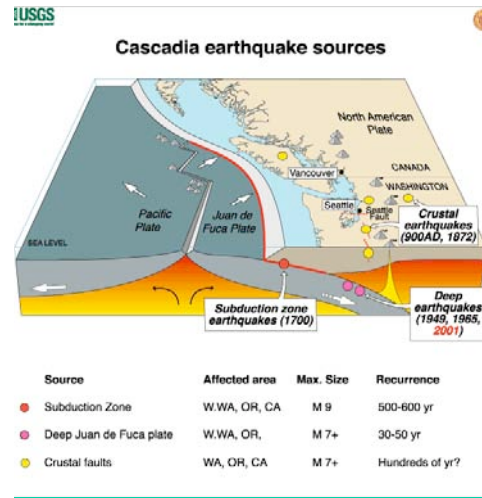


## Earthquake Hazards in Western Washington

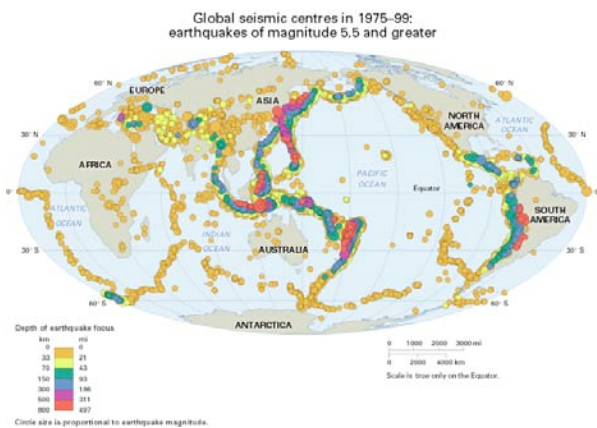
- The mega-thrust at the coast
- Shallow earthquakes in the crust of Puget Sound
- Deep earthquakes in the subducted Juan de Fuca Plate

Which should you worry about?



Three kinds of earthquakes:

- Plate Interface (megathrust, Cascadia, 1700)
- Intralab (deep, Wadati-Benioff, Nisqually 2001)
- North American Plate (Shallow, crustal earthquakes, Seattle, 900)



## Deep Earthquakes

Wadati-Benioff zone earthquakes

Intralab earthquakes

Occur inside the cold subducting lithosphere

Occur to depths of nearly 700 km in many subduction zones where the oceanic plate is old and cold

In Cascadia, the subducting Juan de Fuca plate is young and warm; deepest earthquakes are only 100 km

## Earthquake Hazards in Western Washington

- The mega-thrust at the coast
- Shallow thrusts in the crust of Puget Sound
- Normal faulting in the subducted Juan de Fuca Plate

There have been 3 events in the last 60 years: 1949, 1965 and 2001.

There WILL be more in YOUR lifetime.

The last one caused \$1,000,000,000 in losses that were largely preventable.

