Basin Structure Group
INSTITUTE OF APPLIED GEOSCIENCE

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Spatially variant uncertainty in the geological interpretation of reflection seismic data

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What is uncertainty?

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Lack of (complete) knowledge

(Pshenichny, 2004)

Types of uncertainty

Natural variability – Variation about an observed point (Aleatory)

Interpretation uncertainty - Categorical representation (Epistemic)

(Aven, 2010; Bond, 2015; Suslick et al., 2009; Winkler, 1996)

Impact

Dependent on sensitivity

(Saltelli, 2002)

Geological structures – interpretation uncertainty & bias

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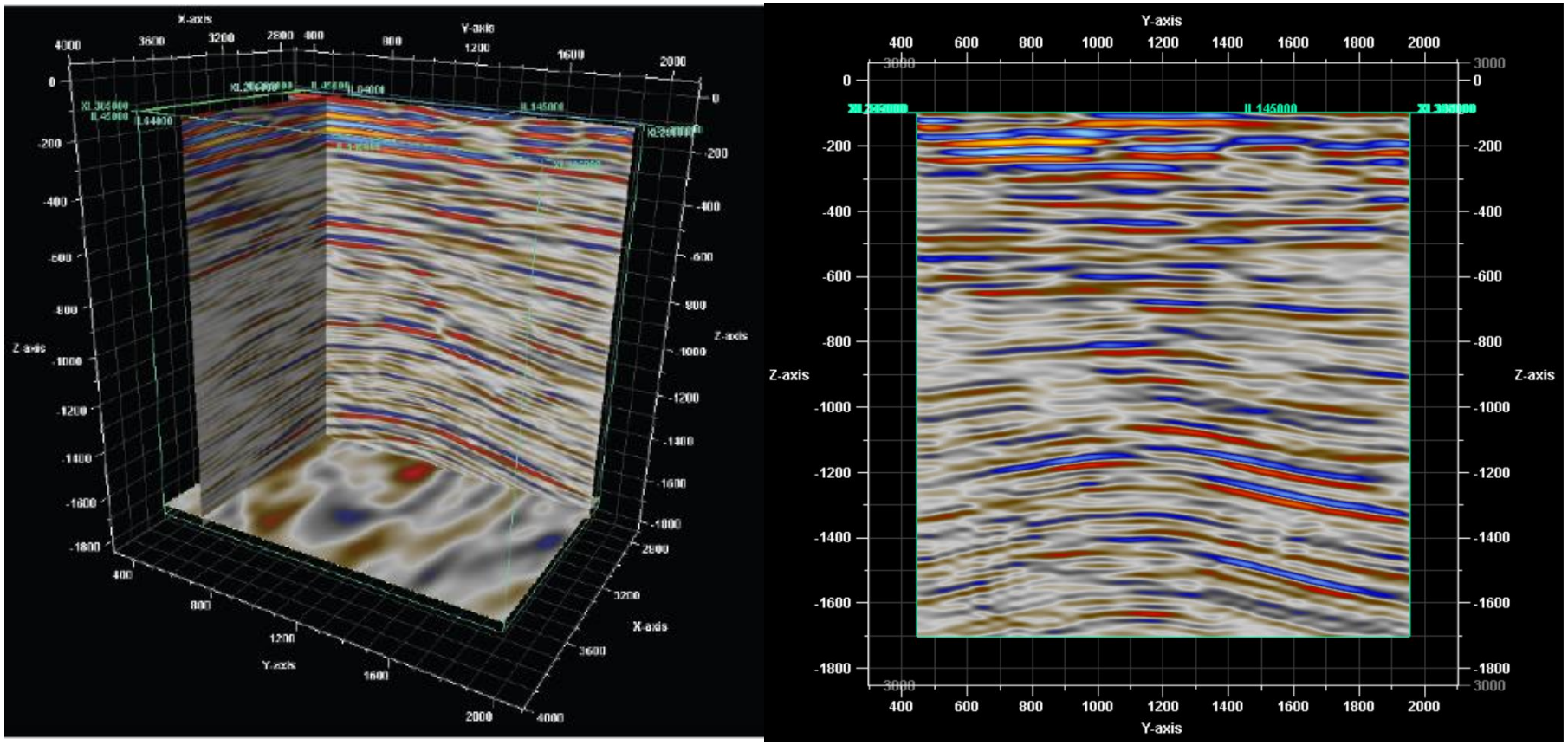
Can you interpret faulting in this image?



Imaging method: Lecomte (2008 & 2015)

