The Pitfalls of Seismic Interpretation: How to Reduce Risk With Certainty*

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Abstract

The process of obtaining and processing seismic data is a lengthy, involved, and expensive one. Indeed the continual reprocessing of seismic is commonly employed throughout the life cycle of a field, and in exploration often offered as a solution when the risks are unclear. The cellular model has become a primary objective in the assessment of a prospect and develops very early in the workflow, with investigations therein limited to adjusting properties of the rigid corner point grid created. In contrast, while the process of horizon identification is seen as an important one, the process of fault interpretation is a relatively short-lived step in the workflow and may lack the rigorous QC it requires. Furthermore it is rarely revisited once completed. Structural issues are regularly quoted in failed post-well analyses (note the recent DECC-OGA report "Exploration well failures in the North Sea"). In many cases this is one of the risks that can be largely mitigated - without the requirement of new seismic - and it is not an issue resolvable using uncertainty analysis or a corner point grid. With the application of a few fundamental principles relating to fault growth/interaction and the understanding that interpretation should be an iterative process rather than a one-off, interpreters (be they graduate explorationists or experienced geophysicists) can create far better realizations - even without "specialist" tools or experience. We present these fundamentals along with examples the recurring pitfalls of interpretation so that more common mistakes, once recognized, are not repeated. Only when a framework model is mechanically robust and defensible should it be cellularized and subject to further analysis, otherwise error is compounded at every derived step in the workflow and what is commonly regarded as a safeguard against error – uncertainty - is merely an exercise in attaining an accurate fallacy. Decisions made on the basis of such fallacies create unnecessary risks.

Selected References

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Ofstad, K., L. Kullerud, and D. Helliksen, 2000, Evaluation of Norwegian Wildcat Wells (Article 1) Improving the Exploration Process by Learning from the Past: Norwegian Petroleum Society, Special Publication No 9, p. 23-31.

Richards, F.L., N.J. Richardson, C.E. Bond, and S.M. Cowgill, 2015, Interpretational Variability of Structural Traps: Implications for Exploration Risk and Volume Uncertainty, *in* F.L. Richards, N.J. Richardson, S.J. Rippington, R.W. Wilson, and C.E. Bond (eds.), Industrial Structural Geology: Principles, Techniques, and Integration: Geological Society, London, Special Publications 421. doi.org/10.1144/SP421.13

Uman, M. F., W.R. James, and H.R. Tomlinson, 1979, Oil and Gas in Offshore Tracts: Estimates Before and After Drilling: Science, v. 205, p. 489-491.

Whipp, P.S., C.A.L. Jackson, R.L. Gawthorpe, T. Dreyer, and D. Quinn, 2014, Normal Fault Array Evolution above a Reactivated Fabric; A Subsurface Example from the Northern Horda Platform, Norwegian North Sea: Basin Research, v. 26, p. 523-549.

The Pitfalls of Seismic Interpretation:

How to reduce risk with certainty

Dave Quinn

Some Pitfalls

1. It's a "stratigraphic trap"

2. Depth conversion

3. Blaming the seismic

4. Structural knowledge gaps

5. Shiny things

6. Analogues
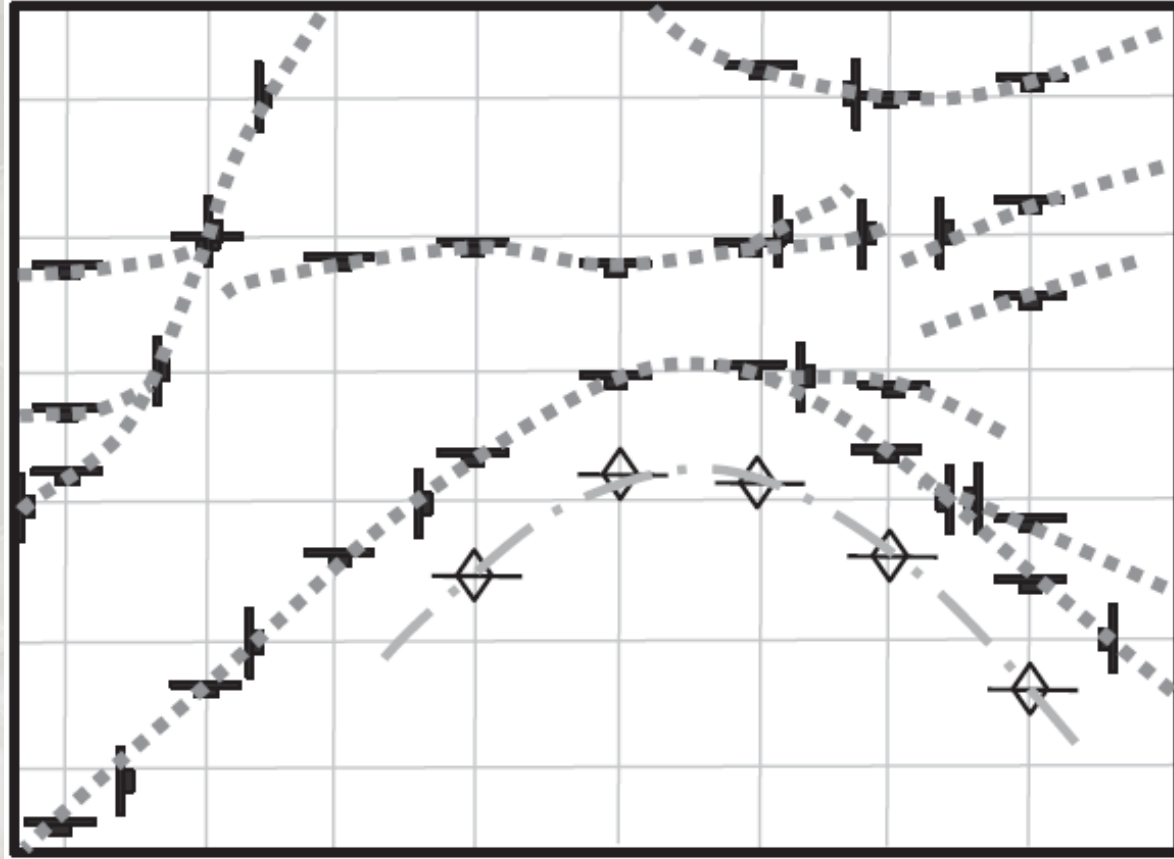
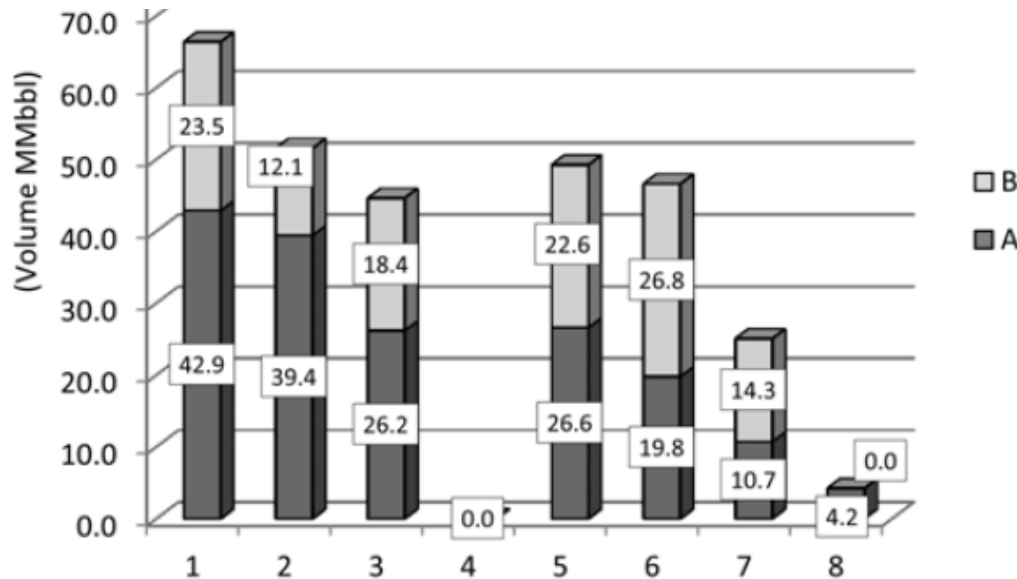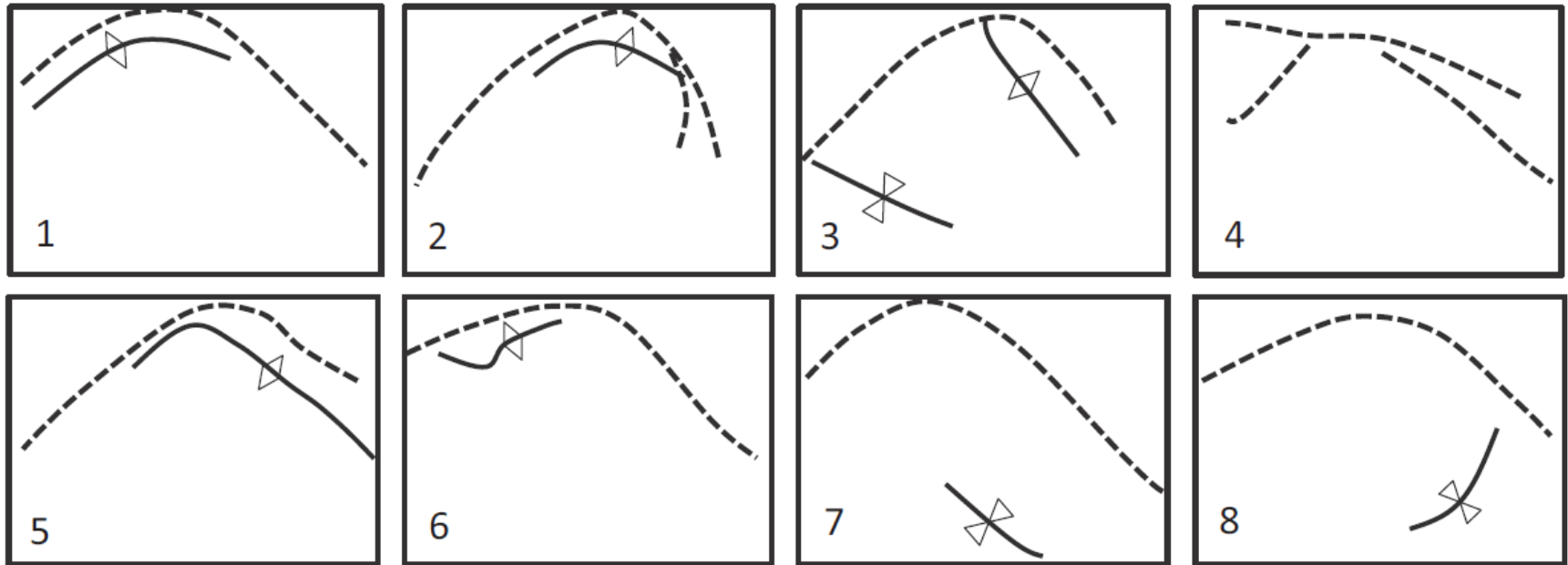# "...we had really low uncertainty in our key risks"

