Isolated cases of remote dynamic triggering in Canada detected using cataloged earthquakes combined with a matched-filter approach

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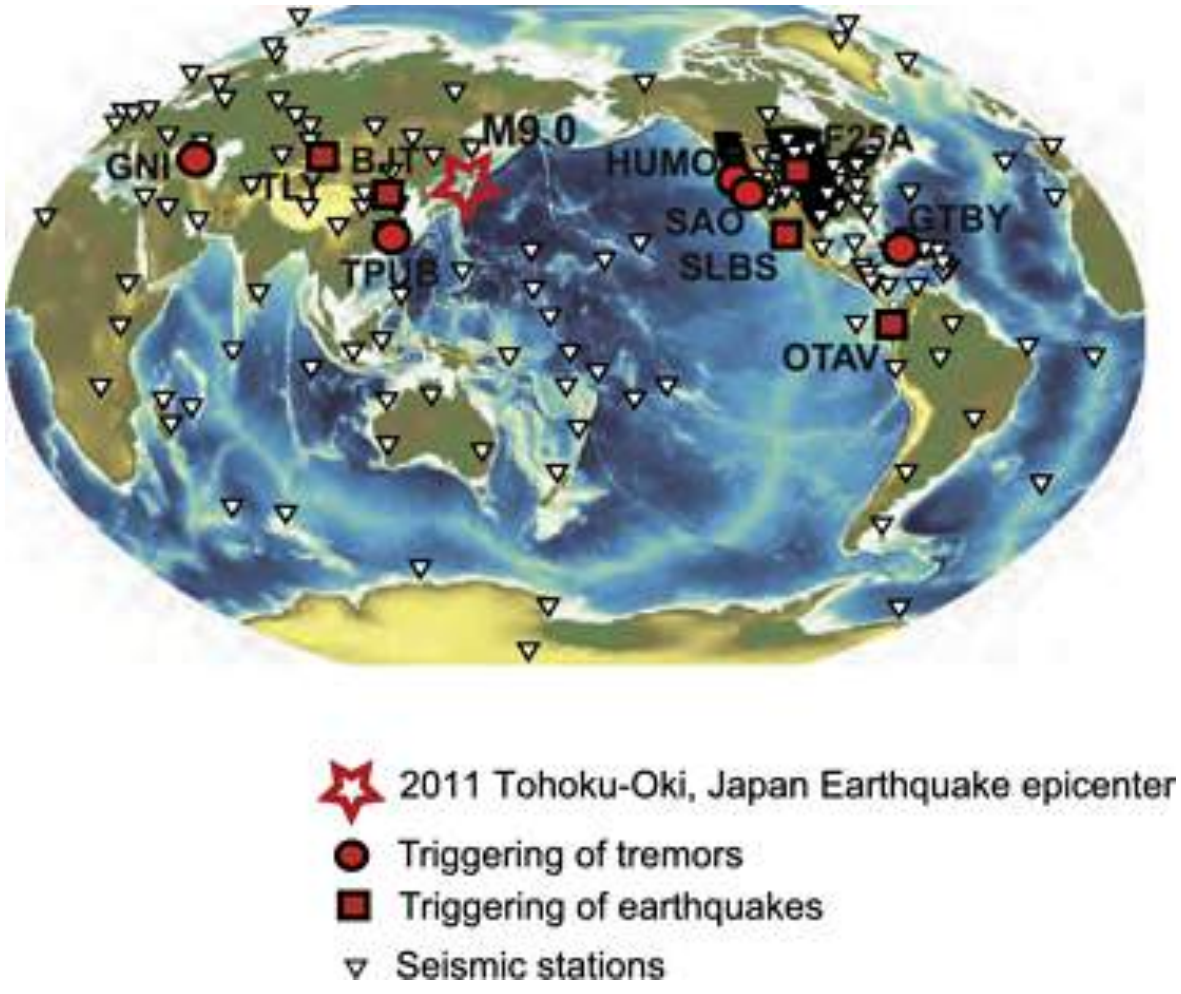
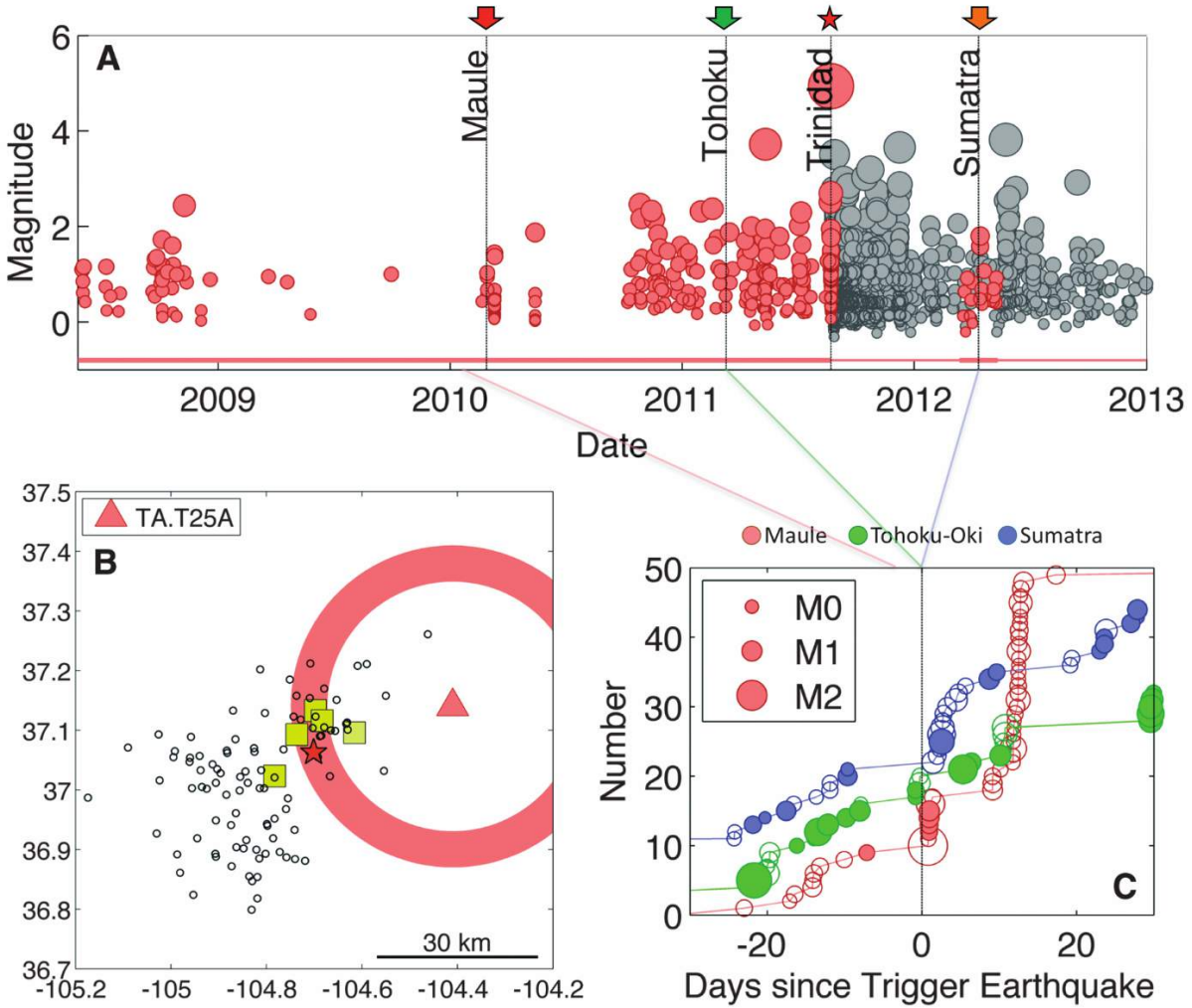
Introduction