Geological structures – interpretation uncertainty & bias

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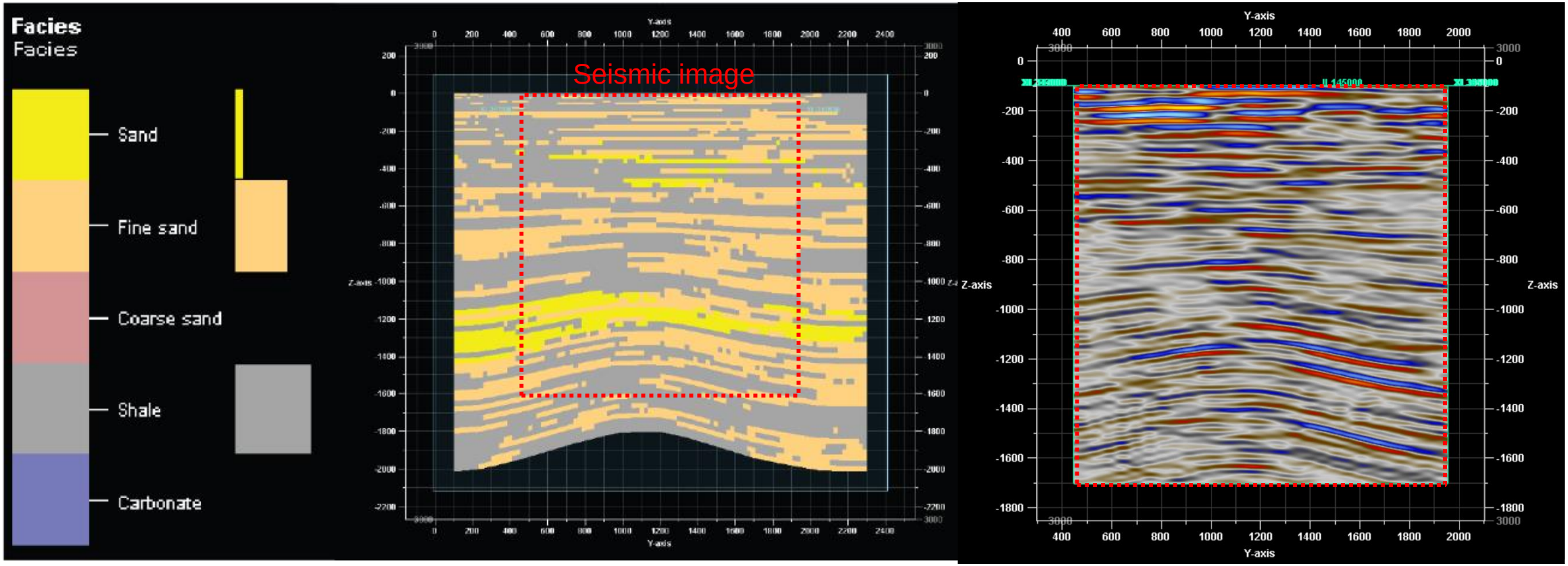
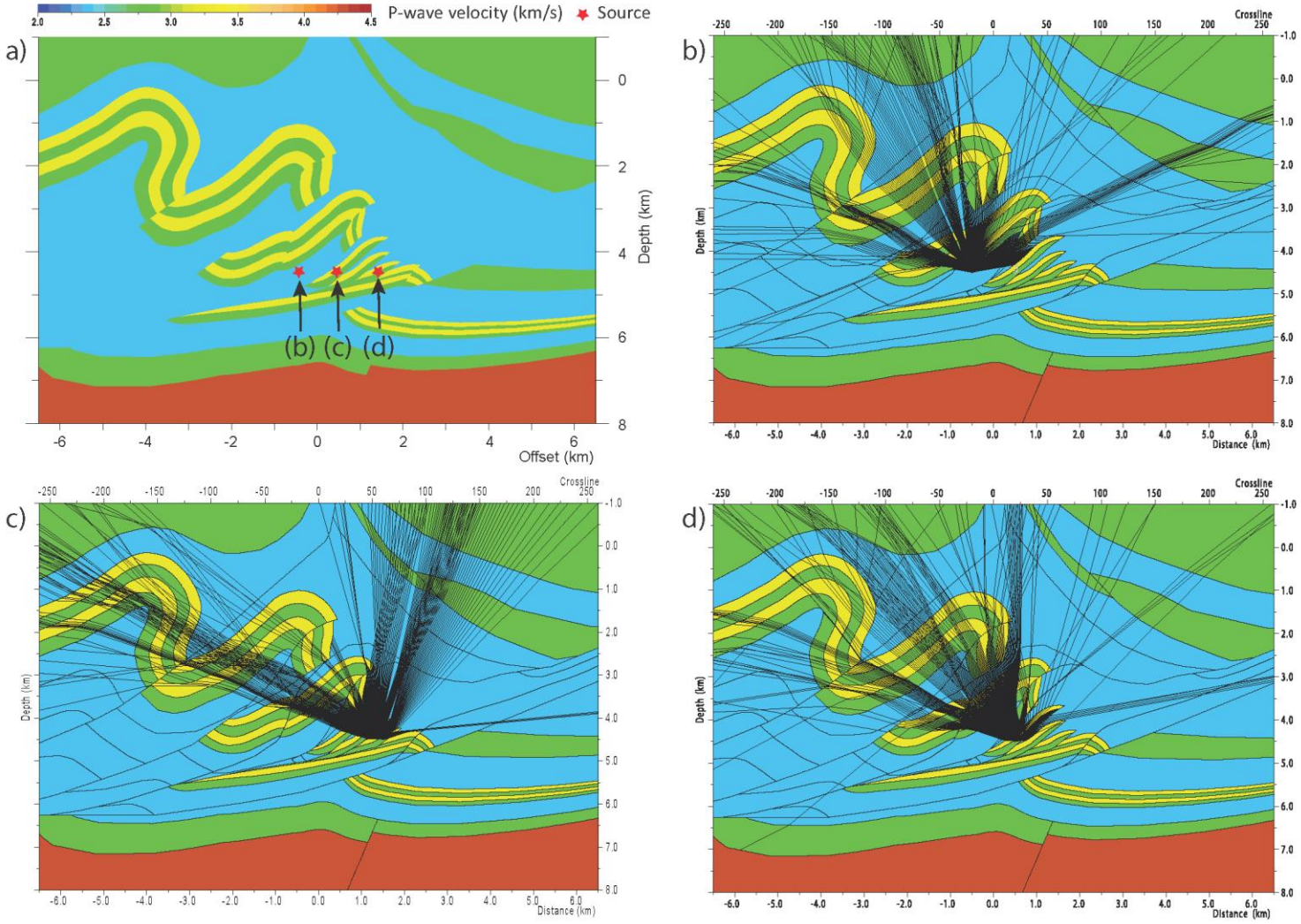


Realistic synthetic models: amplitude and frequency content also correspond to ‘real’ surveys

Misinterpretation to include faults = epistemic uncertainty

Shot trace illumination

- Energy pulses from a shot
- Raypath shown every 0.5°



Subsurface geometry guides the ‘ideal’ acquisition geometry

Spatial variation in uncertainty due to geometry

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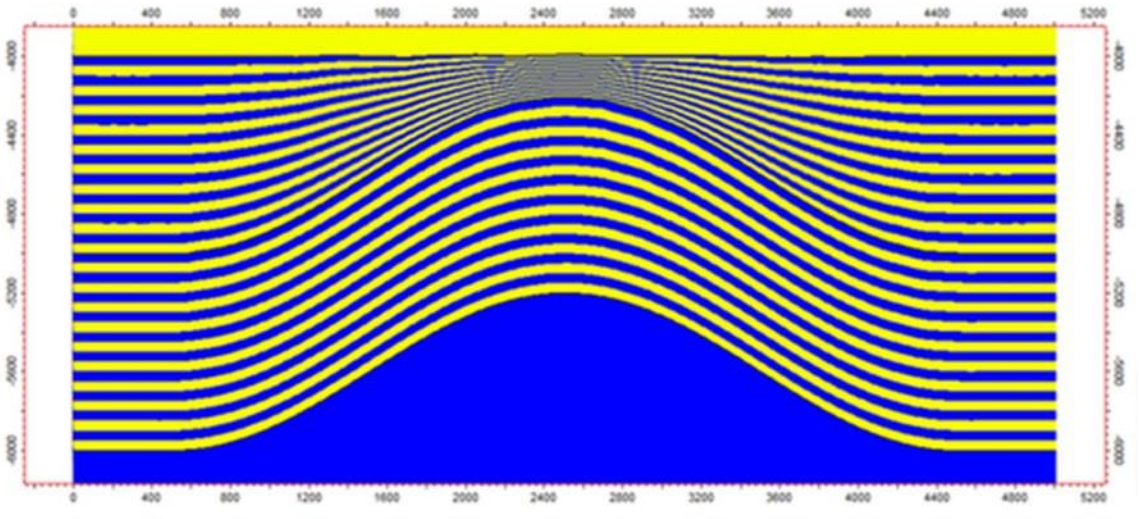
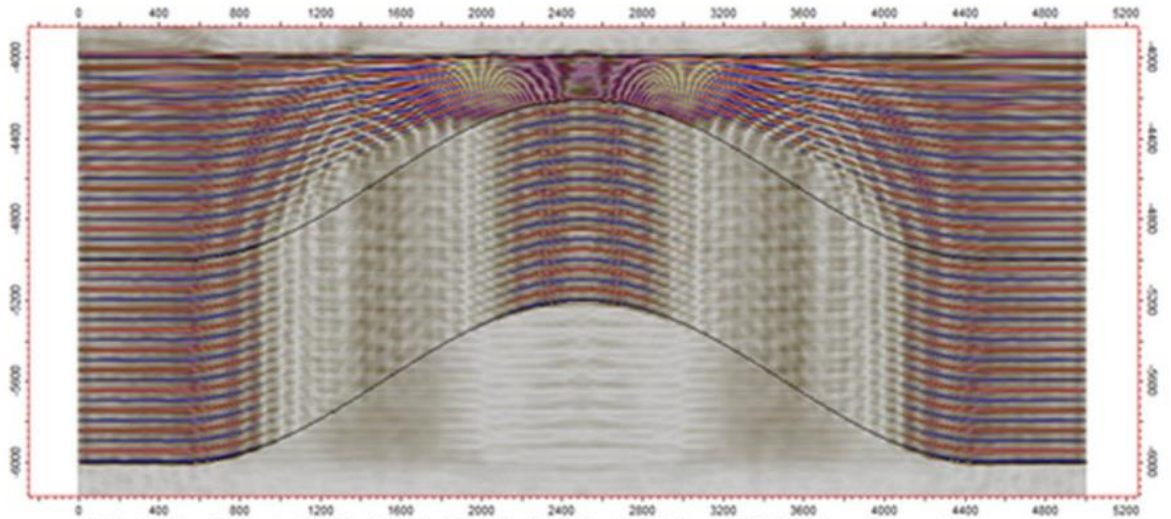
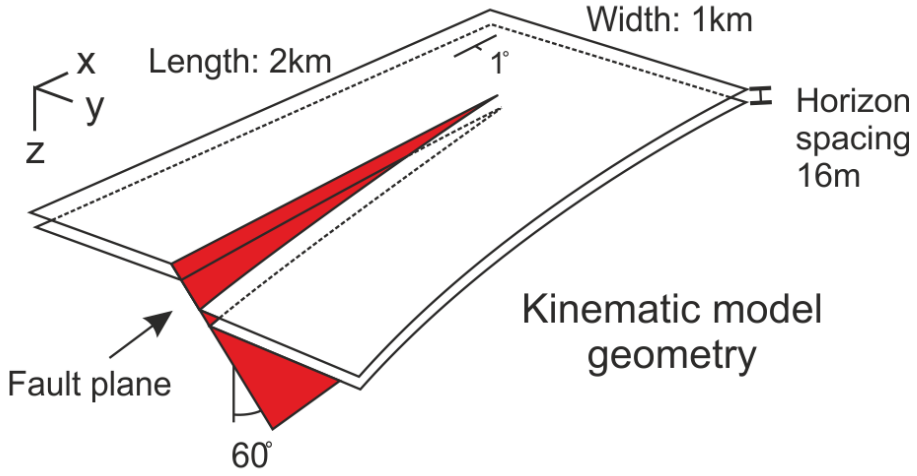