Map interpretation

Richards *et al.* 2015

4

Map interpretation

Richards *et al.* 2015

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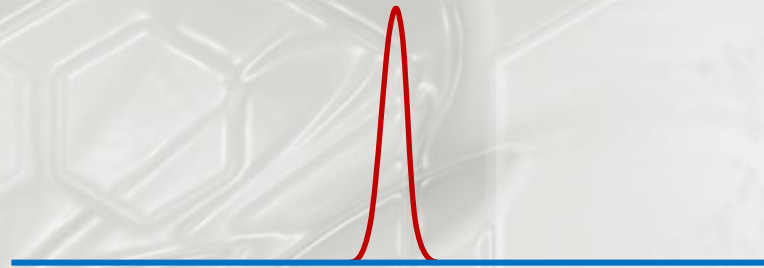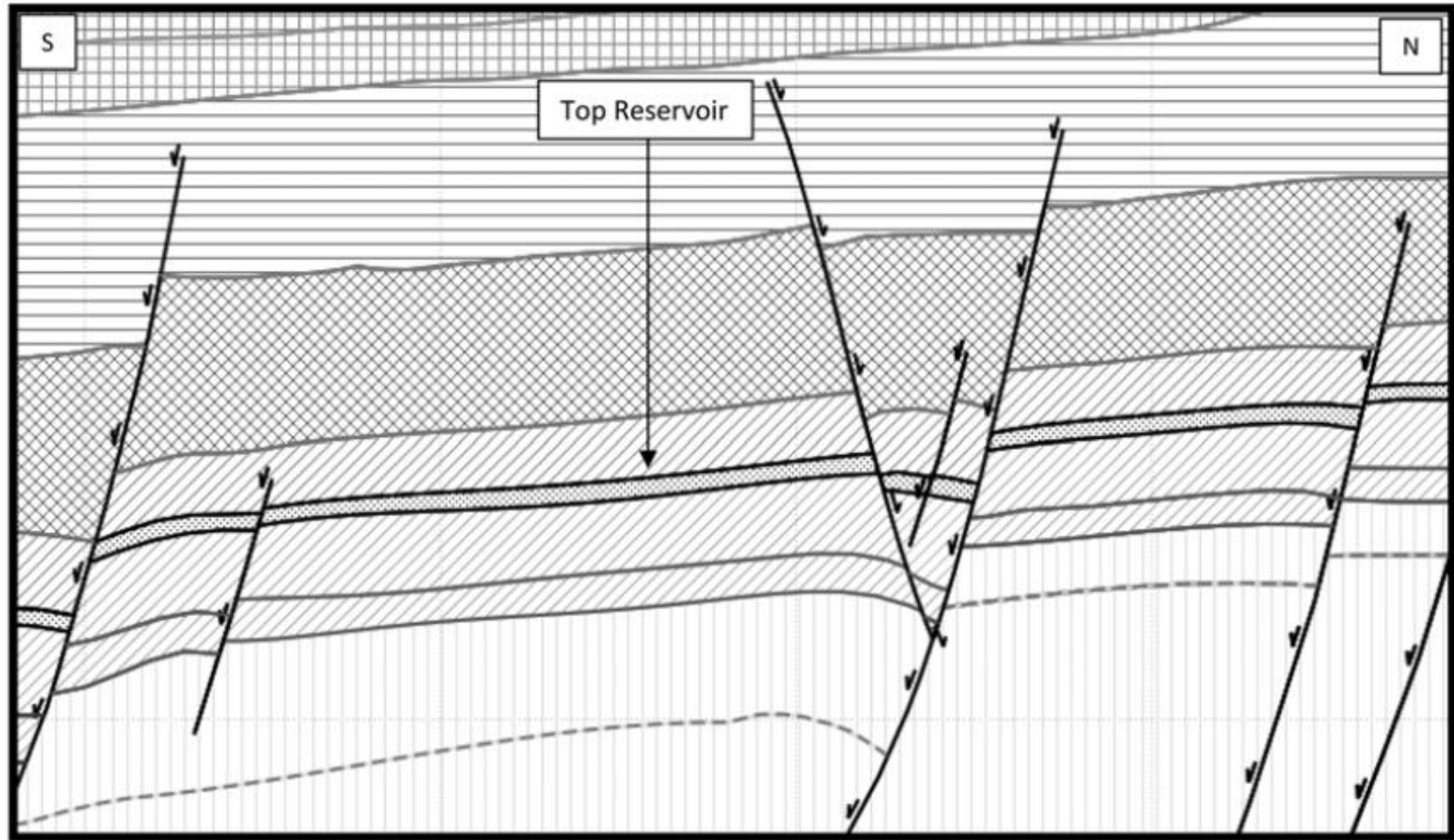
5

Map interpretation

Richards *et al.* 2015

Gross interval	20m
N:G	0.80
porosity	0.25
HC Saturation	0.70
Recovery Factor	0.50

Accuracy Vs Precision

Accurate, but not Precise

Precise, but not Accurate

Not Accurate or Precise

Accurate and Precise

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Accuracy Vs Precision

Accurate, but not Precise
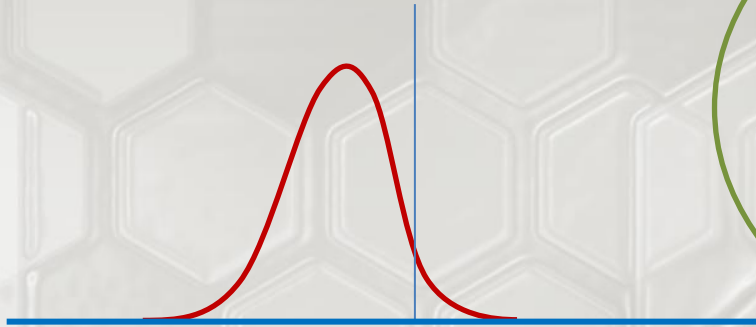
Precise, but not Accurate

SYSTEMATIC ERROR
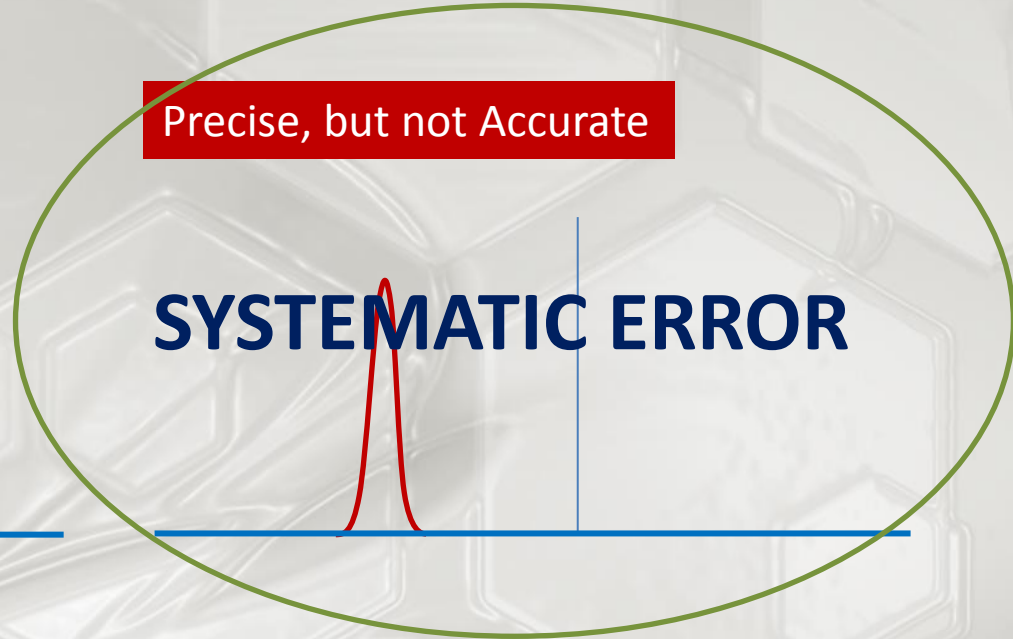
Not Accurate or Precise

Accurate and Precise

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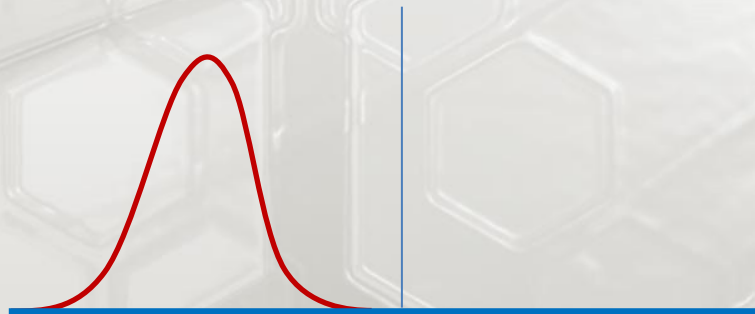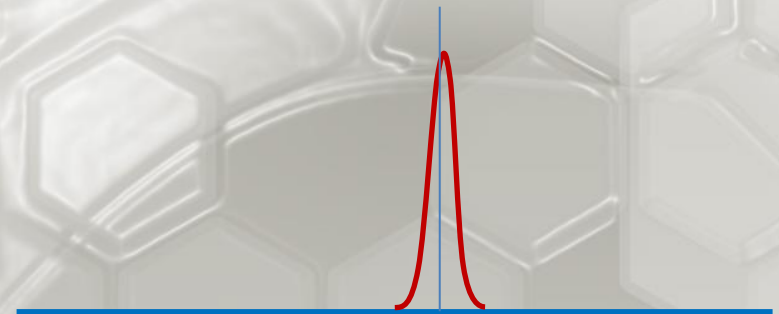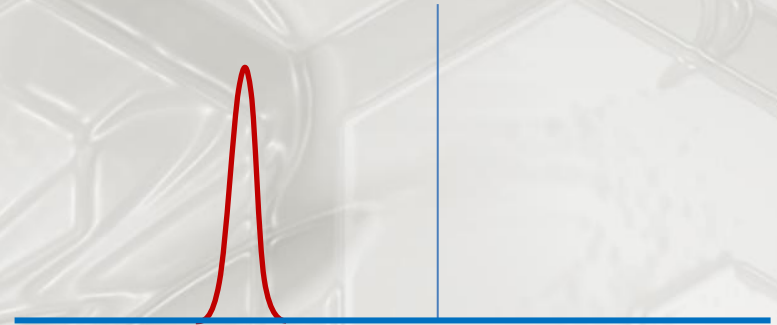
"…we had really low uncertainty in our key risks"

Systematic error

What's no.1 in the Systematic error charts?

