A Tale of Three Corridors

Active Tectonics in Northern California and the Evolving Thermal Structure

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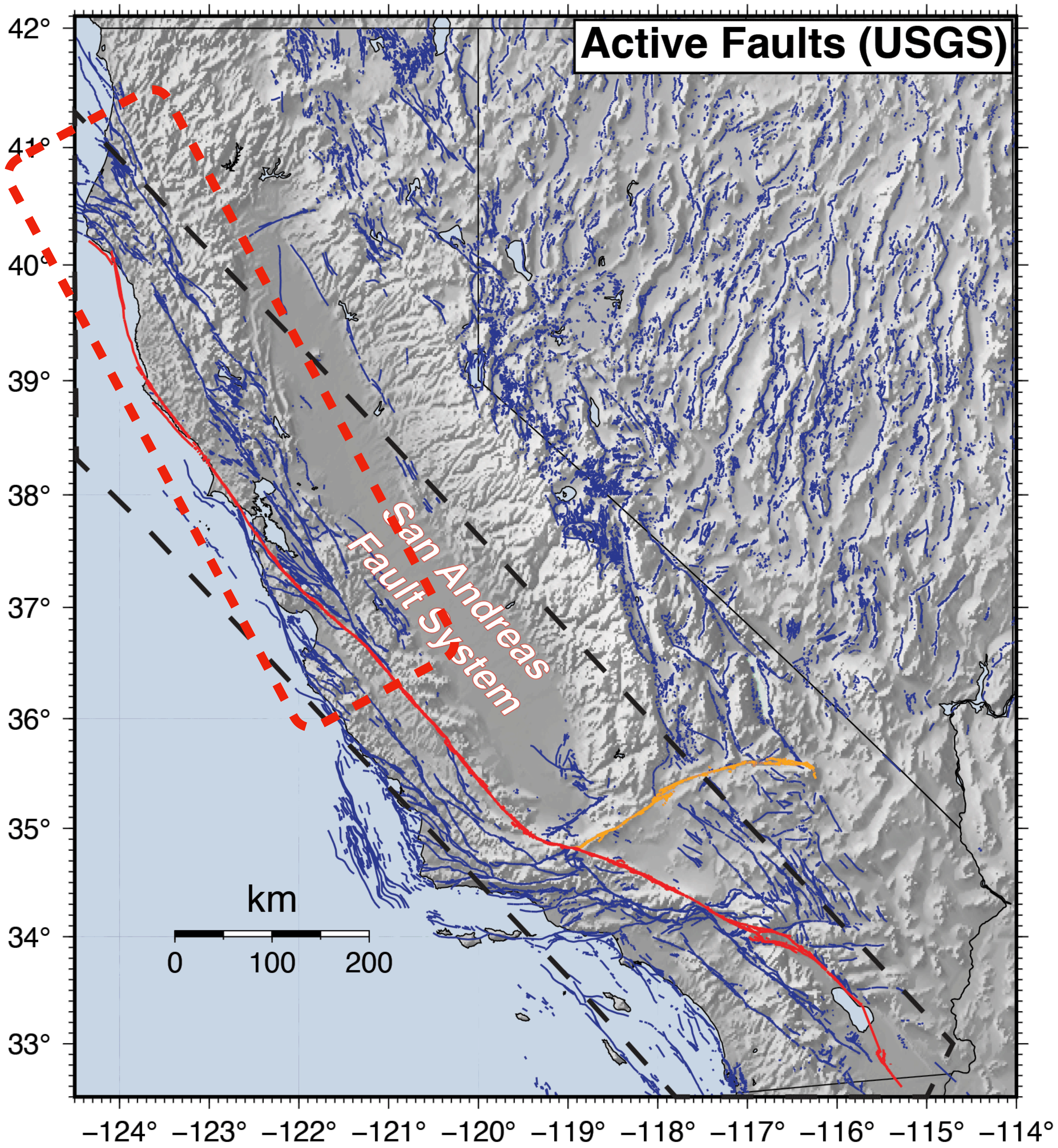


Understanding the Role of Active Tectonics in the Thermal Structure of the California Plate Boundary System - Why does it matter?

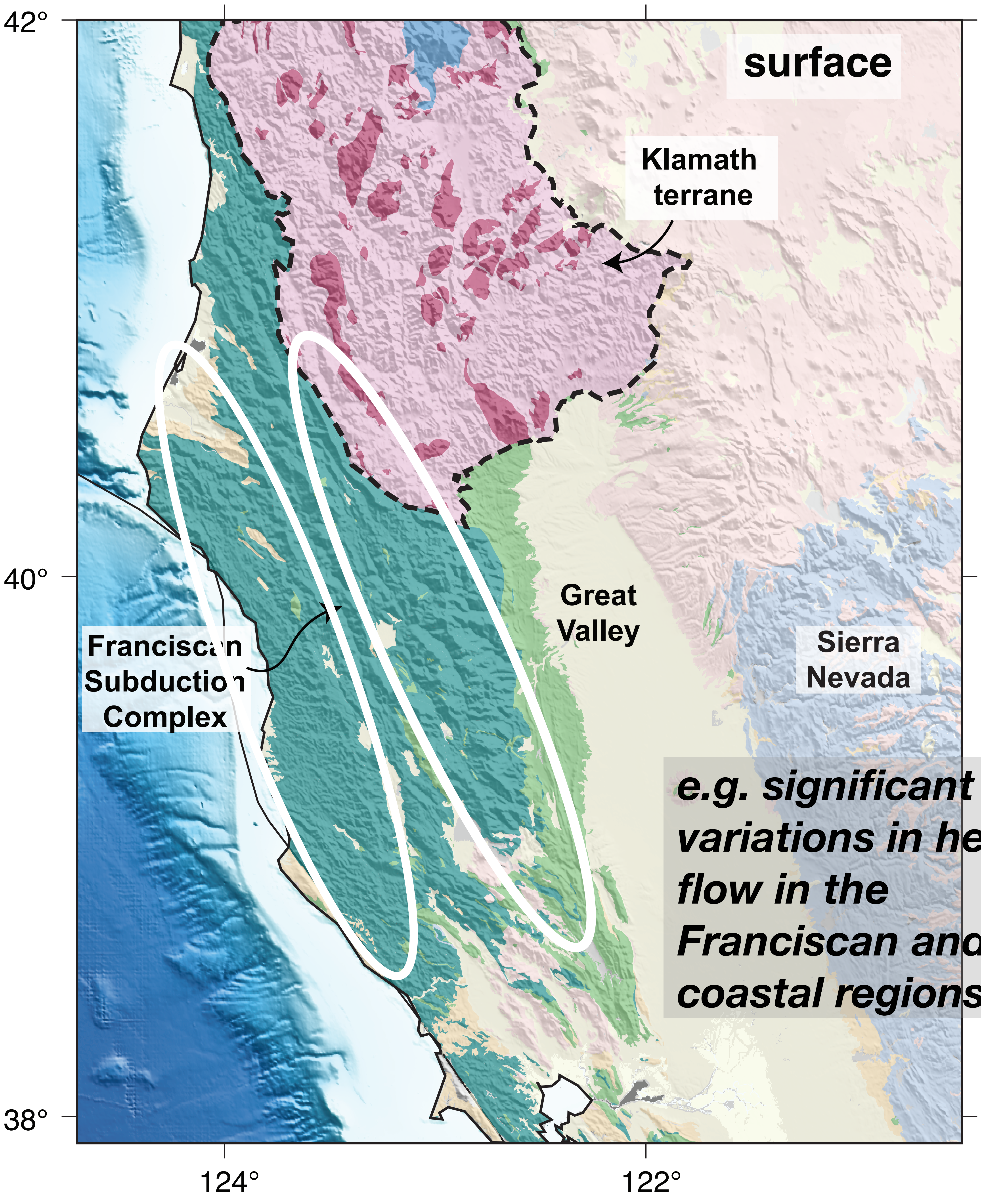
1. *Earthquakes:* *The T-structure largely controls the depth distribution of seismicity. Knowing it helps define extent of seismogenic structures.*

2. *Plate Boundary Rheology:* *Mechanics, time scales and spatial extent of deformation is directly a f(T)*

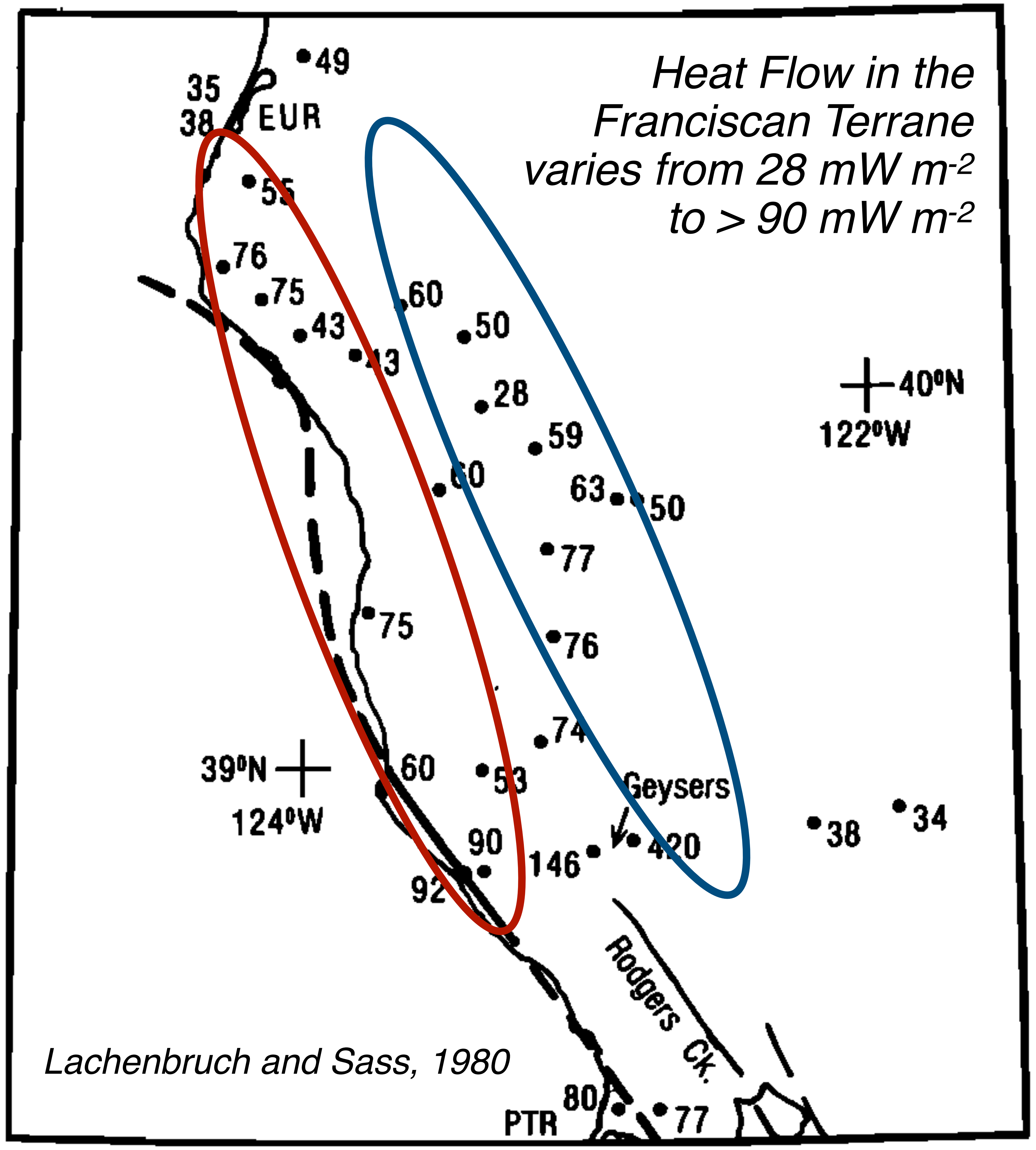
3. *Current Active Tectonics:* *The use of thermochron and other T-dependent observables needs a robust view of the T-structure.*

4. *Plate Tectonic Evolution:* *The T-structure records the sequence of tectonic events that have produced the current plate boundary system.*

