FINAL LECTURE

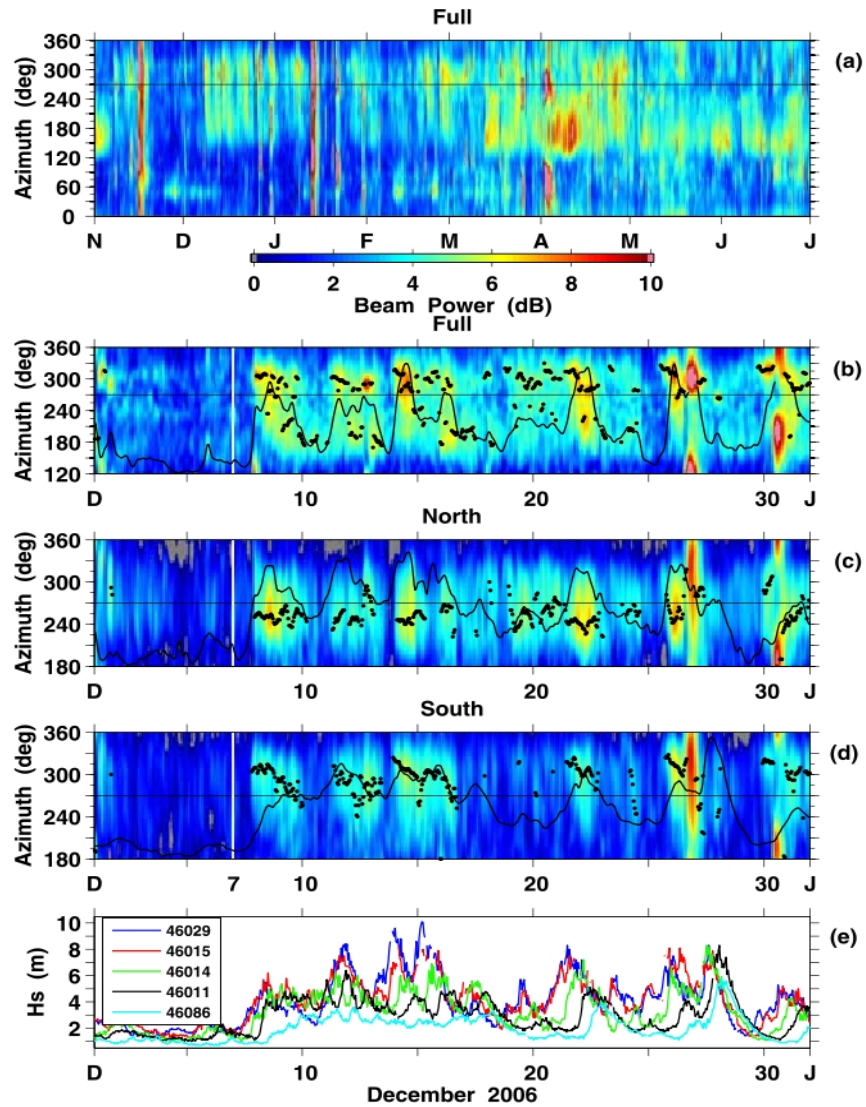
Slide count

Angela	2 slides	
Jenny	2 slides	
Nathaniel	2 slides	
Patty	**4** slides	?
Chunpeng	**5** slides	?
John	2 slides	
Jeff	2 slides	

ANGELA

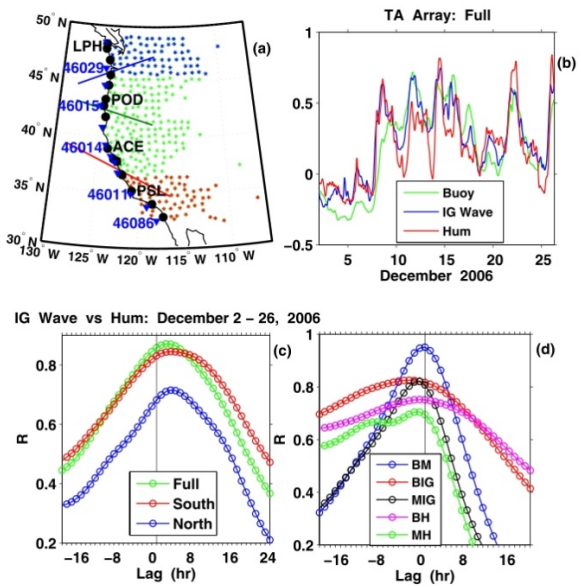
Bromirski and Gerstoft
Dominant source regions of earth's hum are coastal

