Source analysis of the Fox Creek/Crooked Lake earthquake sequence

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Oct 27, Calgary

ECONOMY January 13, 2016 3:33 pm

Fox Creek mayor concerned by oilpatch impacts after earthquake

By Bob Webber, The Canadian Press & Emily Mertz, Global News

NEWS EDMONTON

Alberta Premier Rachel Notley said she wants the regulator to speed up a review the NDP government has asked for into seismic activity in the area.

Fox Creek earthquake renews calls for link between fracking and seismic activity

FIRST POSTED: TUESDAY, JANUARY 12, 2016 04:36 PM MST | UPDATED: TUESDAY, JANUARY 12, 2016 MST

Fox Creek fracking operation closed indefinitely after earthquake

reported, energy regulator says

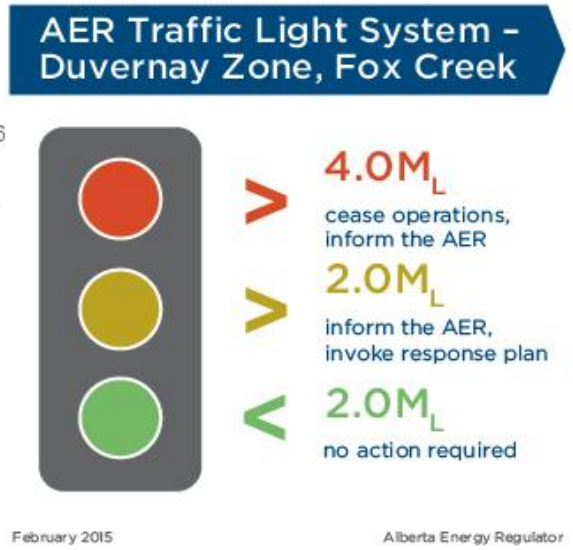
ted: Jan 14, 2016 7:15 PM MT

ENVIRONMENT

Was Canada's Latest Earthquake the Largest Fracking Quake in the World?

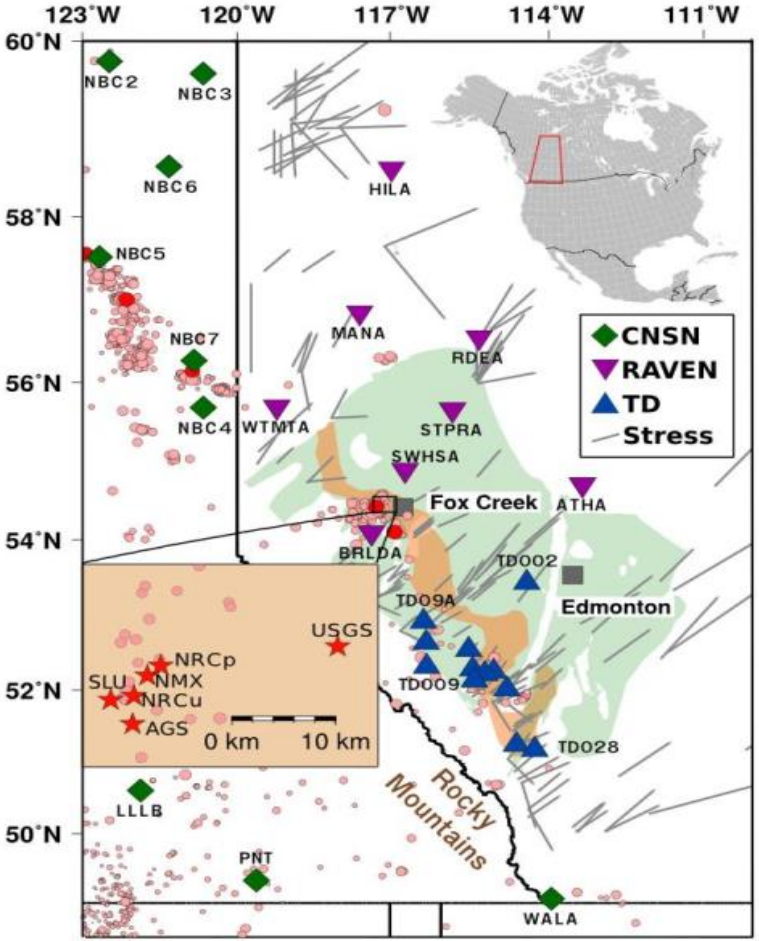
Canada may once again set a world record for the largest earthquake triggered by the controversial drilling process.

