The Subduction Zone Seismogenic Zone

Fundamental Science, Hazard Assessment and International Collaboration

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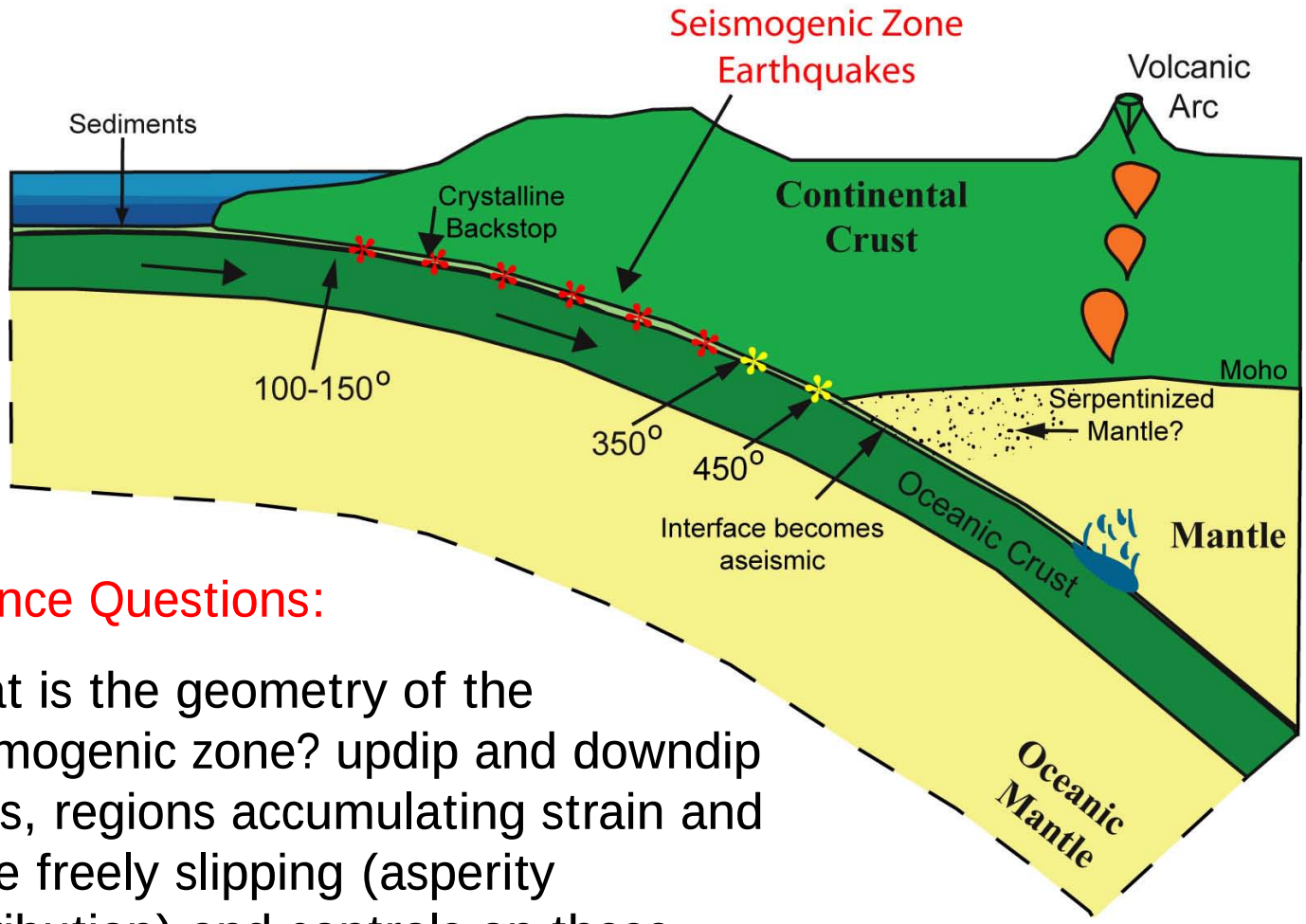
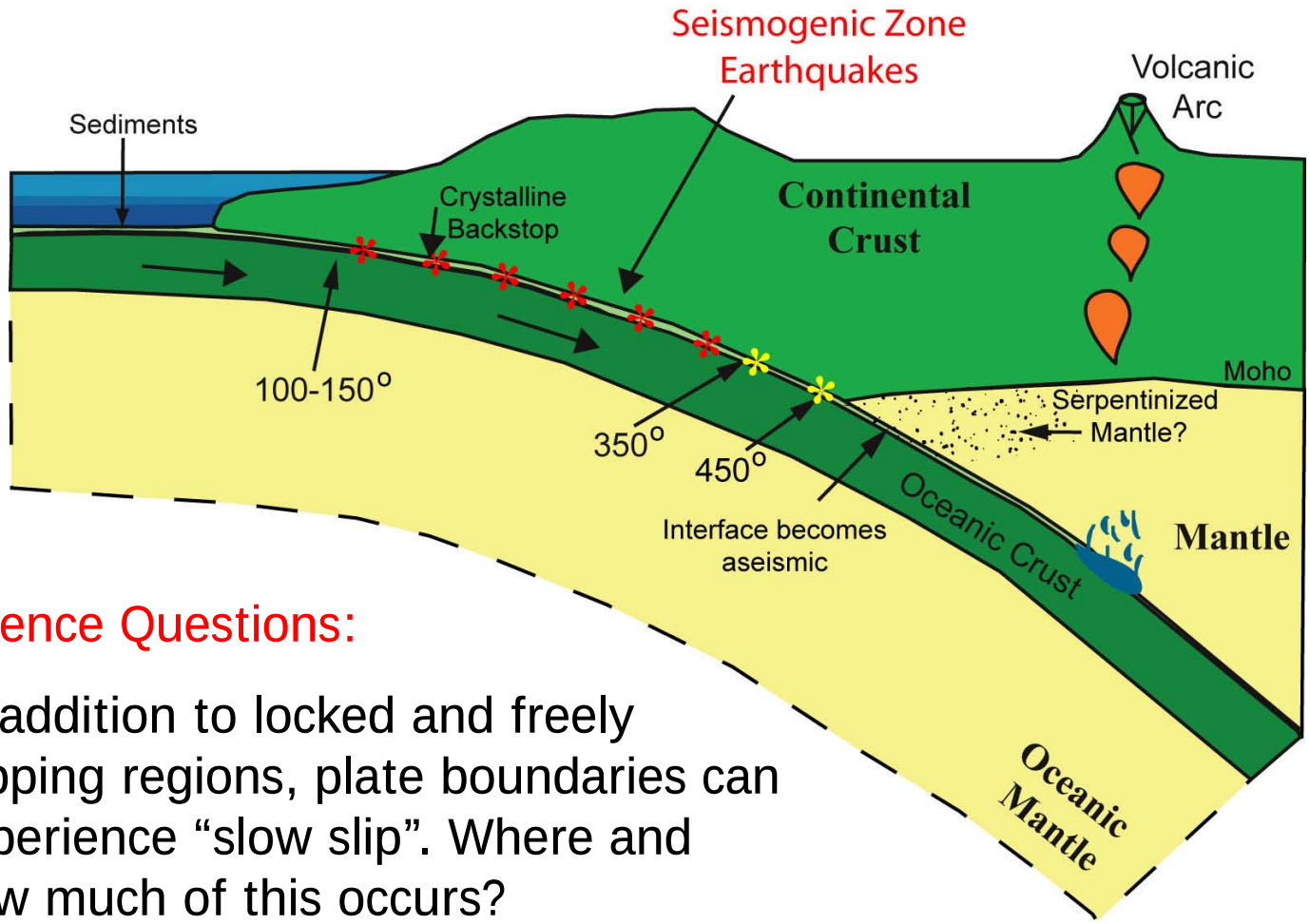
Seismogenic Zone



Science Questions:

What is the geometry of the seismogenic zone? updip and downdip limits, regions accumulating strain and more freely slipping (asperity distribution) and controls on these

