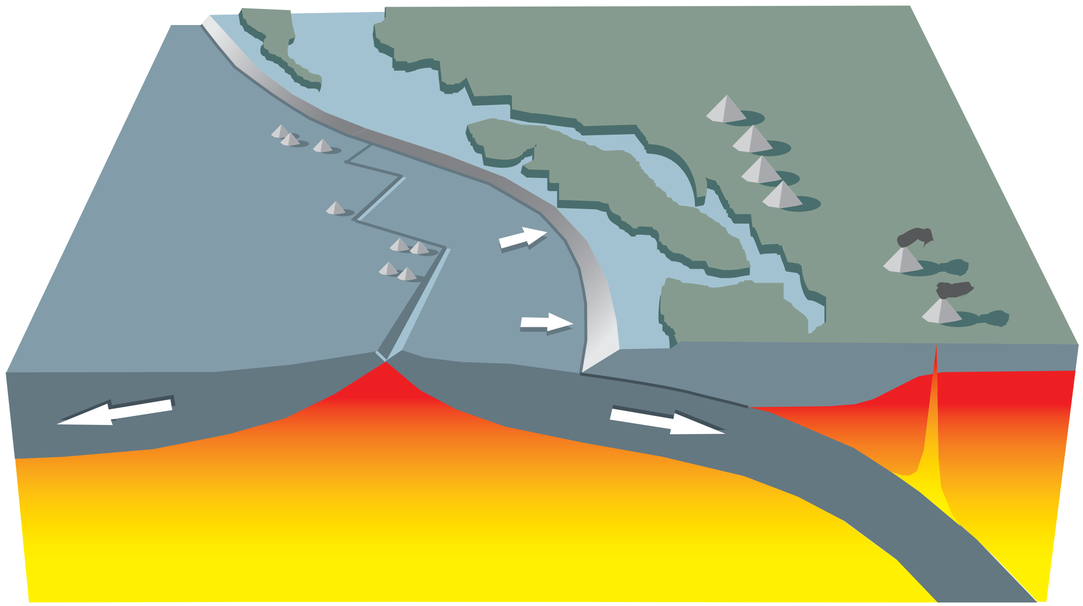
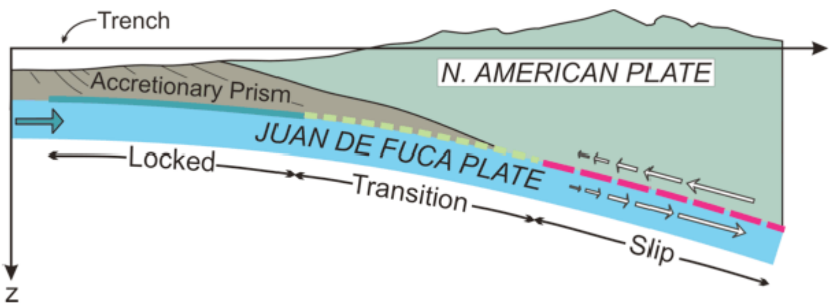