By Lorraine Chow / EcoWatch | January 15, 2016



Station distribution

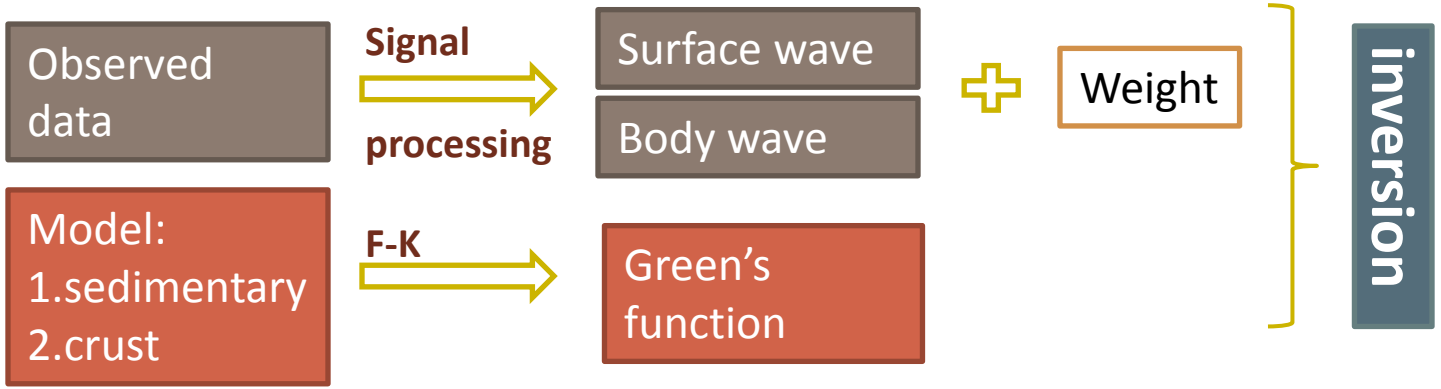
- 3 components
- ~20 stations
- Fox Creek-Duvernay
- Epicenter locations
  - United States Geological Survey (USGS)
  - Nanometrics Athena (NMX)
  - Saint Louis University (SLU)
  - Alberta Geological Survey (AGS)
  - Natural Resources Canada preliminary (NRCp)
  - Natural Resources Canada updated (NRCu)



Wang, et.al., 2016, submitted to GJI

Moment tensor inversion

- Time domain full moment tensor inversion



- Misfit evaluation Variance Reduction (%)
  - d_i-observed; s_i-synthetic

$$VR = \left[1 - \frac{\sum_{i=1}^{m}(d_i - s_i)^2}{\sum_{i=1}^{m} d_i^2}\right] \times 100\%$$