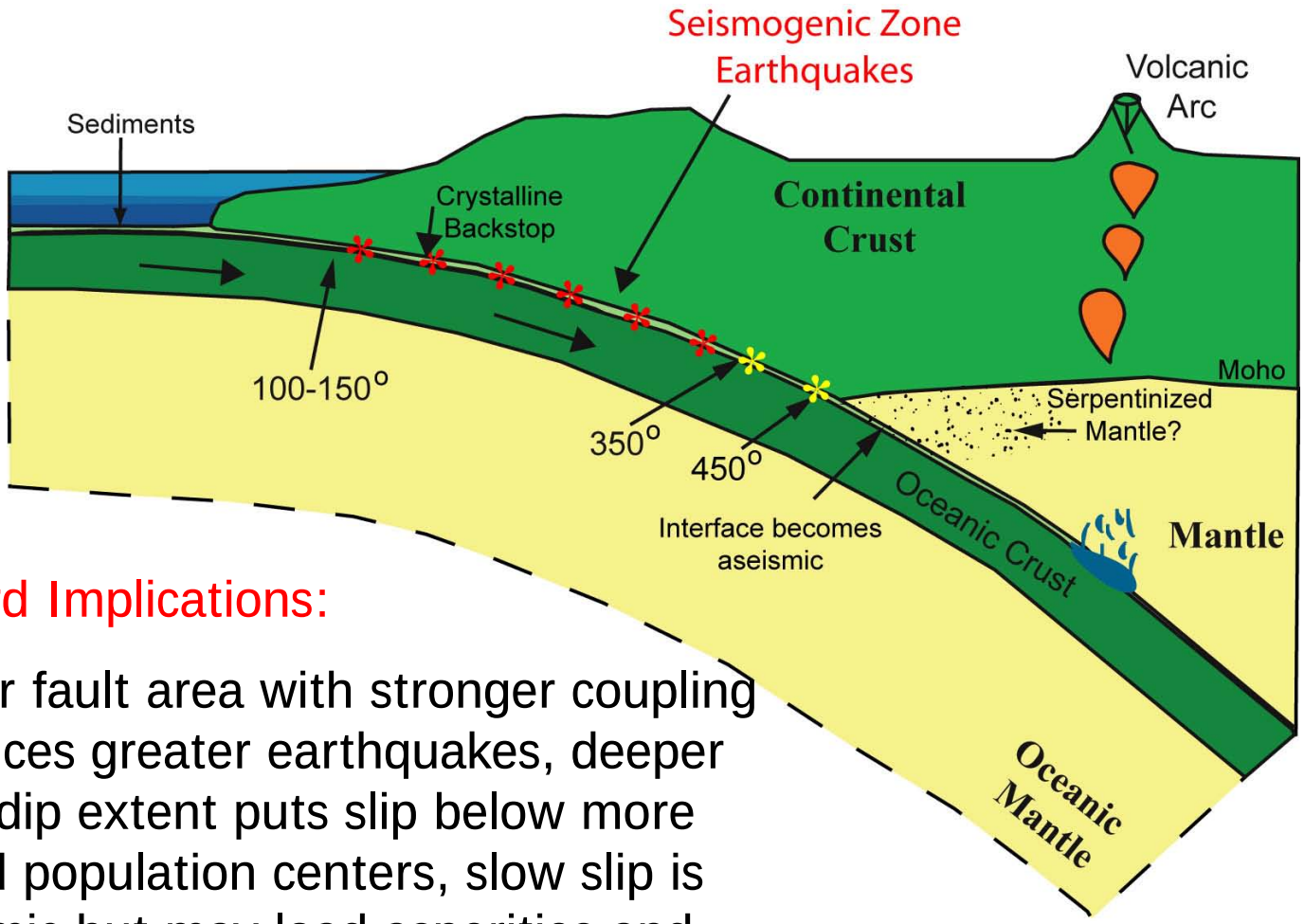
Seismogenic Zone



Science Questions:

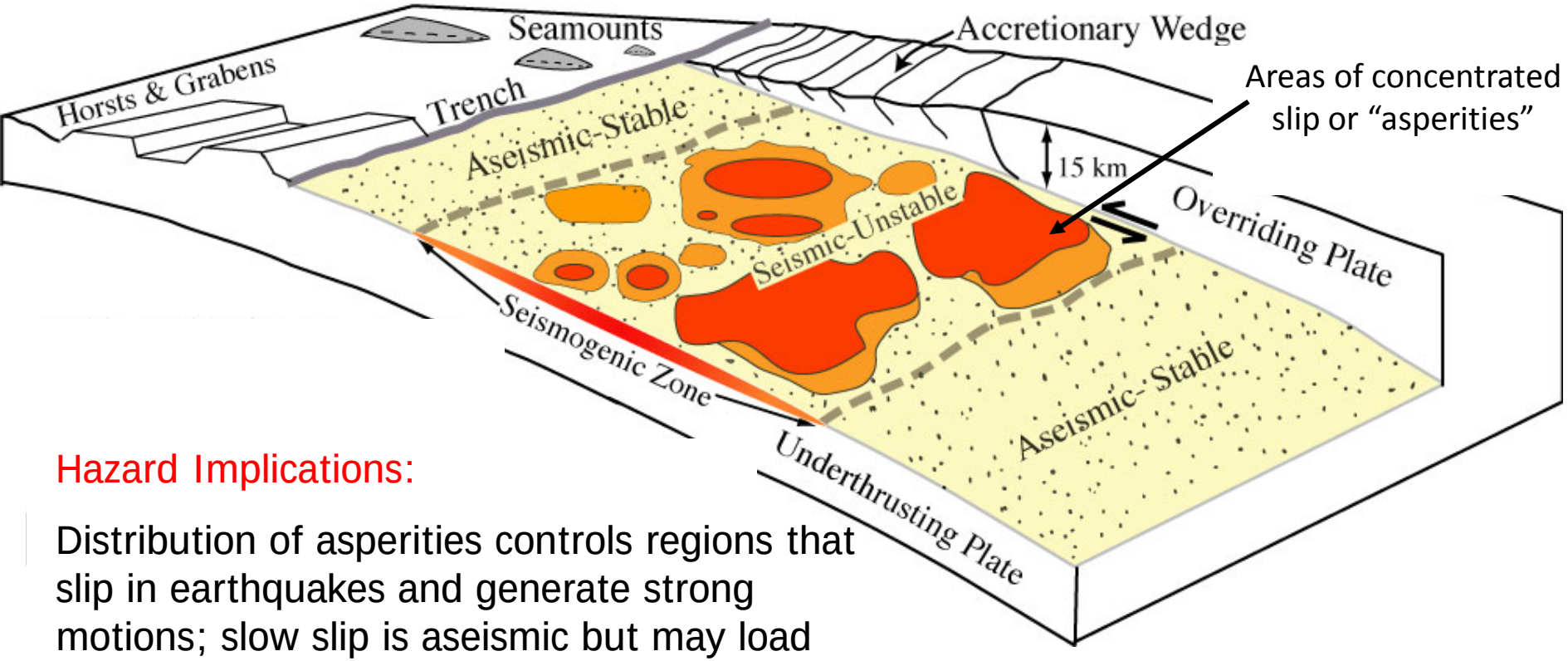
In addition to locked and freely slipping regions, plate boundaries can experience “slow slip”. Where and how much of this occurs?

Seismogenic Zone



Hazard Implications:

Larger fault area with stronger coupling produces greater earthquakes, deeper downdip extent puts slip below more inland population centers, slow slip is aseismic but may load asperities and bring them closer to failure



Hazard Implications:

Distribution of asperities controls regions that slip in earthquakes and generate strong motions; slow slip is aseismic but may load asperities and bring them closer to failure

(Modified from Bilek and Lay, 2002)

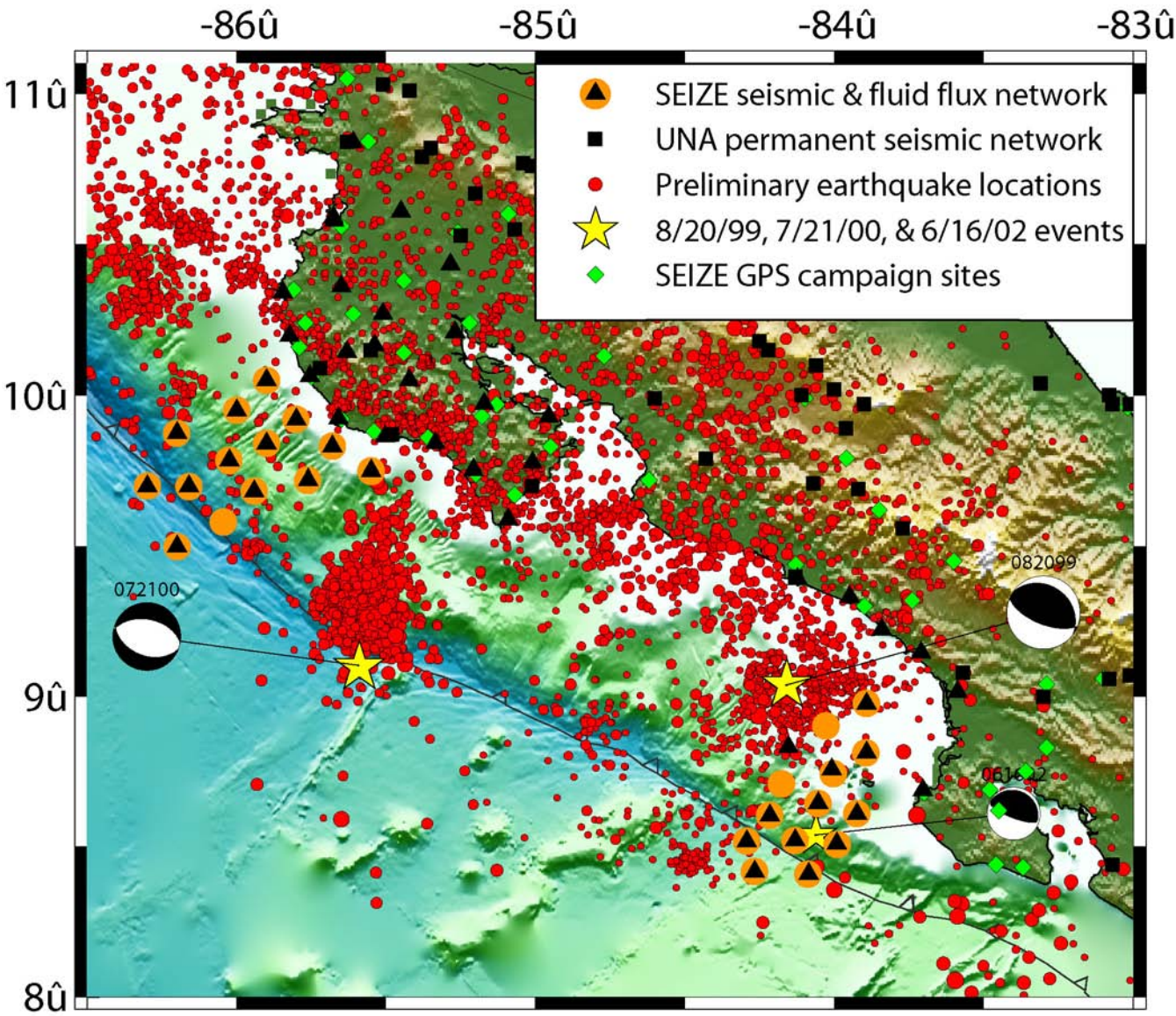
What tools do we have?