The Cascadia Subduction Zone And Related Seismicity

Cheng Cheng
13/04/2012

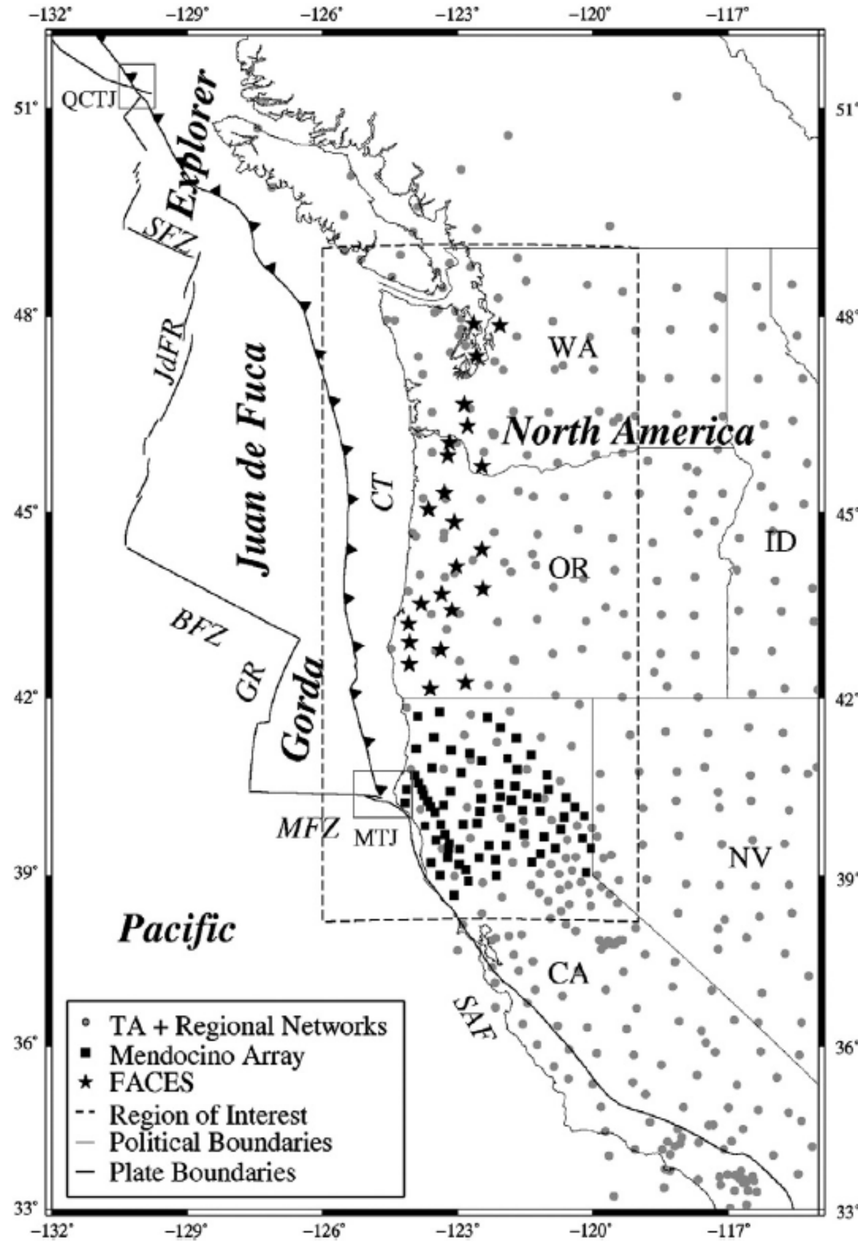
Tectonic Framework



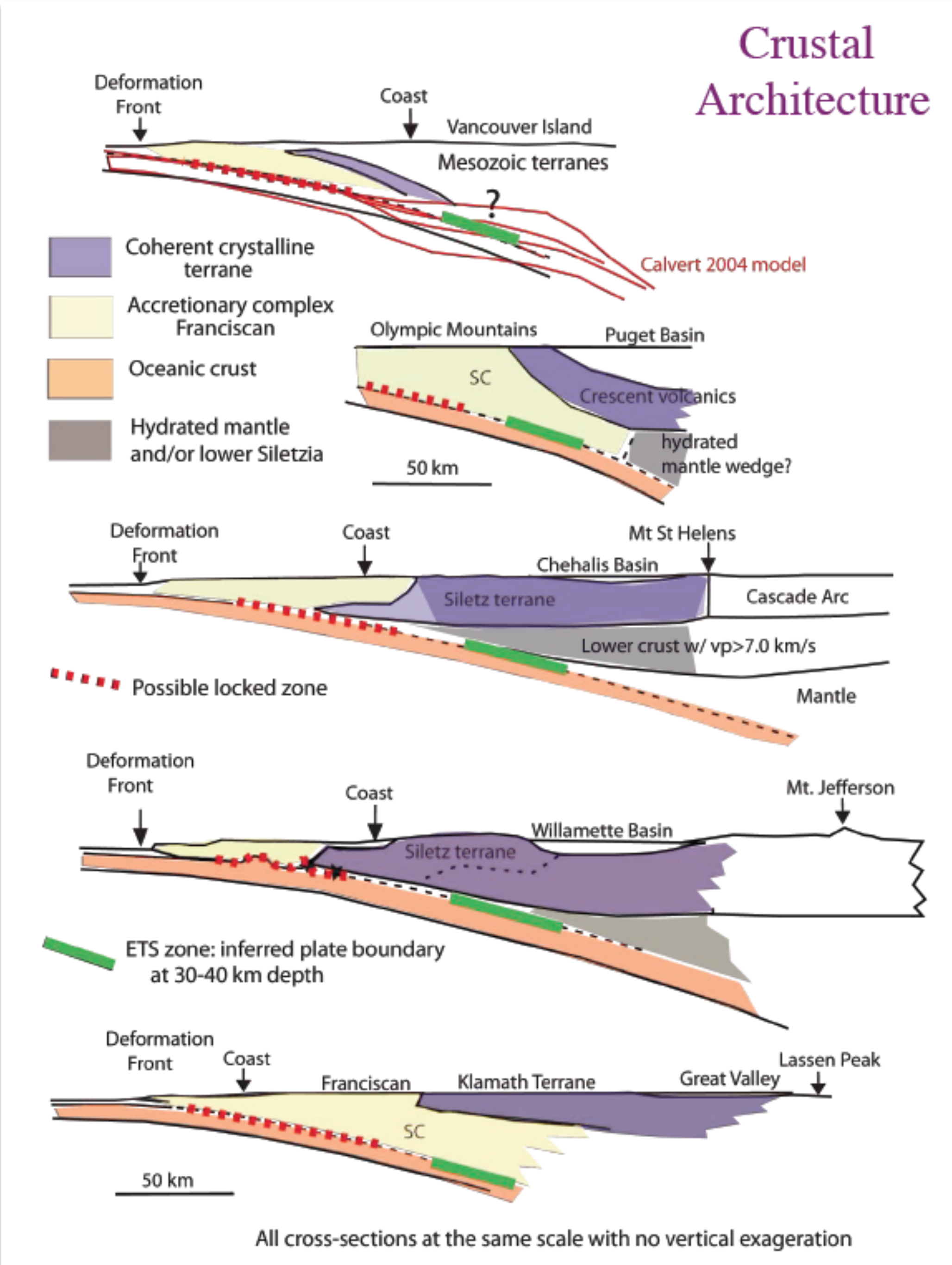
"warm-slab"

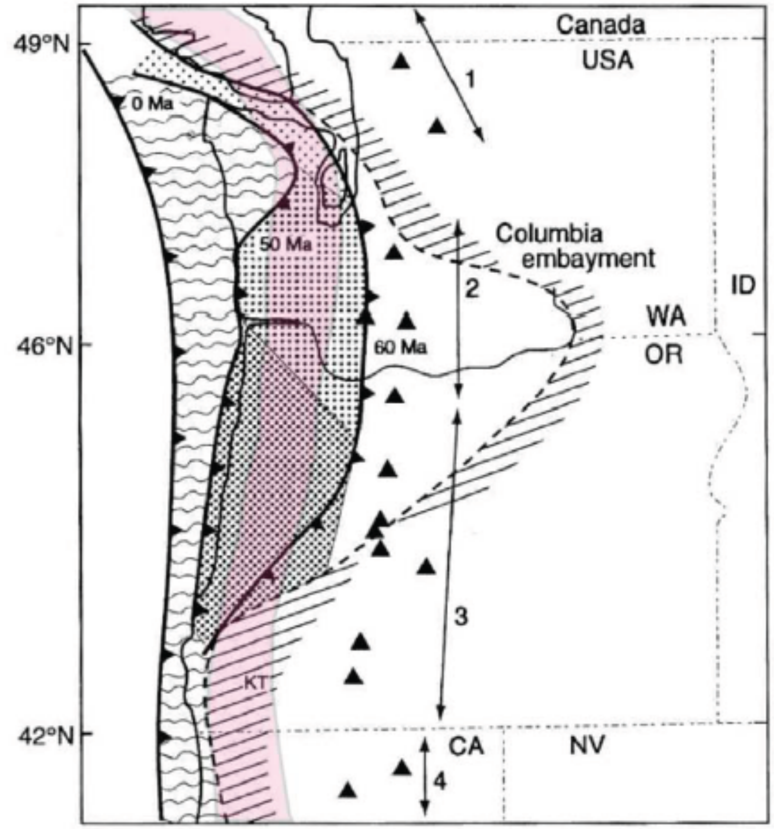
Explorer plate
Juan de fuca Plate
Gorda plate

Klamath Mountains
Siletzia Terrane (43°N)
Crescent Formation
Olympic Peninsula (47°N)