Trap definition

Uman et al. (1979)

Principal reason for dry holes = incorrect structural interpretation (43%)

McMaster (1997)

380 Amoco wells. Most common reason for failure = "Trap Definition"

Ofstad et al. (2000)

Worst defined risk parameter Trap definition (pre-drill = 46%, post = 23%)

Mathieu (2015)

Reasons for failure in 97 wells: Trap = 28 %
Main reason for failure was the lack of lateral seal (27%)... lack of trap (17%).

"Seismic picking is questionable: this highlights the need to improve the Quality Control of the interpretations. There is probably a real need for additional skilled advice (Peer review?) before validating an interpretation"

Trap definition

Not a new issue then, but perhaps the reasons for it have changed?
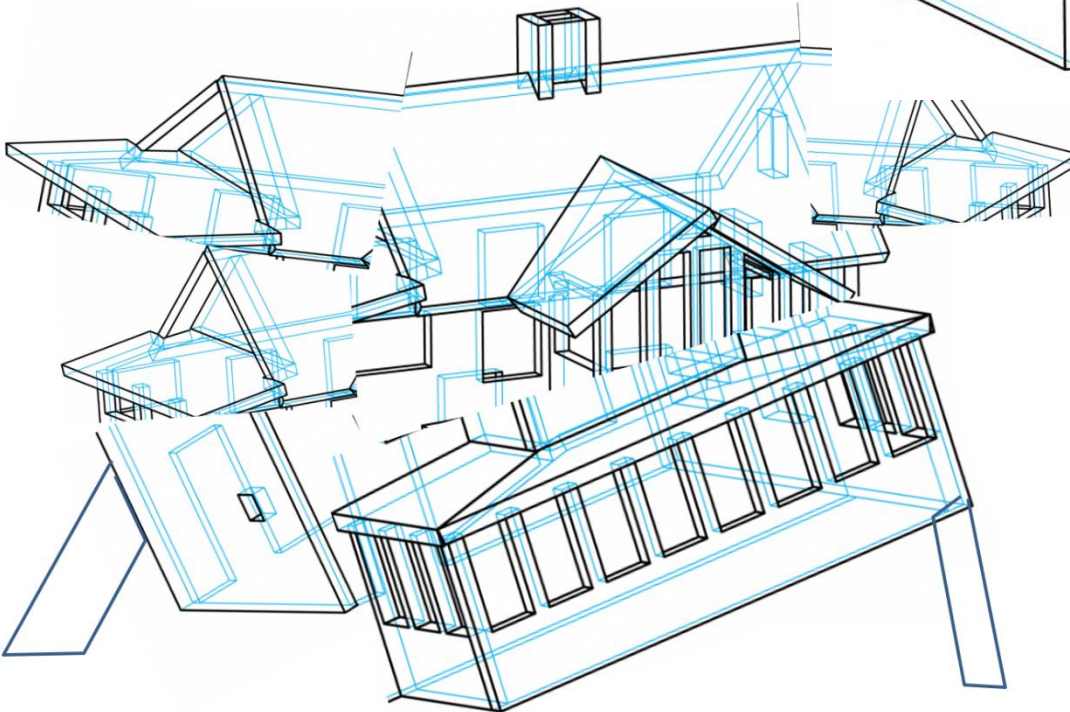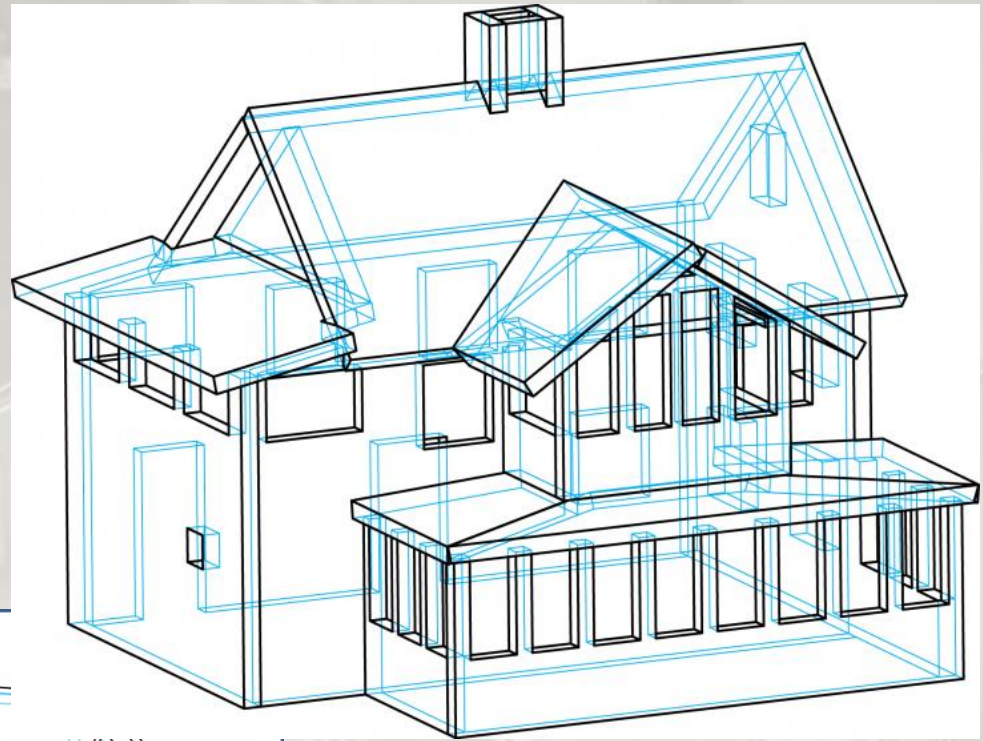
Trap definition

Trap definition

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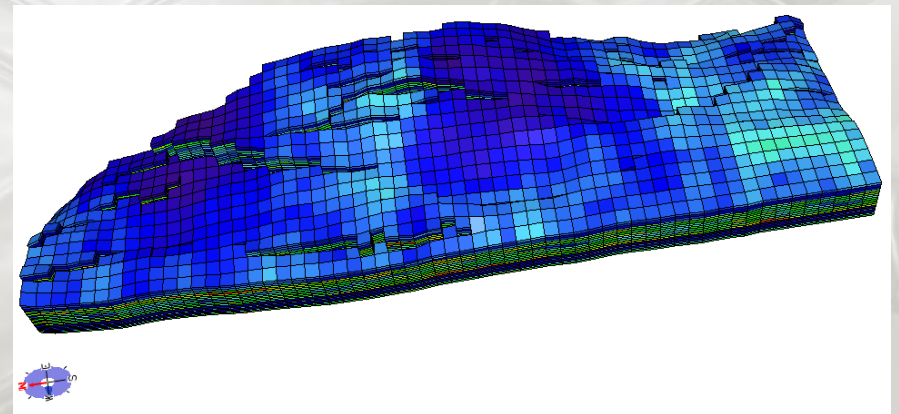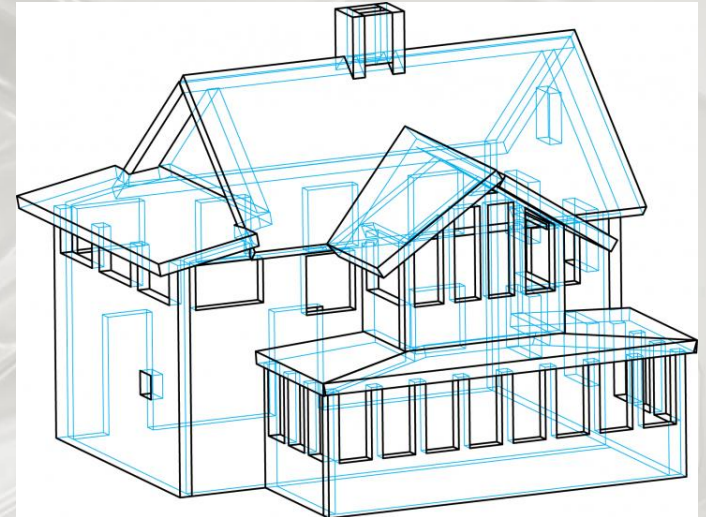
Trap definition in production

**No fault QC
225+ simulations but <u>NO</u> history match**
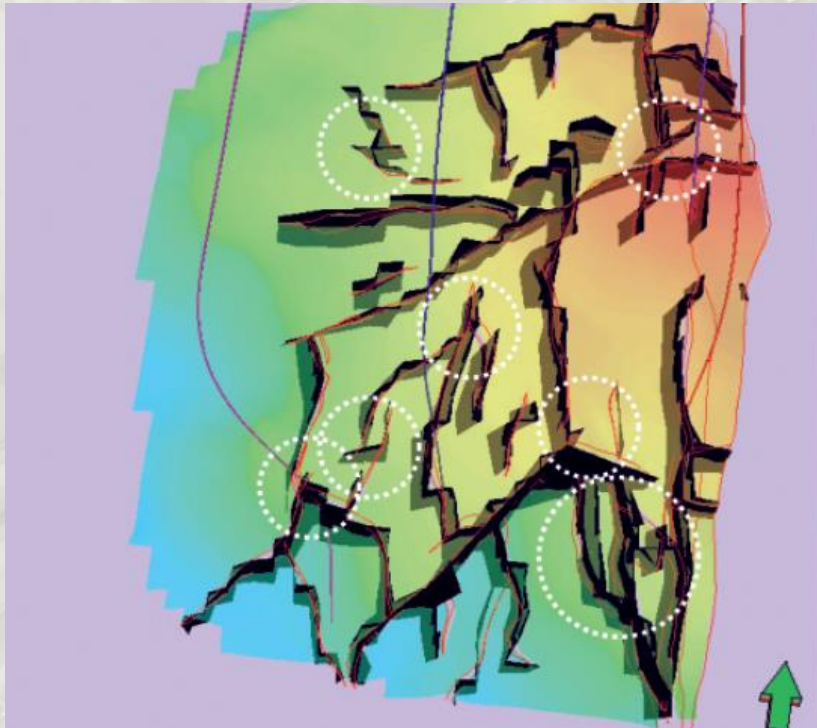
**Fault QC in Badleys software
70 simulations = history match**

