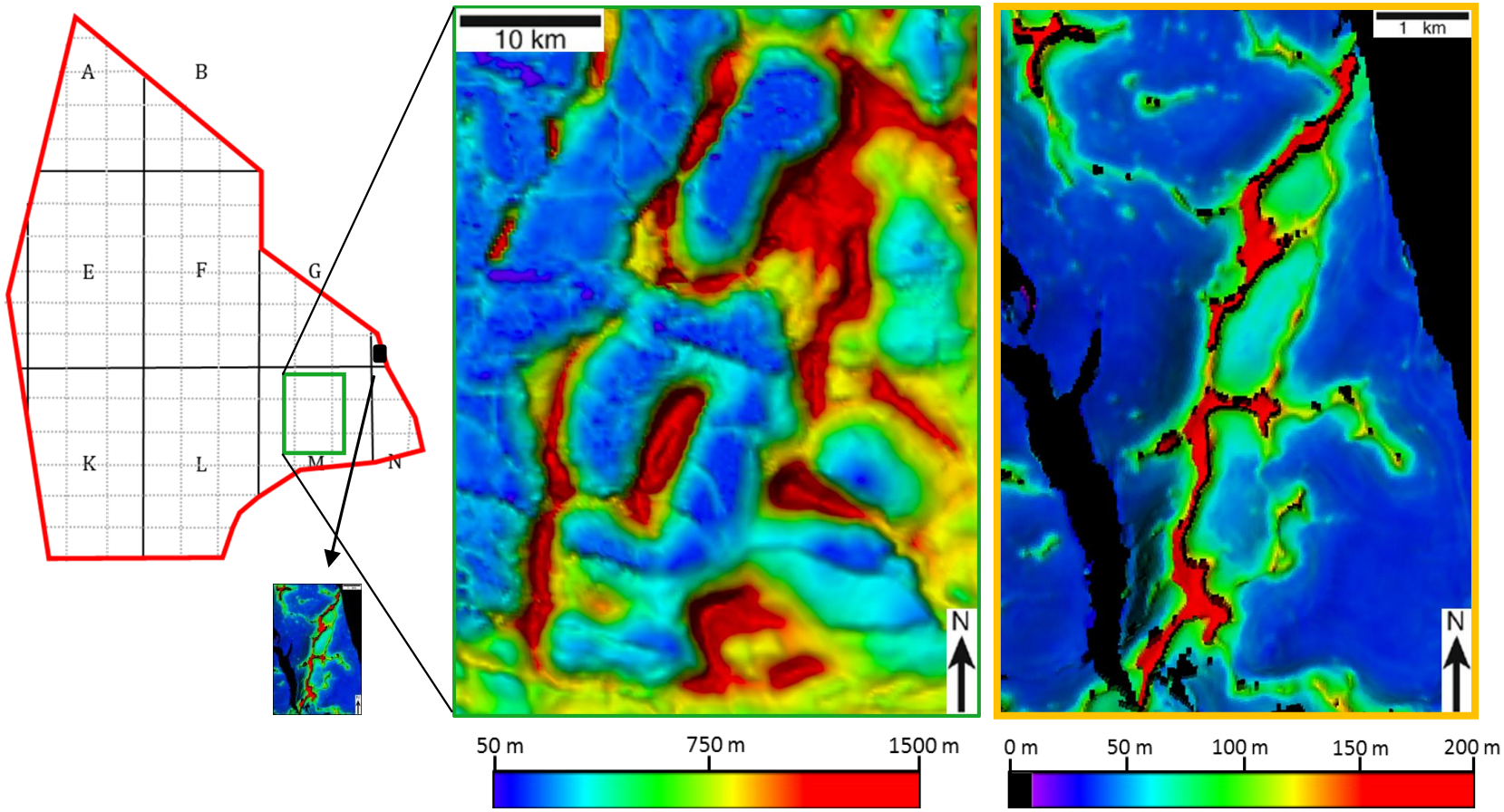




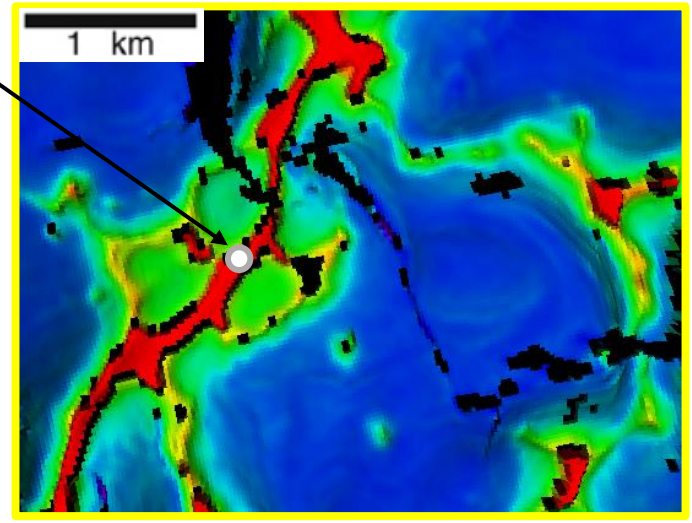
Area of lower seismic quality

