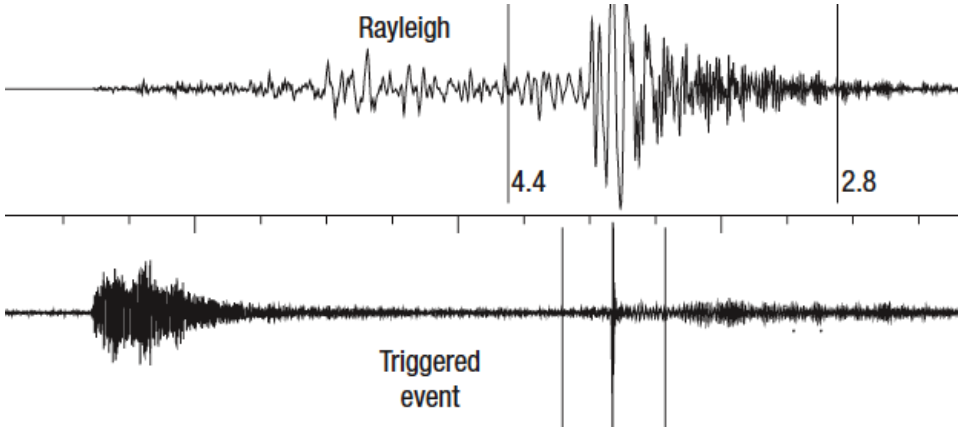


The nature of fault loading, earthquake cycles, and earthquake triggering

Angela Magee and Chunpeng Zhao

Paper 1: Global ubiquity of dynamic earthquake triggering

[Velasco et al., 2008]

- Data: Broadband seismograms
  - ±5h around 15 earthquakes with mag >=7.0
  - Vertical component only
- Method: an automated algorithm
  - High pass filter (5HZ)
  - Antelope software
  - Short Term Average (STA)/ Long Term Average (LTA)
- Conclusion: Dynamic triggering is ubiquitous and independent of the tectonic environment.