Jolley et al. 2007

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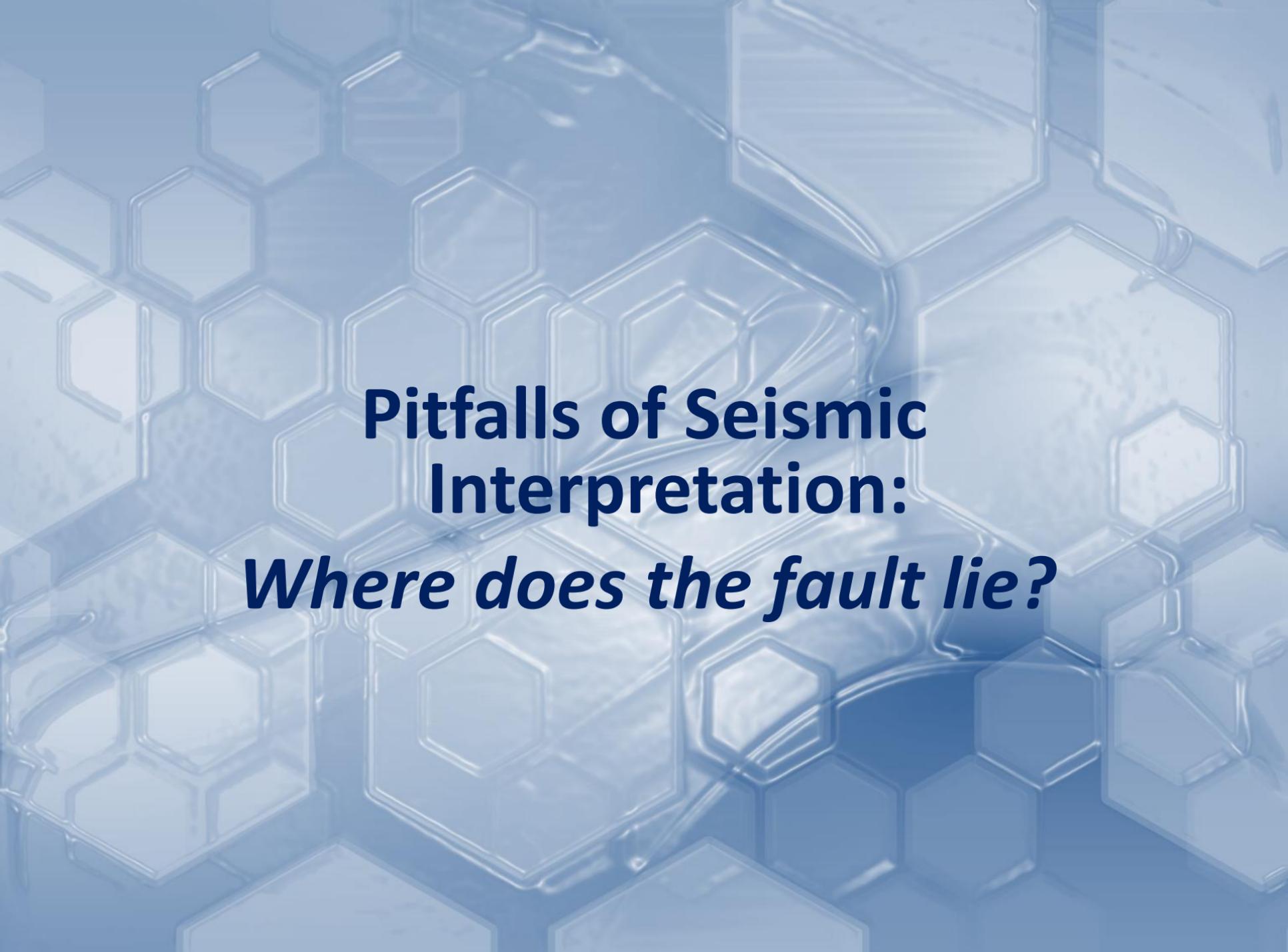
Pitfalls of Seismic Interpretation:
Where does the fault lie?

Why is trap definition so poor?

1. **Seismic**

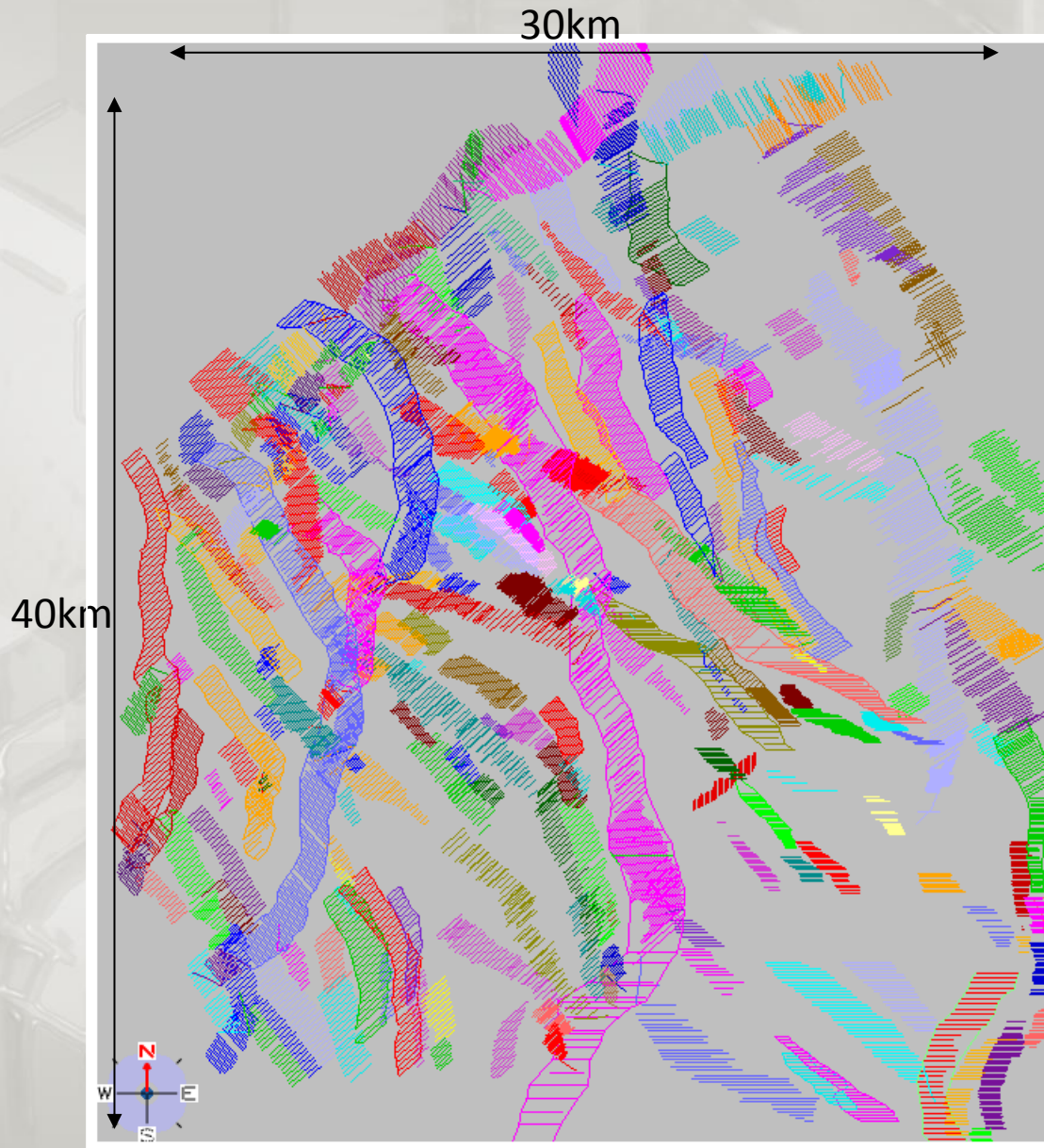2. **Interpretation**

3. **The rush to cellularisation**

4. **The current process of map creation**

Bond 2006
(>200 participants)

Why is trap definition so poor?