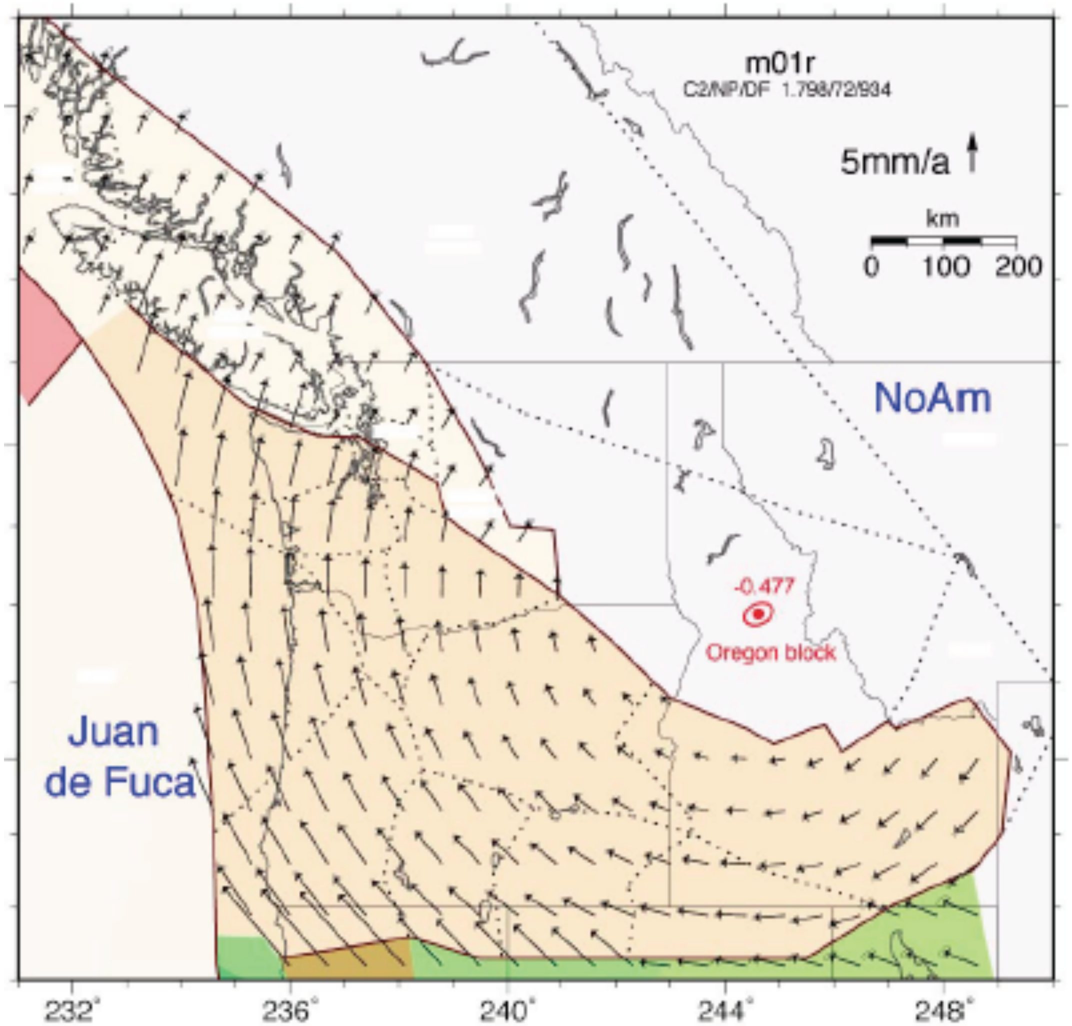
Porritt et al., 2011

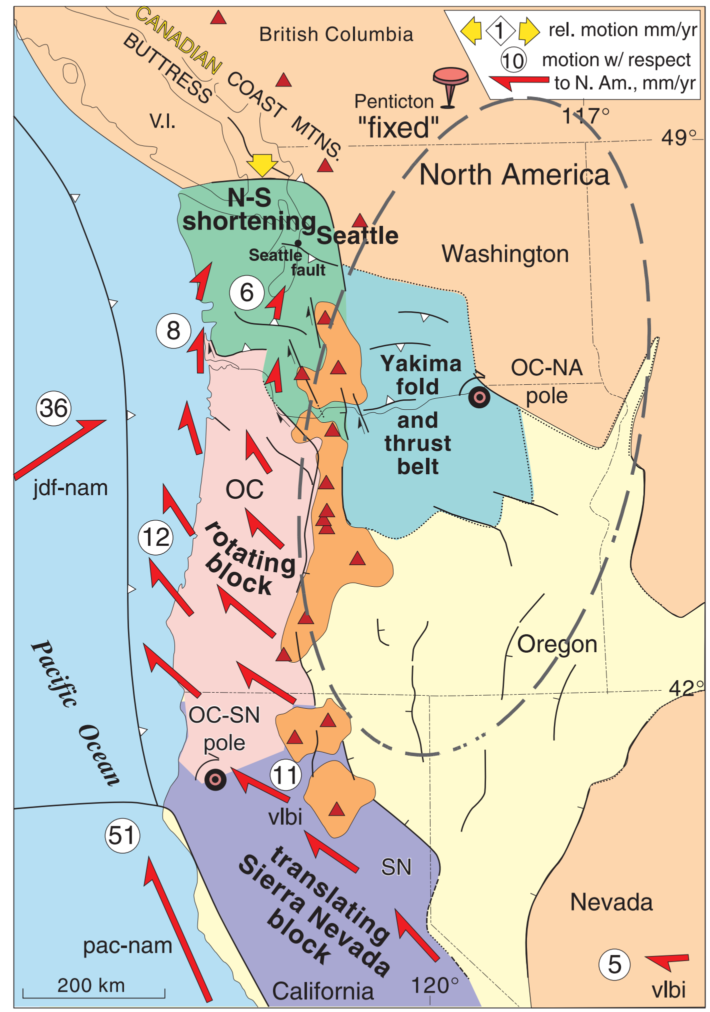




A series of active source crustal imaging experiments:

- Lithoprobe 86
- OR89/91
- Mendo93/94
- SW-Wash
- Orwell 96
- SHIPS 98/99



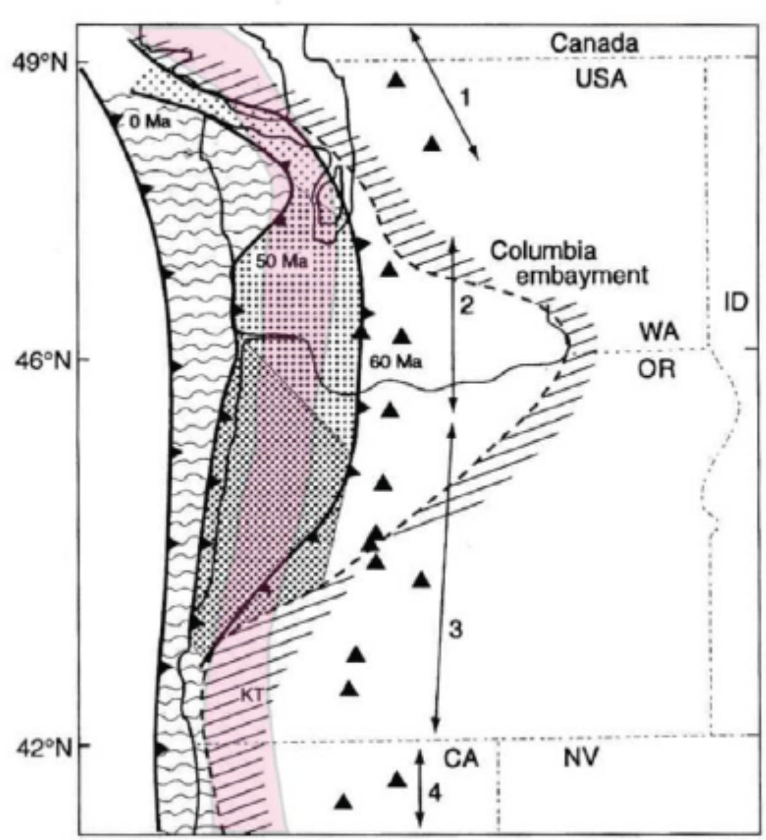


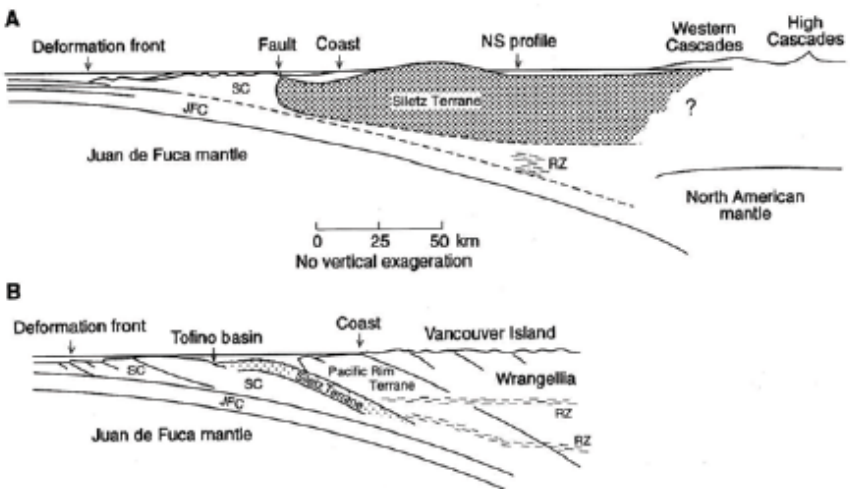
Wells et al., 2002

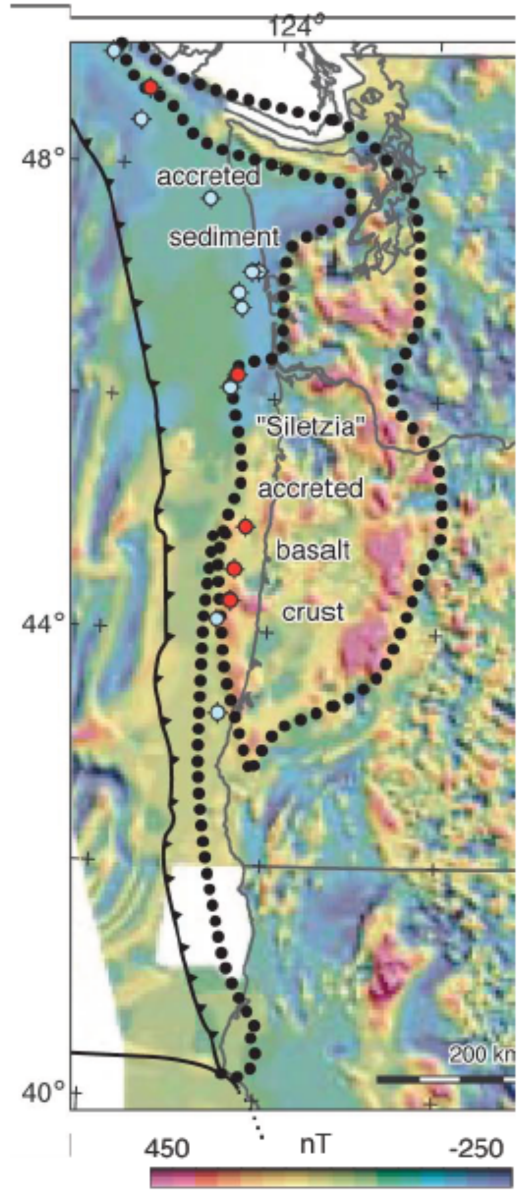
(left) motions relative to NA

Clockwise Rotation

Rollback





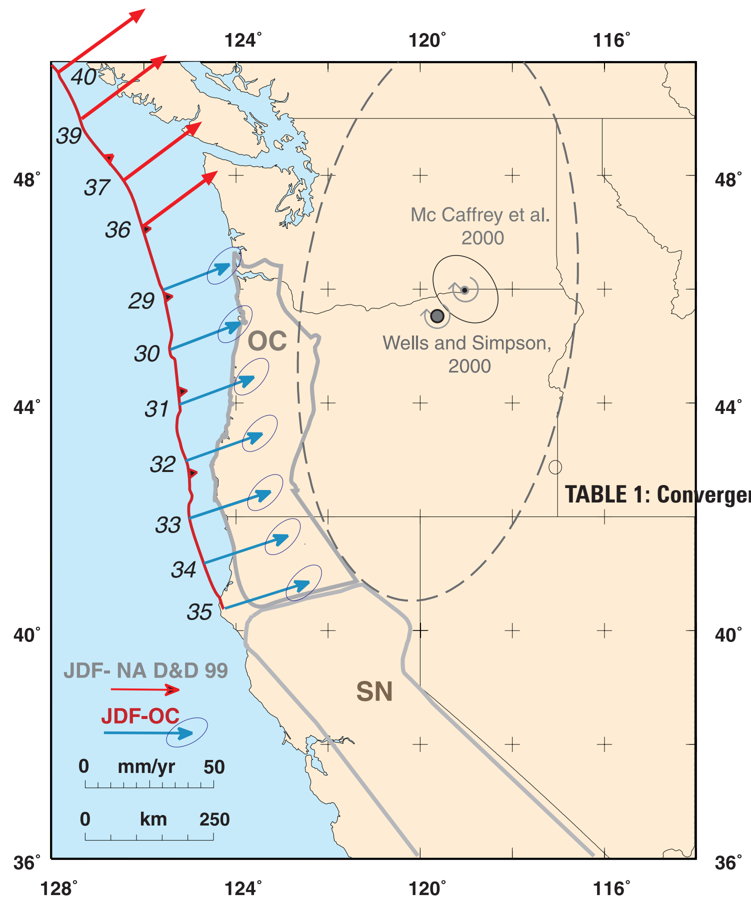


Crustal Architecture

Forearc block rotation is a legacy of accretion of the Siletz terrane – thickened oceanic crust that was too thick to subduct.

Wells et al., Forearc migration in Cascadia and its neotectonic significannce, Geology, 1998

Convergence Rate..



Rotation of the Oregon forearc significantly affects Juan de Fuca plate (JDF) convergence rates

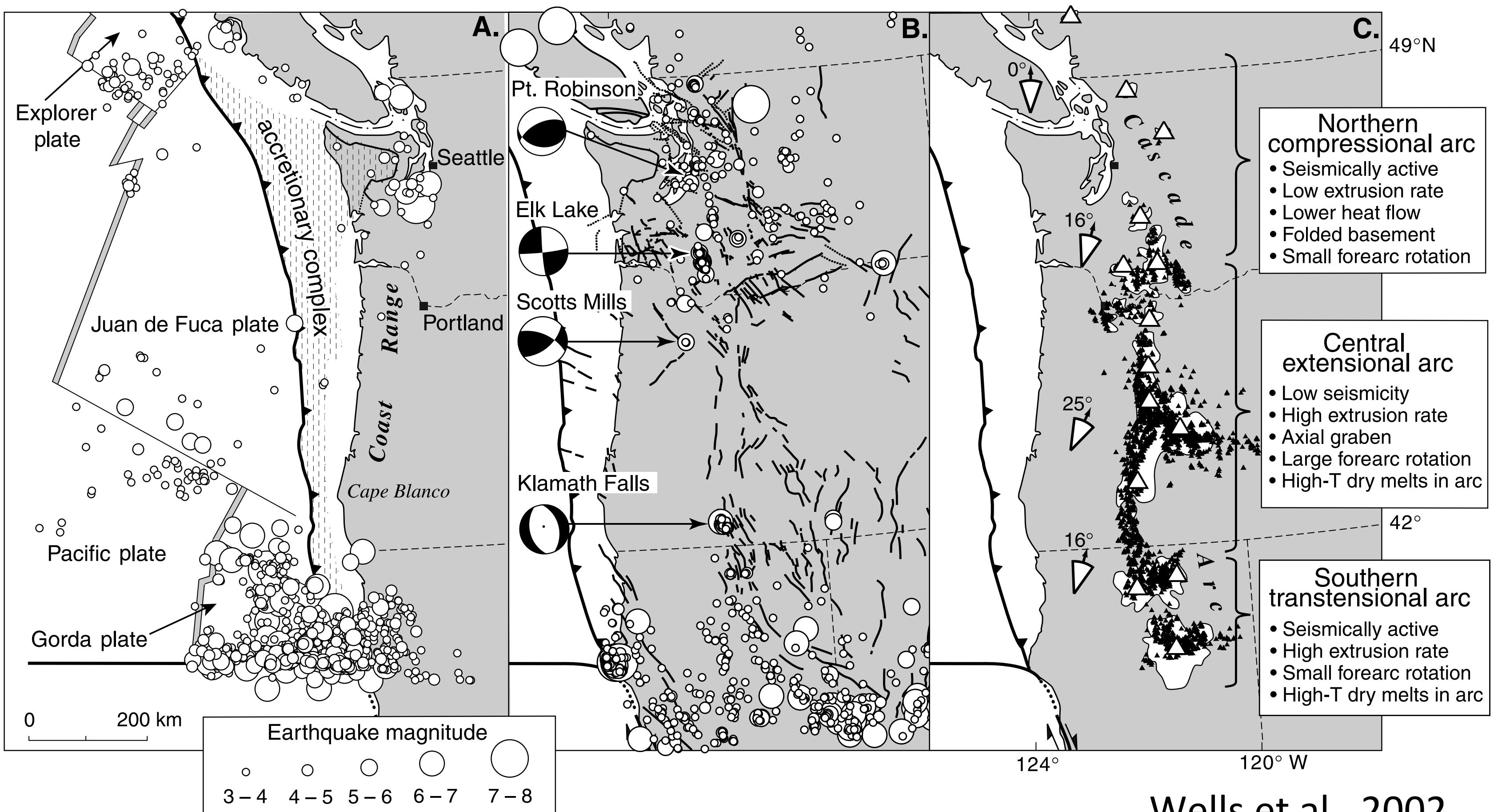
TABLE 1: Convergence velocities of the Juan de Fuca plate (JDF) with respect to North America (NA) and Oregon Coastal block (OC).

Site	JDF-NA (DD99)		JDF-OC (WS00)	
(Lat ° N/Lon ° W)	Az ° E	rate mm/yr	Az ° E	rate mm/yr
40/125			72.7	**35.0**
41/125	45.6	28.7	72.1	**34.0**
42/125	47.6	29.8	71.6	**33.0**
43/125	49.4	30.9	71.0	**32.0**
44/125	51.1	32	70.3	**31.0**
45/125	52.7	33.1	69.6	**29.9**
46/125.5	52.1	34.9	69.2	**28.8**
47/126	53.5	**36**	68.7	27.6
48/126	54.8	**37.2**	67.9	26.6
49/127	54.2	**38.9**	67.7	25.2
50/127	53.5	**40.5**	66.7	24.2

Note: DD 99 is pole of DeMets and Dixon (1999); WS00 is pole of Wells and Simpson, [2001]; bold rates are used in this paper.