Schematic shows remote triggering (Hector et al., 2012)

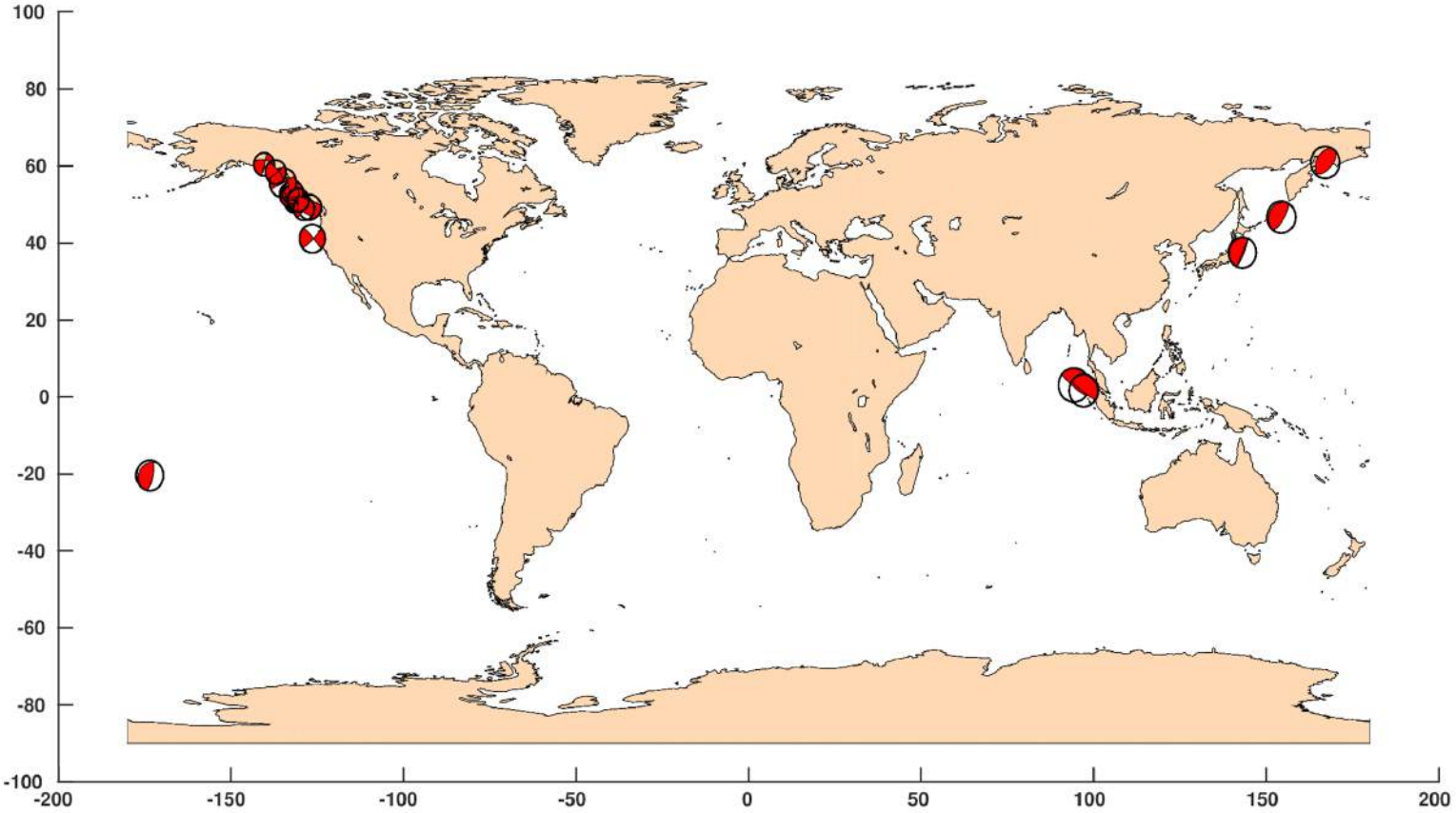
Introduction



Dynamic triggering, Trinidad, Colorado (Van der Elst et al., 2013).