1. **Seismic**

2. **Interpretation**

3. **The rush to cellularisation**

4. **The current process of map creation**

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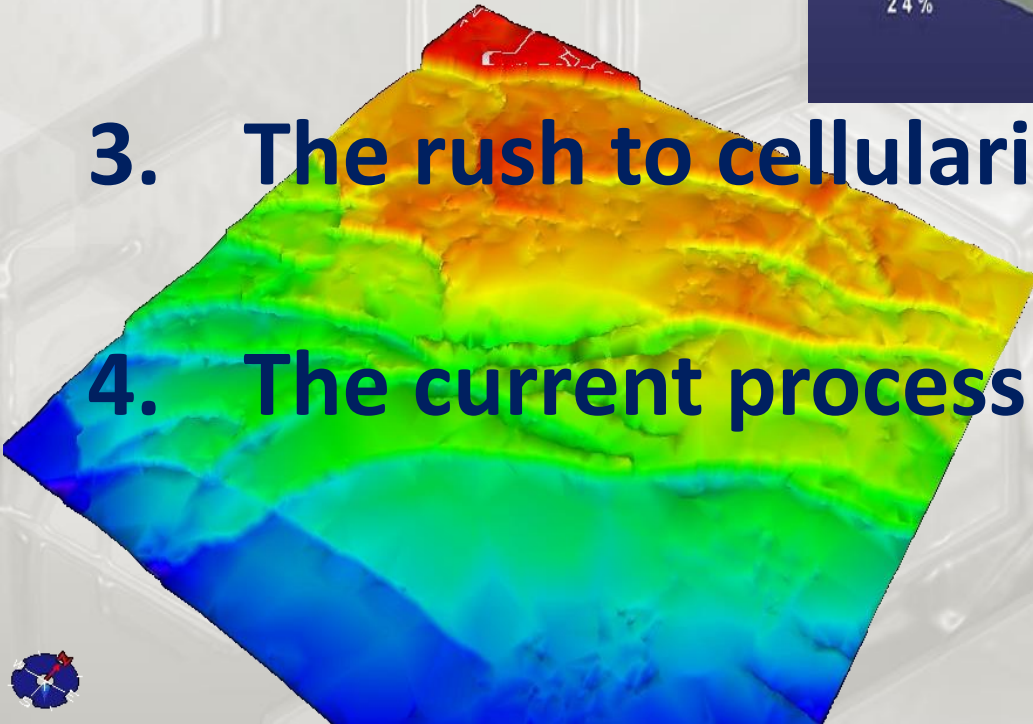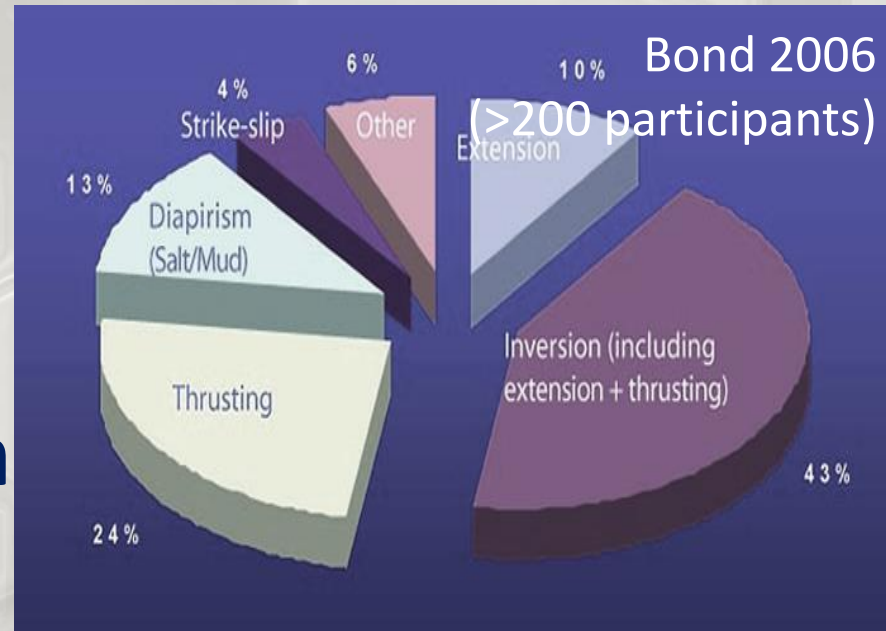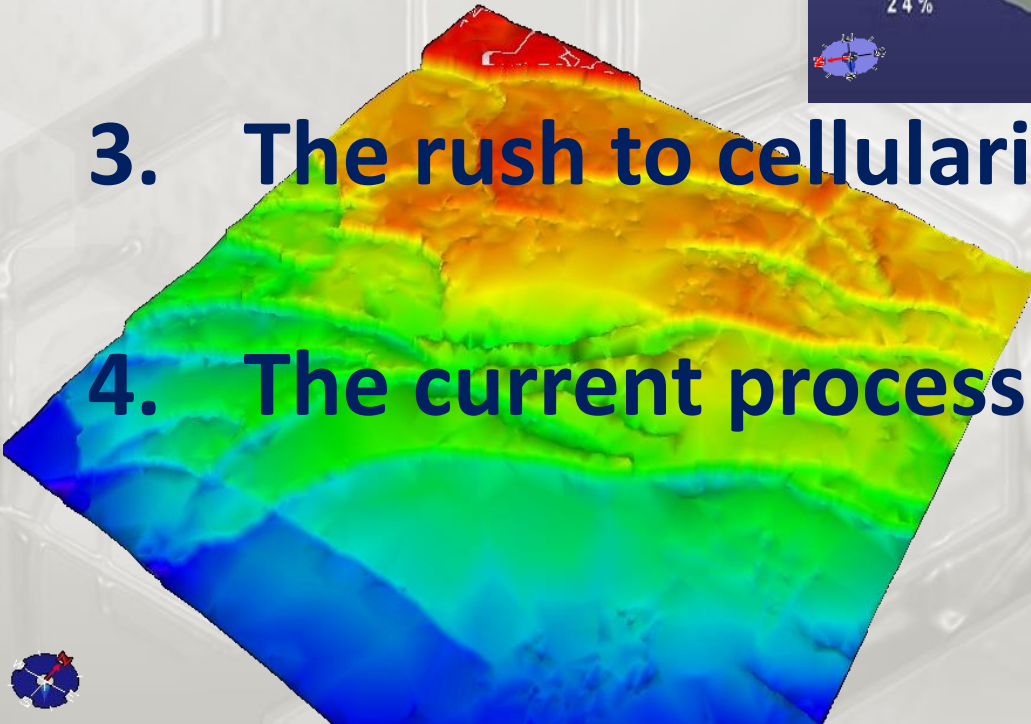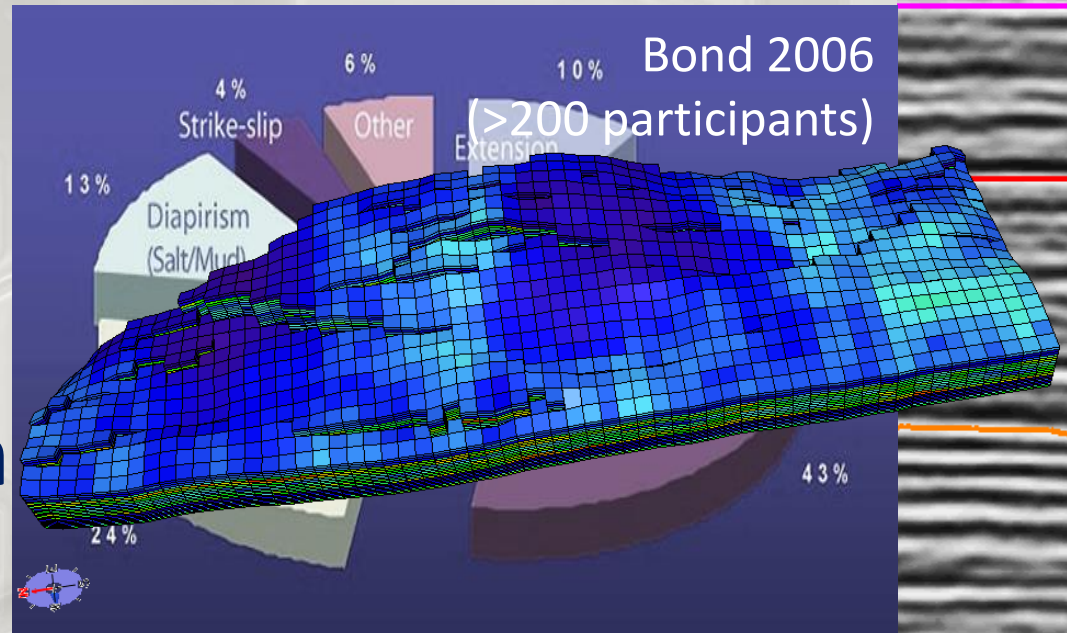
Cliff Faults are very poor practice
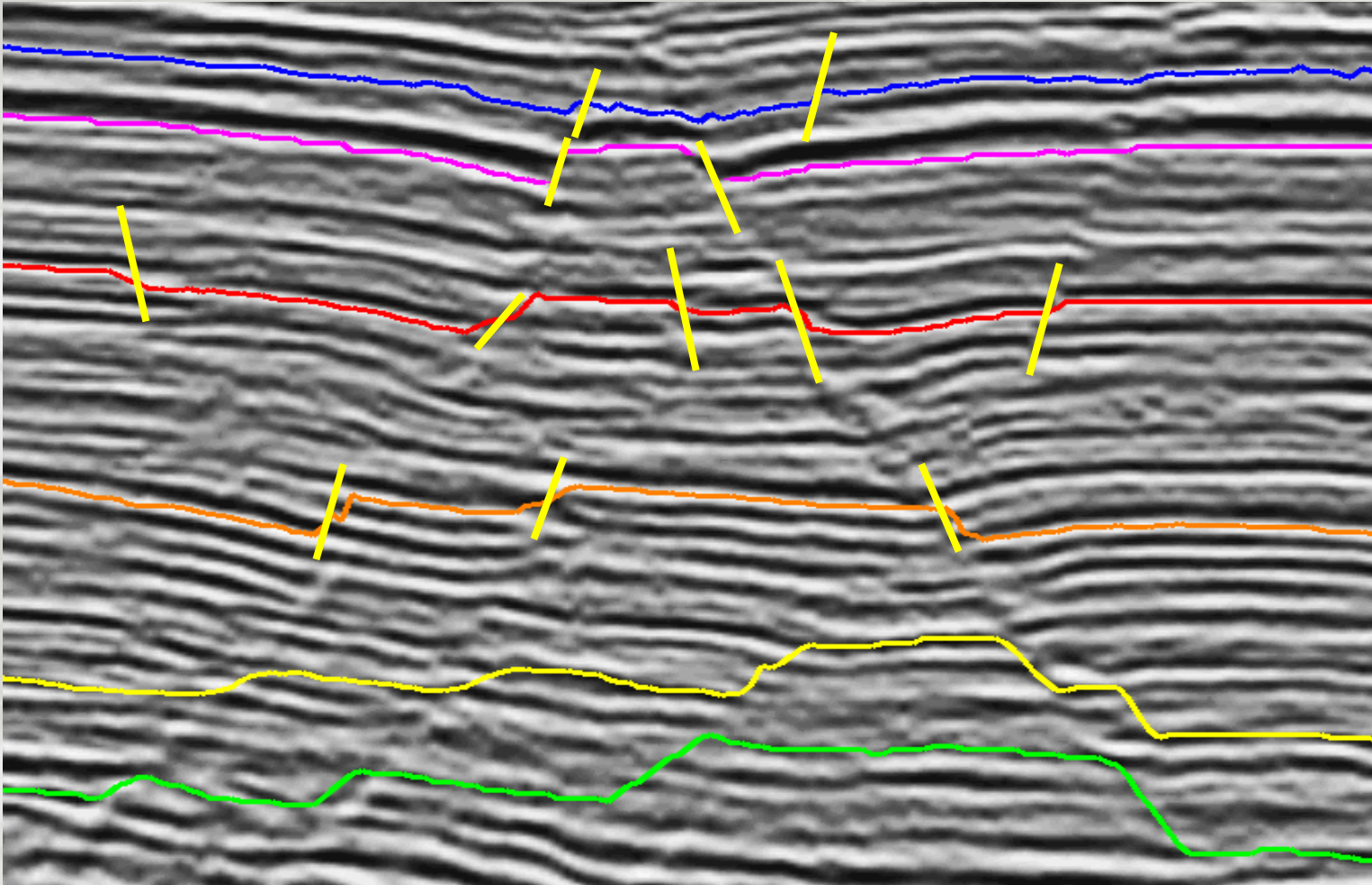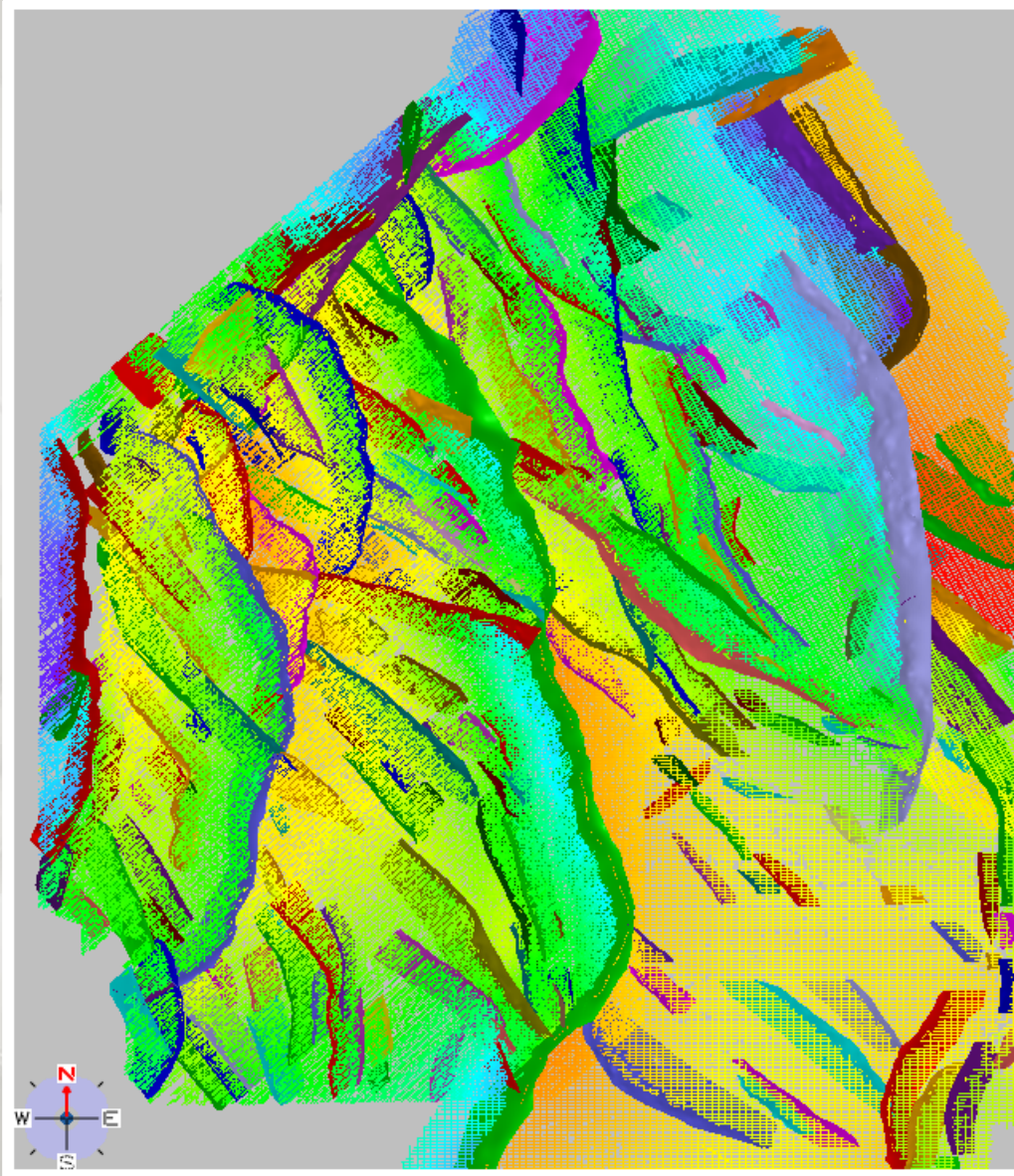
Frameworks – fault sticks