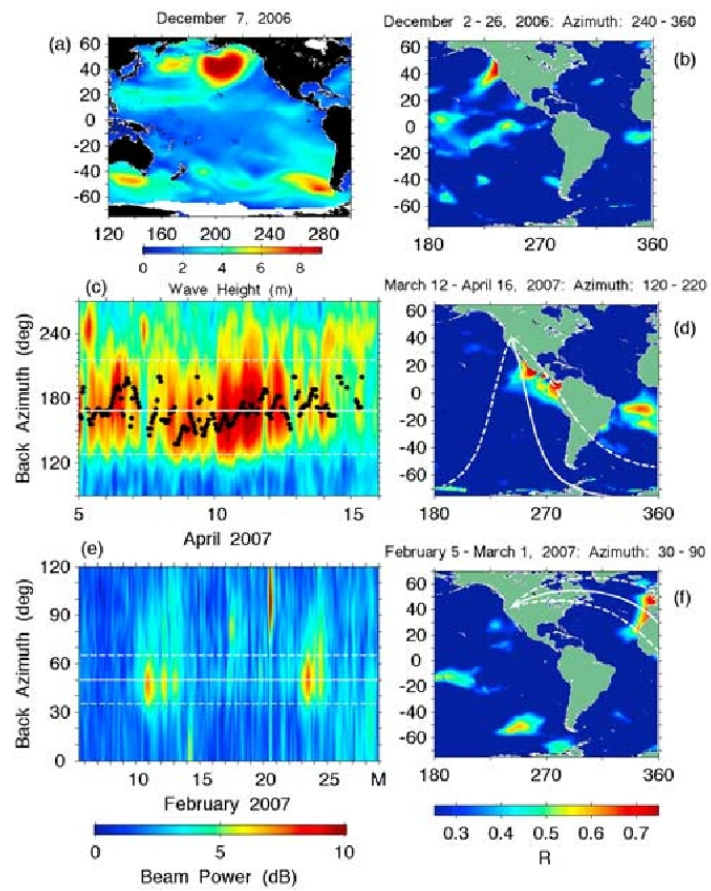
- Hum excited by infragravity (IG) waves generated by ocean swells. Primarily by IG waves in deep ocean or over **continental shelves**?
- Approach
  - 292 TA stations
  - Continuous beamformed vertical-component data
  - Set threshold to reduce earthquake noise
  - $b(\omega, t, \psi, s) = |\mathbf{p}(\omega, \psi, s)^T \mathbf{v}(\omega, t)|^2$
  - Stacked over frequency and Rayleigh wave slowness -> best-fitting plane wave over azimuth during each segment -> determine hum source



Bromirski and Gerstoft
Dominant source regions of earth's hum are coastal

- West coast of North America hum generation
  - Concentrations at particular azimuths associated with seasonal cycle: 220-340º North Pacific, 120-210º west coast of South America, 50º North Atlantic
- Correlation between swell, IG-waves, and hum
- Global wave model correlation with hum
- Conclusions – Dominant hum generating regions are near coasts





JENNY

Virtual seismometers in the subsurface of the Earth from seismic interferometry

Curtis et al. Natural Geoscience (2009) vol. 2 (10) pp. 700-704

Purpose:

Propagating seismic waves limits the resolution of subsurface images because permanent seismometers record seismic energy while being "confined almost exclusively to land based sites.

Proposing that the new approach of using interferometry will allow real time, non invasive, subsurface seismic strain monitoring for areas that are remote from instrumental networks.

Results:

Assumption that the authors' proposal proved to be true takes place.

"Information that can be obtained from these earthquakes about other such events is consistent with that provided by instrumental seismometers. "

The paper appears to be more of a long explanation of their methods rather than exploration of their findings.

Methods

1. Turn earthquakes into virtual seismometers located beneath the Earth's surface.
   a) Seismic waves generated by one earthquake lead to transient strain in the subsurface at other locations around the globe.
   b) This strain can be quantified from seismograms.
   c) This provides information on the subsurface strain in regions of the globe that lack instrumental networks.

2. Turn any energy source into a virtual sensor.
   a) Use passive noise form of interferometry over impulsive source.

3. Reconstruction of surface waves.
   a) Thus derive which components of surface was strain are recorded by virtual receivers constructed from canonical normal, thrust and strike slip earthquakes, allowing verification of the method by comparison with directly recorded seismograms in these cases.

4. To make direct comparisons possible, one could construct horizontal strain measurements by computing scaled differences between closely spaced seismometers.

1. Derive estimates of the scaled horizontal strain in a direction in line with the source seismometer path by taking time derivatives of measured seismograms.
   a) $I\omega = ick$ (ω is temporal spatial frequency, k is in-line spatial frequency, c is phase velocity.)

NATHANIEL

Fluid modeling in Chu et al.