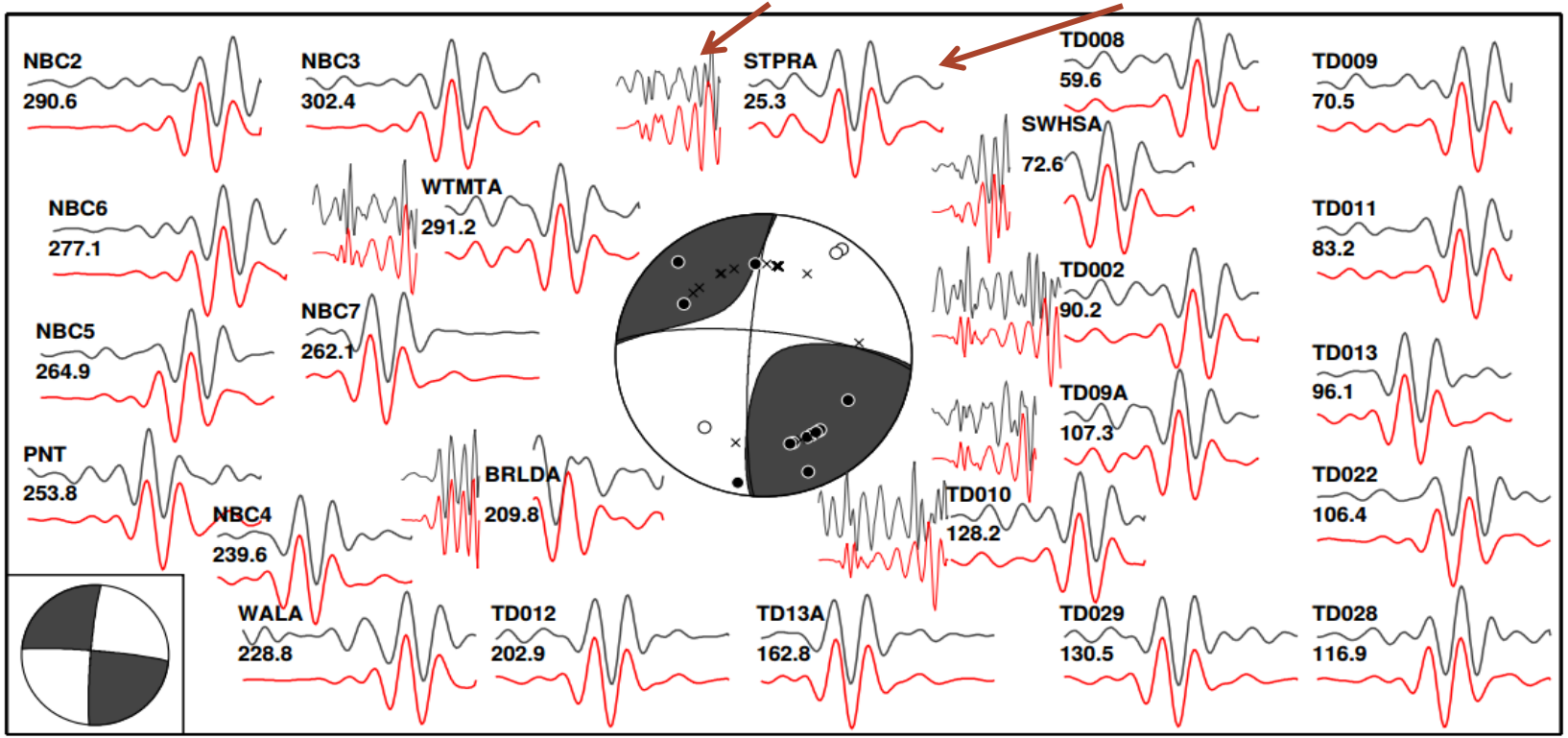
- Moment tensor decomposition
  - Focal mechanism = DC + CLVD + ISO

