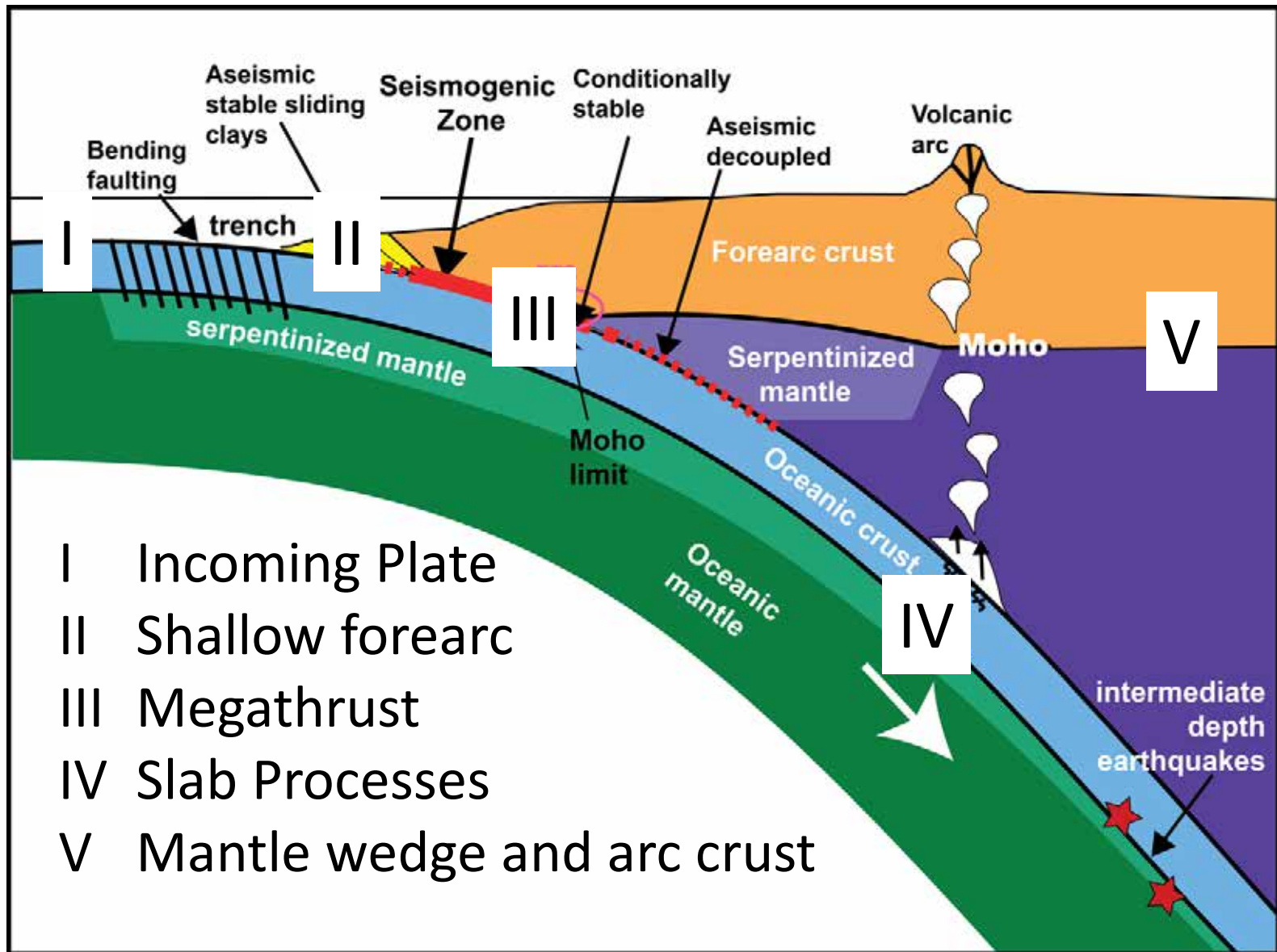


Subduction Cycles and Deformation



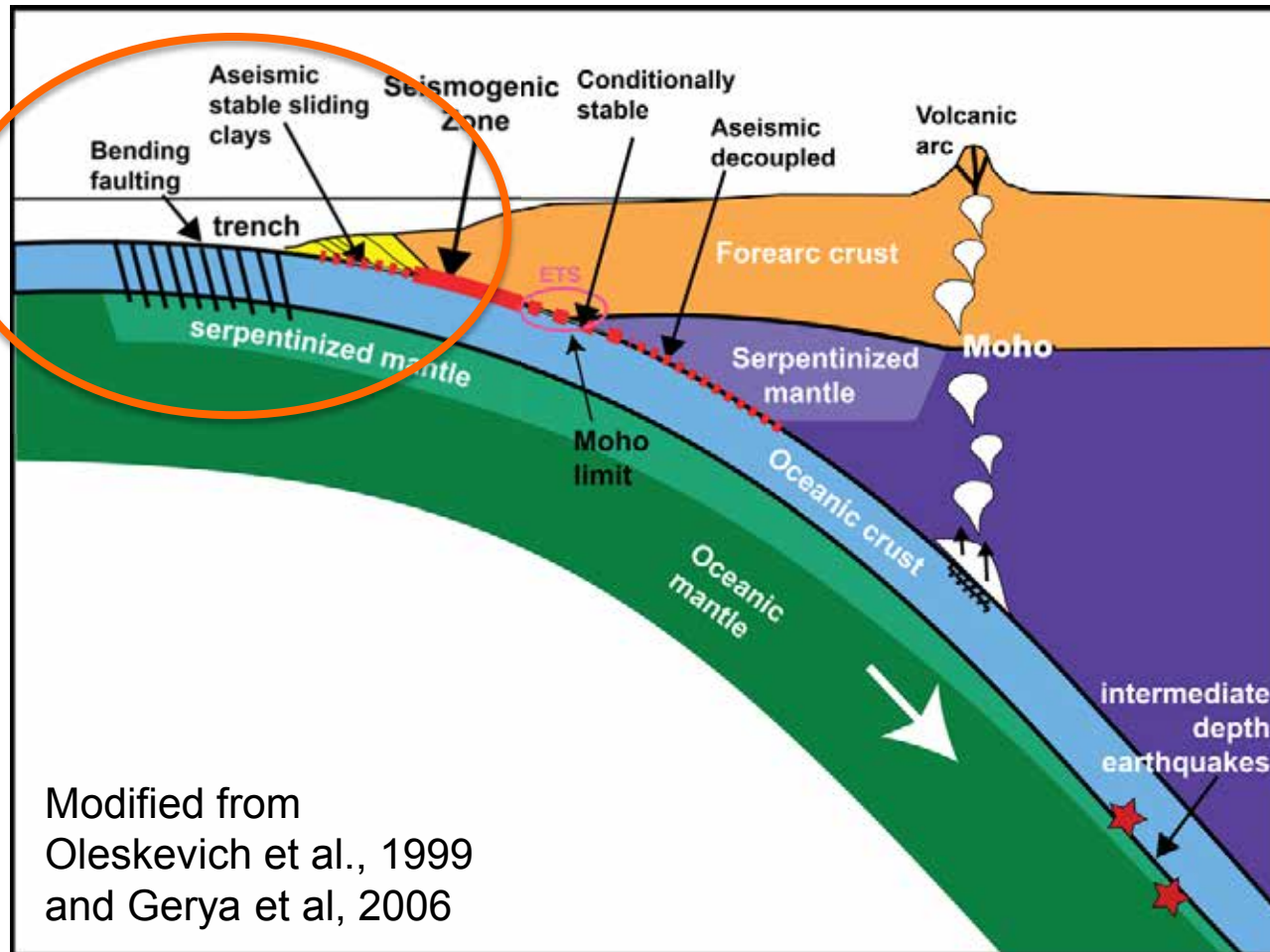
Incoming plate and shallow forearc

Donna Shillington

Sarah Penniston-Dorland

Peter van Keken

The Subducting Oceanic Plate

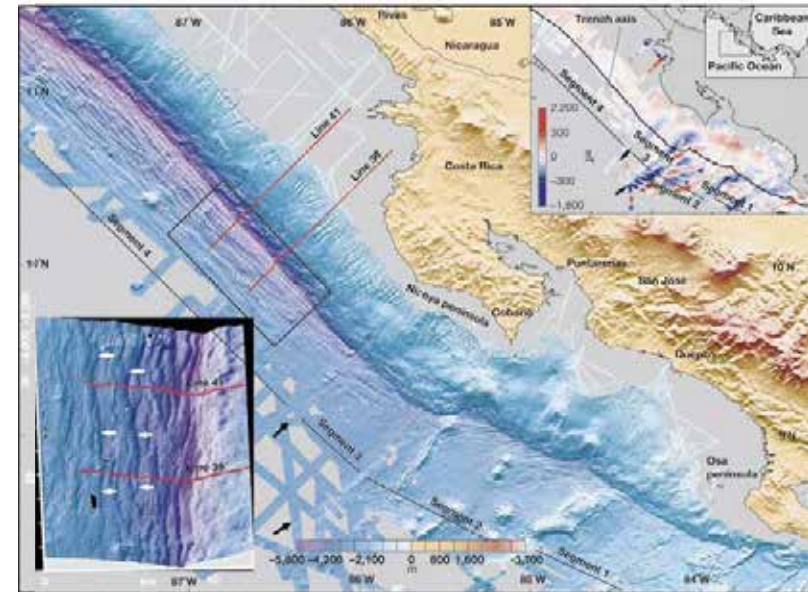
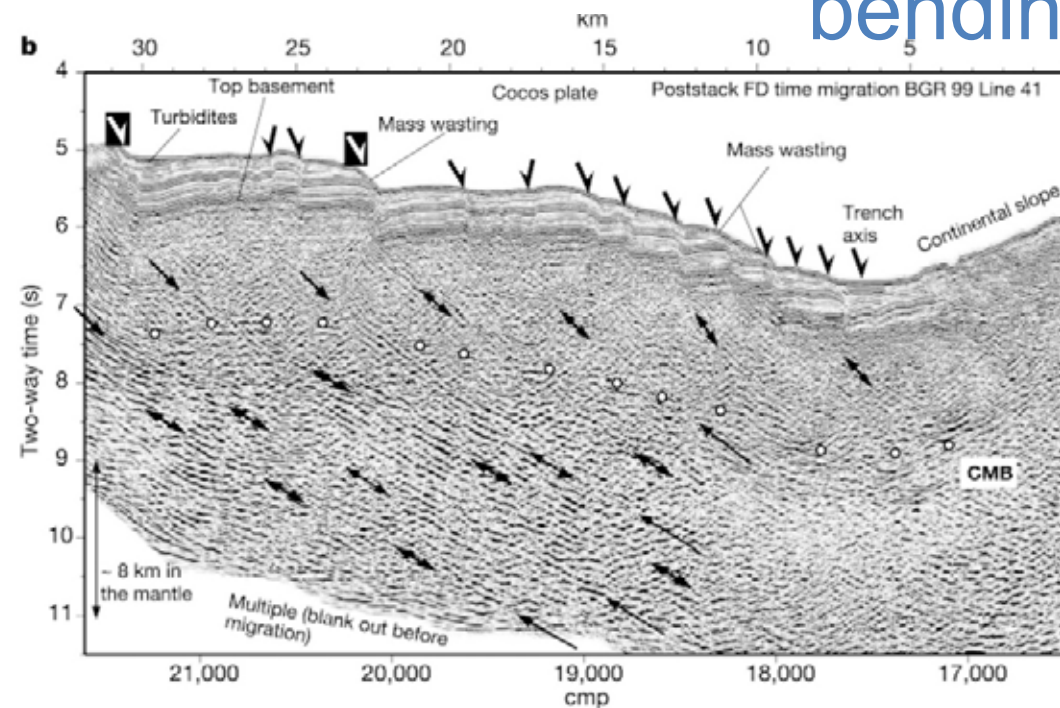


The subducting oceanic plate delivers water into the subduction zone

Sediments and topography at the top of the plate are also thought to influence shallow and deep portions of the megathrust

Mark Reagan talk: characterization of incoming plate from drill cores

Much of the deformation and hydration occur at the outer rise during plate bending