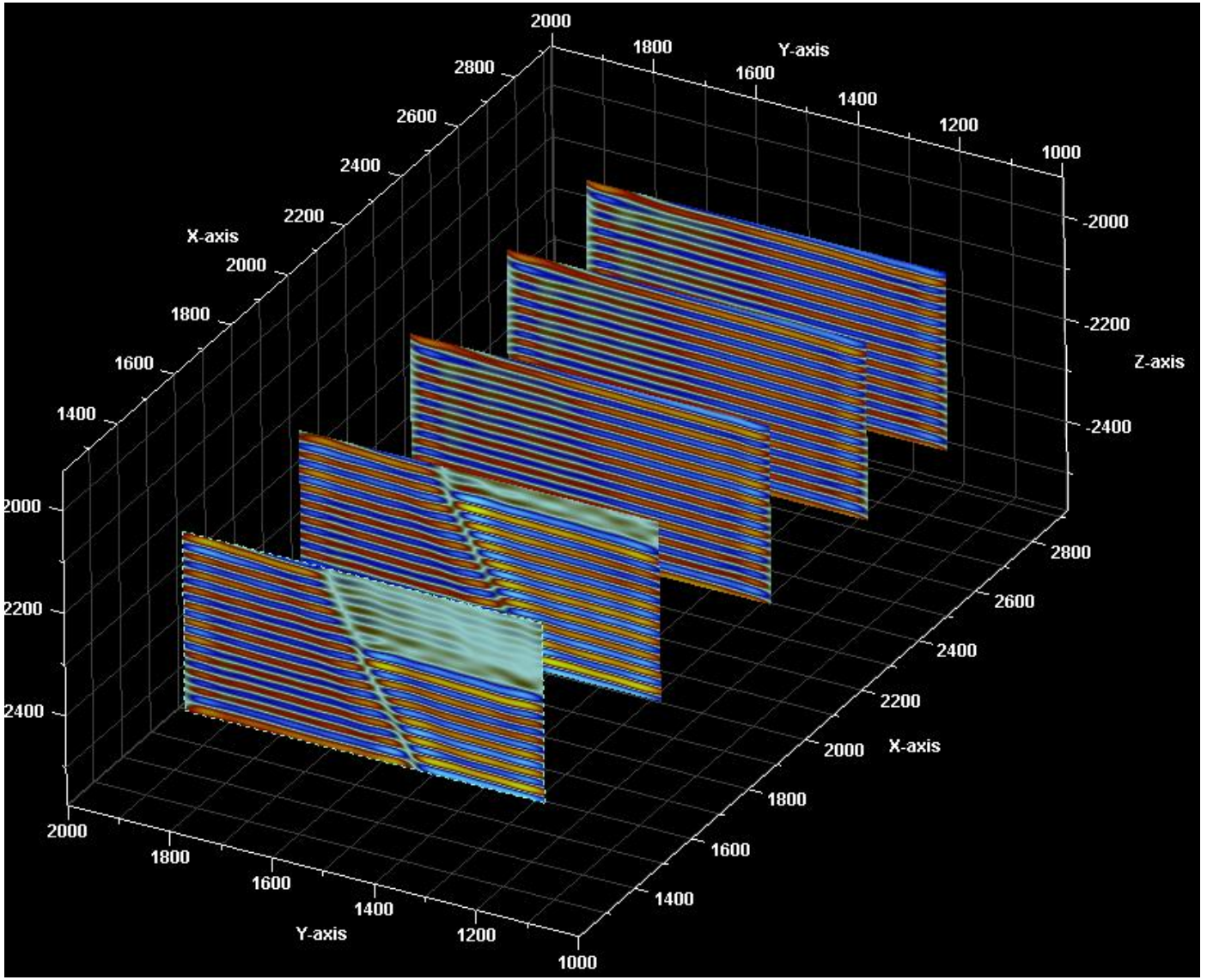


Lack of reflected energy due to illumination of the geometry

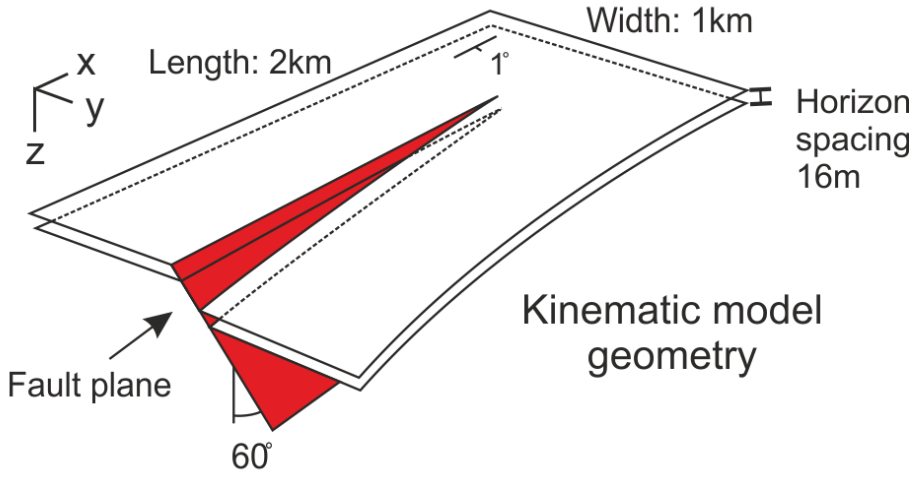
Fault identification



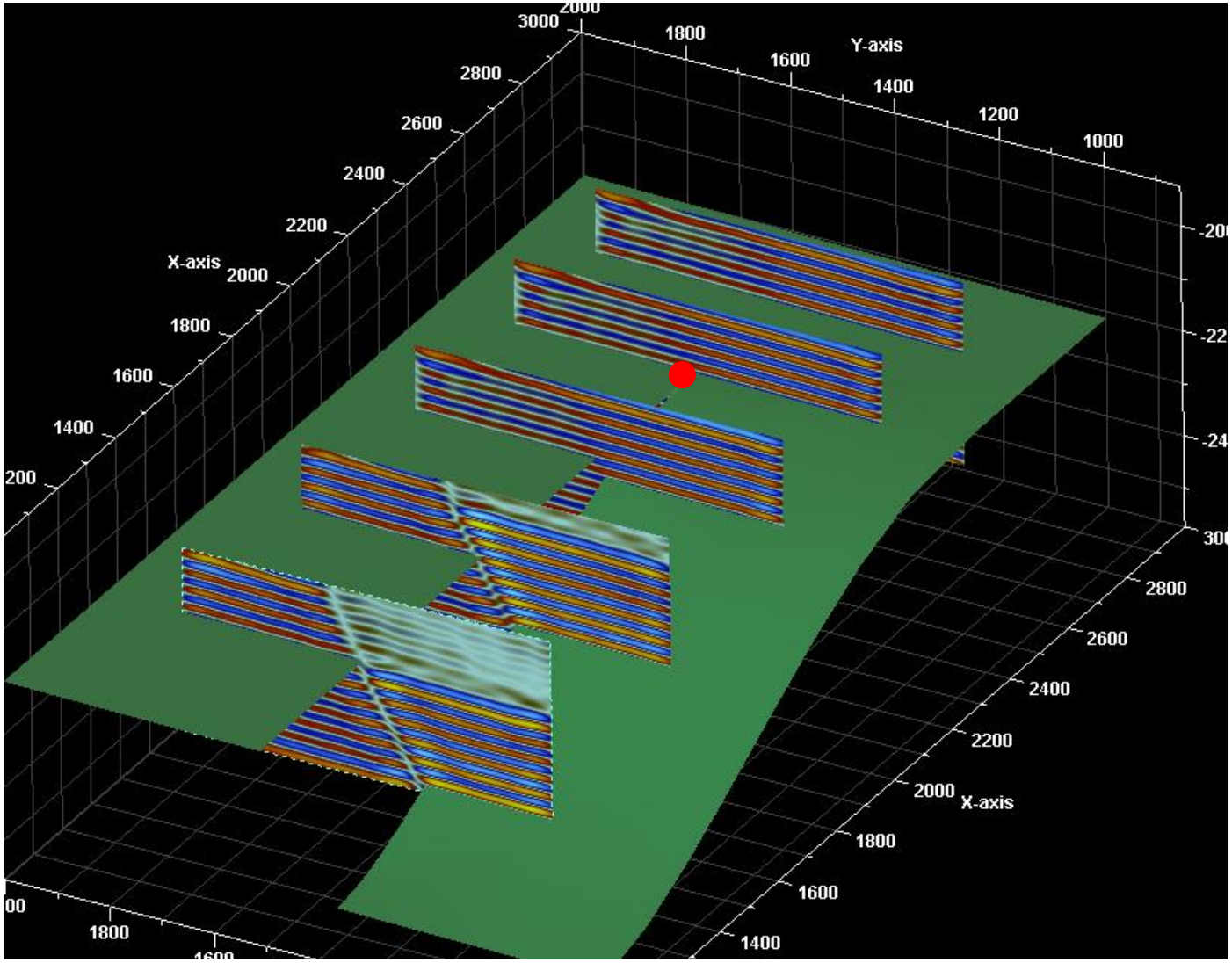
Where is the fault tip?