non-DC

Inversion result

High frequency
Mainly body wave

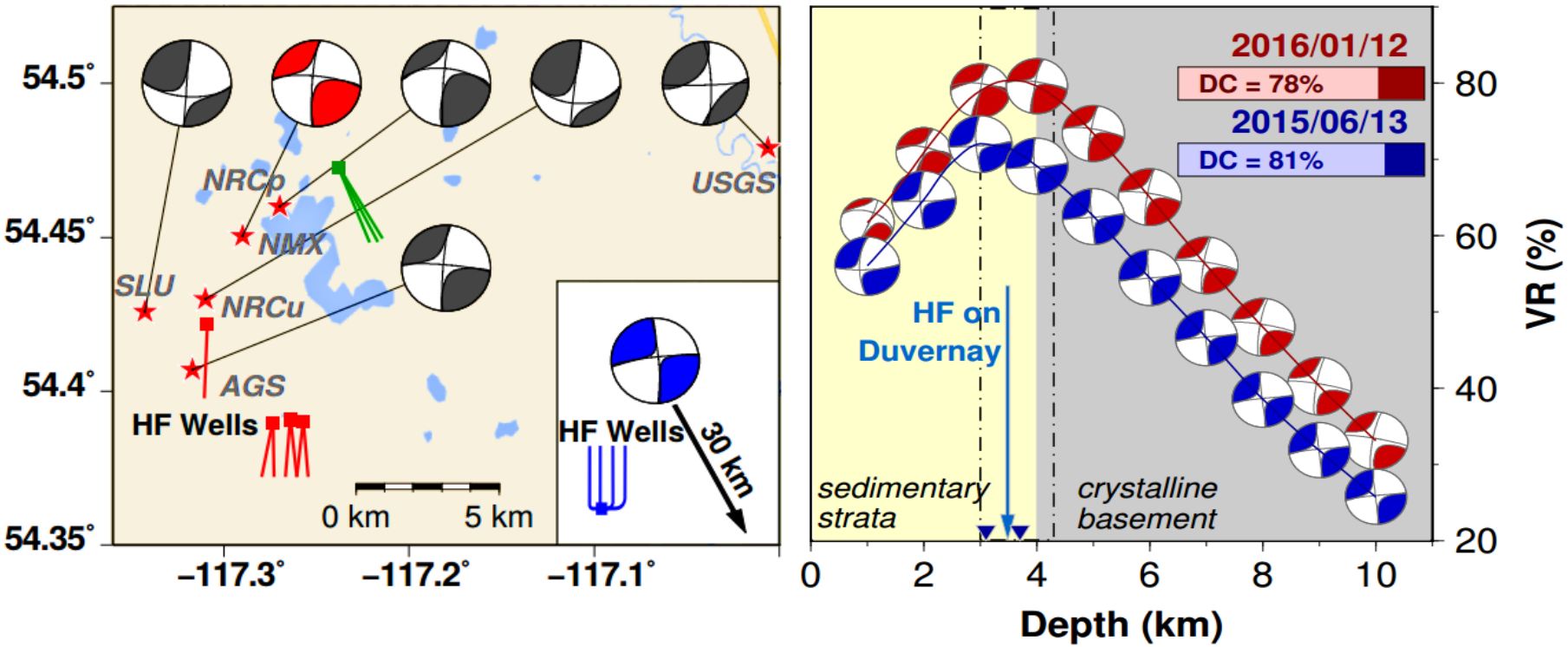
Low frequency
Mainly surface wave



DC

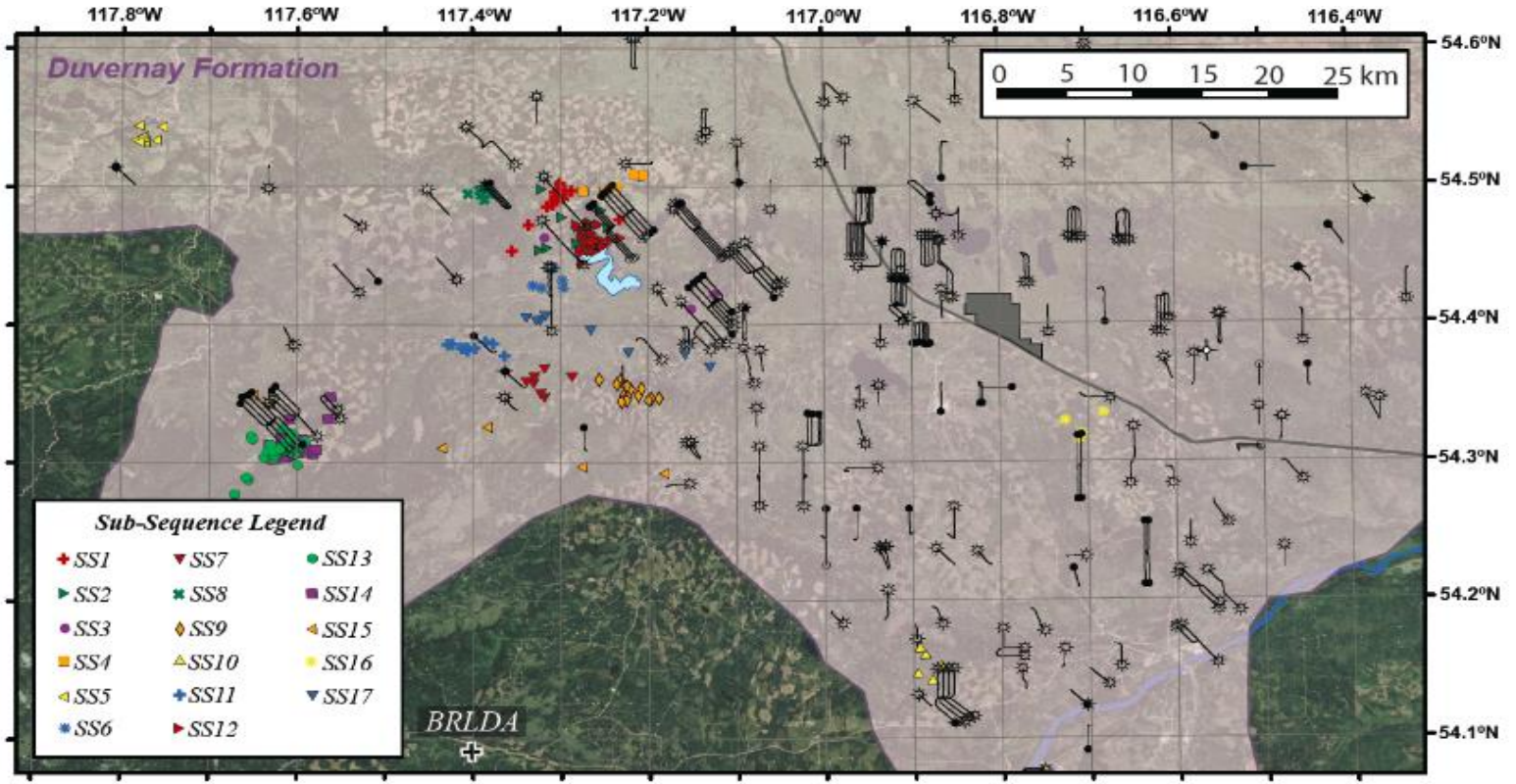
Wang, et al., 2016, submitted to GJI

Hypocenter location