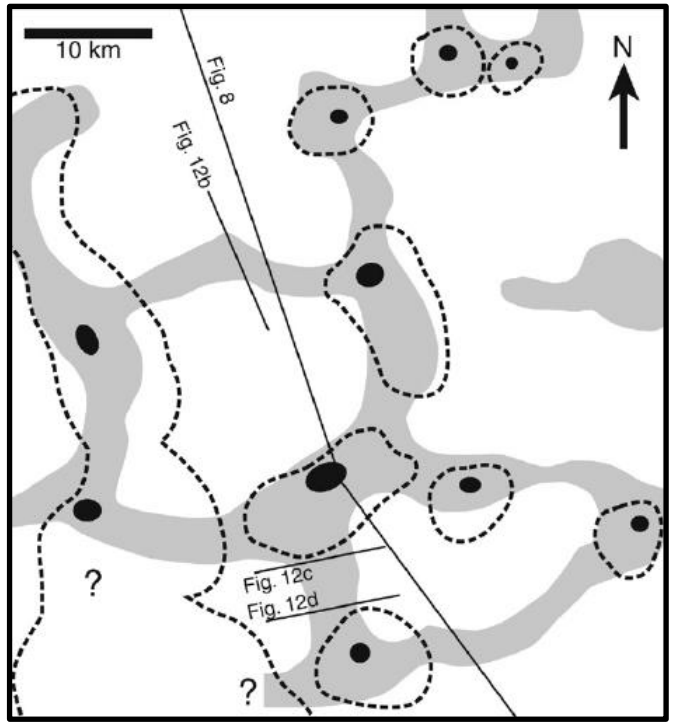


Geometry comparison



Well B

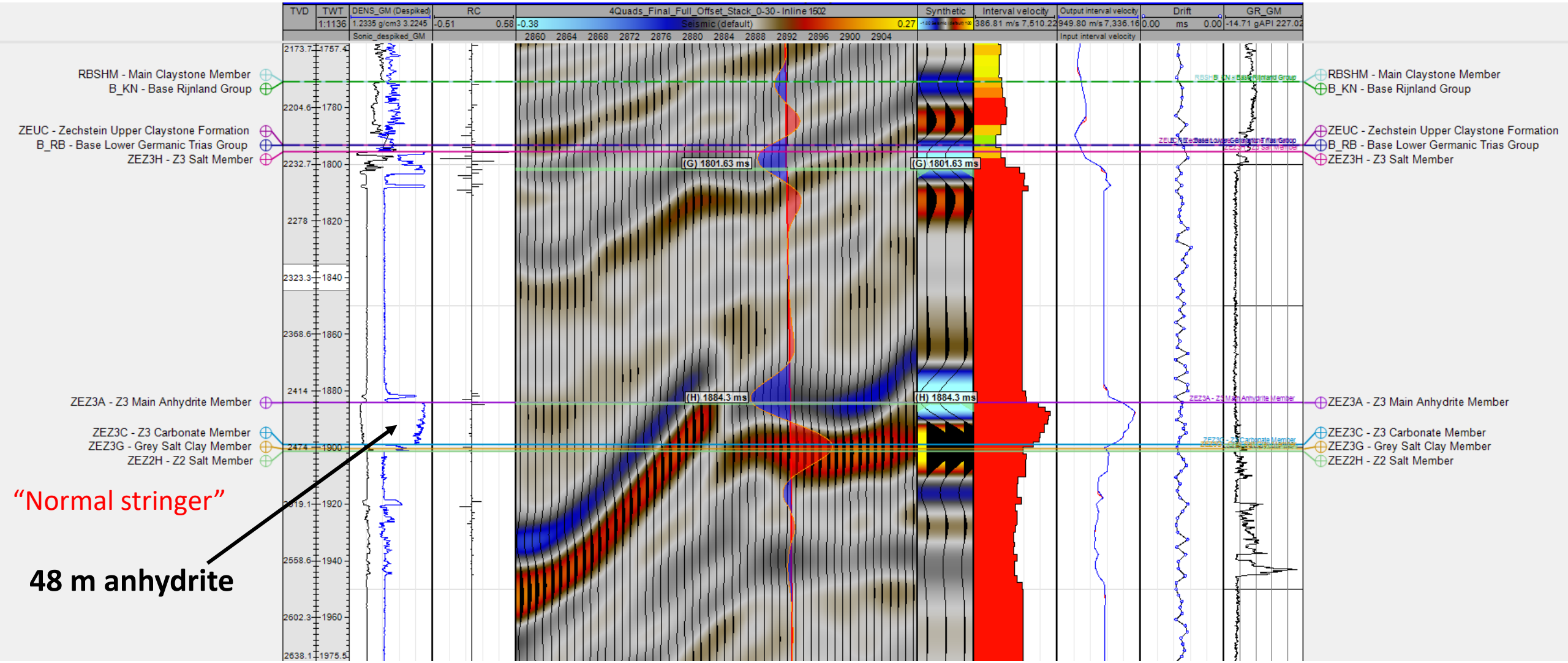