Figure 1

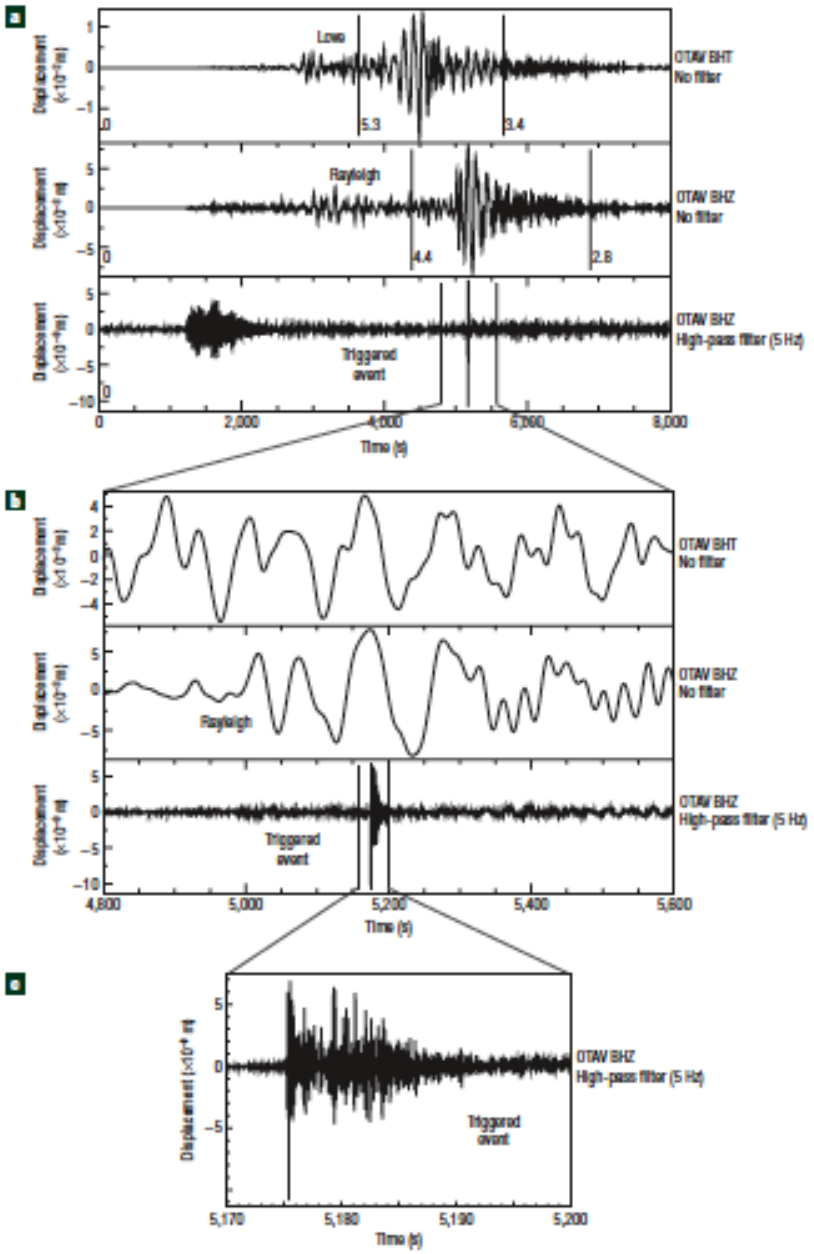

Love
5.3
3.4
OTAV BHT
No filter
Rayleigh
4.4
2.8
OTAV BHZ
No filter
Triggered event
OTAV BHZ
High-pass filter (5 Hz)
Time (s)
OTAV BHT
No filter
Rayleigh
OTAV BHZ
No filter
Triggered event
OTAV BHZ
High-pass filter (5 Hz)
Time (s)
OTAV BHZ
High-pass filter (5 Hz)
Triggered event
Time (s)

