Duvernay Formation reservoir characterization; the use of structure, stratigraphy, and inversion

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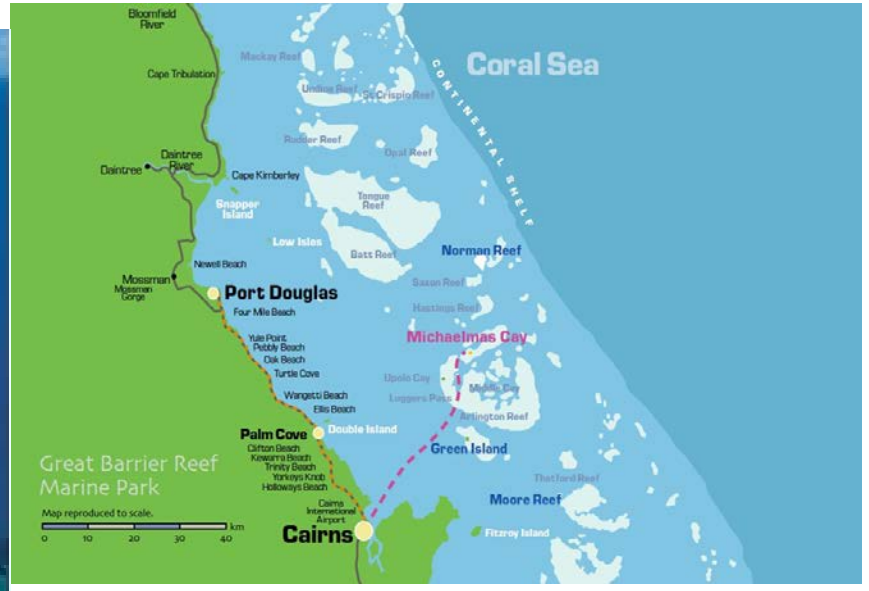
Duvernay Formation

- Depositional system
- Tectonic (post depositional events)
- Observed microseismicity
- Simultaneous inversion
- Combined interpretation

What data do we have?

- Outcrops
  - How does what we observed in outcrops match the seismic interpretation
- Modern analogues
  - How do modern environments match the subsurface interpretation (geologic model)
- Well logs
- 3-D/3-C recorded data
- Microseismic

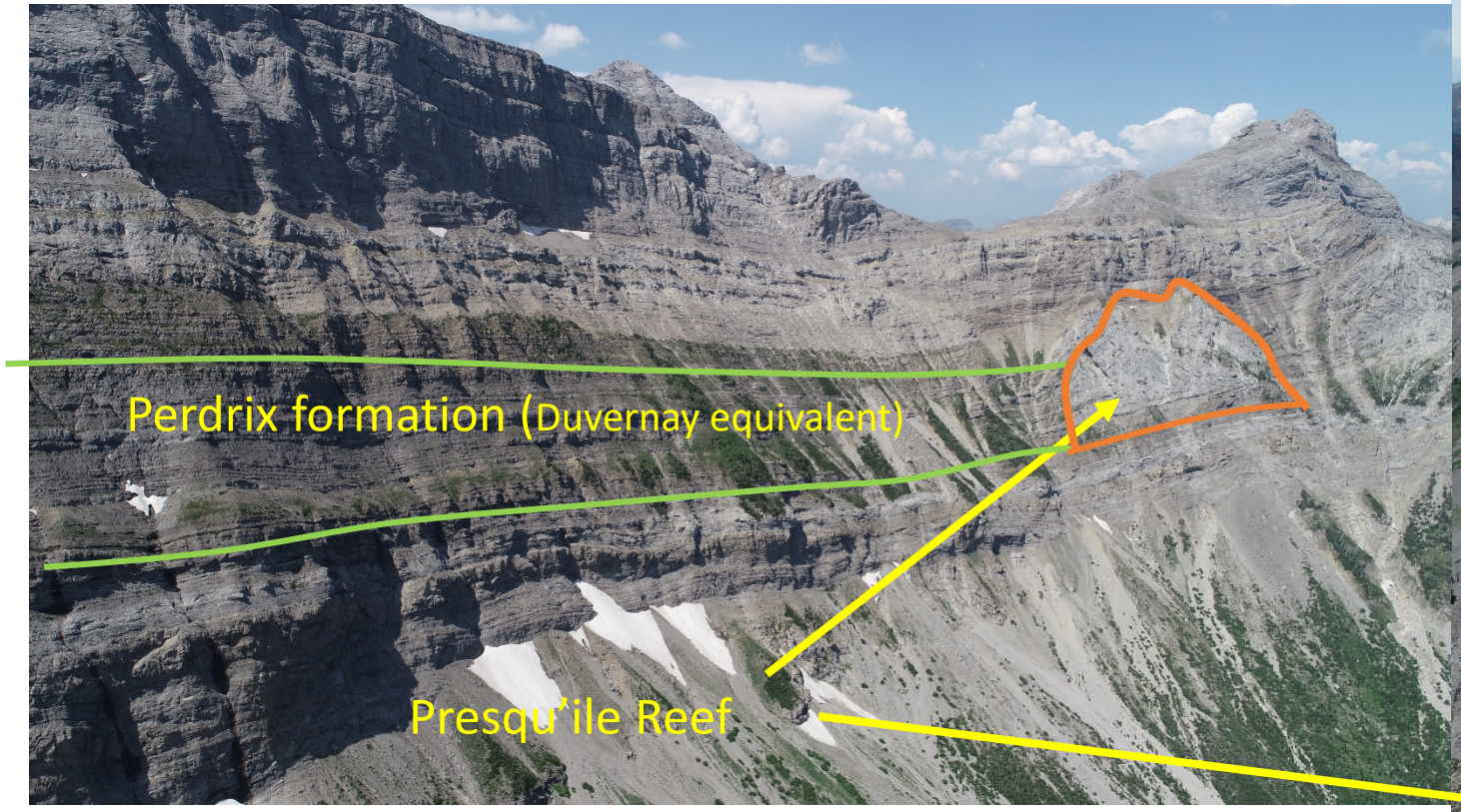
Great Barrier Reef modern analog

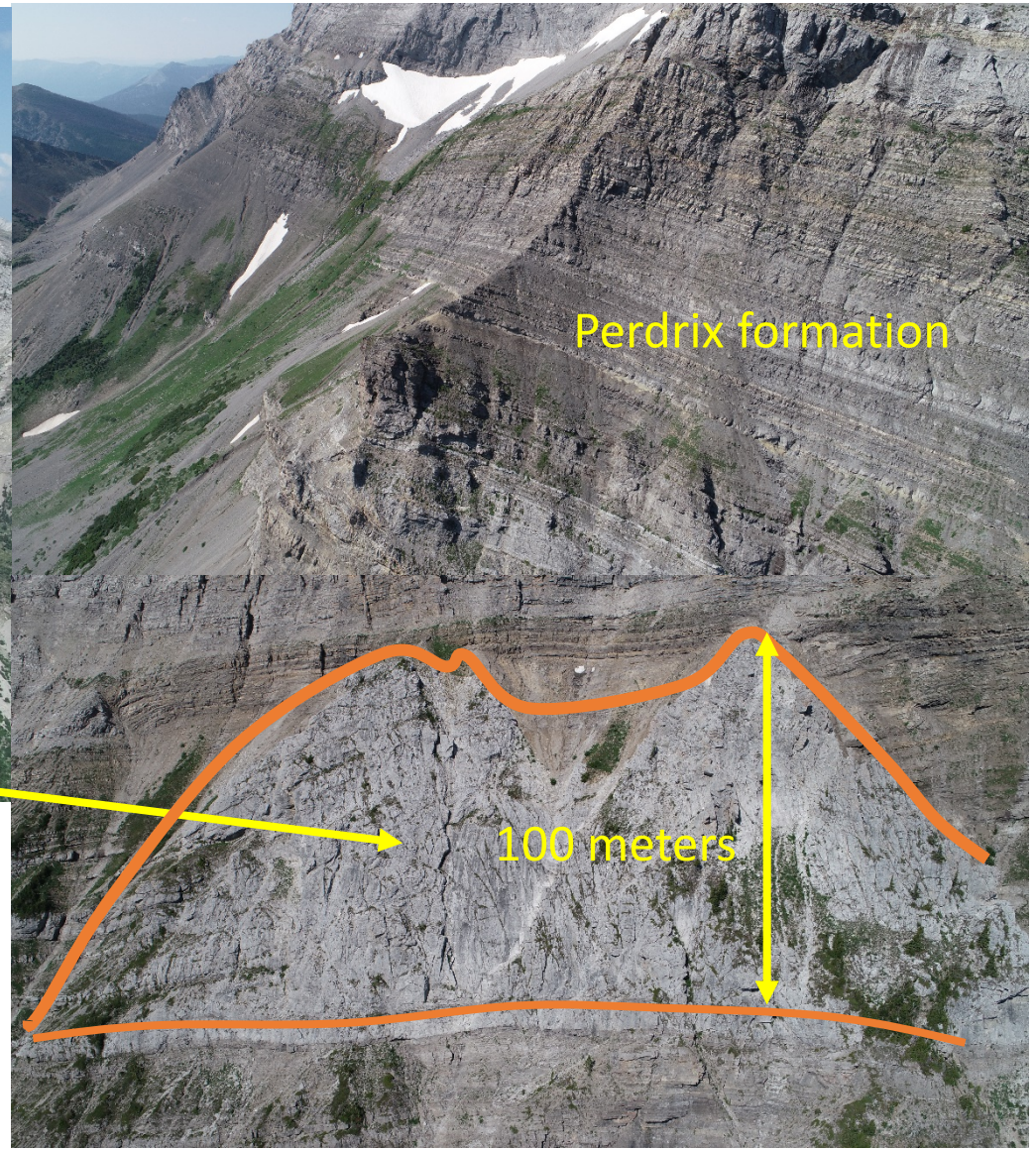


Outcrops, Presqu'ile Formation

These photos are of the Presqu'ile Formation (Leduc equivalent) , and the Perdrix Formation (Duvernay Equivalent). The Perdrix outcrop is in the same order of thickness as in the study area.