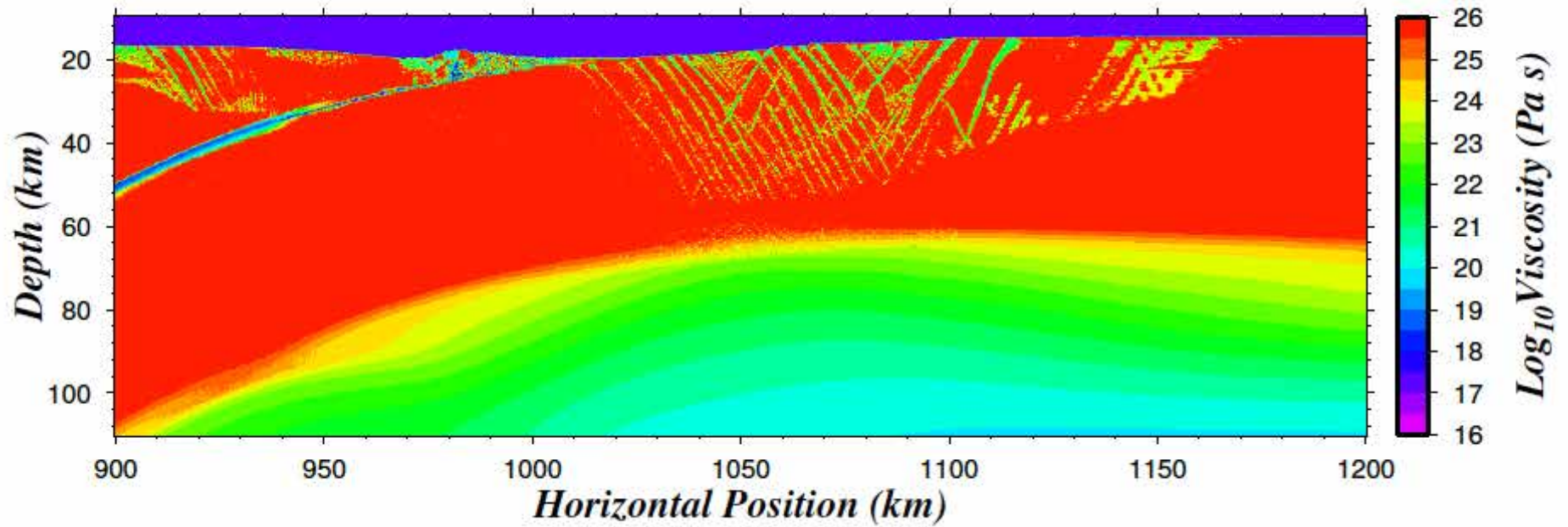
Ranero et al., 2003

Bending faulting in the downgoing plate imaged in bathymetry and seismic reflection data offshore Costa Rica

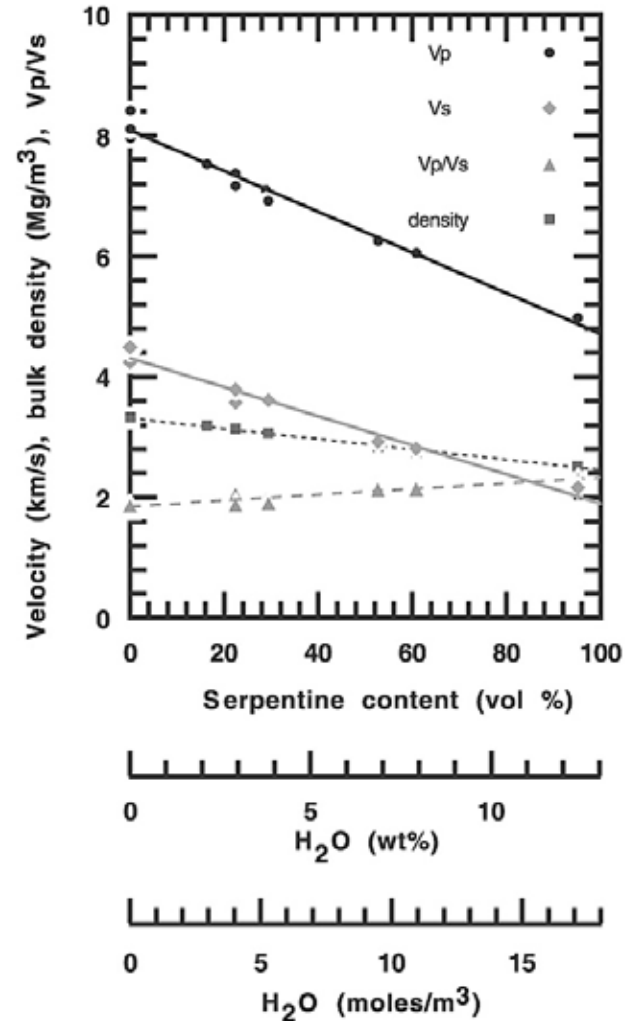
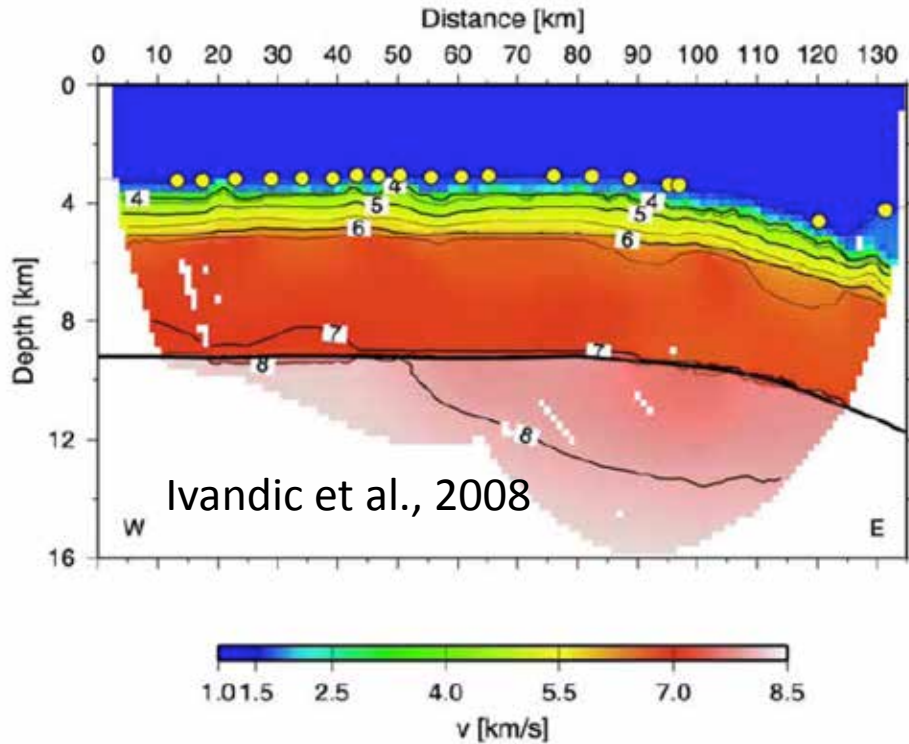
Bathymetry data show changes along-strike in the amount of bending faulting

Magai Billen talk

Outer Rise Normal Faulting



Reduced velocities in the upper mantle at the outer rise: serpentinization and/or faulting?



