# Integrated interpretation: using seismic data to de-risk the Duvernay

R. Weir, D. Lawton, L. Lines

December 10, 2019

NSERC CRSNG
UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
Department of Geoscience
CMC Containment & Monitoring Institute

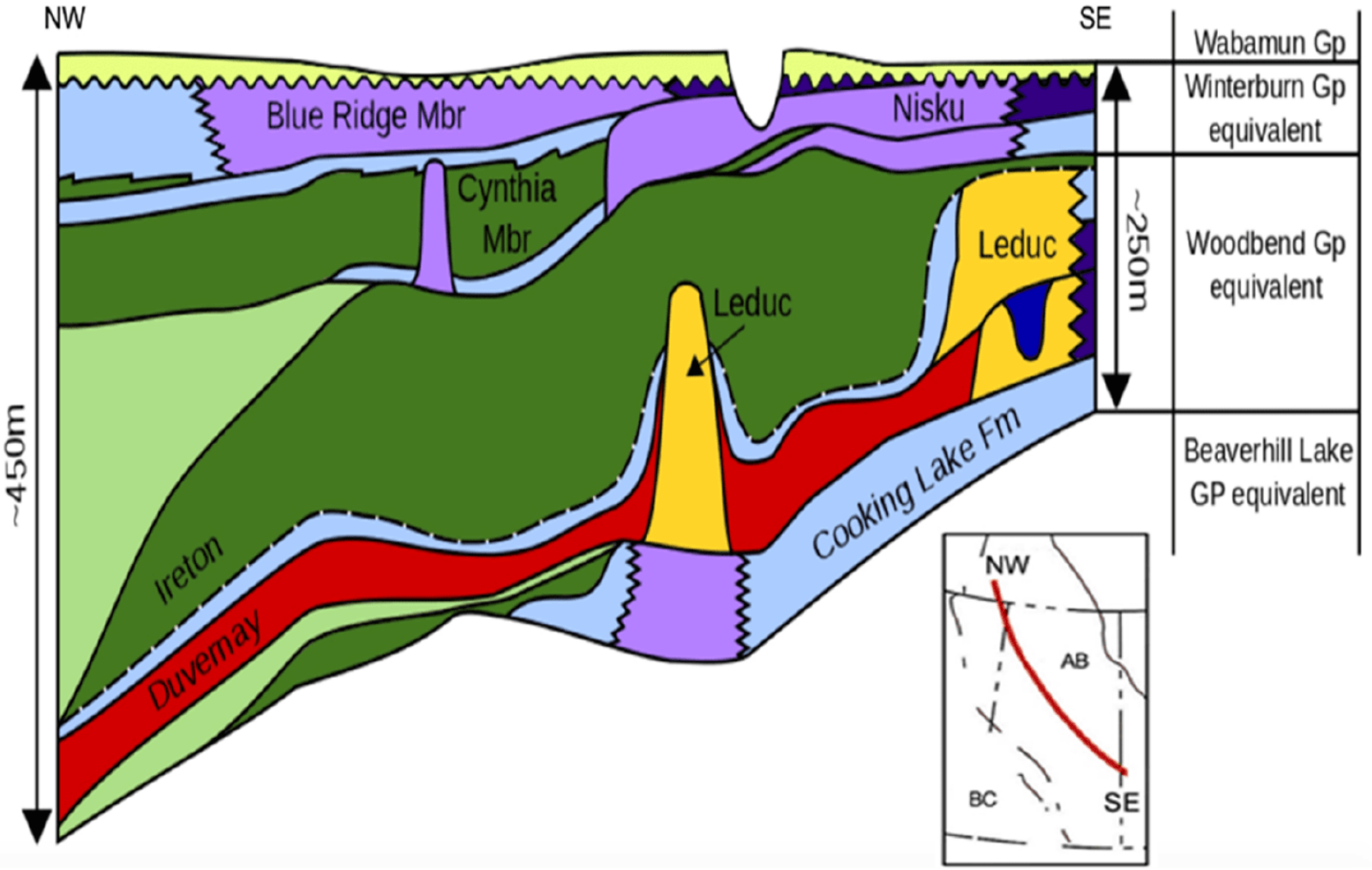
# Duvernay risk summary

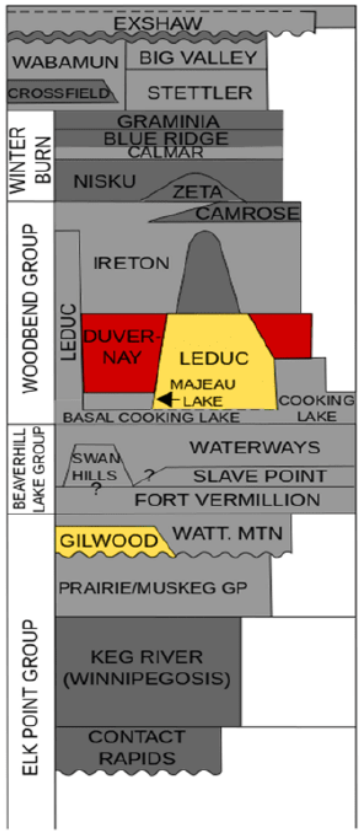
- Hydrocarbon maturity
  - Dry gas
  - Condensate
  - Oil

- Hydraulic fracture stimulation propagation may occur in a direction different from the original well plan

- The potential to generate felt seismicity may be linked to pre-stressed basement-rooted fault systems