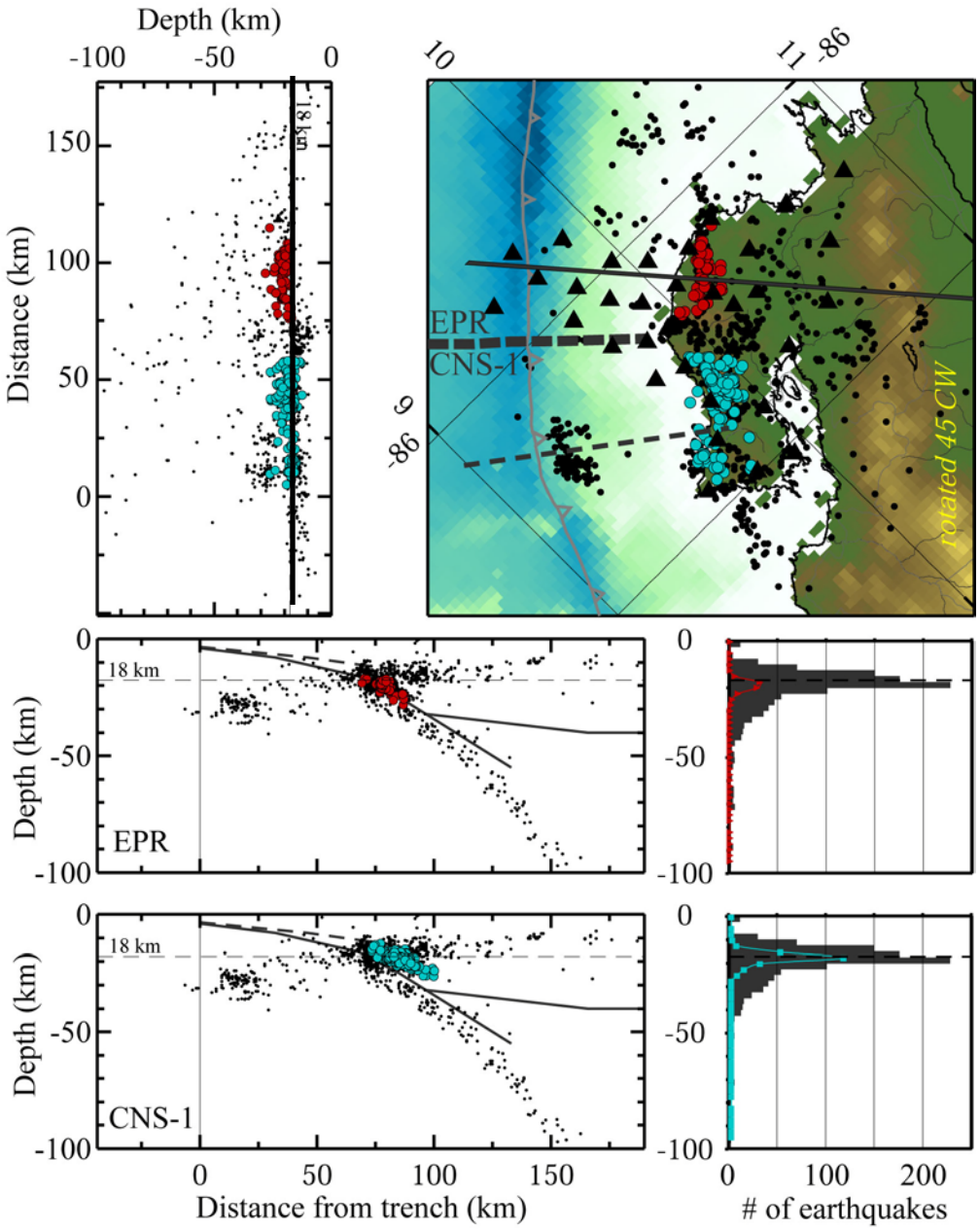
Seismology and Geodesy

CRSEIZE: Costa Rica Subduction Zone Experiment- Instrumenting the Plate Boundary with a Seismic, GPS and Fluid Flow Network

Collaborators: Tim Dixon, Marino Protti, Victor Gonzalez, LeRoy Dorman, Kevin Brown, Heather DeShon, Edmundo Norabuena, Andy Newman, Sue Bilek, Ernst Flueh