## The Nisqually Earthquake

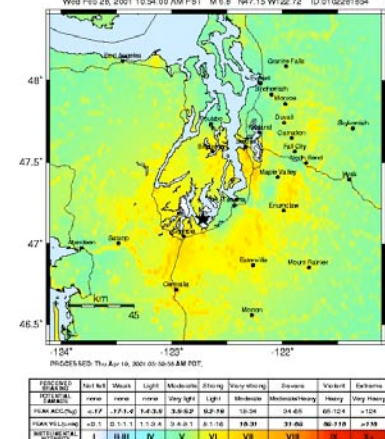
February 28, 2001

10:54:33 AM PST

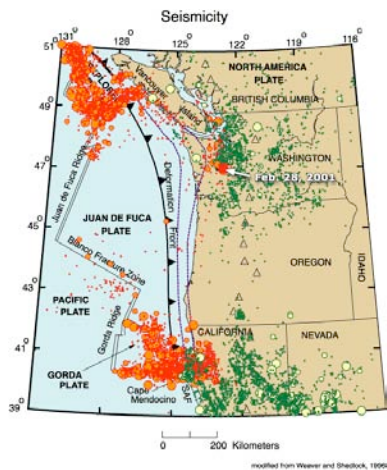
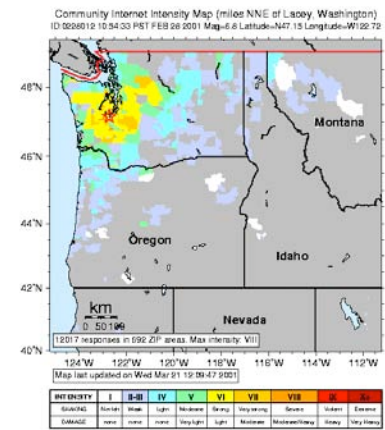
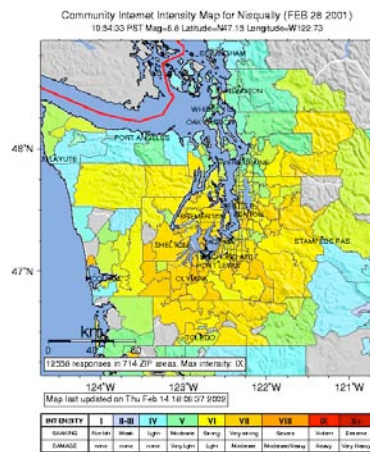
Magnitude 6.8



PNSN Rapid Instrumental Intensity Map Epicenter: 17.6 km NE of Olympia, WA  
Wed Feb 26, 2001 10:54:00 AM PST M 6.6 N47.15 W122.72 ID 010201054

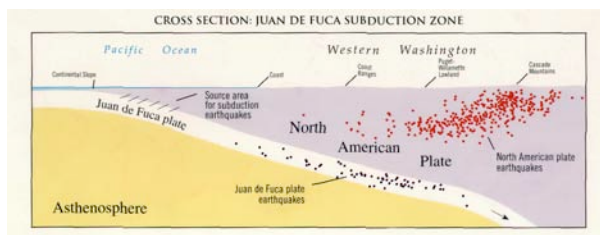
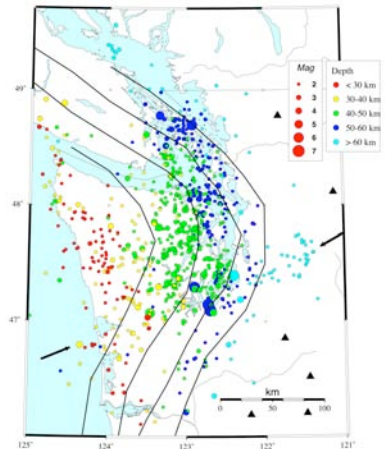






## Intraslab Seismicity

- Largest intraslab earthquakes are in south sound region at base of microseismicity, including 1949 M7.1; 1965 M 6.5 and 2001 M6.8
- Deepest earthquakes are downstream from large events
- Intraslab seismicity is virtually absent north and south of arch
- Intraslab focal mechanisms are widely scattered but generally are in-plane tension
- Should we prepare for M7 or M8 intraslab earthquakes?



SHOW WEB ANIMATION!

# DEEP EARTHQUAKES BENEATH PUGET SOUND

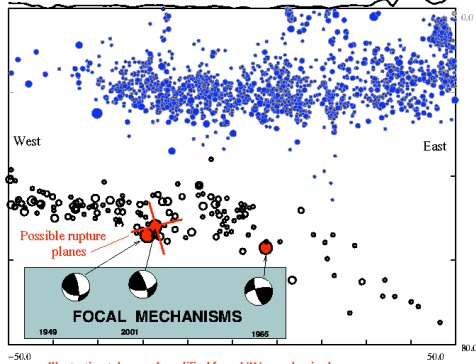


Illustration taken and modified from UW geophysics homepage  
<http://www.geophys.washington.edu/>

# DEEP EARTHQUAKES BENEATH PUGET SOUND

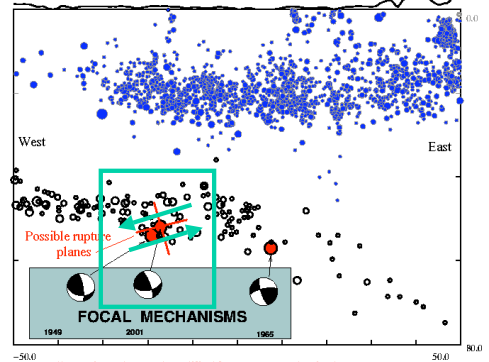


Illustration taken and modified from UW geophysics homepage  
<http://www.geophys.washington.edu/>