Figure 2

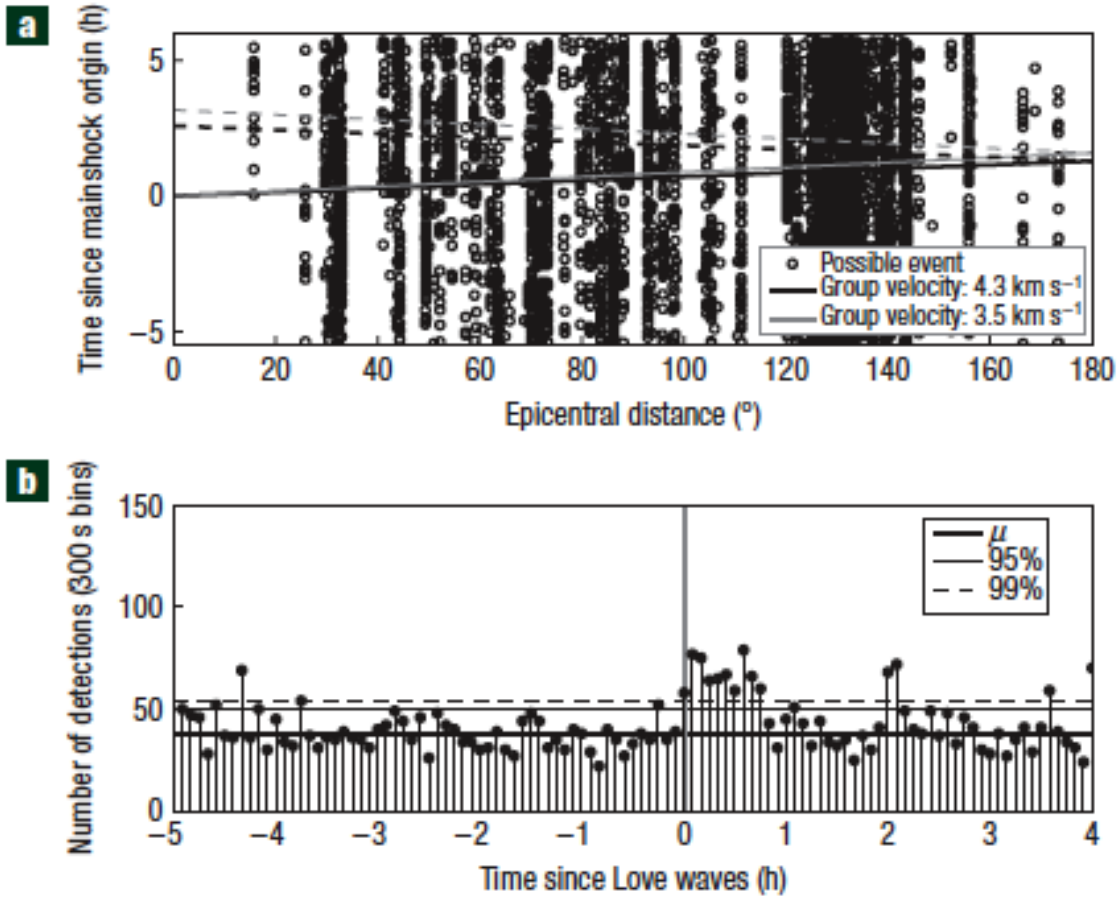

a
Time since mainshock origin (h)
5
0
−5
0
20
40
60
80
100
120
140
160
180
Epicentral distance (°)
Possible event
Group velocity: 4.3 km s−1
Group velocity: 3.5 km s−1