Heat Flow data initially collected to test models of fault strength (frictional heating)



e.g. significant variations in heat flow in the Franciscan and coastal regions

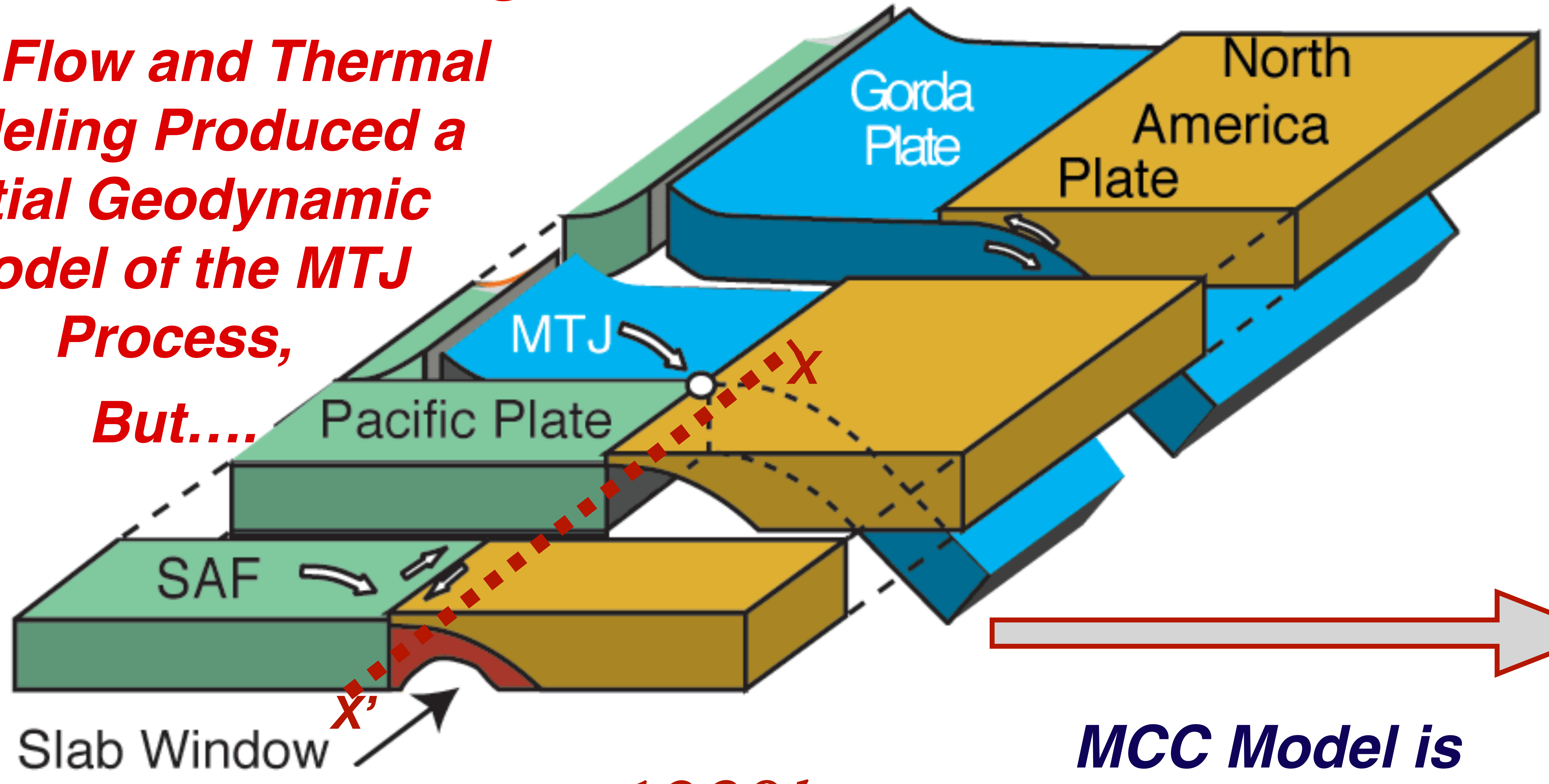


Shear Heating on the faults do not generate the Heat Flow pattern observed!

Slab Window Heating Model

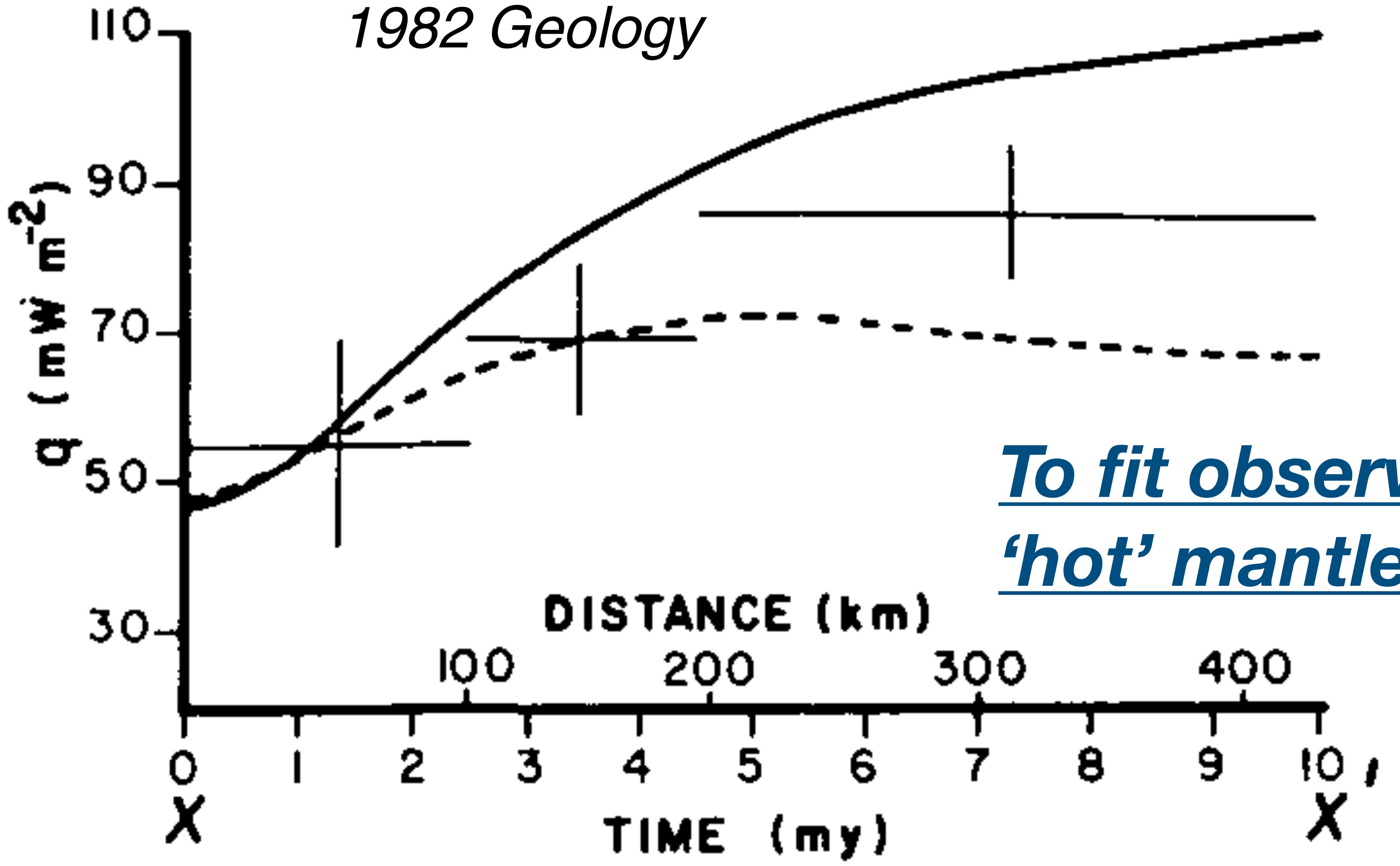
Heat Flow and Thermal Modeling Produced a Initial Geodynamic Model of the MTJ Process,

But….



1980's

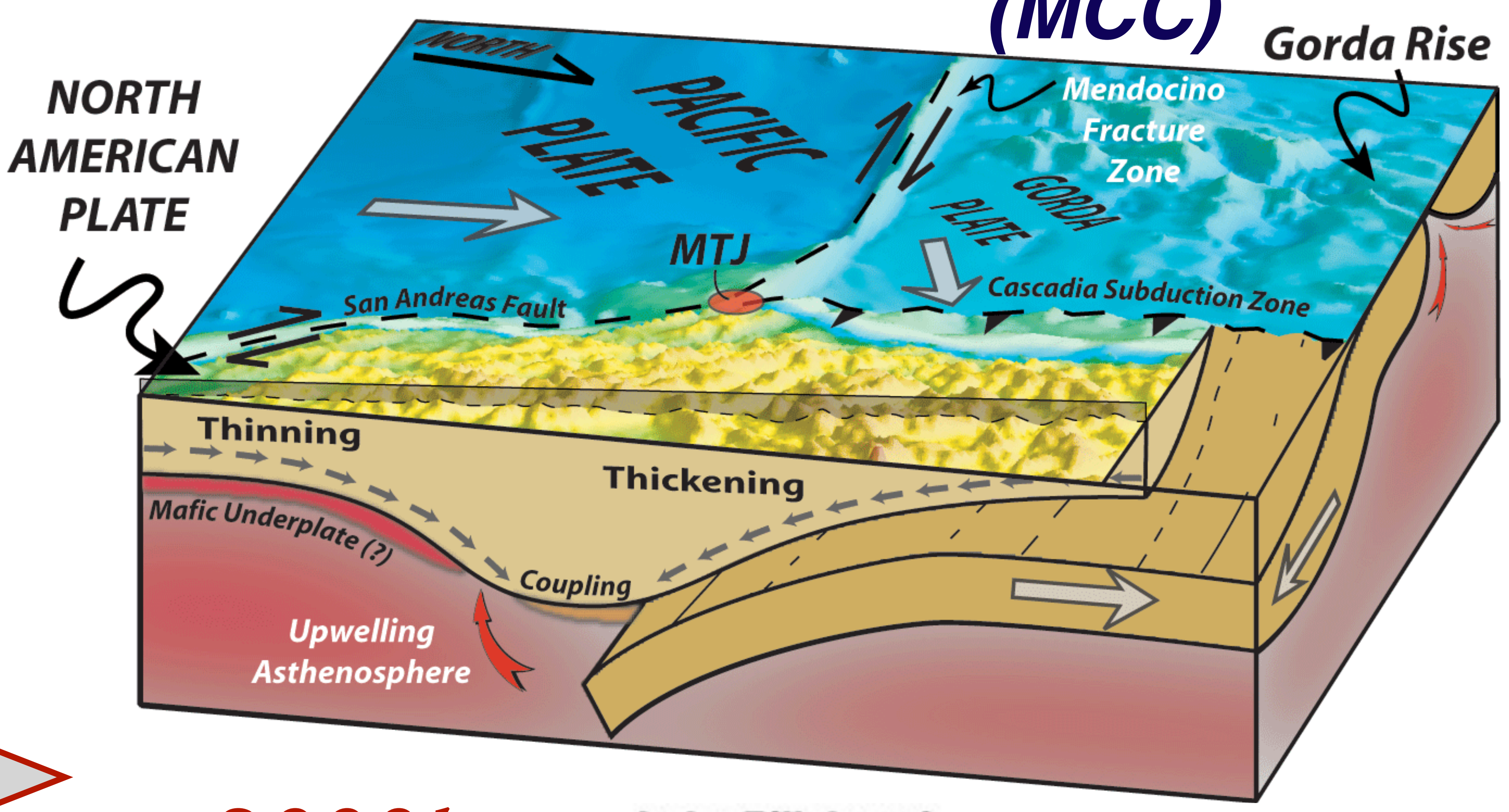
Zandt and Furlong, 1982 Geology



MCC Model is consistent with crustal structure, petrology, and surface processes, but…