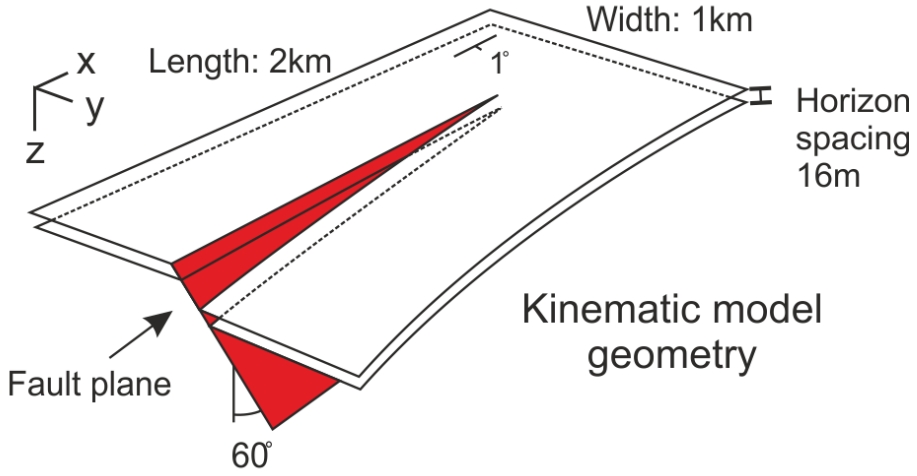
Fault identification

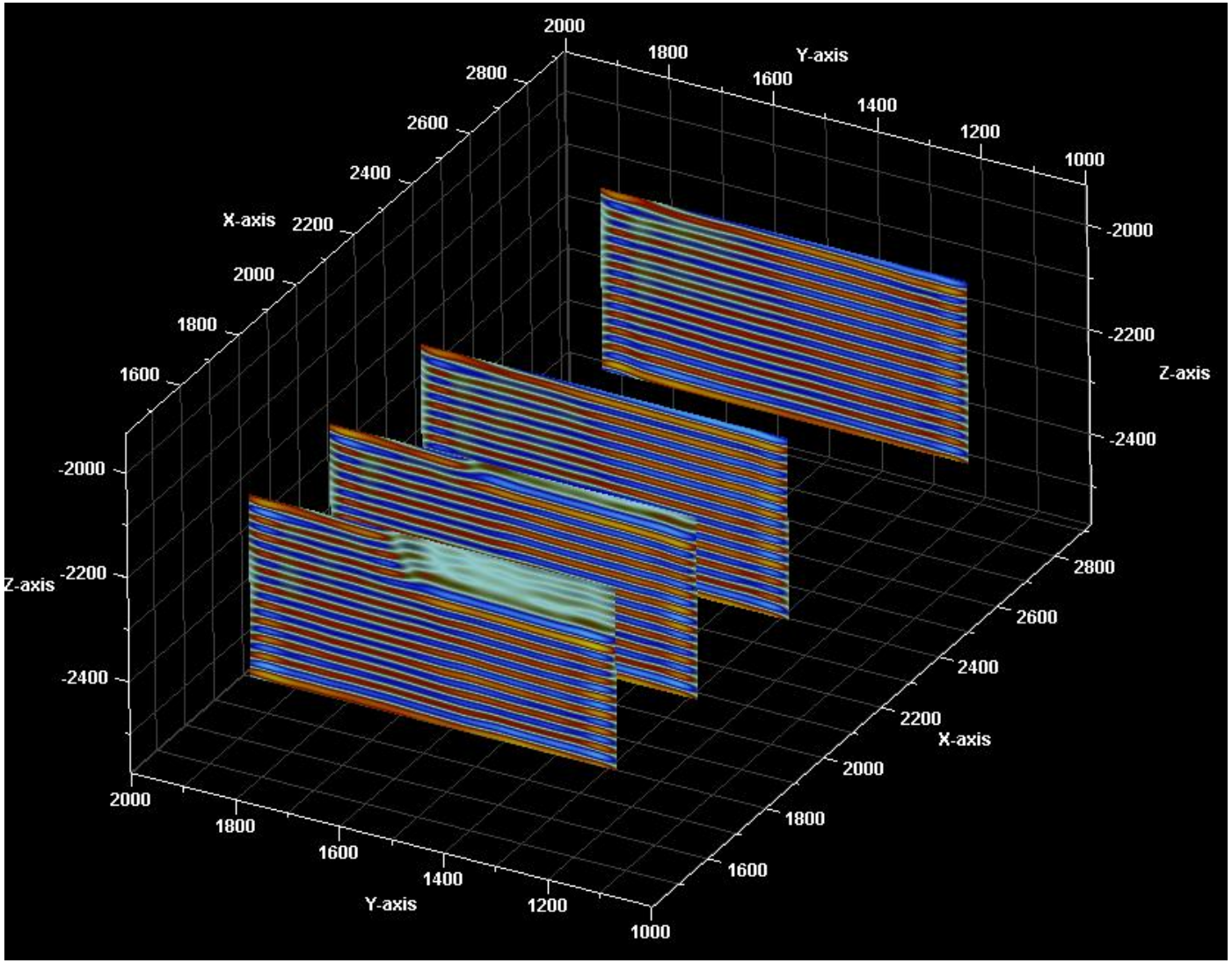


Where is the fault tip?



Fault identification

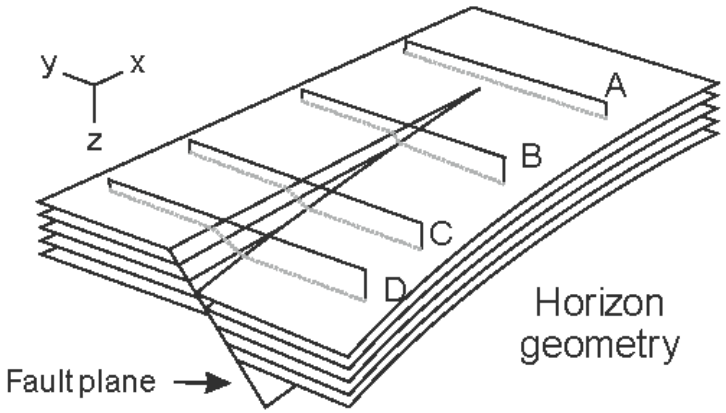




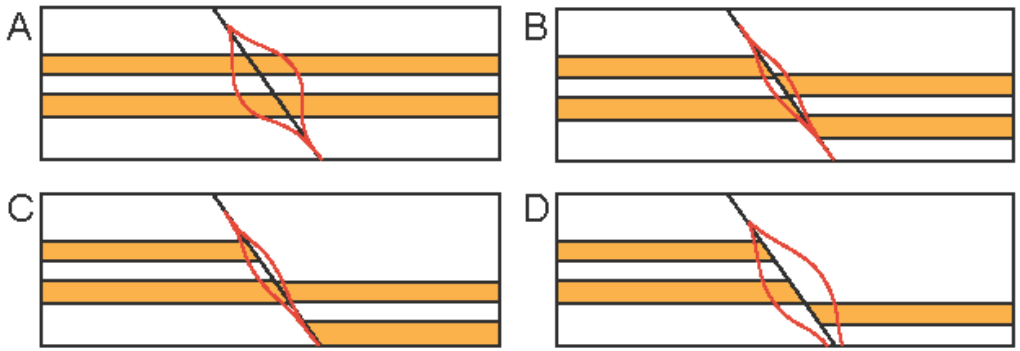
Where is the fault tip?