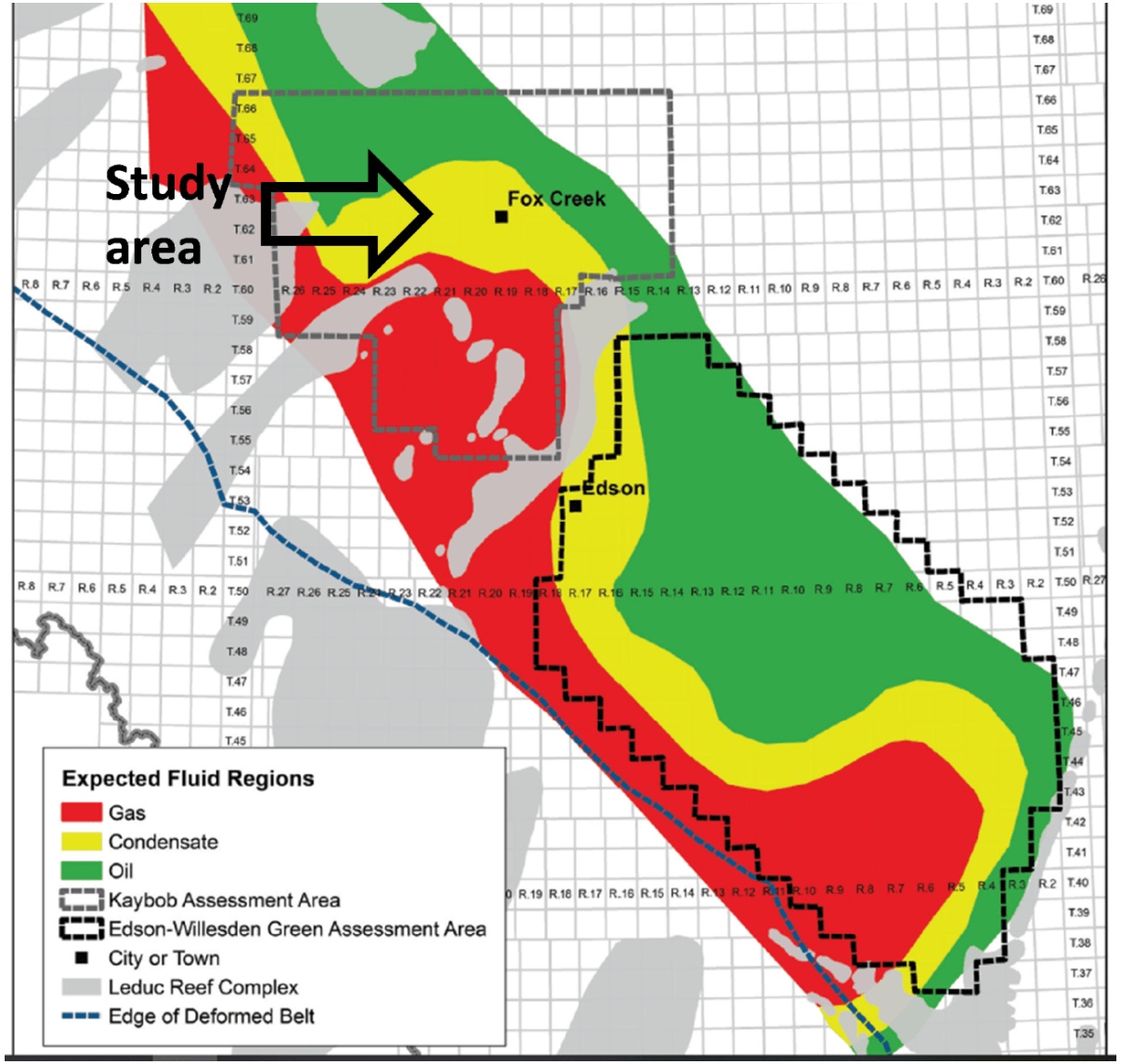
# Schematic cross section



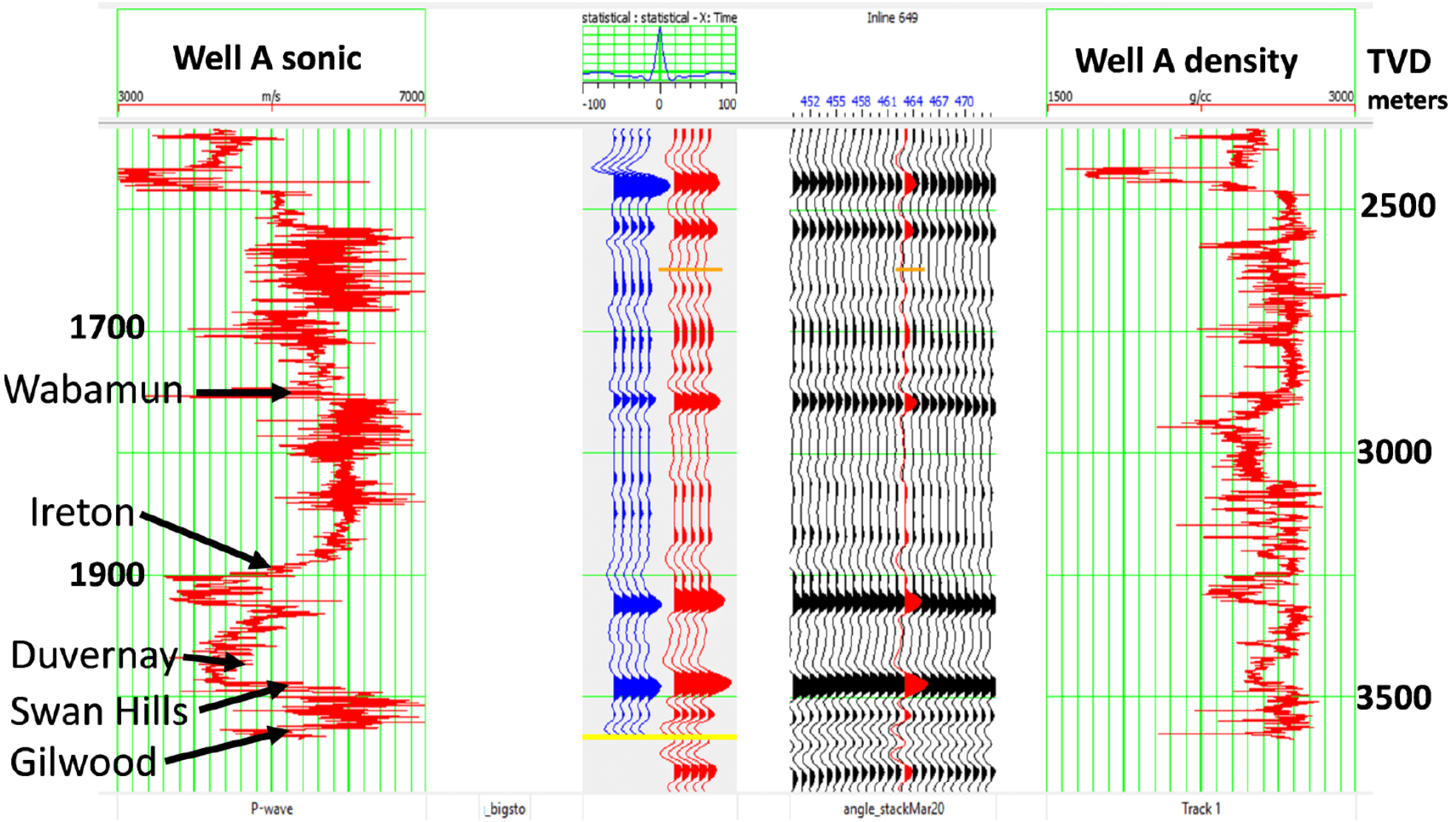

Dry gas --|-- Condensate---|----Oil---------(based on depth)

# Duvernay predicted production areas

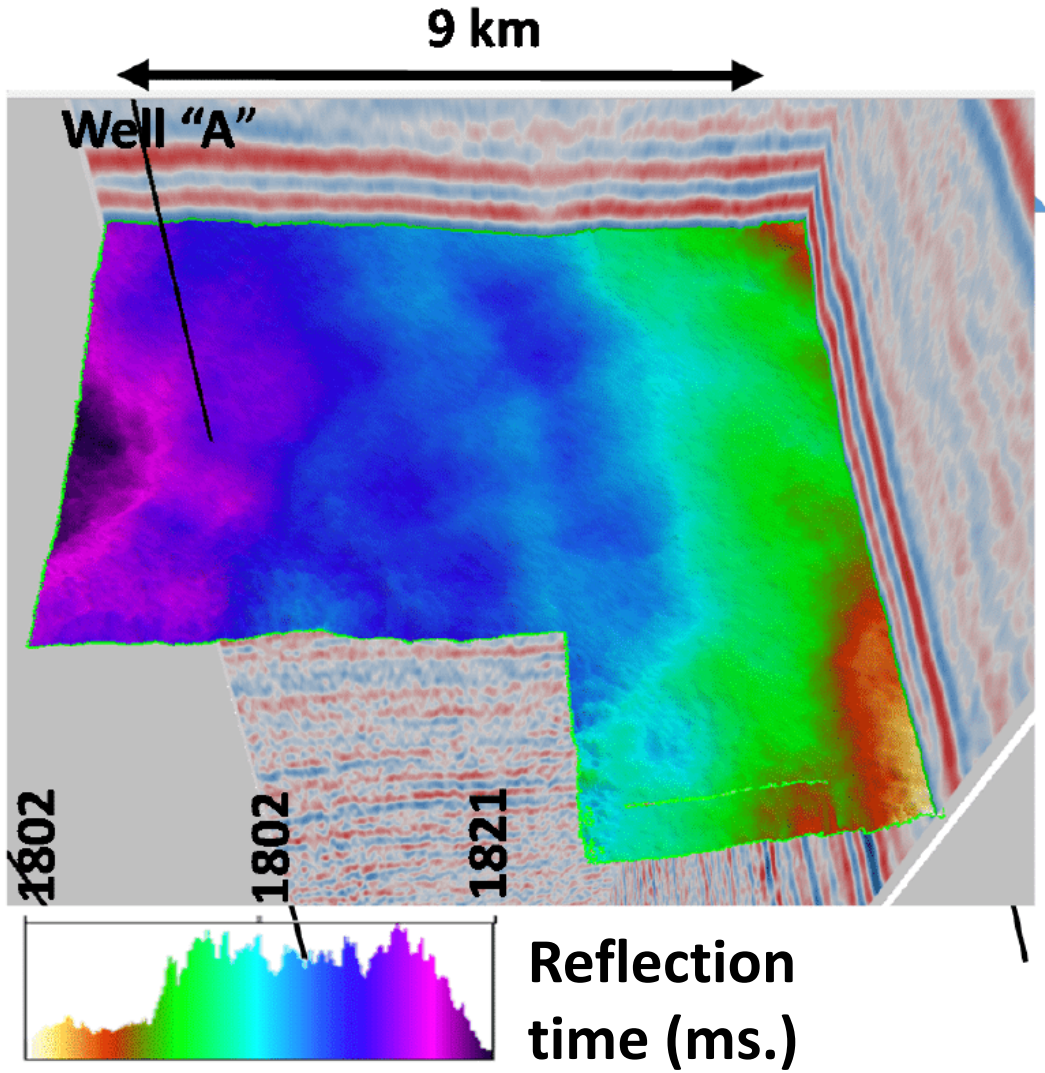



- General Duvernay hydrocarbon maturity map.
- The study area is within the published AER (2016) condensate hydrocarbon window