Remote Triggering in Canada: Catalog study

Year: 2004-2014
Depths < 100km
Ms > 6
Peak ground velocity > 0.2 cm/s

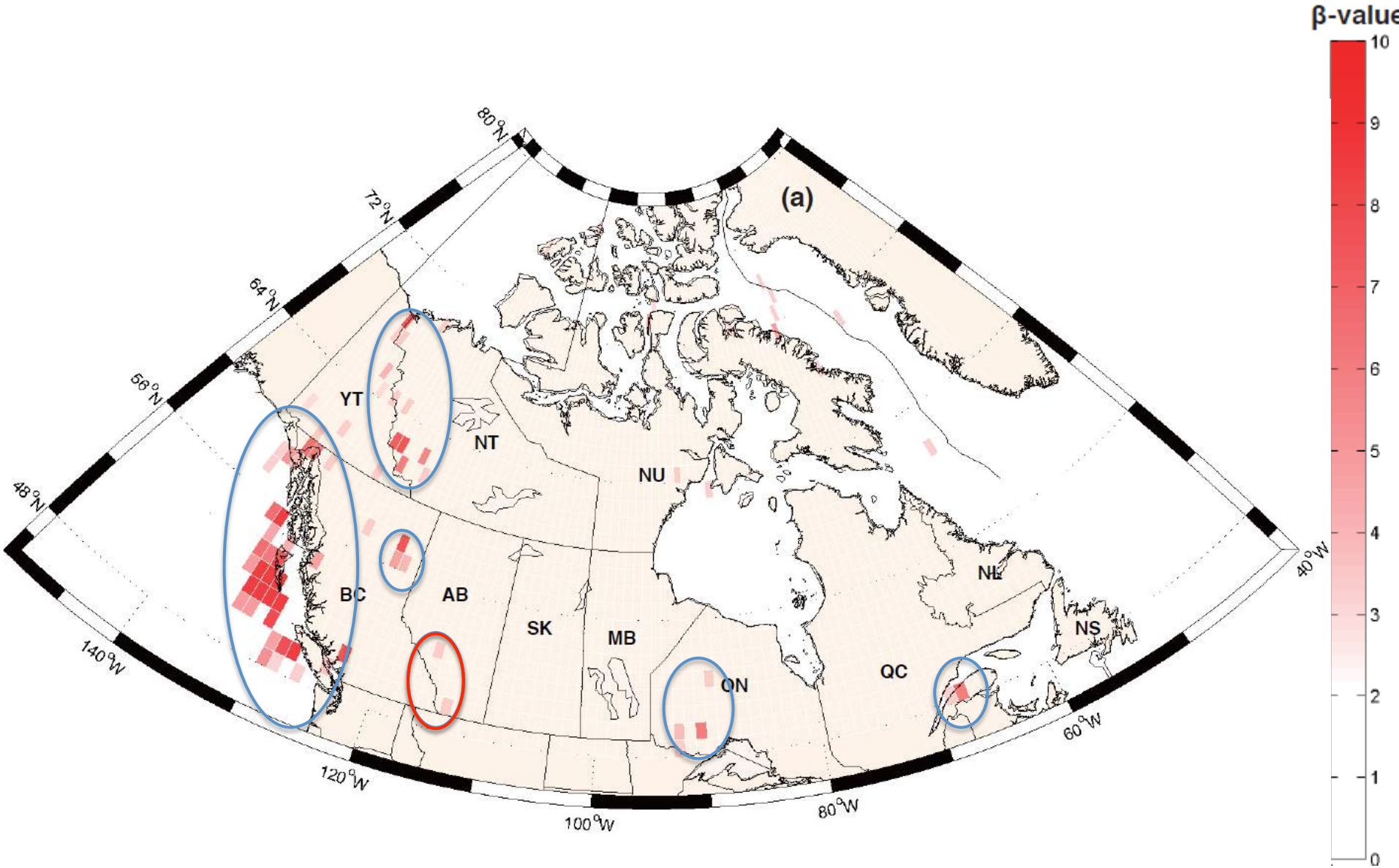


19 mainshocks candidates

Remote Triggering in Canada: Catalog study

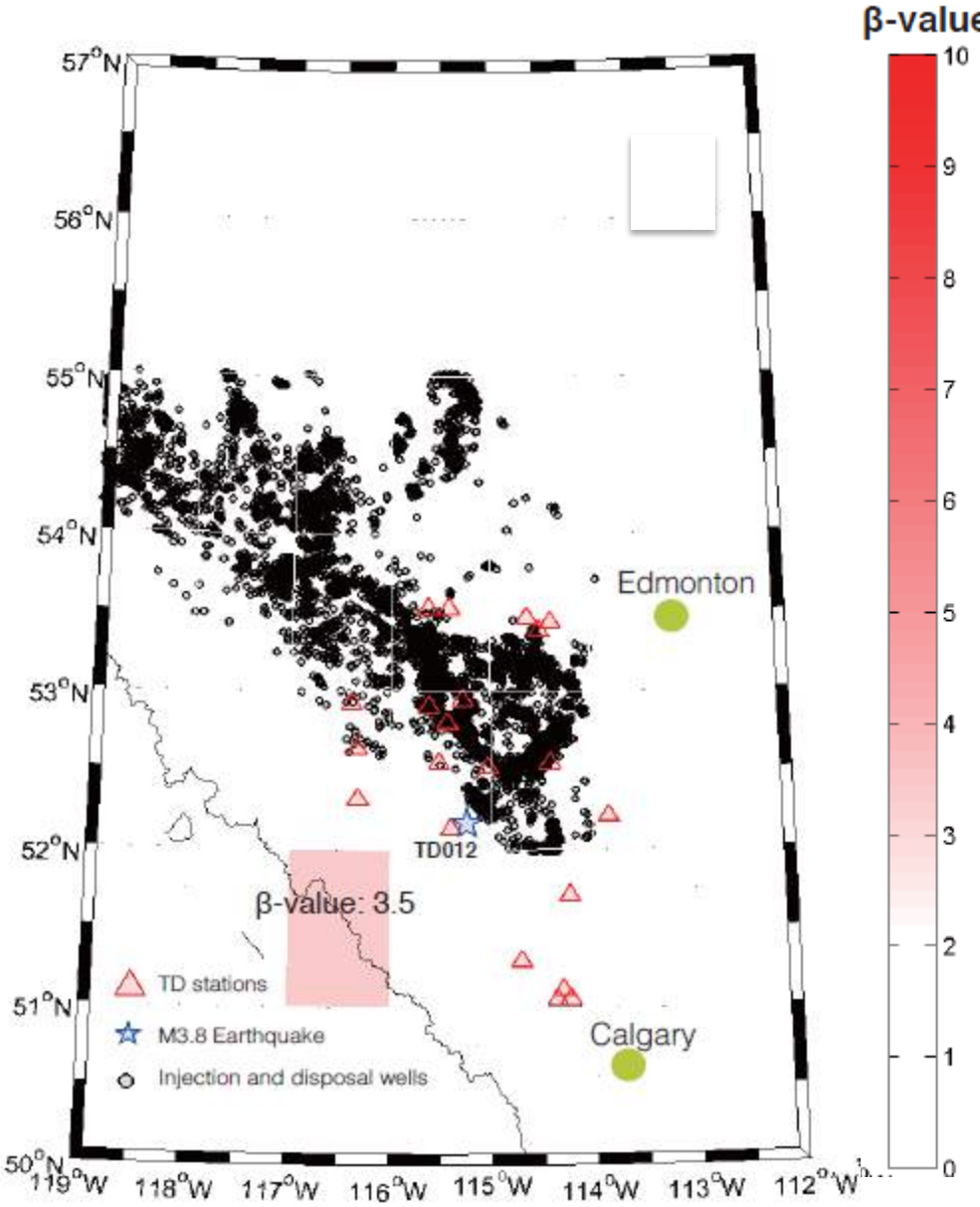
- Count earthquakes in 1°x1° spatial bins in 10-day windows before and after each mainshock
- Calculate the β-value, a quantitative measure of the level of dynamic triggering

