

THEME 1

Deformation at All Timescales

Session Chairs: Phil Skemer & Ikuko Wada

Rift Initiation and Evolution (RIE)

Focuses on the spatial and temporal evolution of rifts and rifted continental margins with four key questions:

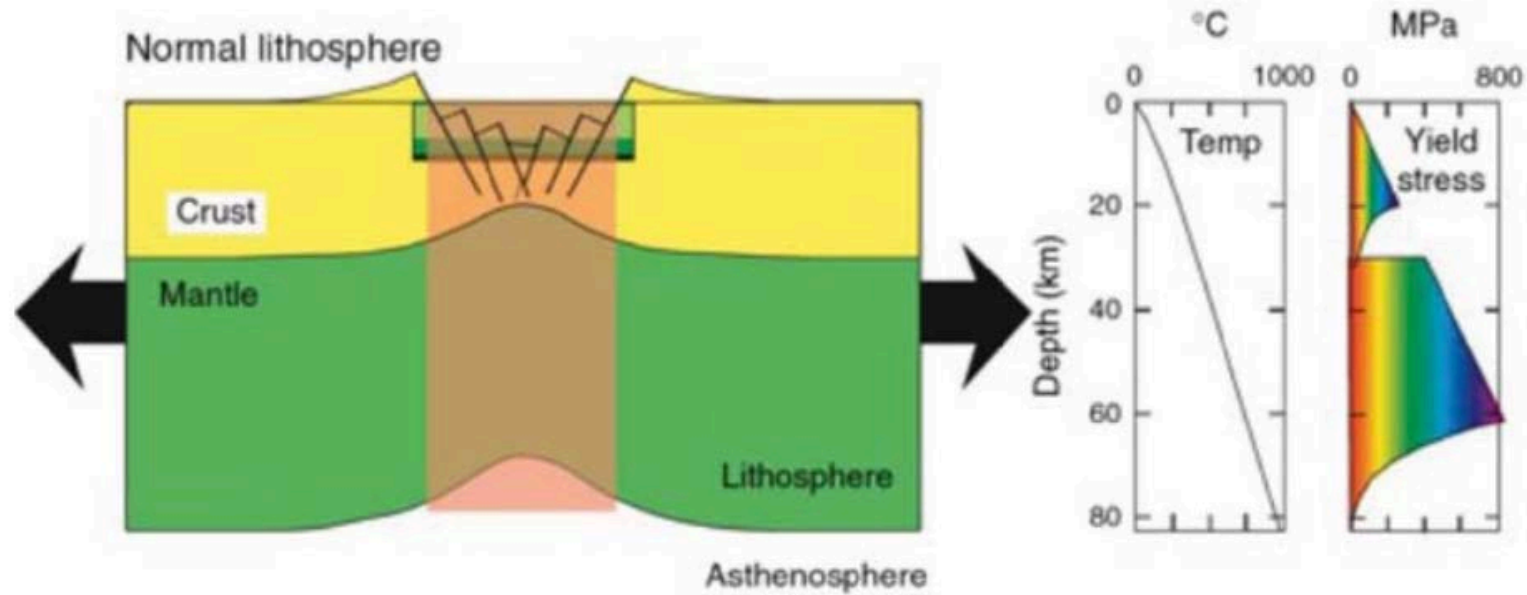
- Where and why do continental rifts initiate?
- How do fundamental rifting processes and their feedback evolve in time and space?
- What controls the architecture of rifted continental margins during and after breakup?
- What are the mechanisms and consequences of fluid and volatile exchange between the Earth, oceans, and atmosphere at rifted continental margins?