b
Number of detections (300 s bins)
150
100
50
0
−5
−4
−3
−2
−1
0
1
2
3
4
Time since Love waves (h)
μ
95%
99%

Figure 3

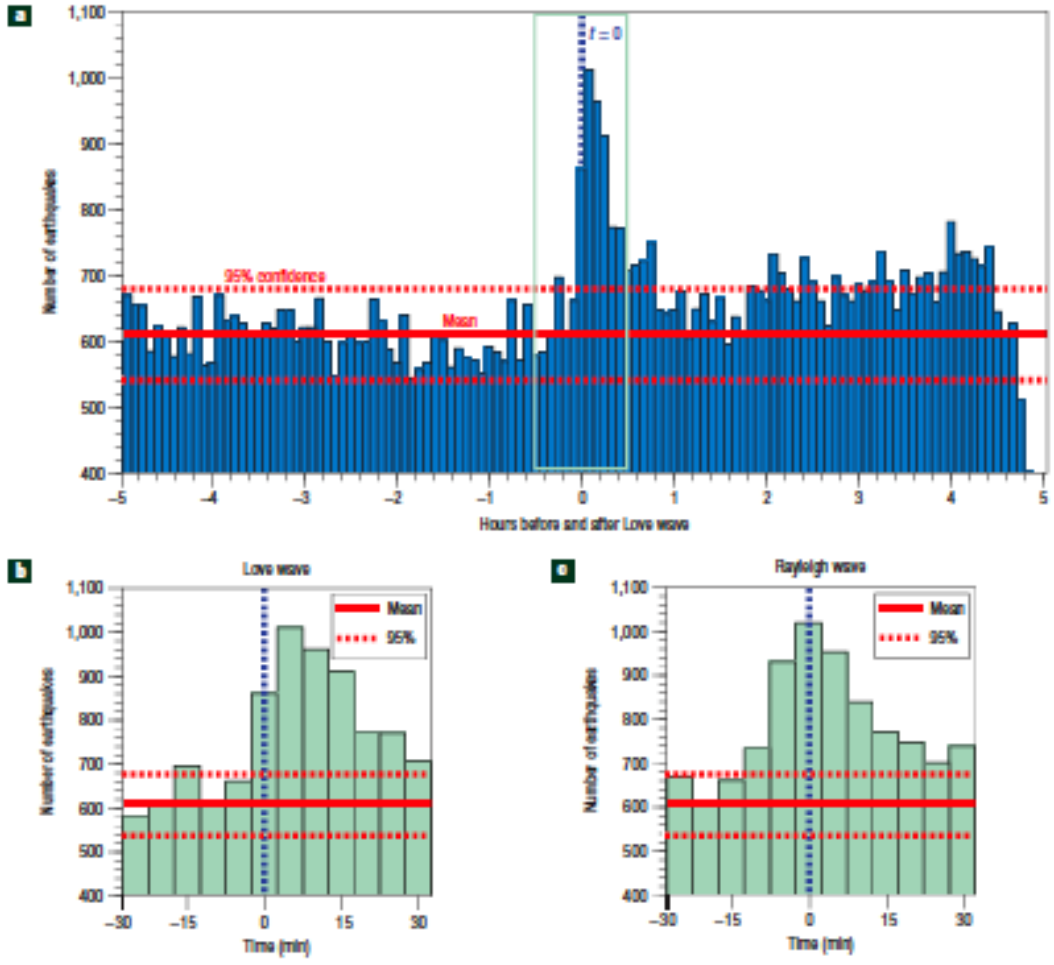
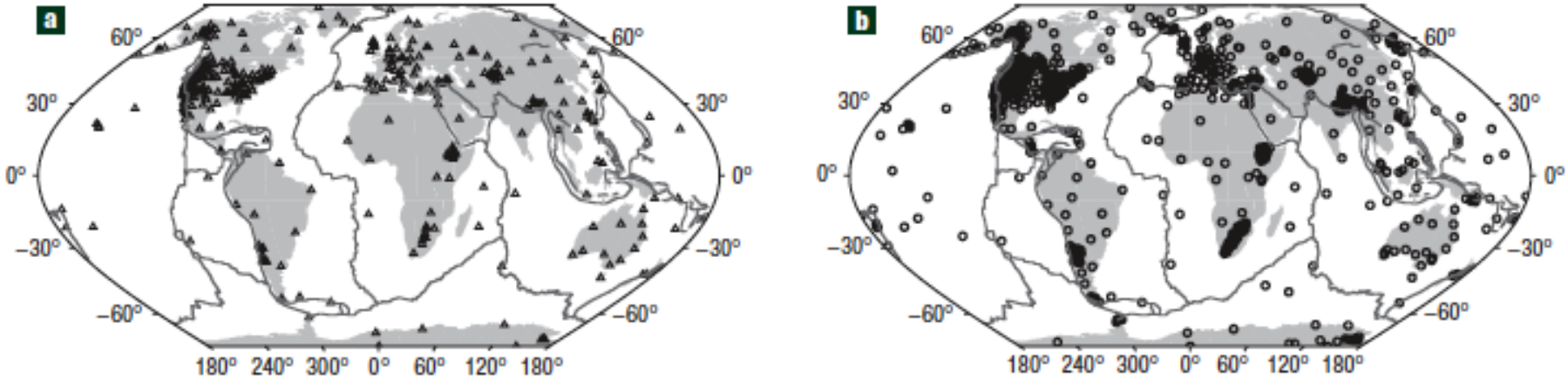