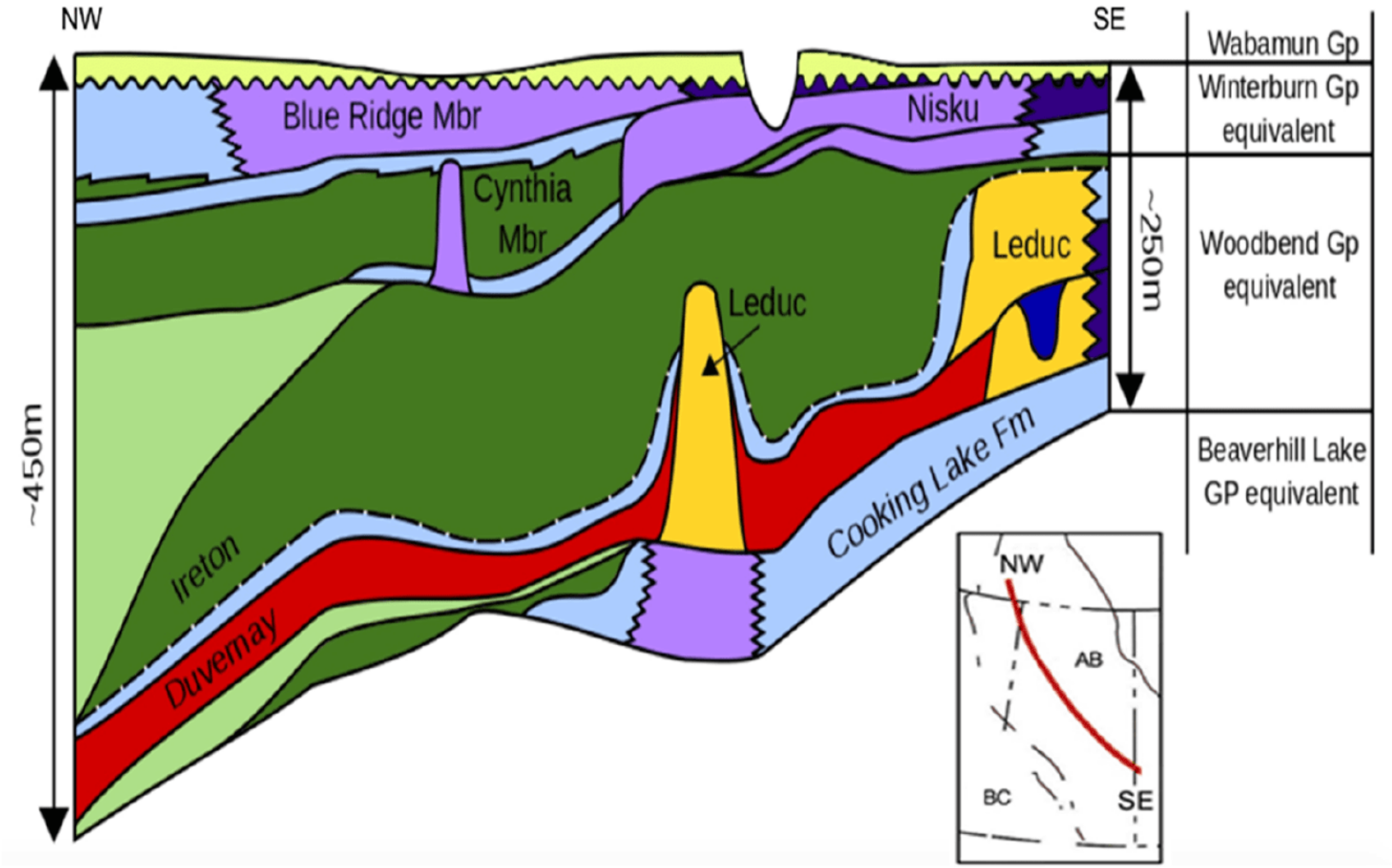
Outcrops, correlated

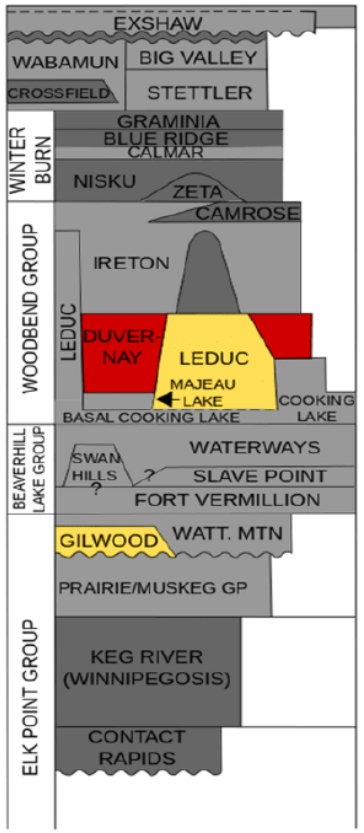




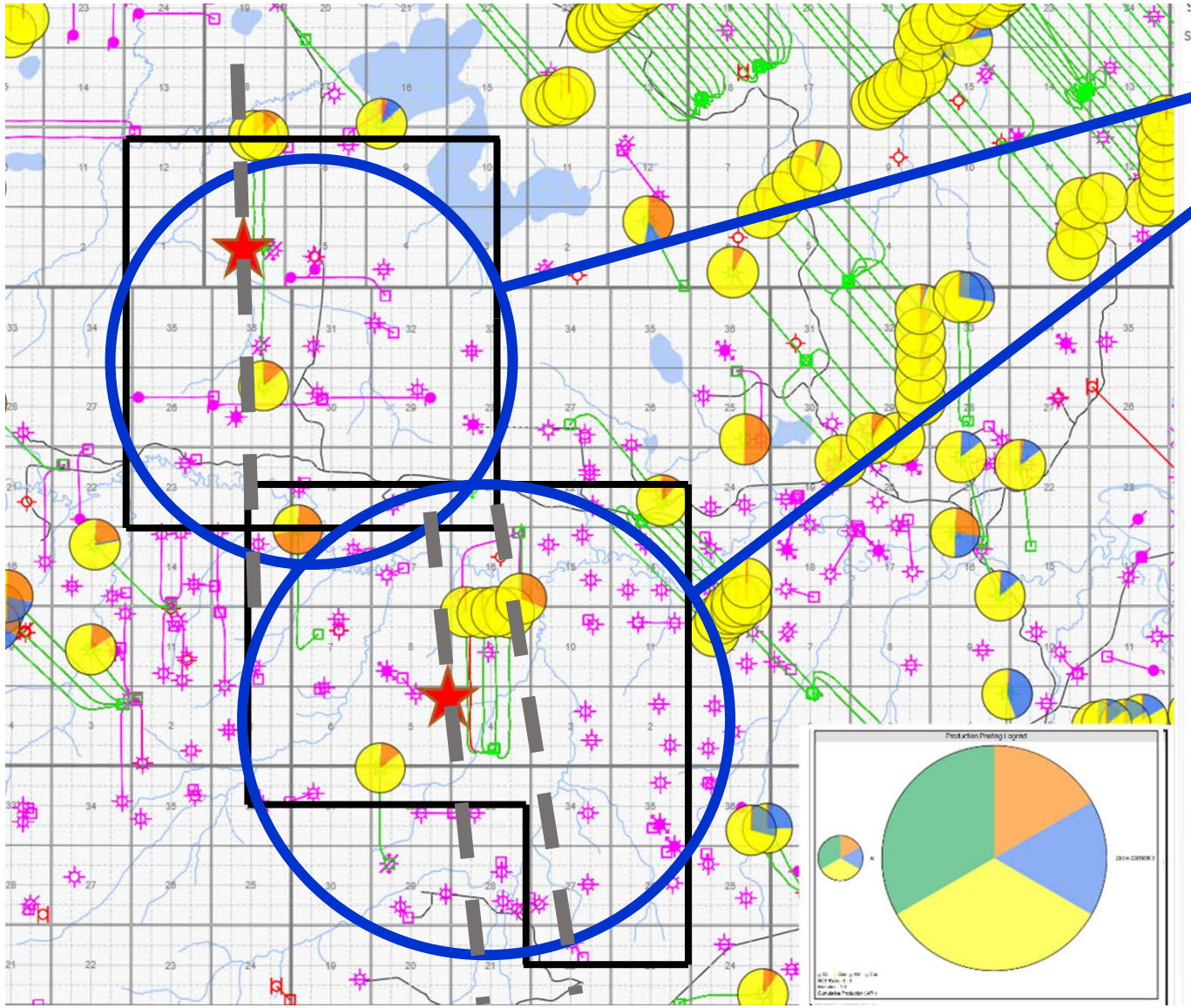
These photos are of the Presqu'ile Formation (Leduc equivalent) , and the Perdrix Formation (Duvernay Equivalent). The Perdrix outcrop is in the same order of thickness as in the study area.

Schematic cross section





Dry gas --|-- Condensate---|----Oil---------(based on depth)



Approximate microseismic array outlines

Approximate 3-D/3-C outlines

Induced seismic events, ~ Mw 4

Basement faults

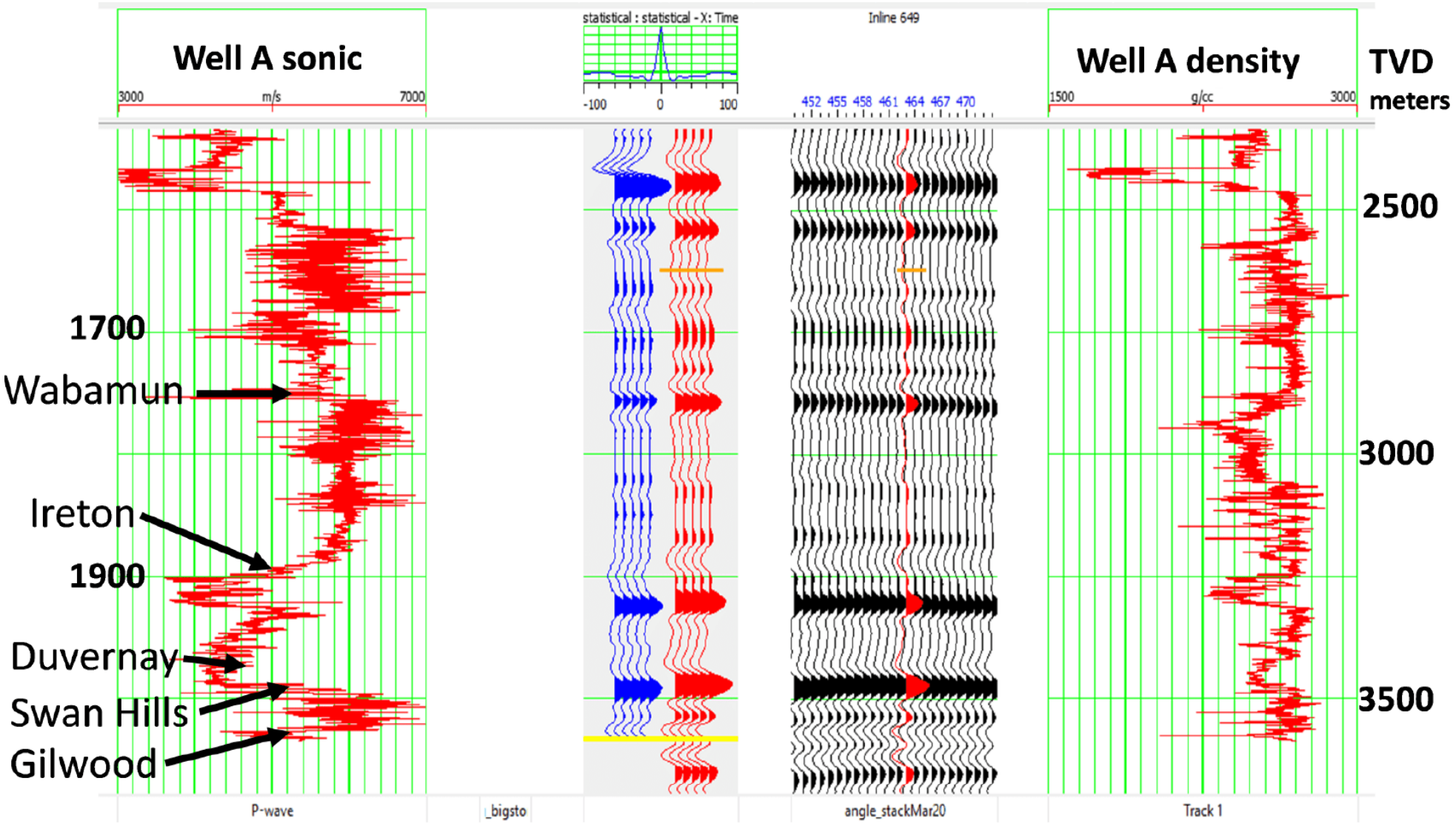
Condensate :

Water :

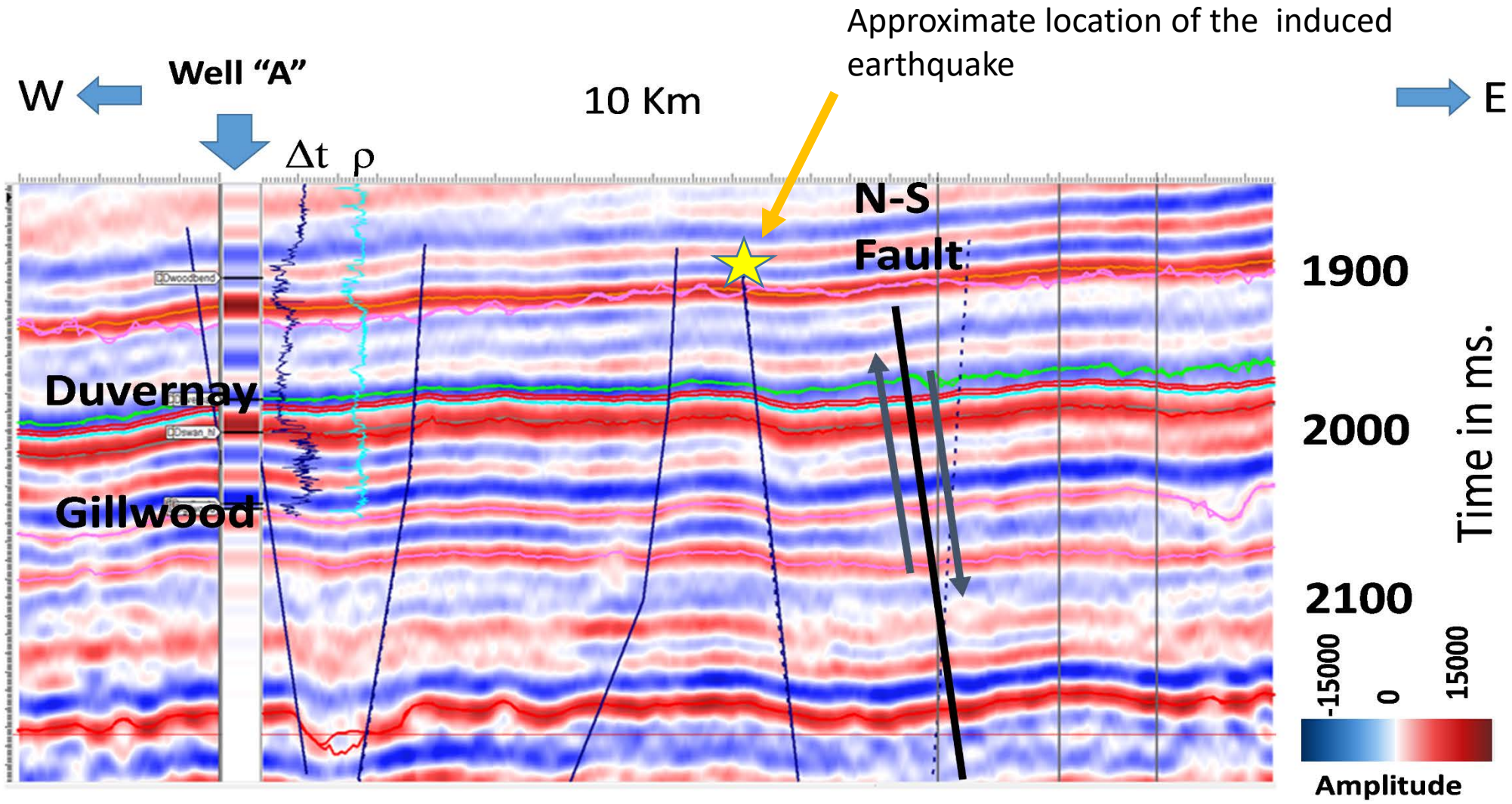
Gas :

Oil :