Note Different Scales!

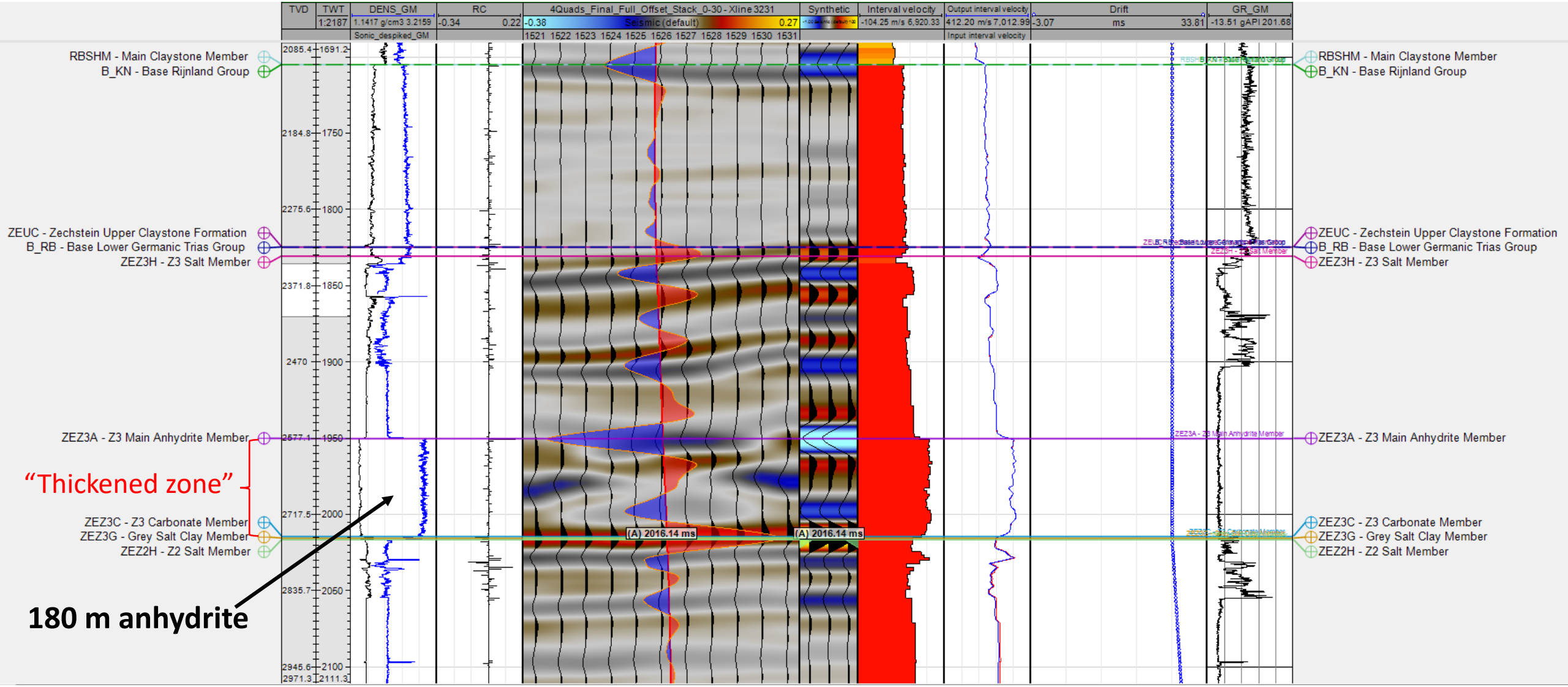
Rowan and Vendeville (2006)