***RIE Primary Sites:** East African Rift System (EARS) and Eastern North American Margin (ENAM)

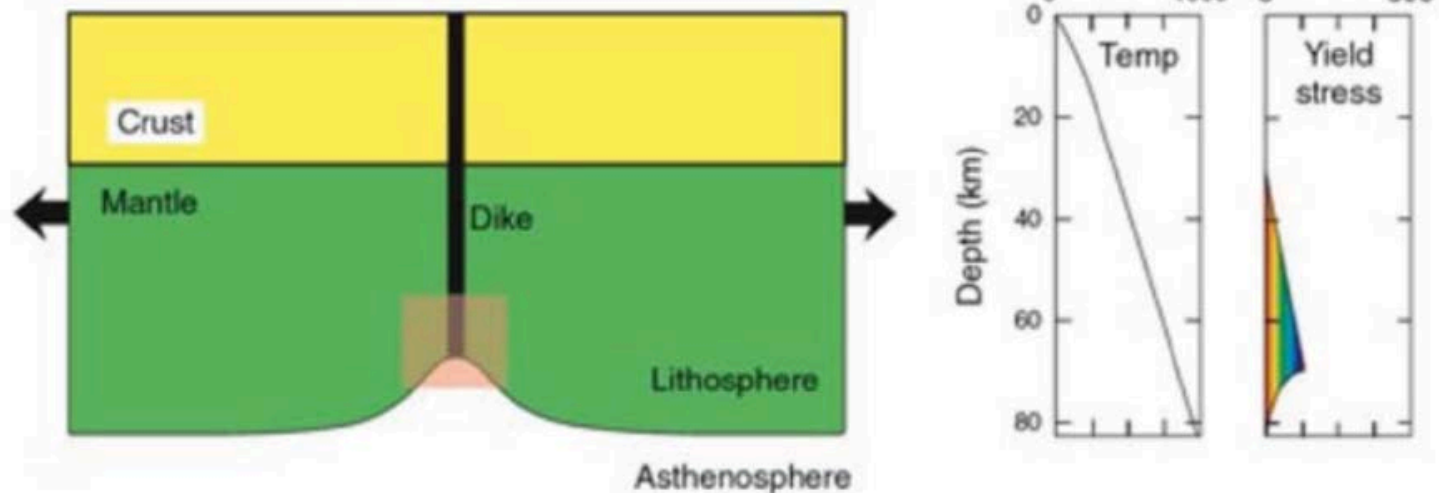
RIE Thematic Studies

- ➔ Theme 1: Rift obliquity
- ➔ Theme 2: Rift processes as functions of strain rate
- Theme 3: Volatiles in rift zone processes
- Theme 4: Sediment production, routing and transport during and after rifting
- ➔ Theme 5: Discrete events at rifted margins

1) What are the relative roles of magmatism and preexisting structures in rift initiation?

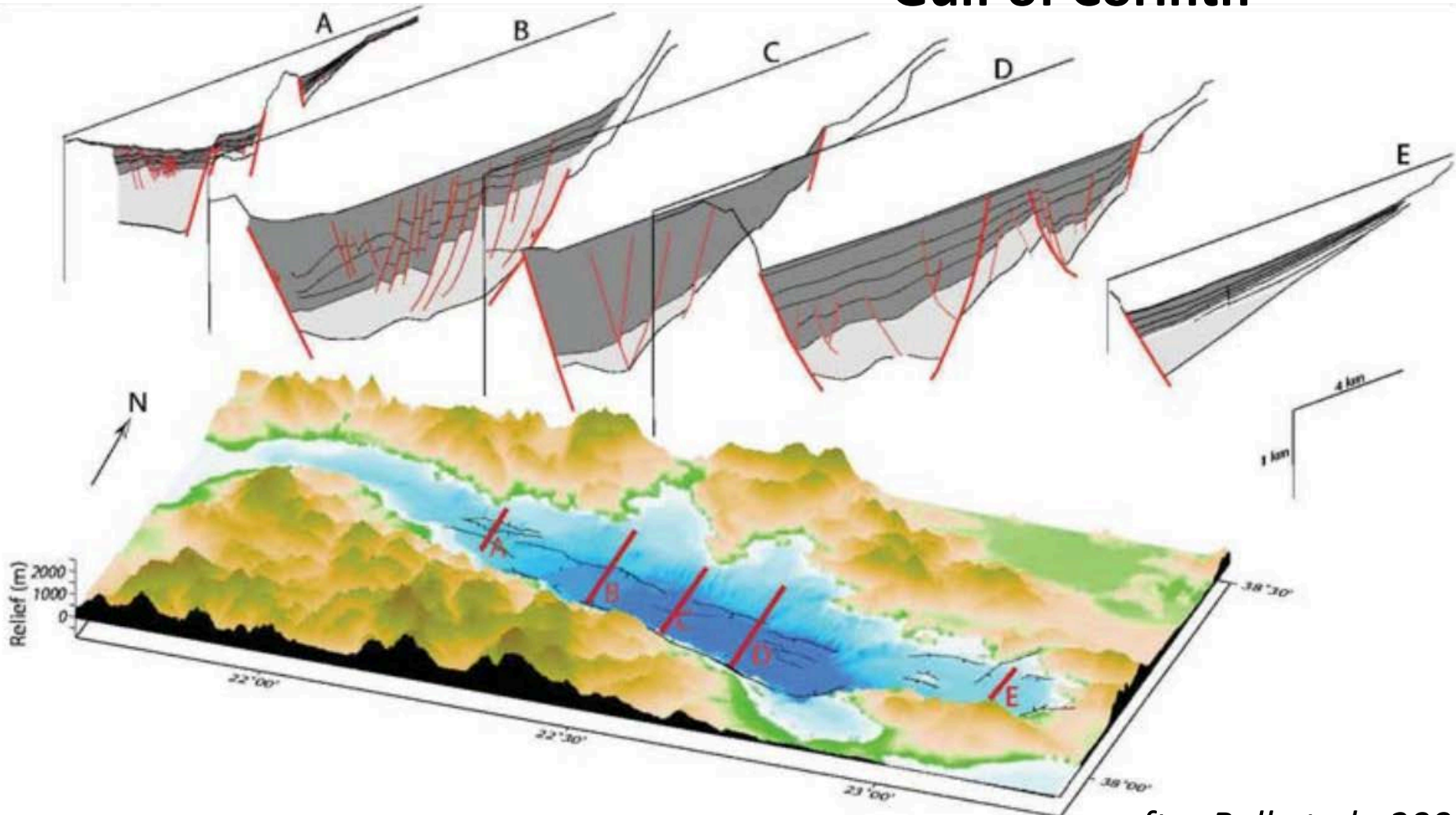


Magmatic extension



2) How do border fault segments form, and how is strain distributed throughout the lithosphere beneath and along early rift stage border faults?

