March 30, 2010

Surface motions and deformation: D I S C U S S I O N

Edward Garnero, ASU
Peiying Patty Lin, ASU

EarthScopeSeminarClass

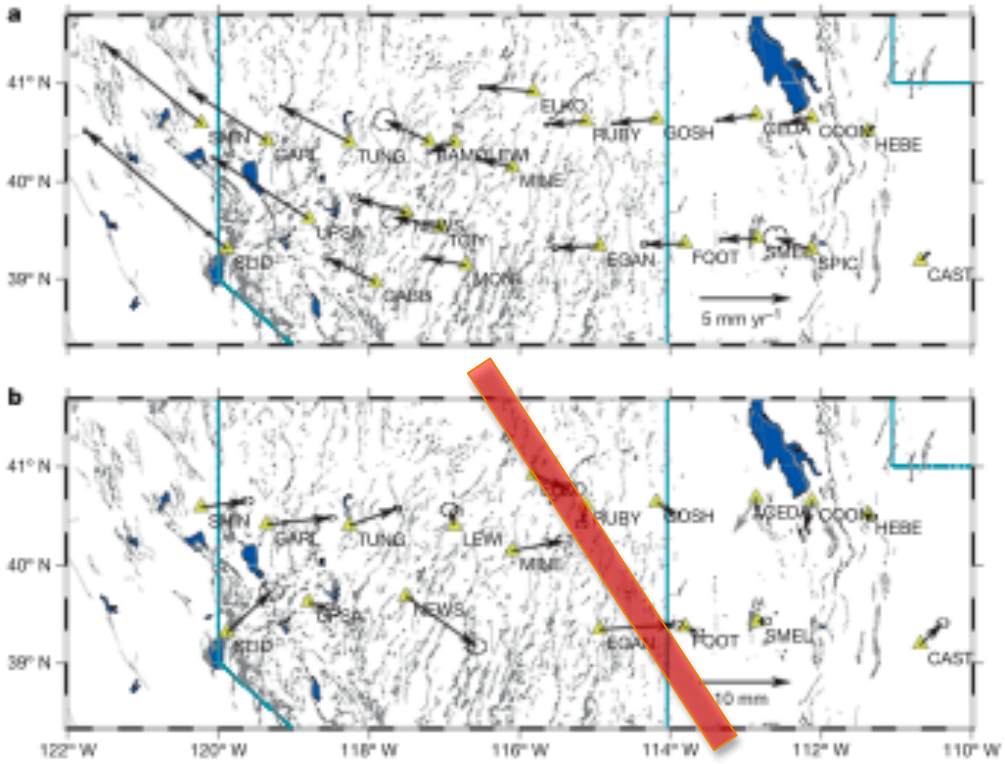
Figures and information referenced from various internet sources

1: Subcontinental-scale crustal velocity changes along the Pacific-North America plate boundary

Davis et al. Nature (2006) vol. 441 (7097) pp.1131-1134

DATA:
Continuous GPS data (1996~2005)

RESULT:
A sharp boundary near the centre of the BR oriented parallel to N-NW relative plate motion vector.



(Davis et al., 2006)

From Patty's March 3 presentation

Paper 1: “sharp boundary”… WHY?

If explanation is Earth (as opposed to method):

- Non-tectonic: e.g., crustal deformation due to hydrological & atmospheric loading and local soil movement (however: not observed locally)
- Post-seismic relaxation to 20th century Eqs may explain Nevada site velocities
- Deep crustal or lithospheric source: episodically creeping 500 km wide detachment horizon at base of crust
- Others?

Base of crust detachment horizon

- Mantle translates or stretches smoothly below horizon: creates a westward component of shear traction on base of crust before 1997 to 2000.
- To east of 'boundary', plastic deformation → internal stretching, crustal movement eastward
- Thus, contrast in lithospheric properties on either side of boundary (Vs: partial melt to west of bdy?)
- Large scale strain transfer, starts in east, propagates west over ~ 1 yr time scale