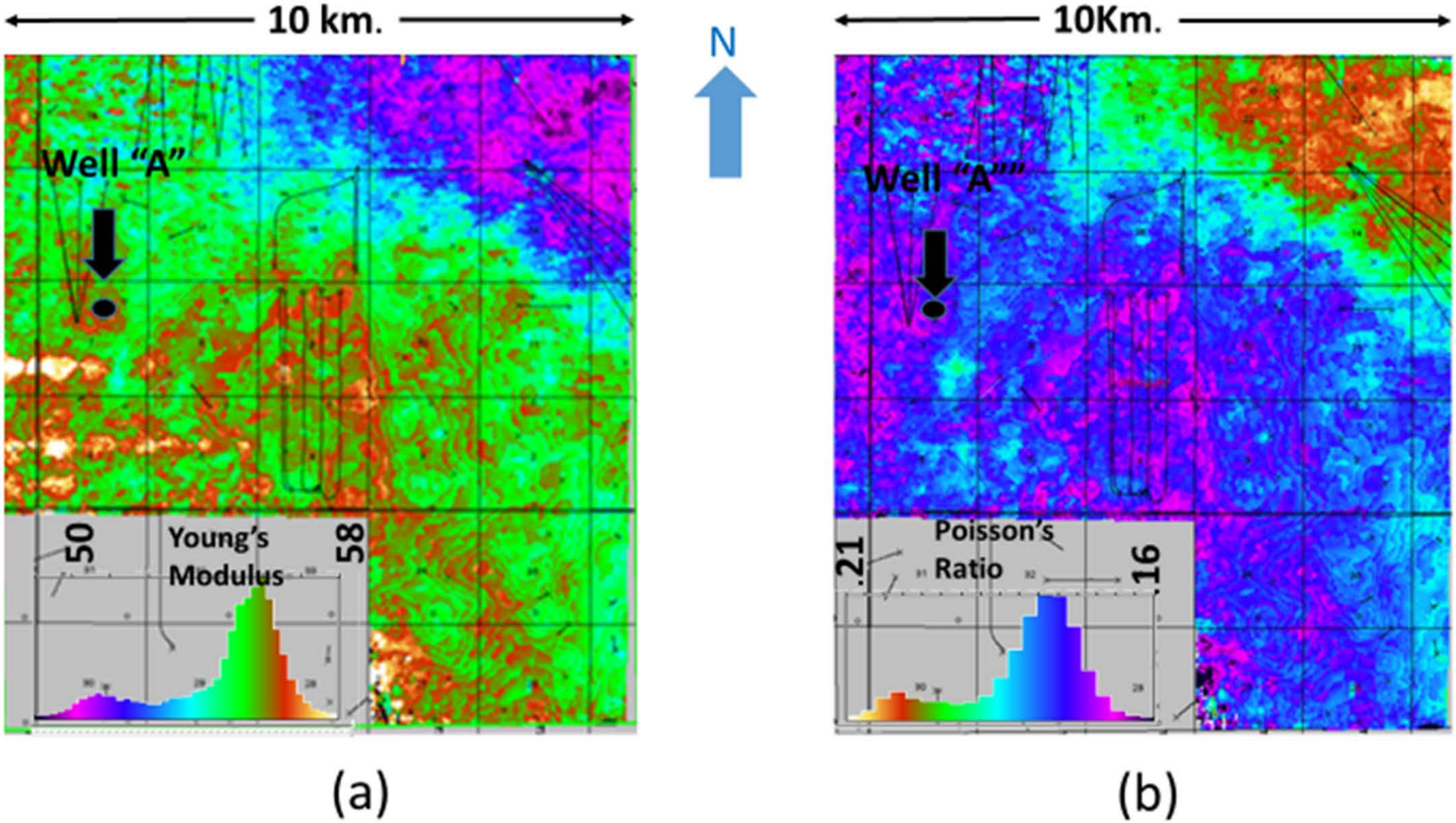
Well logs with synthetic seismogram tie



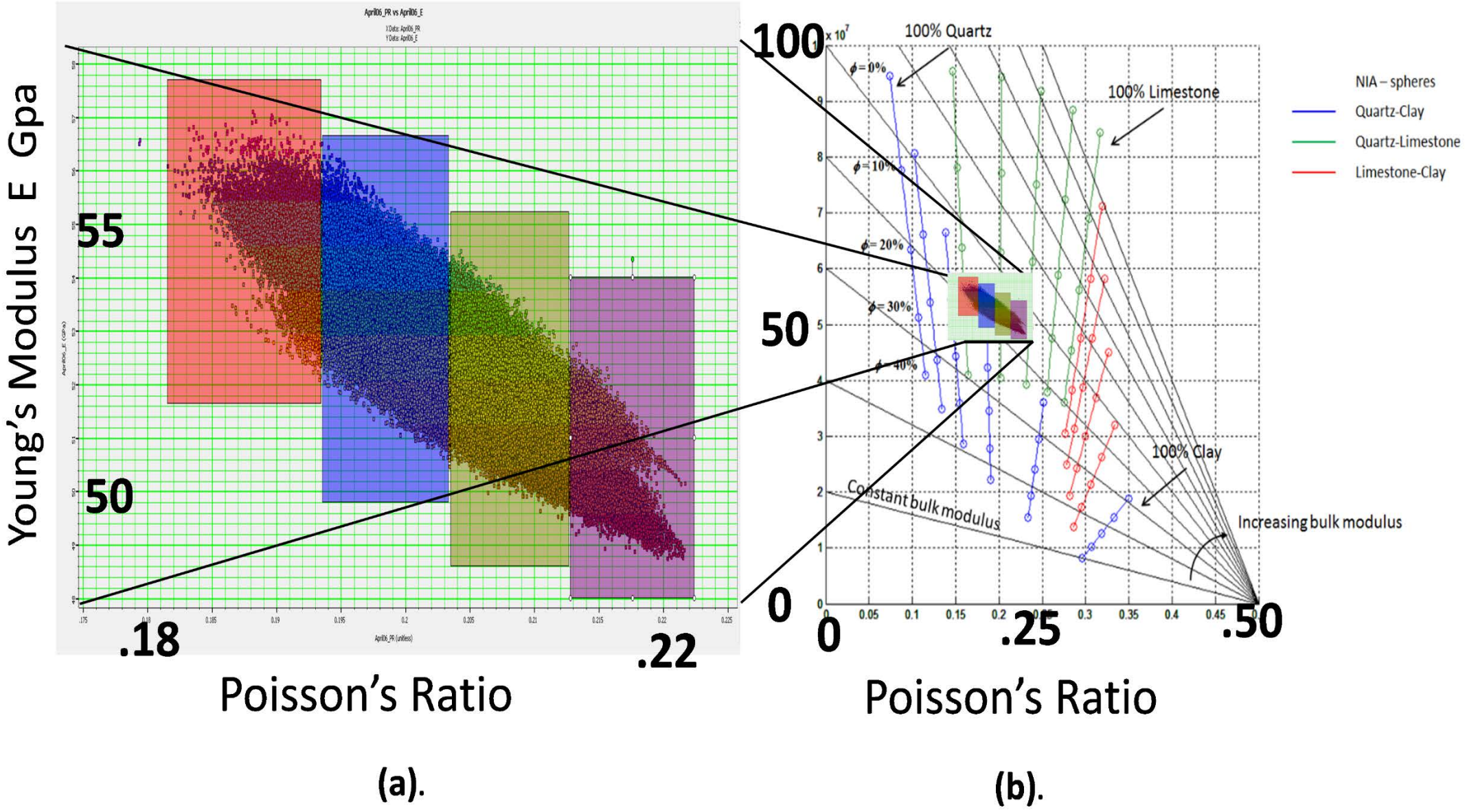
East-West seismic cross section



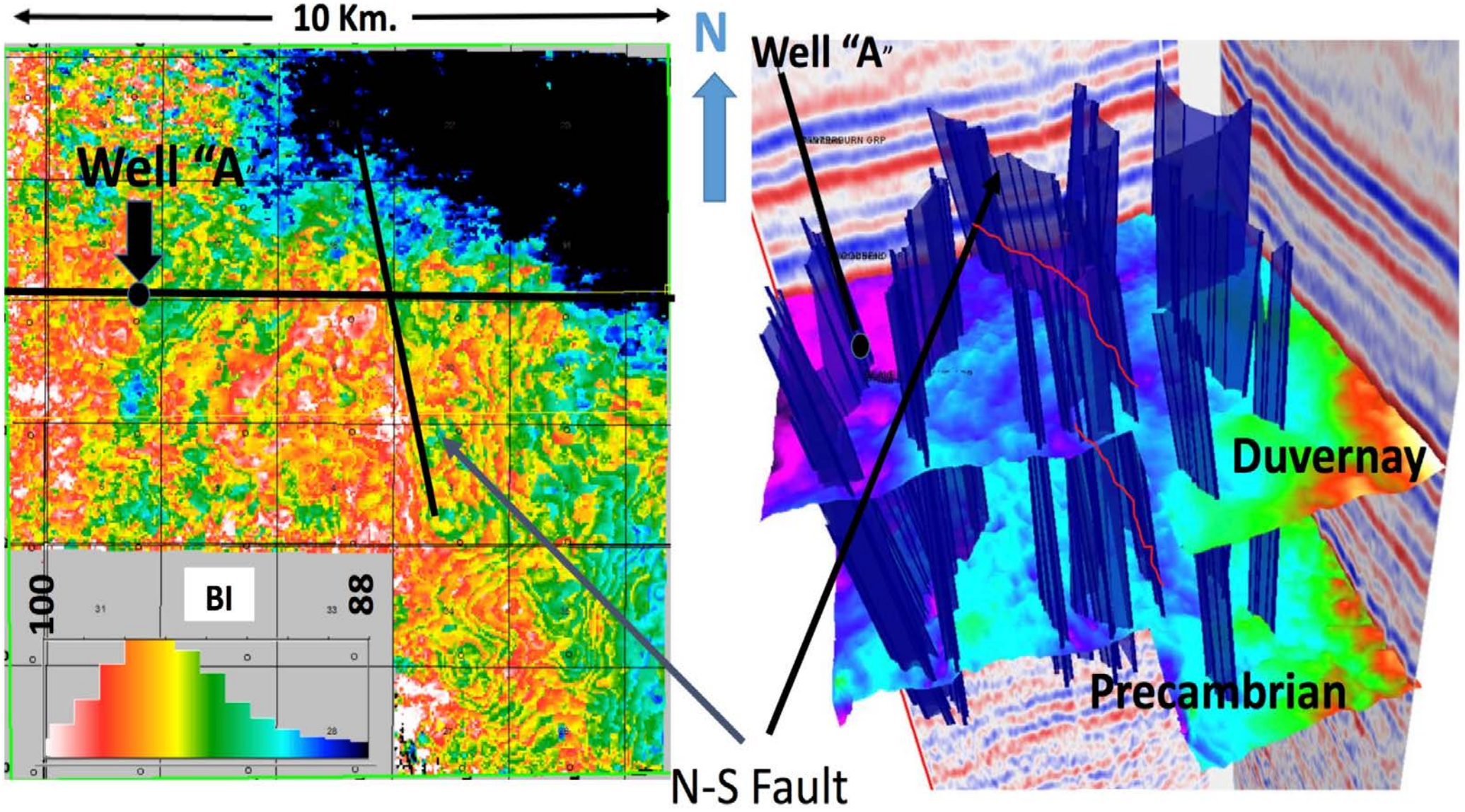
Youngs Modulus, and Poisson Ratio derived from inversion



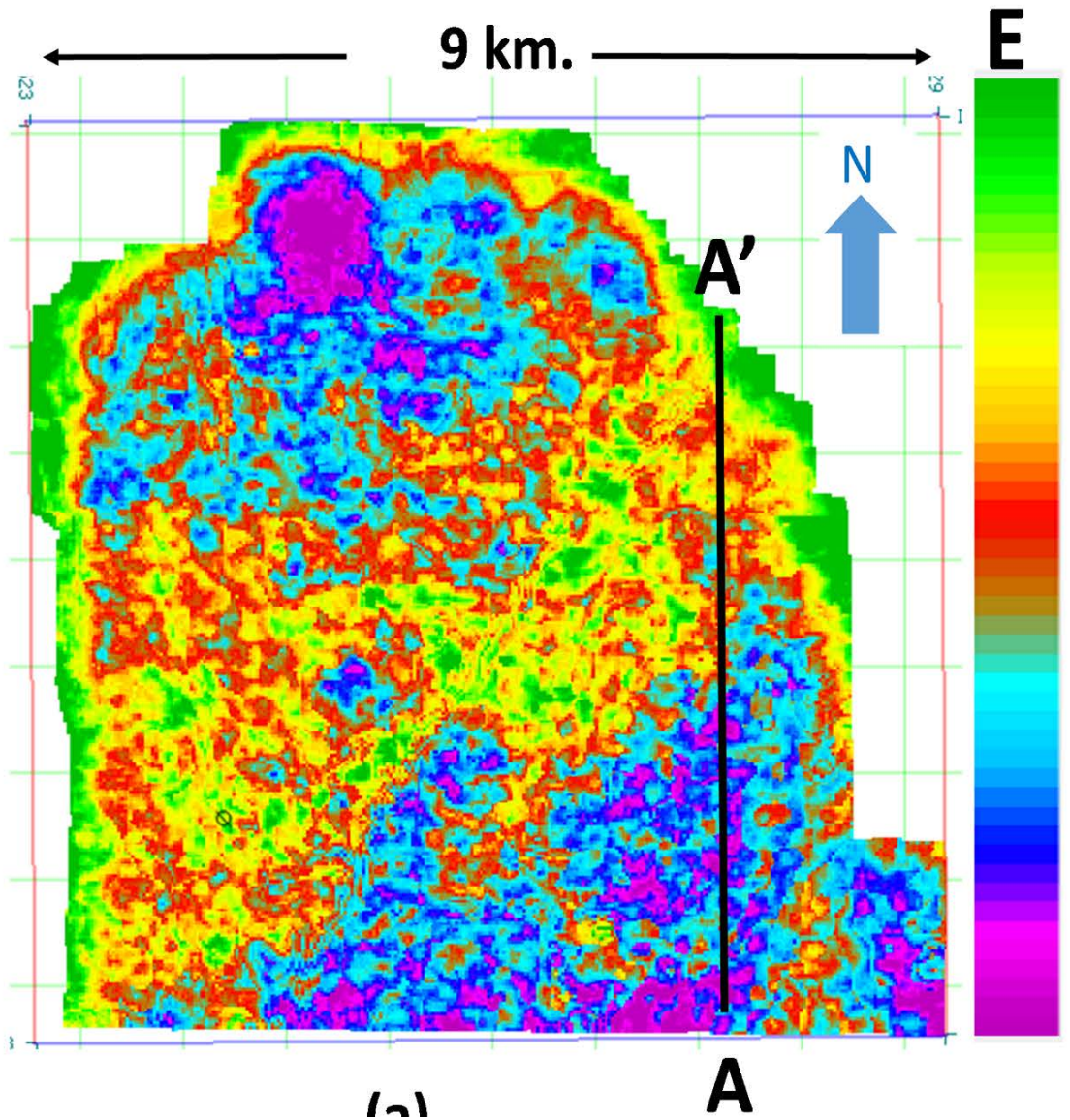
Rock Properties extracted within the Duvernay formation