Seismic-to-Well Tie – Well A



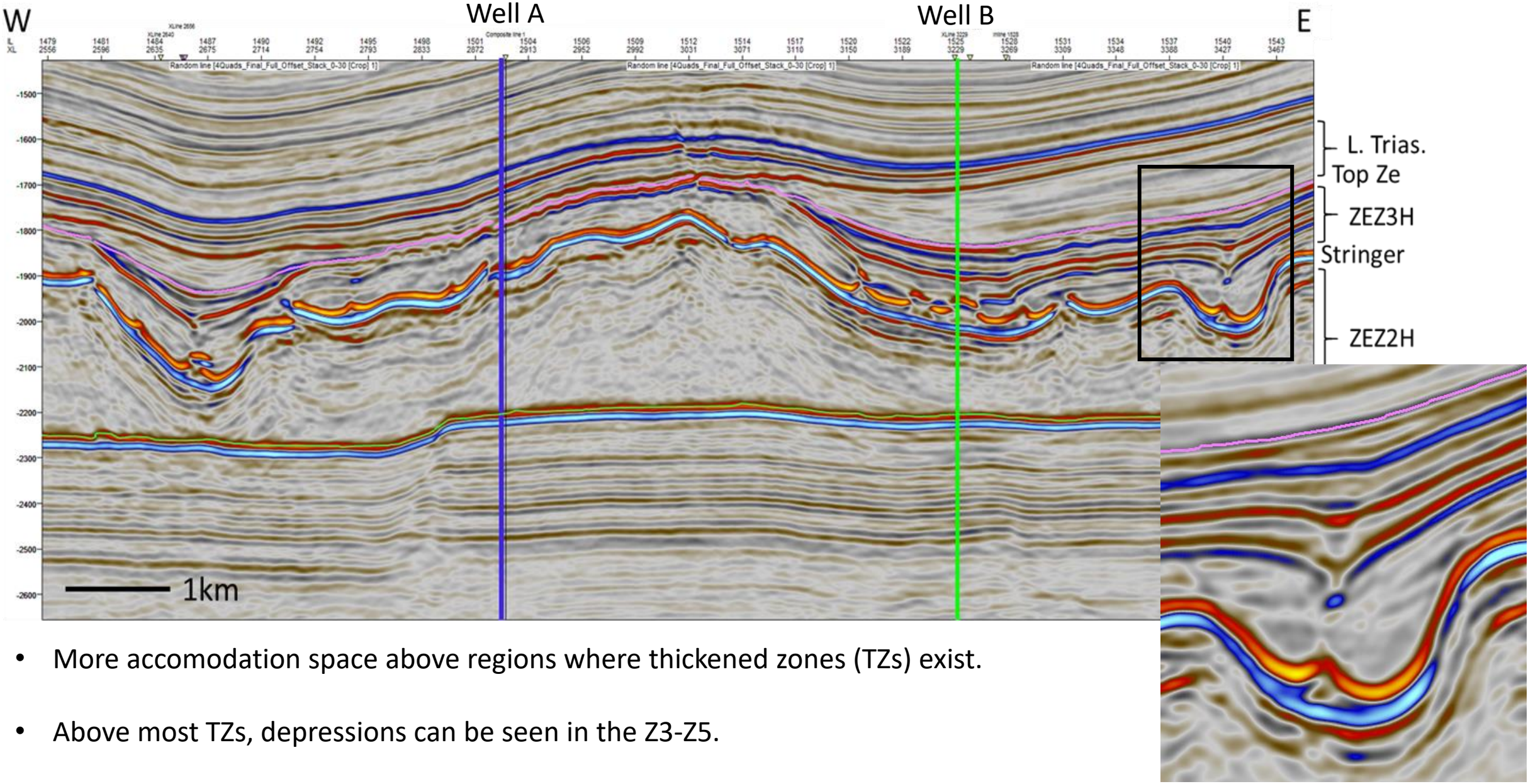
Note colours are reversed!