Technical/Instrumental Assistance: Dan Sampson, IRIS, UNAVCO

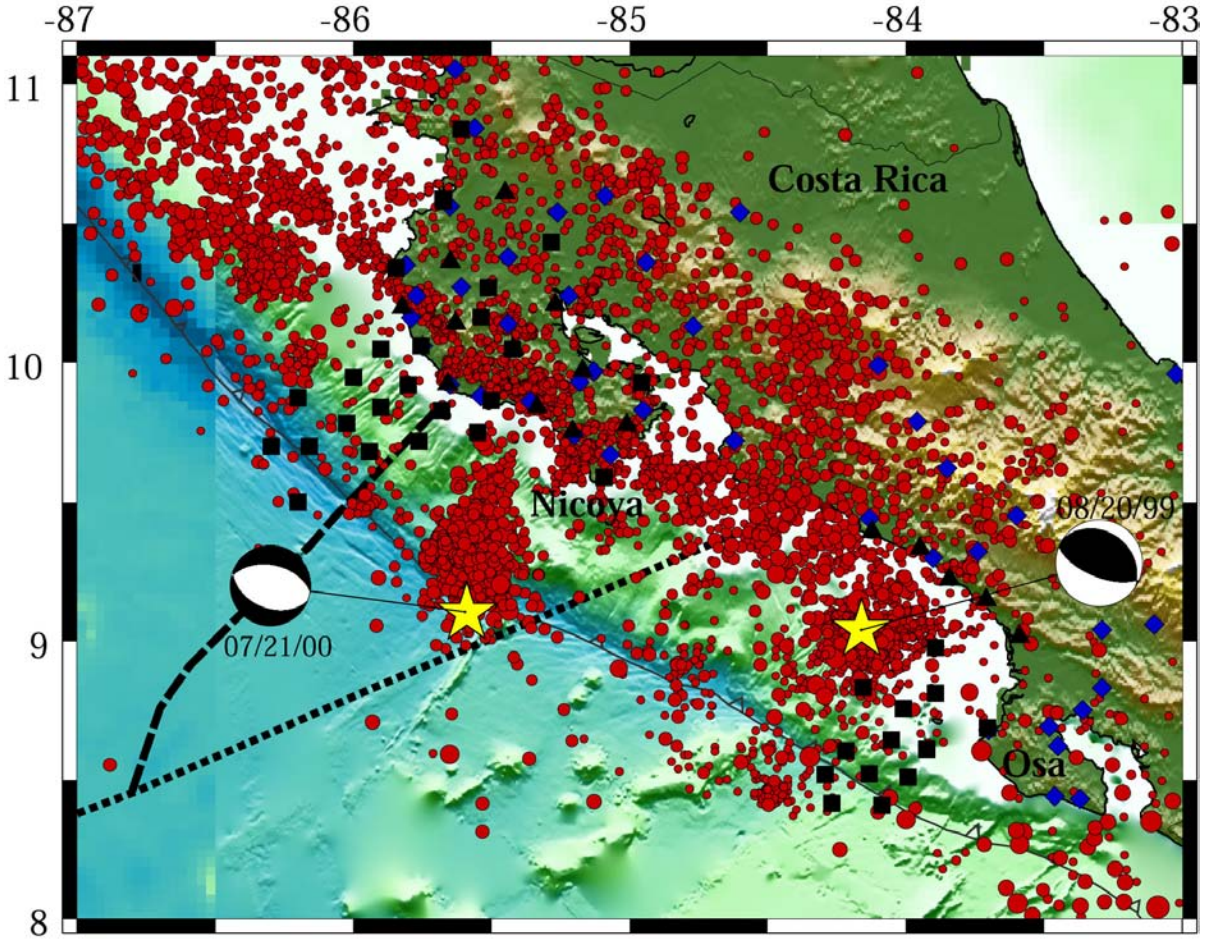


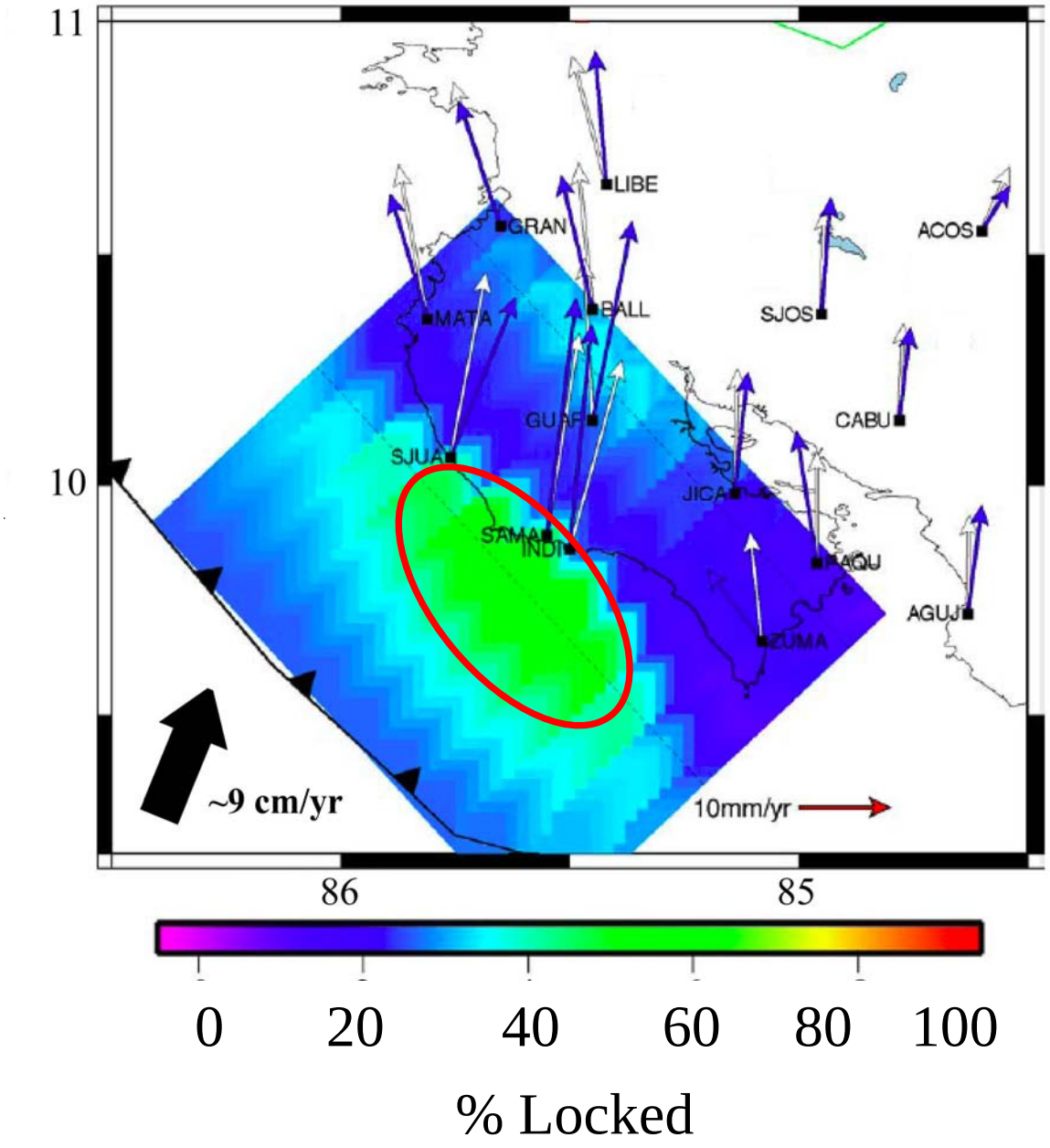


EPR interface seismicity: 17-28 km

CNS interface seismicity:12-24 km shallower dip

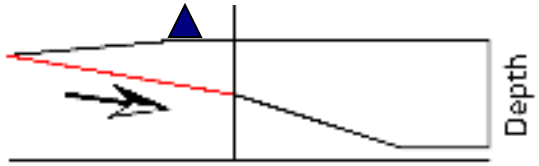
Determination of strain accumulation on the plate interface



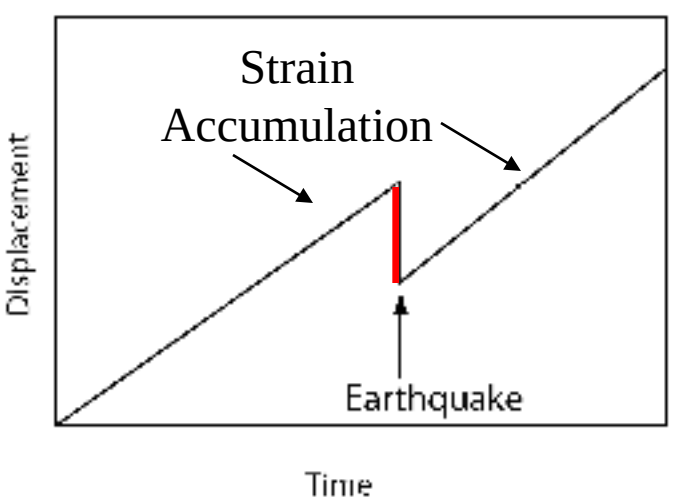


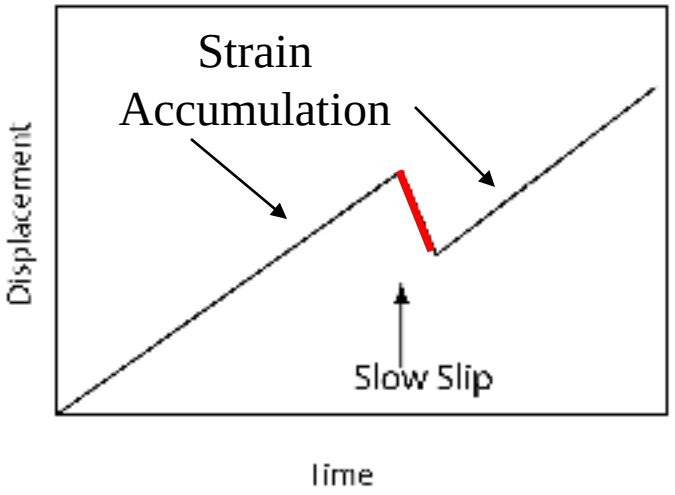
8mm/yr arc parallel motion

SLOW SLIP

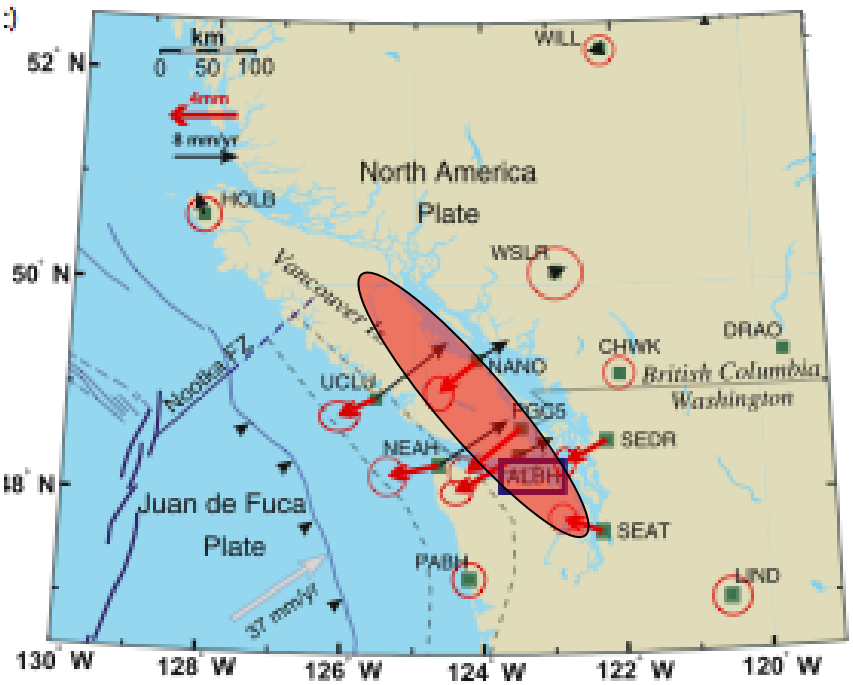


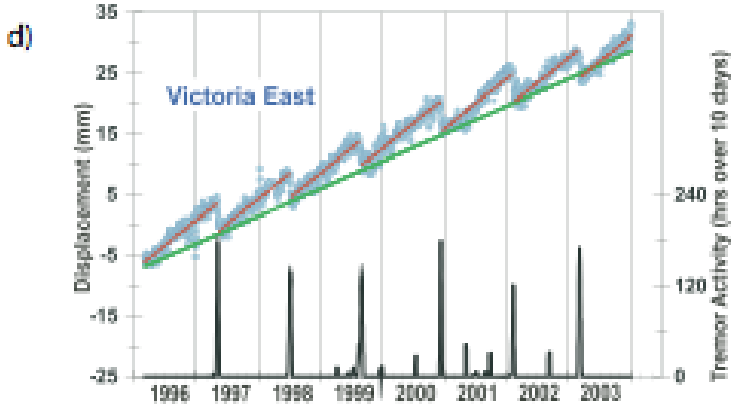
Trench Normal Distance





Cascadia Slow Slip Earthquakes- or Episodic Tremor and Slip (EPS)