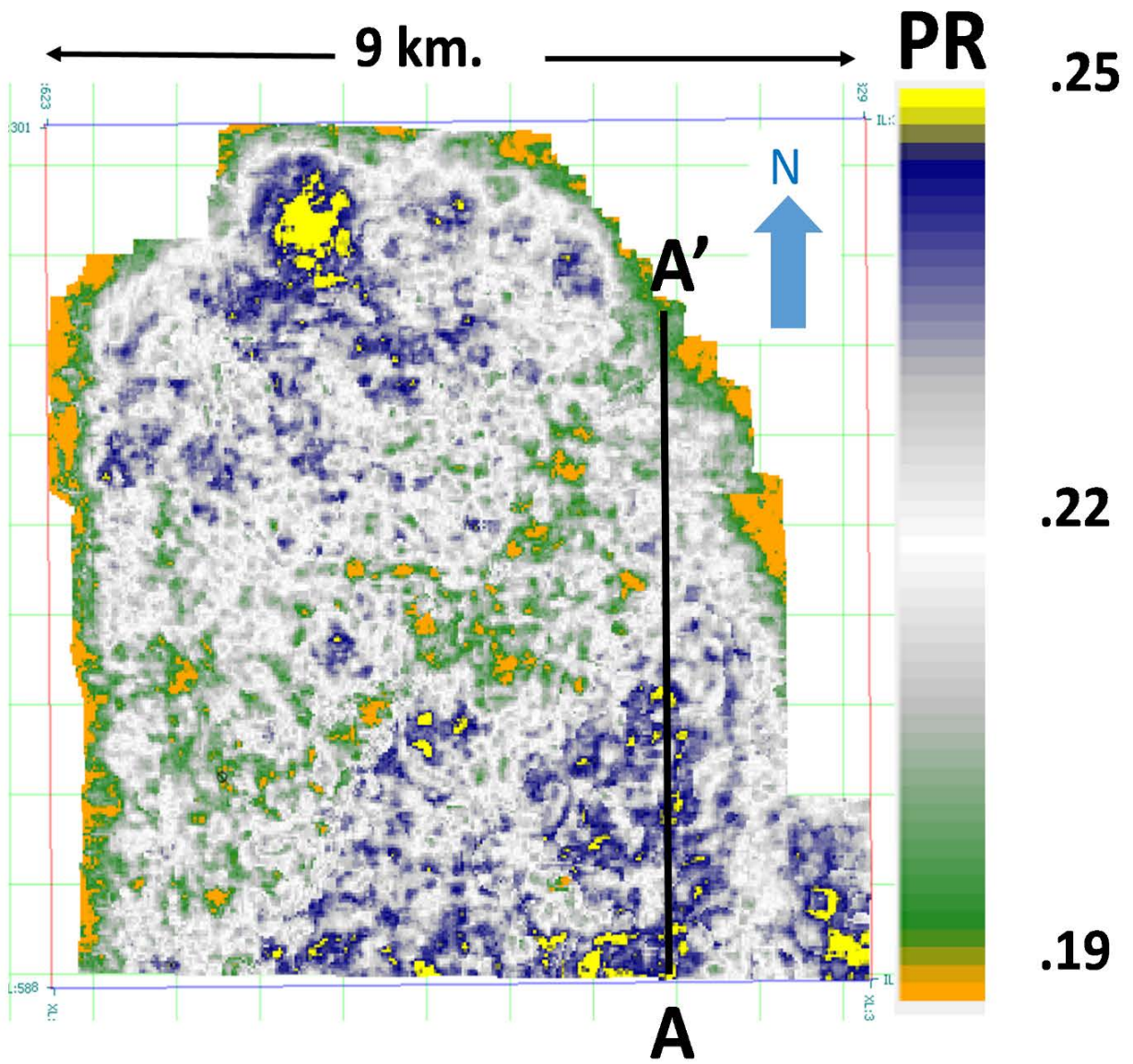


Brittleness, and Duvernay Formation structure

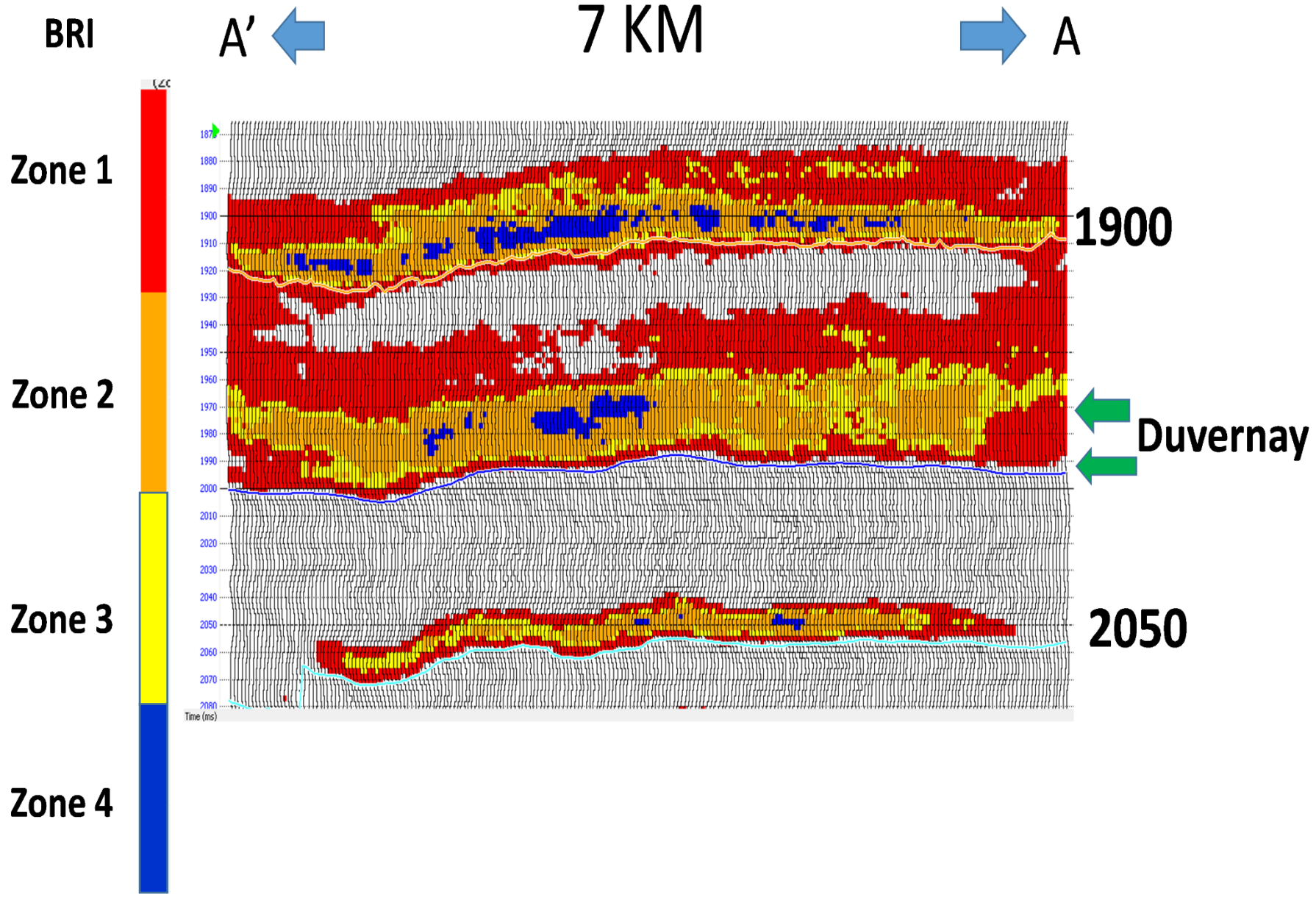


Duvernay Formation Young's Modulus, and Poisson Ratio

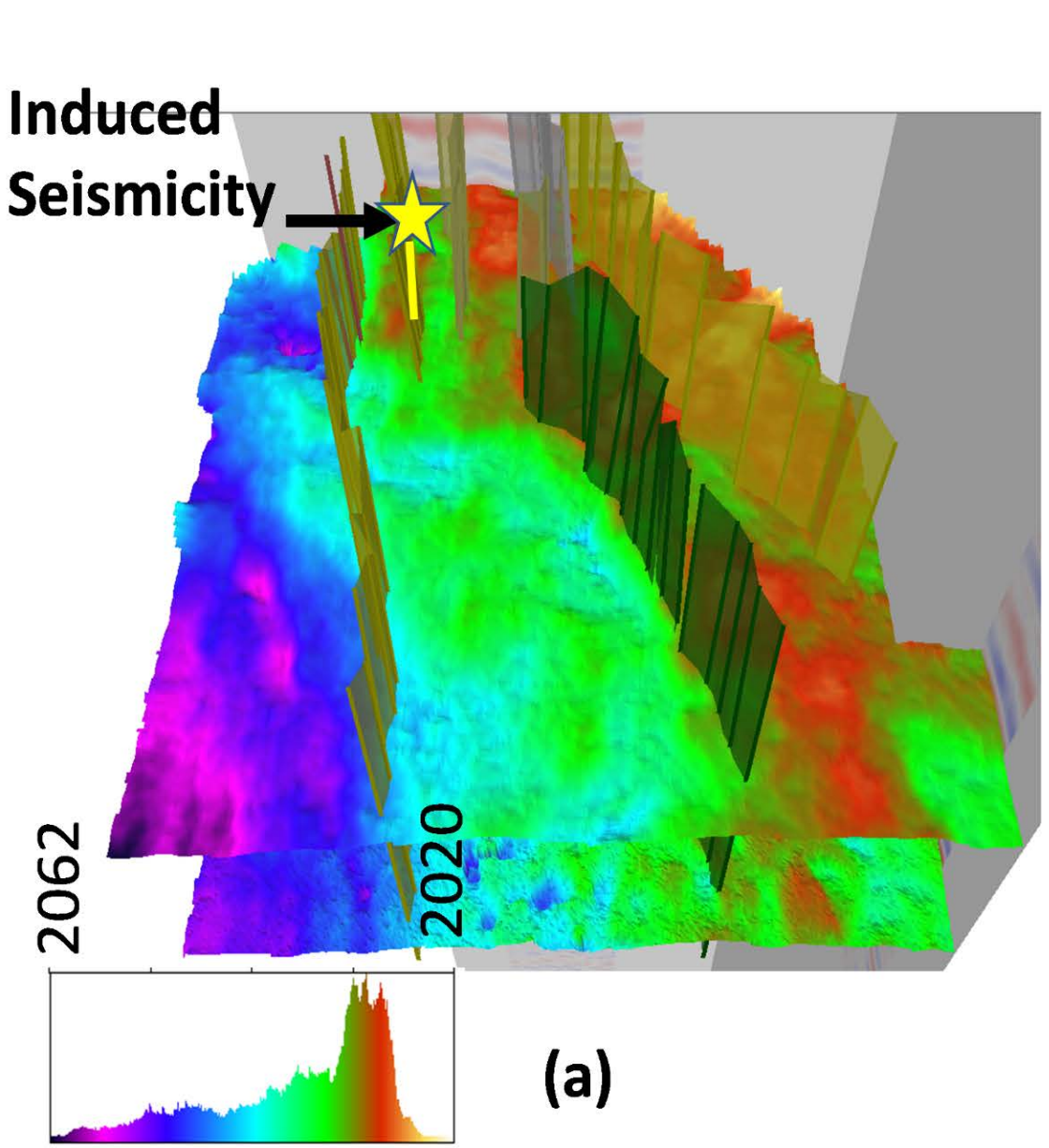


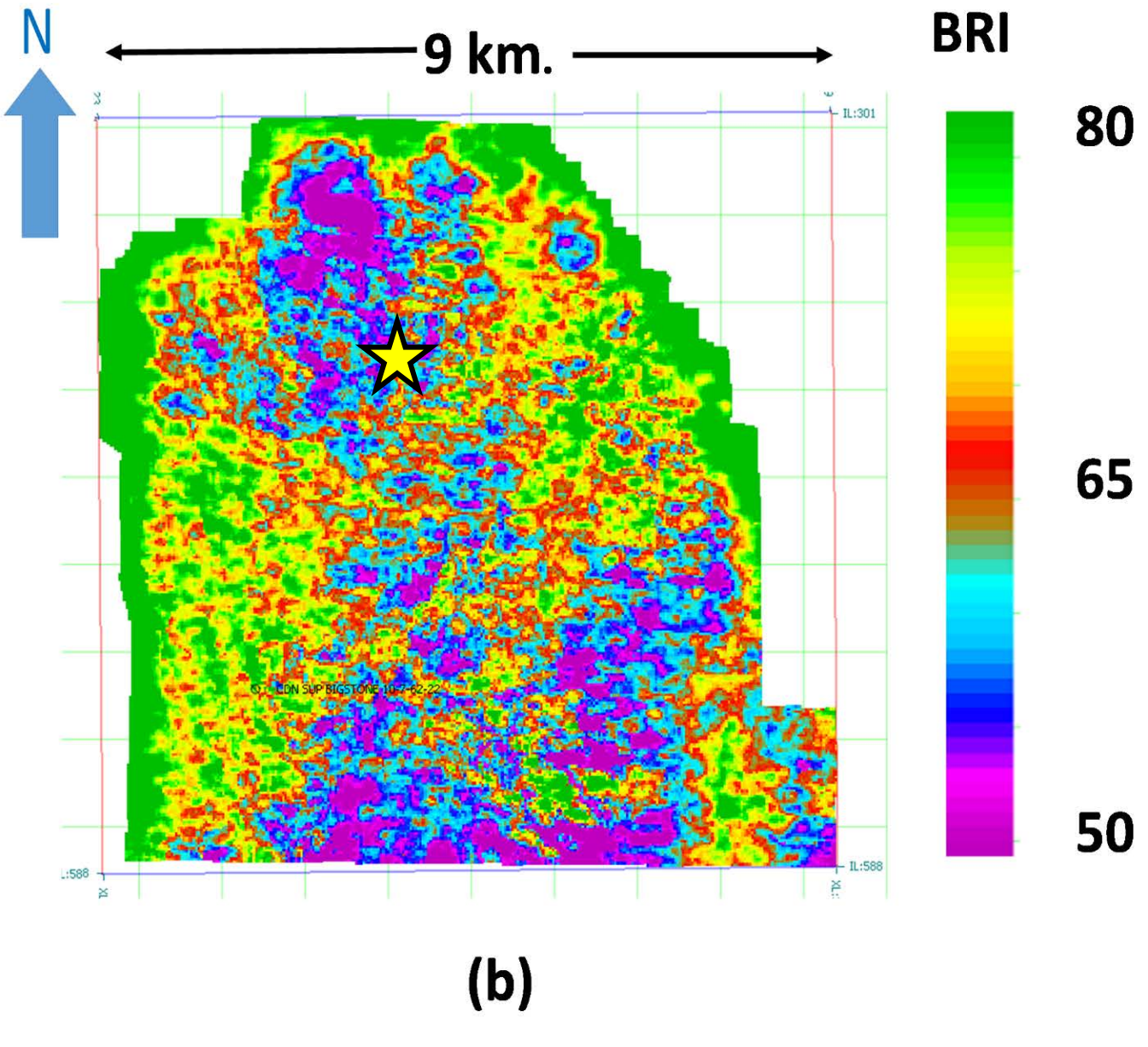


Seismic cross section plotted with BRI

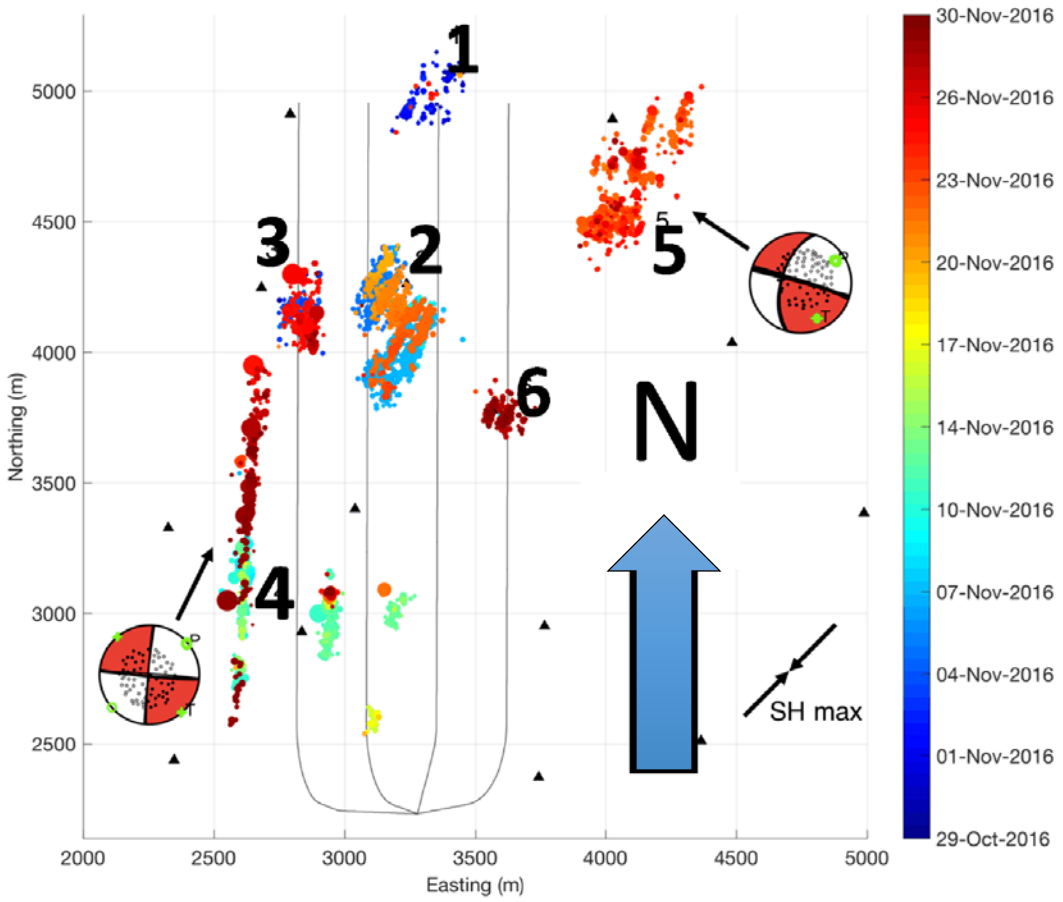