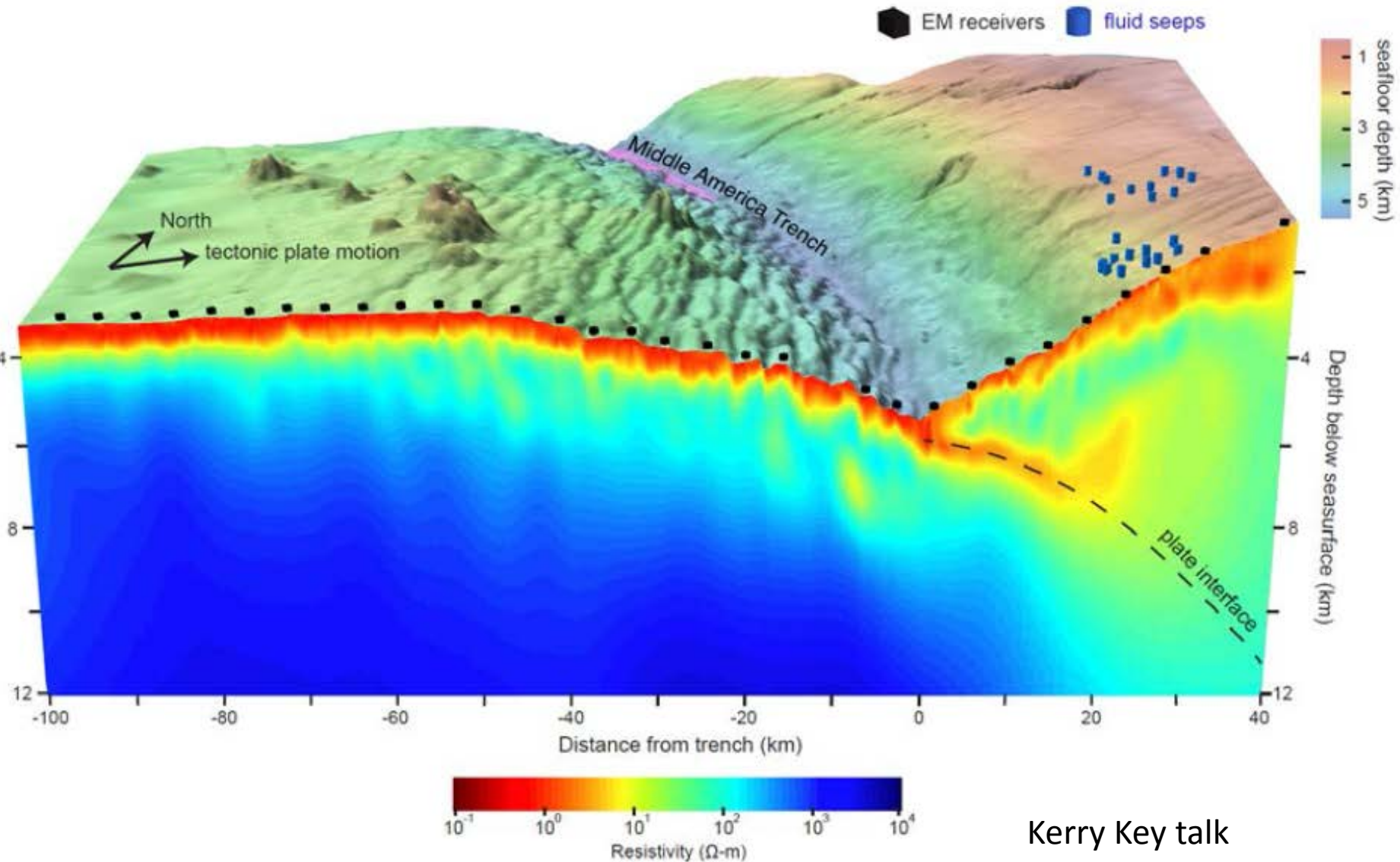
Carlson & Miller, 2003

Increased porosity due to brittle deformation

Anisotropy

Serpentinization

Naif, Key, Constable and Evans Controlled-source electromagnetic survey



Kerry Key talk

Upper Mantle Serpentinization: Central America

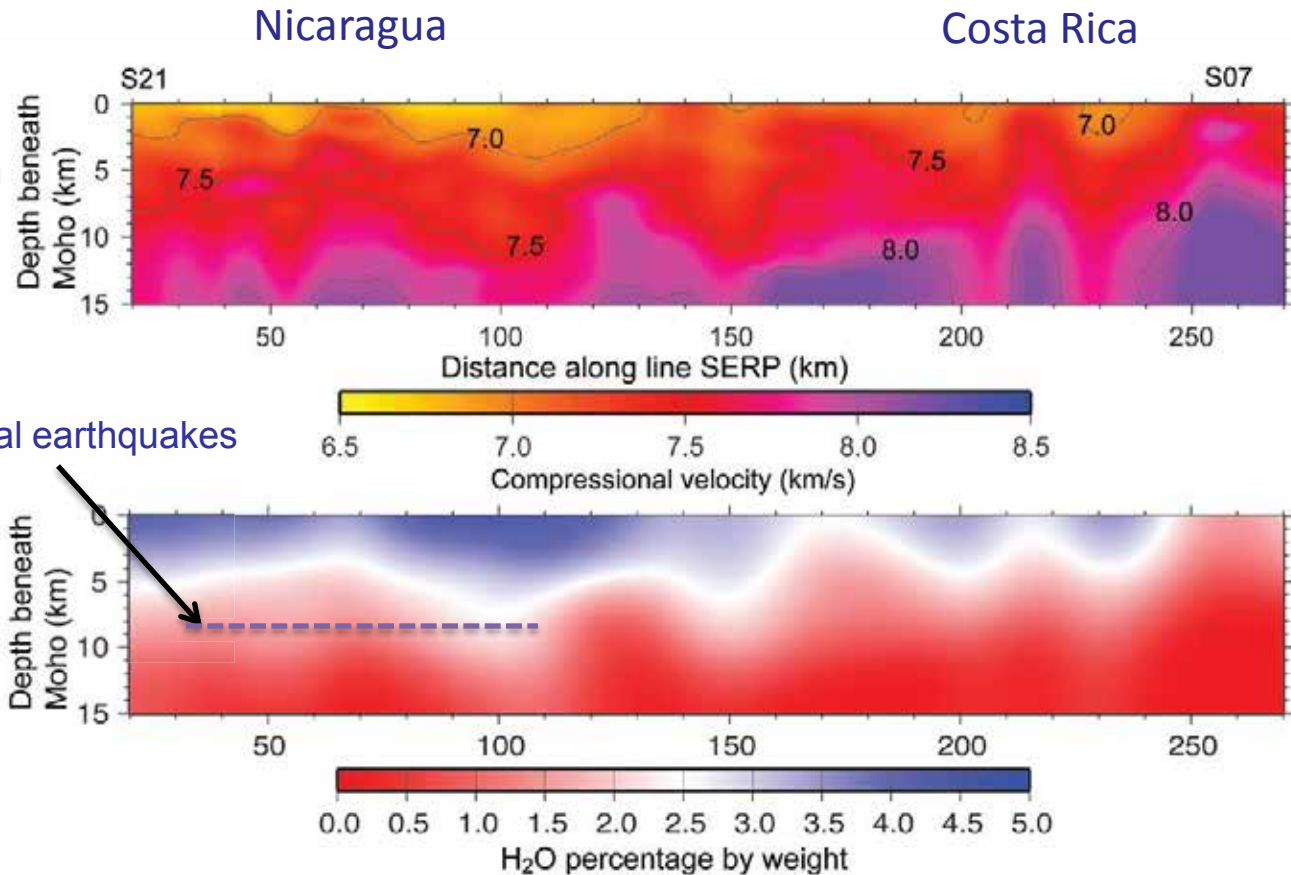
Sub-Moho seismic velocity in
subducting Cocos plate

Maximum depth of extensional earthquakes
Lefeldt et al. [2009]

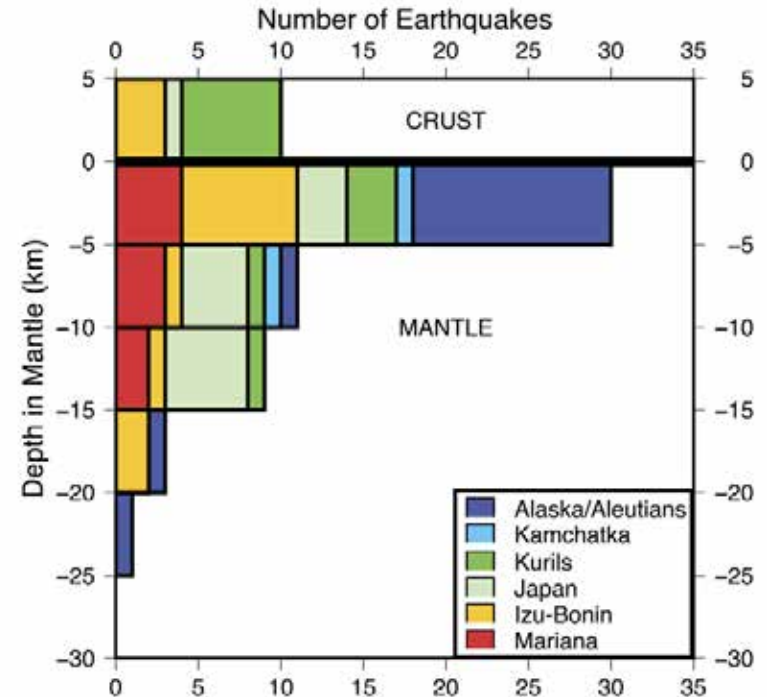
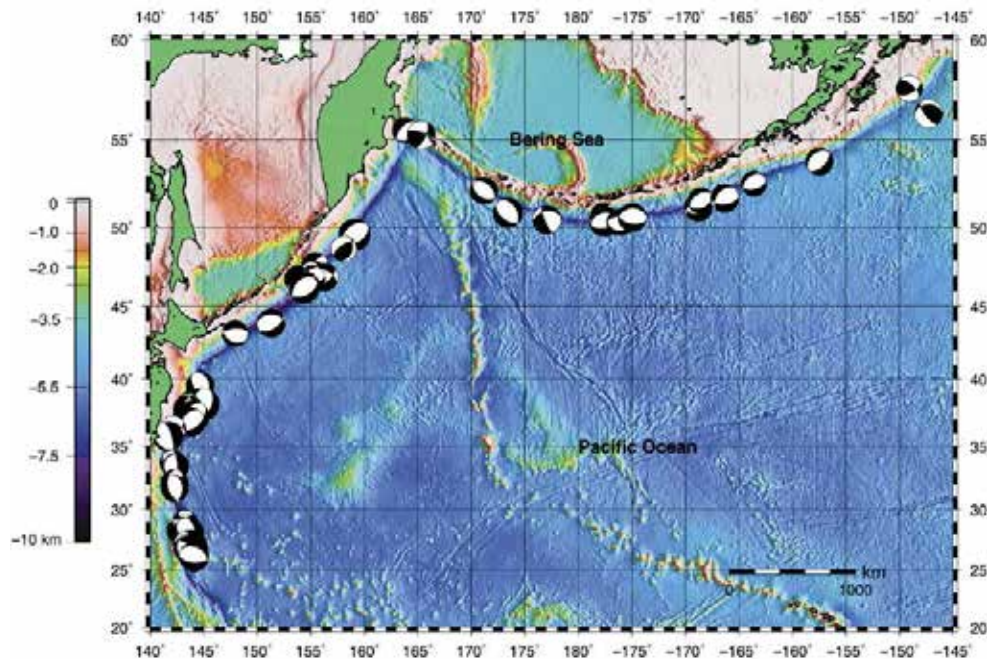
H₂O distributed in mantle

Doug Wiens talk

Seismic section of the subducting mantle parallel to the trench



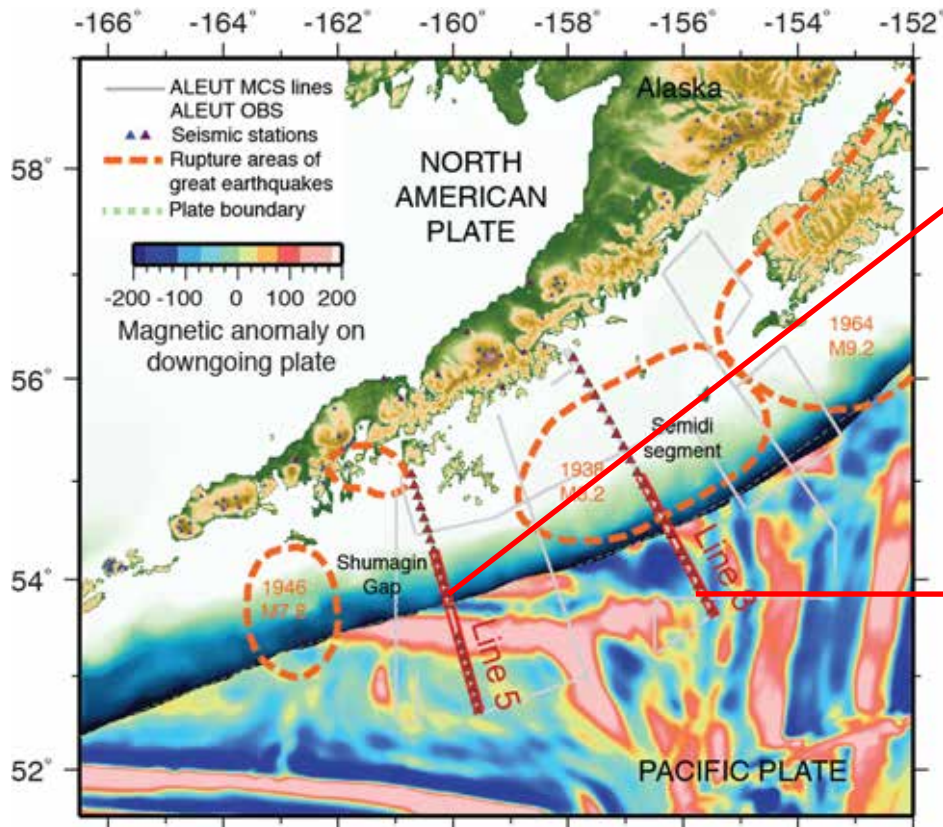
Potential Importance of Incoming Plate Faulting



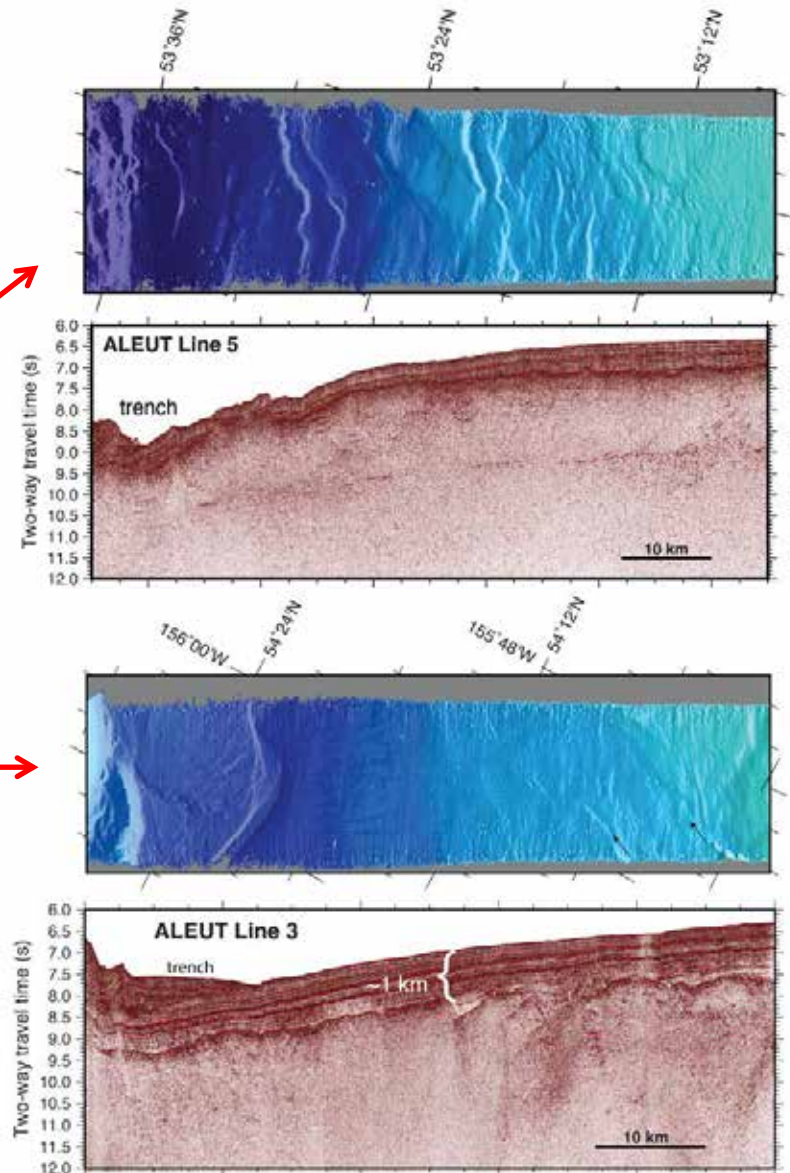
Incoming plate normal faulting earthquakes are numerous in all subduction zones
They are concentrated in the upper 10 km of the subducting mantle