Remote Triggering in Canada: Catalog study



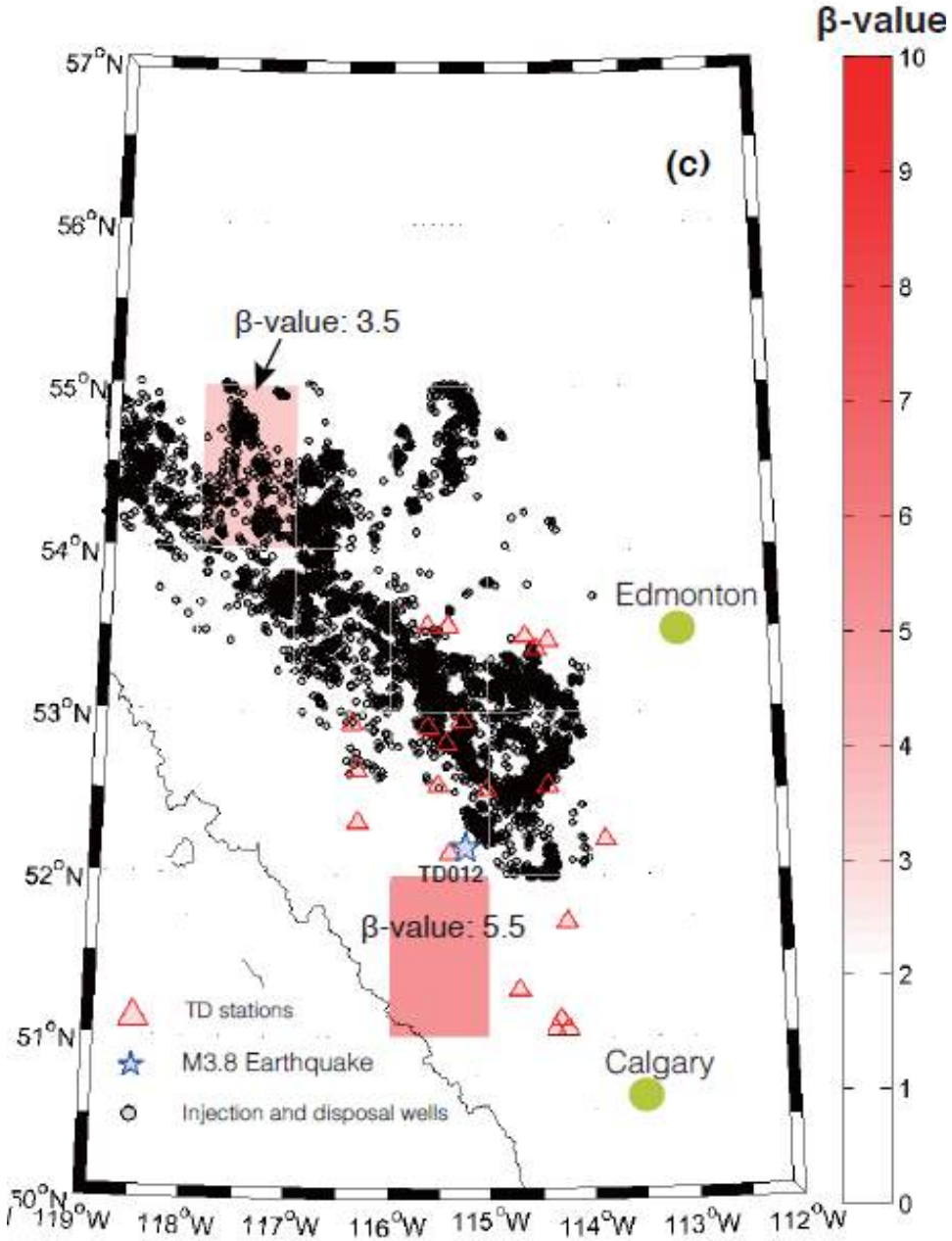
Cumulative β-value

Alberta Geologic Survey catalog study (2006-2010)



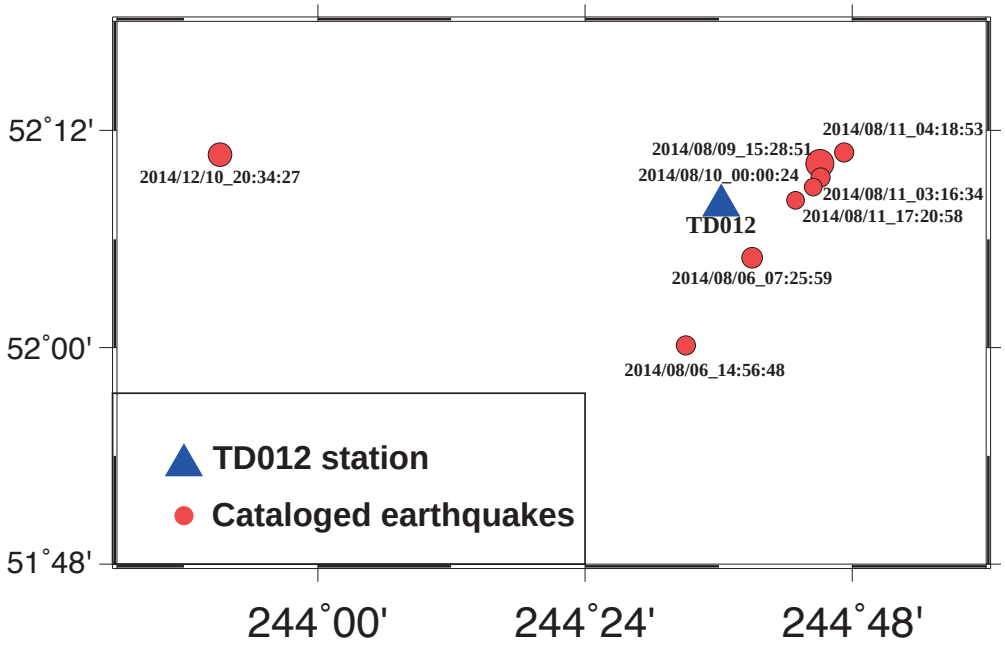
2006/11/15 11:15:18	Ms 8.3	Kuril Islands
2008/01/05 11:01:00	Ms 6.7	Vancouver Island Region
2008/01/09 14:40:03	Ms 6.1	Queen Charlotte Islands Region