Swan Hills structure and brittleness map

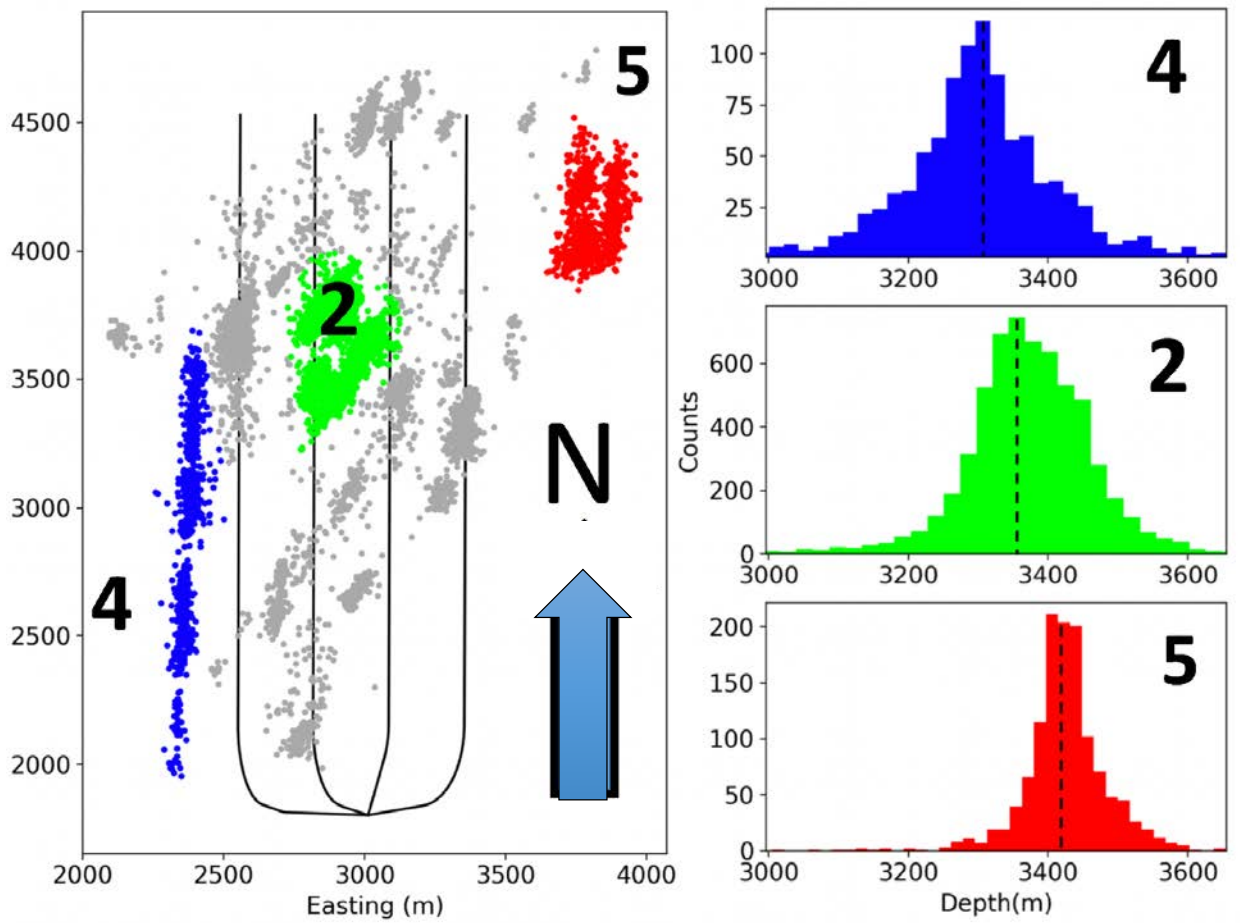




Microseismic catalogue, South area

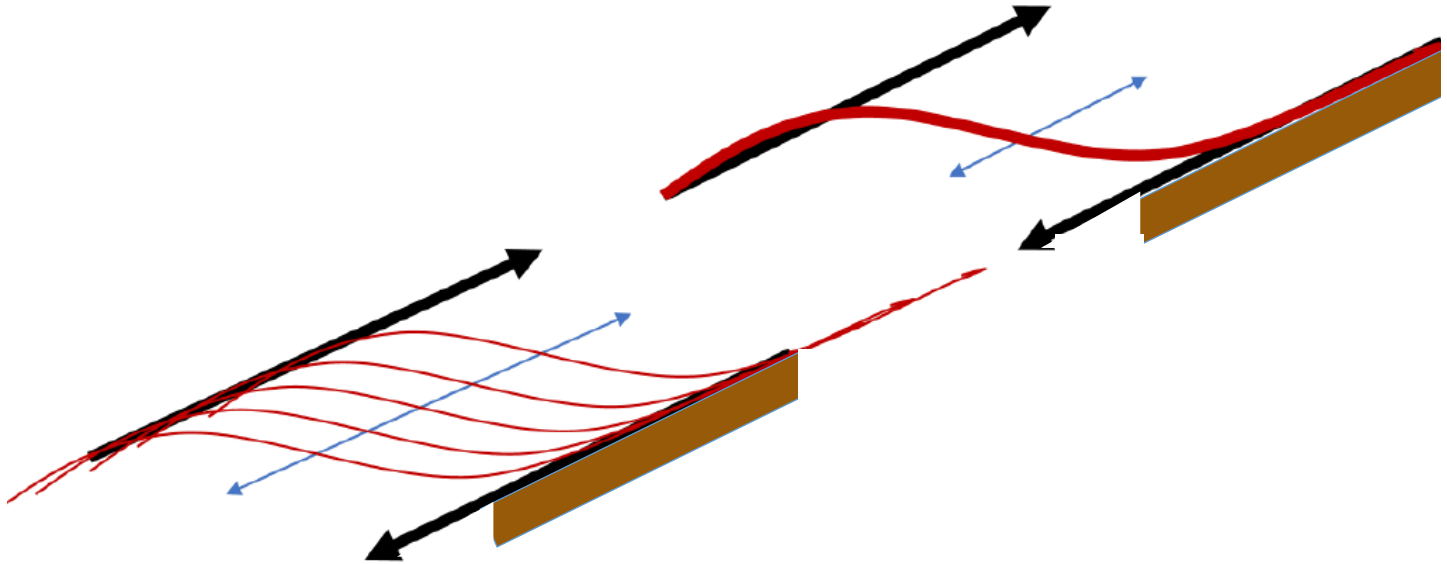


(Eaton et al. 2018)

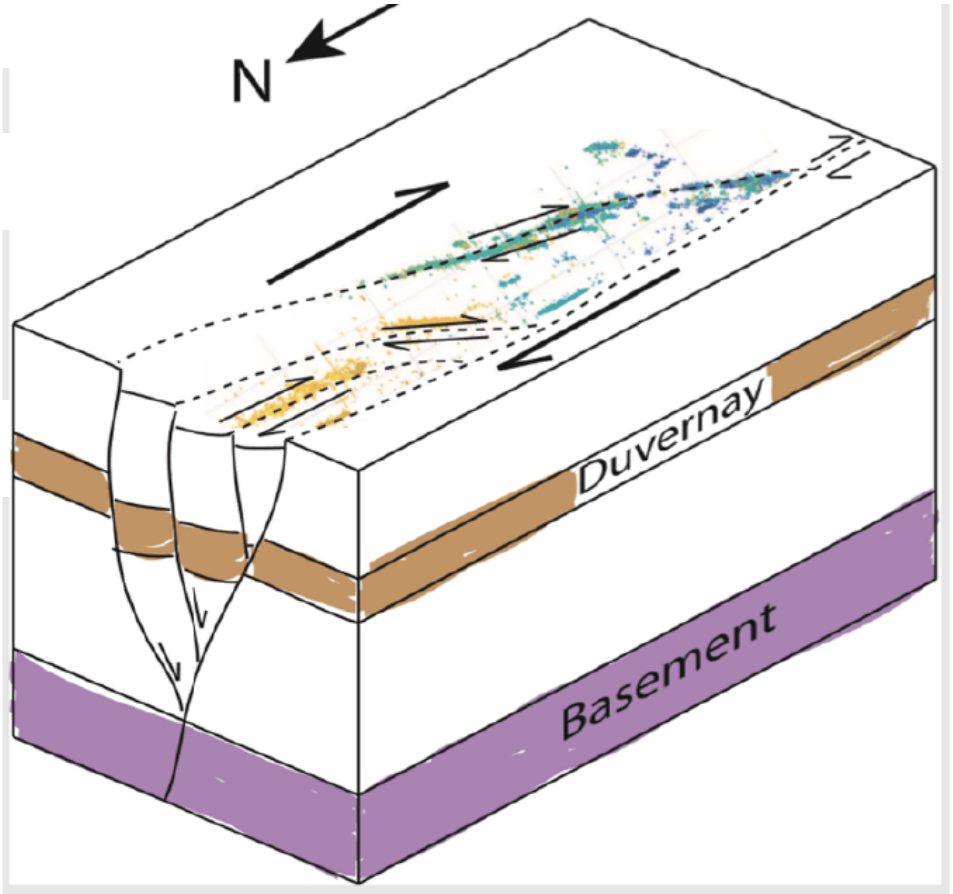


(Poulin et al. 2019)

Transcurrent fault mechanism



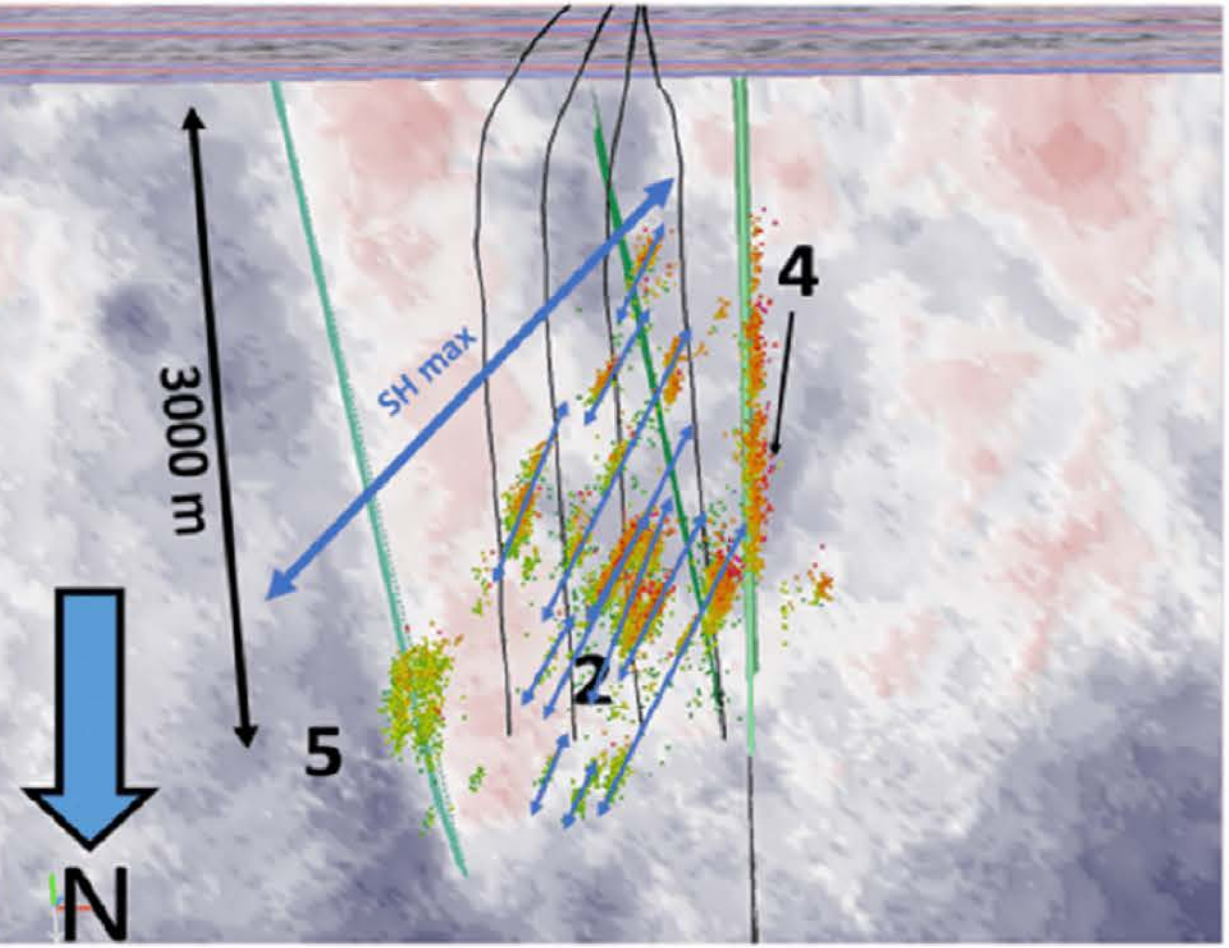
Associated transpressional fault mechanism, Swan Hills formation