Bending faulting and pre-existing structures - Alaska

More favorably oriented pre-existing structures, more faulting



Donna Shillington poster

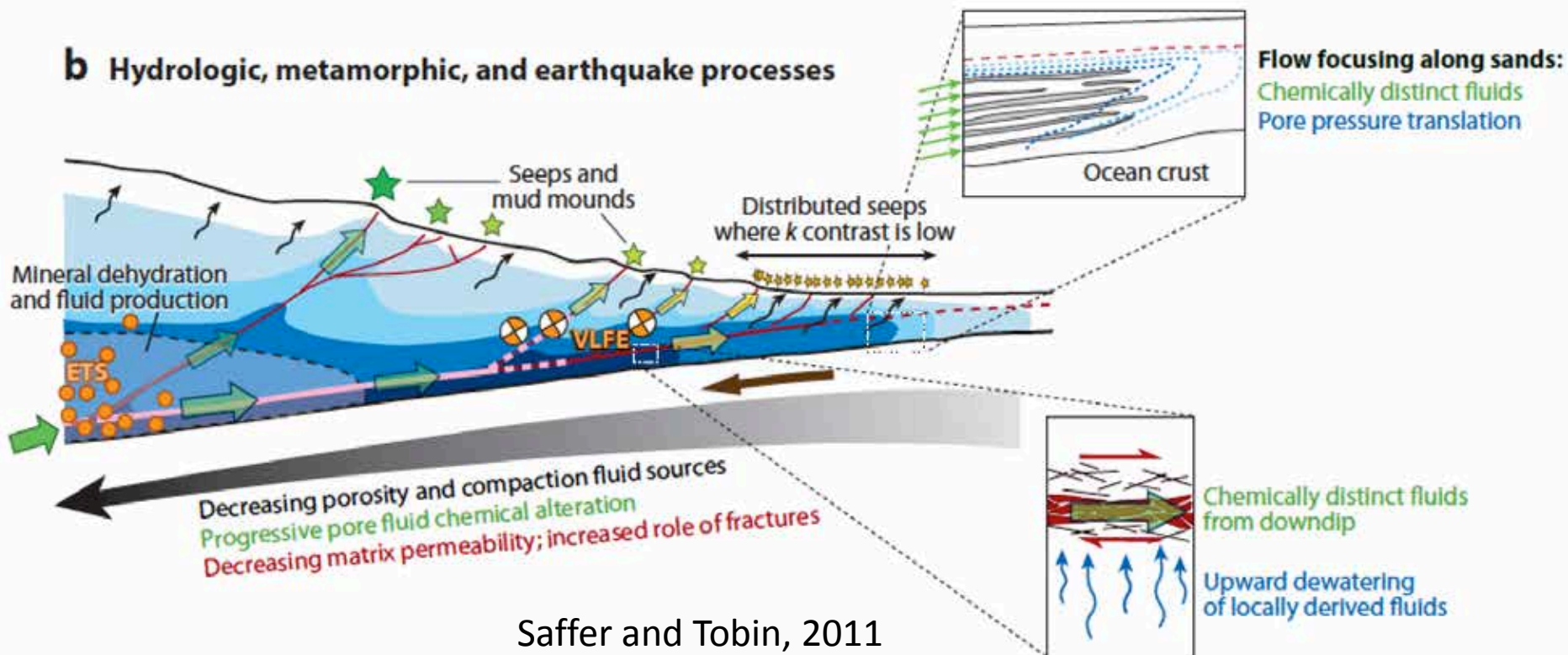


The Shallow Forearc

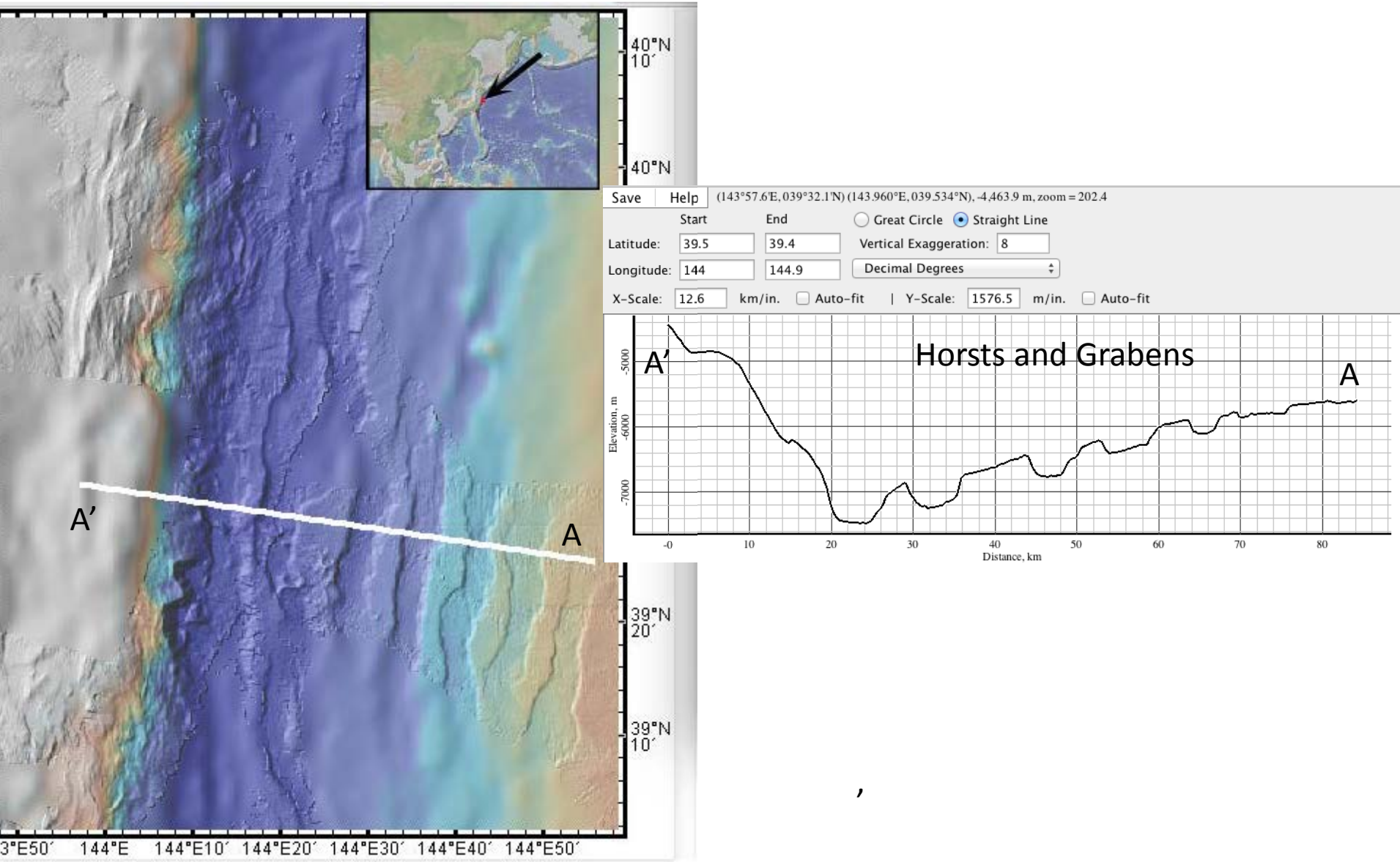
Dynamic regions of fluids, fluid flow, and overpressure

Can host shallow slip and cause tsunami

Impacted by sediments and structures on the subducting plate



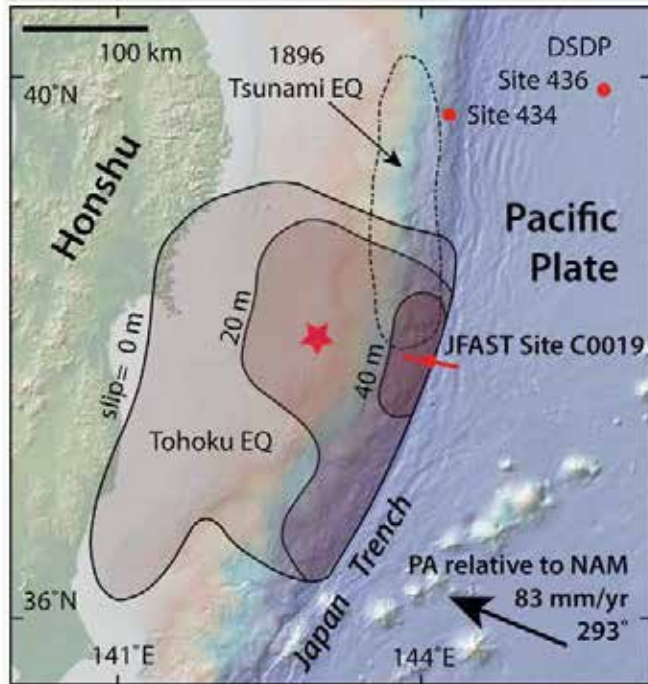
Casey Moore talk
also: Shuichi Kodaira talk W



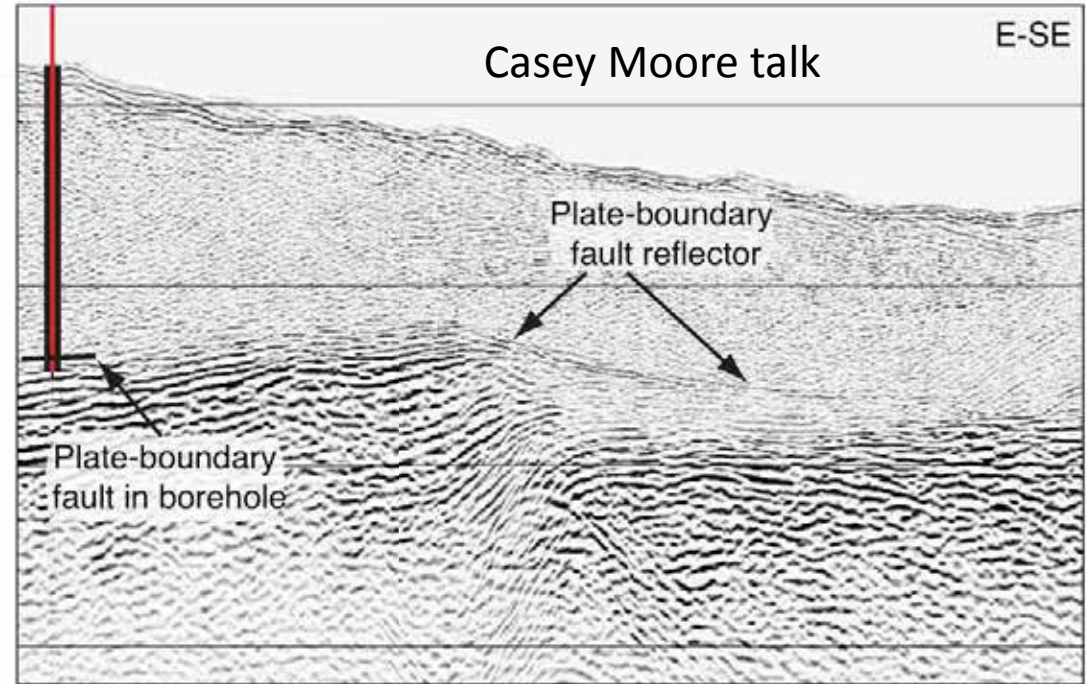
Tohoku-oki Earthquake-related Deformation (Kodiara et al., 2012, Nakamura et al., 2013, Chester et al., 2013)

- Deformation of graben fill
- Plate Boundary Fault dives beneath graben fill, and tends to emerge near trench axis
- Overall ~ 50 m of displacement

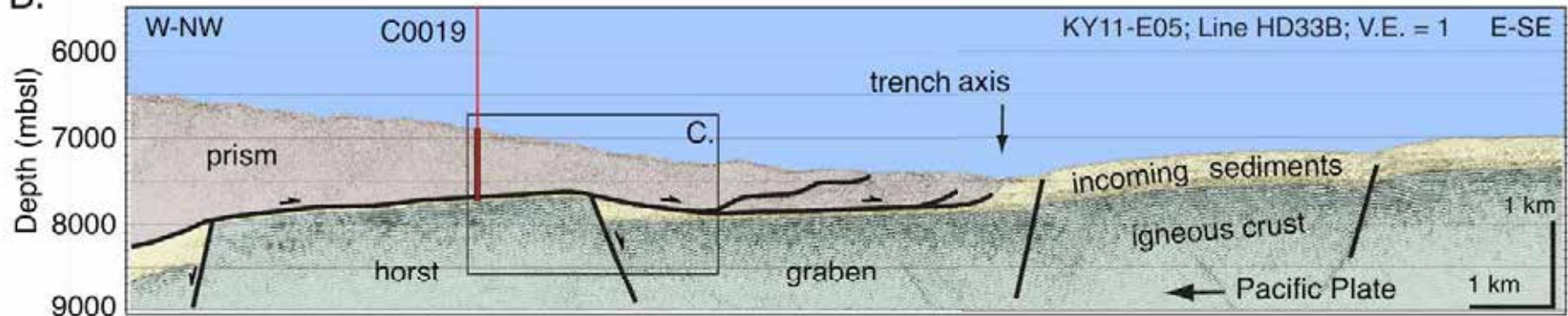
A.