Modified from Dragert and Rogers [2004]

Collaborators:

Marino Protti, Victor Gonzalez (OVSICORI-UNA)

Jake Walter, Dan Sampson (UCSC)

Tim Dixon, Kim Outerbridge (UM)

Andy Newman (Georgia Tech)

SFB574 Borehole Seismic:

Ernst Flueh, Wolfgang Rabbel, Martin Thorwart (Christian-Albrechts University, Germany)

Teruyuki Kato, Tokyo University
Yoshiyuki Kaneda, IFREE-JAMSTEC

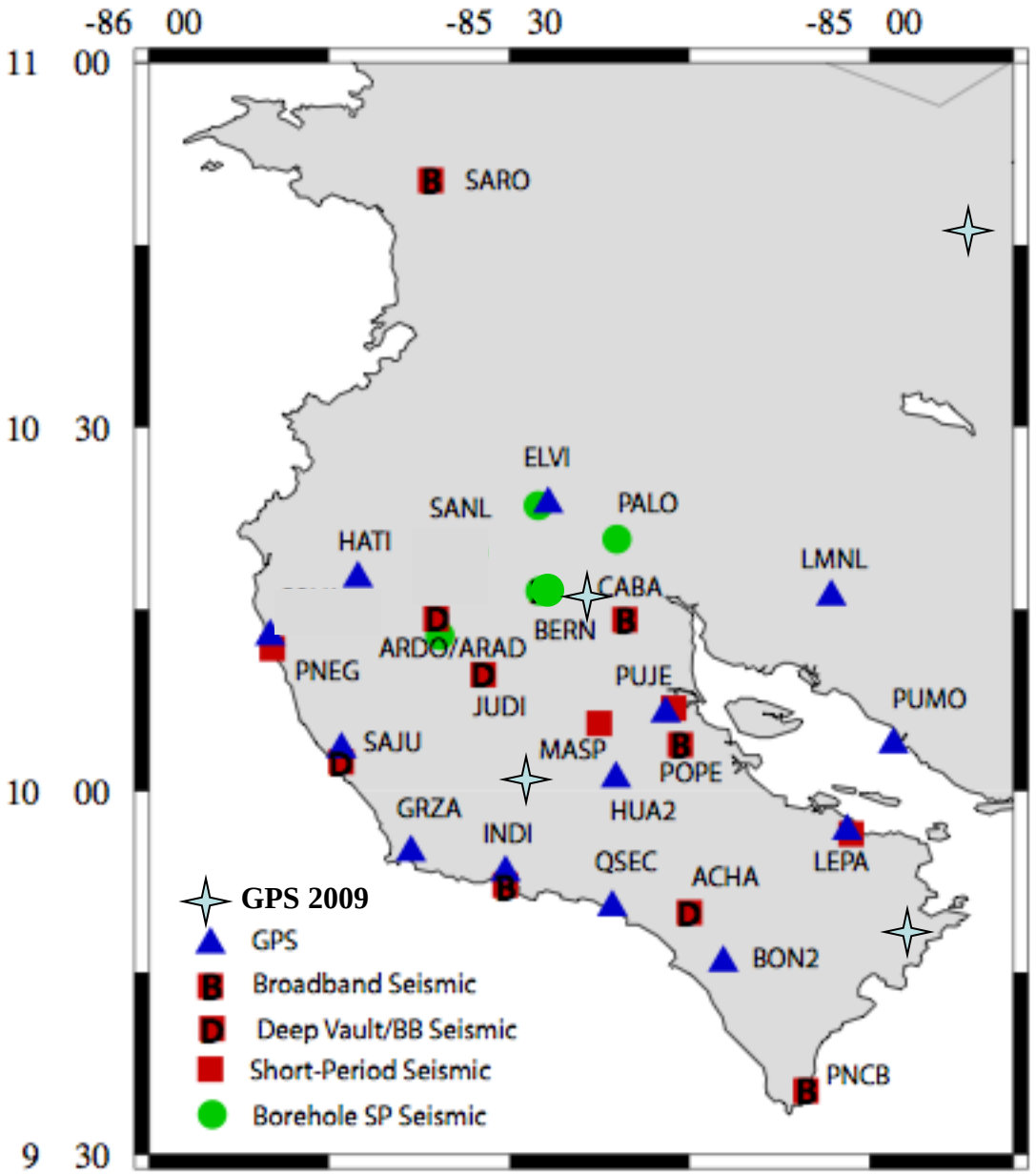
Technical Assistance:

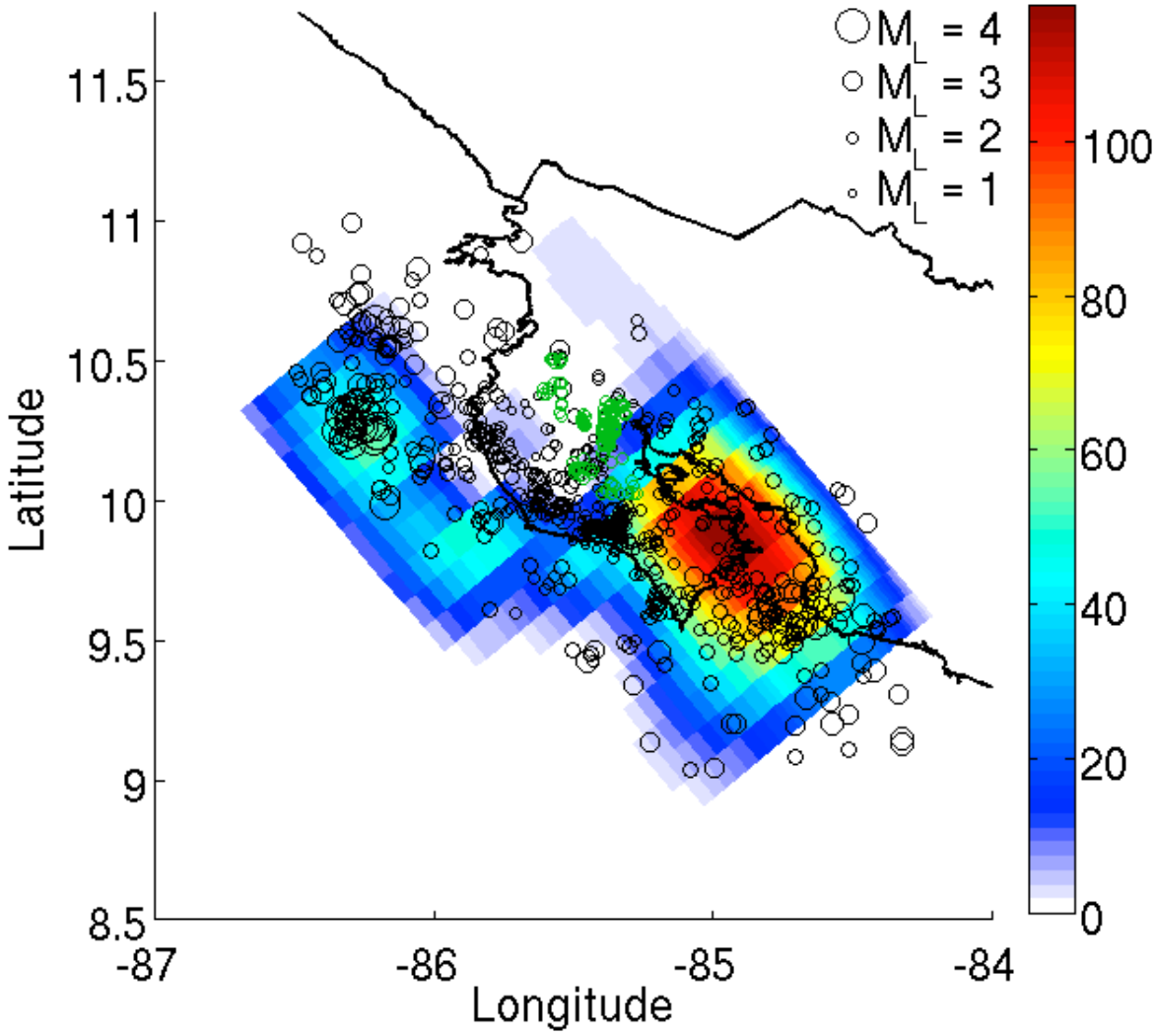
UNAVCO and IRIS

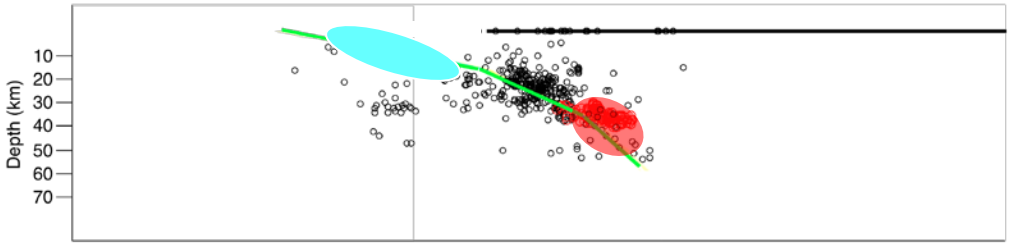
Funding:

NSF, SFB574

2009 Backbone GPS/Seismic Network







Other Subduction Zones

Slow slip locates only at down dip frictional transition

Costa Rica

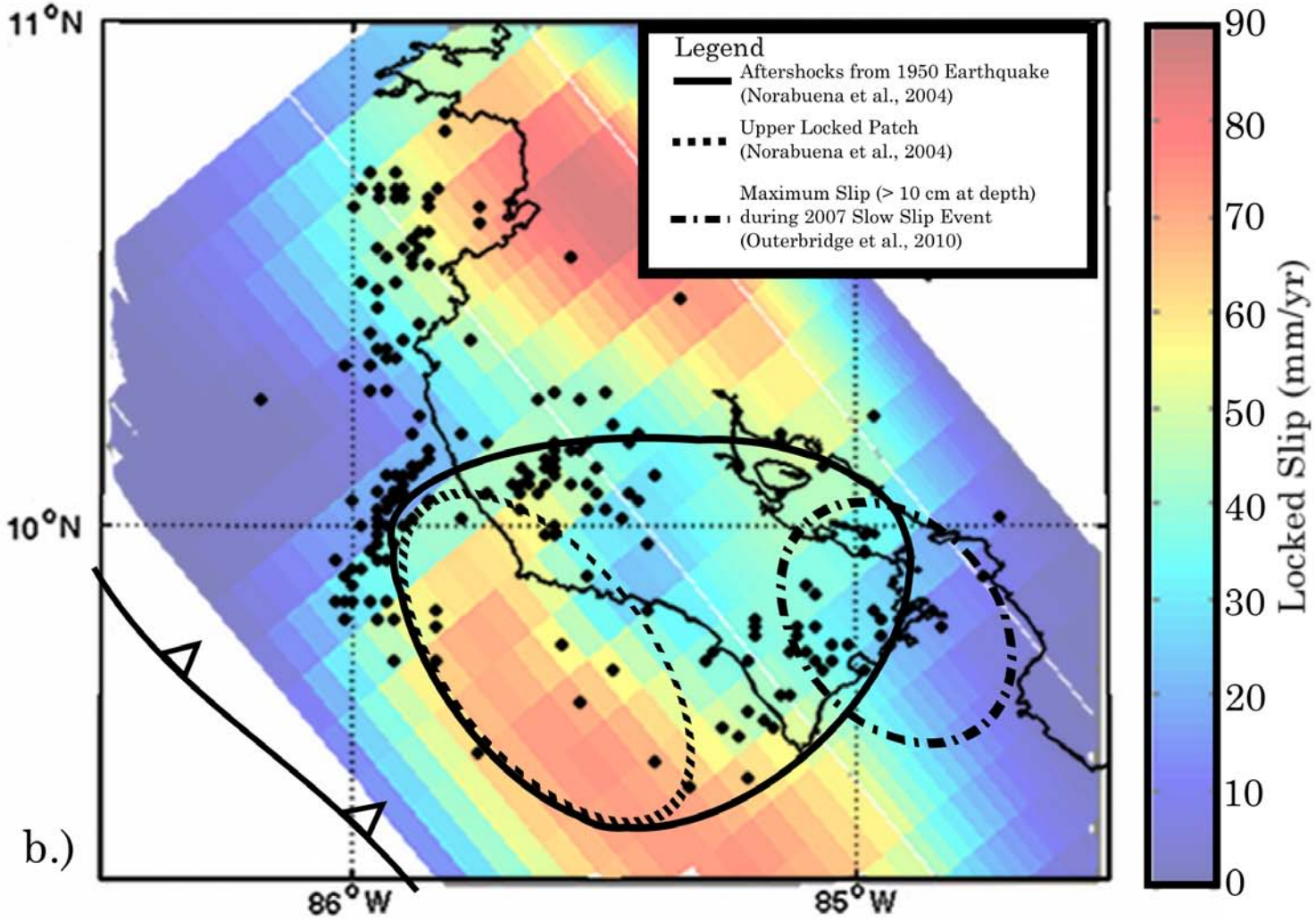
Slow slip locates at up and down dip transitions

Other Subduction Zones

Slow slip locates only at down dip frictional transition

Costa Rica

Slow slip locates at freely slipping regions within the seismogenic zone



Collaborators:
UC Santa Cruz
OVSICORI-UNA
CAU-ICE/UCR-
(seismic and MT)

CONCLUSIONS

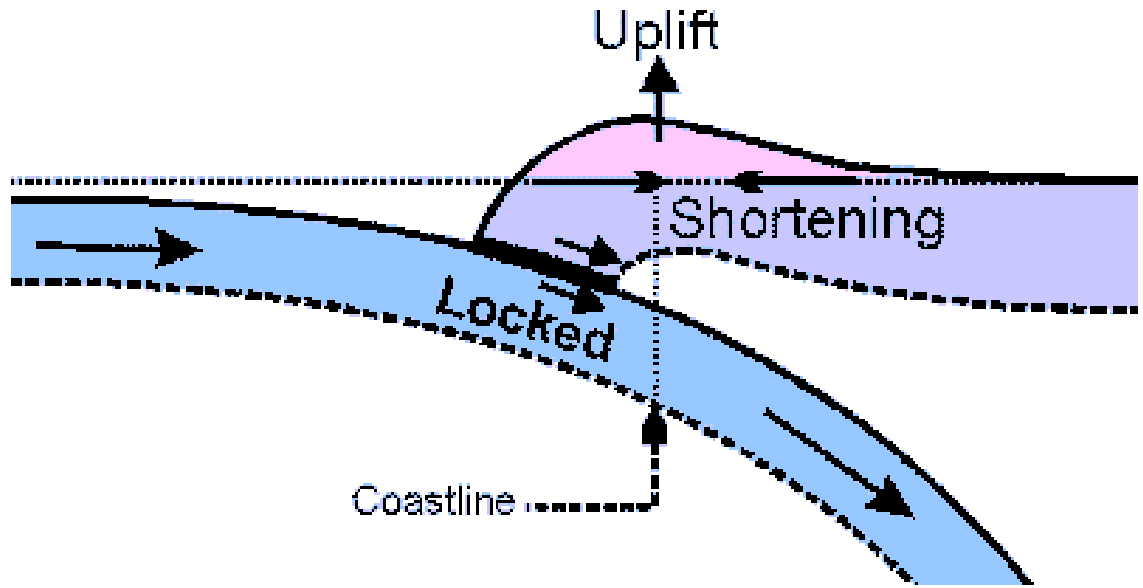
There are important science and hazard questions that need to be addressed at the seismogenic zone of convergent margins.

The Nicoya seismic/geodetic network is the result of a successful collaboration between the US, Costa Rica, Germany and Japan. It is a network for science, to understand the behavior of the seismogenic zone but can an should be used for hazard assessment, especially in light of the imminence of the next Nicoya earthquake.