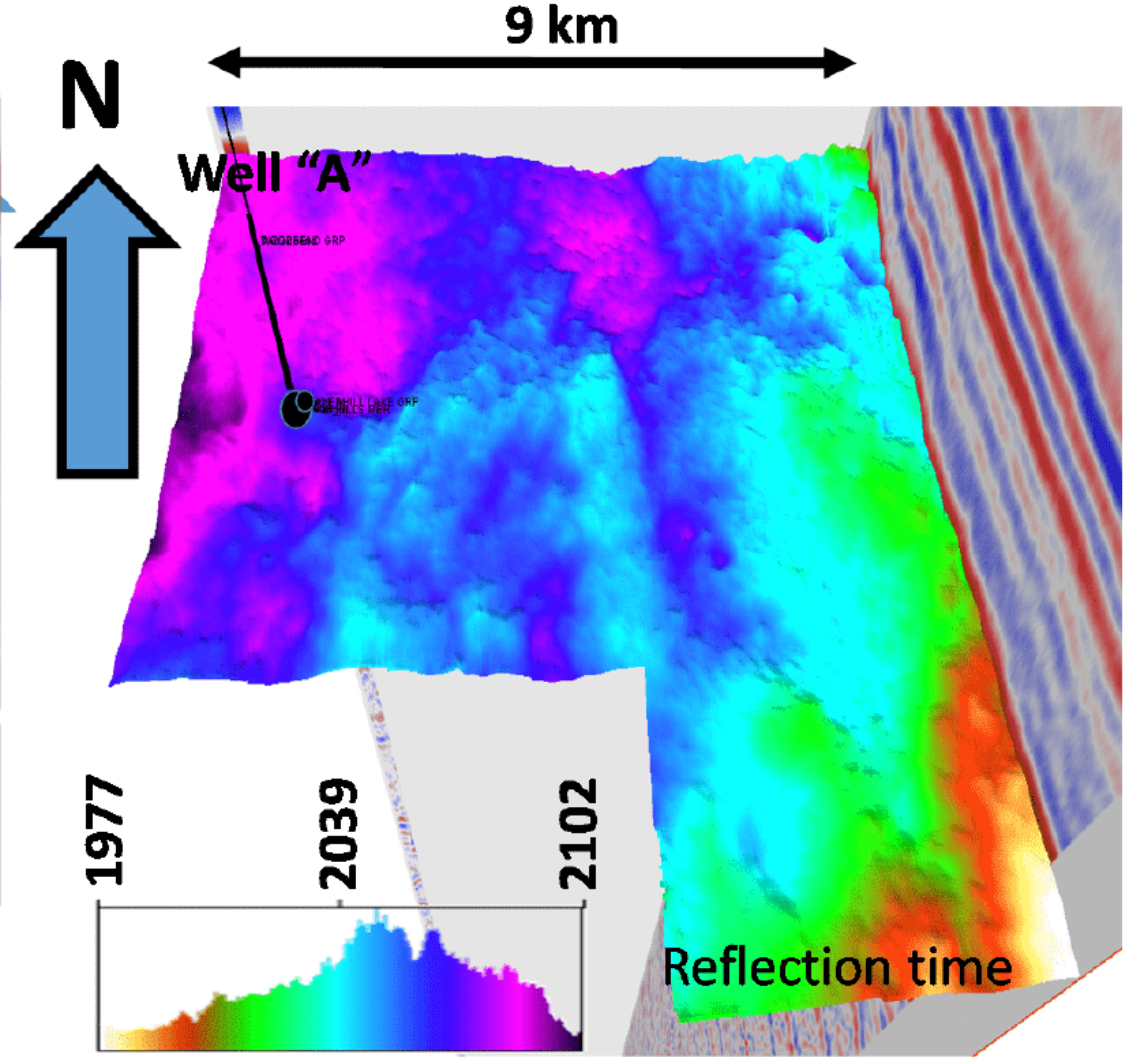
# Synthetic seismogram tie



# Time structure maps




Wabamun reflection




Swan Hills reflection

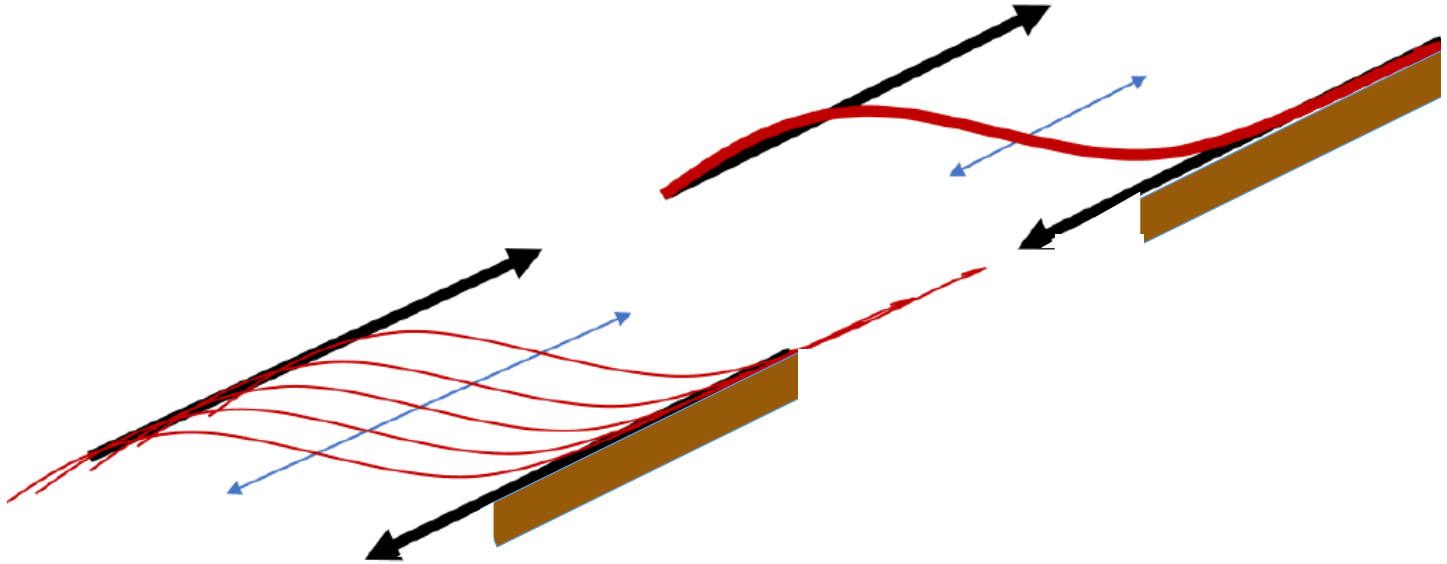
# Strike-slip displacements

1. Moment tensors inversion indicate strike slip motion

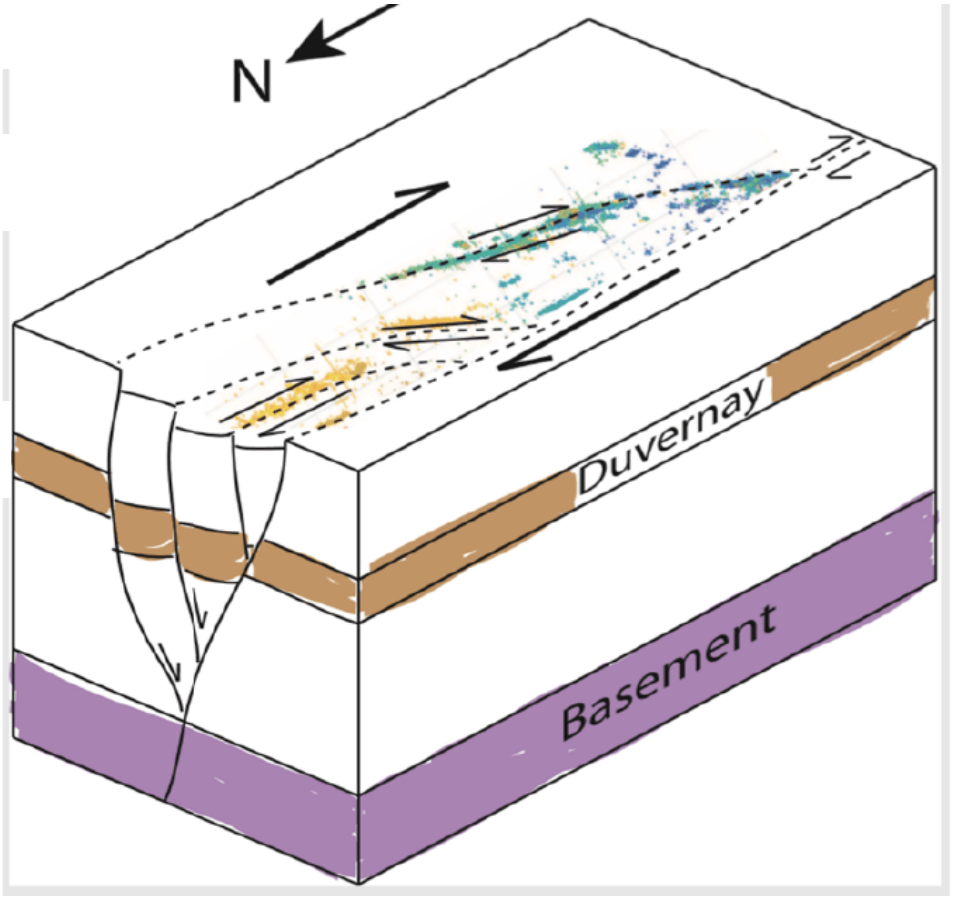
2. Strike slip motion is apparent on the Gilwood member structure map