C.



B.



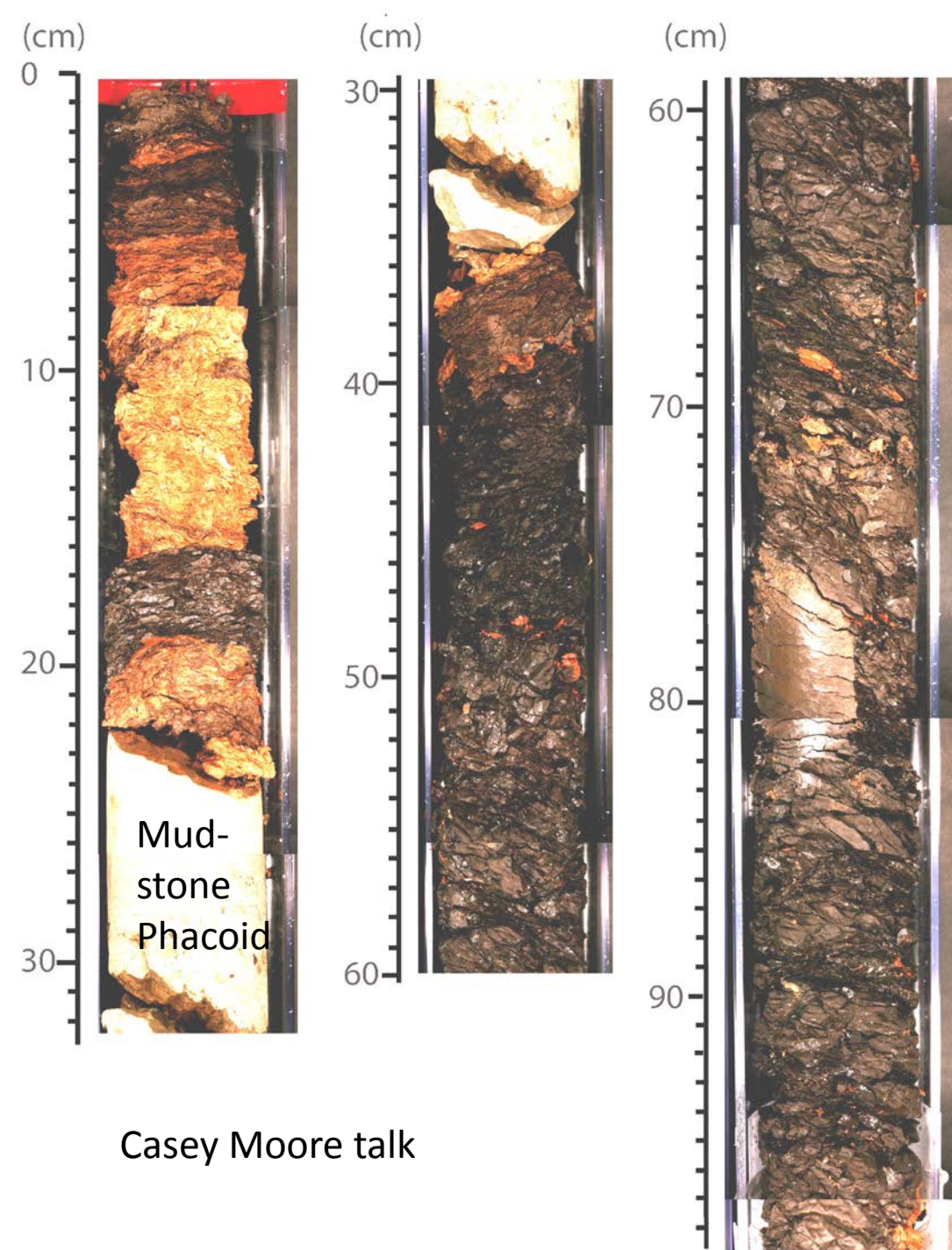


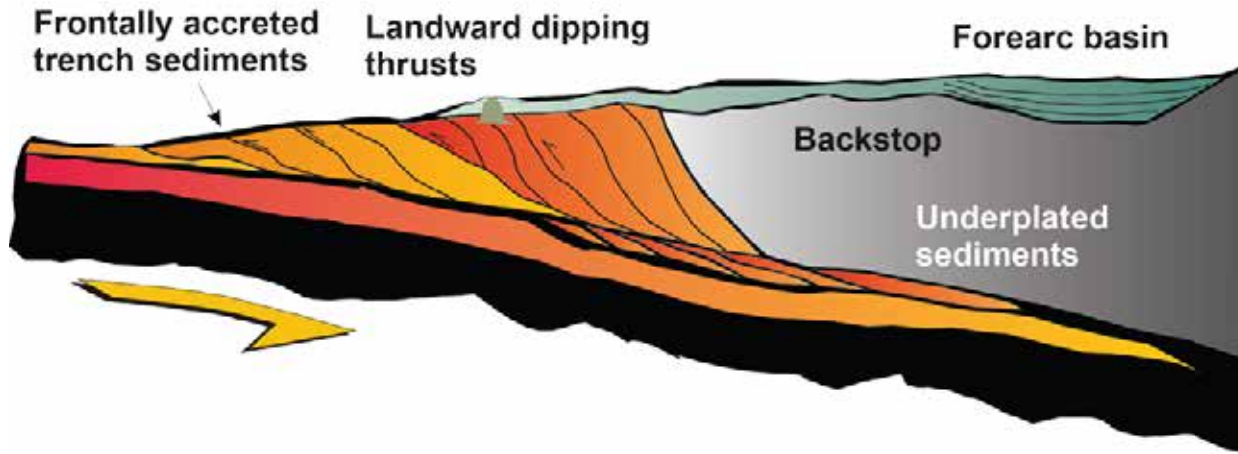
Plate Boundary Fault:
Very Fine Grained,
Rich in Smectite

1 m Core of Scaly
Claystone
Detail of 49-58 cm

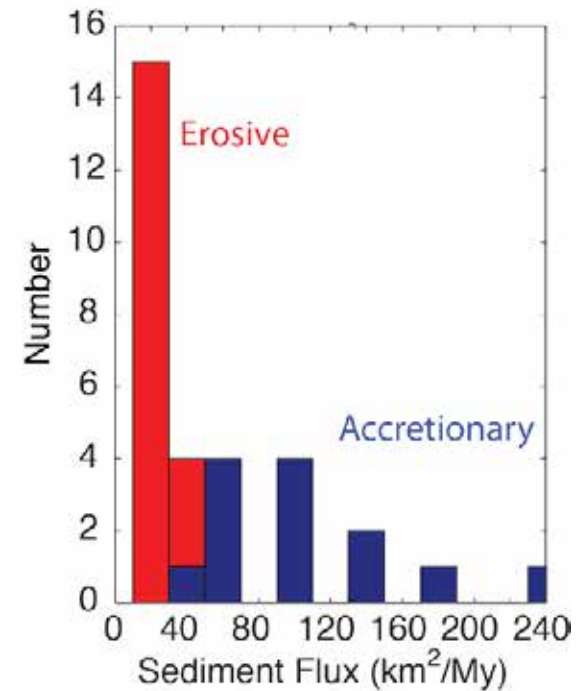
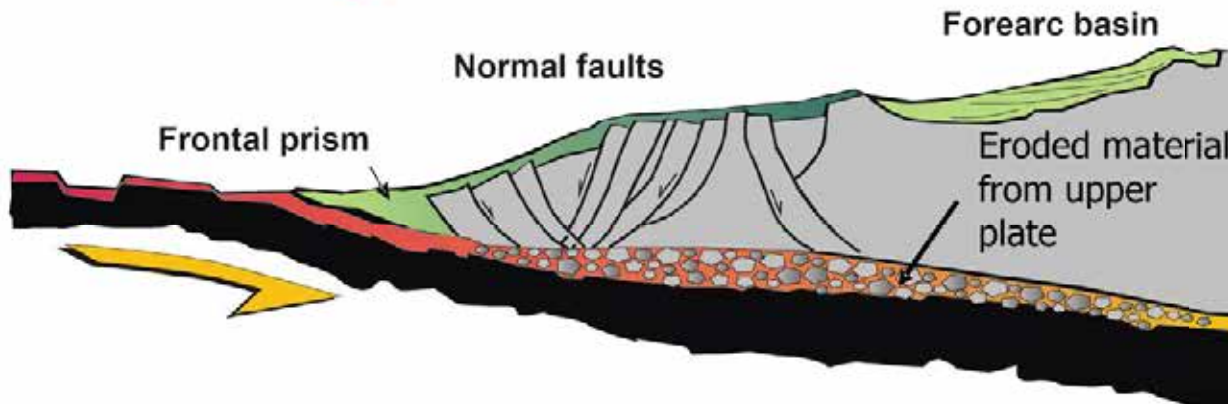


Accretionary Margin

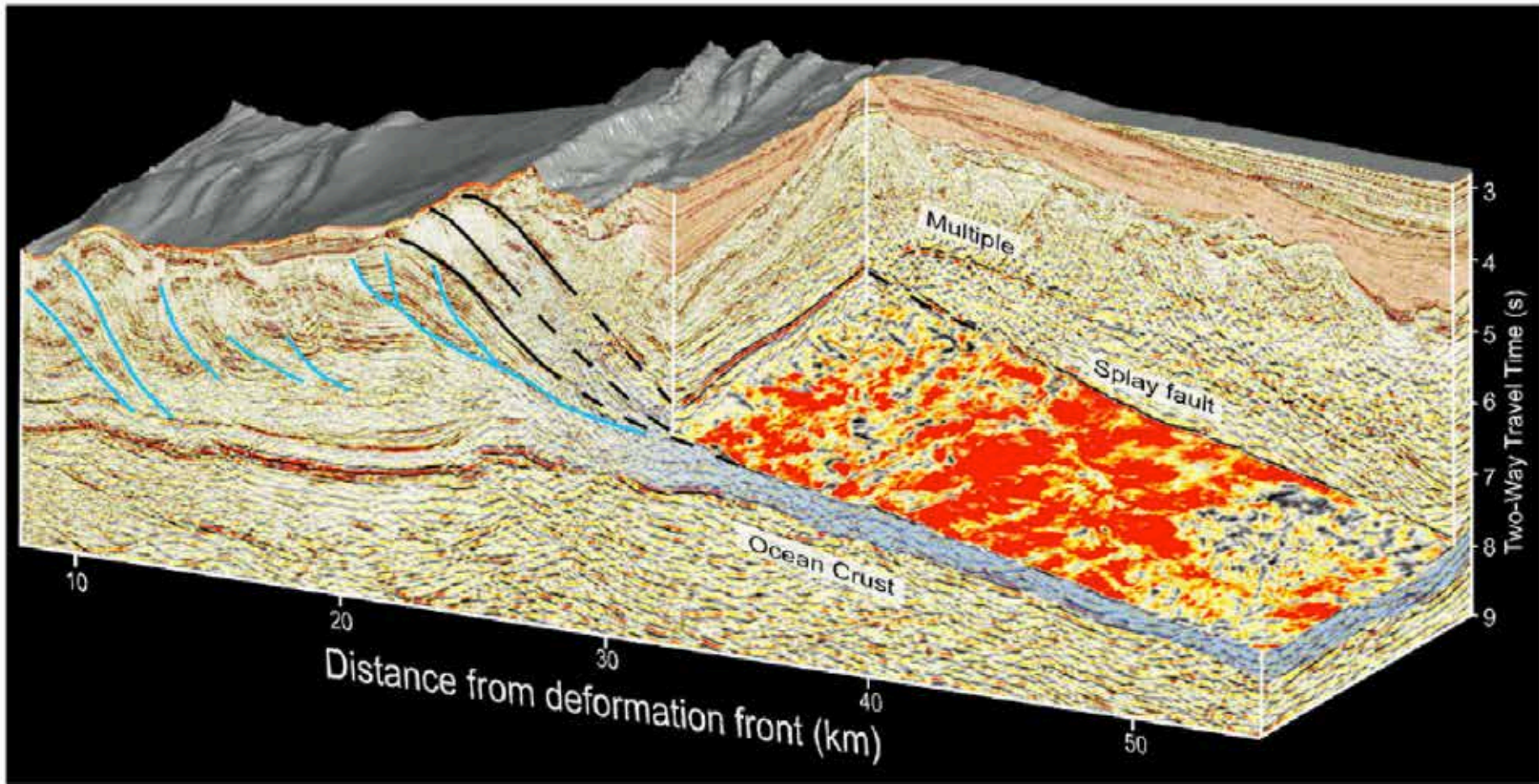
Rob Harris presentation



Erosive Margin



Sediment subduction and elevated pore-fluid pressures along the decollement - Nankai