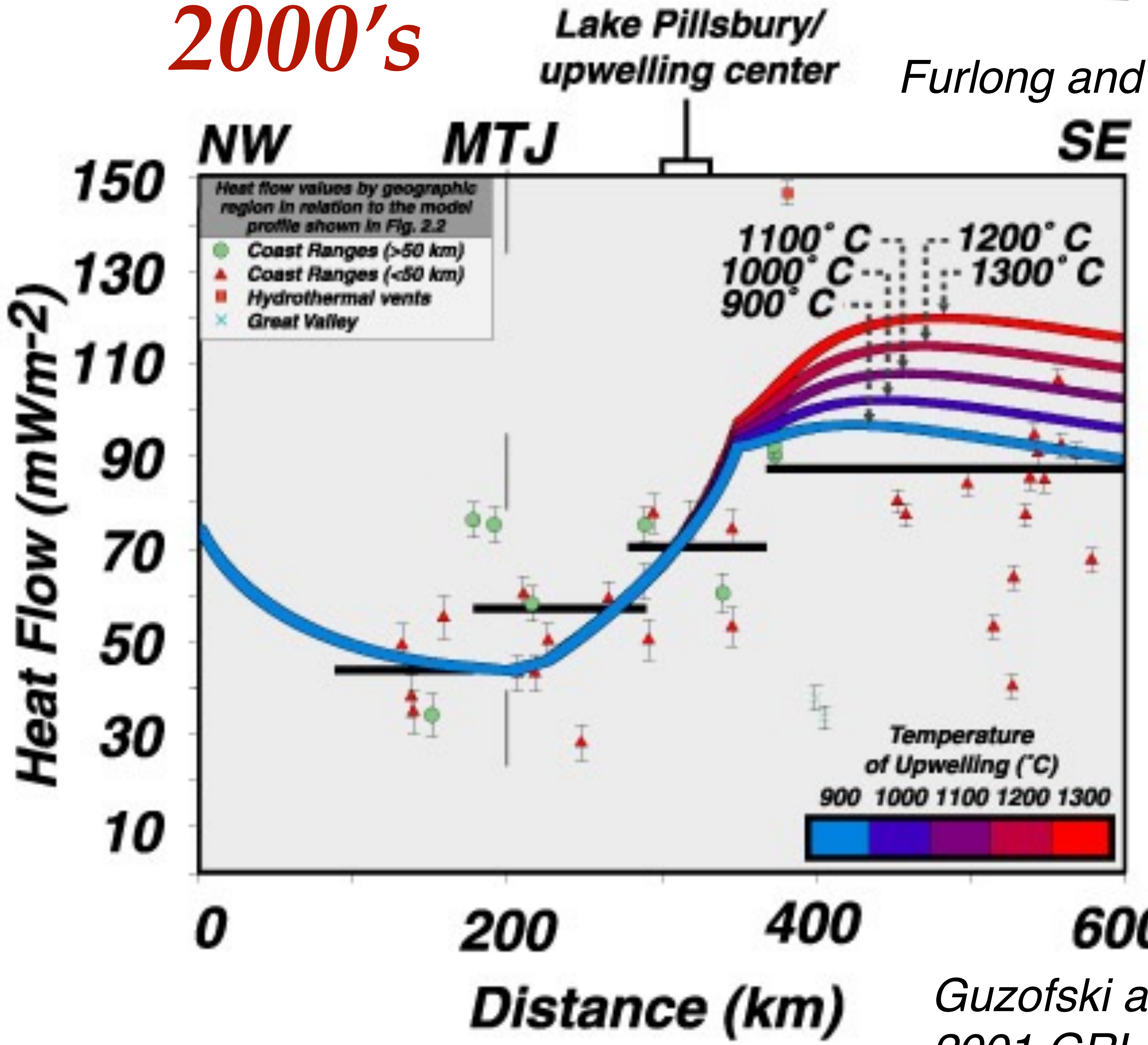
To fit observations, needed 'hot' mantle and 'thin' crust

Mendocino Crustal Conveyor Model (MCC)



2000's

Furlong and Govers, 1999 Geology



Guzofski and Furlong, 2001 GRL

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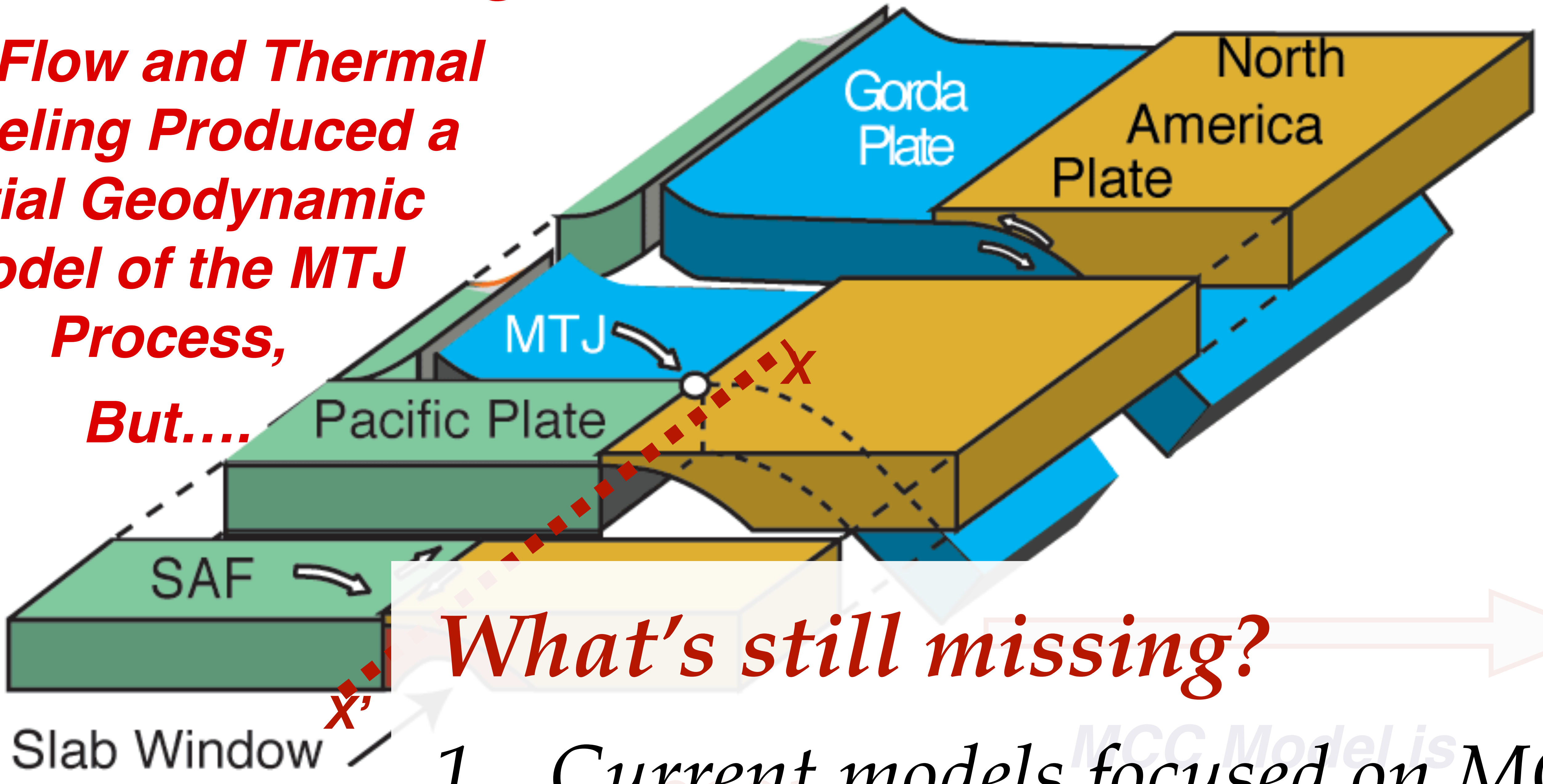

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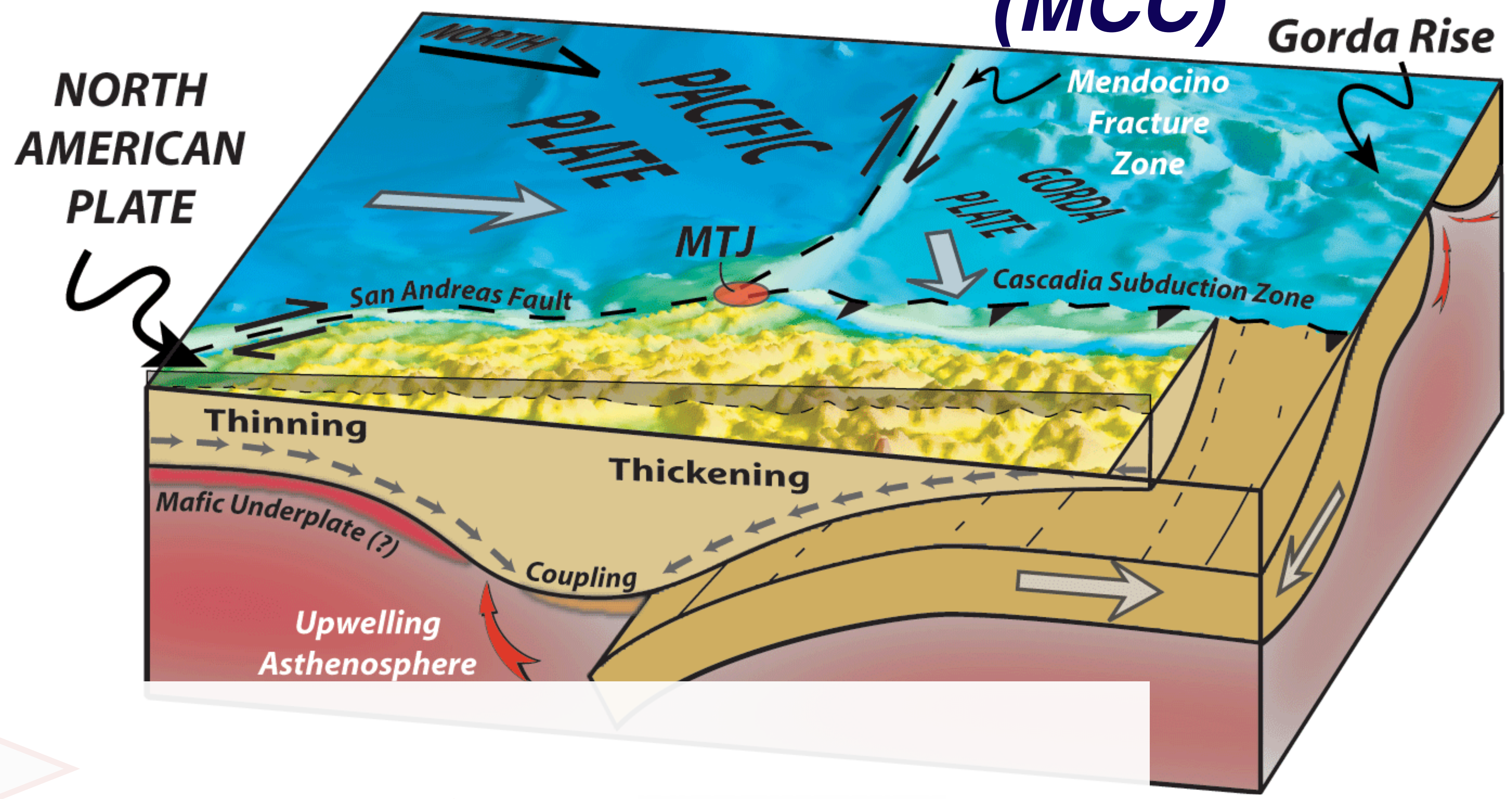
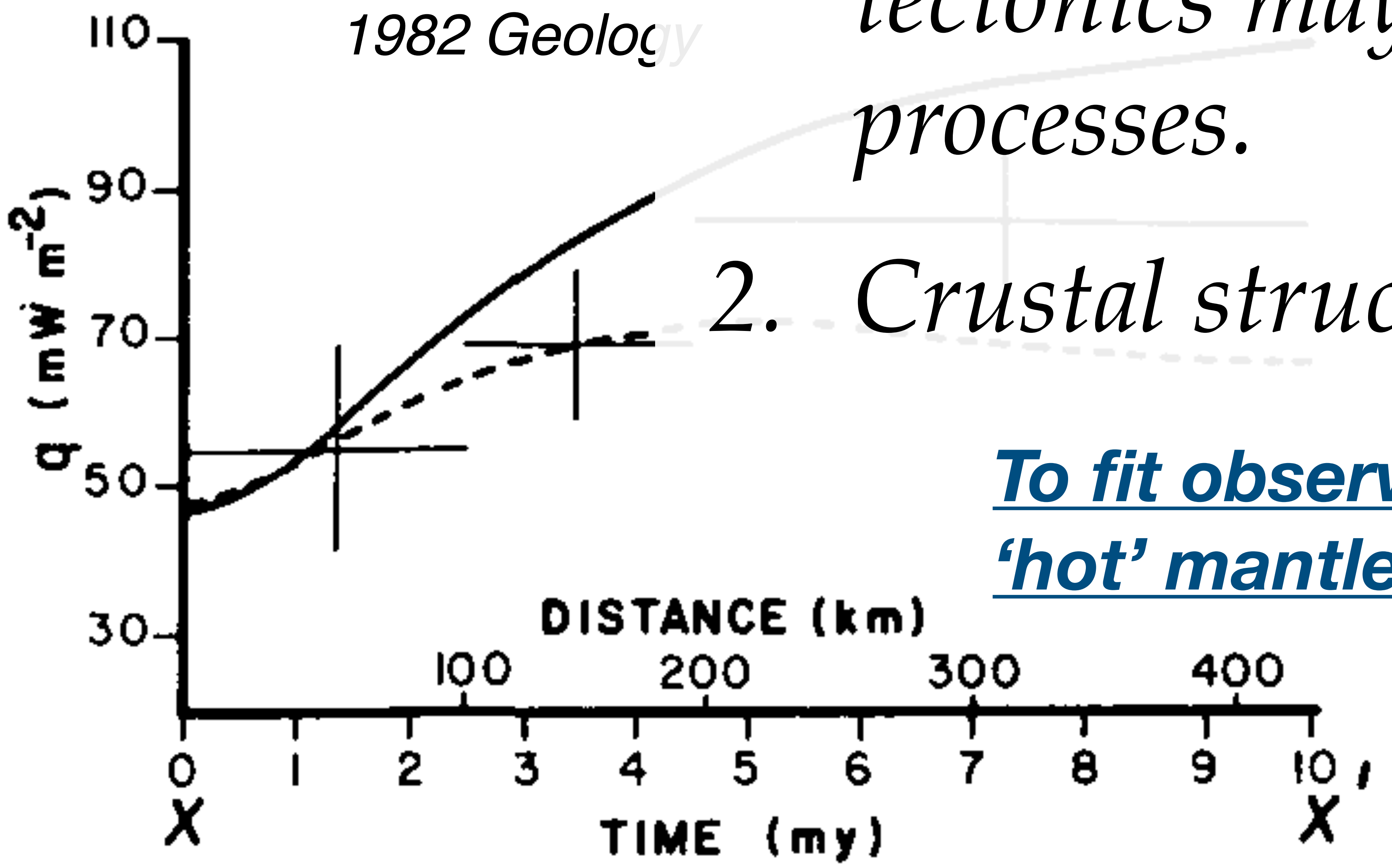