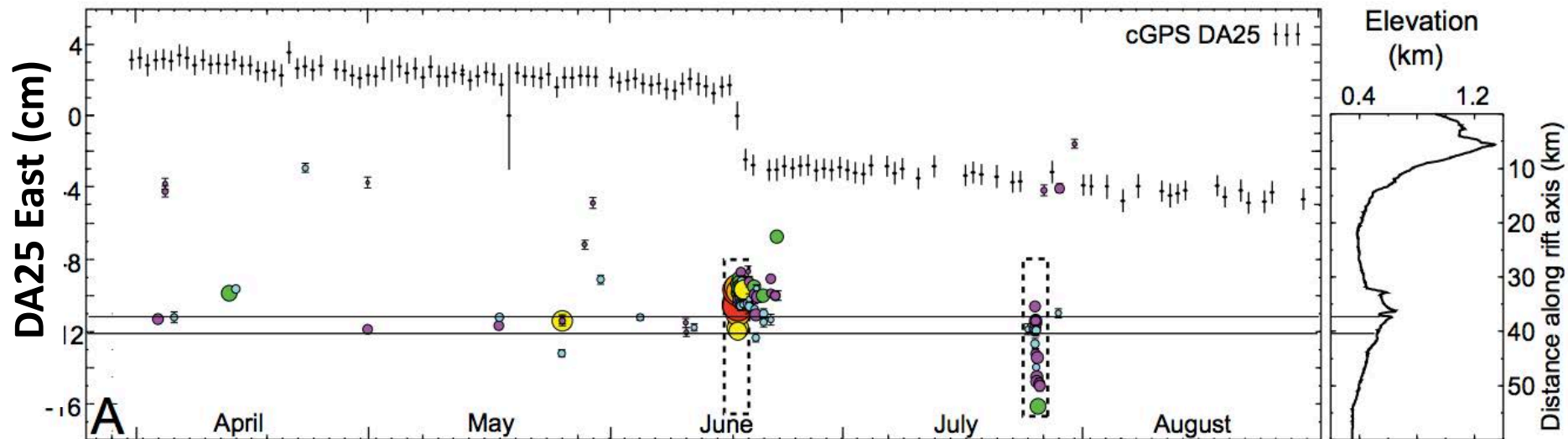
Gulf of Corinth



after Bell et al., 2009

3) What is the relative importance of discrete rifting events versus continuous deformation in accounting for plate divergence?