- Used Gassmann's realtions to derive elastic moduli (and velocity) from concentration of fluid saturated pores
  - Valid only for “very low frequency”
  - Valid? Are we at very low frequency? What is very low frequency?
- Does the volatile content imply an eruption risk?
  - Do we need to make another supervolcano special for Discovery Channel?

The Shape of the Dike

- I think they chose the shape based on where seismicity was absent
- Explains the dogleg in the paper
- Why draw it as blocks instead of curves?

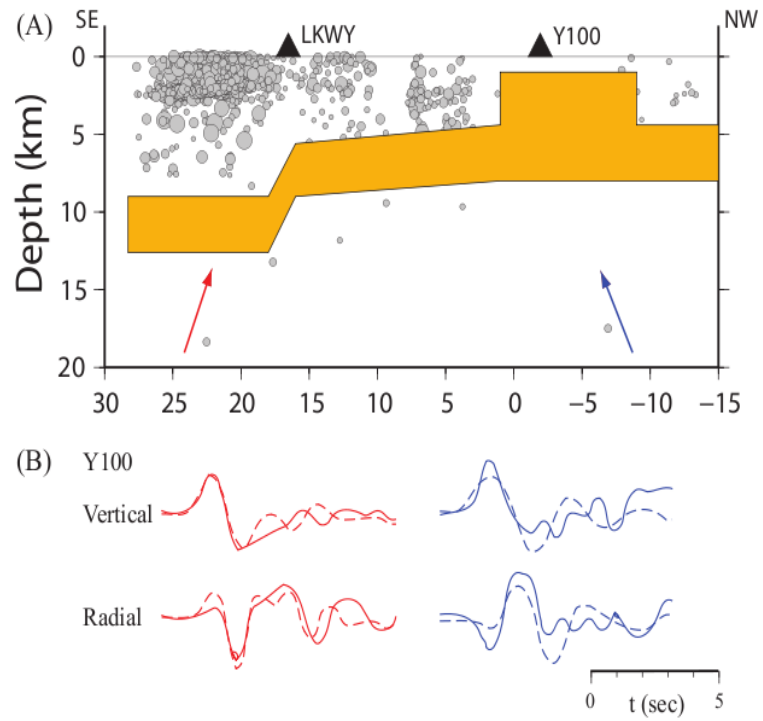


Figure S15. (A) Cross section along profile CD. (B) Synthetic seismograms for teleseismic waves from southeast. Numbers after each waveforms are station locations in (A). See caption of Fig. S13 for details.

PATTY

May 5, 2010

Is the track of the Yellowstone hotspot driven by a deep mantle plume?