Furlong and Govers, 1999 Geology

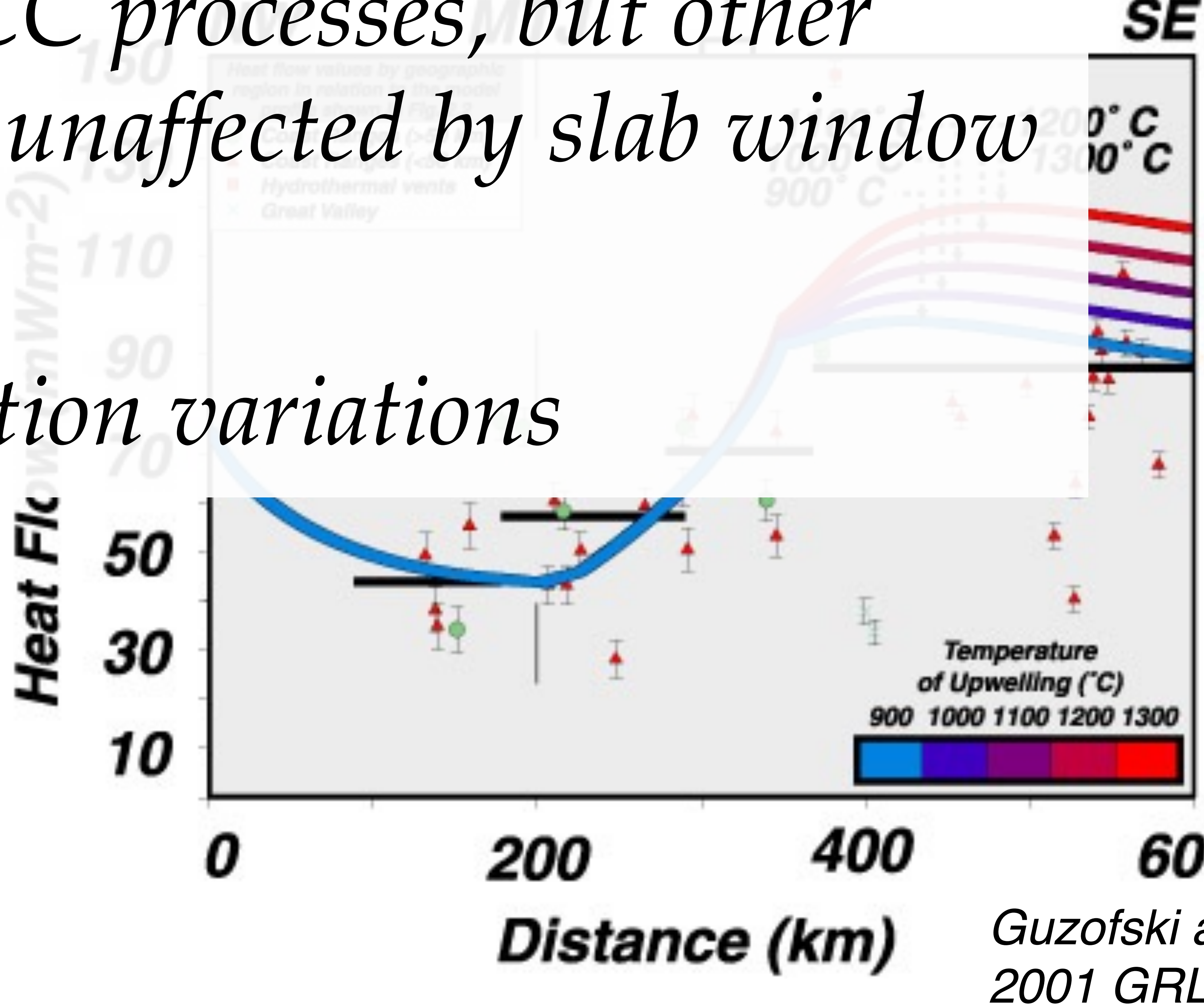
What's still missing?

1. *Current models focused on MCC processes, but other tectonics may apply to regions unaffected by slab window processes.*
2. *Crustal structure and composition variations*

Zandt and Furlong, 1982 Geology



To fit observations, needed ‘hot’ mantle and ‘thin’ crust



Guzofski and Furlong, 2001 GRL

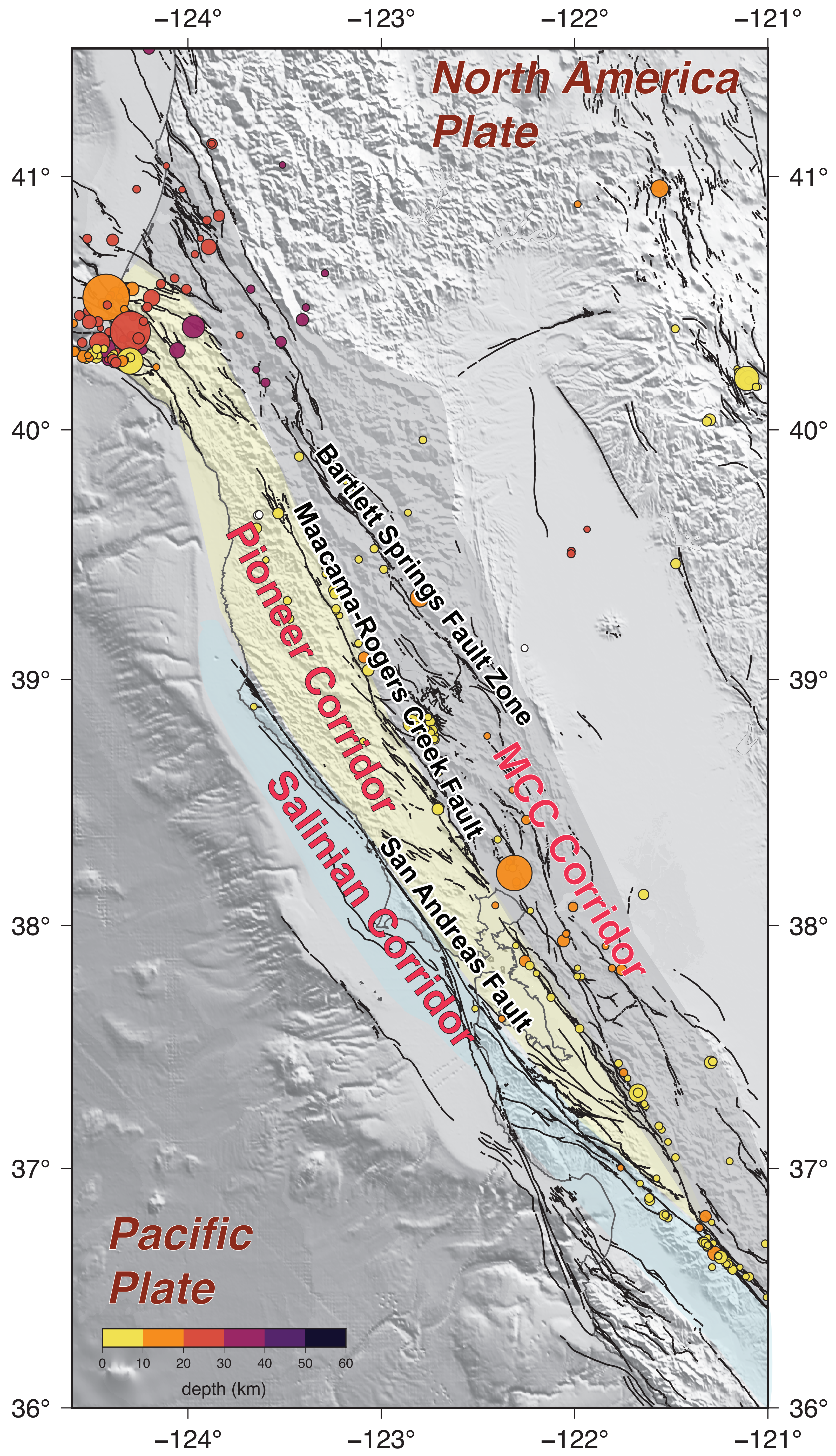
New, ‘high resolution’ tomography lets us define better crustal structure models for the region - helps to define corridors

Defining the 3 Thermal-Tectonic Corridors along the Northern San Andreas Plate Boundary

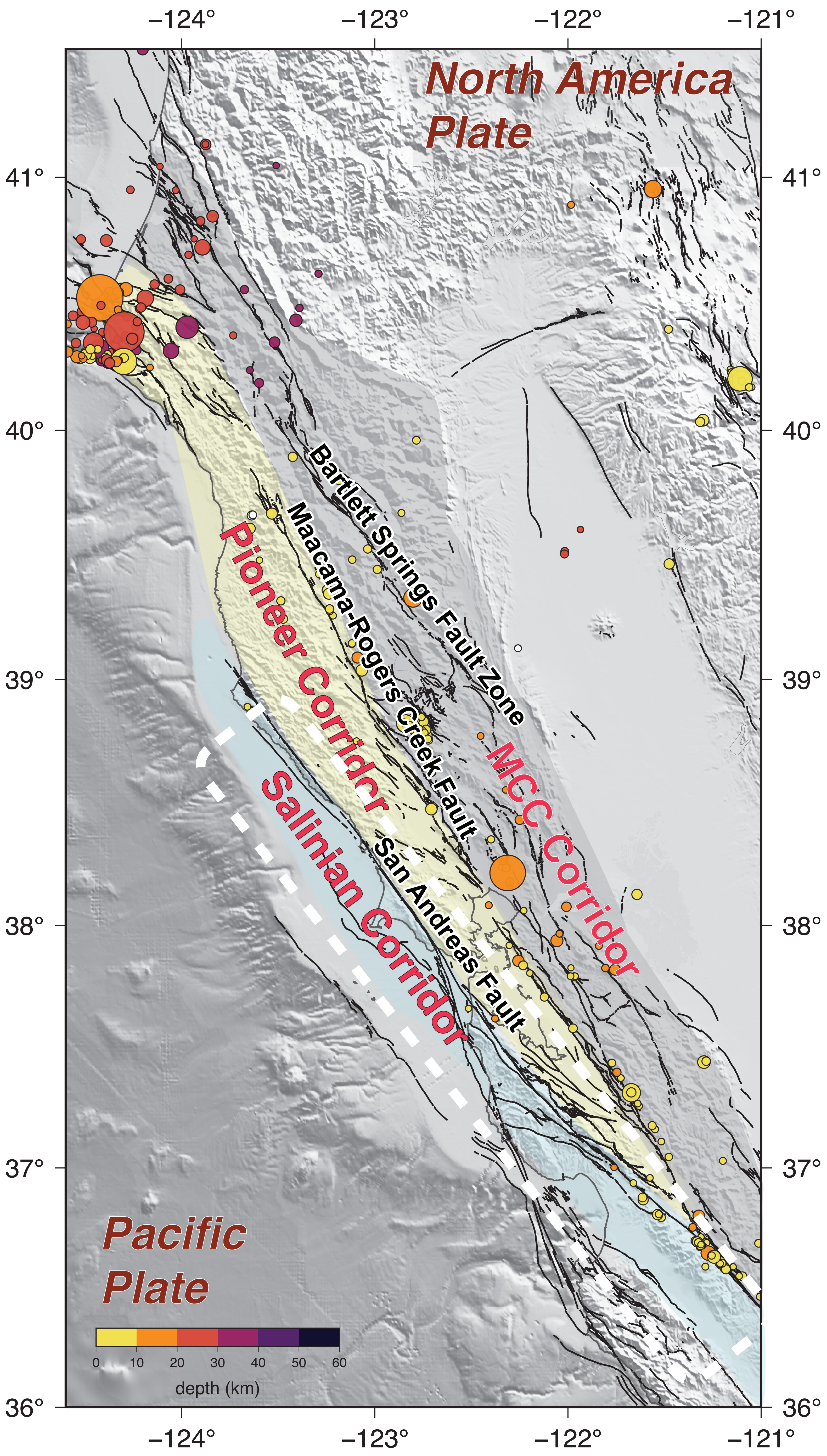
1. *Salinian Corridor: Emplaced Salinian terrane over Pacific Plate - bounded on the East by the San Andreas Fault. T-modifying tectonics as terrane is translated through the Santa Cruz Mtns.*