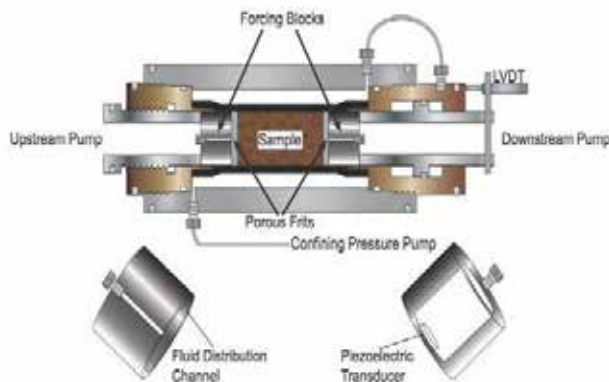
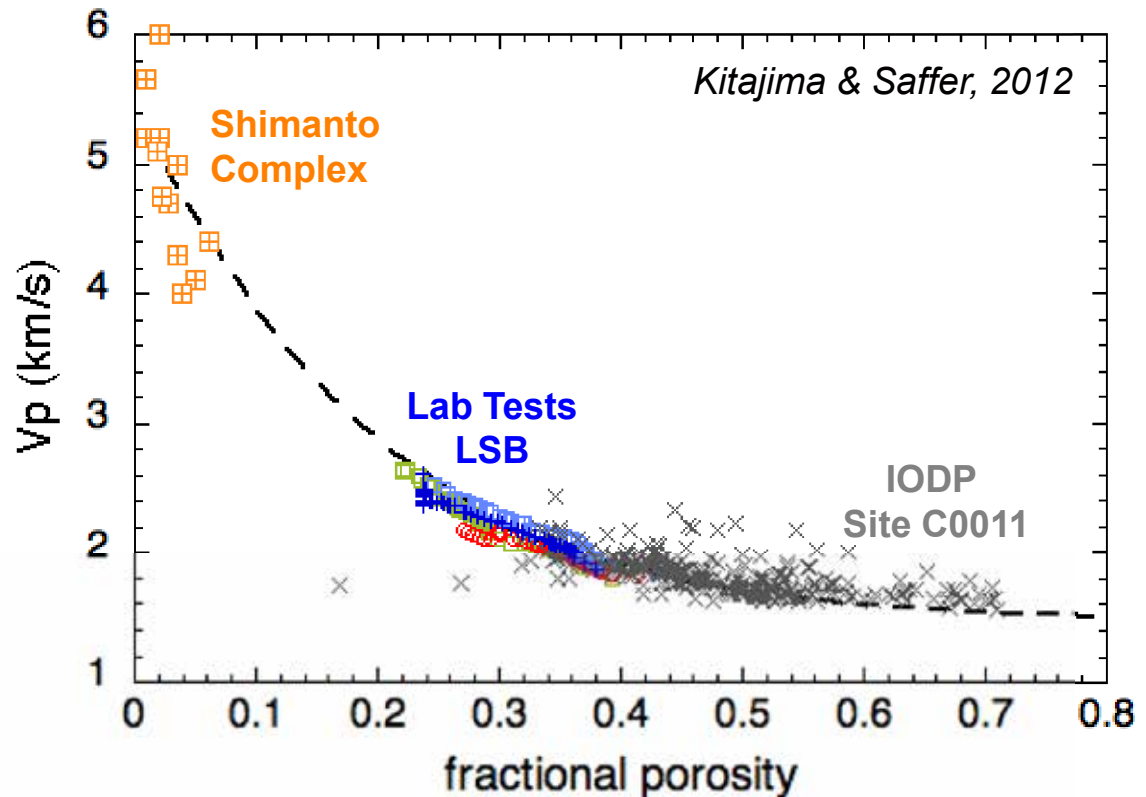
Bangs et al., 2009

Lab Data to Define Constitutive Behavior

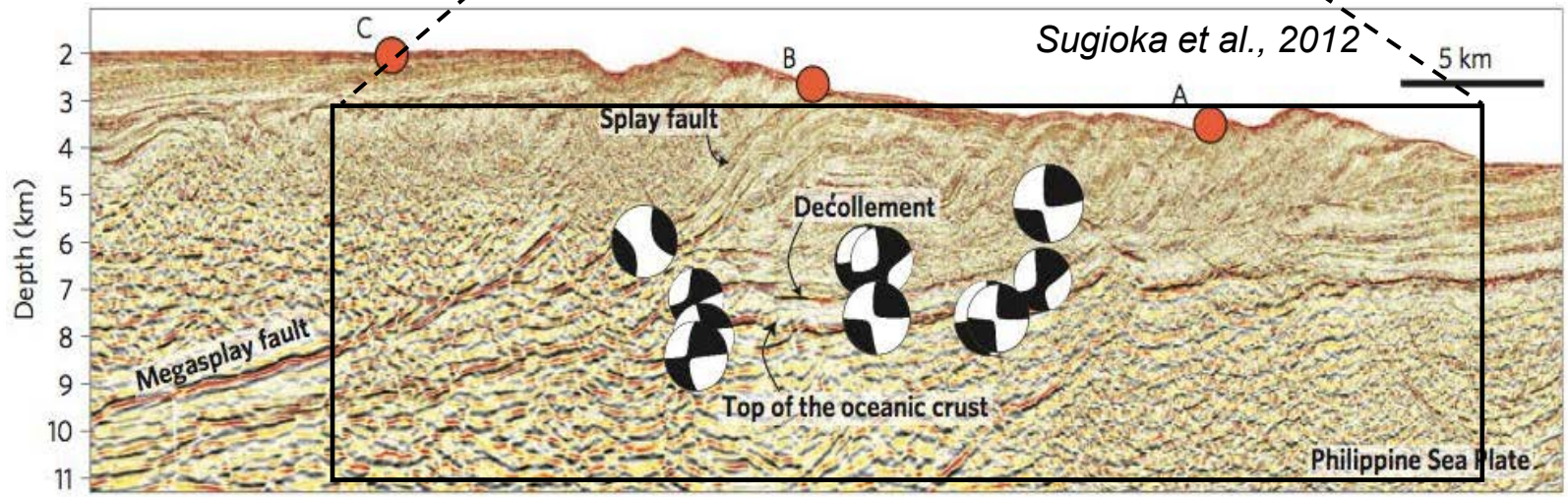
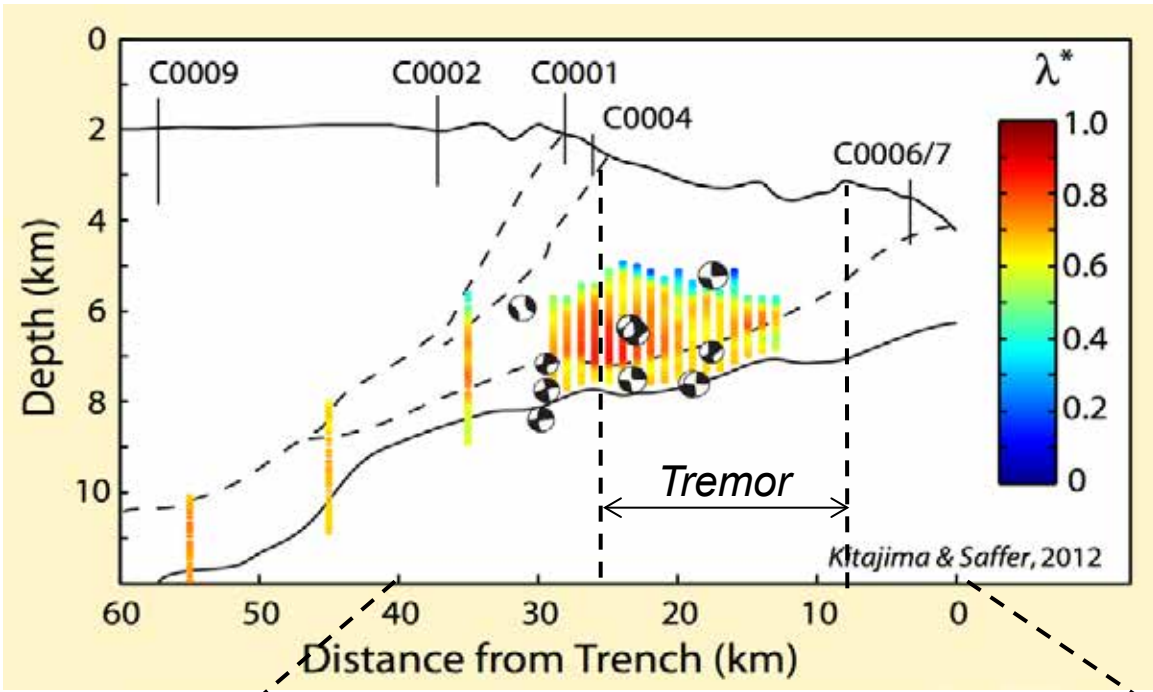
Drillcore samples of subduction “inputs”

Varied stress paths, including failure at critical state

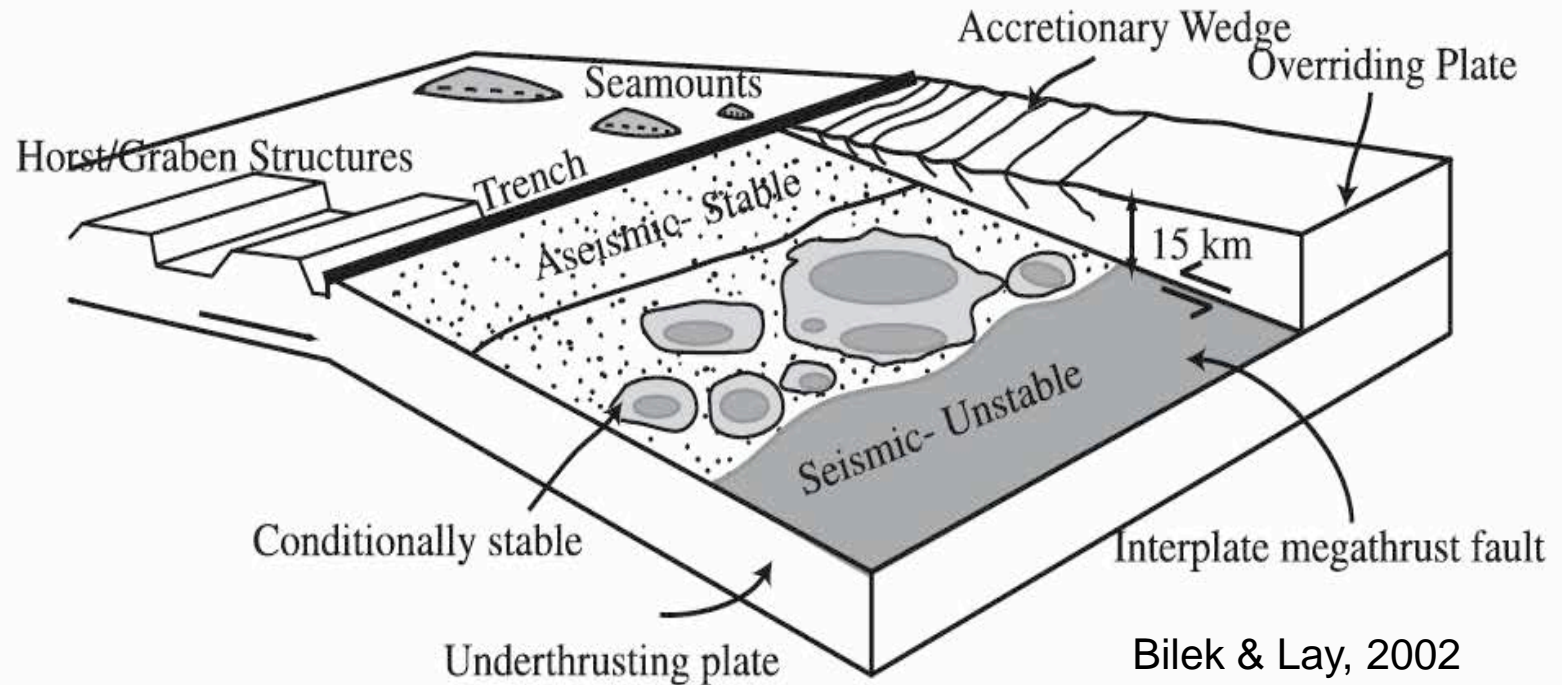
P- and S-wavespeed measurements (ultrasonic)