2: Rotation and place locking at the southern Cascadia subduction zone

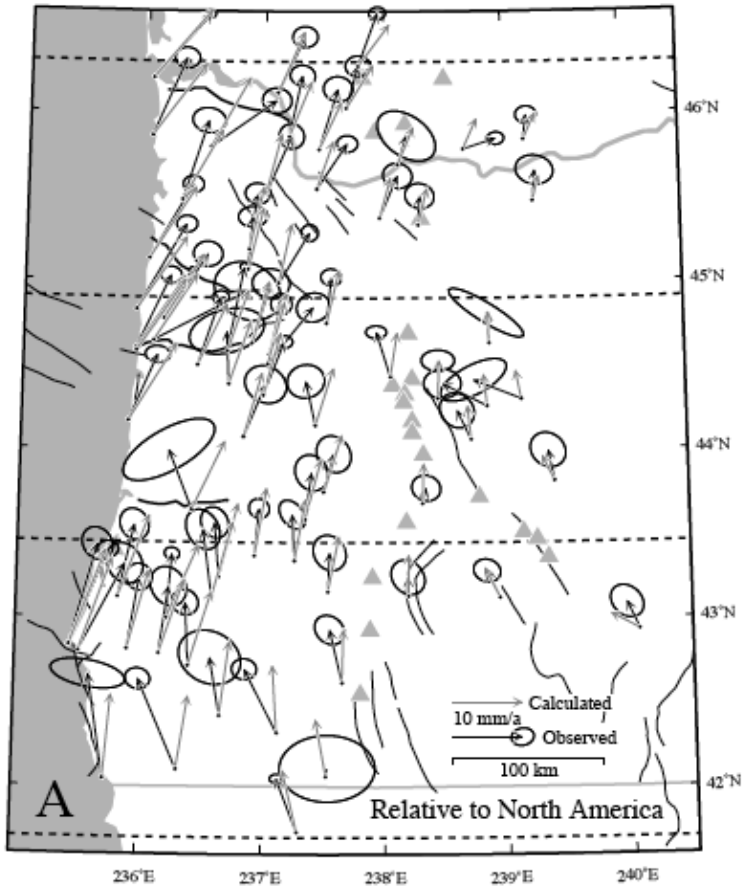
McCaffrey et al. Geophysical Research Letters (2000) vol. 27 (19) pp. 3117-3120

DATA:

GPS vectors and surface tilt rates

RESULT:

Rotation of western Oregon and plate locking on the southern Cascadia subduction thrust fault

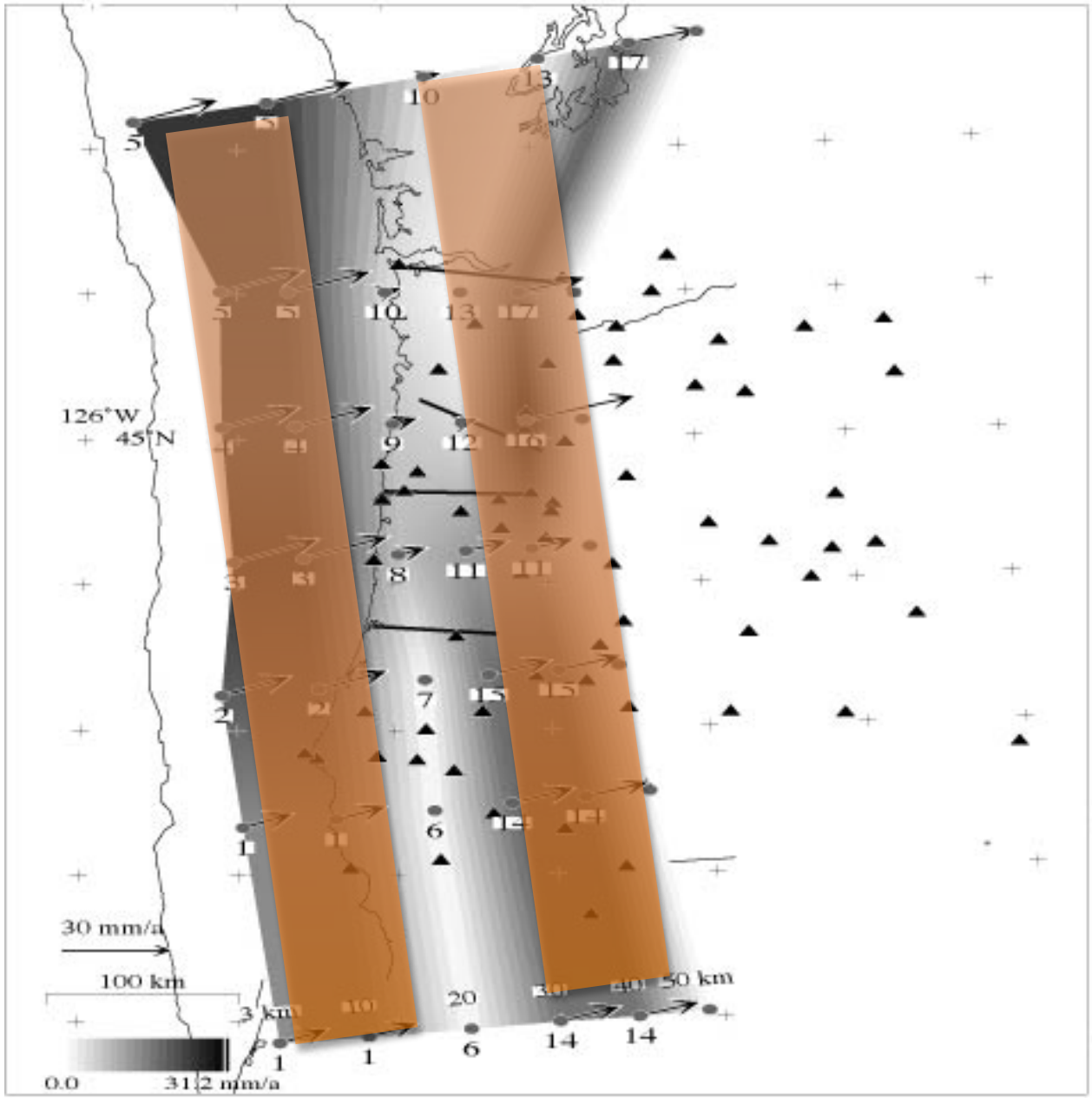


(McCaffrey et al., 2000)