2. *Pioneer Corridor: Primarily Franciscan terrane (Coastal Belt) along swath transited by the Pioneer Fragment (Pacific Plate). T-modifying tectonics at MTJ (rapid exhumation) and restricted MCC deformation.*

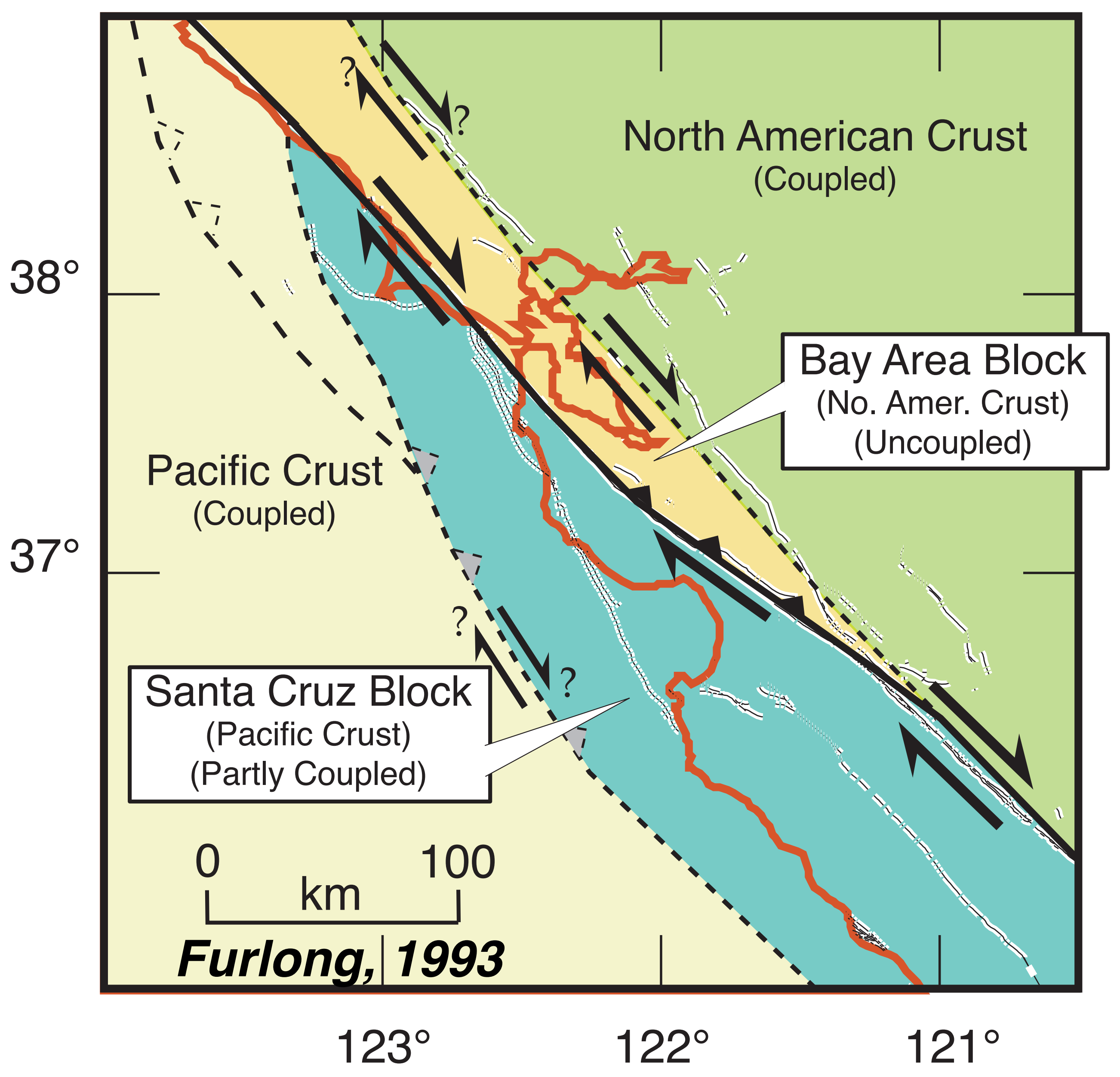
3. *MCC Corridor: Primarily Franciscan terrane (Central and Eastern Belt) associated with slab window tectonics. T-modifying tectonics include transient crustal thickening/thinning and changes in sub-crustal thermal regime.*



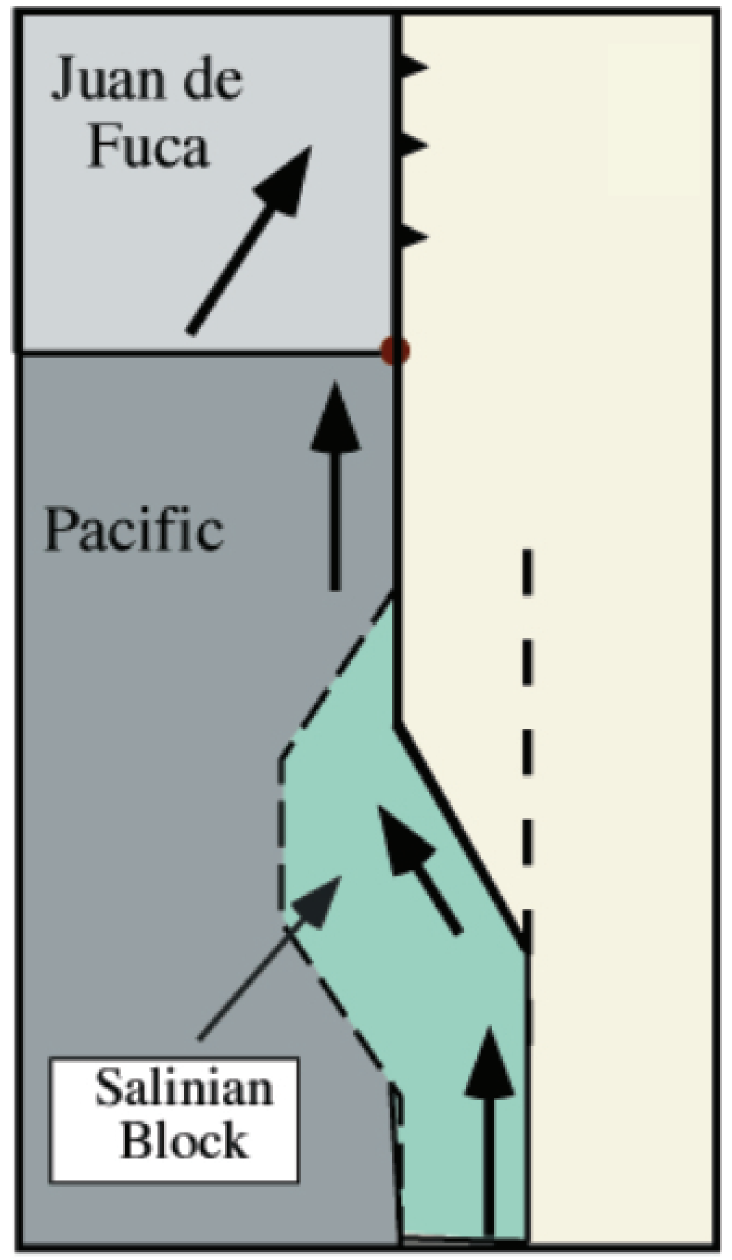
Salinian Corridor Thermal-Tectonic Evolution