Subaerial Red Sea rift segment

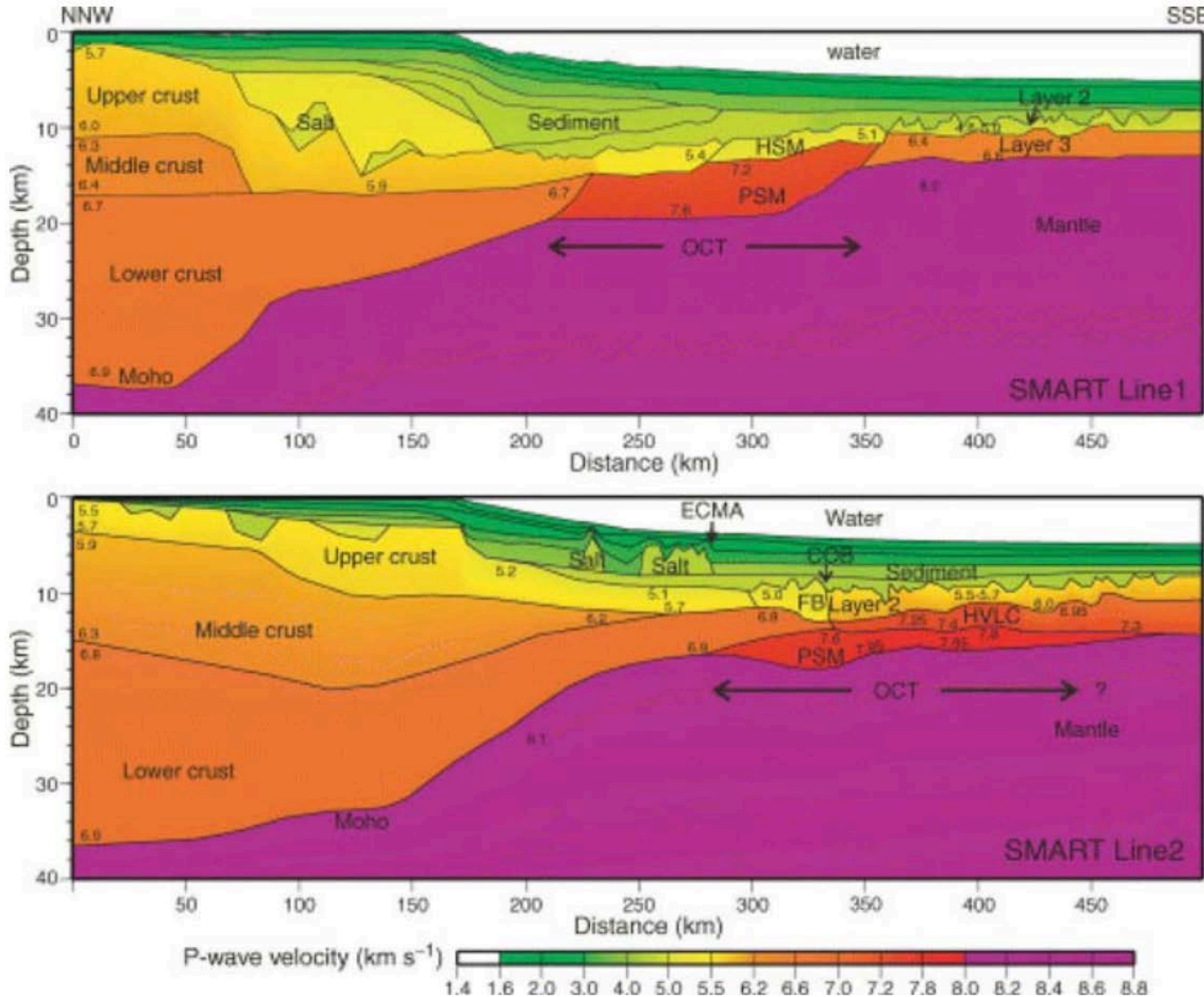


Keir et al., 2009

**Lateral dike
propagation**

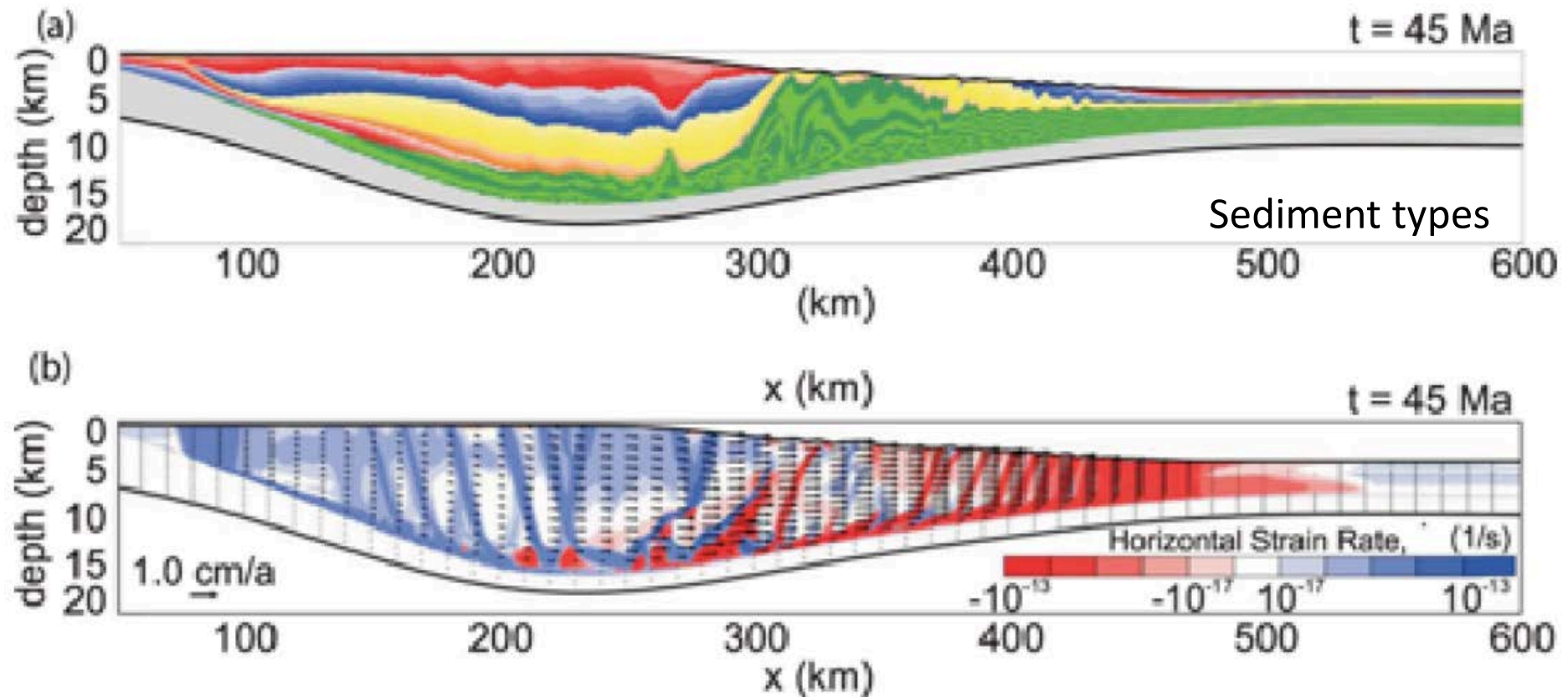
4) What controls the large scale form of evolving rifted margins?

Seismic velocity structures offshore of Nova Scotia



5) What active processes influence the form of the post-rift continental margin?

Differential loading of thinned crust with visco-plastic sediment



Subduction Cycles and Deformation (SCD)