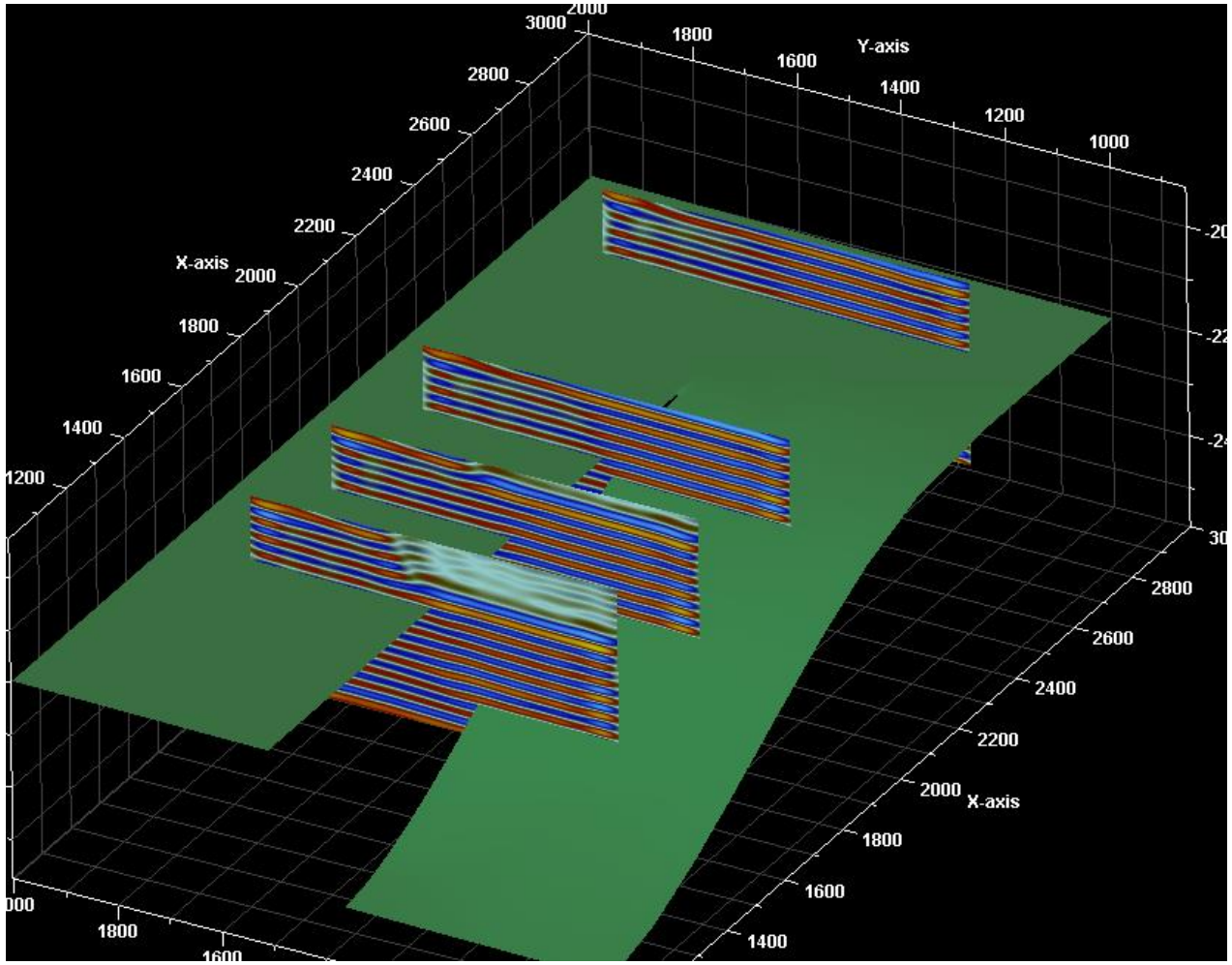
Identical input model

Fault identification

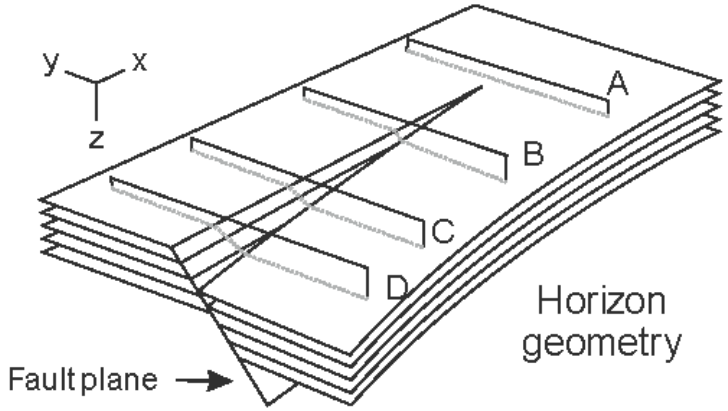


Uncertainty envelope

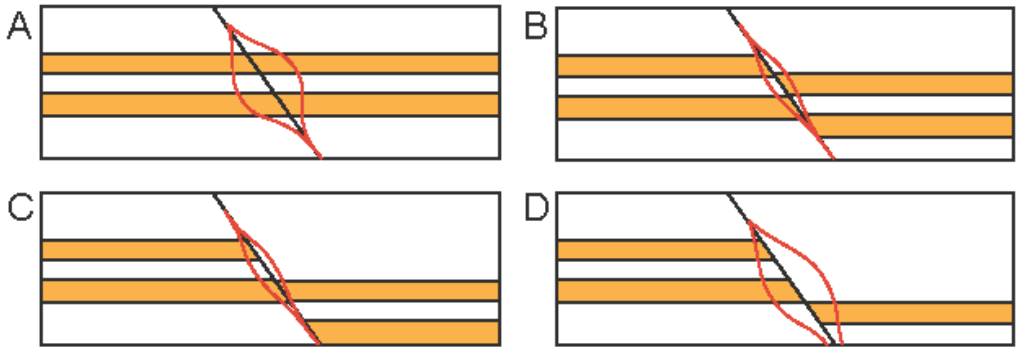




Concluding remarks



Uncertainty envelope



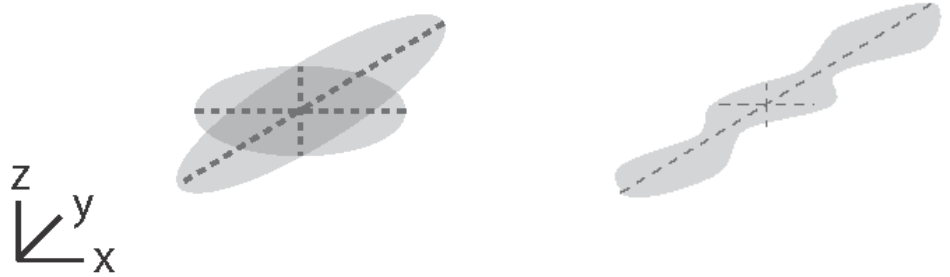
- Fault uncertainty envelopes should be irregular