30km

40km

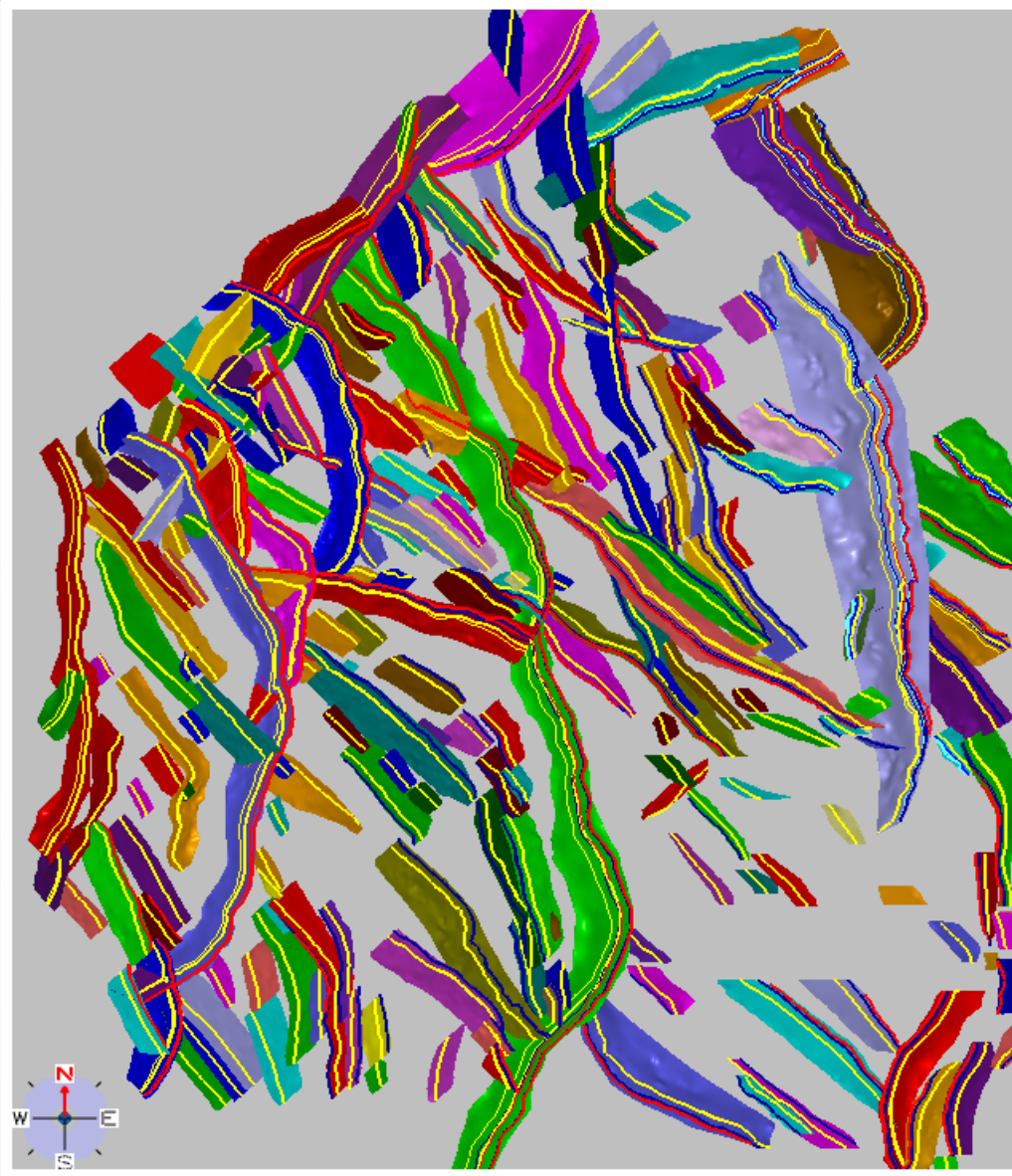After Whipp et al. 2014

Connected fault surfaces
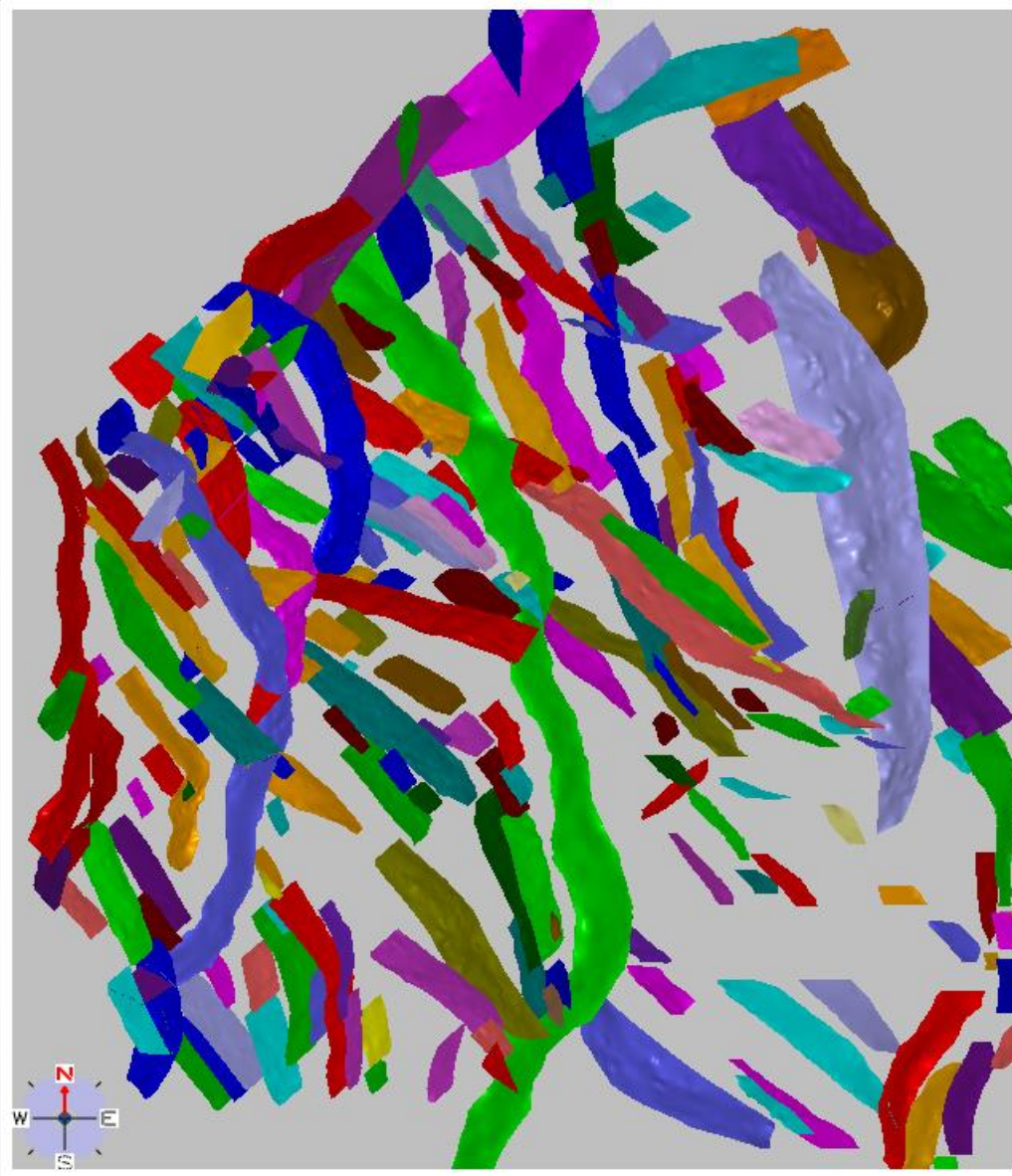
After Whipp et al. 2014