a
1,100
1,000
900
800
700
600
500
400
Number of earthquakes
t = 0
95% confidence
Mean
–5
–4
–3
–2
–1
0
1
2
3
4
5
Hours before and after Love wave
b
Love wave
Mean
95%
Number of earthquakes
–30
–15
0
15
30
Time (min)
c
Rayleigh wave
Mean
95%
Number of earthquakes
–30
–15
0
15
30
Time (min)

Figure 4



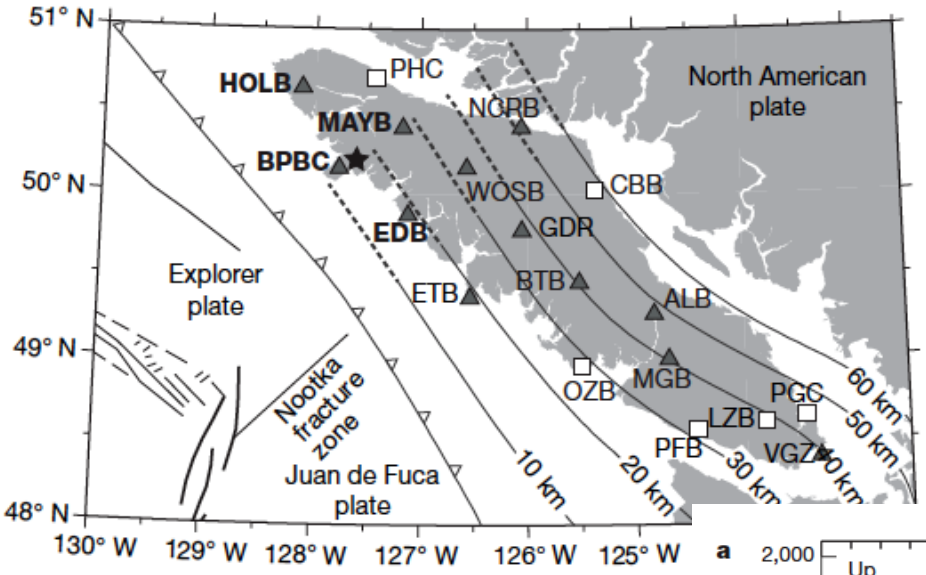
Discussion

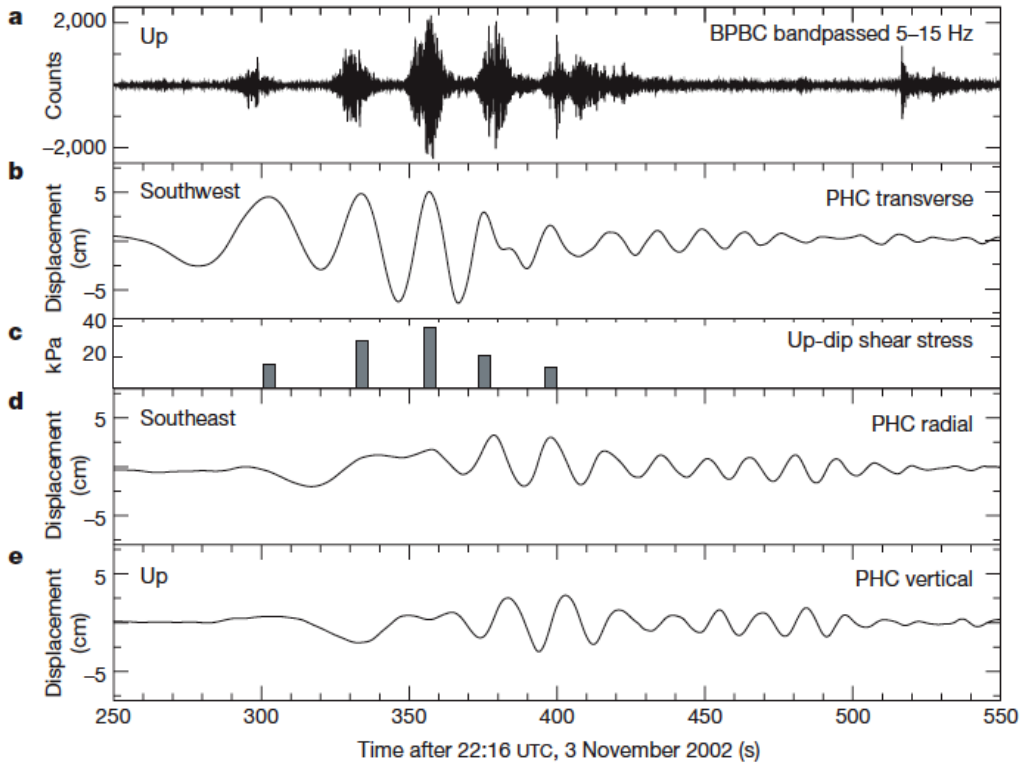
- Boundary between triggered events and natural events during their analysis
- What is their criterion for determining and detecting triggered events?

Paper 2: Non-volcanic tremor driven by large transient shear stresses

[Rubinstein et al., 2007]

- Data: Broadband seismograms
  - For the 3 November 2008 Mw=7.8 Denali earthquake
- Method: High pass filter analysis
  - Found tremor signal
  - Grid search of the tremor location
  - Shear stress amplitude and direction analysis
- Conclusion: Due to the unique geometry between the Denali event and the subduction strike, large shear stresses introduced by the Love waves, which travels parallel to the convergent direction, alternatively prompts and halts the relative plate motion.