- Along-fault seismic response is irregular

(without facies, fluids or fault segmentation)

Fault uncertainty envelopes:

Conventional

More realistic?



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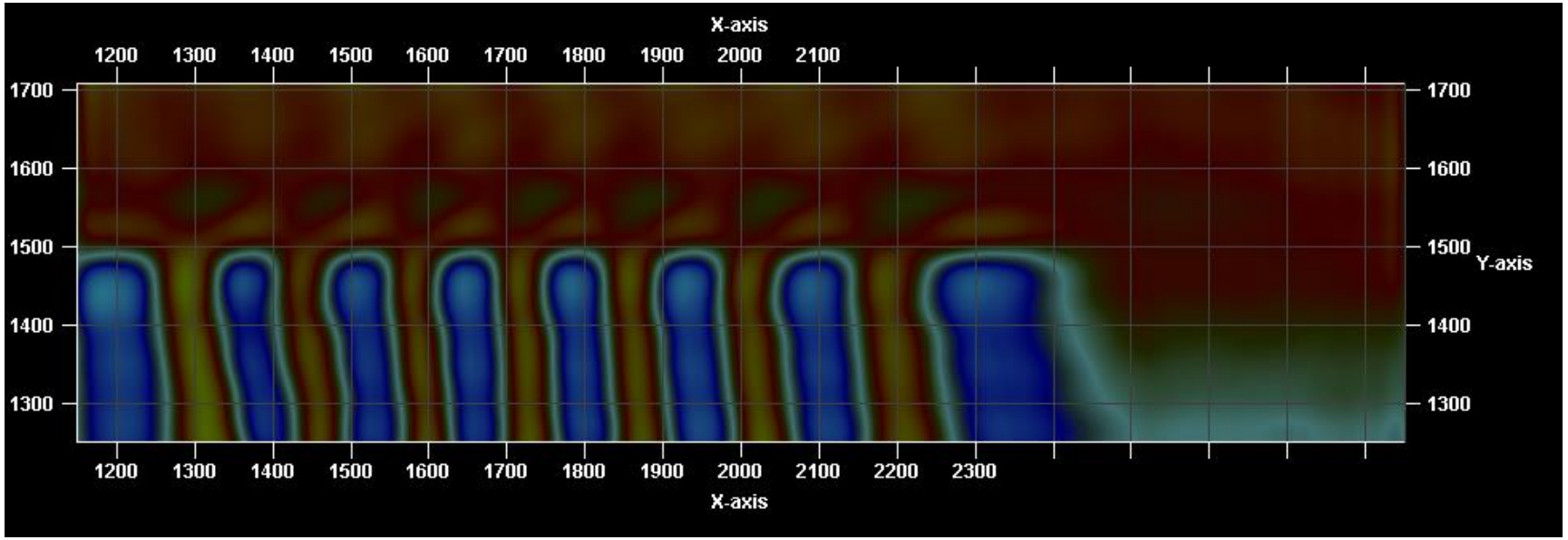
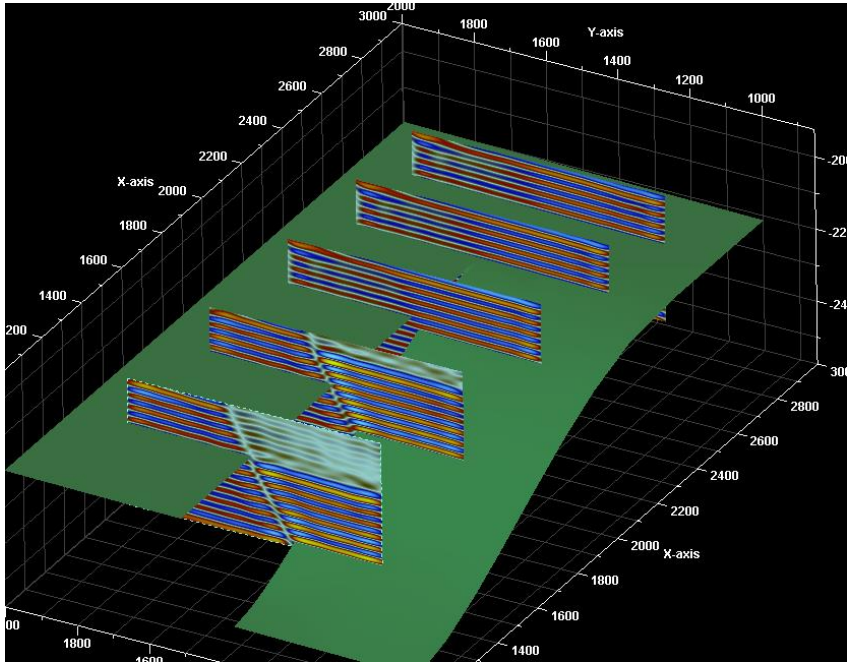
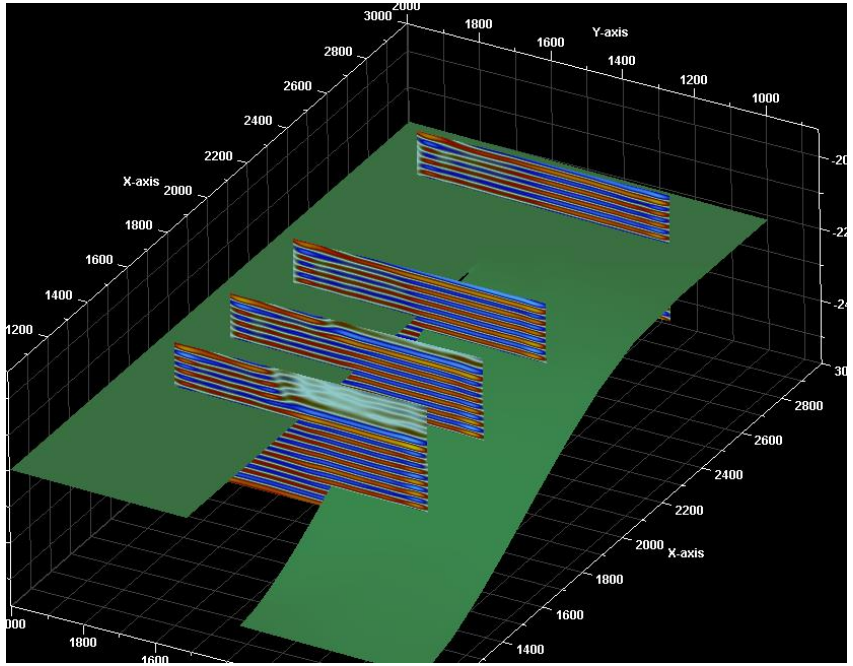