Add raw horizon data

After Whipp et al. 2014

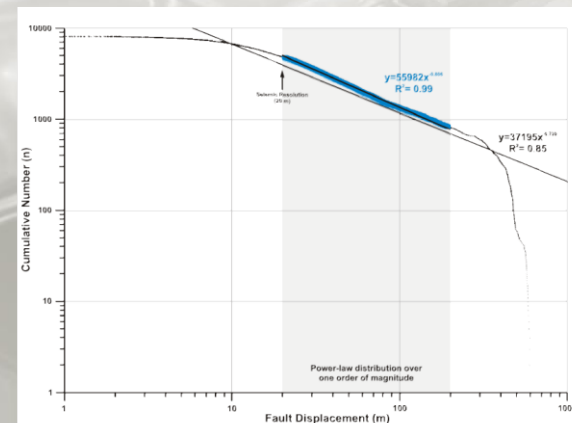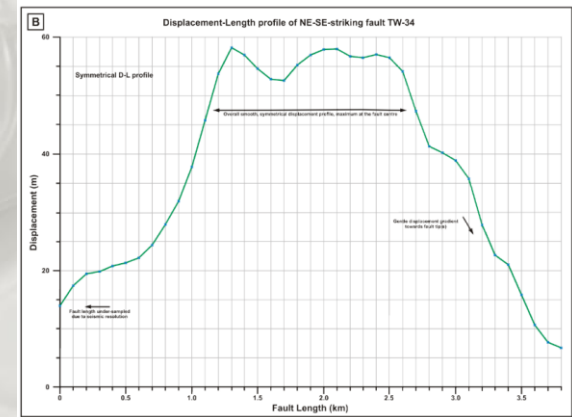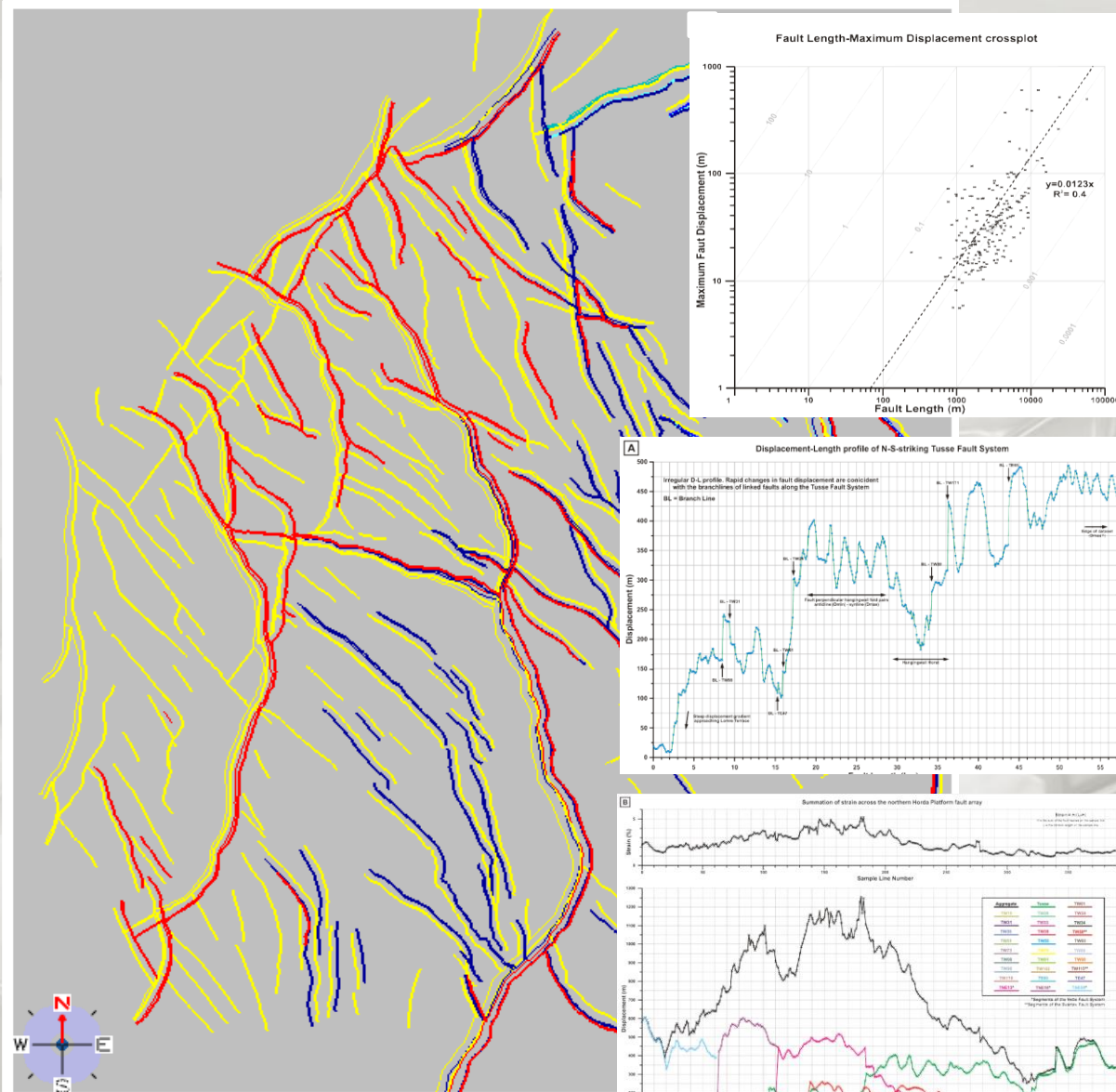# Create intersection polygons

After Whipp et al. 2014
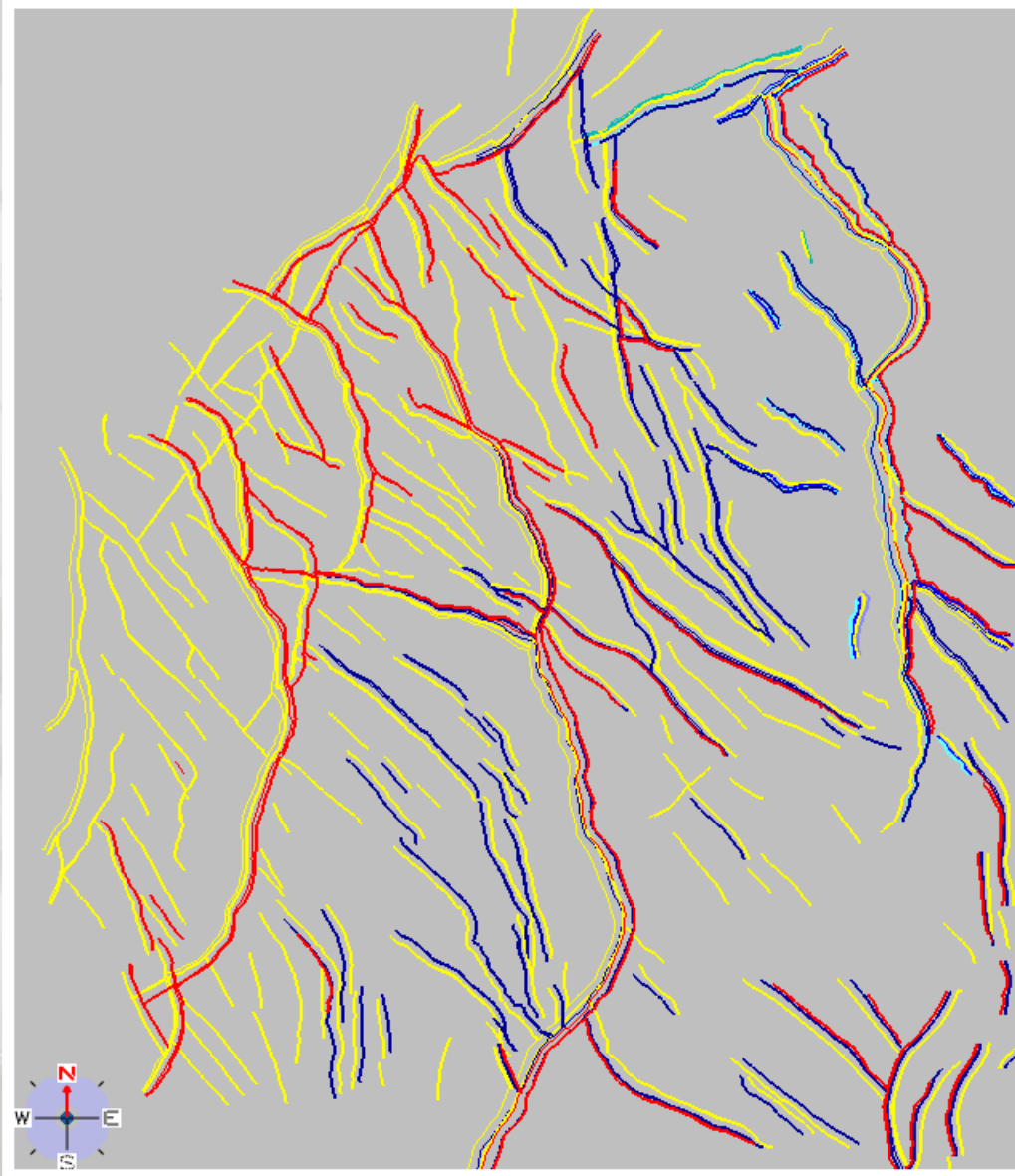
The basis for displacement analysis