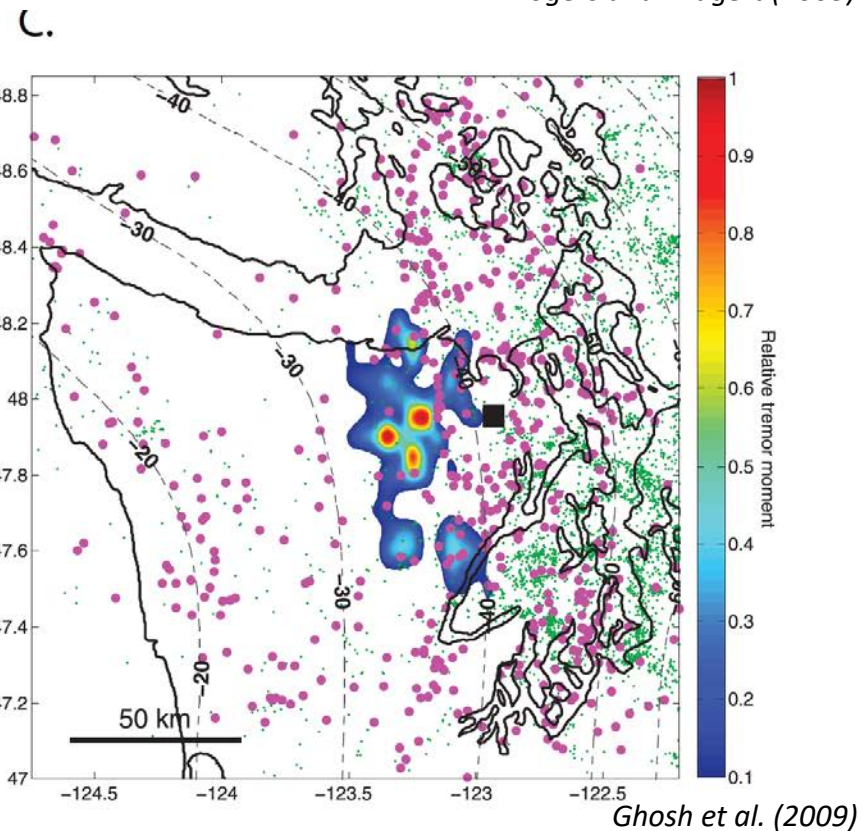
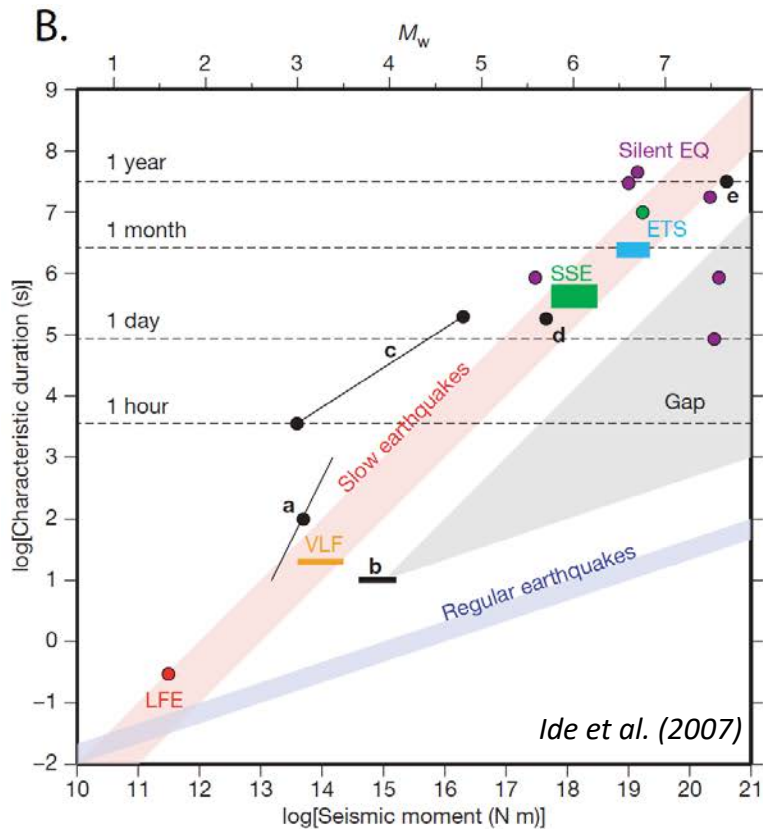
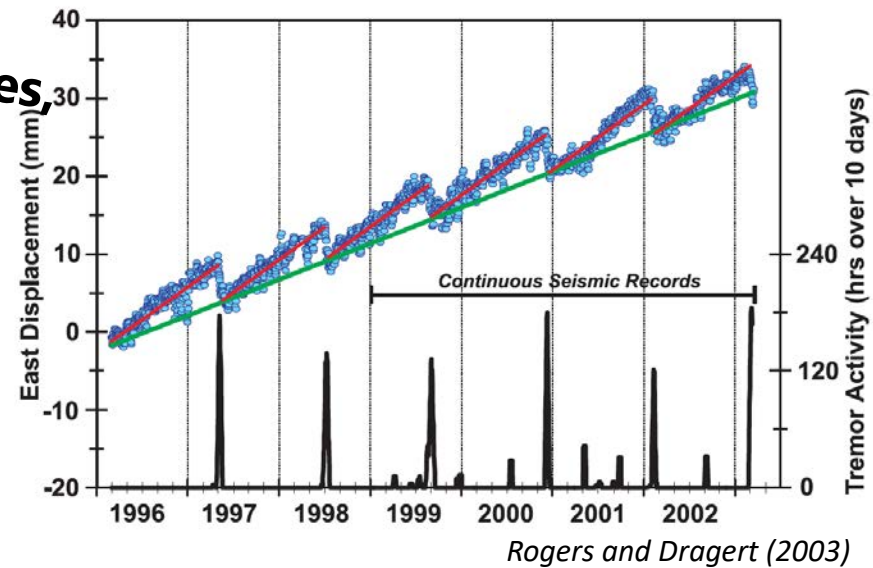
Focuses on long-term margin evolution and material transfer and short-term plate boundary deformation connected through 5 themes:

SCD Comparative and Thematic Studies

- ➔ Theme 1: Identifying Controls on Fault Slip Behavior and Deformation History
- ➔ Theme 2: Understanding Mantle Wedge Dynamics
- Theme 3: Fore-arc to Back-arc Volatile Fluxes
- Theme 4: Conditions and Reactions in Subduction Zones at Depth
- ➔ Theme 5: Subduction Initiation

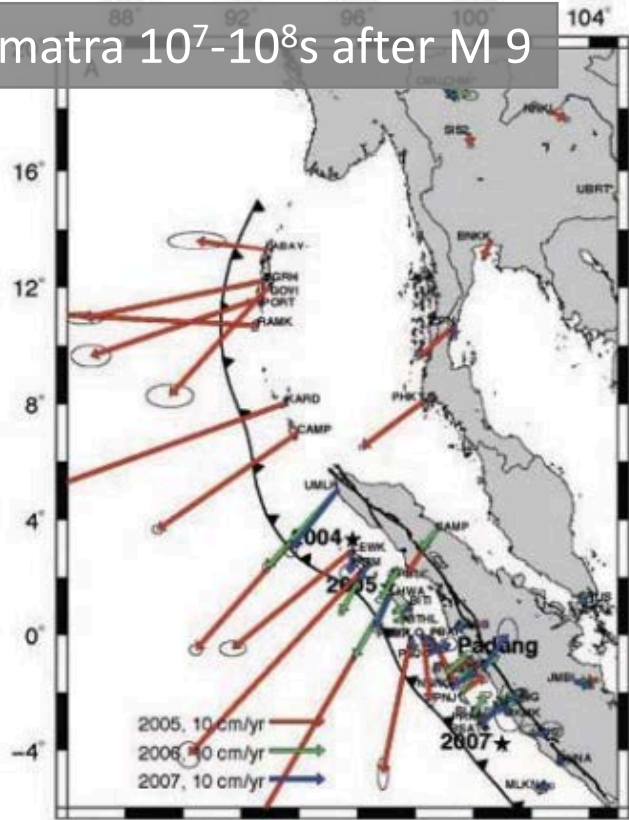
1) What mechanical properties and/or fault zone conditions control the wide spectrum of slip rates observed on subduction megathrusts?

physical processes



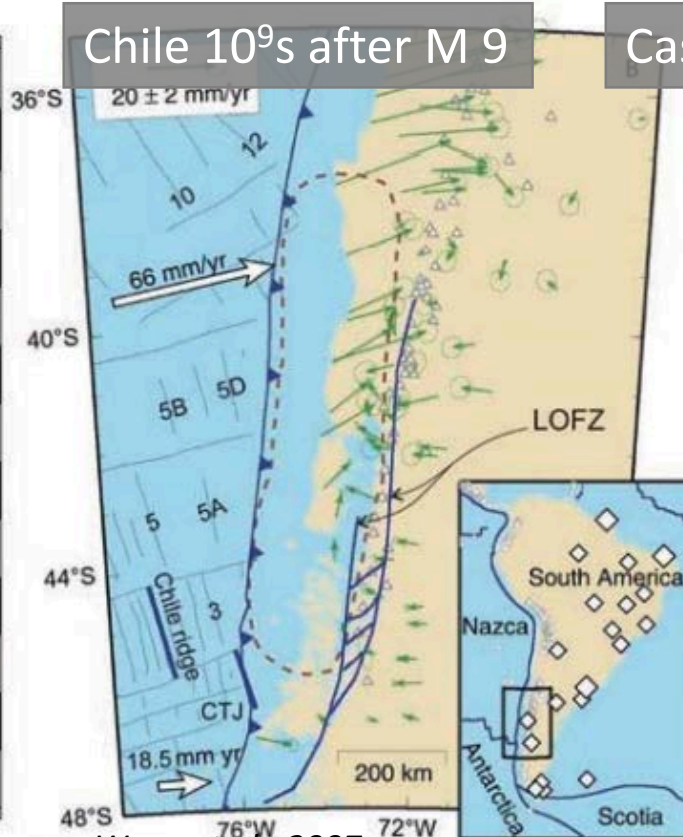
2) What is the time history of surface displacements through the seismic cycle, and what are the respective contributions from mantle flow, upper and lower plate deformation, and the subduction interface?