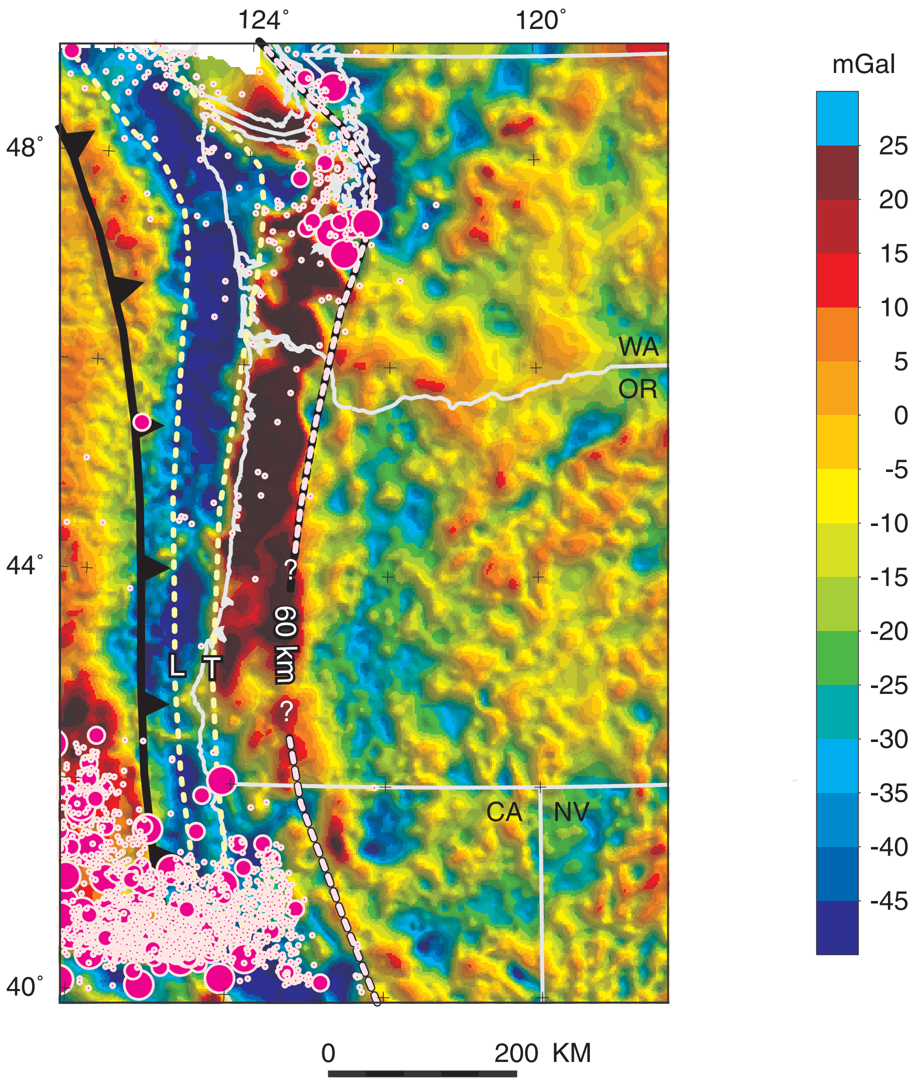
Wells et al., 2002

Seismicity



Wells et al., 2002

People argue that the co-location of upper and lower plate earthquakes is the result of fluid flow into the upper plate from dehydration reactions in the subducting plate



Some of the earth- quakes in the lower plate beneath Washington appear to line up along gravity gradients presumed to be caused by structures in the upper plate

Wells et al., 2002

Why is it lack of with-in slab earthquake and upper plate earthquake in Oregon ?

tectonic segmentation
+
convergence rate
+
seismicity segmentation

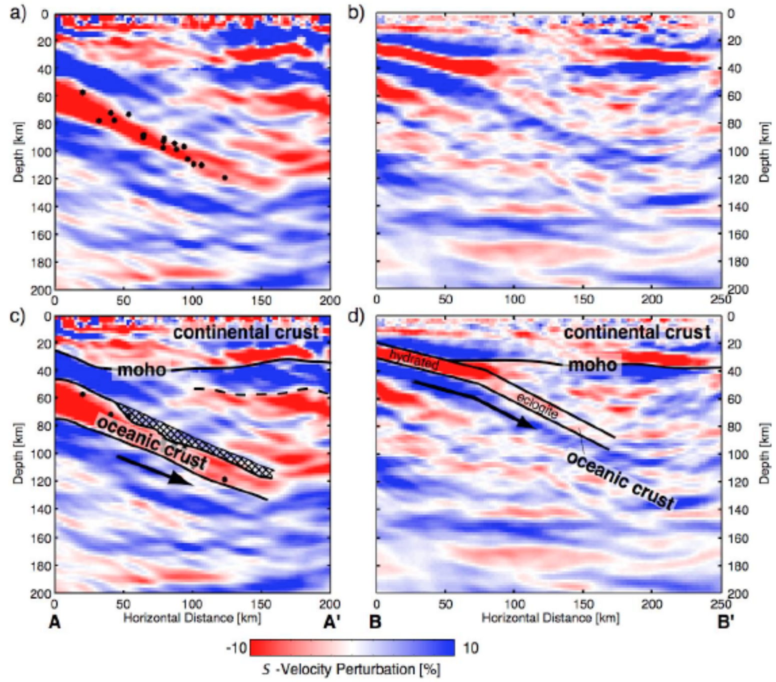
Basalt → Eclogite ?

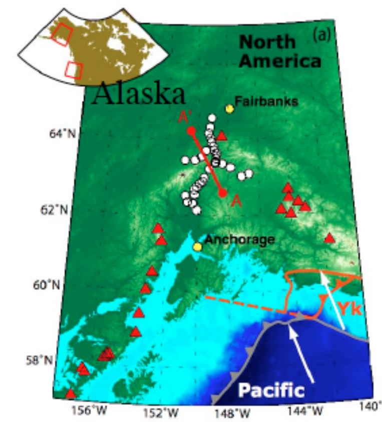
Lack of deep slab (so lack of slab-pull force)coupled with the decrease of convergence rate ?

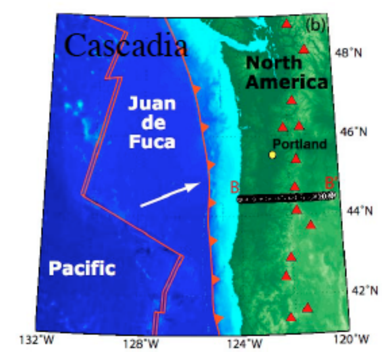
Alaska vs. Oregon

(Rondenay, Abers & van Keken, Geology, 2008)