3. Induced events show an alignment with pre-existing structures

# Transpressional fault mechanism



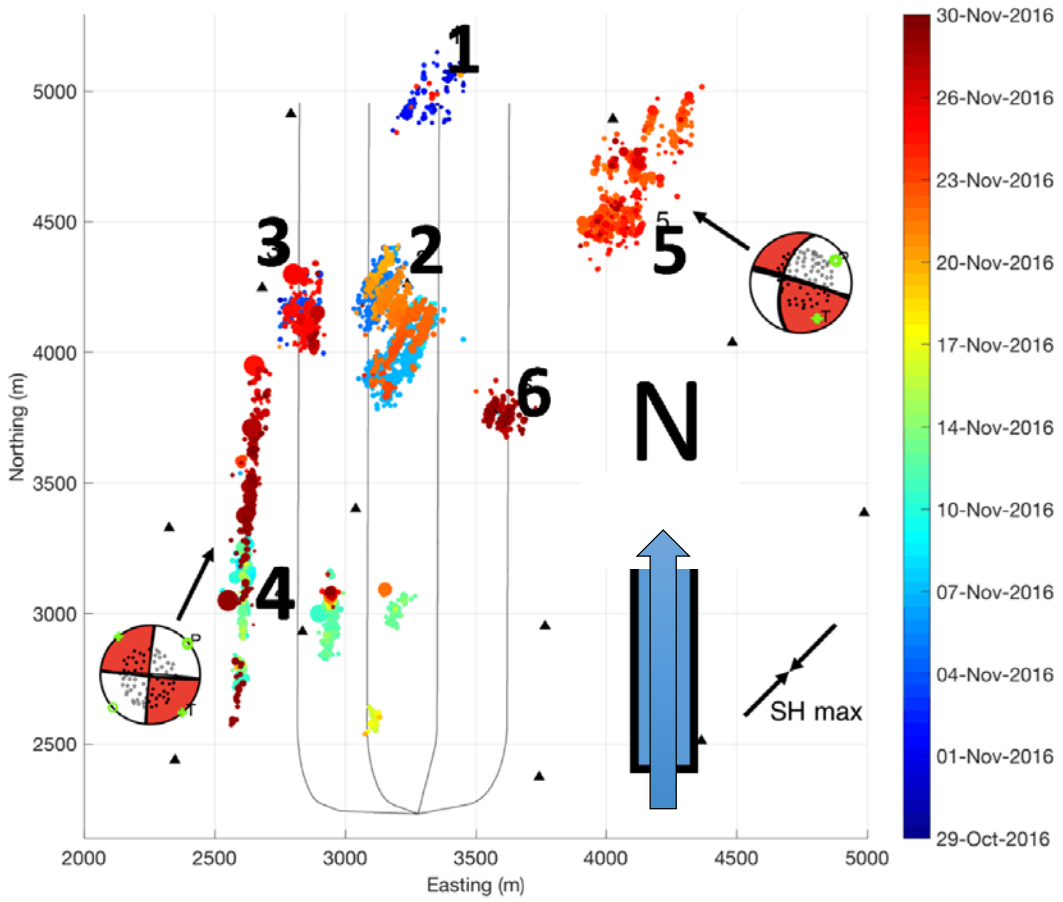
Associated transpressional fault mechanism, Swan Hills formation



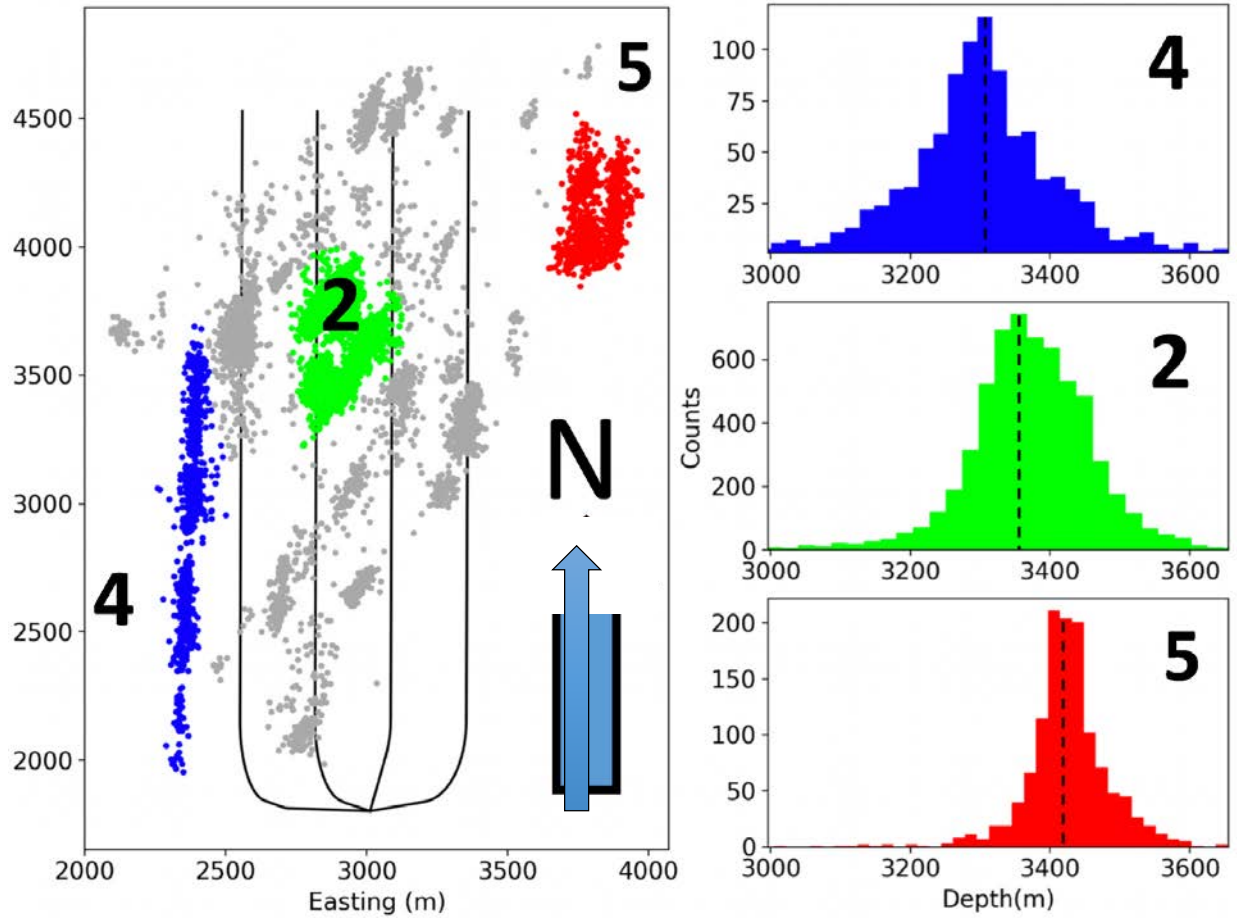

Strike-slip fault flower structure

Eyre (2019)