2009/11/17 15:30:35	Ms 6.8	West of Vancouver Island

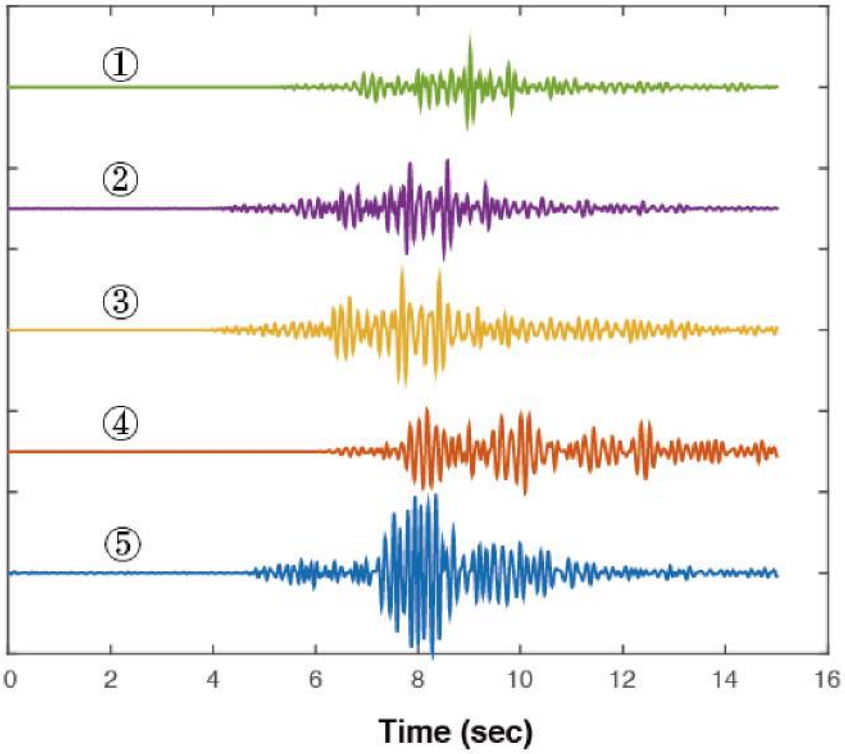
Alberta Composite catalog study (Jan. – Nov., 2014)



2014/10/14 03:06:18	Ms 7.3	El Salvador earthquake
2014/08/24 11:01:00	Ms 6.1	South Napa earthquake
2014/07/25 14:40:03	Ms 6.0	Southeastern Alaska earthquake