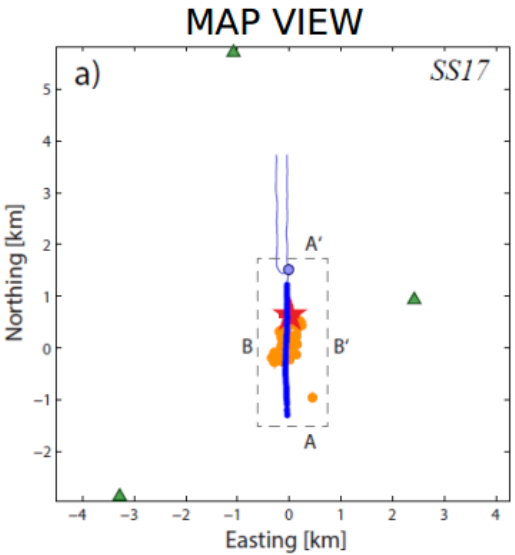
Wang, et al., 2016, submitted to GJI

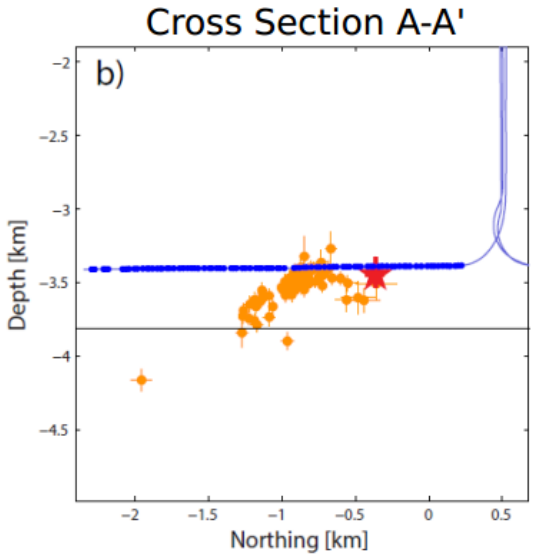
Multiples

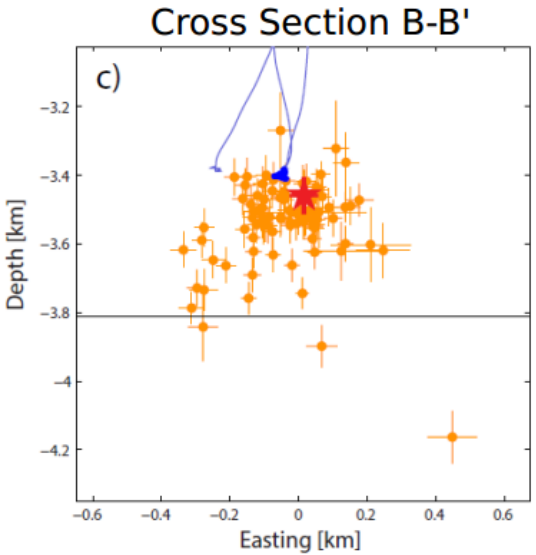


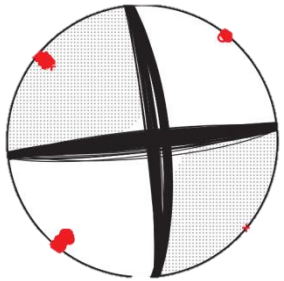
Schultz, et al., 2016, JGR Solid Earth, revised