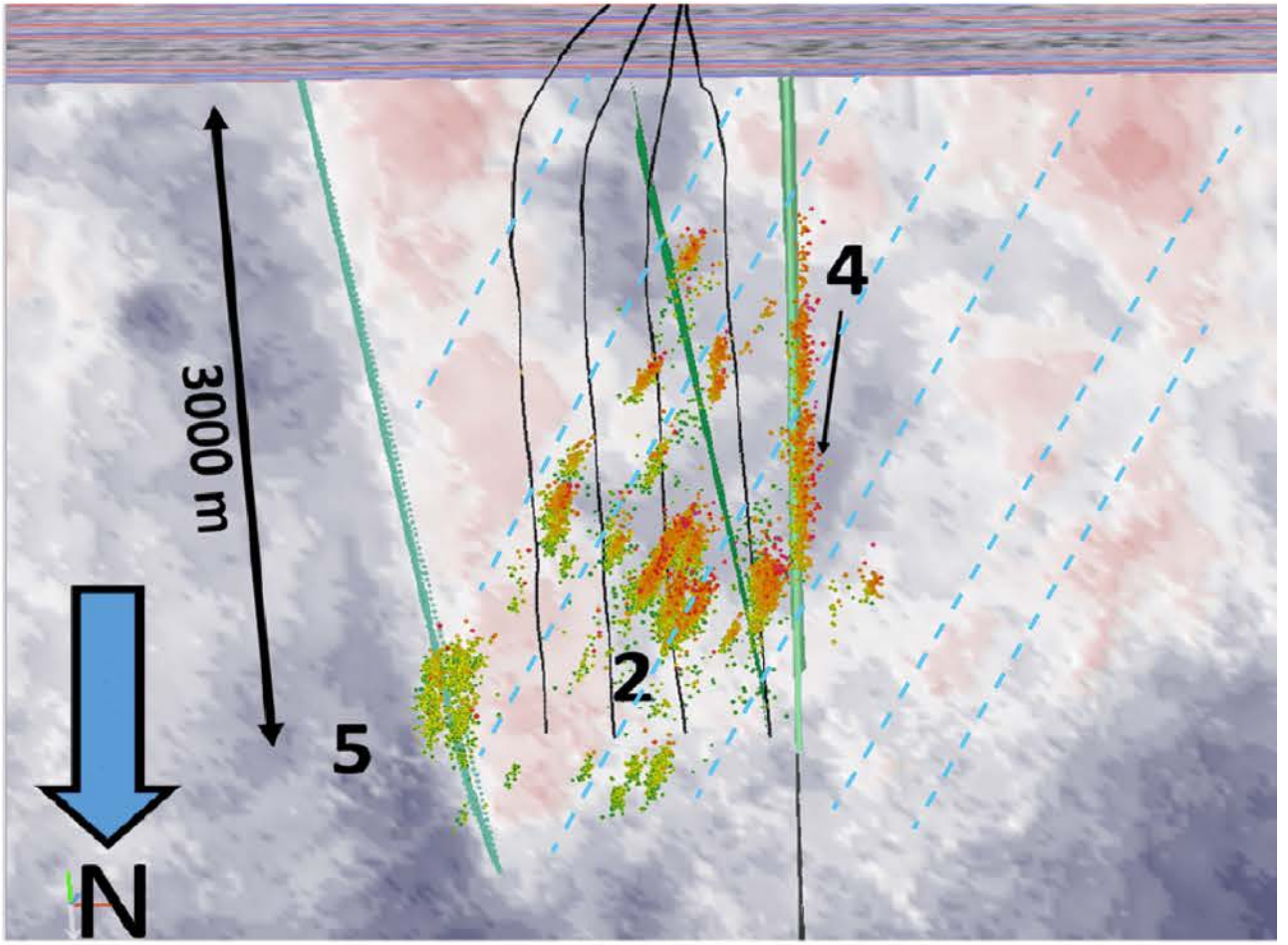


Strike-slip fault flower structure

Eyre (2019)

Swan Hills Formation depth structure



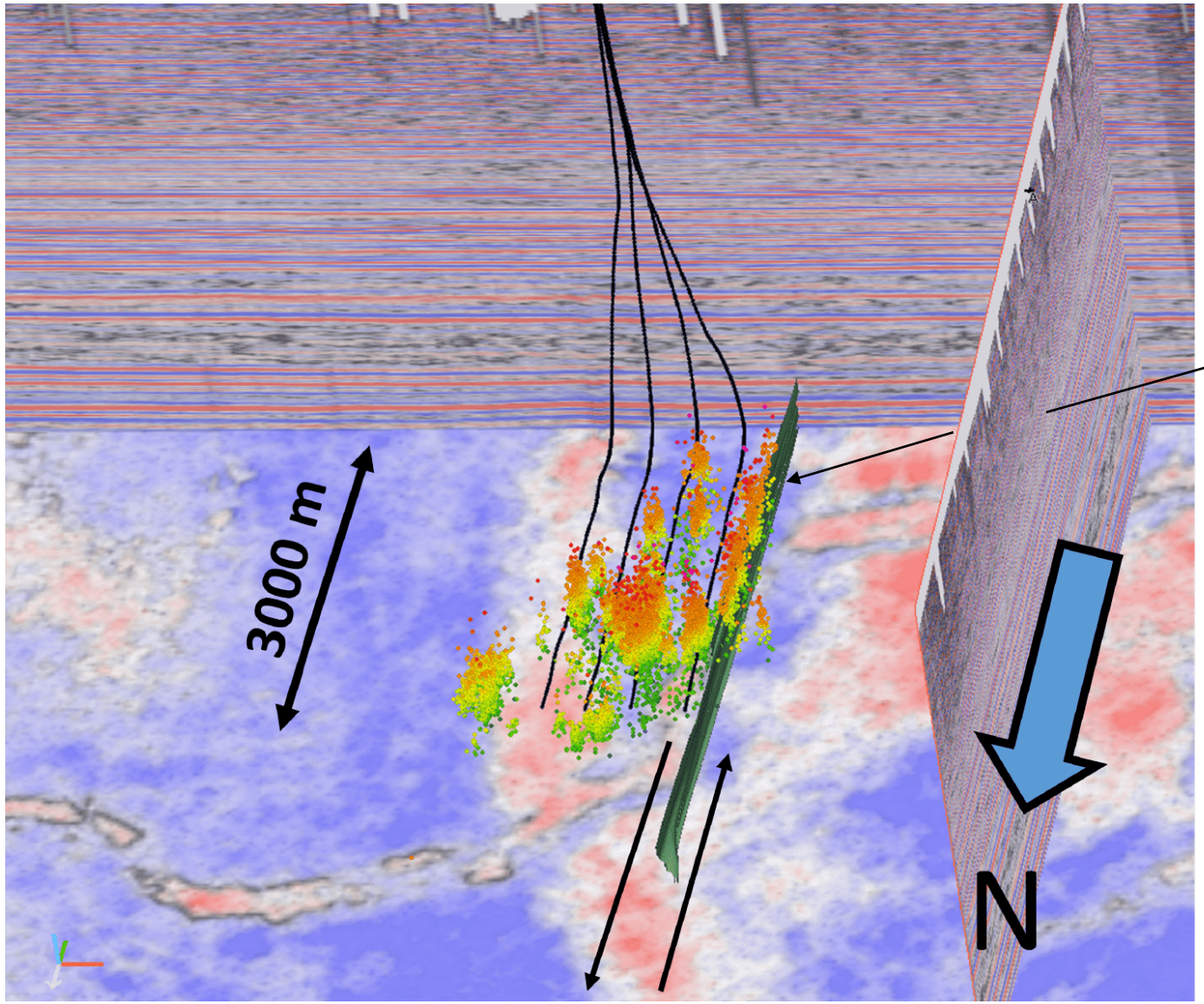


This fault interpretation is based on the transpressional geologic model

3500 3600 Meters below datum

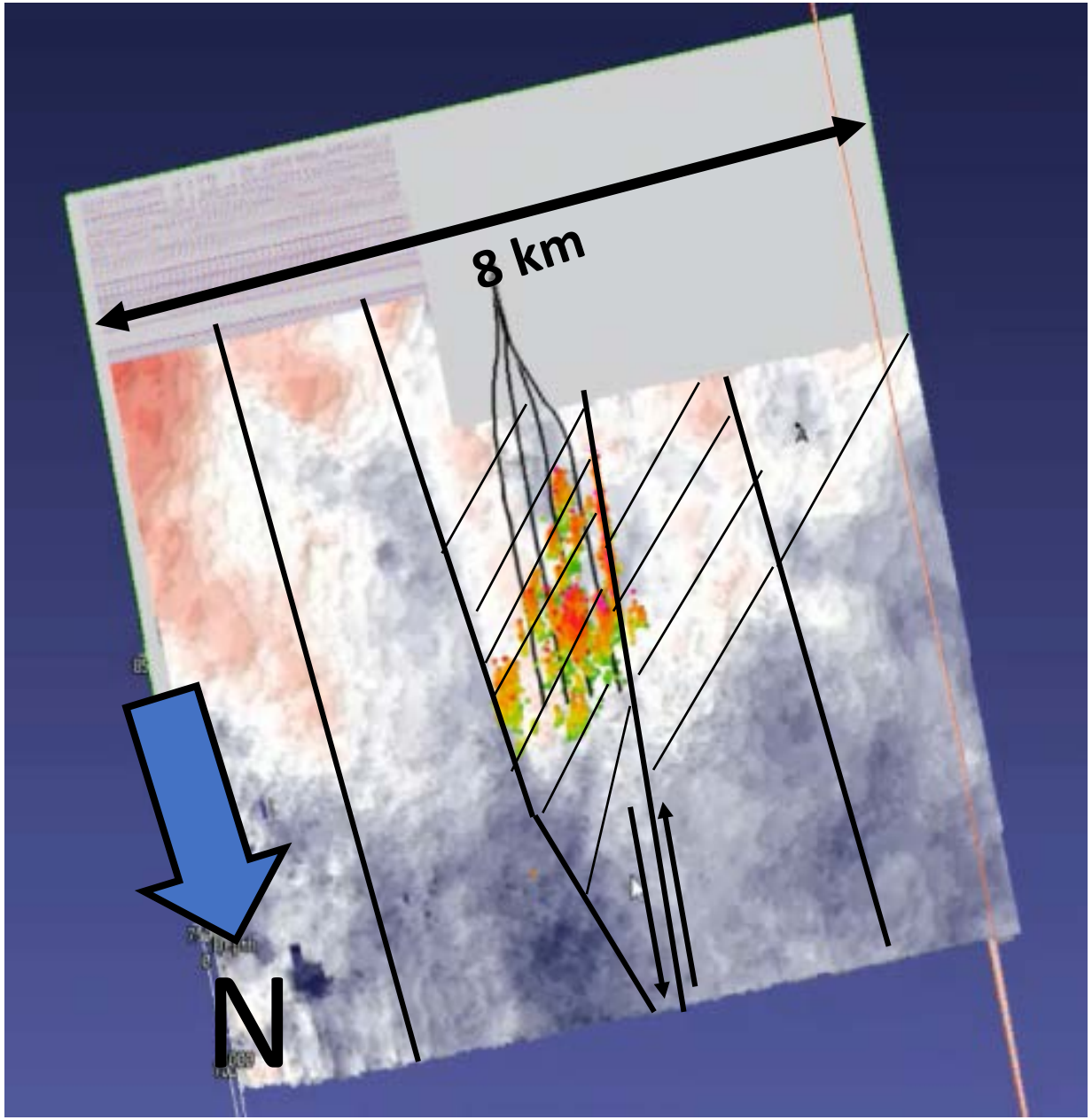
Swan Hills Group, depth structure map

Time slice through the Gilwood Member

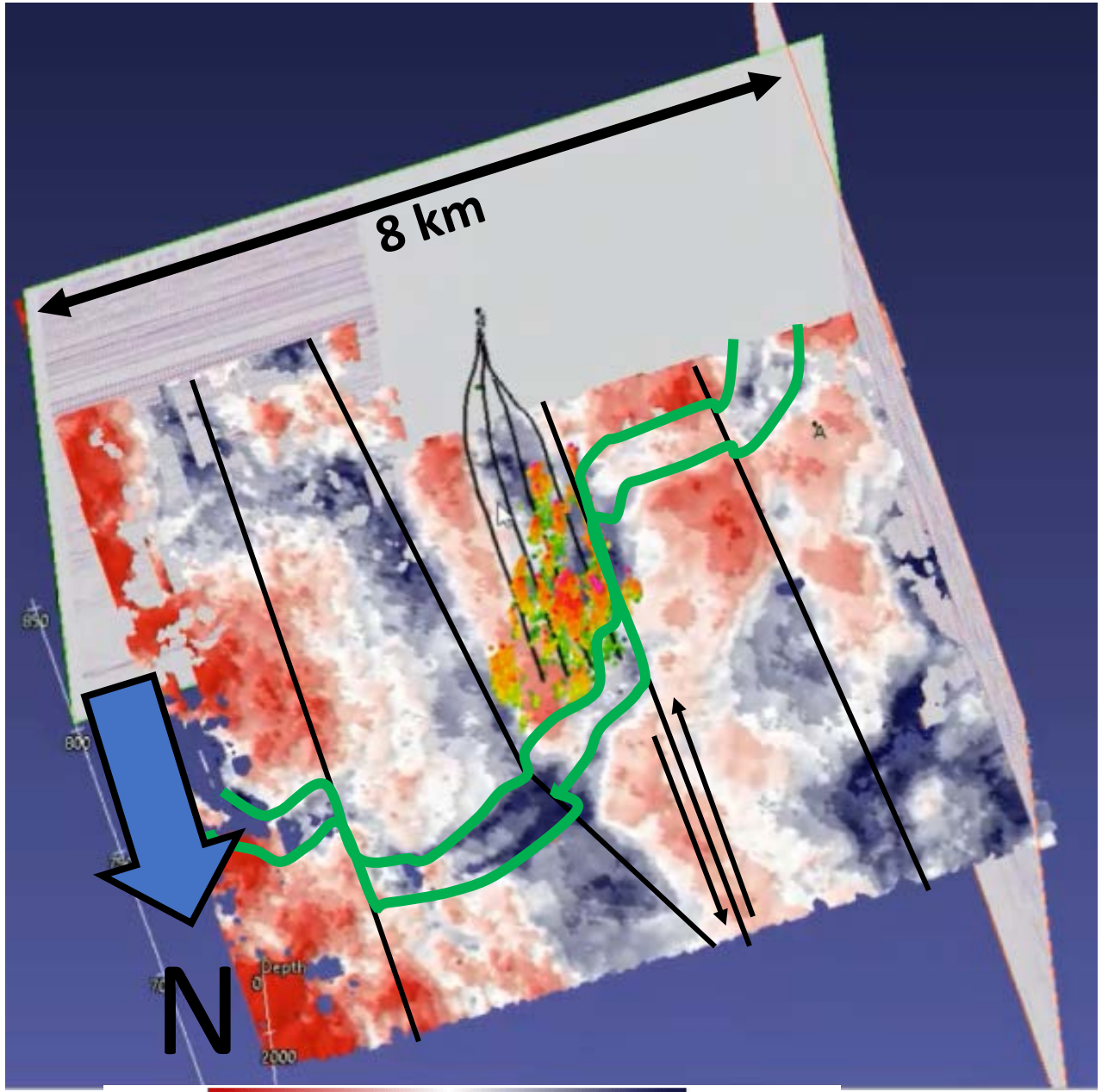


- Note the displacement on the Gilwood channel
- The fault is mapped vertically to the seismic cluster associated with group 4
- These basement faults may be associated with localised areas of higher heat flow (Li, 2016)