Sumatra 10^7 - 10^8 s after M 9



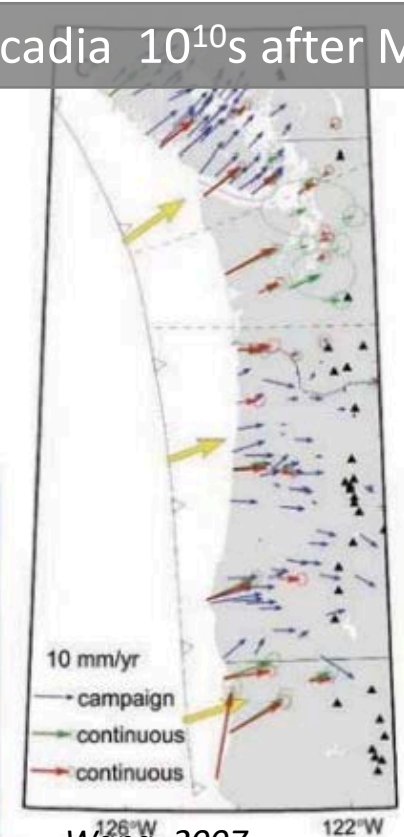
Grijalva et al., 2009

Chile 10^9 s after M 9

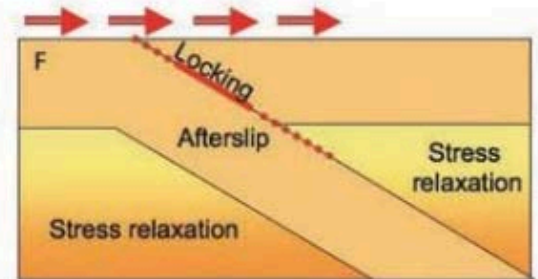
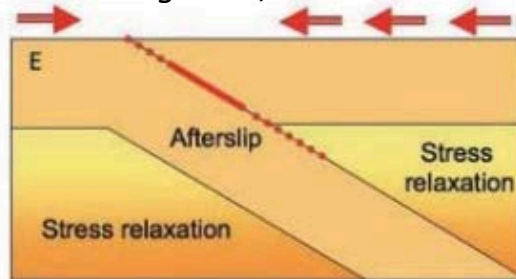
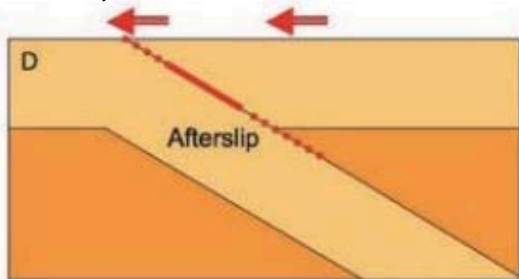