From Patty's March 3 presentation

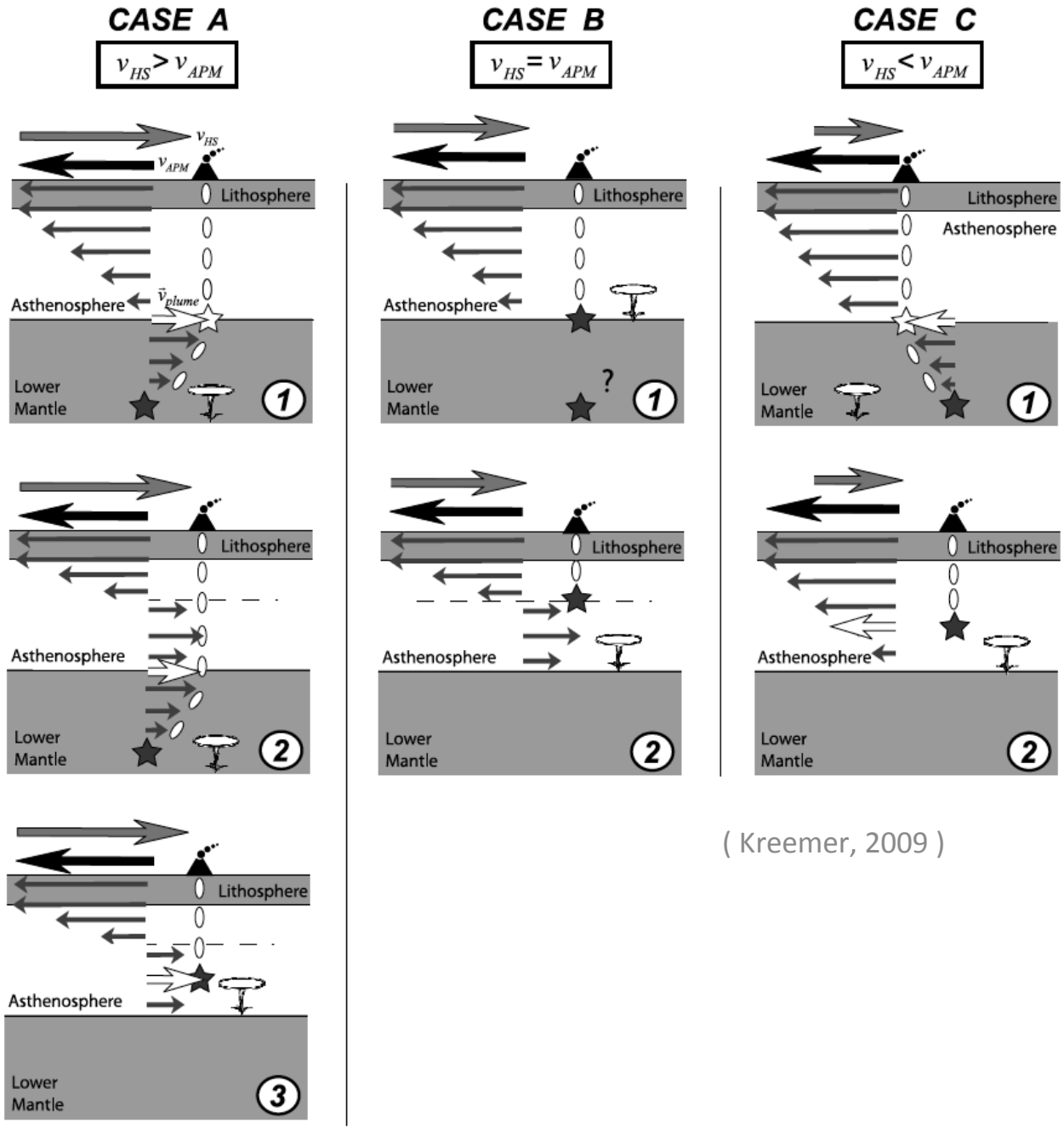
Paper 2: “plate locked offshore, Oregon rotates”

- Plate locked offshore may explain periodic great earthquakes inferred from geology.
- Rotation may be driven by shortening of NW Washington station from collapse of BR (w/ extension in OR, contraction in WA)
- Favorite quotes: “details of the earthquake history … are sketchy”, “upper plate deformation … remains poorly quantified”.


126°W
45°N
30 mm/a
100 km
3 km
0.0
31.2 mm/a
50 km

Inland locked zone: artifact

- Base of lithosphere: assumed NO SLIP boundary (produces unrealistically high resistance to trench-perpendicular contraction of lithosphere)
- Steep reduction in surface velocities above down-dip edge of coupled zone (contradicts w/ F.E. modeling)
- Thus: only oceanic area assumed LOCKED.



(Kreemer, 2009)