— Review of volcanism, faulting, and uplift in light of new data

Pierce and Morgan

J VolcanolGeoth Res (2009) vol. 188 (1-3) pp. 1-25

Peiying Patty Lin, ASU

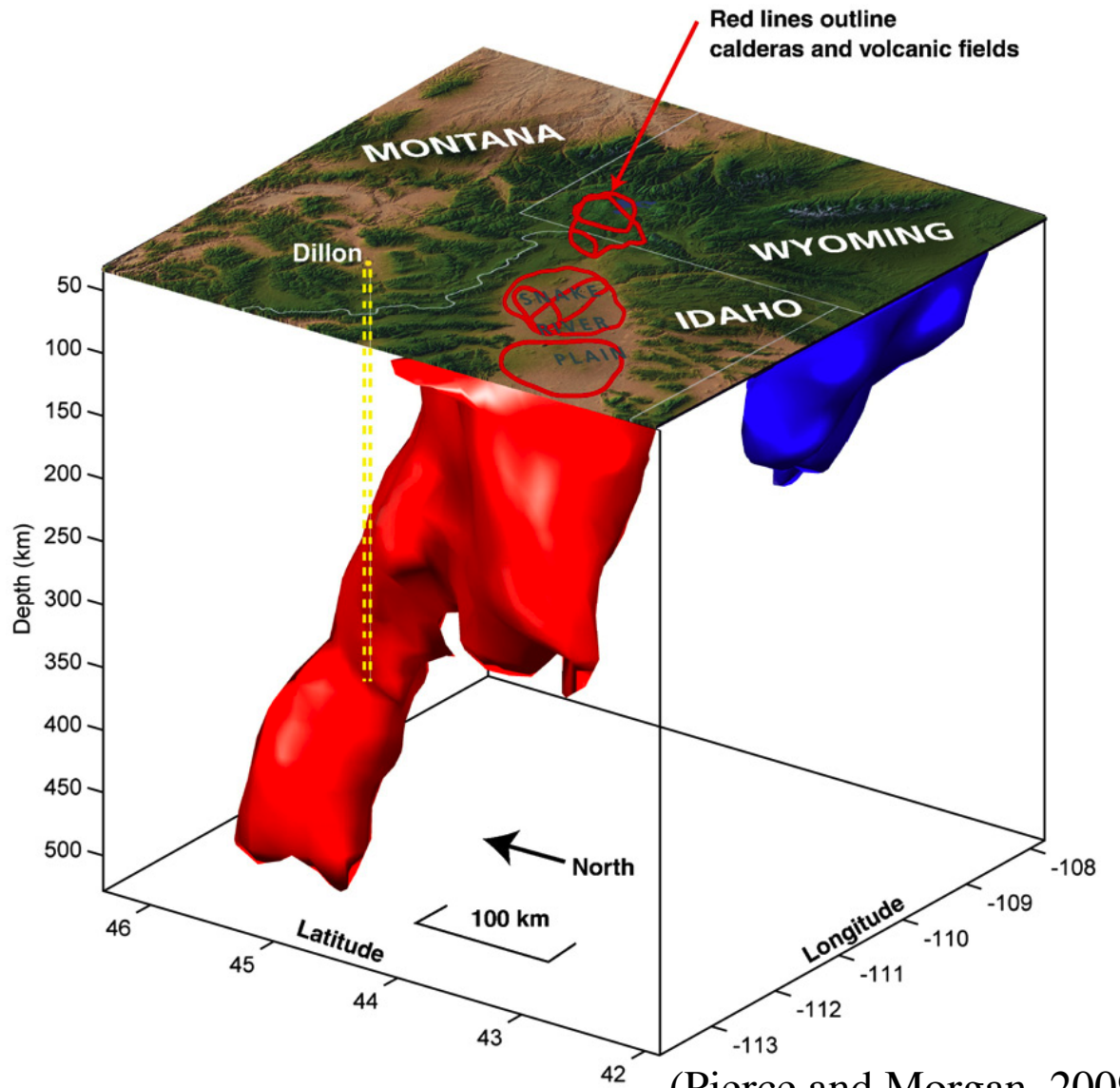
EarthScopeSeminarClass

Figures and information referenced from various internet sources

Seismic tomography (Yuan and Dueker ,2005)

- Warm mantle material inclined to NW from beneath Yellowstone.
- Tomography resolved a Low-velocity mantle plume to a depth of 500-600km
- At 500km depth, the inferred plume is beneath Dillon.

➔
Yellowstone hotspot is an upper mantle plume
(Yuan and Dueker, 2005; Waite et al, 2006)



(Pierce and Morgan, 2009)

Argument- a deep (> 500km) mantle plume

Supporting evidences:

(1) Flood basalt volcanism including a northward spreading plume head
(2) Coeval rhyolite volcanism to the south through generally more cratonic crust
(3) A large mass deficit

(Pierce and Morgan, 2009)

Issues need to be clarify

(1) the size of the plume head
(2) the depth of the plume origin
(3) whether or not the lithosphere thickens eastward across the cratonic boundary
(4) plume interaction with the Juan de Fuca slab
(5) 17–10 Ma hotspot migration rates 2.5 times too high for plate motion.