# Focal mechanism and event depth distribution

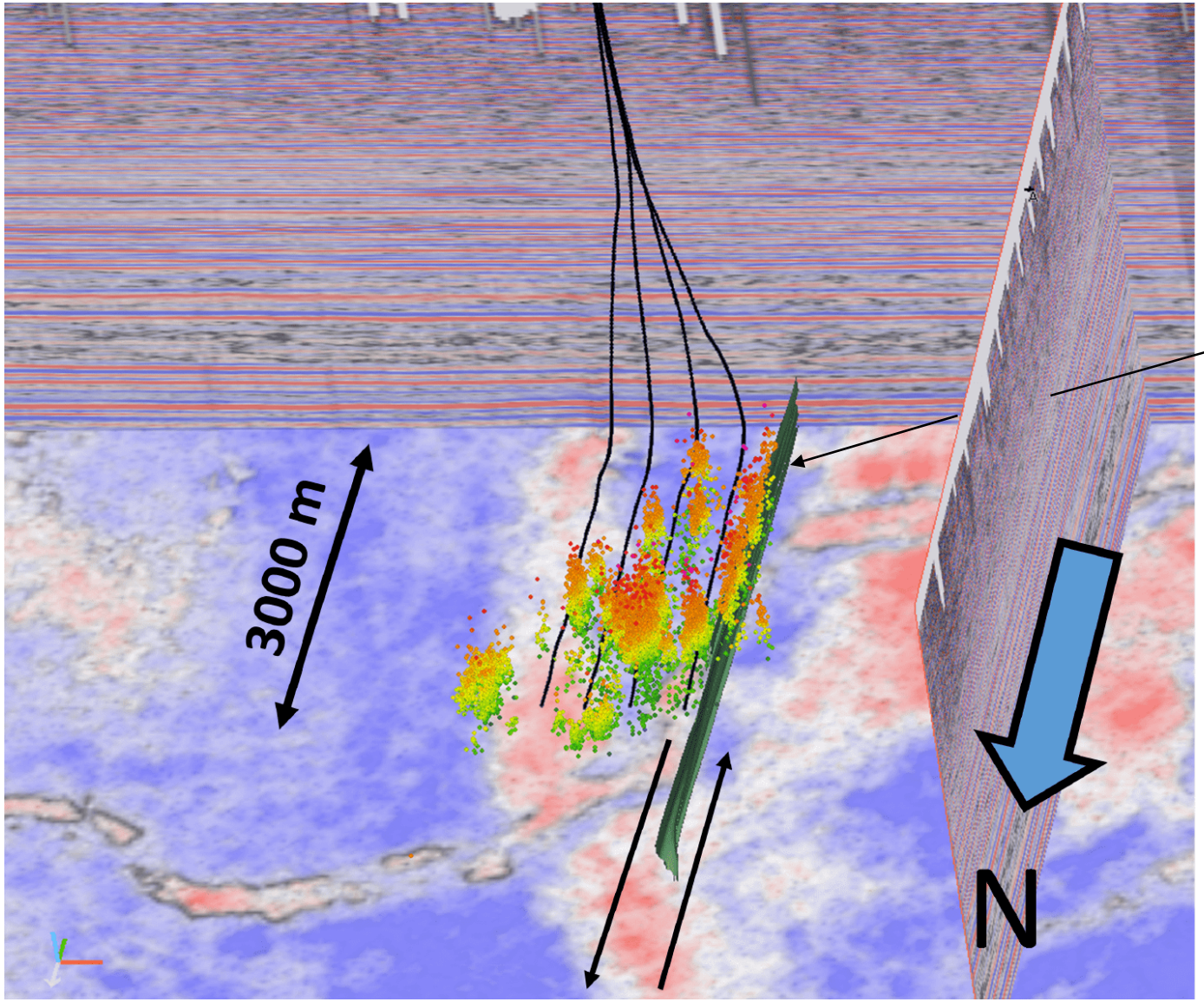



(Eaton et al. 2018)



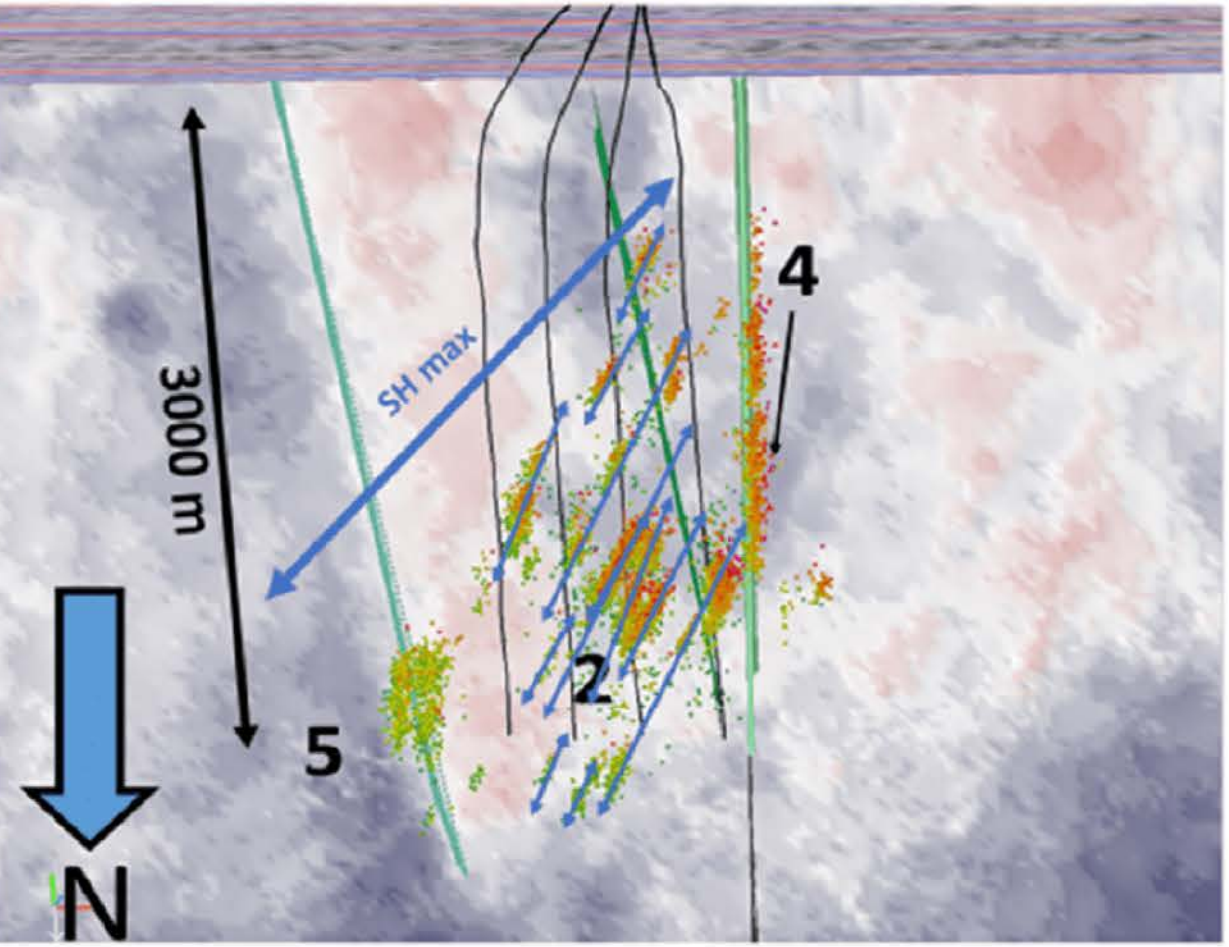

(Poulin et al. 2019)