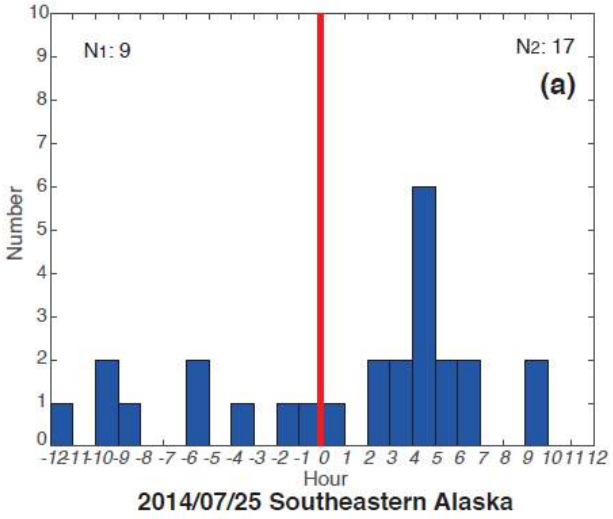
Waveform Study for Alberta : Matched-filter approach

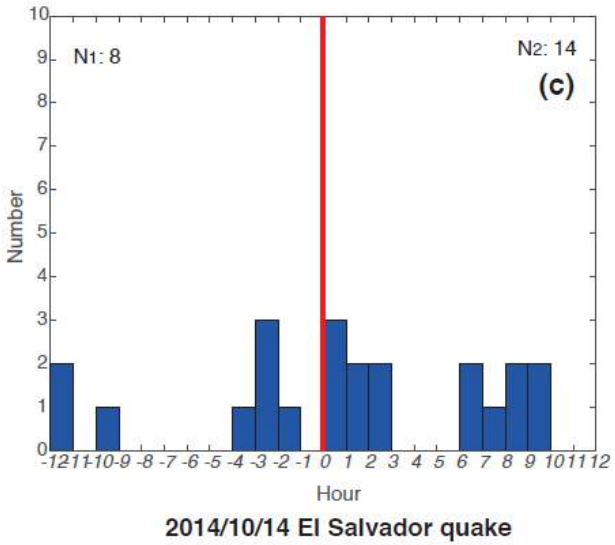


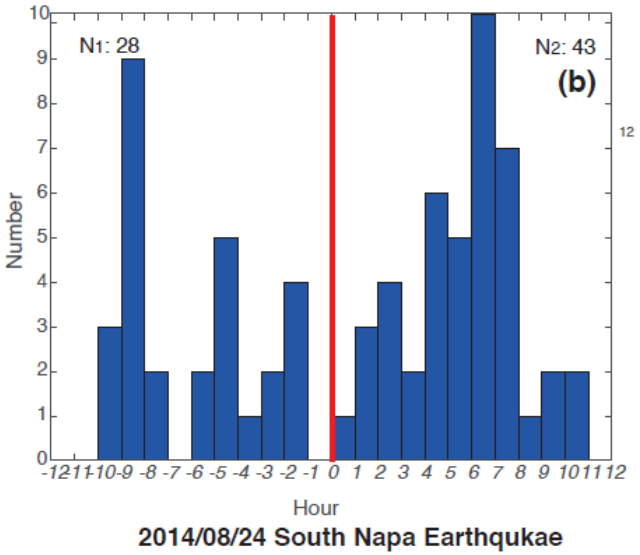


Waveform Study for Alberta: Matched-filter approach

Earthquakes 12 hours before and after mainshocks







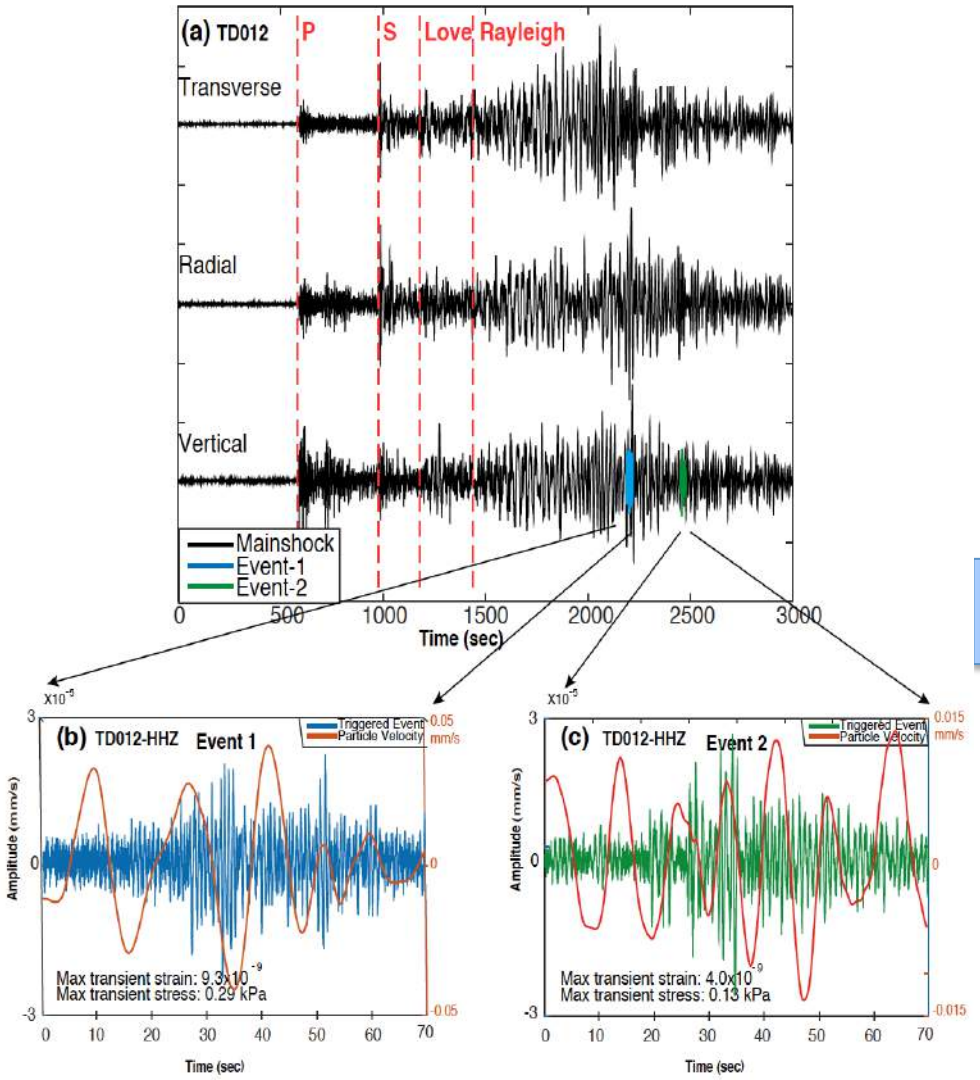
β-value:2.67
P-value:0.063
Significance level: 94%