CHUNPENG

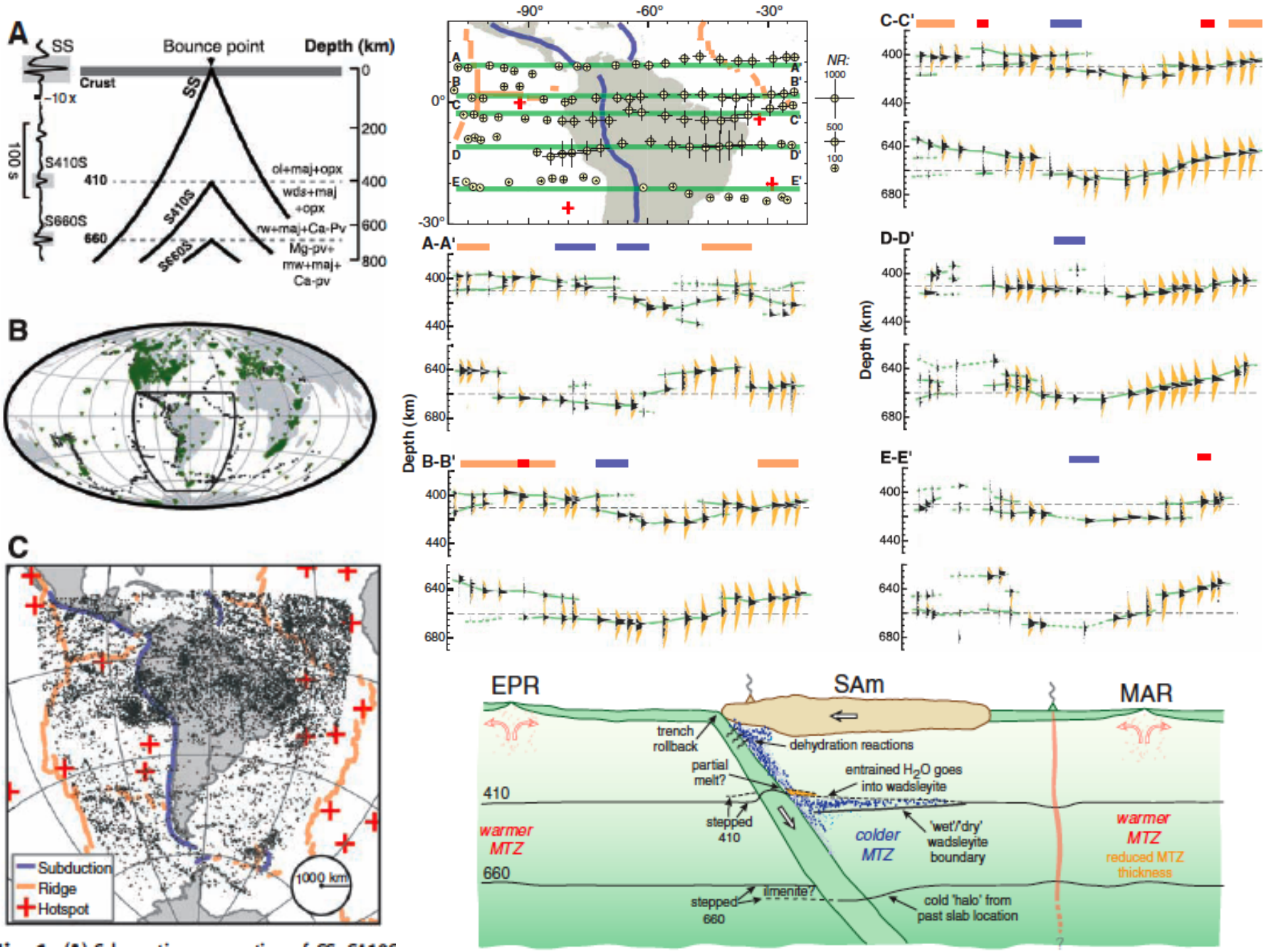
Detailed Deep Mantle Structure Maping Using Usarray Data

•Chunpeng Zhao

Upper Mantle Discontinuity Topography from Thermal and Chemical Heterogeneity

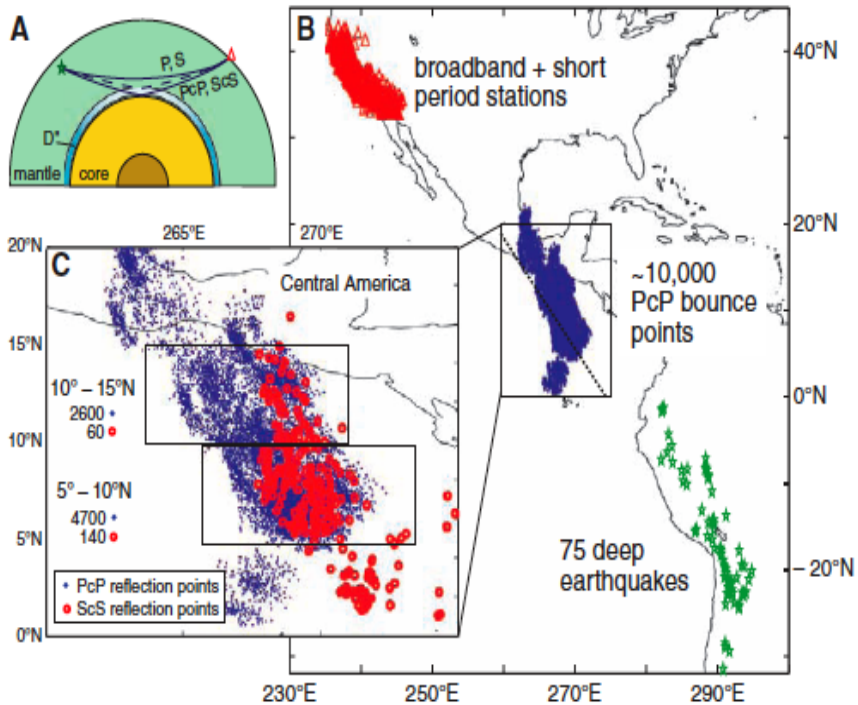
[Schmerr and Garnero 2007]