Swan Hills Group, depth structure map



meters sub-datum

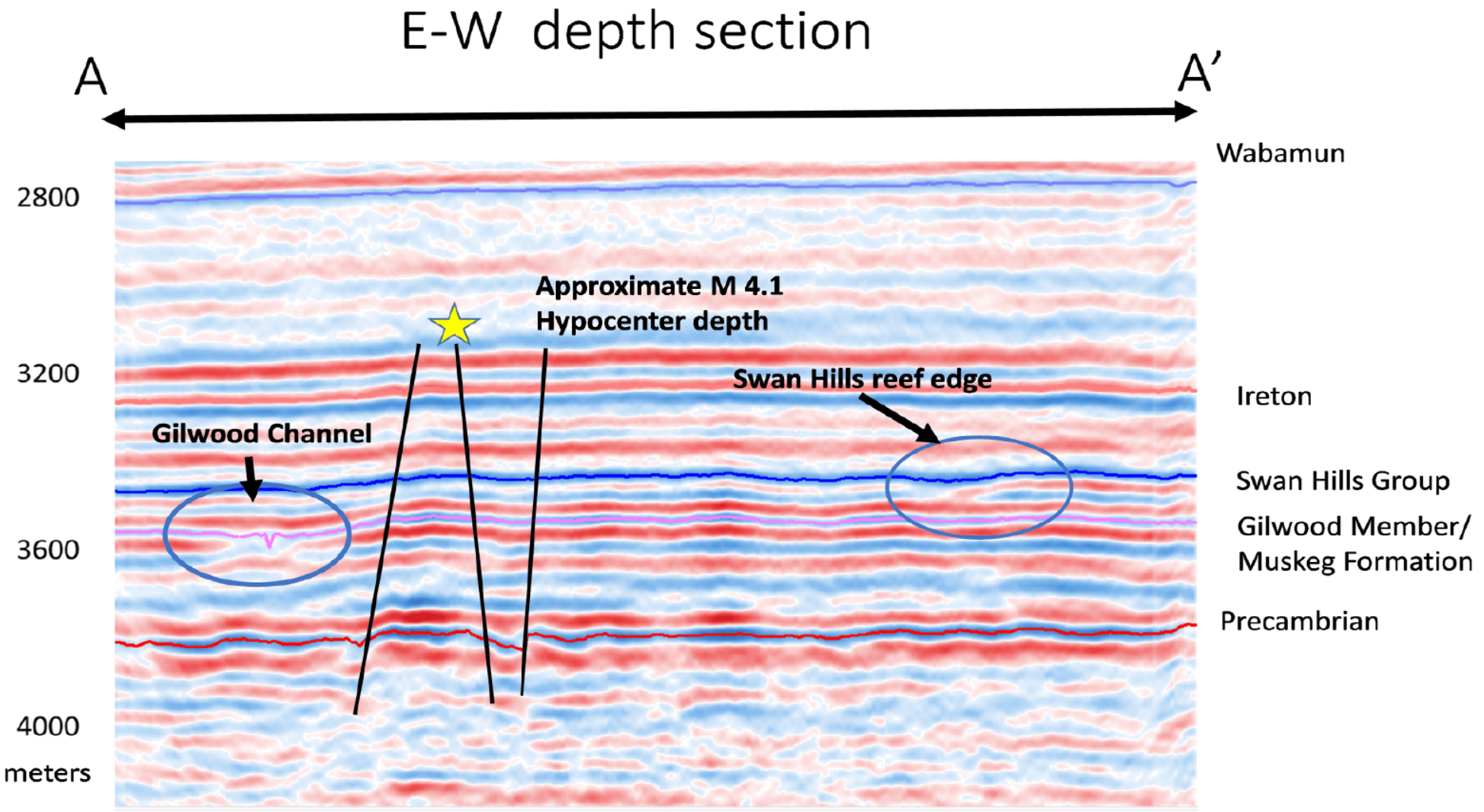


meters sub-datum

(b)

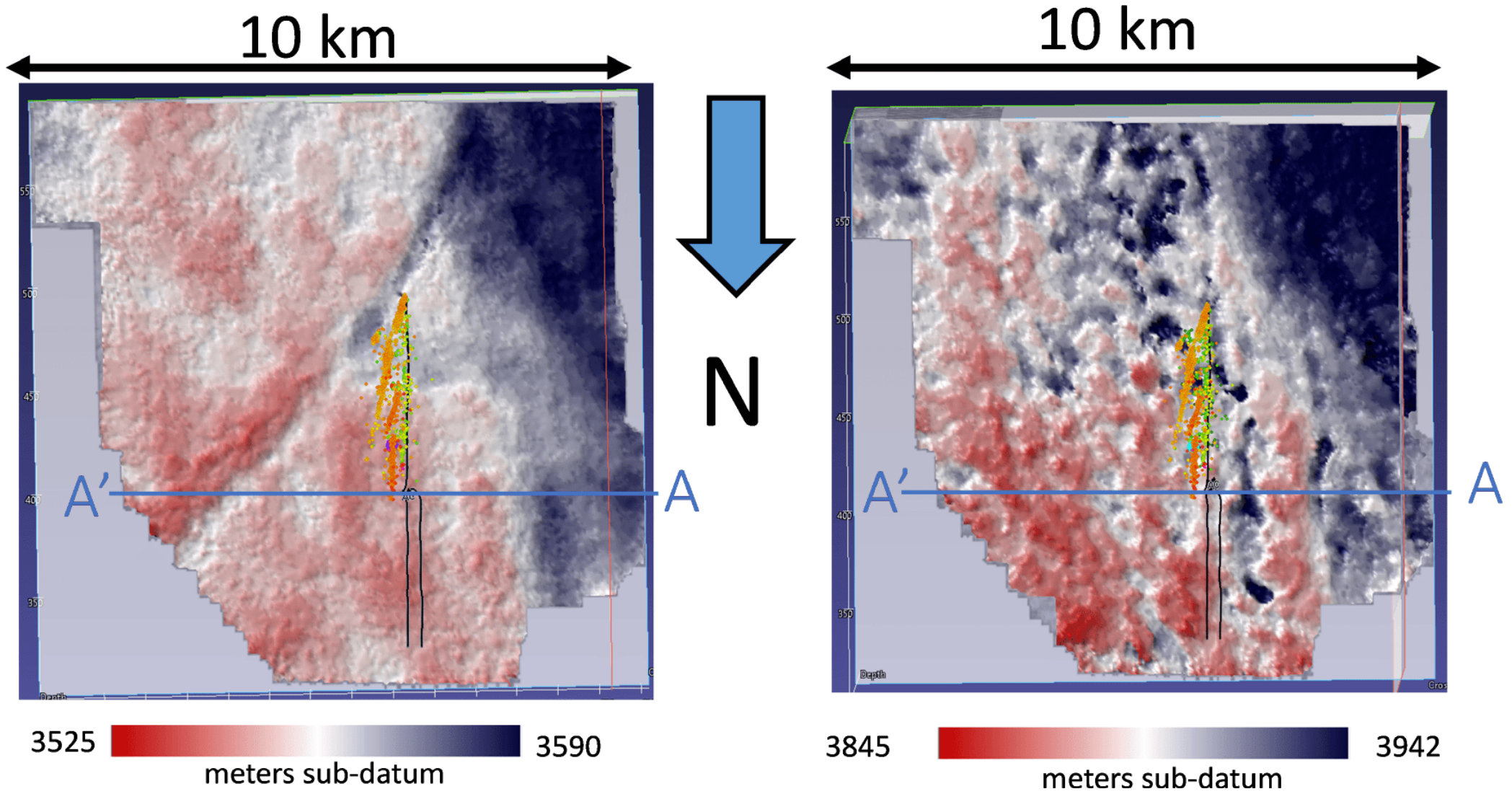
Gilwood Member, Muskeg Formation depth image

East-West seismic cross section

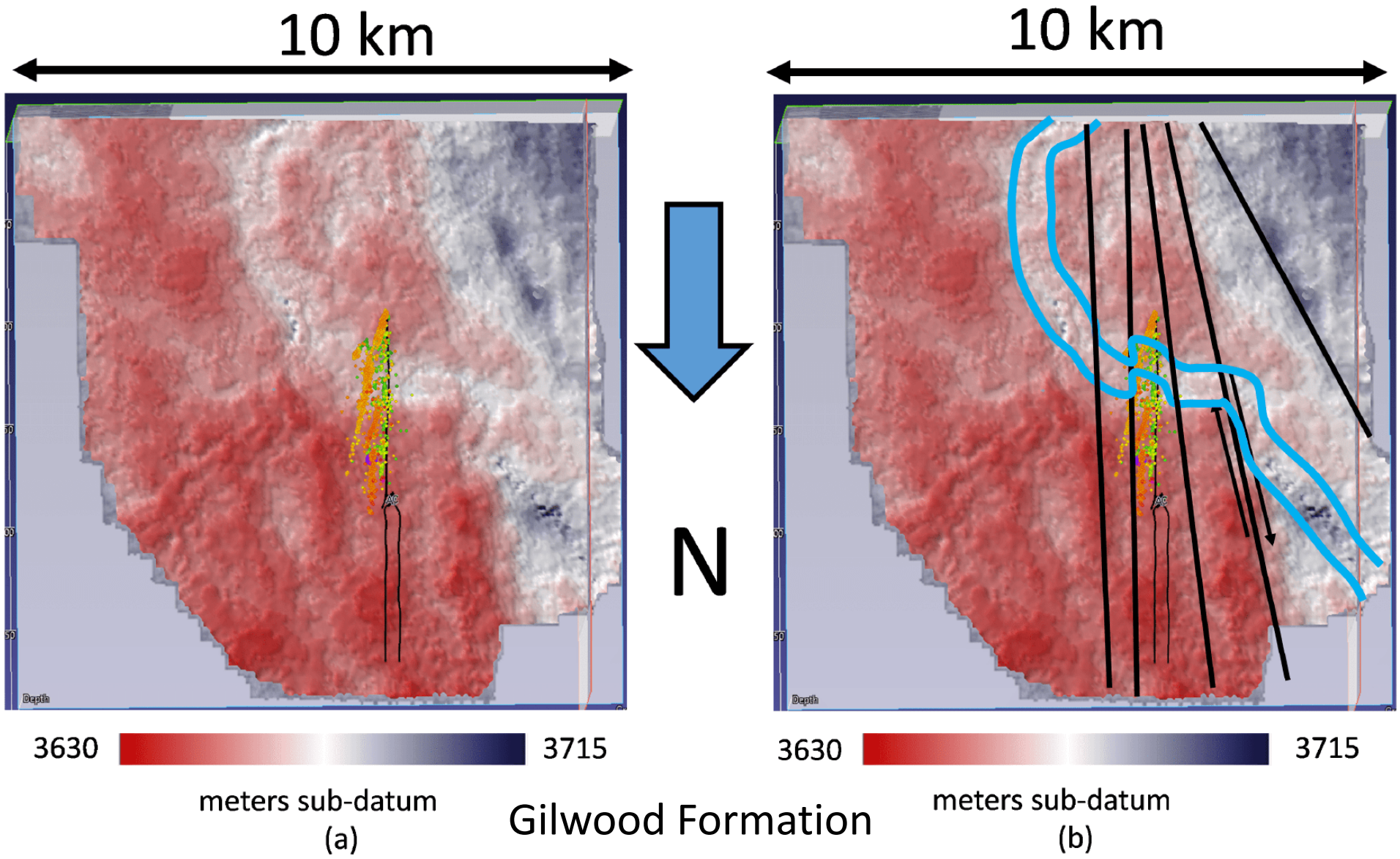


Modified from Eyre et al. (2019)

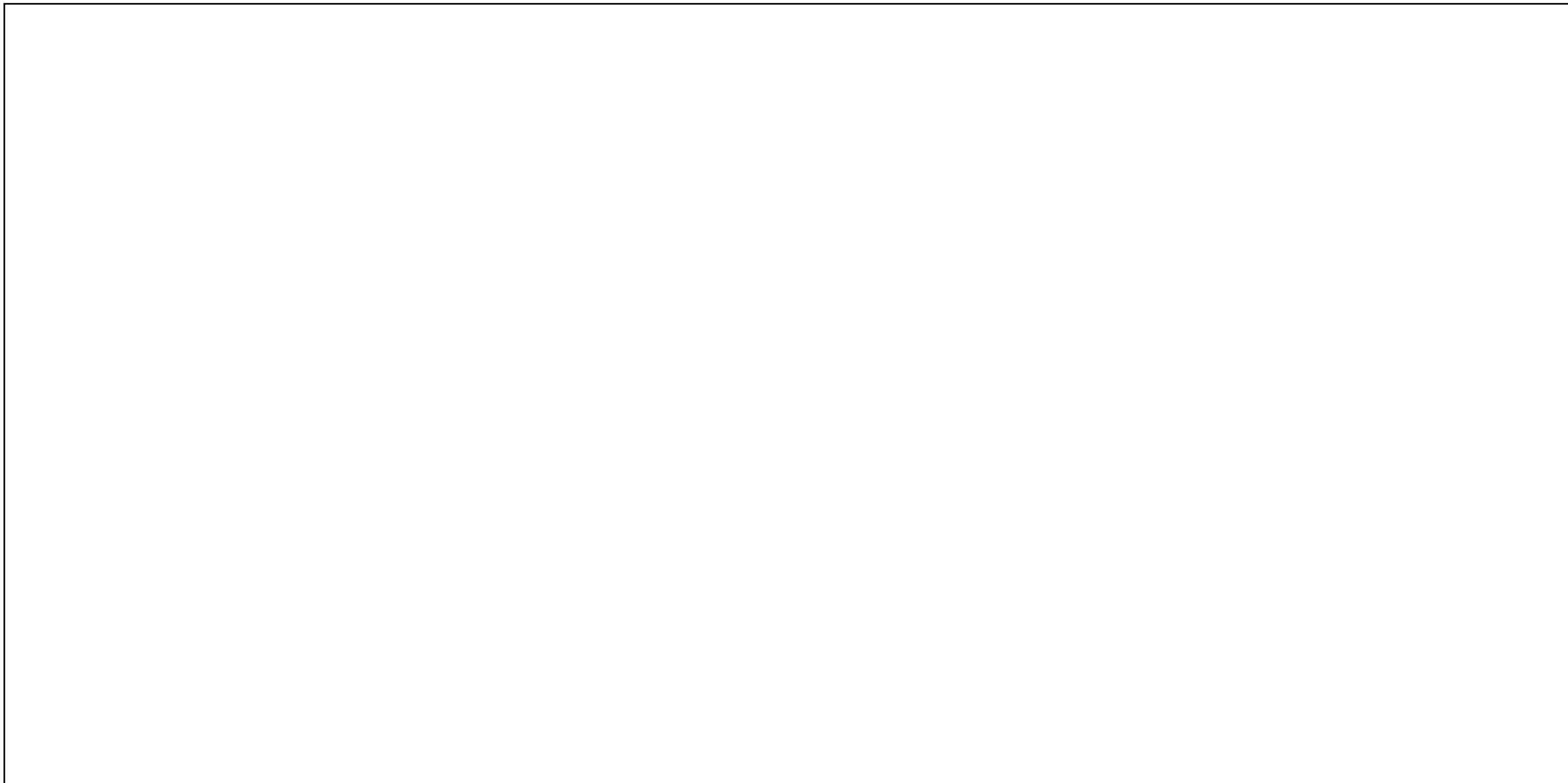
Depth maps, Swan Hills Group, Precambrian