Alaska Oregon Cascades



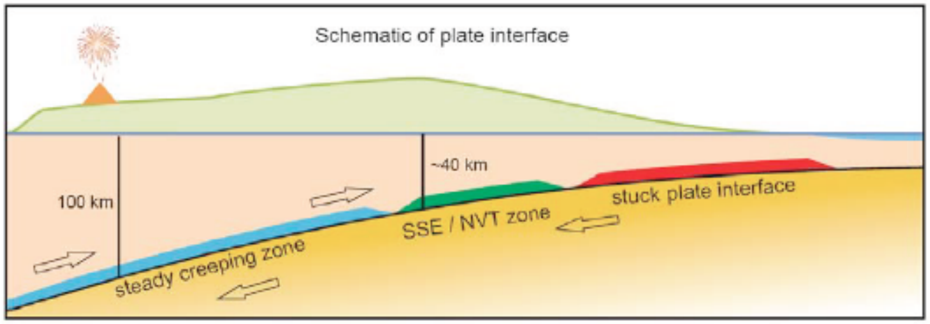




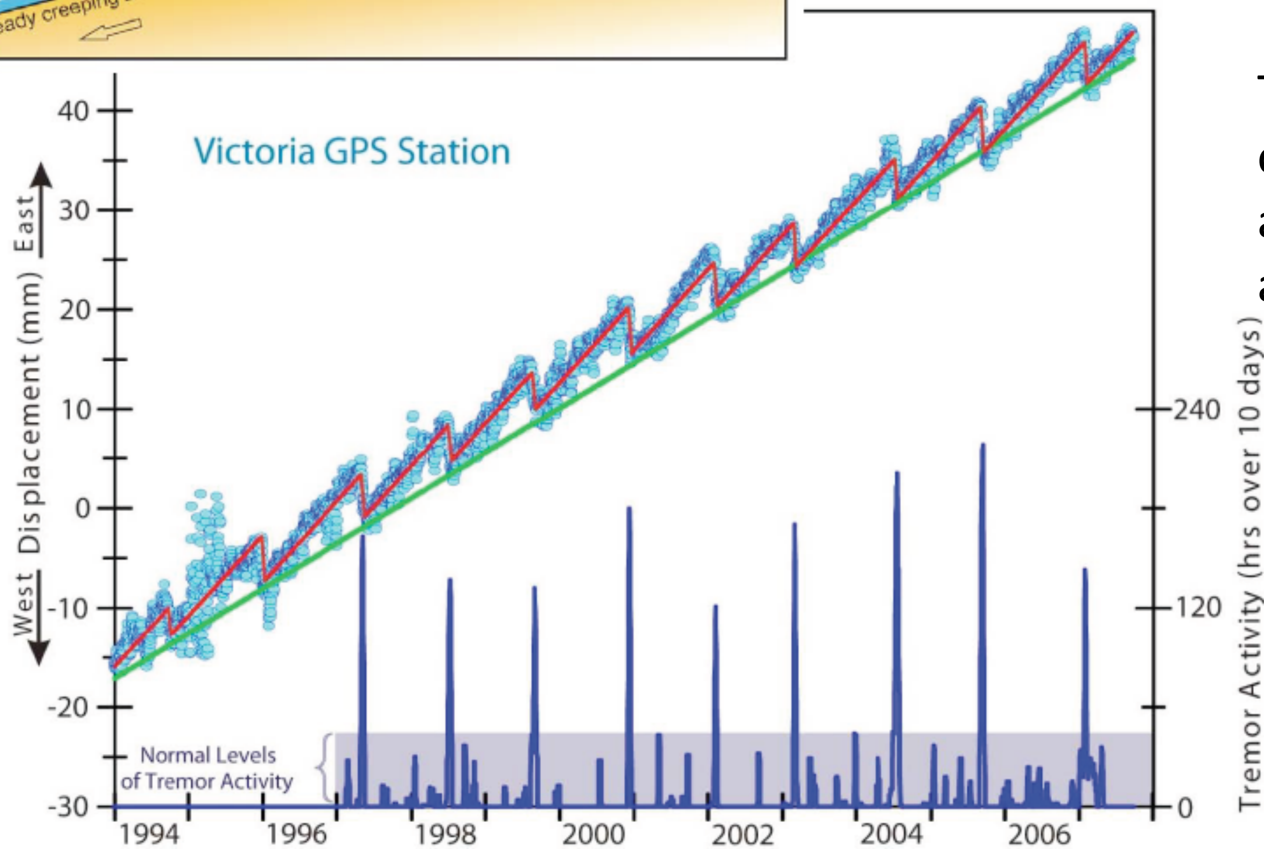
receiver functions migrated to dVs/Vs

15-20 km vs. 8 km
120 km vs. 40 km

ETS in Cascadia

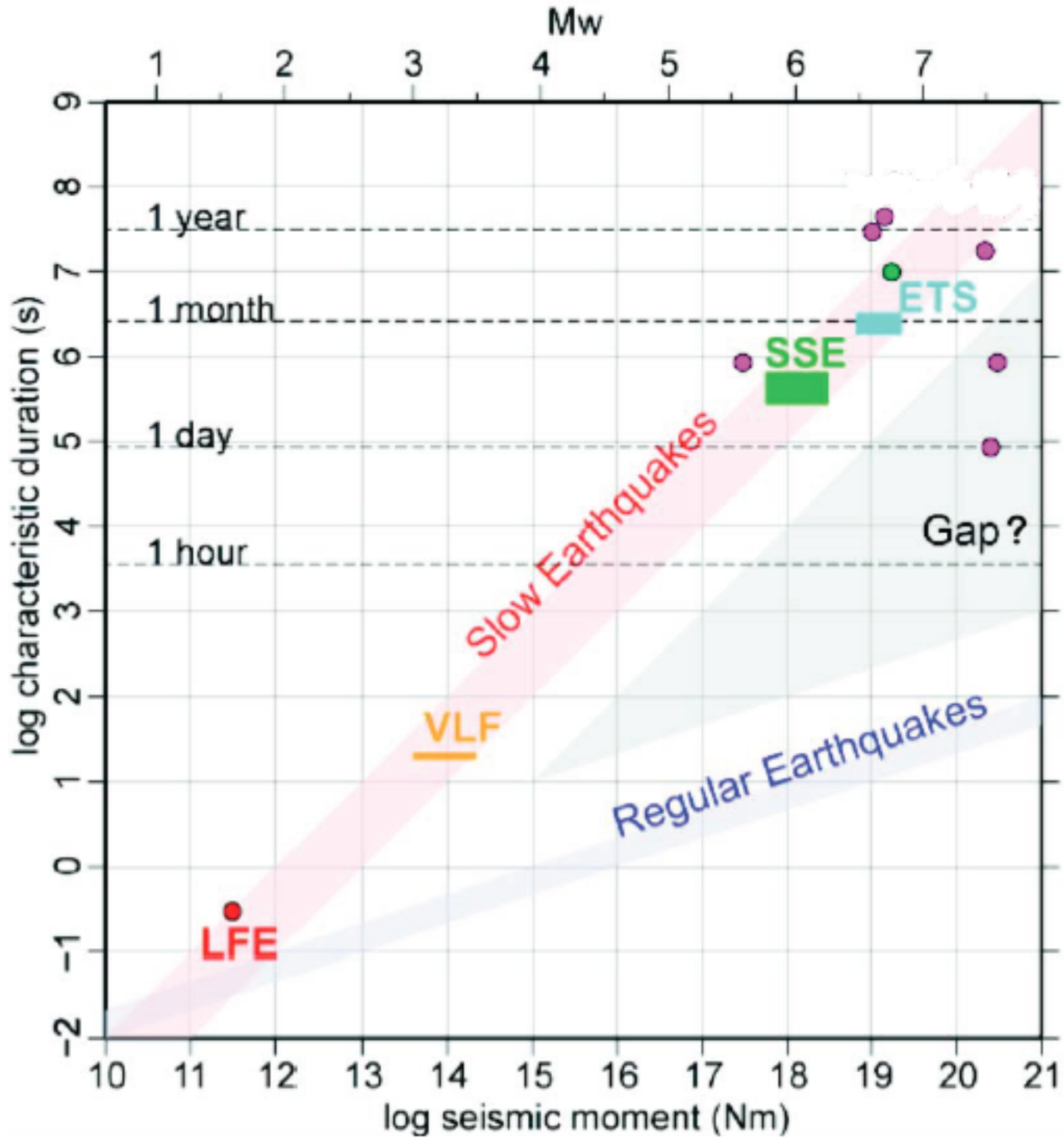


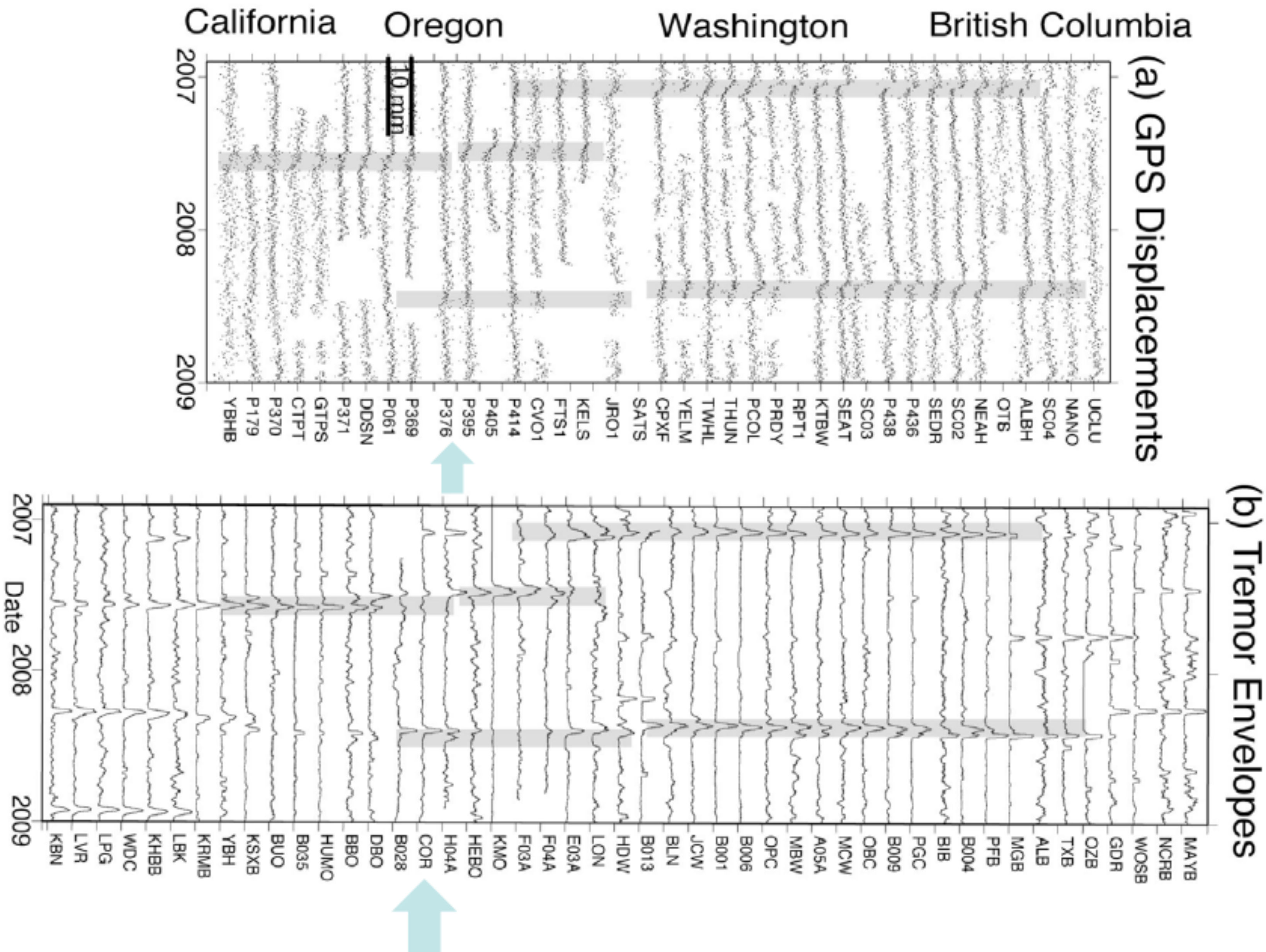
ETS (episodic tremor and slip) between the locked and steadily slipping zones.