X-axis
1200 1300 1400 1500 1600 1700 1800 1900 2000 2100
1700
1600
1500
1400
1300
Y-axis
1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300
X-axis


Y-axis
X-axis


Y-axis
X-axis

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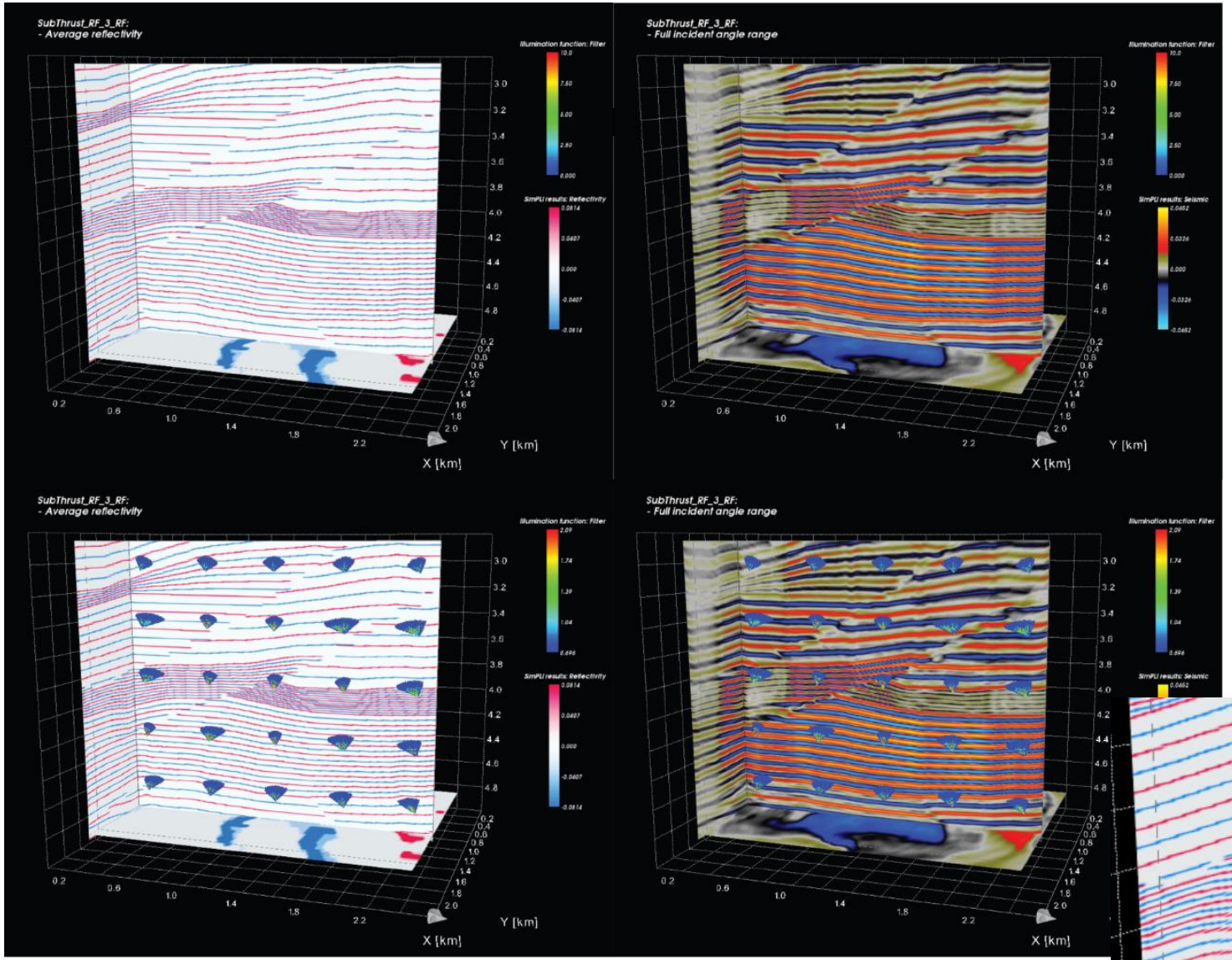
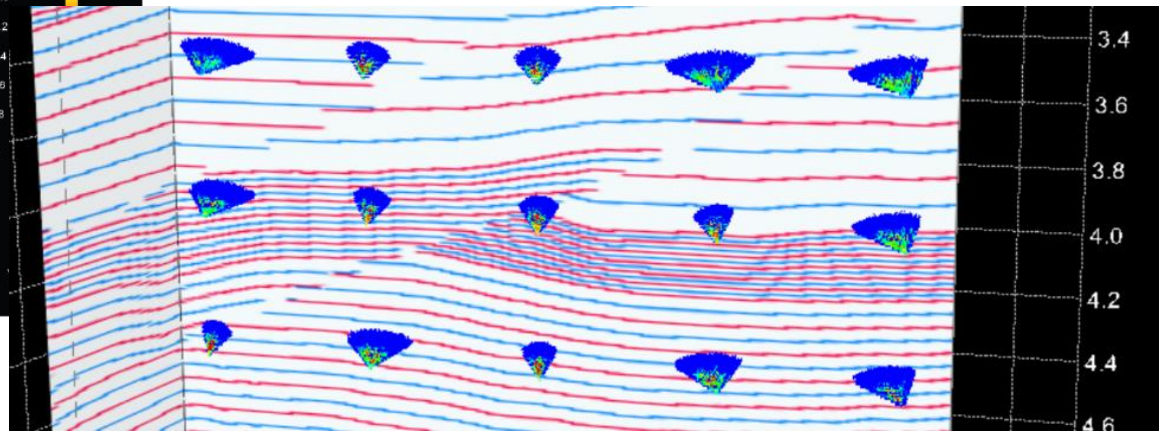
Reflectivity **Seismic**

