Earthquake Triggering

ASU Earthscope Seminar 2010
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Earthquake Triggering

- Static Triggering
  - Within a couple of fault lengths
  - aftershocks
  - static stress (1/r^3) change larger
- Dynamic Triggering
  - Passing surface waves
  - dynamic stress (1/r^2) change larger

Examples of Remote Triggered Seismicity

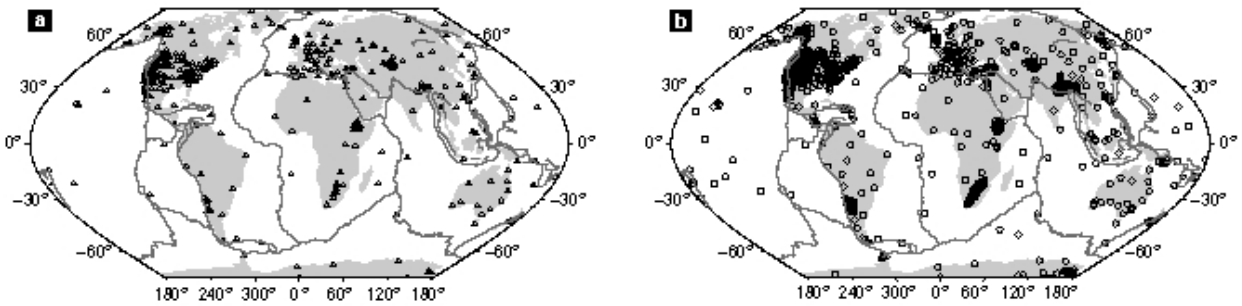
- 1992 M 7.3 Landers
  - boundary of Basin and Range and Sierra Nevada, Geysers thermal area in northern California, southern Cascade range in northern California, western Idaho, Yellowstone National Park
- 2002 M 7.9 Denali fault, Alaska
  - throughout western North America from British Columbia to Southern California, Mount Rainer in central Washington, Coso and Geysers geothermal fields and Mammoth Mountain and Long Valley Caldera in California, Yellowstone, Utah's main seismic belt
- 2000 M 7.4 Izmit, Turkey
  - widespread seismicity triggered in Greece
- Microearthquakes swarms triggered at Geysers by
  - Landers, Loma Prieta, Petrolia, two 1991 events (Ms=6.9 and 7.1) on the Gorda Plate, 1994 Ms=6.6 Northridge earthquake, 1988 Ms 7.6 Gulf of Alaska earthquake
- others...

Mechanisms for Dynamic Triggering

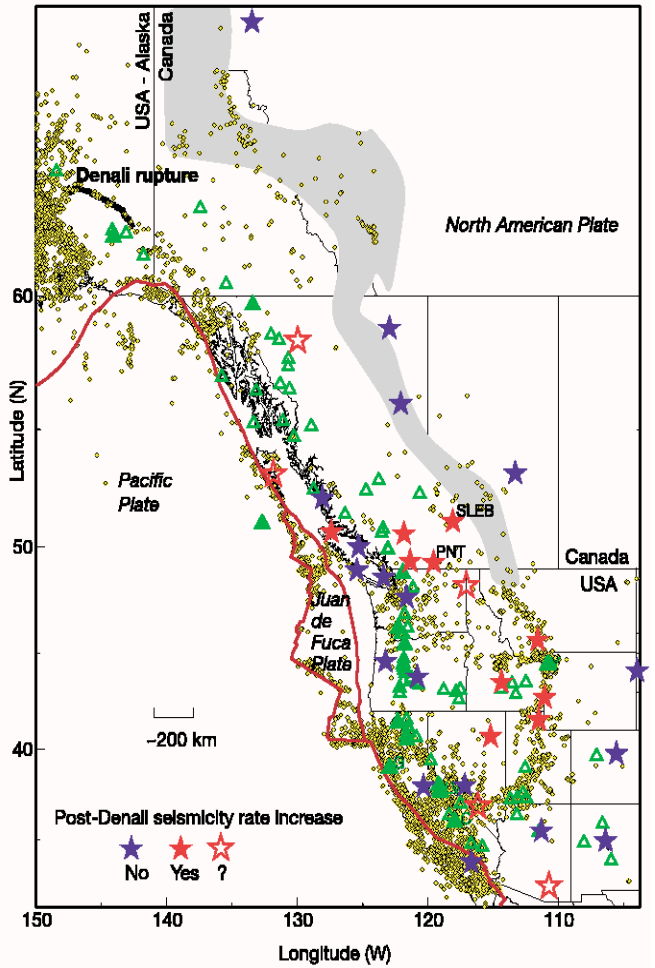
- Instantaneous Triggering
  - Existed Faults close to Frictional failure
- Delayed Triggering
  - Time-dependent acceleration to failure process
    - Rate-and-state friction
    - Subcritical crack growth
  - Fluids
    - Increase pore pressure
    - Bubbles in magma
      - Rectified diffusion
      - Advective overpressure

Where?