β-value:2.83
P-value:0.039
Significance level: 96%

β-value:2.12
P-value:0.11
Significance level: 89%

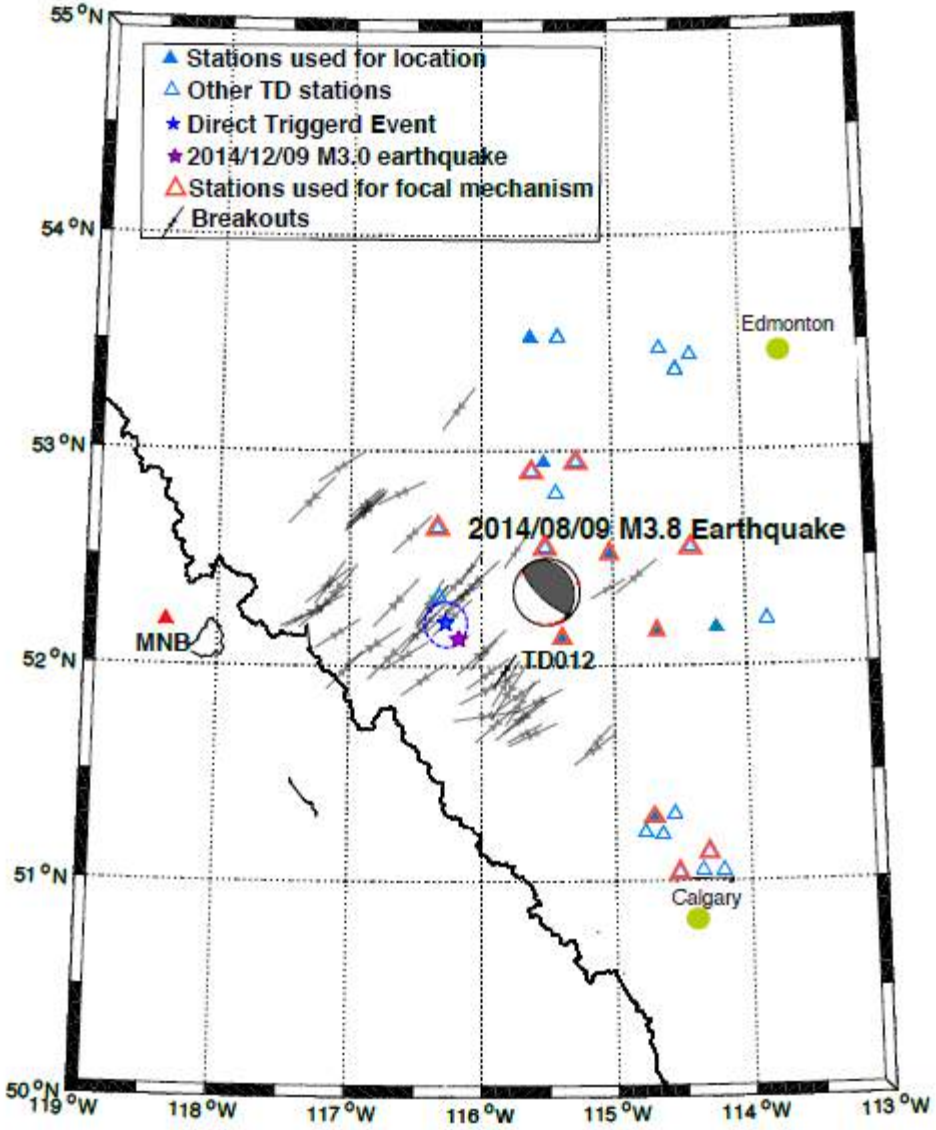
Waveform Study for Alberta: Direct triggering in Rayleigh wave train

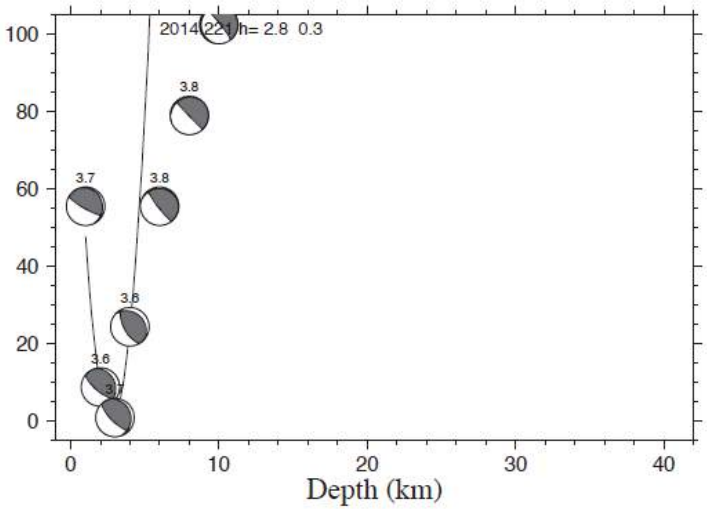
Transient stress: 0.29 kPa
Transient Strain: $9.3*10^{-9}$