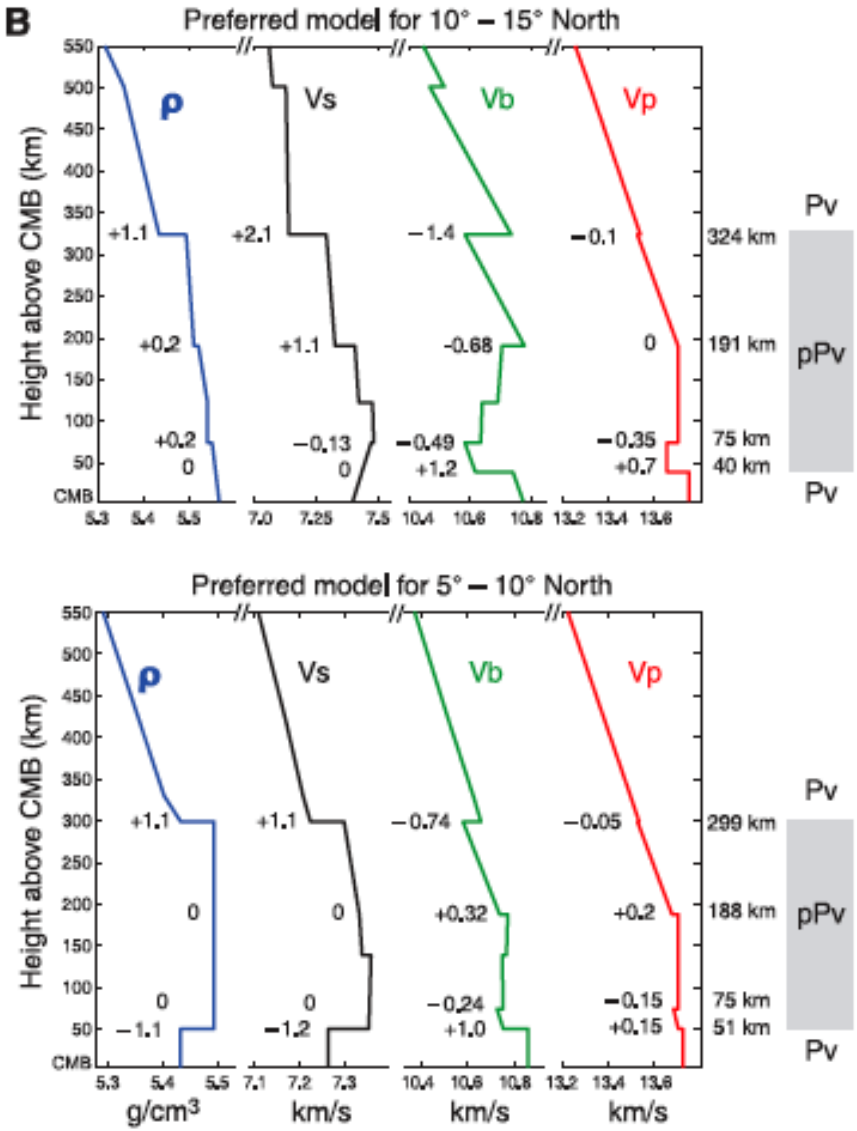
- Data:
  - 16000 high-quality broadband seismograms densely sampling the mantle beneath South America
- Method:
  - Bootstrap stacking of SS precursors which can be used to determine the mantle transition zone thickness
- Result:
  - A detailed topography of the 410 and 660 discontinuity beneath SA.
  - Thermal and Chemical Heterogeneity caused by entrainment of water is required to explain the depressed 410 and 660 to the east of the slab


A
SS
Bounce point
Depth (km)
Crust
~10 x
100 s
S410S
410
S660S
660
ol+maj+opx
wds+maj
+opx
rw+maj+Ca-Pv
Mg-pv+
mw+maj+
Ca-pv
B
C
Subduction
Ridge
Hotspot
1000 km
-90°
-60°
-30°
0°
-30°
NR:
1000
500
100
A-A'
B-B'
C-C'
D-D'
E-E'
Depth (km)
EPR
SAm
MAR
trench
rollback
dehydration reactions
partial
melt?
entrained H2O goes
into wadsleyite
410
stepped
410
'wet'/'dry'
wadsleyite
boundary
warmer
MTZ
colder
MTZ
warmer
MTZ
reduced MTZ
thickness
660
ilmenite?
stepped
660
cold 'halo' from
past slab location

Anticorrelated Seismic Velocity Anomalies from Post-Perovskite in the Lowermost Mantle [Hutko et al. 2008]

- Data:
  - 17550 high-quality broadband and short period P waves and a similar dataset of S waves
- Method:
  - Deconvolution of source wavelet
  - Double array stacking of P and S wave to amplify the reflected energy after P and S by D'' discontinuity.
  - Scattering migration to model the P wave post cursor.
- Result:
  - 1-D P and S velocity model for this small region suggest anticorrelated Vp and Vs discontinuity at 2570 km deep