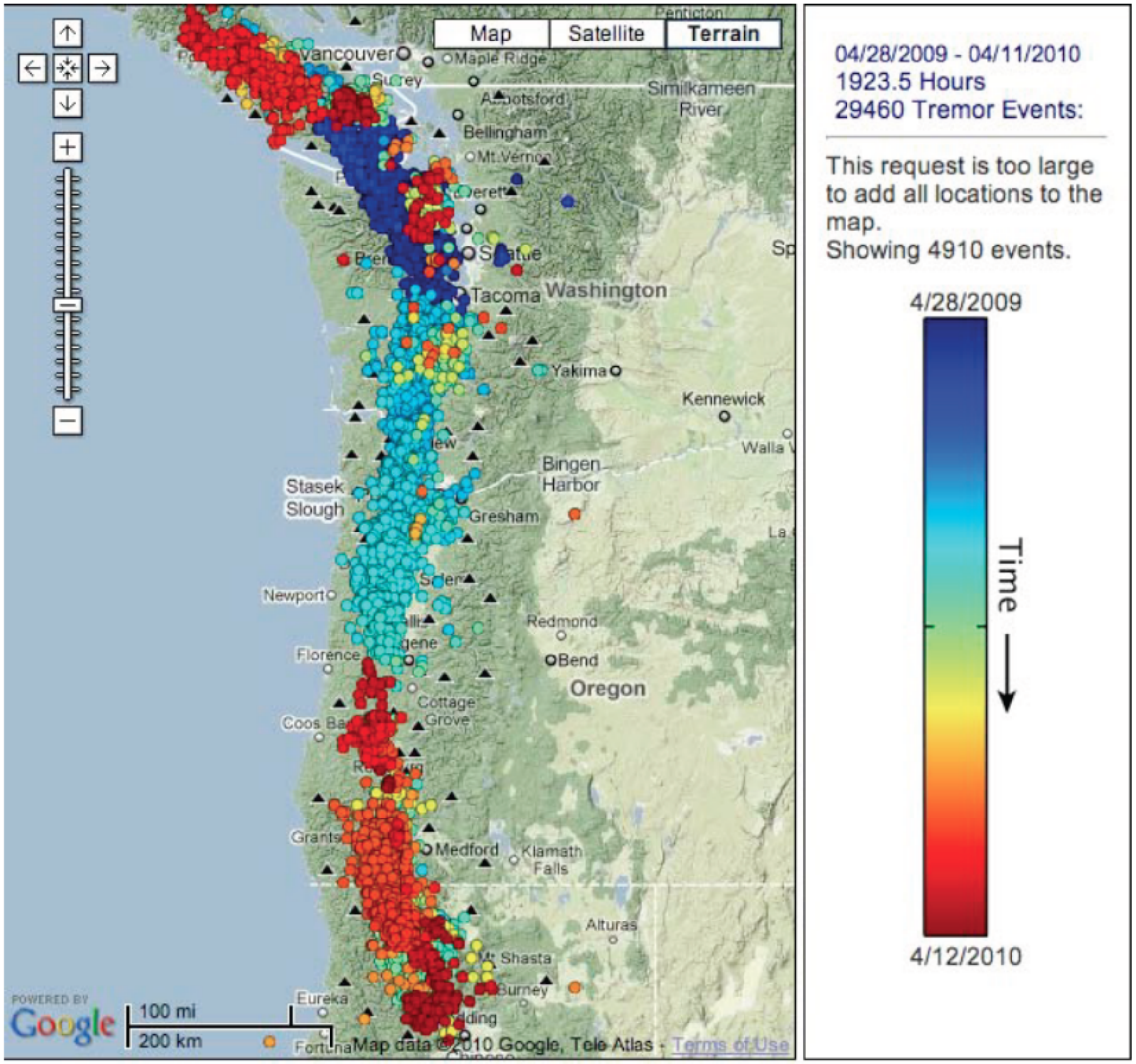
The synchronous occurrence of slowslip and vigorous tremor activity

Slow slip vs earthquakes





Gomberg et al., 2010



Some observations about ETS:

•Generally occurs where plate is 30-40 km deep.

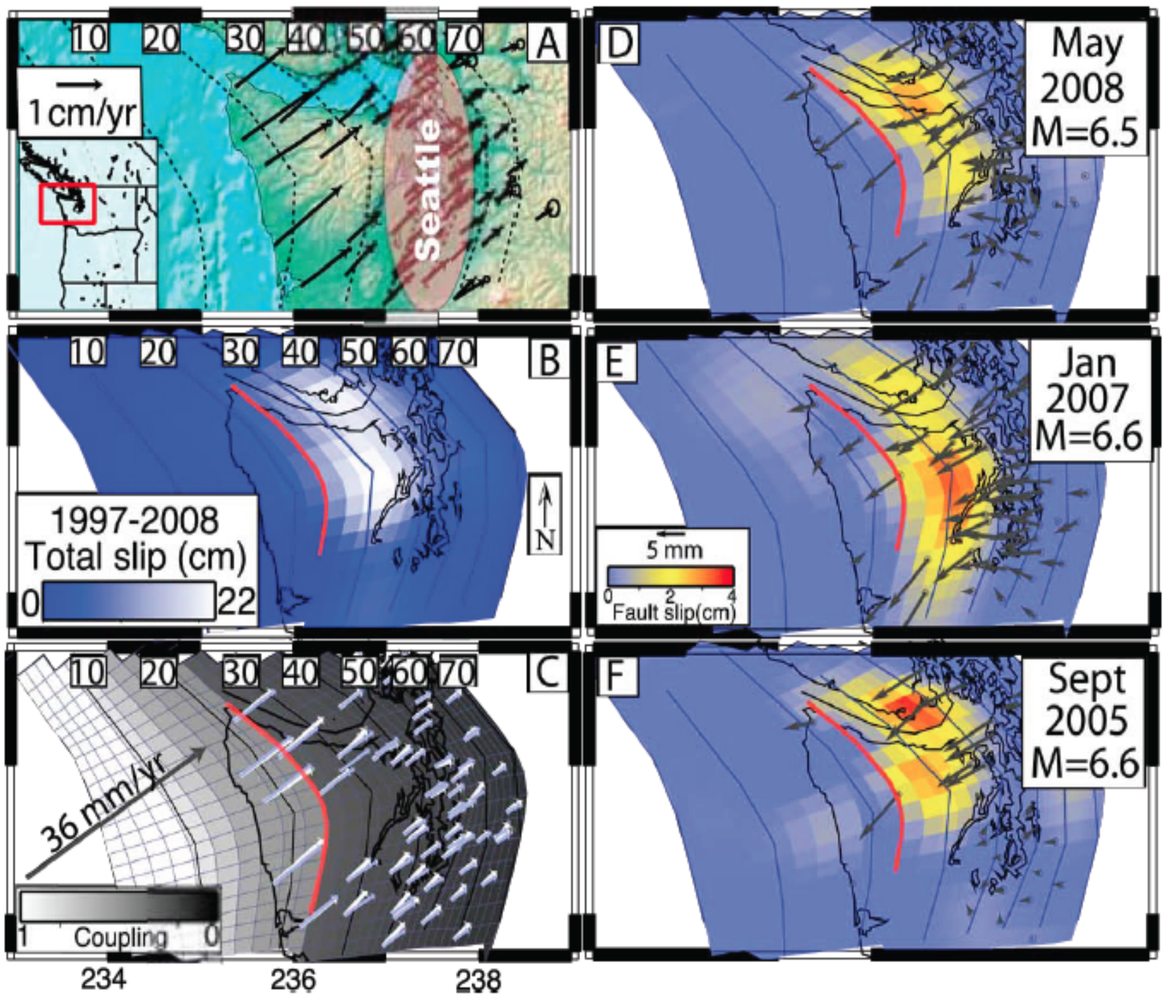
• Average repeat rate varies along strike and may also vary with time.