# DEEP EARTHQUAKES BENEATH PUGET SOUND

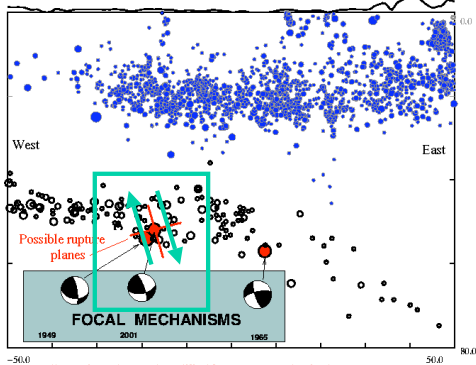
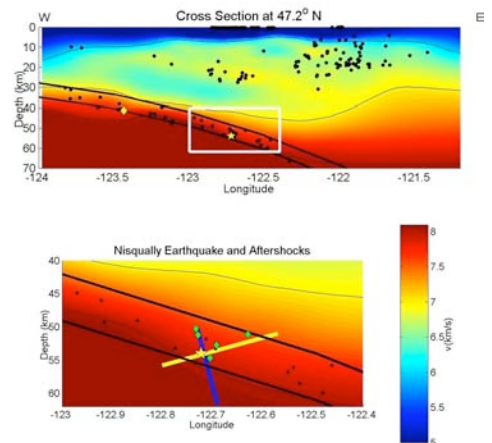
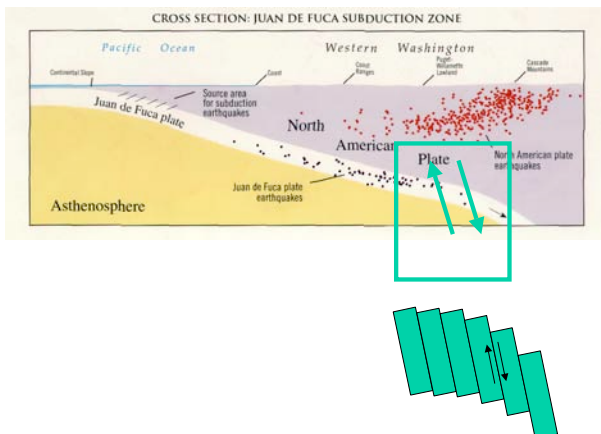
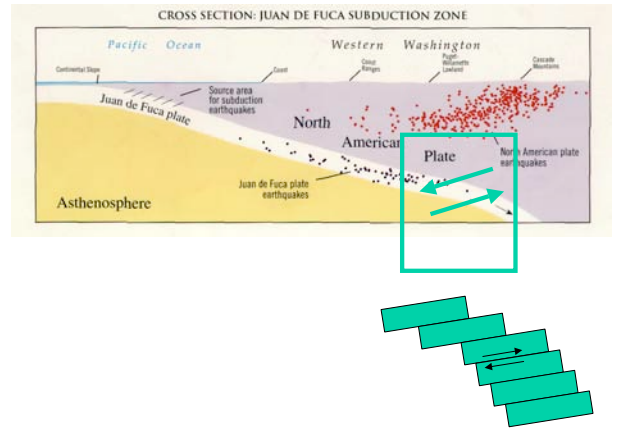
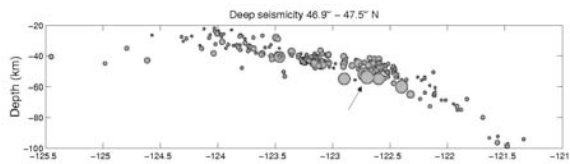


Illustration taken and modified from UW geophysics homepage  
<http://www.geophys.washington.edu/>



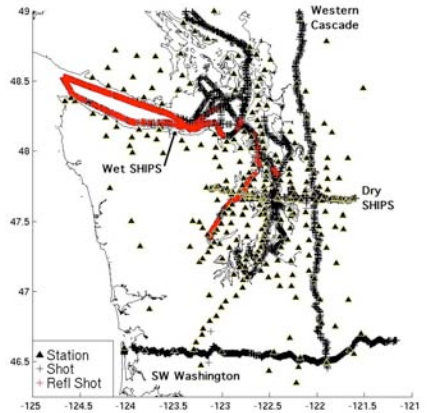


The largest intraslab earthquakes tend to occur at the base of the seismic zone.