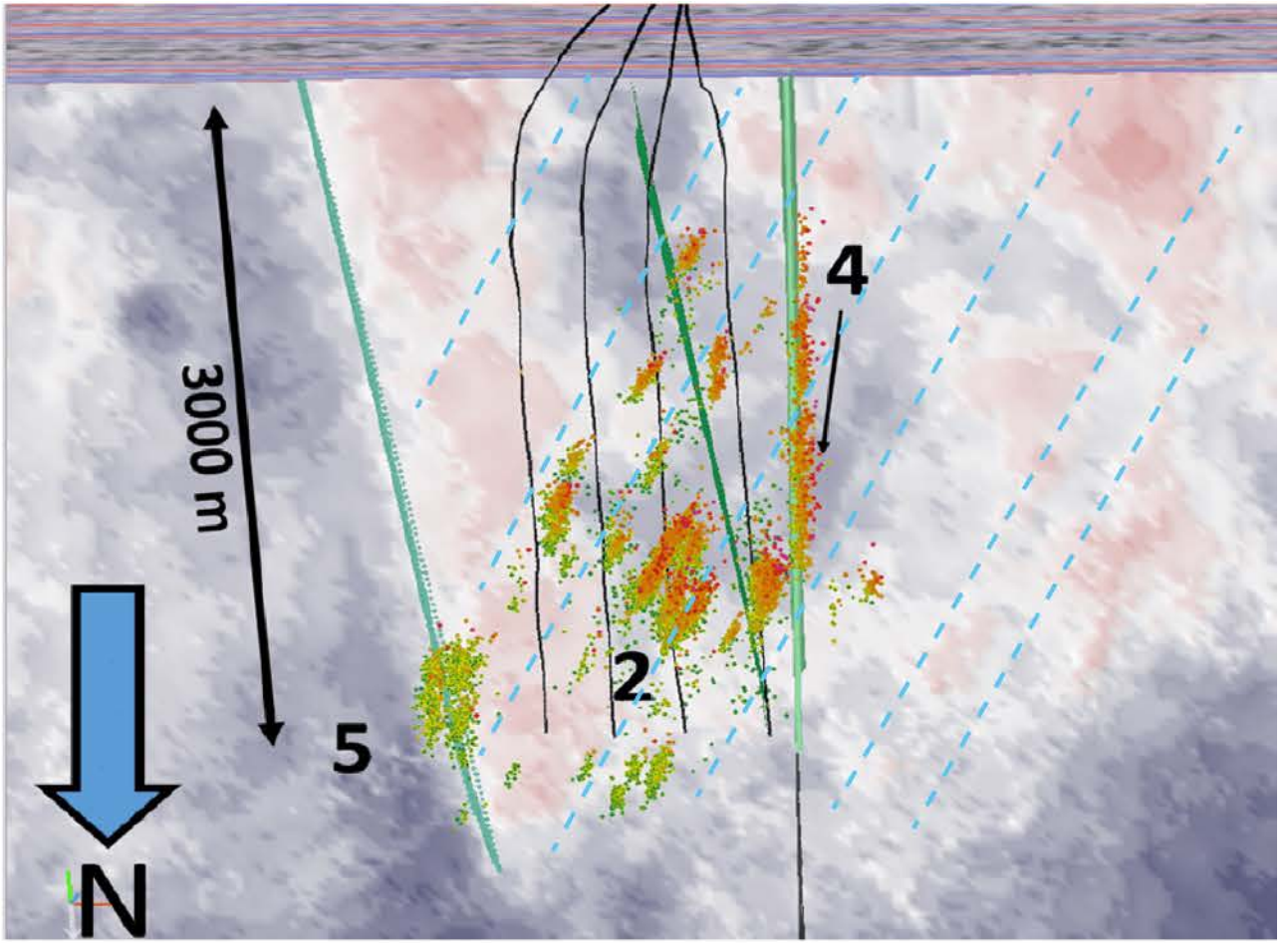
# Time slice through the Gilwood Member




- 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 Formation depth structure