Seismic-to-Well Tie – Well B



Note colours are reversed!

Composite W-E Cross Section Through Well A & B



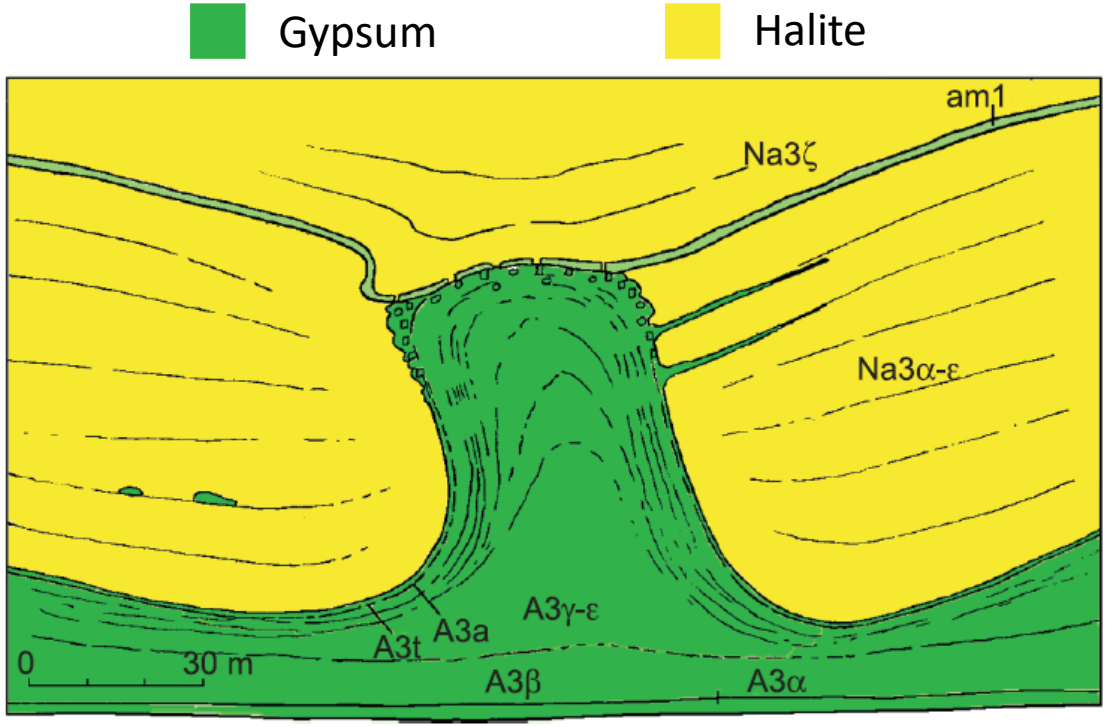
- More accomodation space above regions where thickened zones (TZs) exist.
- Above most TZs, depressions can be seen in the Z3-Z5.

“Thickened Zone” Analogue?

(Based on outcrop and salt miners data in Harz area, Germany)

Proposed geological history:

1. Gypsum doming start after some deposition of Leine salt member.
2. Gypsum converts into anhydrite and loses ~40% of volume by water.
3. Water escapes laterally and vertically
4. Overburden dissolves and collapses.
5. With time Anhydrite domes sink in underlying halite, due to differential loading creating a syncline.