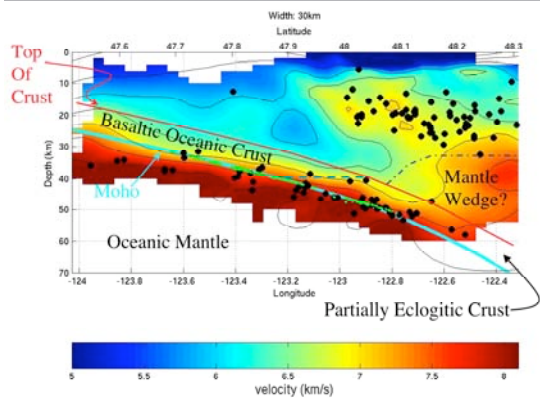
### 3-D Tomographic Inversion Active-Source Data

■ ~92,000 first arrivals from active source experiments (e.g. SHIPS)

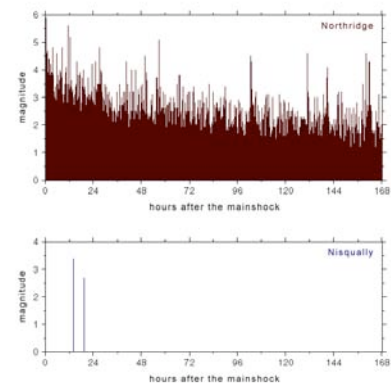
■ 1200 wide-angle reflection times from SHIPS



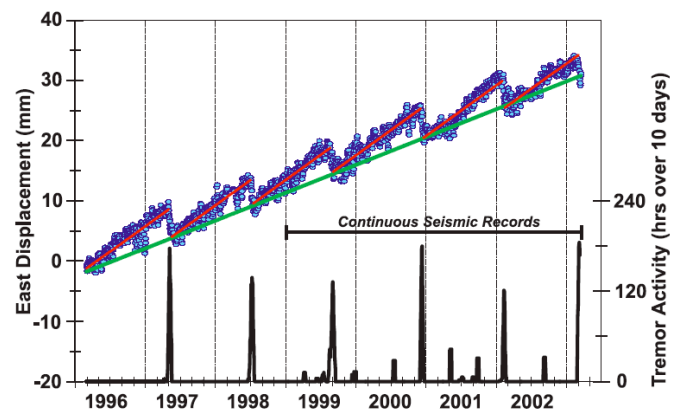
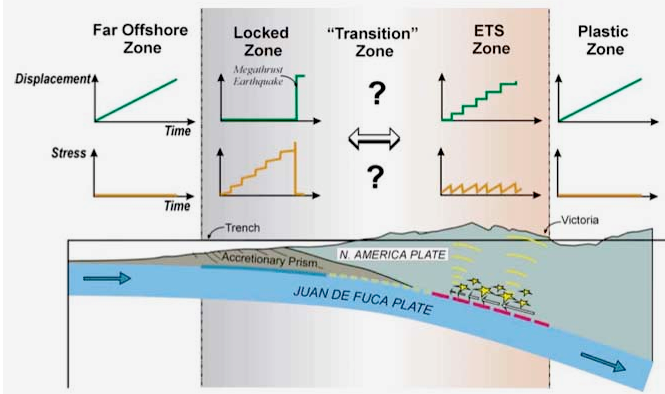
### Previous Tomography (Preston et al. 2003)