A
P, S
PcP, ScS
D"
mantle
core
B
broadband + short period stations
~10,000 PcP bounce points
75 deep earthquakes
40°N
20°N
0°N
20°N
230°E
250°E
270°E
290°E
C
265°E
270°E
20°N
15°N
10°N
5°N
0°N
Central America
10° – 15°N
2600
60
5° – 10°N
4700
140
PcP reflection points
ScS reflection points

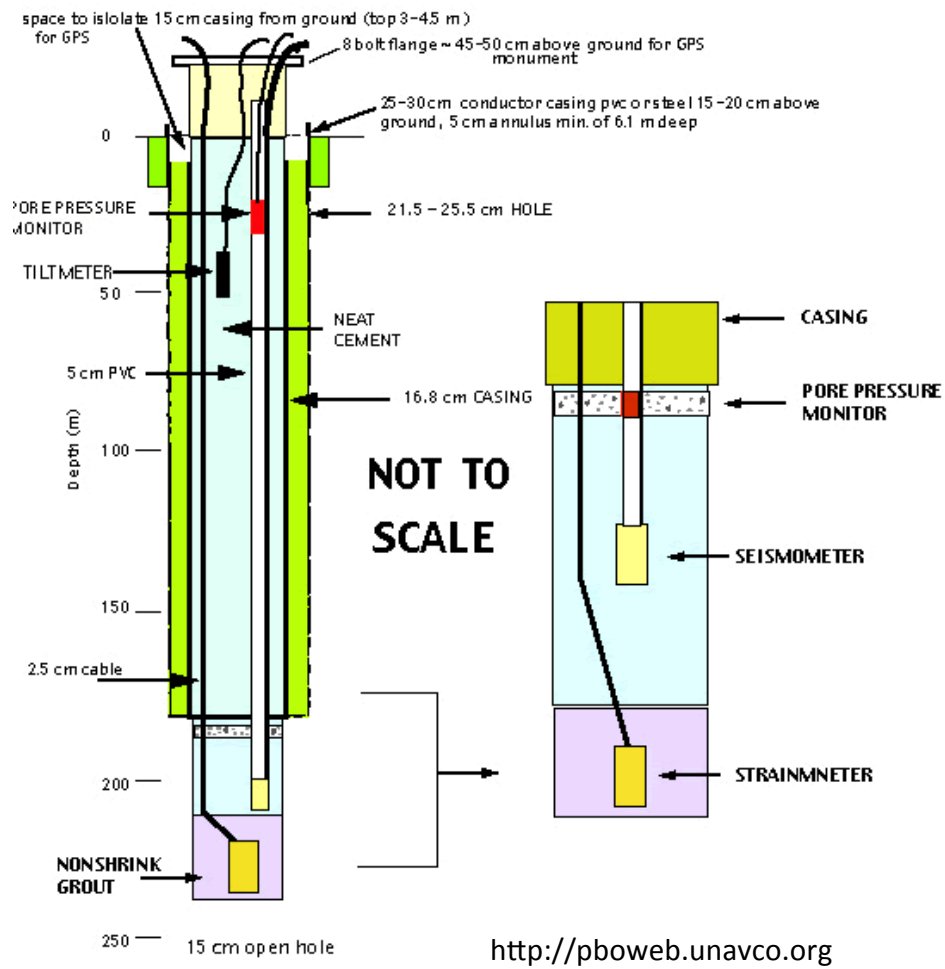

B
Preferred model for 10° – 15° North
Height above CMB (km)
ρ
Vs
Vb
Vp
+1.1
+0.2
+0.2
0
+2.1
+1.1
−0.13
0
−1.4
-0.68
−0.49
+1.2
−0.1
0
−0.35
+0.7
Pv
324 km
191 km
pPv
75 km
40 km
Pv
Preferred model for 5° – 10° North
+1.1
0
0
−1.1
+1.1
0
0
−1.2
−0.74
+0.32
−0.24
+1.0
−0.05
+0.2
−0.15
+0.15
Pv
299 km
188 km
pPv
75 km
51 km
Pv
g/cm3
km/s
km/s
km/s

JOHN

Strainmeters in the EarthScope experiment

Smith and Gomberg (2009), A search in strainmeter data for slow slip associated with triggered and ambient tremor near Parkfield, CA, JGR 114 B00A14

http://pboweb.unavco.org



http://pboweb.unavco.org

Question: does slow slip accompany triggered tremor, and can it be detected using PBO strainmeters?

Background: borehole strainmeters in some locations show strain changes with tremor, slow slip, and/or earthquakes.

Slow slip defined as strain changes with clear onset and lasting several to 10's of days.