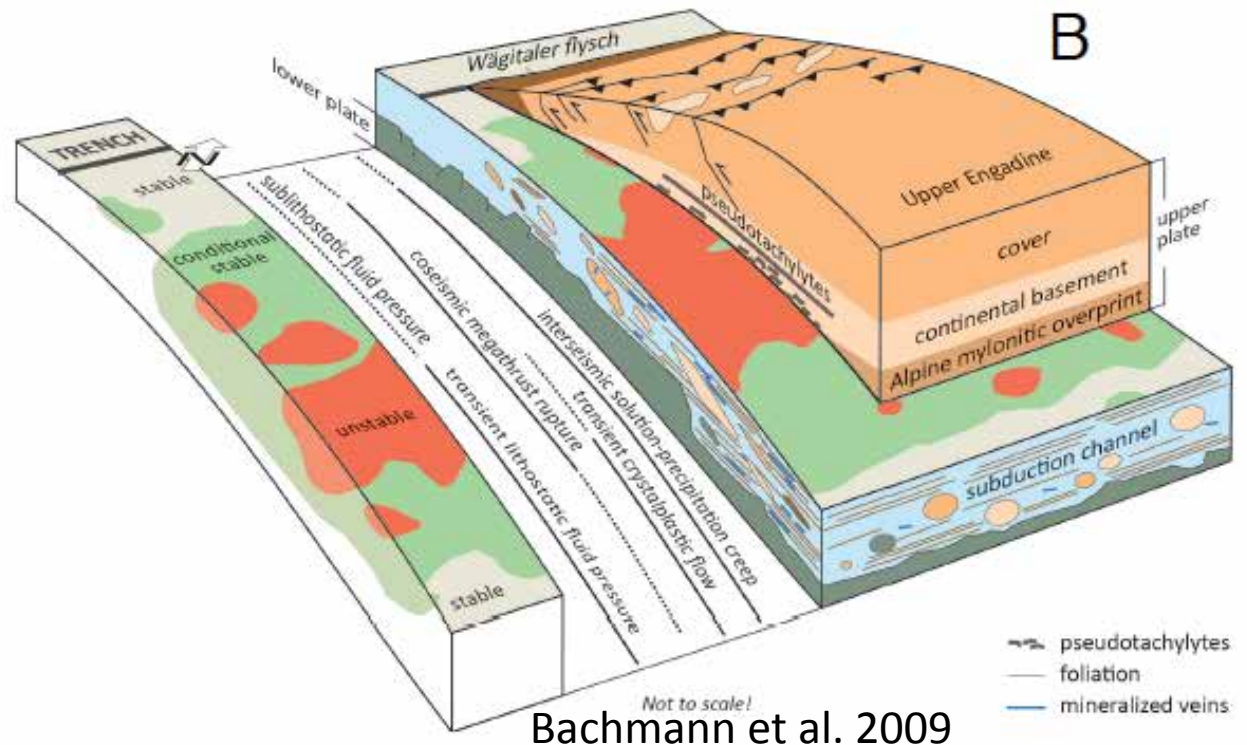
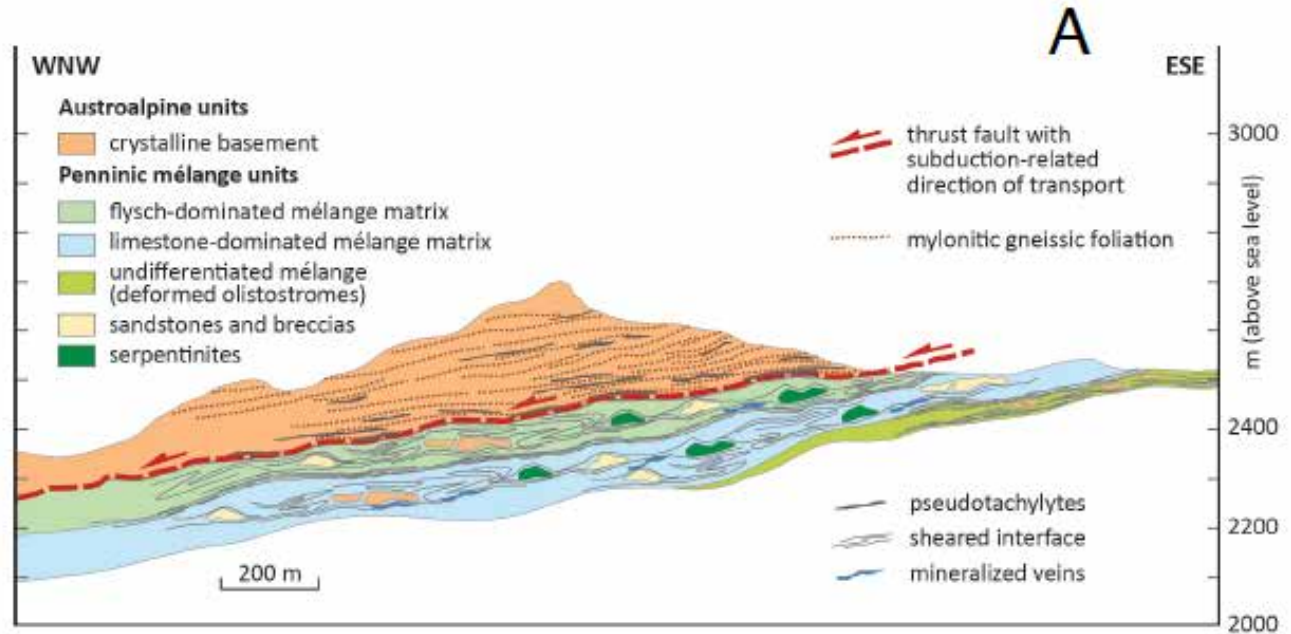
Nankai Margin Low Frequency EQ occur within quantitatively identified region of overpressure