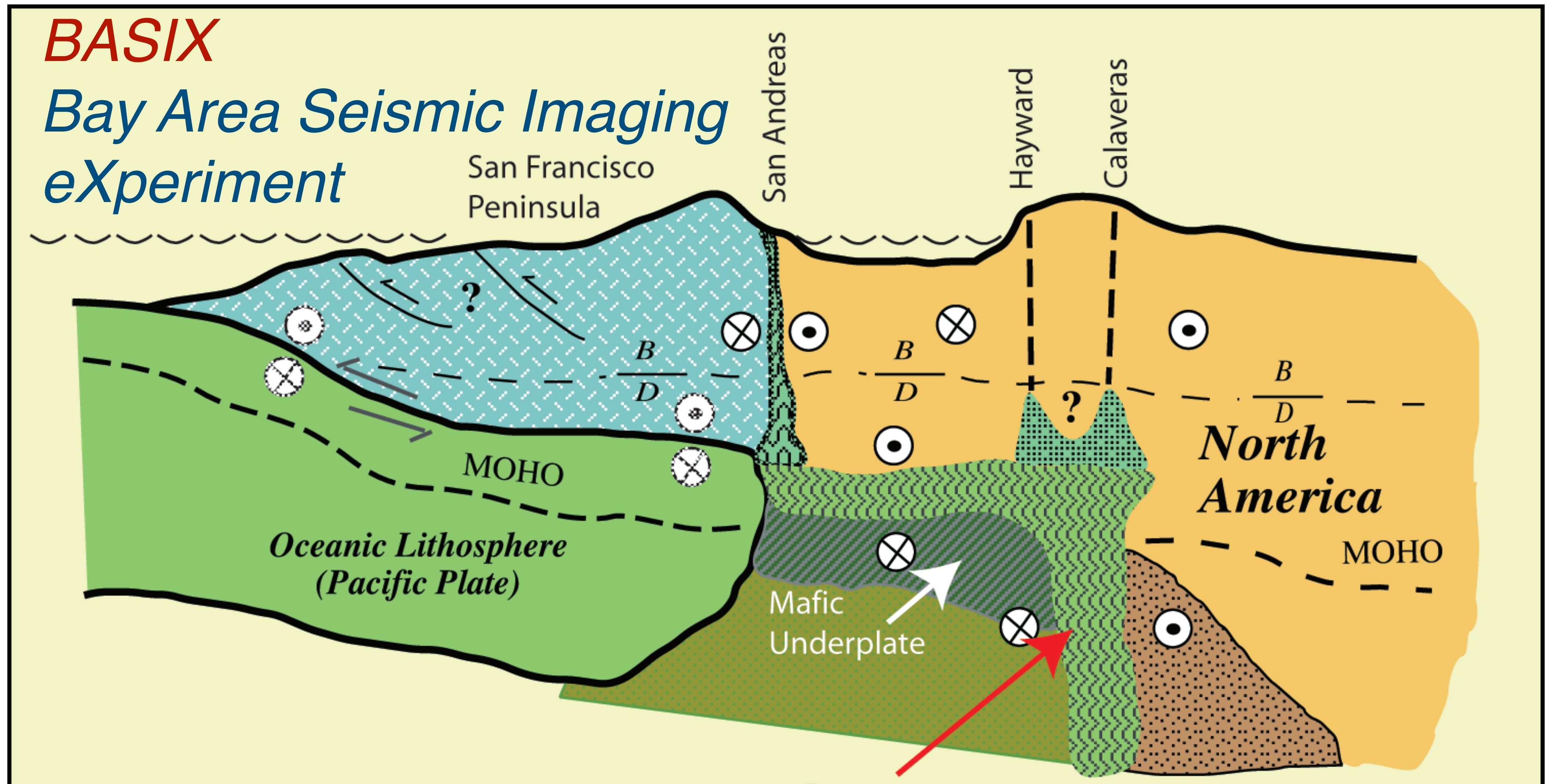


CRUSTAL KINEMATICS



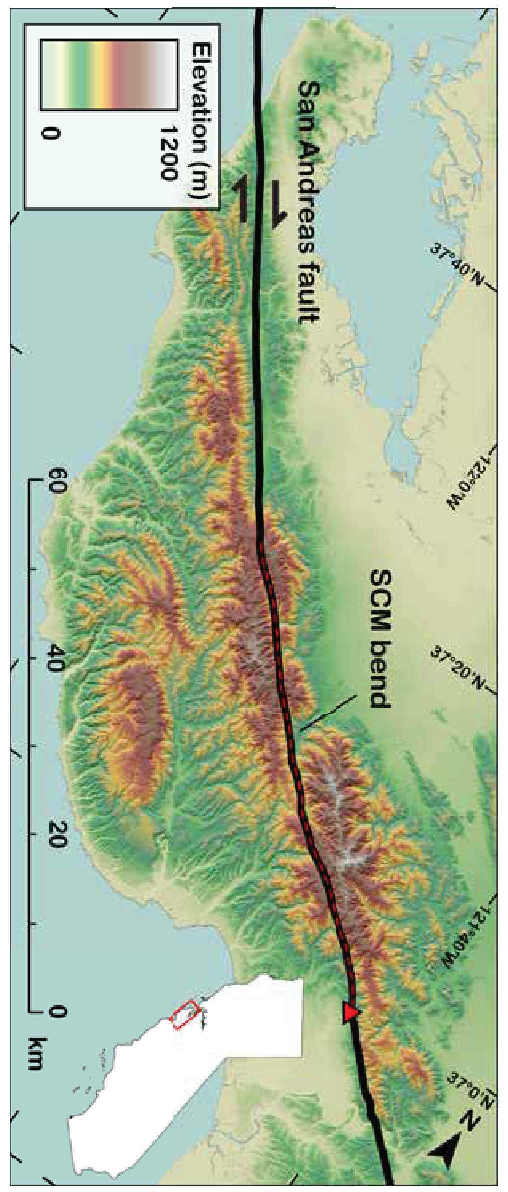
Furlong, 1993



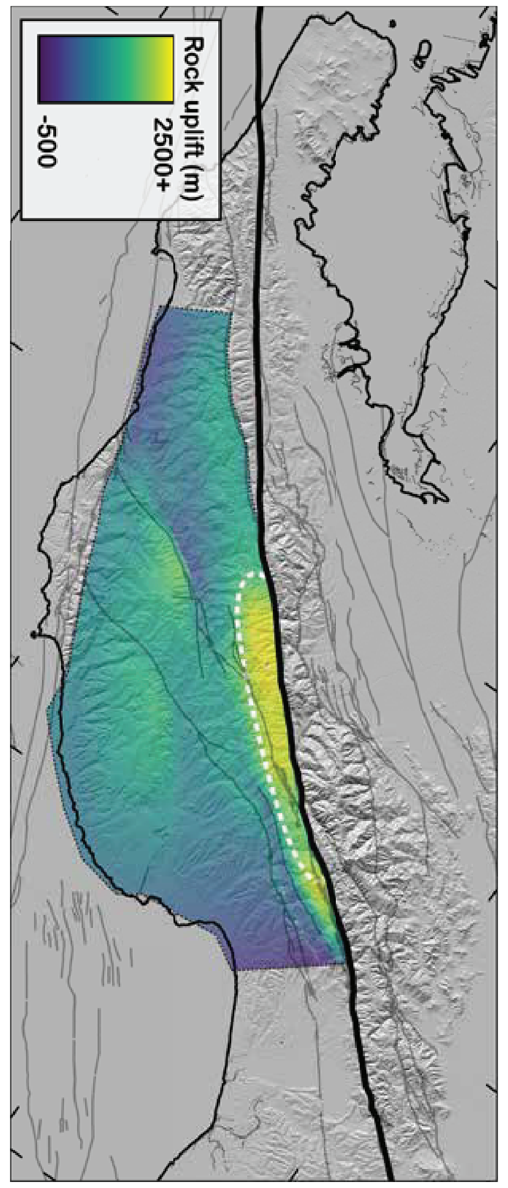


Modified from Brocher et al., 1994

Santa Cruz Mtns. Topography



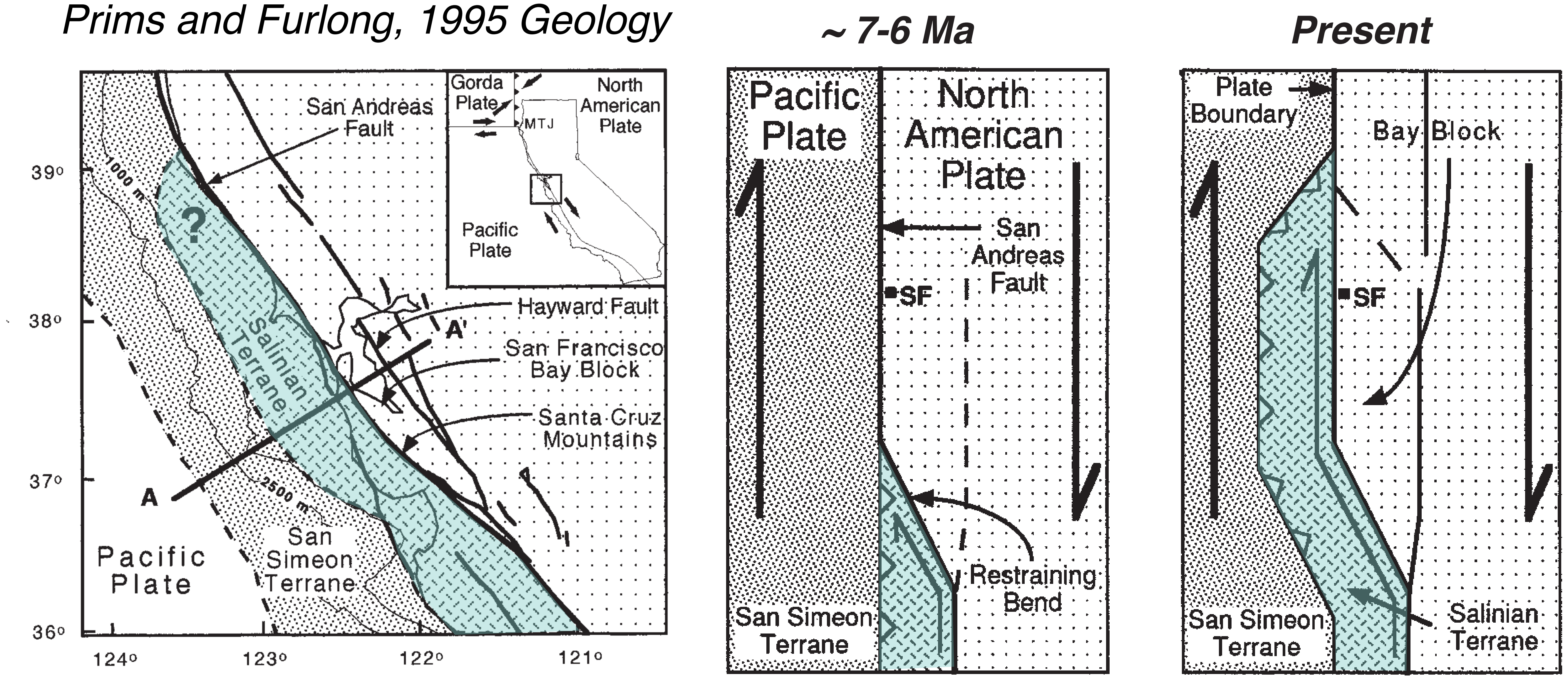
Observed Rock Uplift



Baden et al., 2022 Sci.Adv.