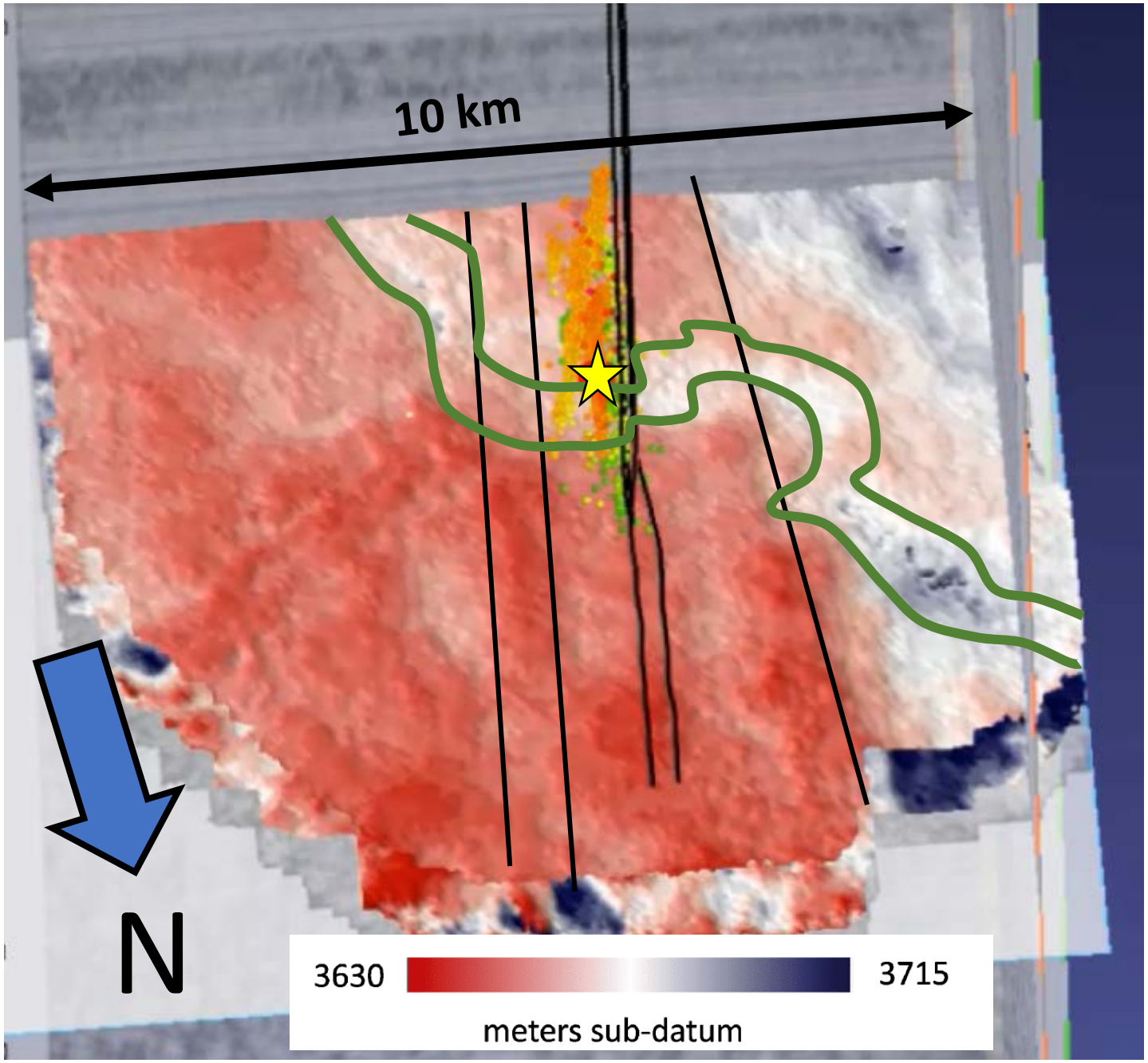


Depth structure, Gilwood Formation

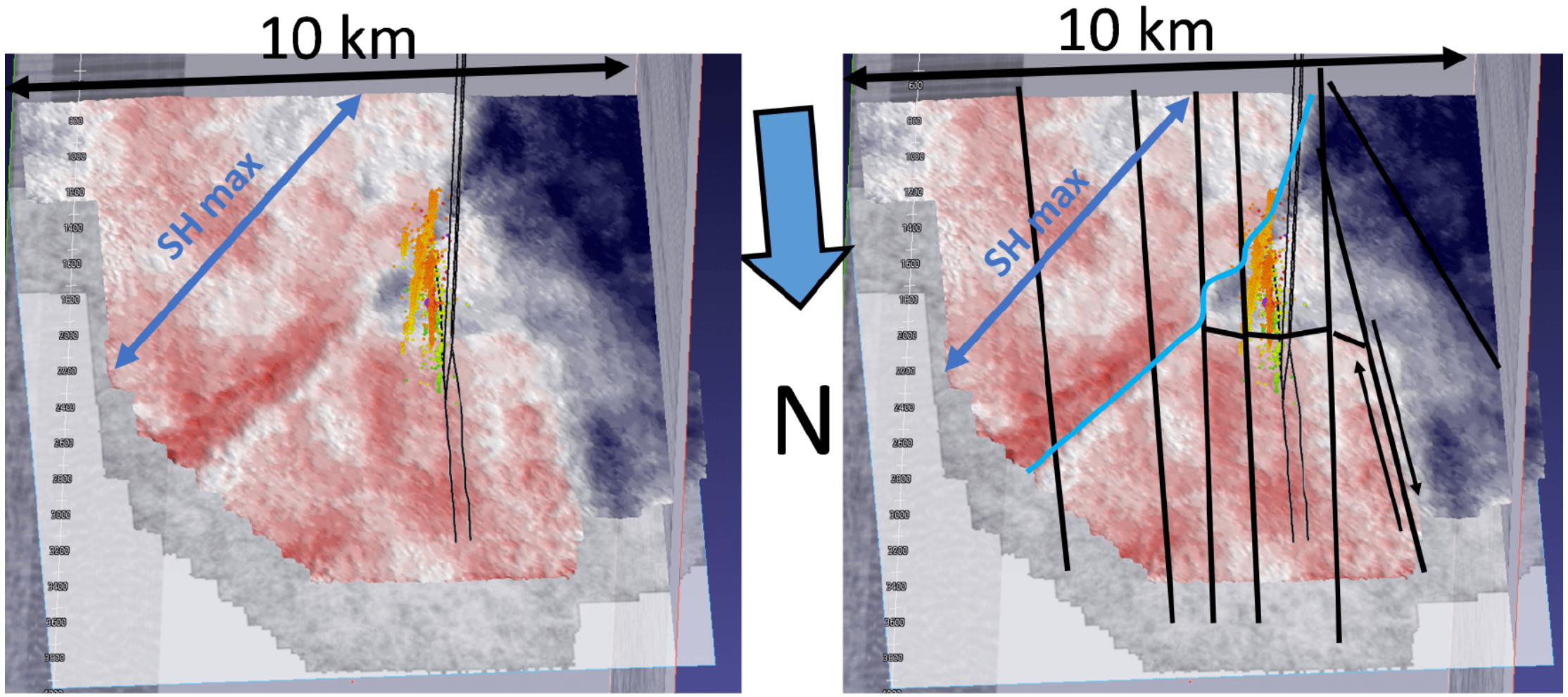


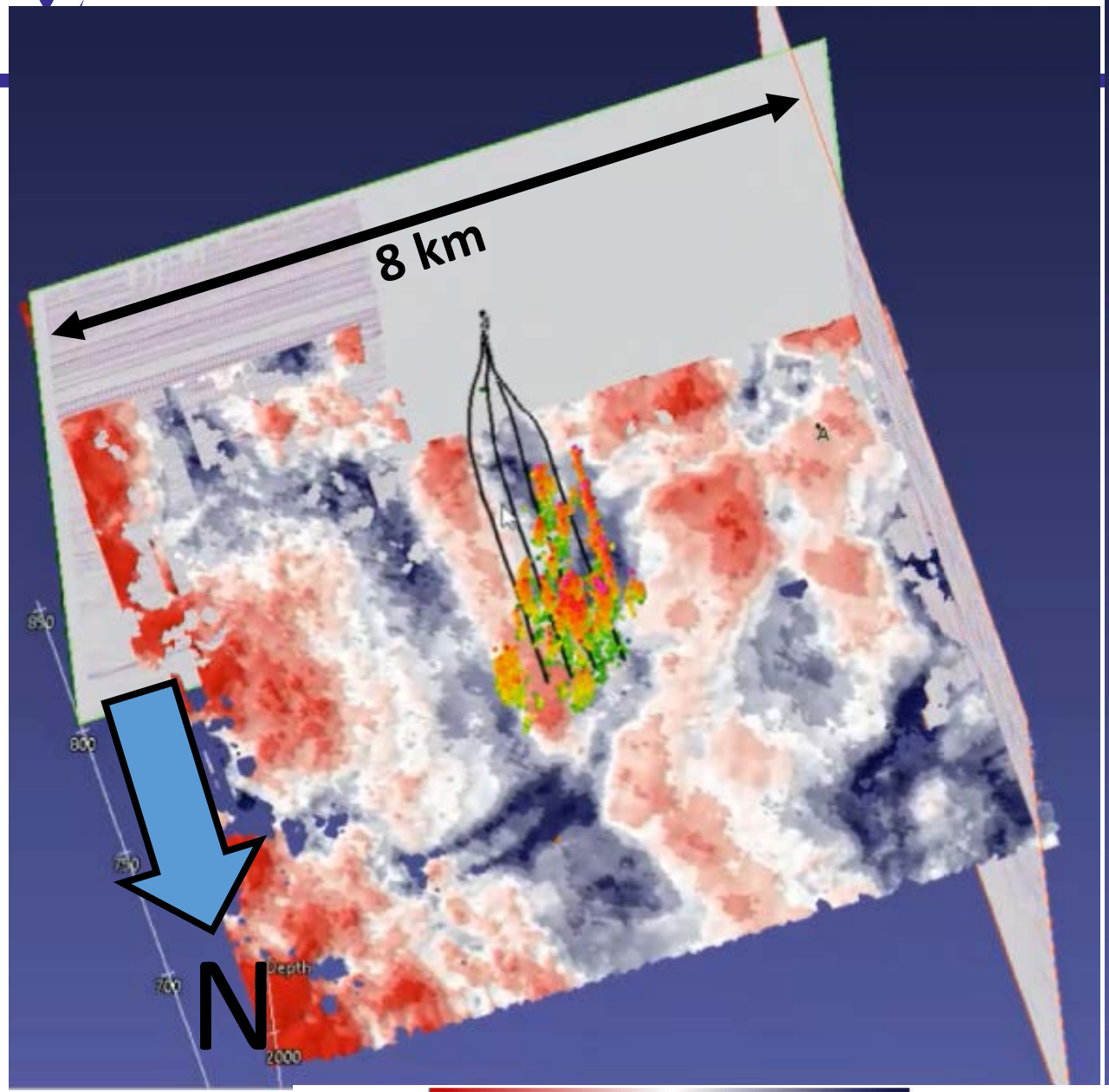
Gilwood Member/Muskeg Formation, depth structure



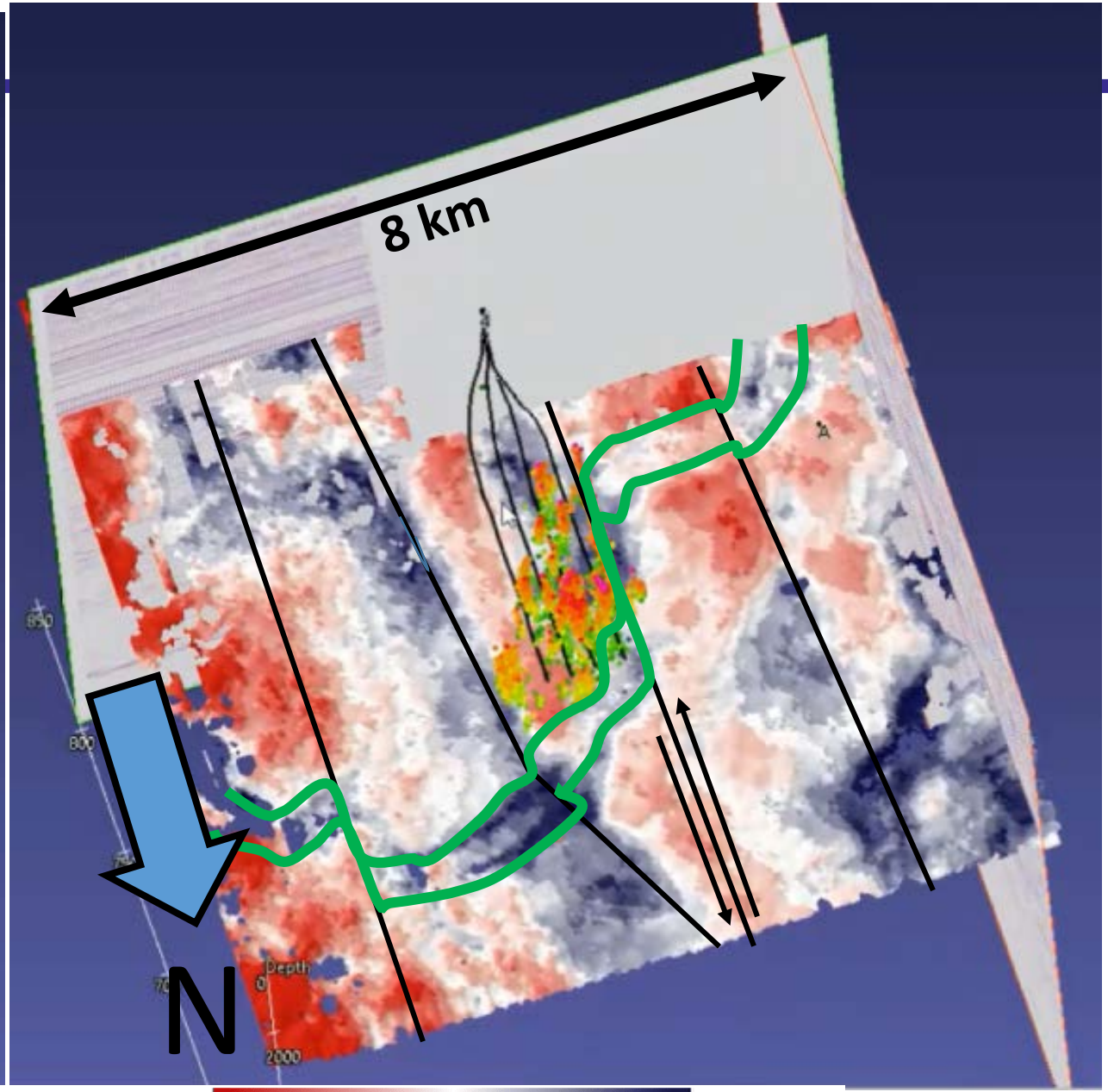

10 km
N
3630
3715
meters sub-datum

Swan Hills Formation depth structure




8 km
N
3630
3715
meters sub-datum

(a)


8 km
N
3630
3715
meters sub-datum

(b)

Swan Hills Group, depth structure

Conclusions

- Rock Properties derived from the joint inversion align with geologic structural features. This may high grade areas for reservoir development
- The geological process of transcurrent faulting is able to explain the observed structural features in both the North and South study areas
- The pattern of induced seismicity preferentially follow pre-exiting zones of weakness; transcurrent faulting and major strike-slip
- This seismic analysis can provide a method whereby horizontal drilling programs are optimised, and geohazard risk is reduced

Acknowledgements

- TGS Canada for the contribution of the 3-D, 3-C data.
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- Geoscout
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