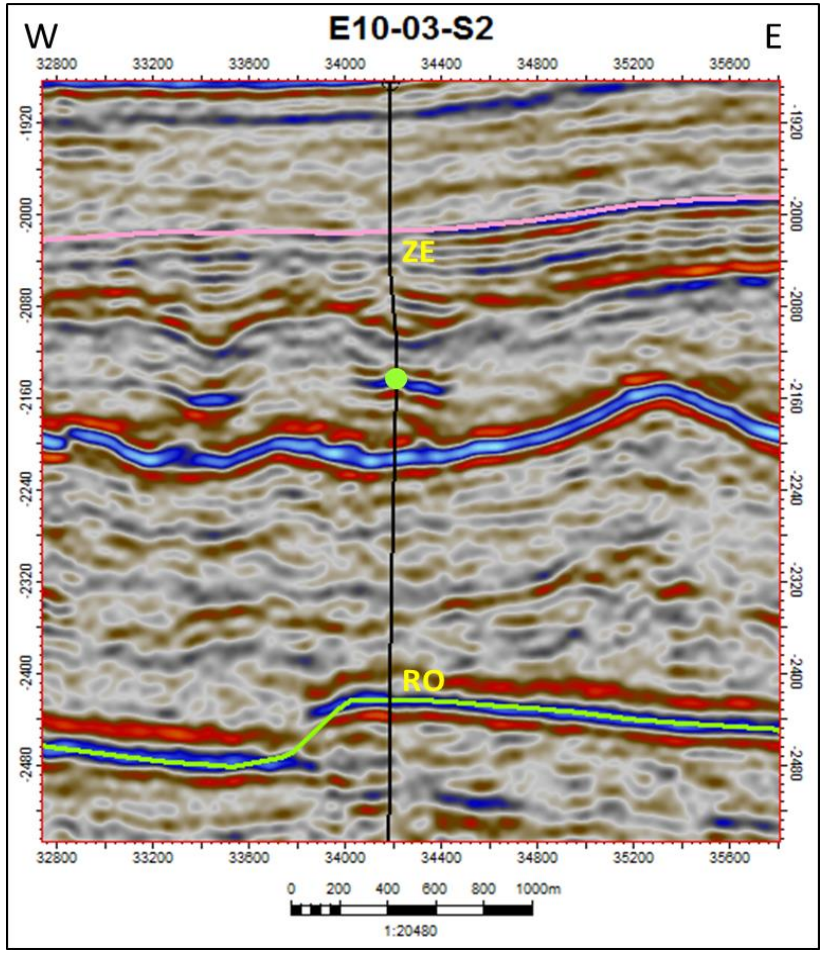


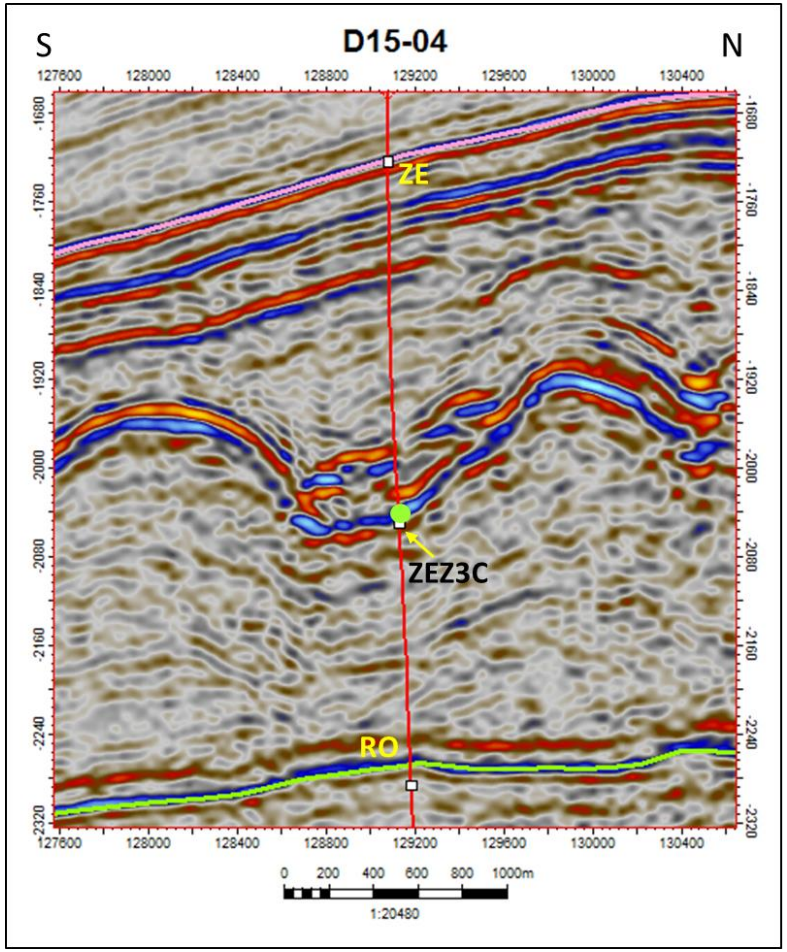
AnhydritKlippen, Paul (2014)