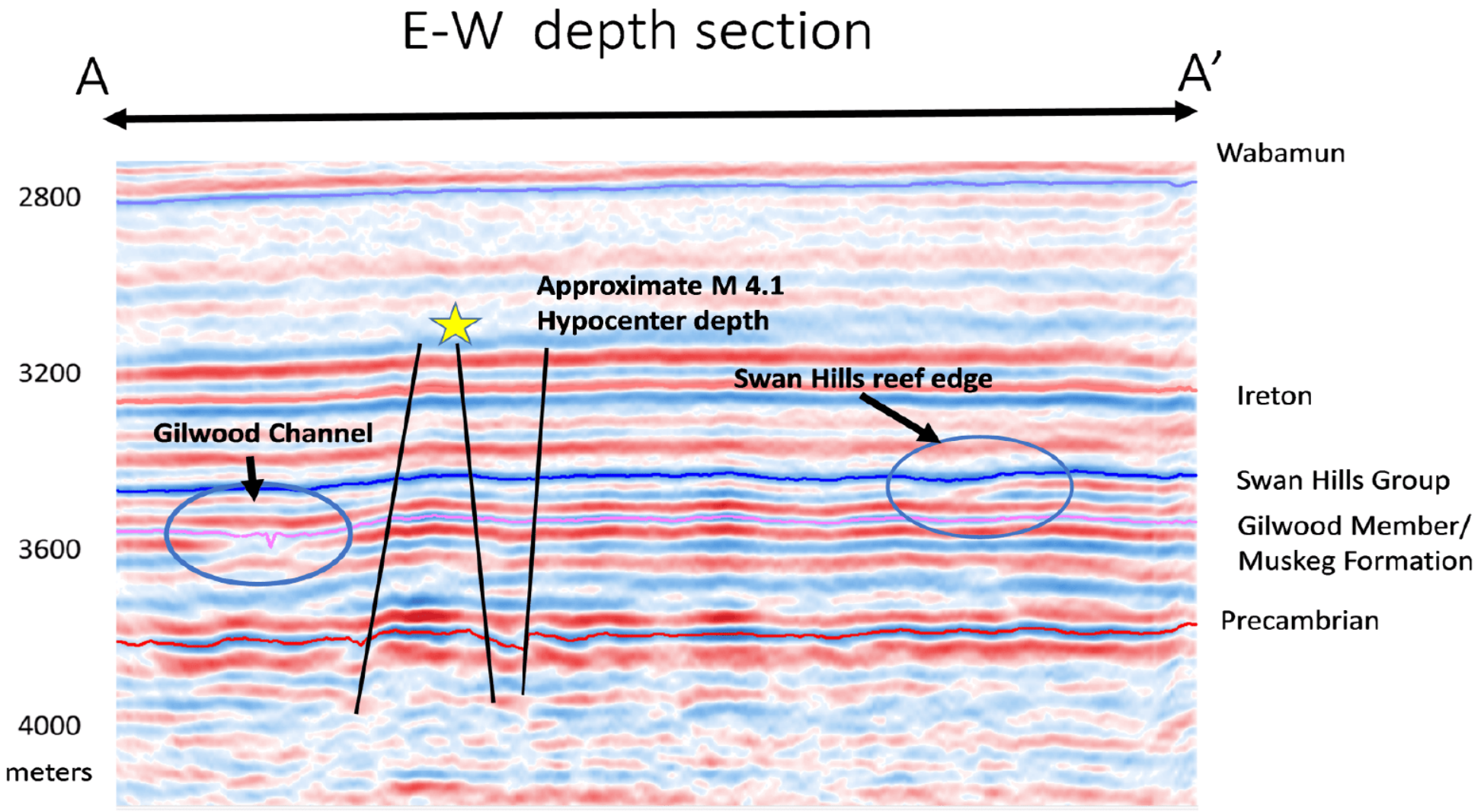



This fault interpretation is based on the transpressional geologic model

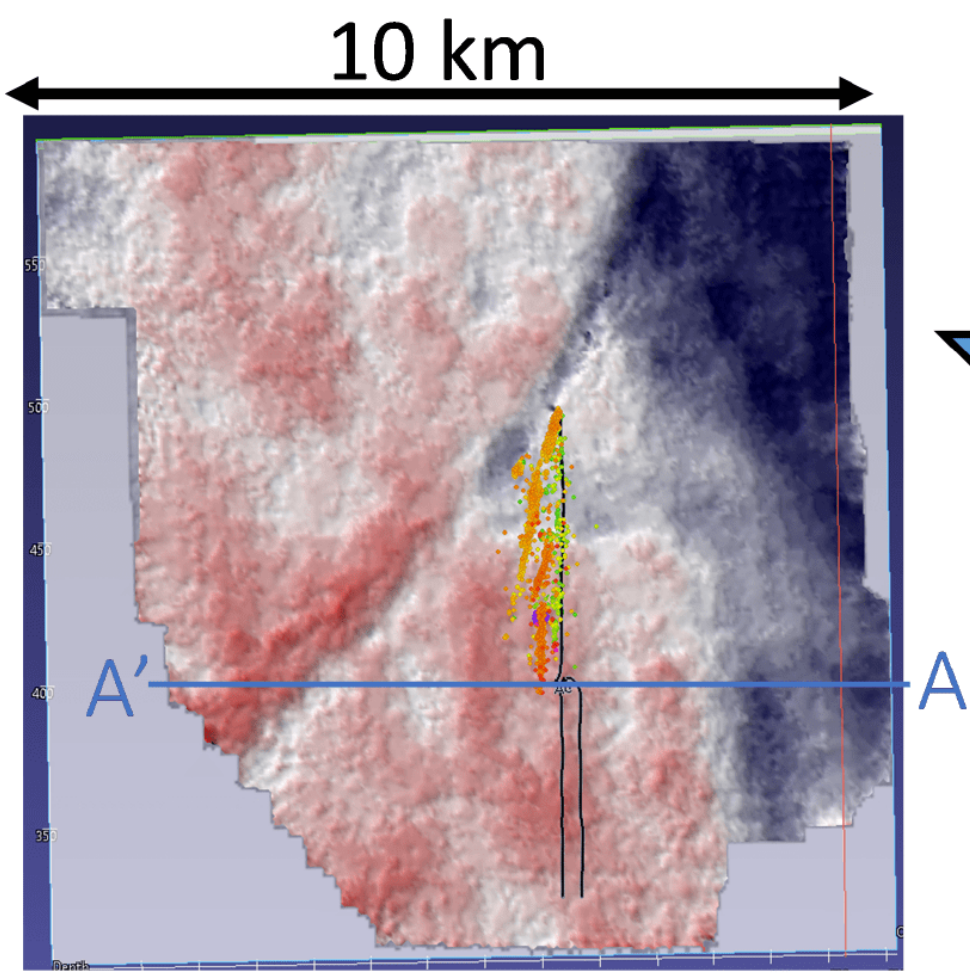
3500 — 3600 Meters below datum

# East-West seismic cross section

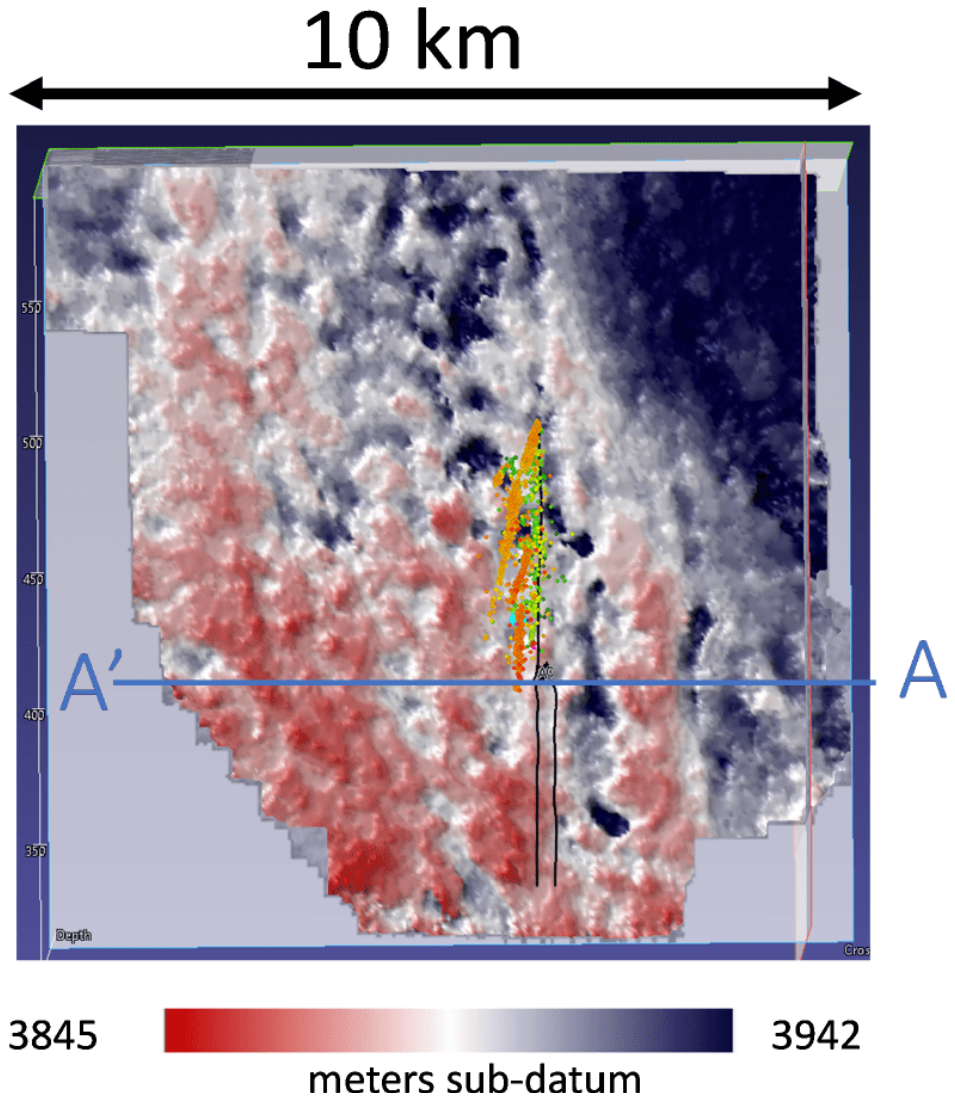



Modified from Eyre et al. (2019)