Also: Anderson, 1994

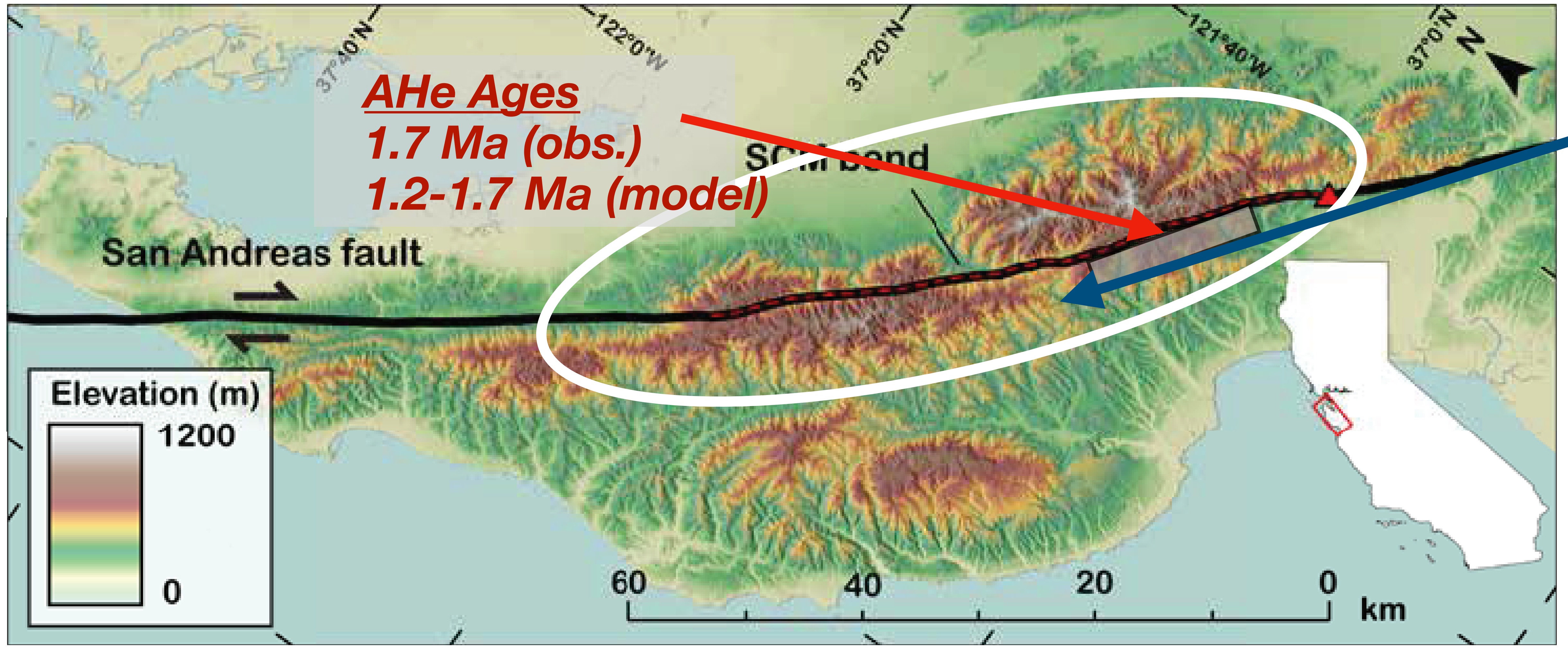
Prims and Furlong, 1995 Geology

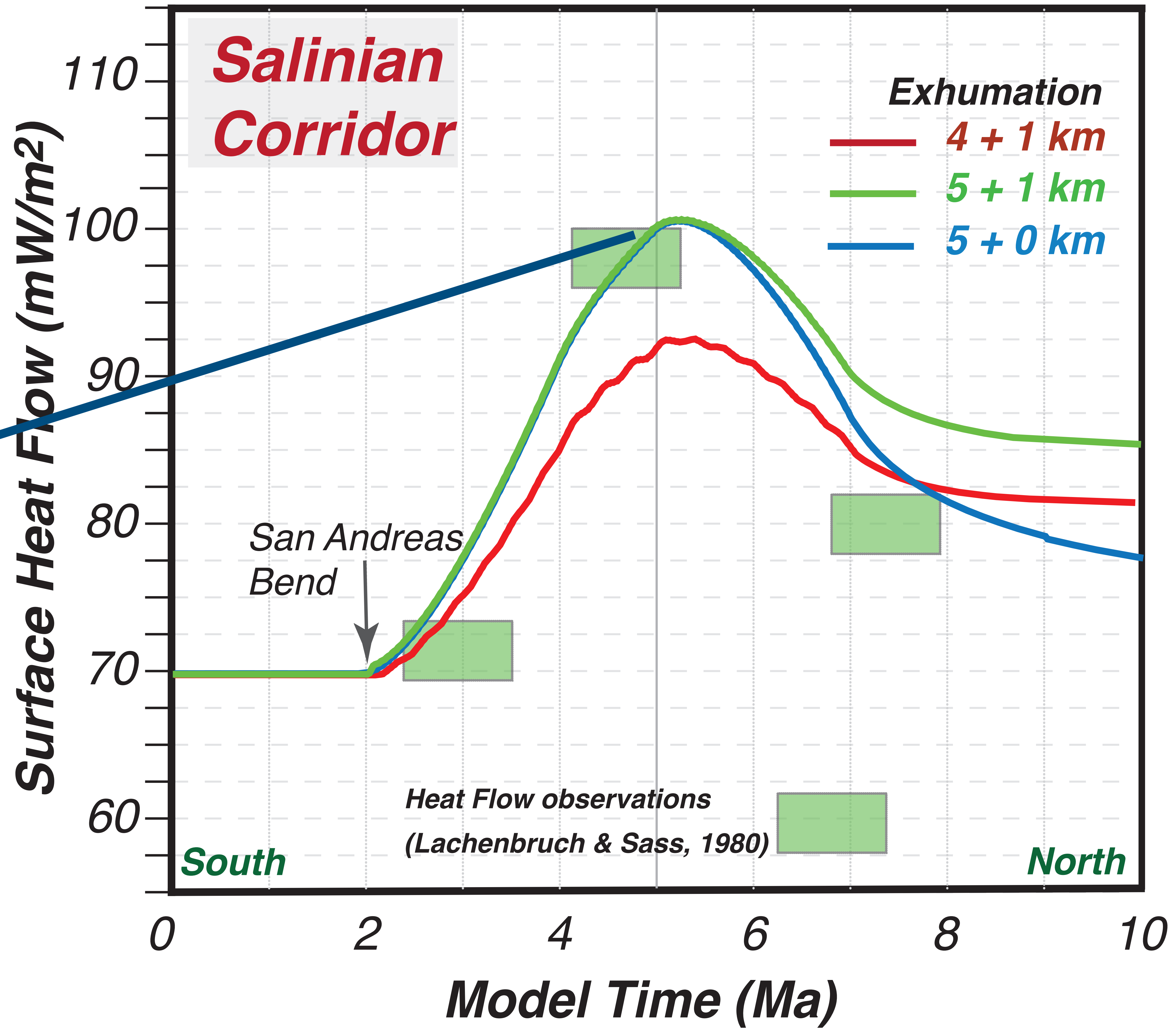


Salinian Corridor Thermal Evolution

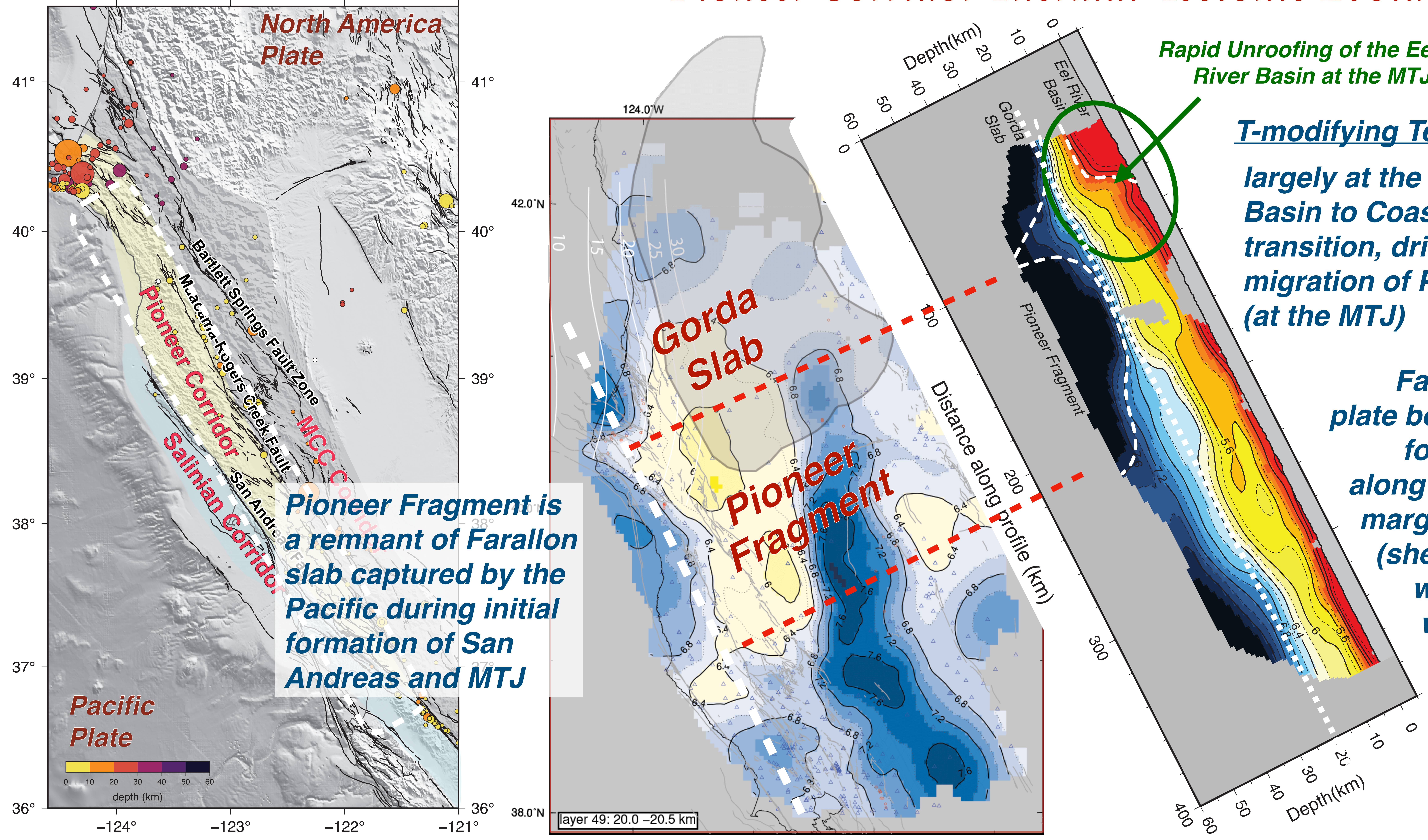
1. Crustal Thickening through restraining bend
2. Exhumation from resulting uplift (3 m.yr.)
3. Slower (no) exhumation north of SF Peninsula

Santa Cruz Mountains topography





Pioneer Corridor Thermal-Tectonic Evolution

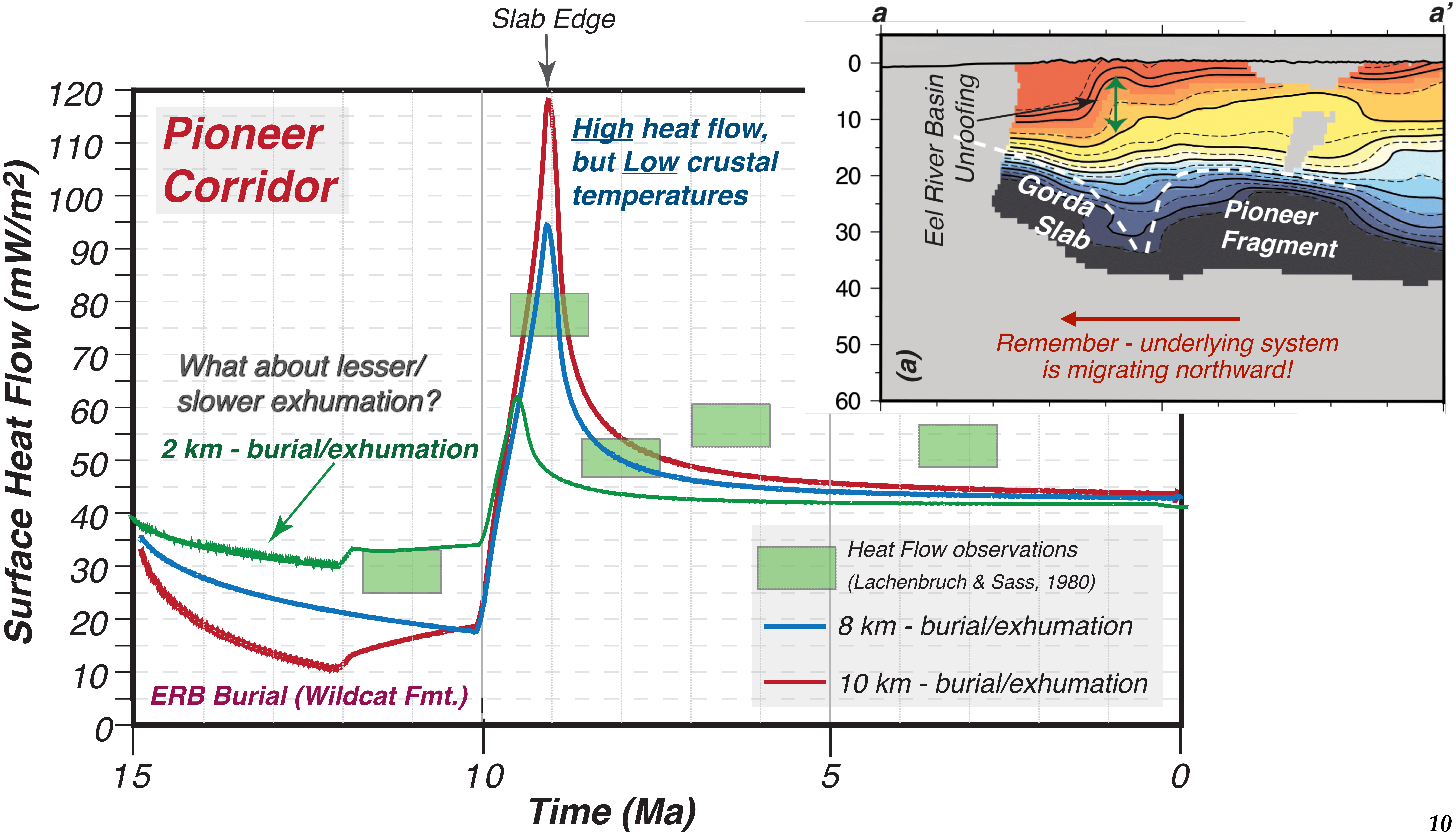


T-modifying Tectonics:

largely at the Eel River Basin to Coastal Belt transition, driven by migration of PF (at the MTJ)

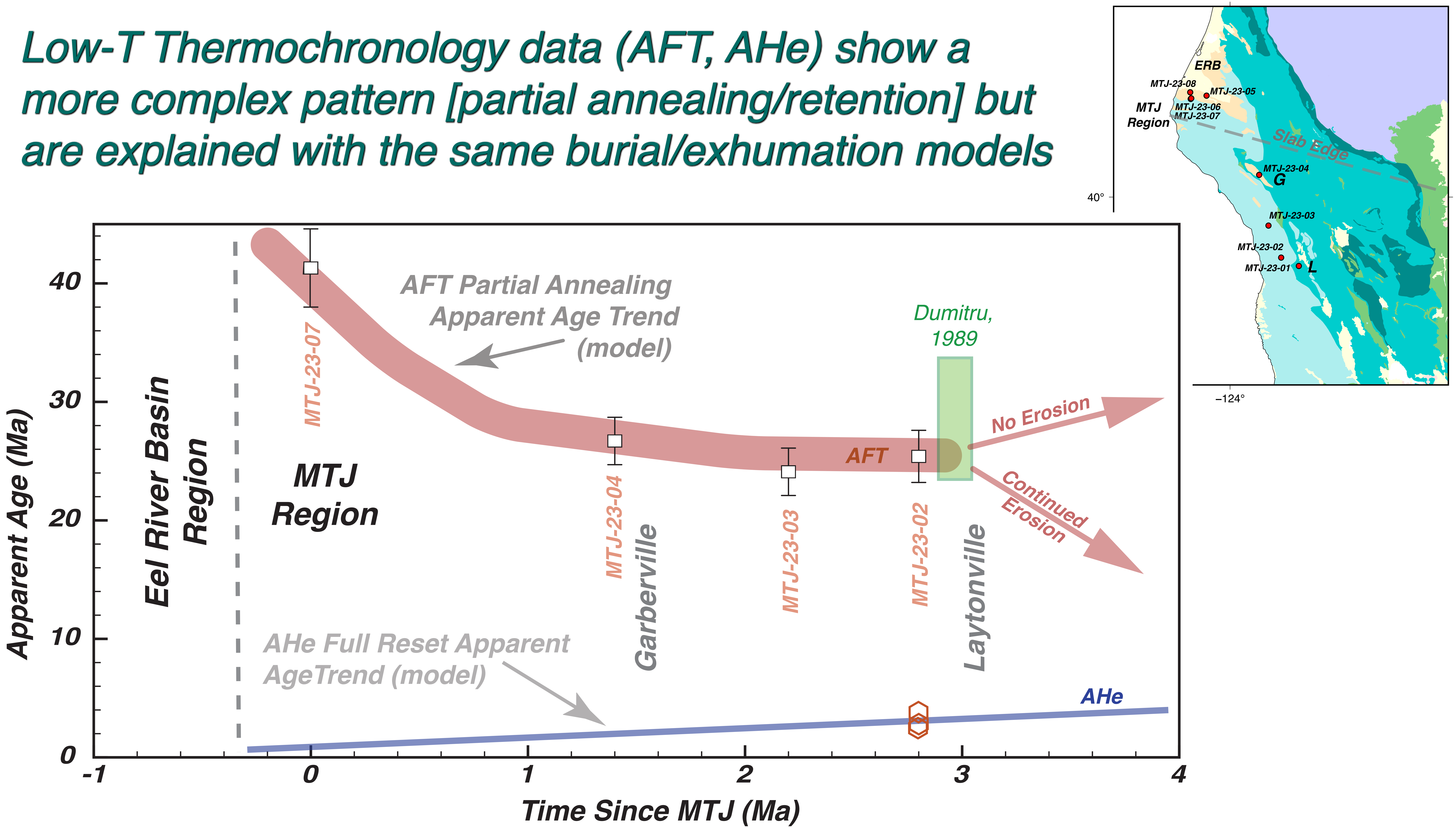
Facilitates plate boundary formation along eastern margin of PF (shear zone with slab window)