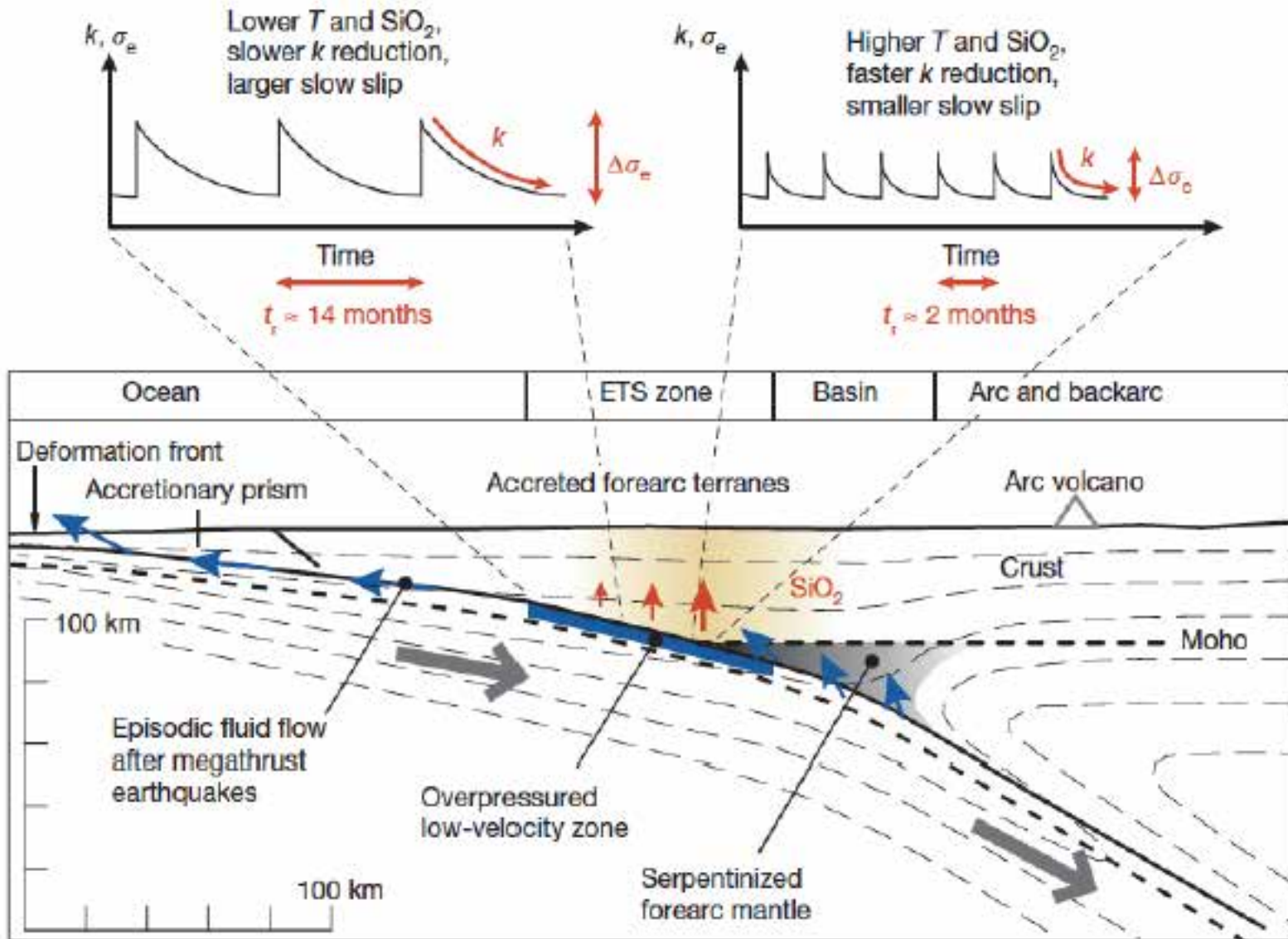
Shallow slip in the forearc



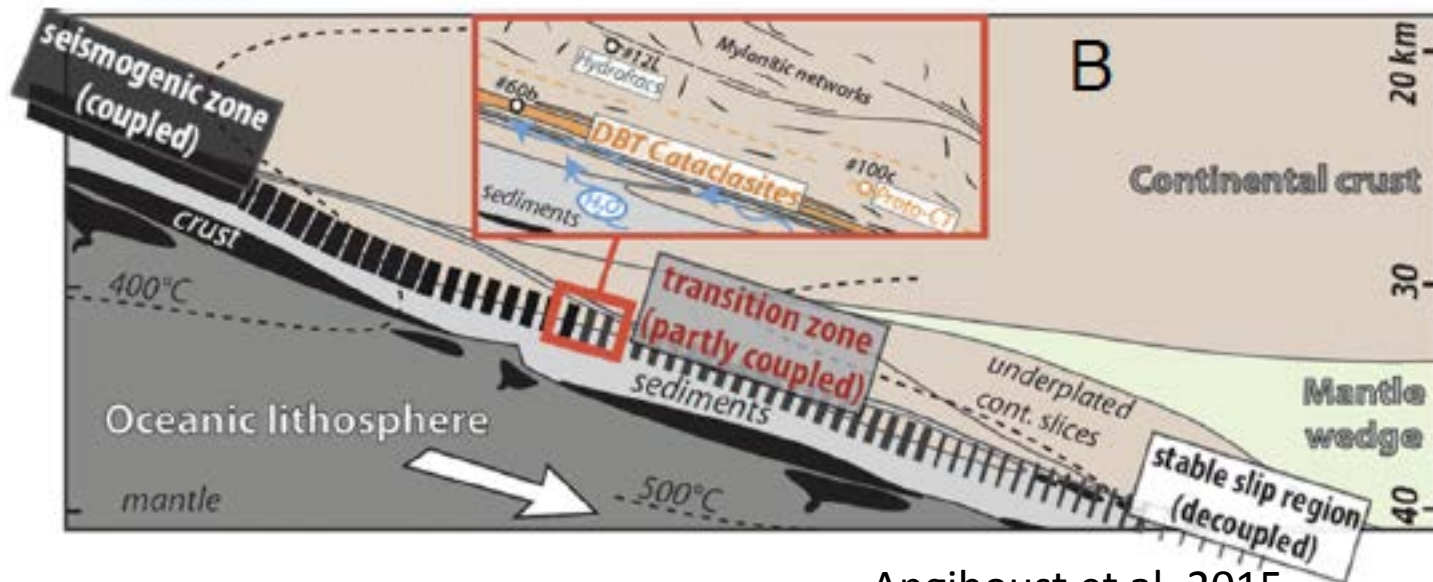
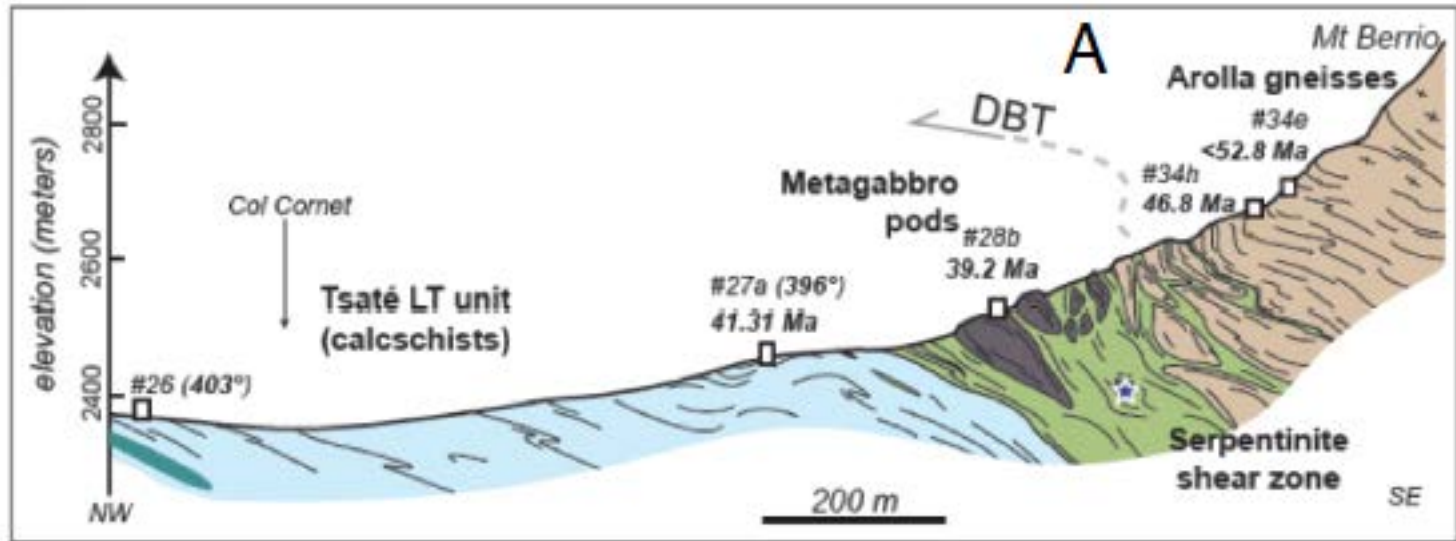
Connection with field observations in the metamorphic rock record: Arosa, Switzerland, Western Alps



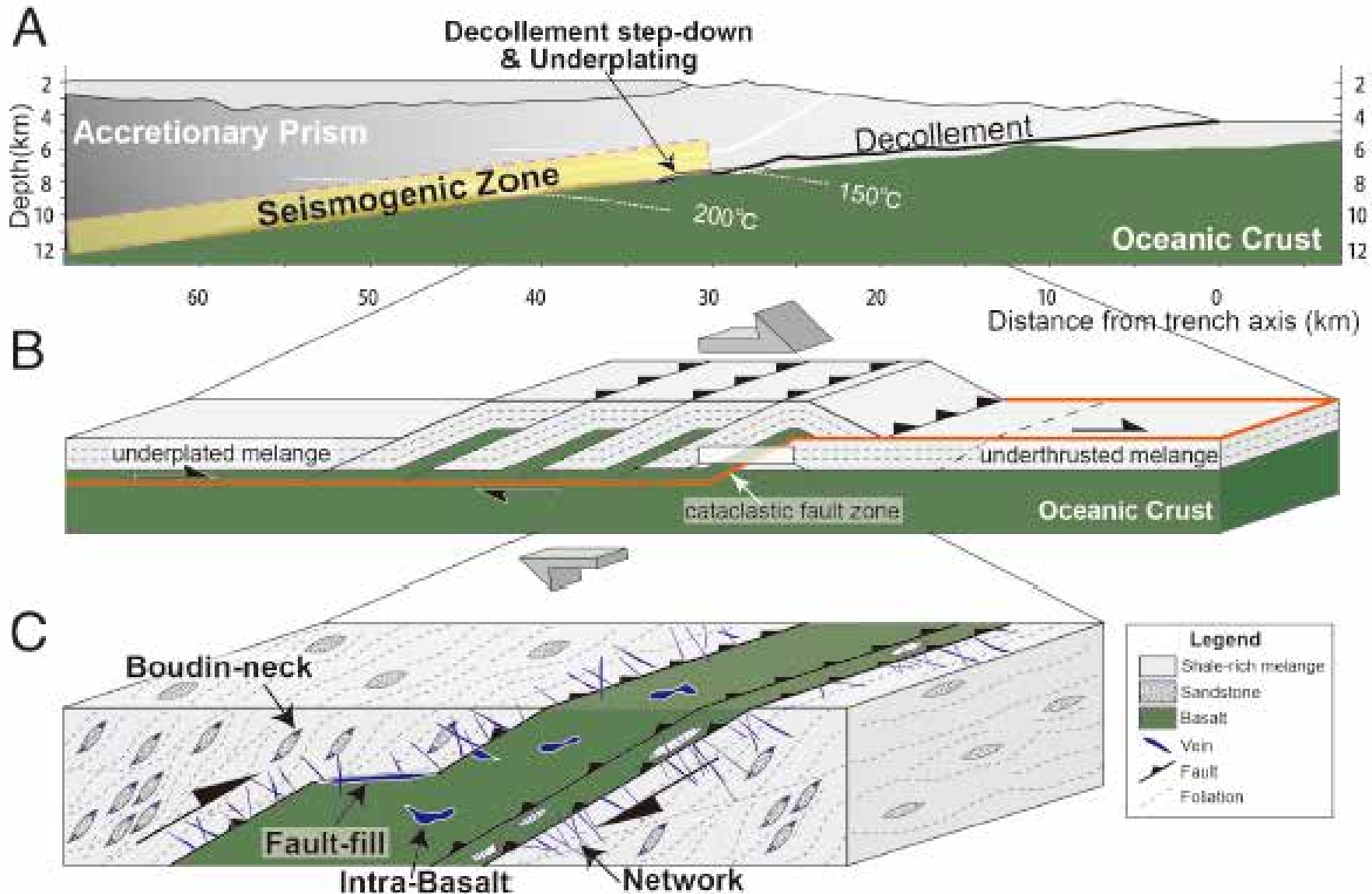
How silica enrichment controls slow earthquake behavior in northern Cascadia



Connection with field observations in the metamorphic rock record: Dent Blanche Thrust, Western Alps



Connection with field observations in the metamorphic rock record: Mugi melange



ExTerra Field Institute and Research Endeavor

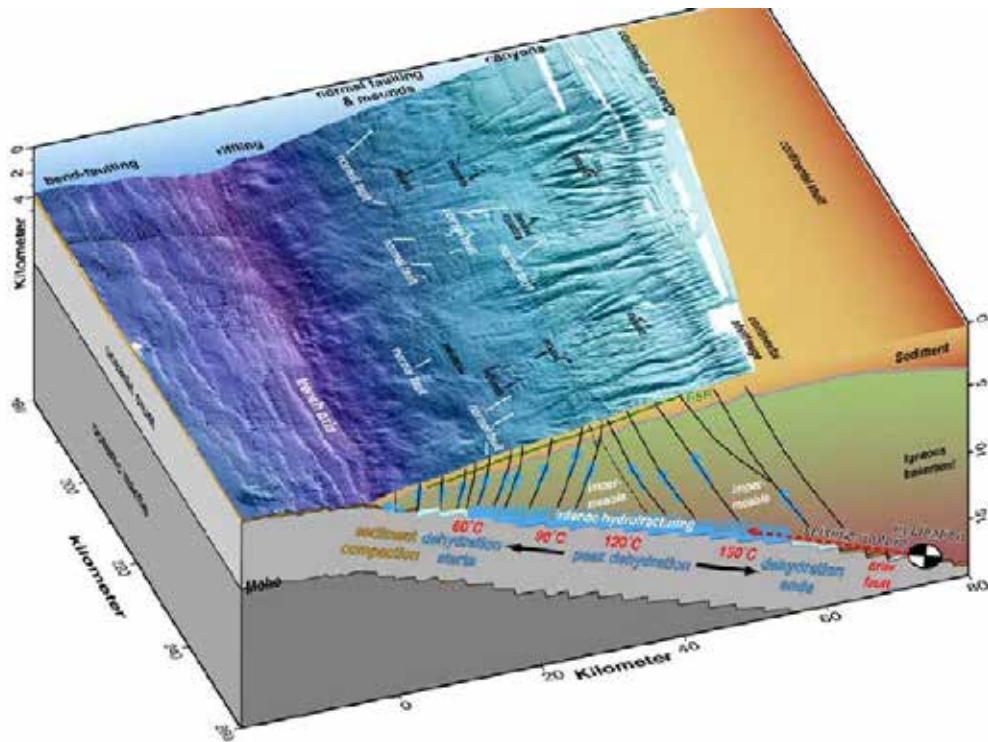
A group of hikers is seen from behind, walking along a rocky mountain trail. The hikers are wearing backpacks and hats. In the background, there are steep, rocky mountain slopes with patches of green vegetation and snow-capped peaks under a clear blue sky.

...will consist of 8 PhD students and 2 post-docs working on projects with ExTerra scientists and European ZIP (Zooming in between Plates) scientists in the Western Alps to develop new approaches to answering questions about the nature of subduction

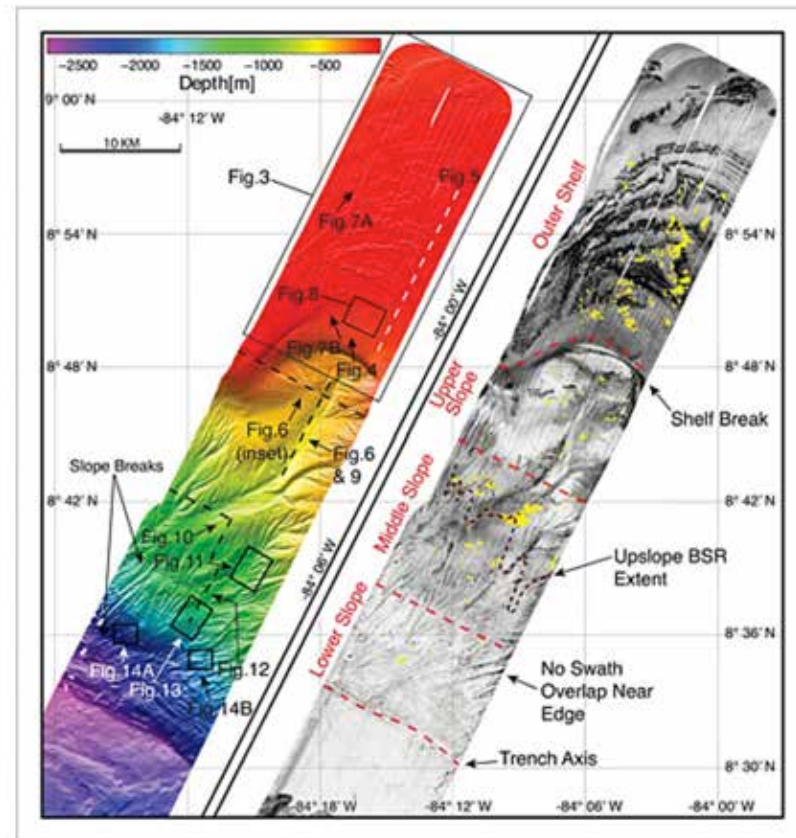
We are actively seeking applications for student and post-doctoral fellows

Please encourage interested, motivated, bright students to visit our website: <http://geoprisms.org/exterra/e-fire/> for more information

Hydrogeology of an erosional margin



Ranero et al., 2008



Kluesner et al., 2013