Methodology: measure strain signal, subtract out tides, atmospheric pressure & long term drift, look for non-noise signals in the remaining time series, especially signals which correlate between multiple strainmeter locations.

Results: (a) No evidence of slow slip accompanying tremor or induced by teleseismic waves.

(b) There are significant calibration and sensitivity differences between instruments; differences are time varying.

Conclusions: Slow slip may only be detectable if slip is shallow and instrument is located in or very near the slip zone, or if slip is very large (>M5).

JEFF

Subsurface fault geometries and crustal extension in the eastern Basin and Range Province, western U.S.

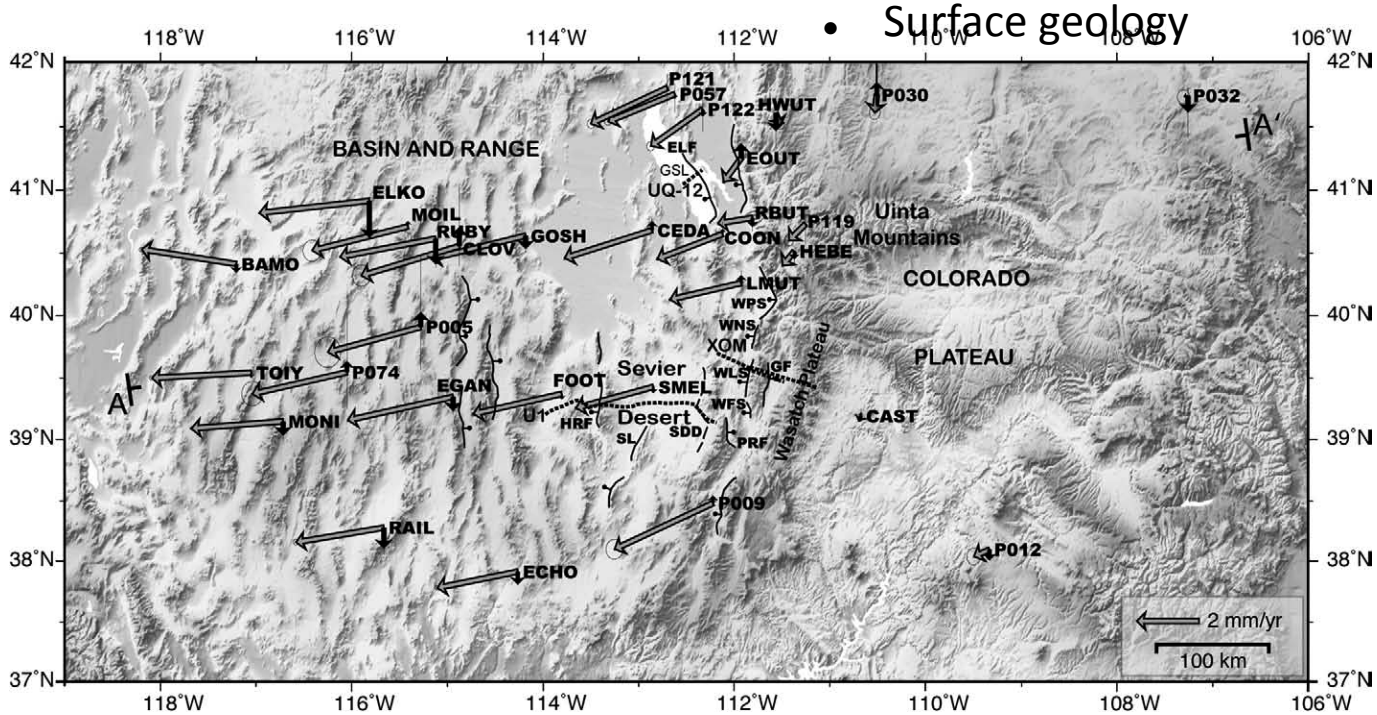
Velasco, M.S., et al.- Tectonophysics (2009), doi:10.1016/j.tecto.2009.05.010

Purpose

- To identify fault geometry & rheological structures in the eastern B&R.
- Better understand fault mechanisms and seismic hazard.

Data Sources

- New seismic reflection lines
- Continuous GPS crustal velocity datasets (inc. PBO network).
- Surface geology



Subsurface fault geometries and crustal extension in the eastern Basin and Range Province, western U.S.

Velasco, M.S., et al.- Tectonophysics (2009), doi:10.1016/j.tecto.2009.05.010

- Results:
  - Regionally extensive low-angle basal detachment beneath entire eastern B&R at 7-10 km depth.
  - Shallower normal faults are high-angle reactivated Sevier structures that coalesce into listric detachment.
  - Lithospheric strain is accommodated by aseismic slip and/or ductile flow along basal detachment.