WHY ?

• Patterns vary along the subduction zone.

• Slip generally correlated with tremor, although it may extend farther up-dip

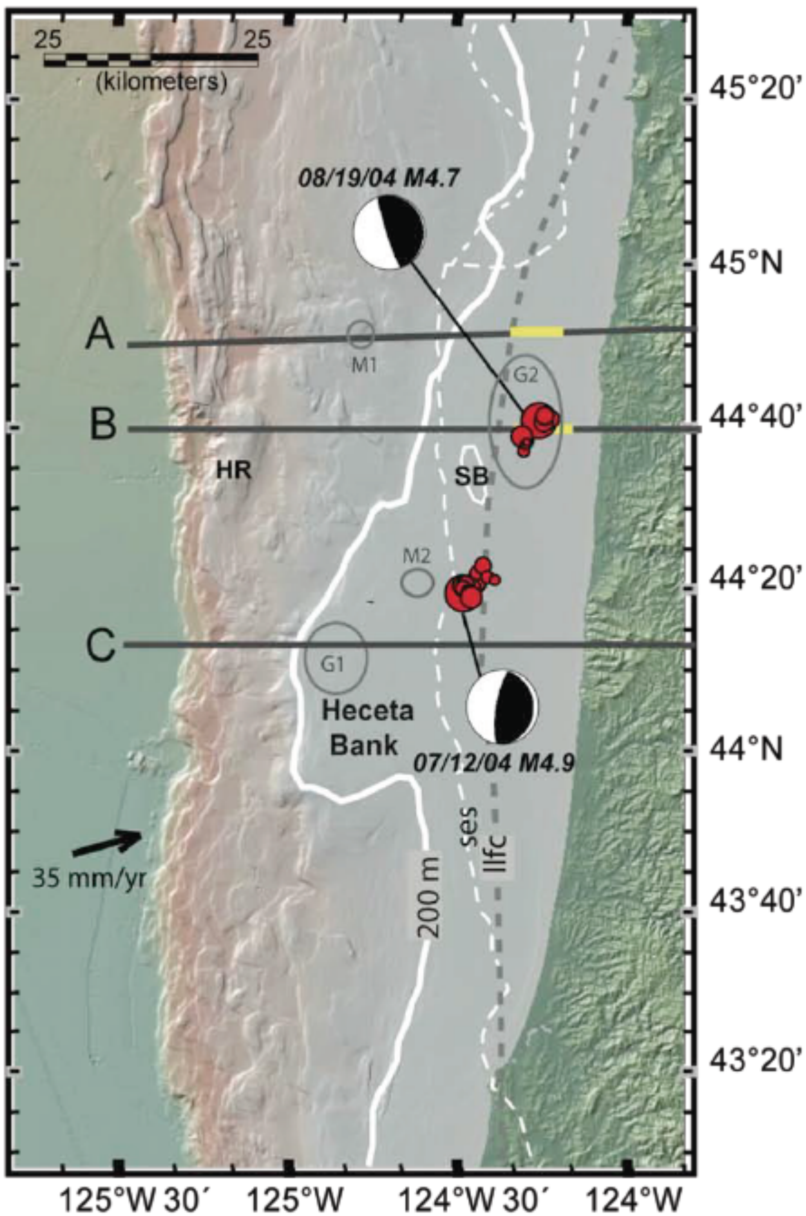
ETS can inform us about earthquake hazard :

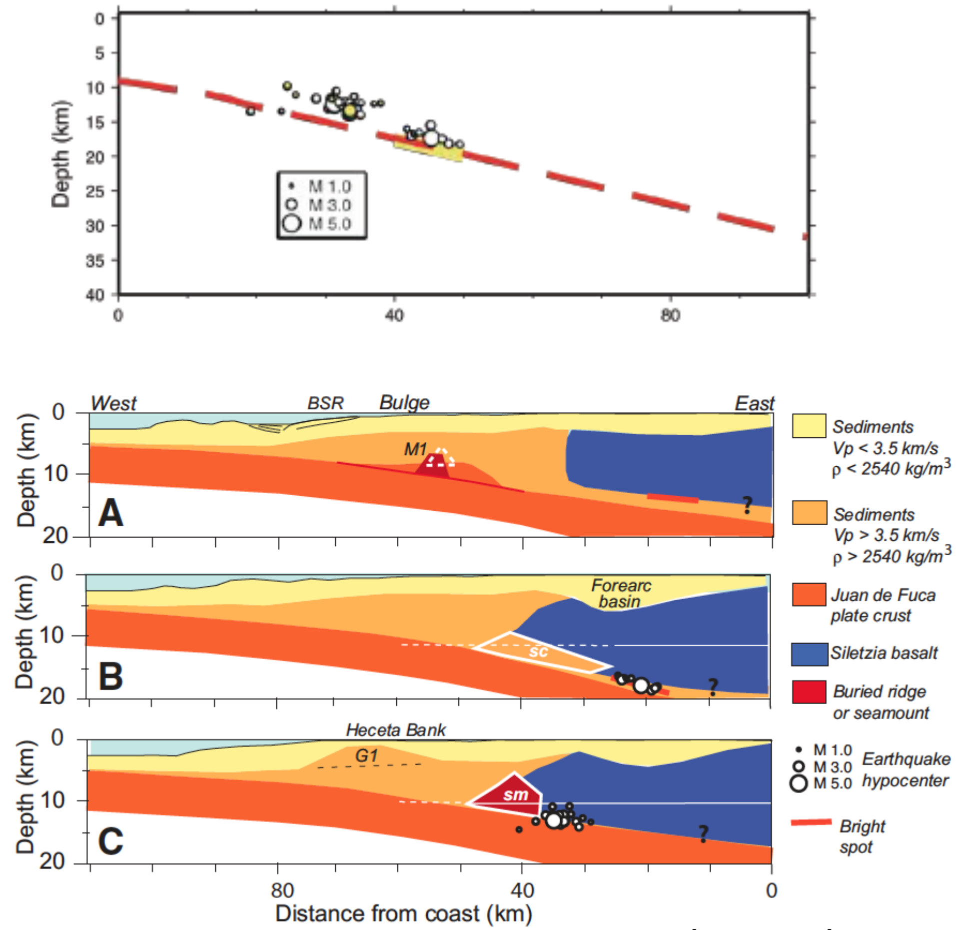


80-100% of plate tectonic motion at depth > 25 km accommodated by slip events and that coupled part of the plate extends farther landward than indicated by the 450 degree isotherm

Chapman and Melbourne, GRL, 2009

Subducted seamounts and shallow megathrust earthquake





Trehu et al., 2011

Correlations between buried seamounts on the subducting plate, structures in the upper plate, ETS, and interseismic locking. What do they mean for seismic hazards?

Thanks !