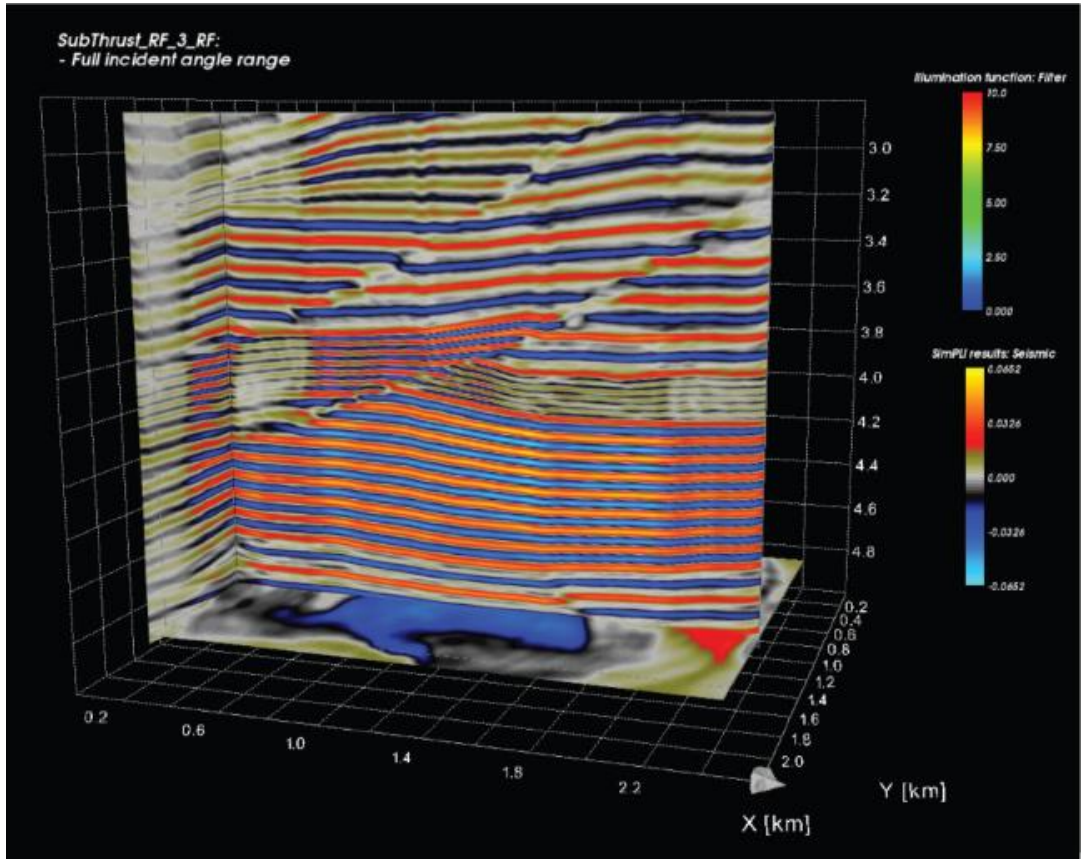


Illumination functions illustrate the distribution of incident energy.

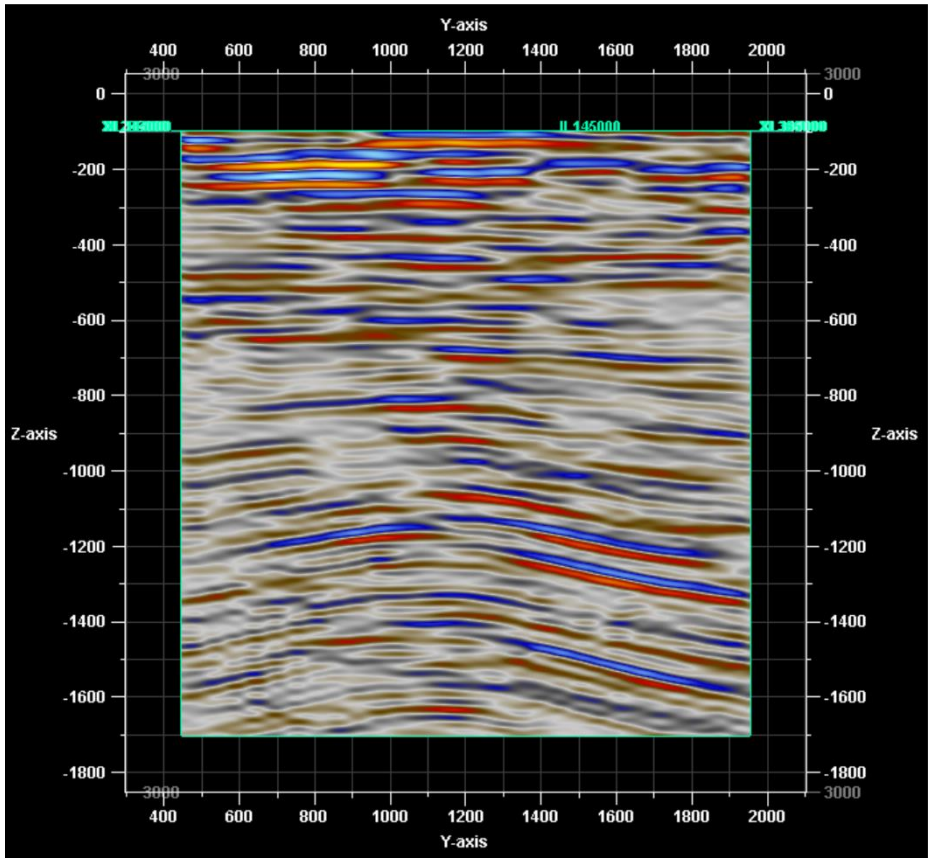
Horizons orthogonal to these are to be optimally oriented for illumination.



Structural versus stratigraphic control



No facies variation



Solely facies variation

Abstract

Quantifying uncertainty in seismic interpretation is typically achieved through stochastic modelling. Propagating expected variability in structural geometry through the seismic processing and interpretation workflows considers inherent errors however fails to constrain uncertainty in the interpretation.

Misinterpretation may occur when practitioners make a categorical decision adjusting the assumptions applied during interpretation. Applying different a priori knowledge this may lead the interpreter to apply inappropriate base values during stochastic modelling.

Modelling the seismic reflection response of alternate interpretation cases provides new insight into interpretation uncertainty. Furthermore it provides the initial steps of quantifying interpretation uncertainty.

Understanding the illumination, resolution and detectability of data constrains the variation of interpretation uncertainty in space. Combining knowledge of this spatial variation with basic logic of interpretation provides a means to greatly improve our potential to conceive and consider alternate models.

Oral session – 12 min + 3 min questions

Thursday, 12 Apr 2018, 10:45–11:00 Room -2.31

TS11.5/GD10.5: Understanding the unknowns: recognition, quantification, influence and minimisation of uncertainty in the geosciences (co-organized)