Wang et al., 2007

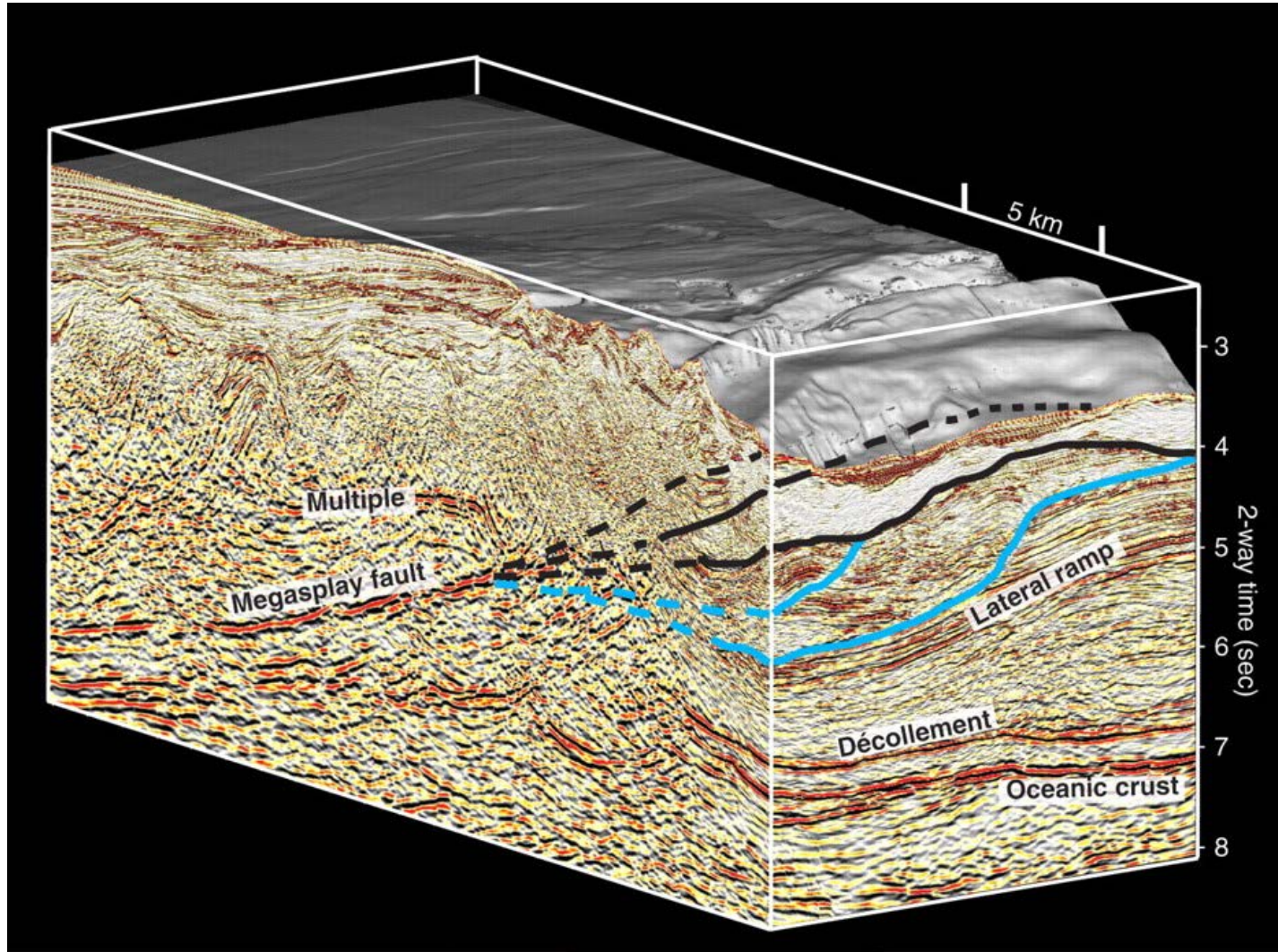
Cascadia 10^{10} s after M 9



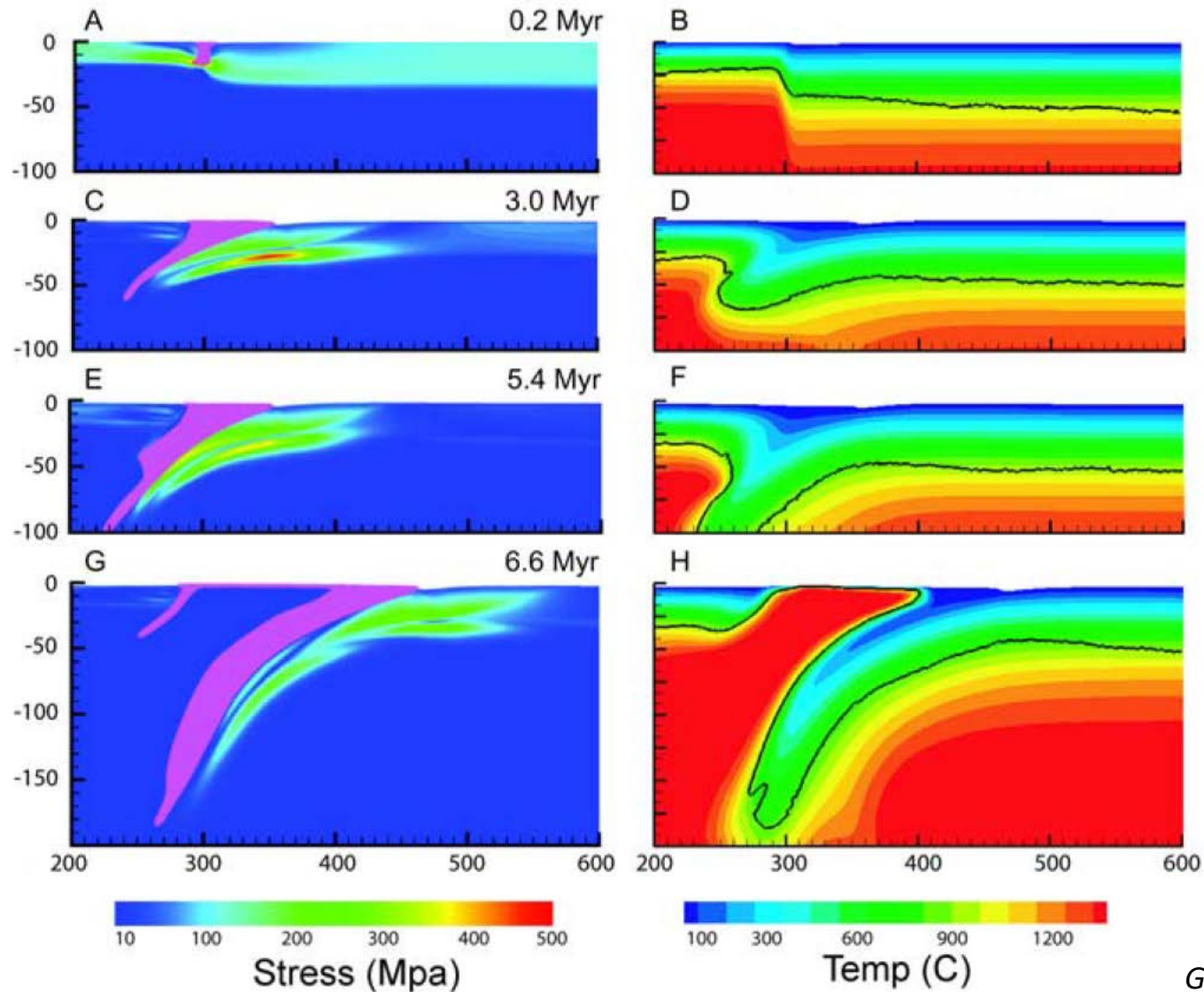
Wang, 2007



3) What is the role of secondary faulting in the upper and lower plates in accommodating strain accumulation and what are the potential earthquake and tsunami hazards from earthquakes on these faults?



4) How does the initial tectonic state control the initiation and subsequent evolution of subduction, and how do plate kinematics, deformation, and petrology change before, during, and after initiation?



TOPIC 1a: The role of structural inheritance in plate tectonic events

- RIE: How does preexisting lithospheric structure control the architecture of rifted continental margins during and after breakup? – Jolante van Wijk
- SCD: What are common geological settings for subduction initiation, and what tectonic events precede the development of self-sustaining subduction? – Mark Reagan

TOPIC 1b: Reconciling strain budgets at different time scales

- RIE: What is the role of discrete and transient events, including magmatic diking, in the breakup of continents and the onset of seafloor spreading? – Cindy Ebinger
- SCD: How does deformation across the subduction plate boundary evolve in space and time, through the seismic cycle and beyond? – Jeff Freymueller

Questions for Breakout Session 1

- Where do we have **gaps** in our understanding? What are remaining or emerging science questions?
- What kind of **infrastructure** does our community need to address current science questions? What **data sets** must we collect?
- Is an **amphibious research program** required to accomplish our goals? How do we maintain a cohesive community that conducts research across the shoreline?
- How do we capture the **momentum** of the GeoPRISMS community? Can a Research Coordination Network (RCN) serve this purpose?