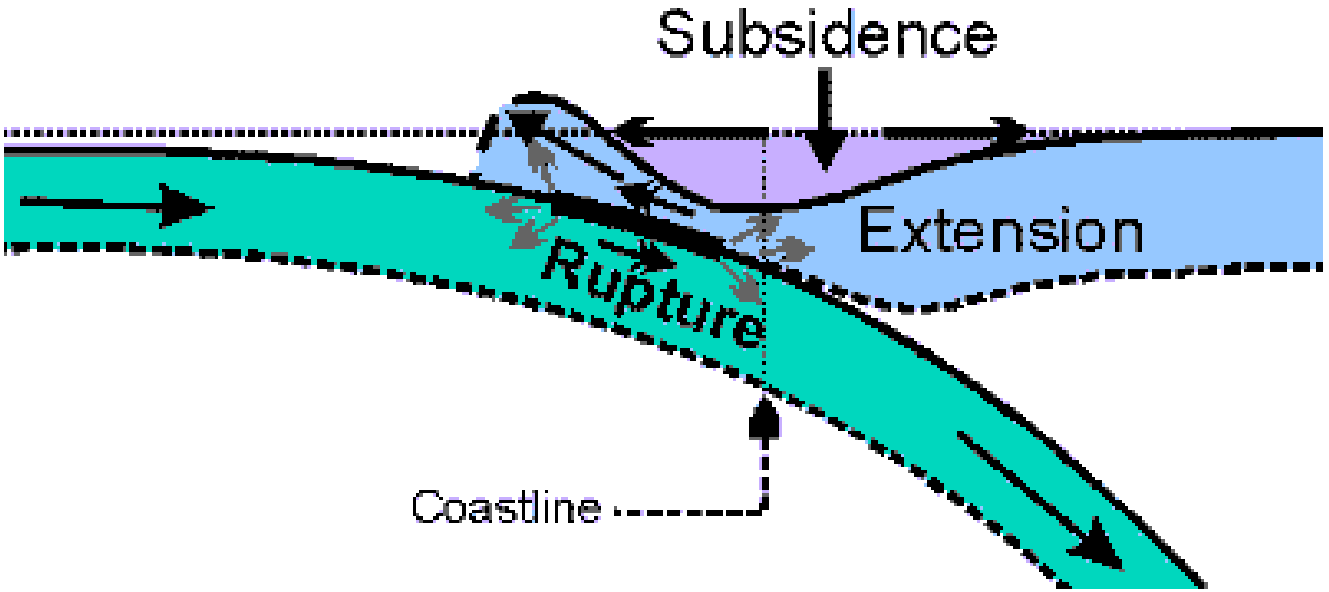
Its usefulness in hazard assessment can be greatly enhanced with a small monetary investment of co-locating accelerometers with existing seismic sensors.


GRACIAS!
QUESTIONS?

Recognizing Slow Slip using GPS Geodesy

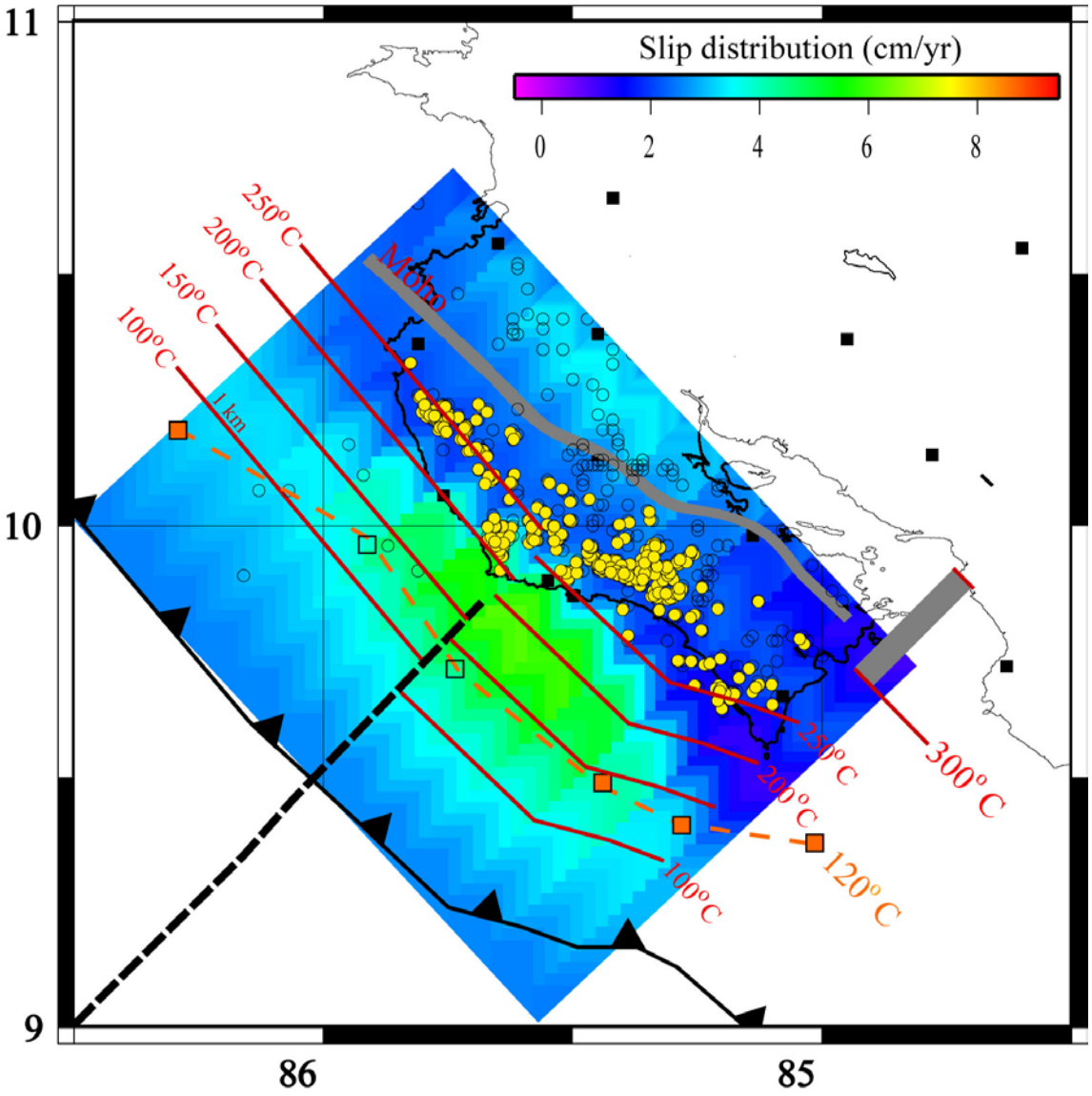


Strain Accumulation- Plate interface is locked. Directly over the plate interface, vertical motion is up and horizontal motion is in the direction of plate motion.



Earthquake or Slow Slip-

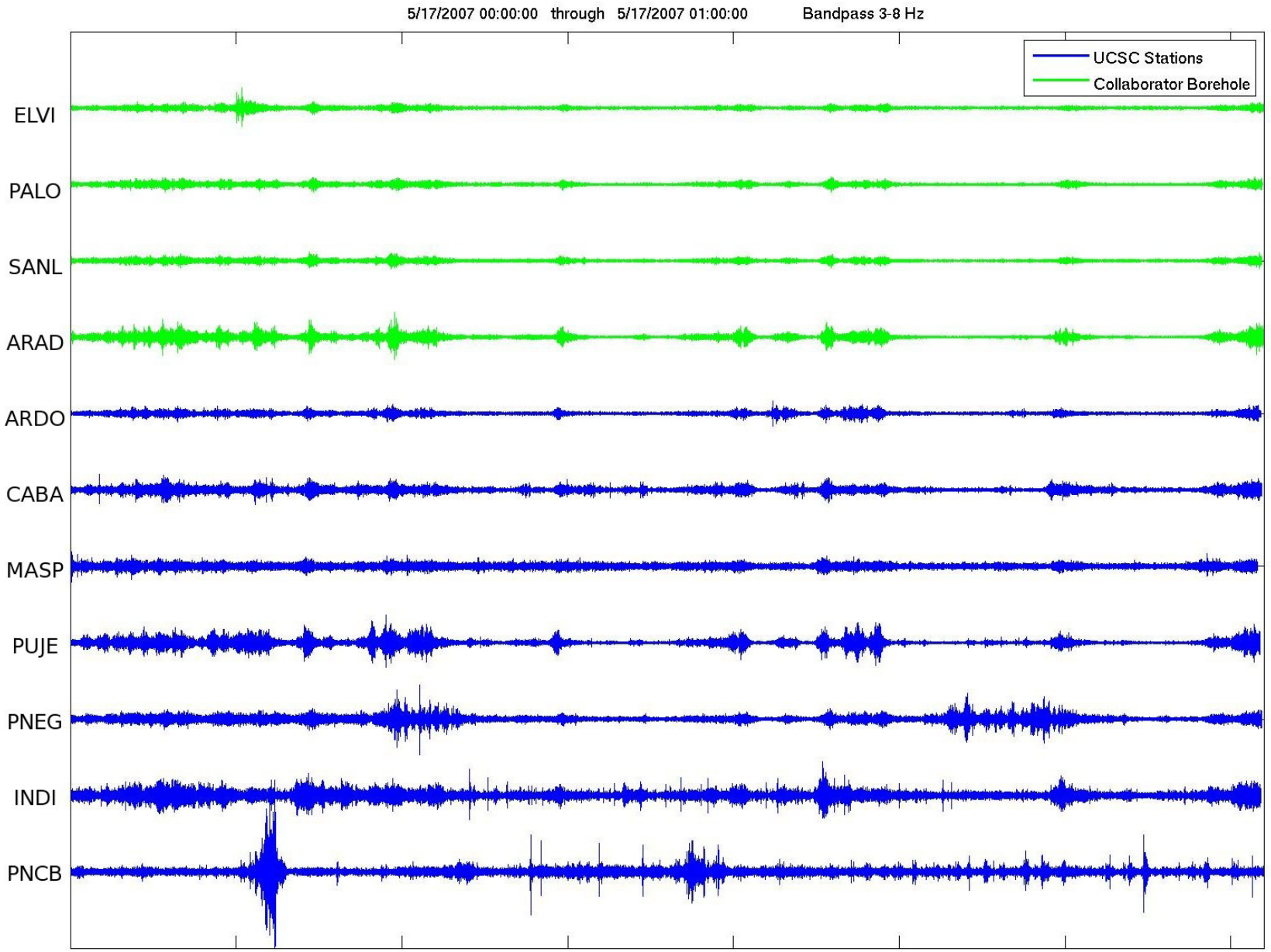
Motions are in opposite direction like co-seismic but take days to months