# Depth maps

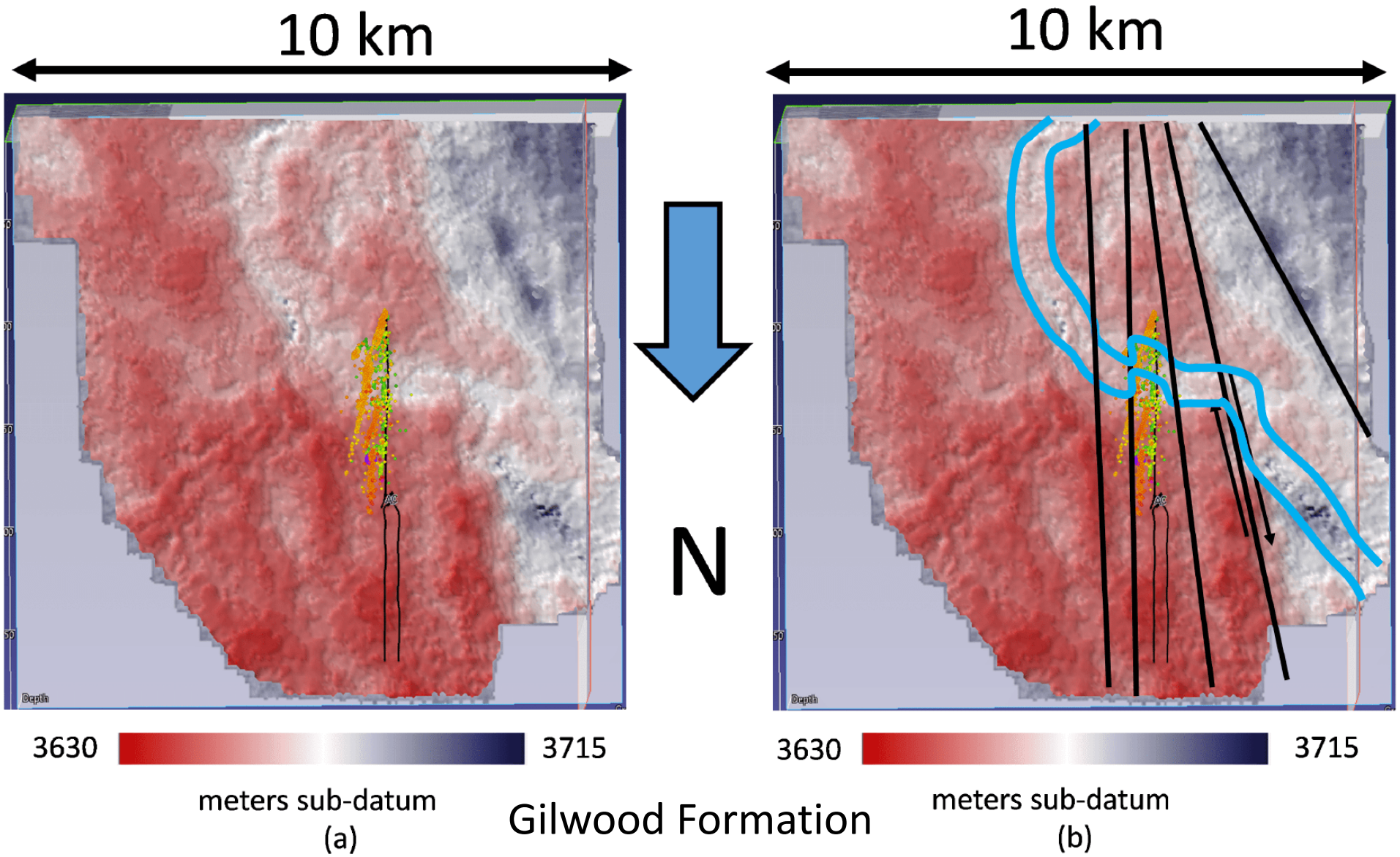



Swan Hills Formation

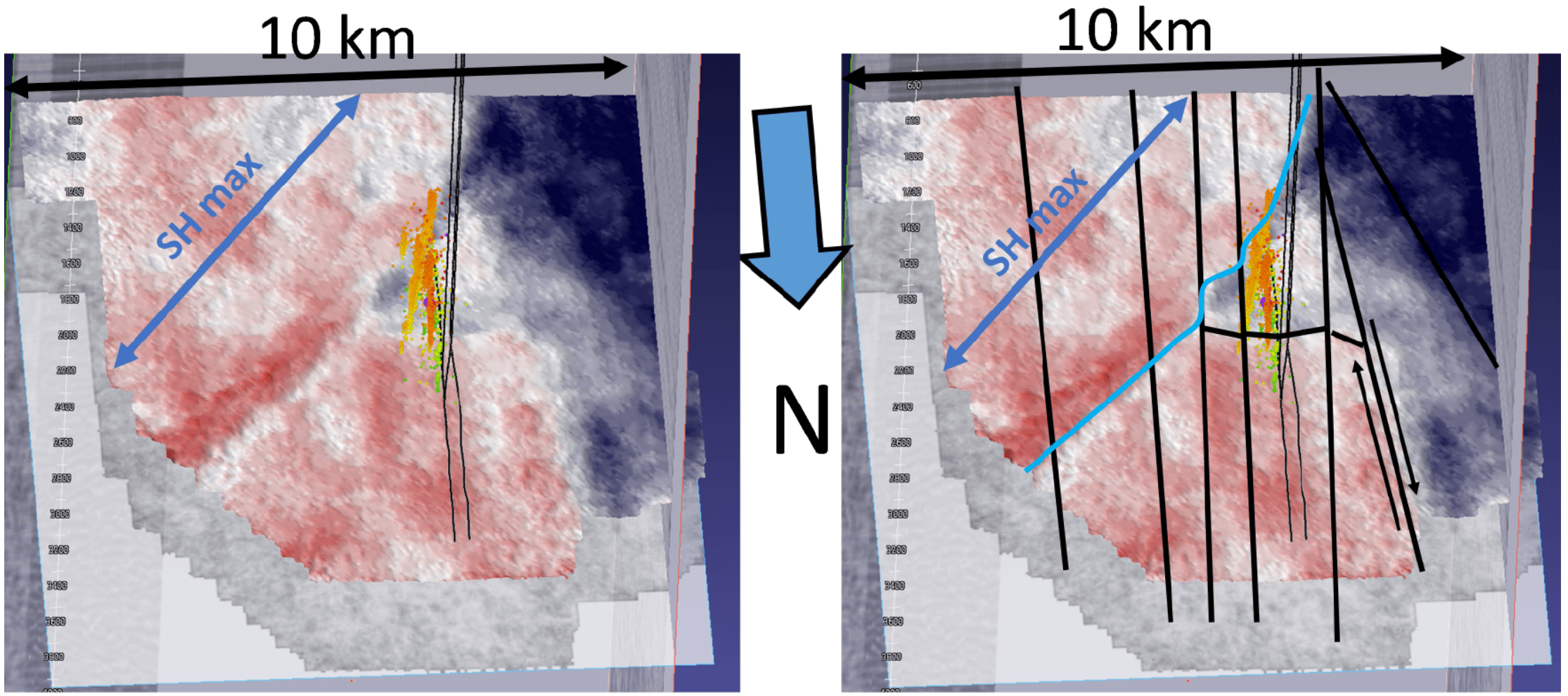



Precambrian Basement

# Depth structure



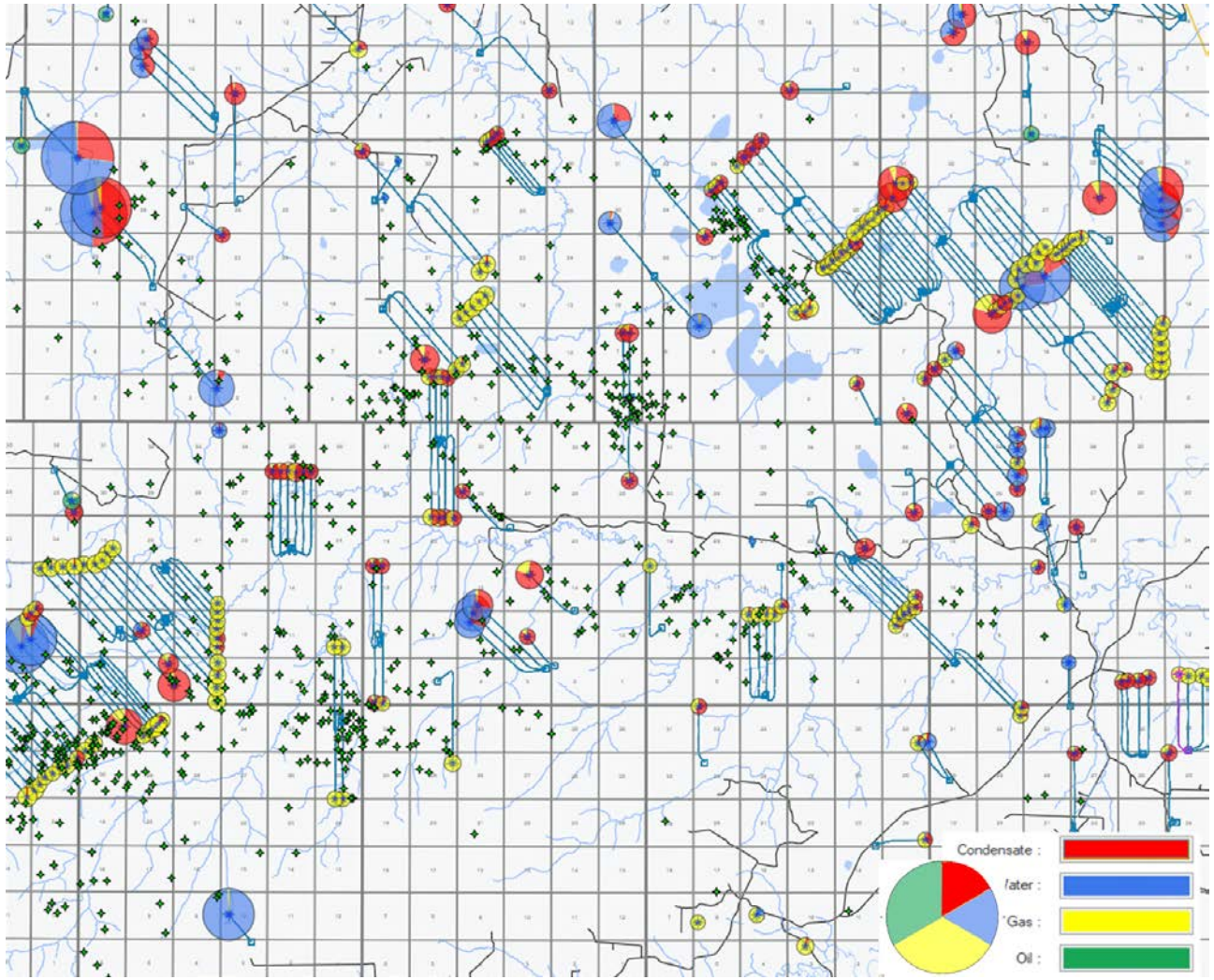
# Swan Hills Formation depth structure




Swan Hills Formation

Fault and reef interpretation

# Reported Production




- The study area is within the predicted condensate window.
- Reported Duvernay production is highly variable, changing from dry gas, to condensate or wet gas production over short distances (km's).

# Conclusions

- Pattern of induced seismicity appears to reflect an underlying transpressional fault system
- The fault system can be mapped using a combination of seismic mapping, and spatial patterns of microseismicity
- Hydrocarbon maturity, as indicated by reported production of dry gas, wet gas and condensate, is more heterogeneous than indicated in published maps
- We speculate that basement-rooted fault systems may have provided conduits for deep, relatively hot fluids (“radiators”) that created localized thermal perturbations that influenced hydrocarbon maturity

# Acknowledgements


- TGS Canada for the contribution of the 3-D, 3-C data.
- CREWES sponsors
- CGG for the use of Insight Earth software
- MIC for access to the microseismic catalogues
- Seisware for the interpretation and 3-D imaging software
- Geoscout
- NSERC (Natural Science and Engineering Research Council of Canada) through grants CRDPJ 461179-13, CRDPJ 474748-14, IRCPJ/485692-2014, and IRCSA 485691
- The SEG Earl D. & Reba C. Griffin Memorial Scholarship

# A special thank you Larry

- Supervisor
- Mentor
- Teacher
- Friend