Transient stress: 0.13 kPa
Transient Strain: $4.0*10^{-9}$

Waveform Study for Alberta: Location and focal mechanism



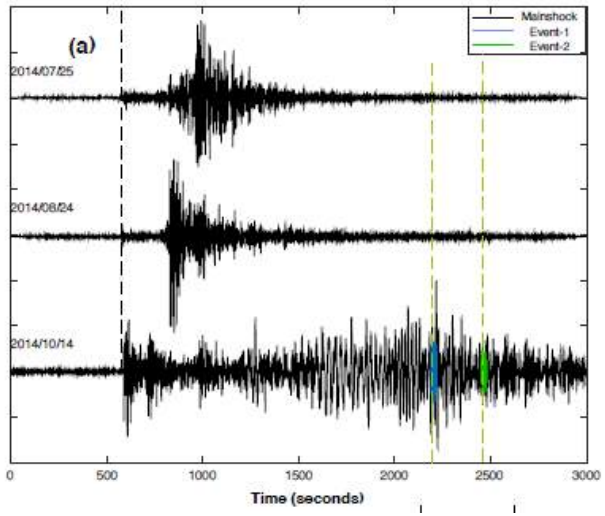


S24A-0342, Carey et al

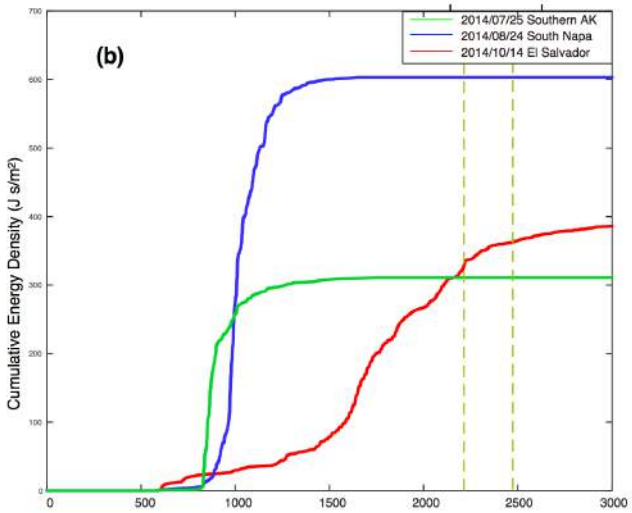
Waveform Study for Alberta

Mainshocks	Maximum stress	Maximum strain
2014/10/14 M_S 7.3 El Salvador earthquake	0.37 kPa	1.14×10^{-8}
2014/08/24 M_S 6.1 South Napa earthquake	0.46 kPa	1.43×10^{-8}
2014/07/25 M_S 6.0 Southeastern Alaska earthquake	0.41 kPa	1.29×10^{-8}

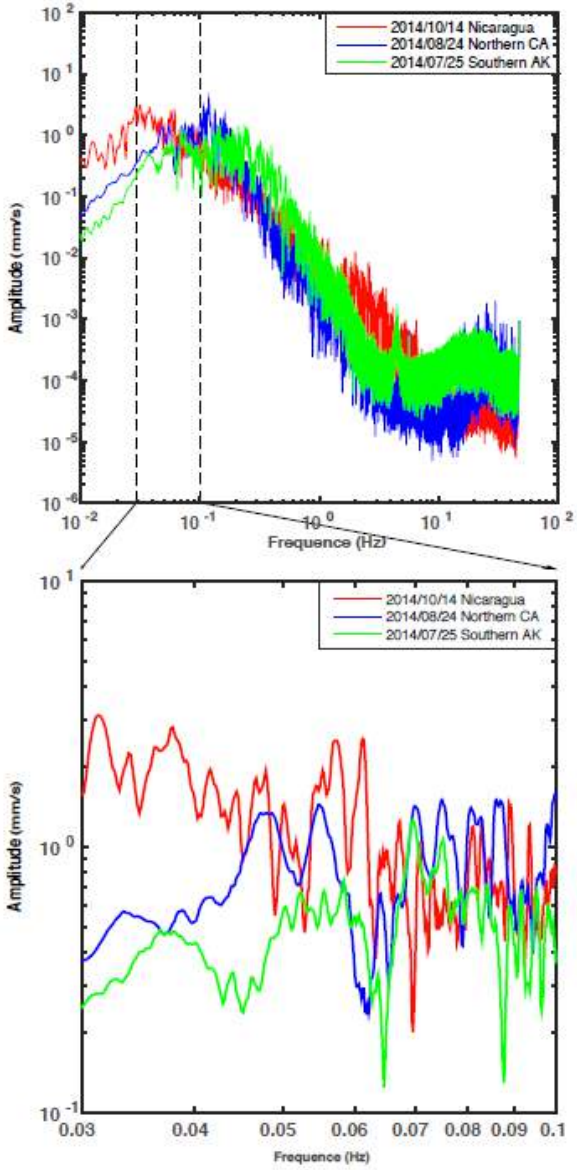
Triggering Factors?



Duration



Energy



Spectrum

Conclusions

- We observe **isolated triggering** in several locations in Canada
- We observe statistically significant triggering in Alberta as well as **two directly triggered events** during the 2014 El Salvador mainshock.
- **Small stress** perturbations suggest pre-existing faults near the western Alberta may be **critically stressed**
- **Long-period shaking below 20 s** may be more effective at triggering than cumulative energy.

Thanks!