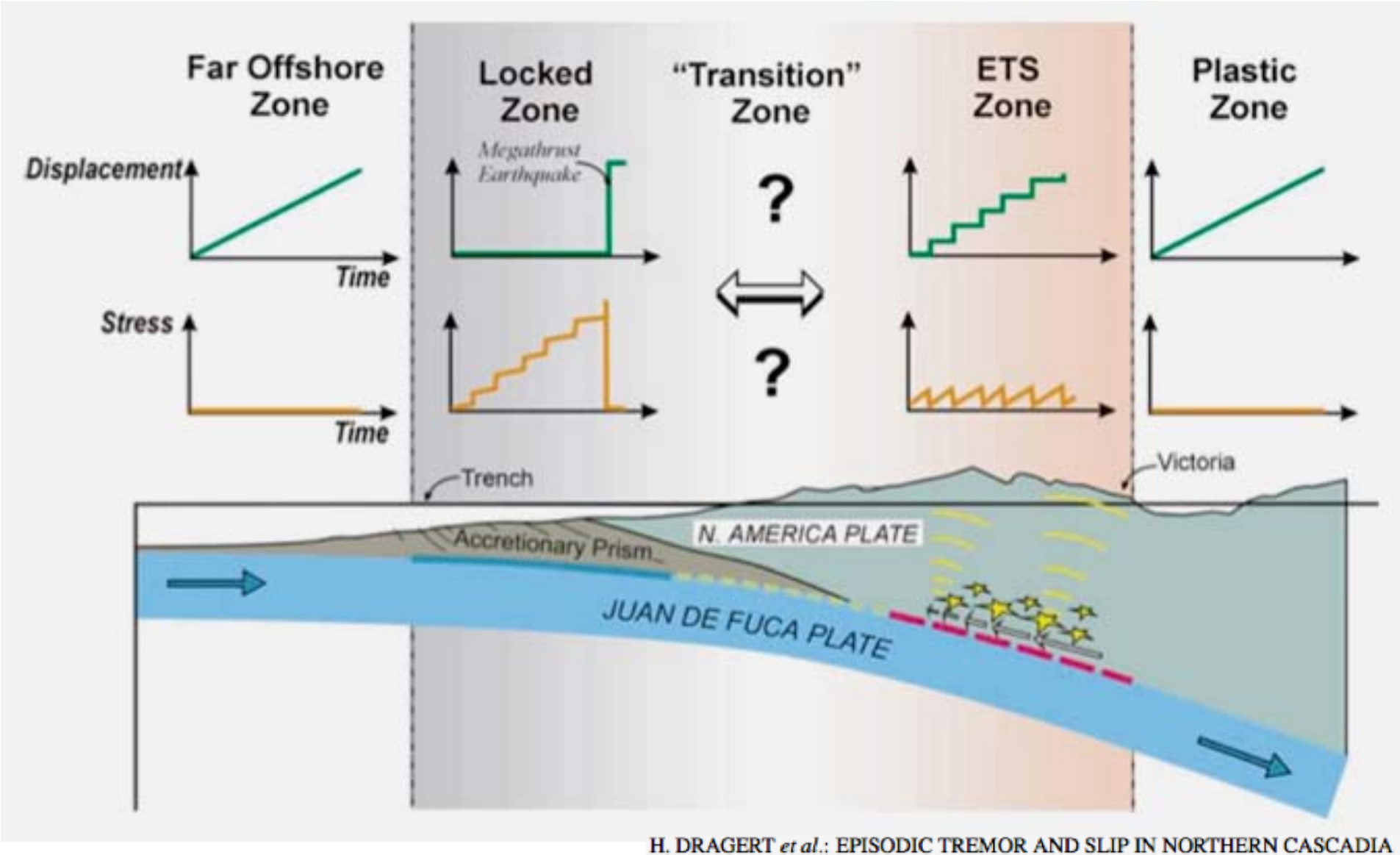
Thermal Modeling by Spinelli and Saffer (2004)

300^{o} C isotherm from Harris and Wang (2002)

Seismic Tremor Often Accompanies Slow Slip



Cross-section of subduction megathrust

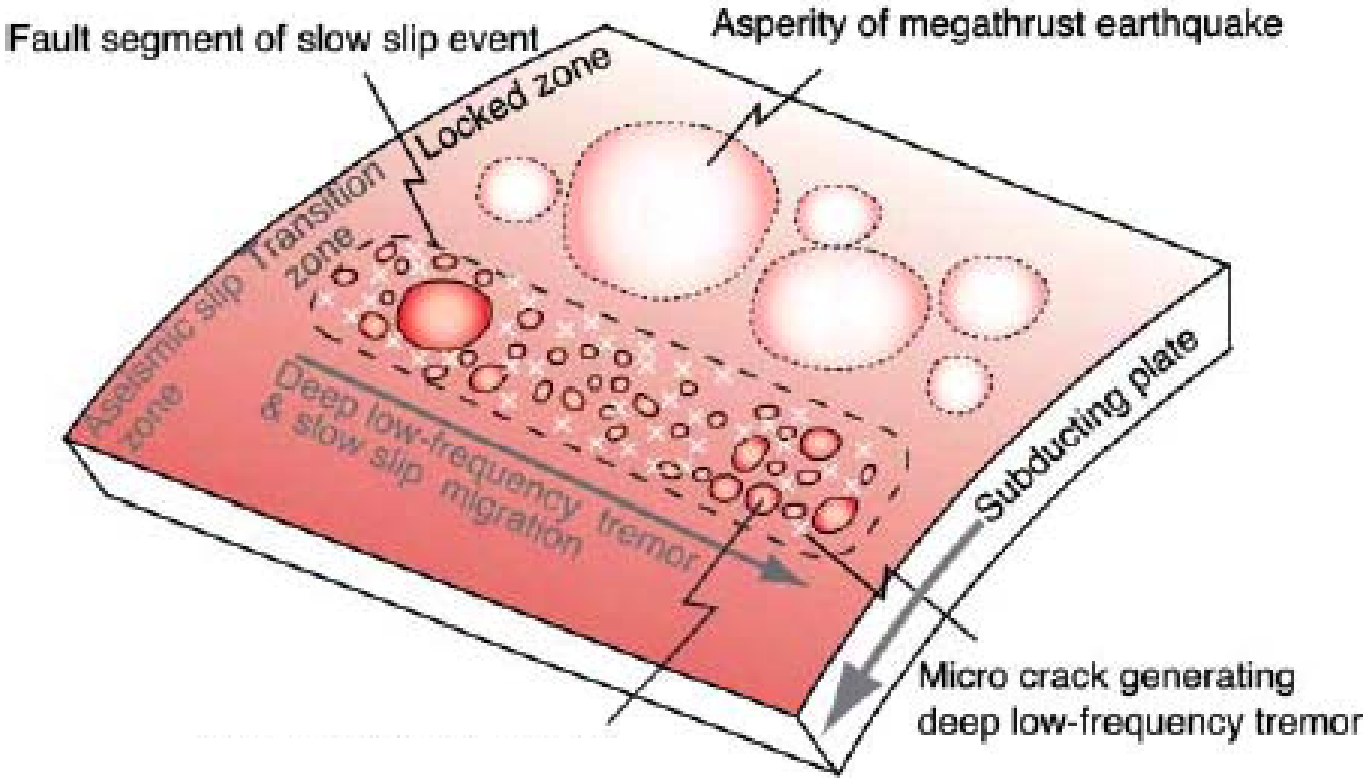


H. DRAGERT *et al.*: EPISODIC TREMOR AND SLIP IN NORTHERN CASCADIA

Why Study Slow Slip at the Nicoya Peninsula?

- The Nicoya Peninsula sits directly over the seismogenic zone so land instrumentation can monitor the entire plate boundary.
- Plate convergence is VERY FAST (~10 cm/yr) so strain accumulates quickly
- Has history of M~7.7 earthquakes every 50 years, last in 1950- Can learning about slow slip help us to understand more about the next large event?


GU08
GU04
GU03
GU01
GU00
GU07
GU02
GU05
GU06
1000 m



Ito et al., 2006