After Whipp et al. 2014

The basis for displacement analysis
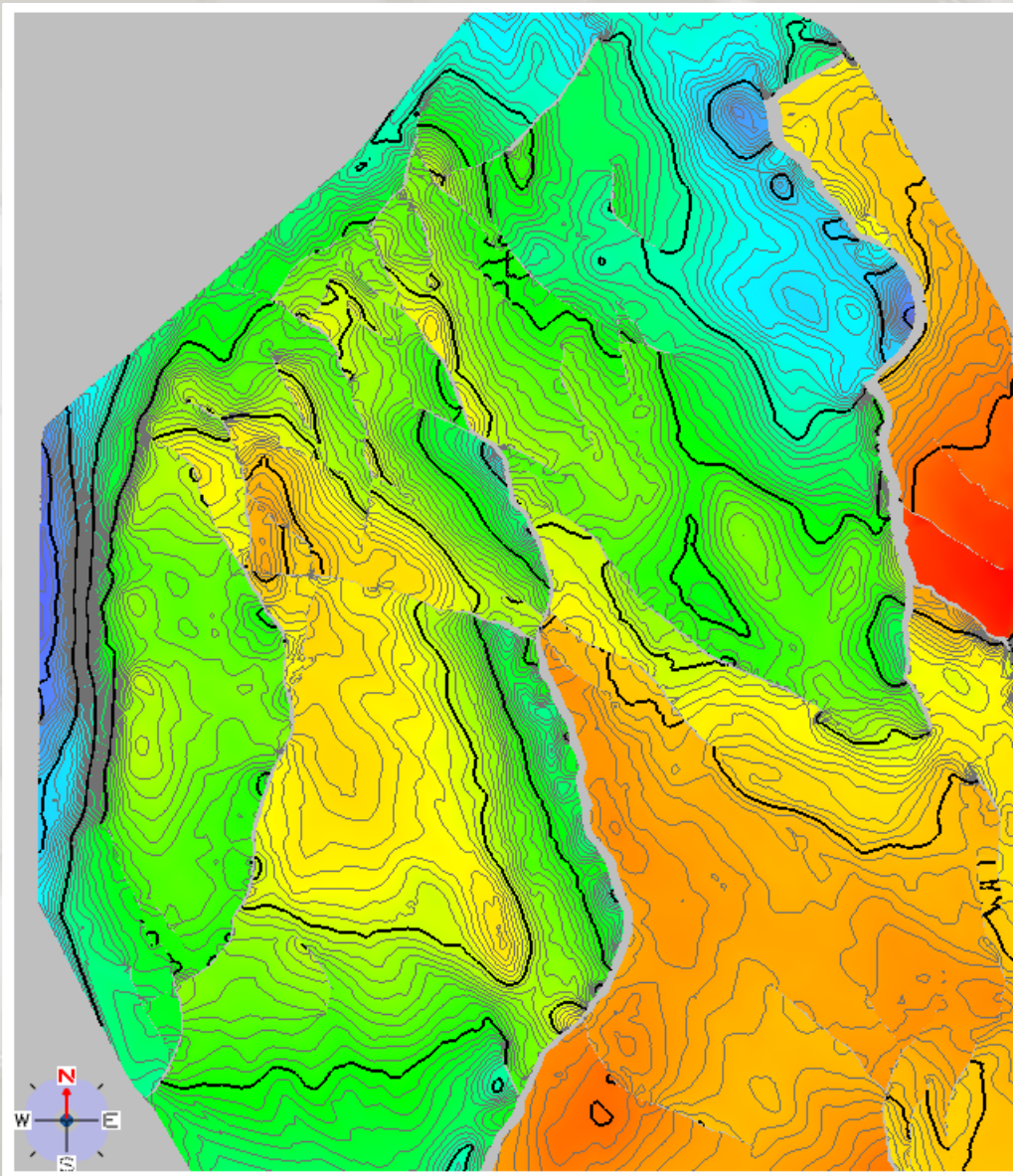
After Whipp et al. 2014

Iterate

After Whipp et al. 2014
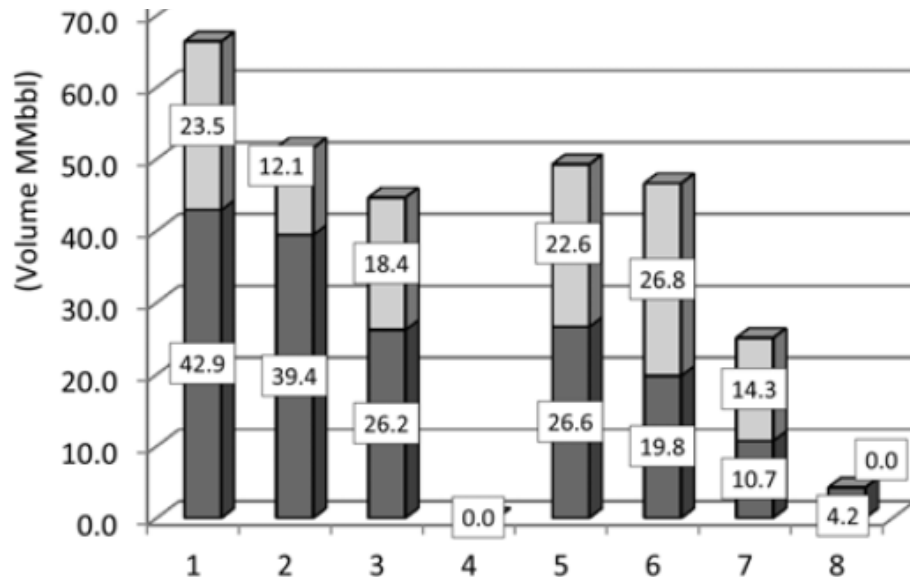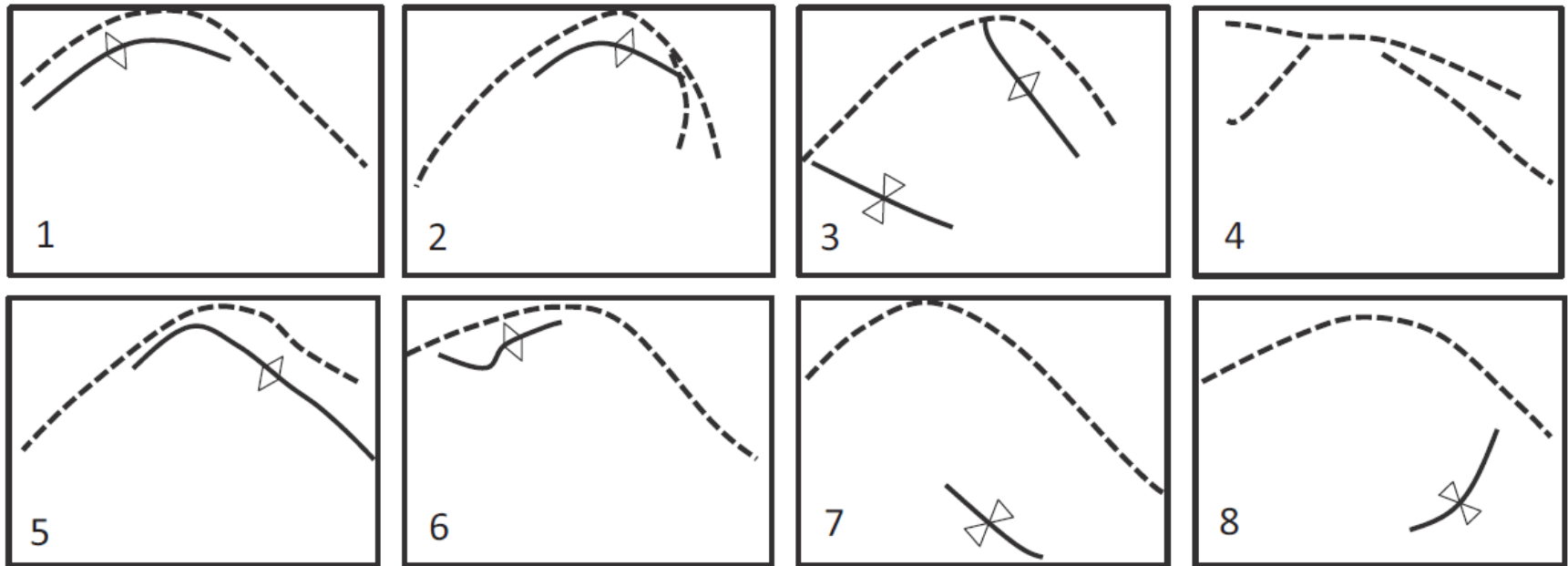
THEN create horizon surface

... a map worth investing in

After Whipp et al. 2014

Error #1: Trap definition/integrity

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Gross interval	20m
N:G	0.80
porosity	0.25
HC Saturation	0.70
Recovery Factor	0.50

Error #1: Trap definition/integrity

CPGs are not an appropriate tool

Autotrackers don't create geology – there is only one way to come by a solid floorplan

New seismic doesn't always have the answers

Understand the critical data to avoid introducing systematic error
> seismic
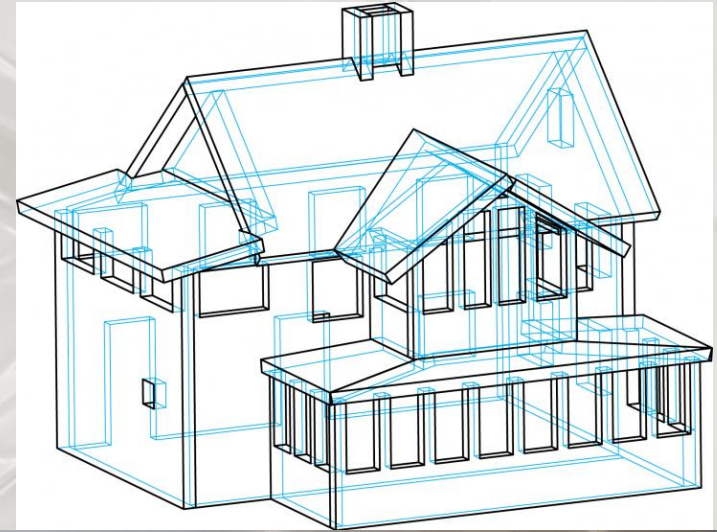> framework interpretation
> well interpretation
> stratigraphic interpretation
> ……software cannot do this for you

Any derived analysis, let alone volumetrics, is dangerous on a poorly defined trap.

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