- Volcanic or geothermal areas
- Background seismicity or faults
- Anywhere



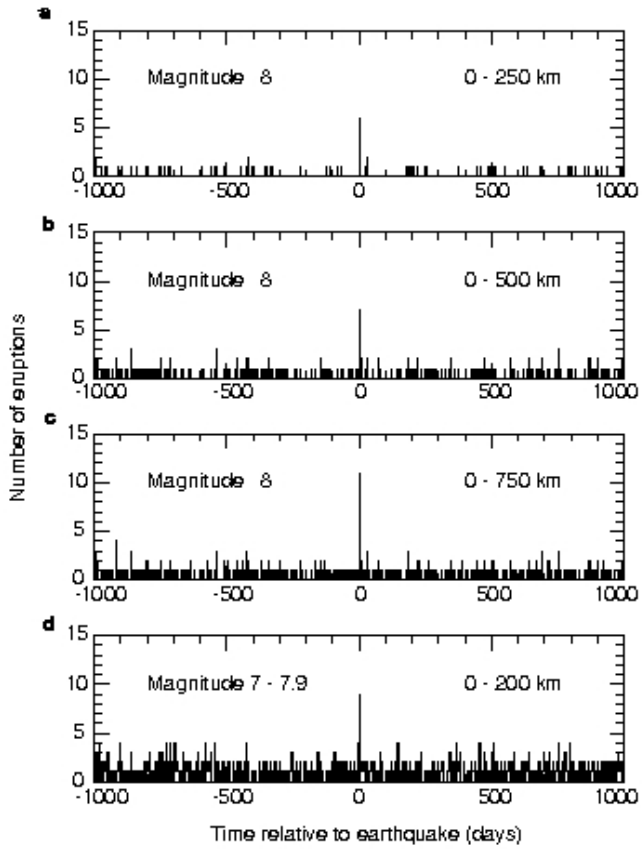
Velasco et al., 2008, Figure 4



Gomberg et al., 2004, Figure 1

Data & Methods

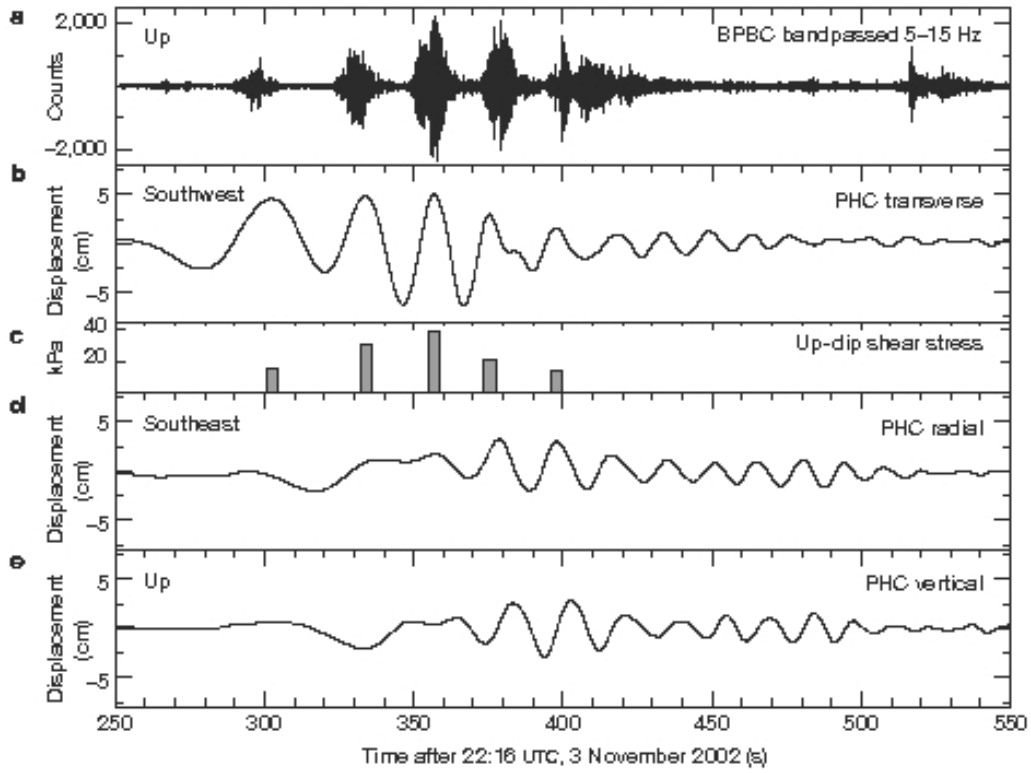
- Catalogs statistical analysis
- Passing by surface wave from large earthquakes
  - High pass filter (e.g. >5 Hz) so can see local events during passing seismic waves of large earthquake that would have been missed
  - Locate the triggered event
- Combination of both



Linde & Sacks, 1998, Figure 1

Non-volcanic tremor driven by large transient shear stresses
Rubinstein et al, 2007

·Look for tremor possibly triggered by Denali fault earthquake
·Canadian National Seismic Network stations on Vancouver Island
·High pass filter >5 Hz
·Compare to passing Love and Rayleigh waves – most happens when Love waves add to up-dip shear stress



Global ubiquity of dynamic earthquake triggering
Velasco et al., 2008

·M > 7.0 earthquakes since 1990
·Global broadband data from IRIS DMC, 5h before and after each large earthquake
·High pass filter > 5 Hz
·Antelope software, STA/LTA to detect possibly triggered events