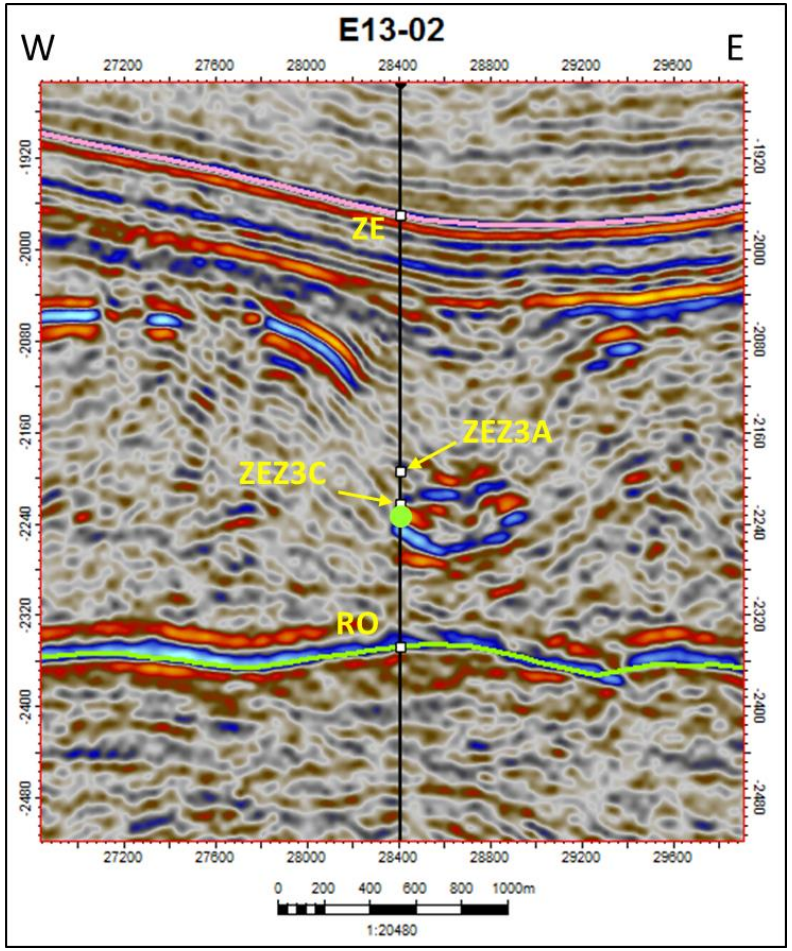
Implications: lower chance on kicks due to early over-pressure leak off?

Kicks Are Observed in Anhydrite Domes

- Kick in head of anhydrite dome, possibly driled a water pocket?
- No depression present above anhydrite dome, no early pressure leak off?
- Edges are faulted zones and have increase porosity and permeability.







- Kick location

Conclusions

- *Thickened Zones in ZeZ3 stringer* consist of up to 180m of (Haupt)anhydrit compared to typical stringer thickness of ~50m

- TZ can be explained by gypsum movement similar to halite halokineses, which later convert to anhydrite. Comparable to analogue model from Paul (2014), Harz mountains, Germany.

- TZ are interpreted to be anhydrite domes.

- Despite the indications for fluid escape associated with TZ, overpressures while drilling have been observed.

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Questions?

Acknowledgement: ONE Dyas B.V.