51° N
50° N
49° N
48° N
130° W
129° W
128° W
127° W
126° W
125° W
HOLB
PHC
MAYB
NCRB
BPBC
WOSB
CBB
EDB
GDR
BTB
ETB
ALB
OZB
MGB
PGC
LZB
PFB
VGZ
North American plate
Explorer plate
Nootka fracture zone
Juan de Fuca plate
10 km
20 km
30 km
40 km
50 km
60 km

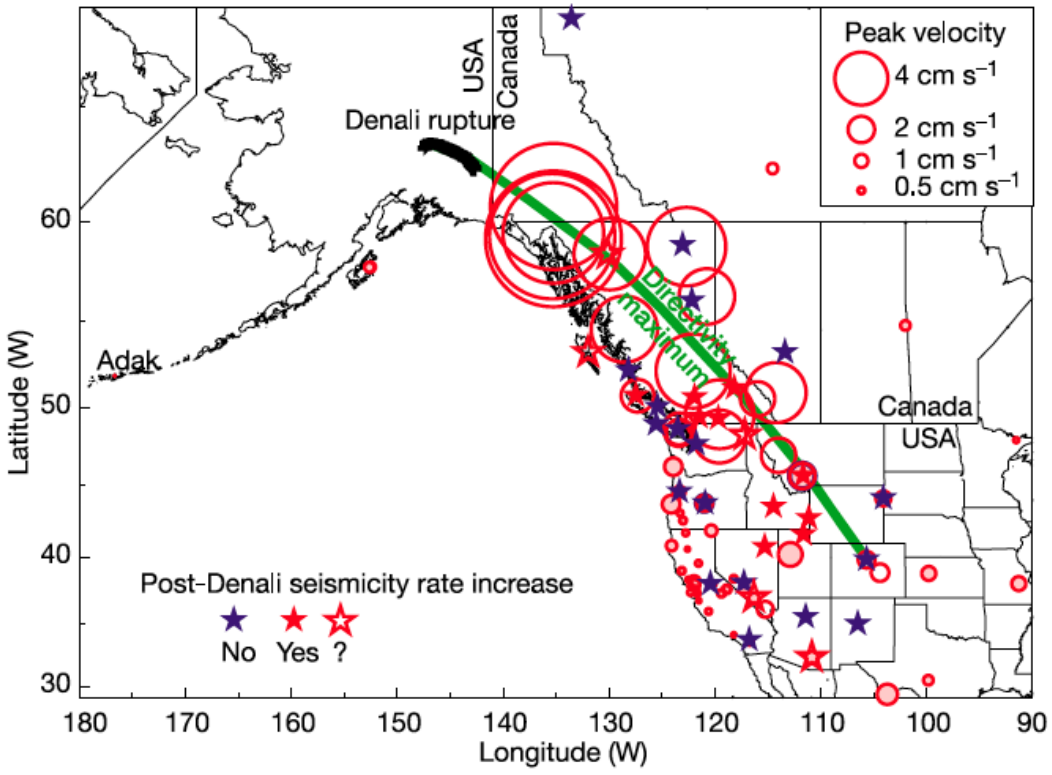

a
2,000
Counts
–2,000
Up
BPBC bandpassed 5–15 Hz
b
Displacement (cm)
5
–5
Southwest
PHC transverse
c
kPa
40
20
Up-dip shear stress
d
Displacement (cm)
5
–5
Southeast
PHC radial
e
Displacement (cm)
5
–5
Up
PHC vertical
250
300
350
400
450
500
550
Time after 22:16 UTC, 3 November 2002 (s)

Discussion

- Tremor or triggered earthquake?

Paper 3: Earthquake Nucleation by transient deformations caused by the M=7.0 Denali, Alaska, earthquake [Gomberg et al., 2004]

- Data:
  - Broadband seismogram and GPS data
- Method:
  - High Pass filter seismograms
  - Analysis GPS data
- Conclusion:
  - Dynamic triggering is ubiquitous and unpreditable



Paper 4. Triggering of Volcanic Eruptions
[Linde and Sacks, 1998]

- Data:
  - Global Catalogs for the past several hundred years
  - Large events M>=7.0
  - Volcanic eruptions within a few days of the earthquake and within 750 km
- Method:
  - Stastical analysis
- Conclusion:
  - Within a day or two of large earthquakes, there are many more eruptions within a range of 750 km.
  - Eruption pairs are triggered by earthquake too.