Relocation of Multiples





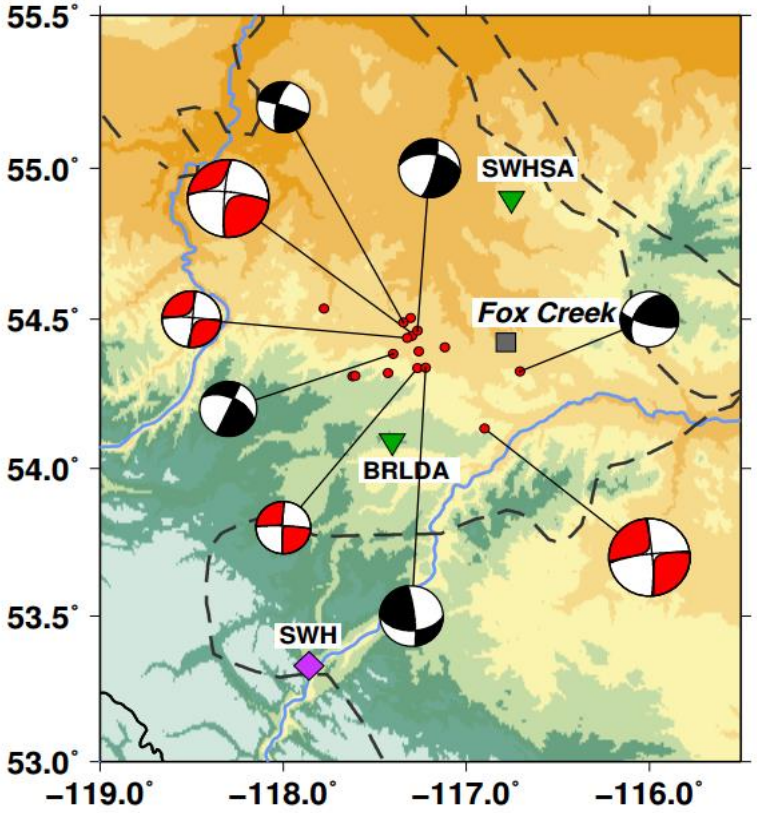




- Detected multiples for the Jan 12, 2016 event
  - The location is close to well
  - Fault orientation?

Schultz, et al., 2016, JGR Solid Earth, revised

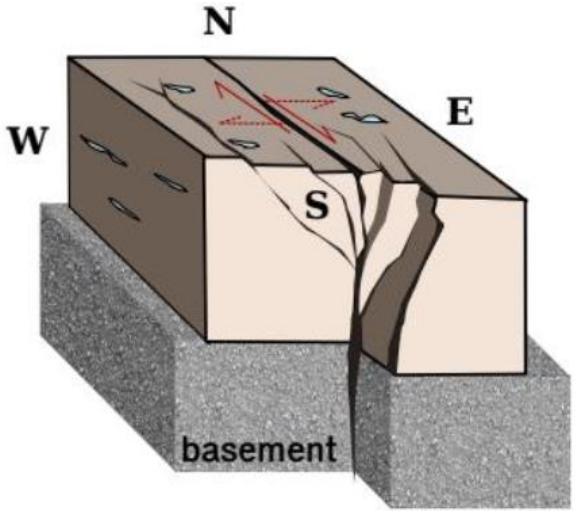
Geological Interpretation



Modified from Schultz, et al., 2016

Moment tensor inversion

DC forward modeling



Wang, et al., 2016, submitted to GJI

Conclusions

- The January 12 2016 event is very likely to be induced.
- Most events around Fox Creek/Crooked Lake are dominated by double-couple, showing vertical fault-plane solutions.
- The geological background seems to prefer a N-S orientation of the potentially reactivated fault(s).
- More information from the geological aspect, near-source close monitoring will help.

Alberta Geological Survey
University of West Ontario
University of Calgary
McGill University

THANK YOU