Aftershocks of the Northridge and Nisqually Earthquakes

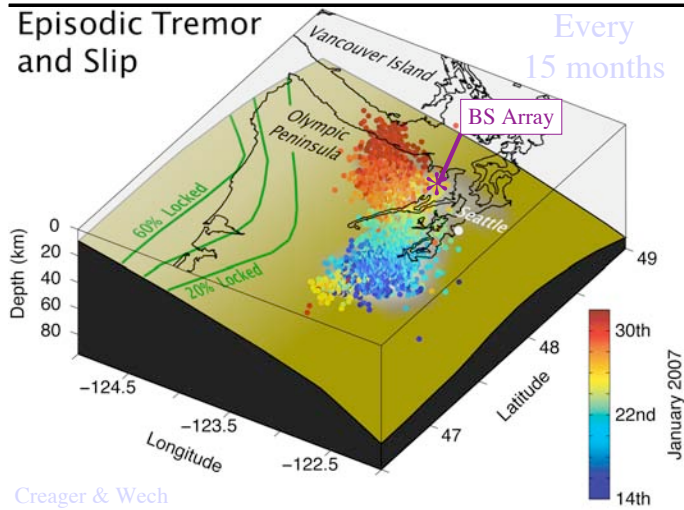


H. DRAGERT *et al.*: EPISODIC TREMOR AND SLIP IN NORTHERN CASCADIA



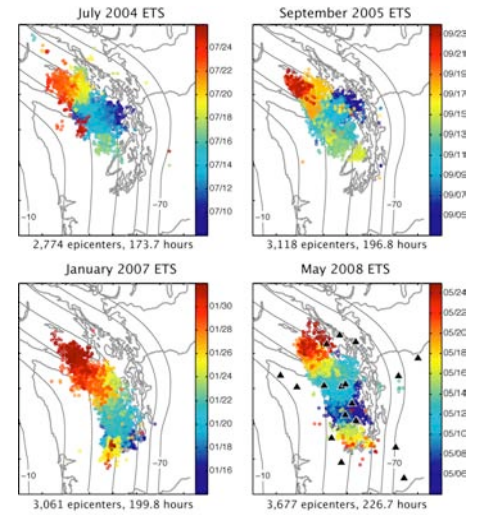


## Episodic Tremor and Slip



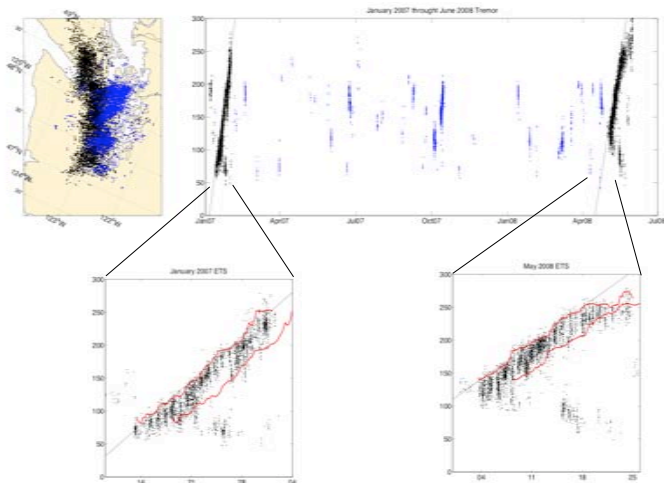
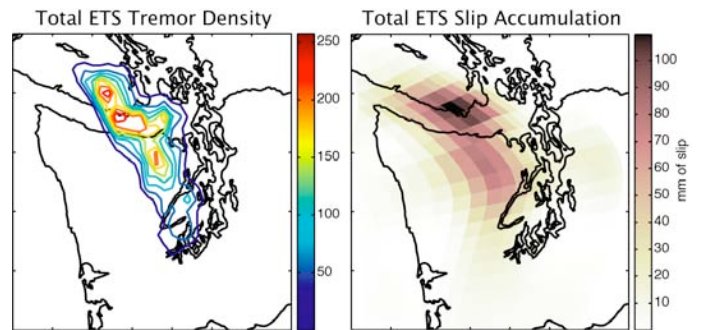
Creager & Wech

## Tremor Migration for four ETS events



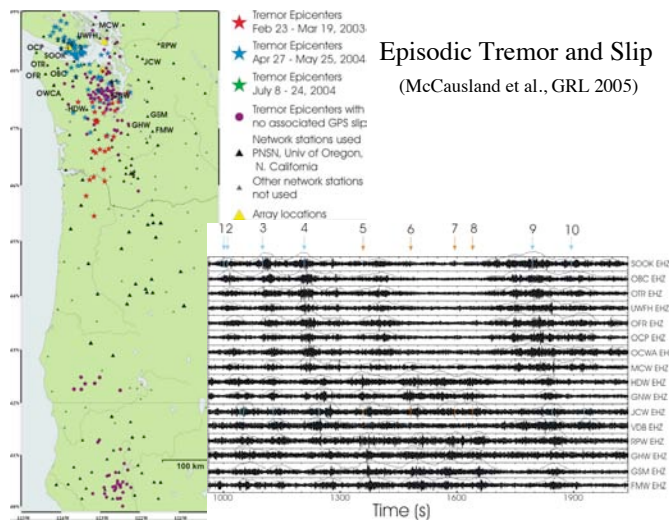
## Tremor and Slip summed over 4 ETS events

Wech, Creager and Melbourne, JGR, submitted



## Episodic Tremor and Slip

(McCausland et al., GRL 2005)



## Cascadia