Tomography from Furlong et al. 2024, Tectonics

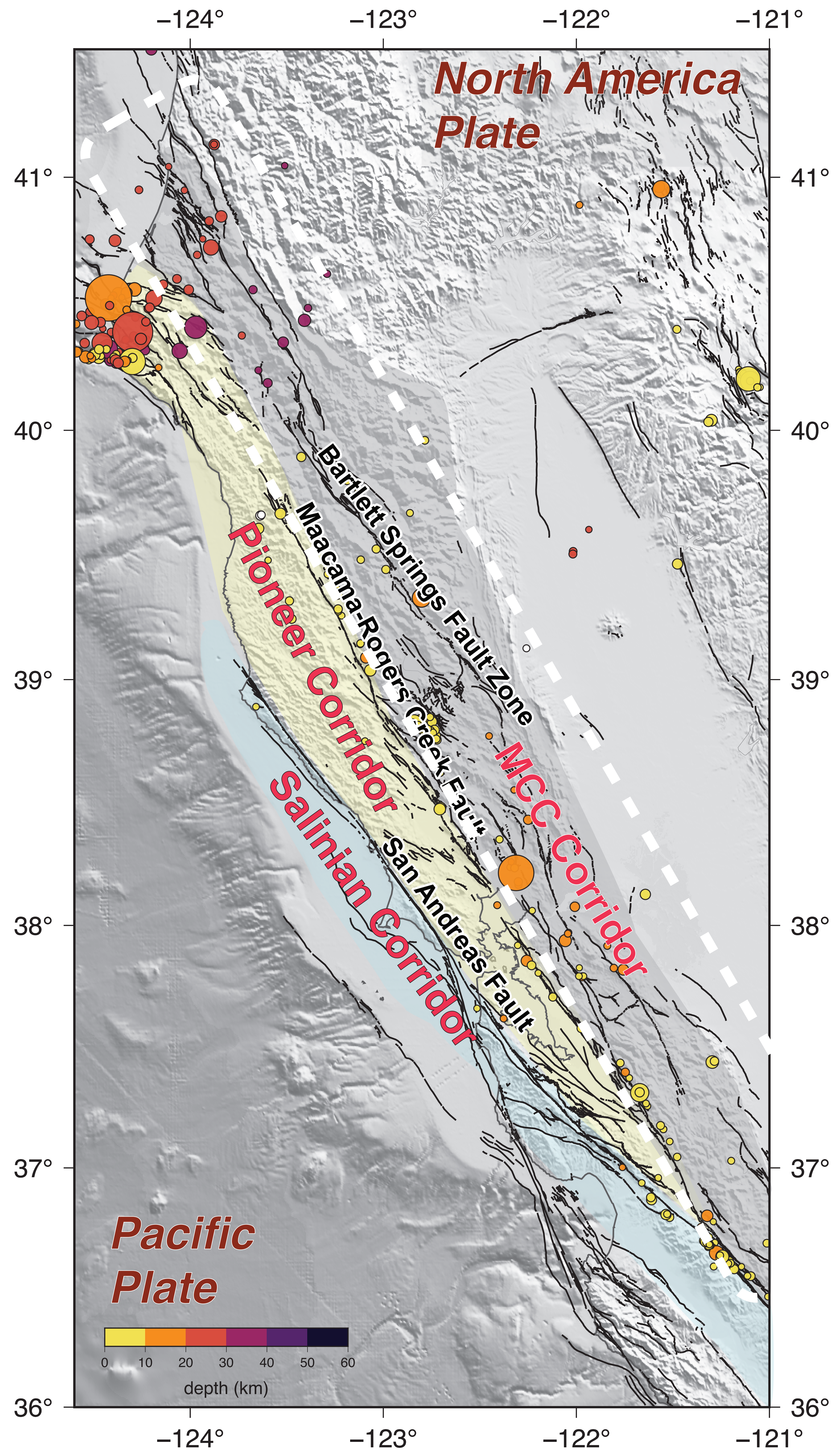


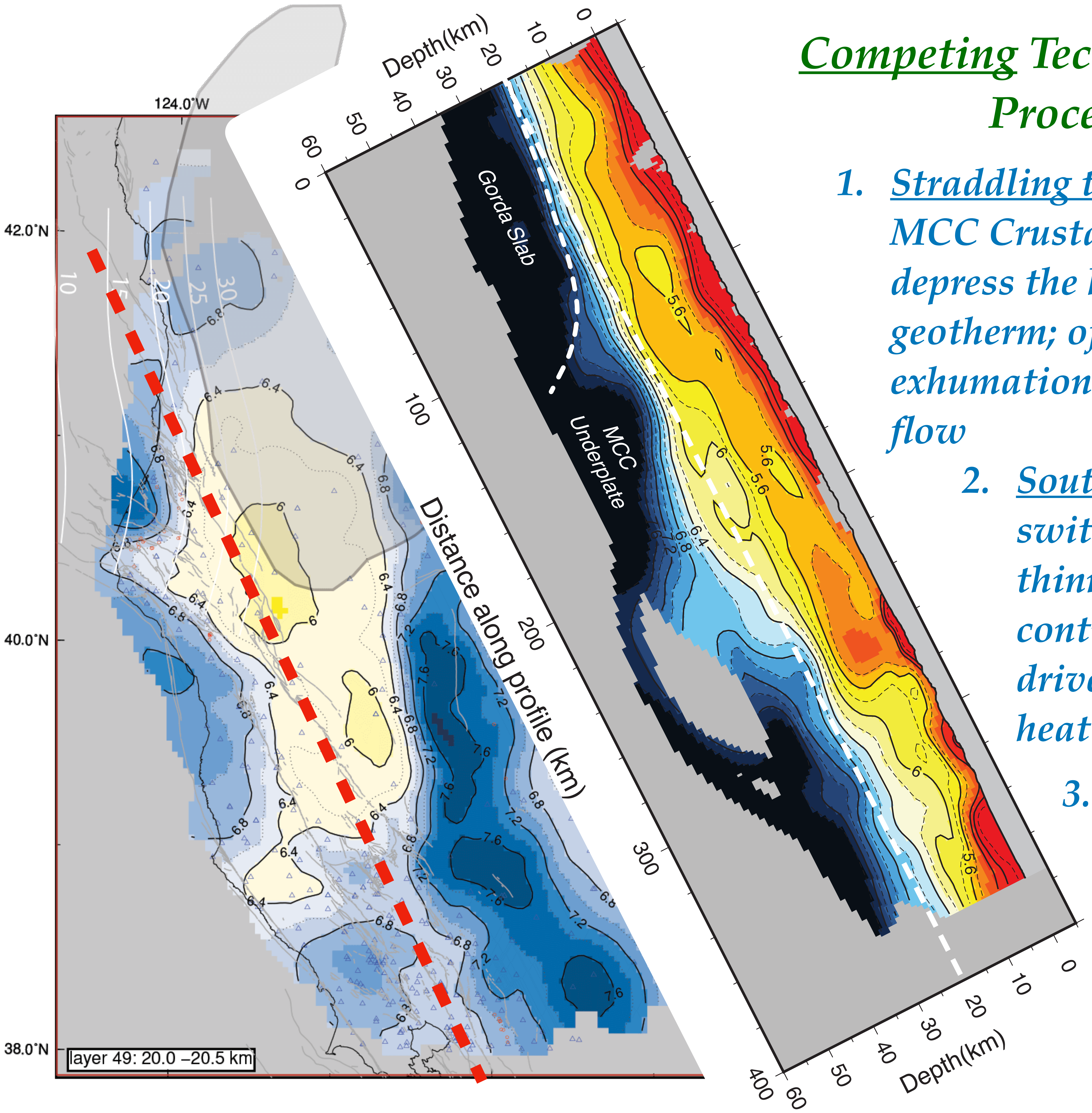
Slab Edge
Pioneer Corridor
High heat flow, but Low crustal temperatures
What about lesser/ slower exhumation?
2 km - burial/exhumation
ERB Burial (Wildcat Fmt.)
Heat Flow observations (Lachenbruch & Sass, 1980)
8 km - burial/exhumation
10 km - burial/exhumation
Surface Heat Flow (mW/m²)
Time (Ma)
a
a'
Eel River Basin Unroofing
Gorda Slab
Pioneer Fragment
(a)
Remember - underlying system is migrating northward!

Low-T Thermochronology data (AFT, AHe) show a more complex pattern [partial annealing/retention] but are explained with the same burial/exhumation models



MCC Corridor Thermal-Tectonic Evolution

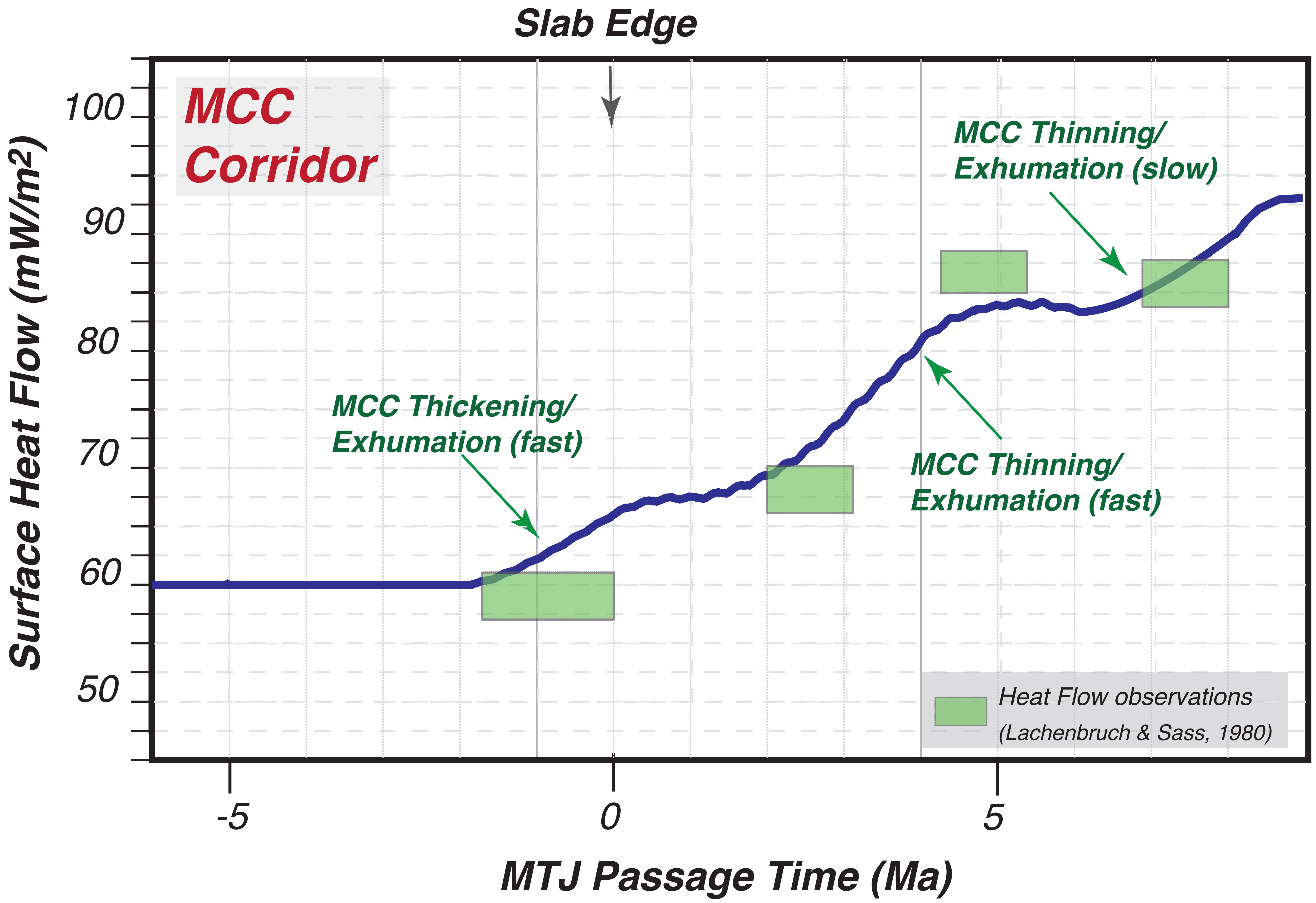


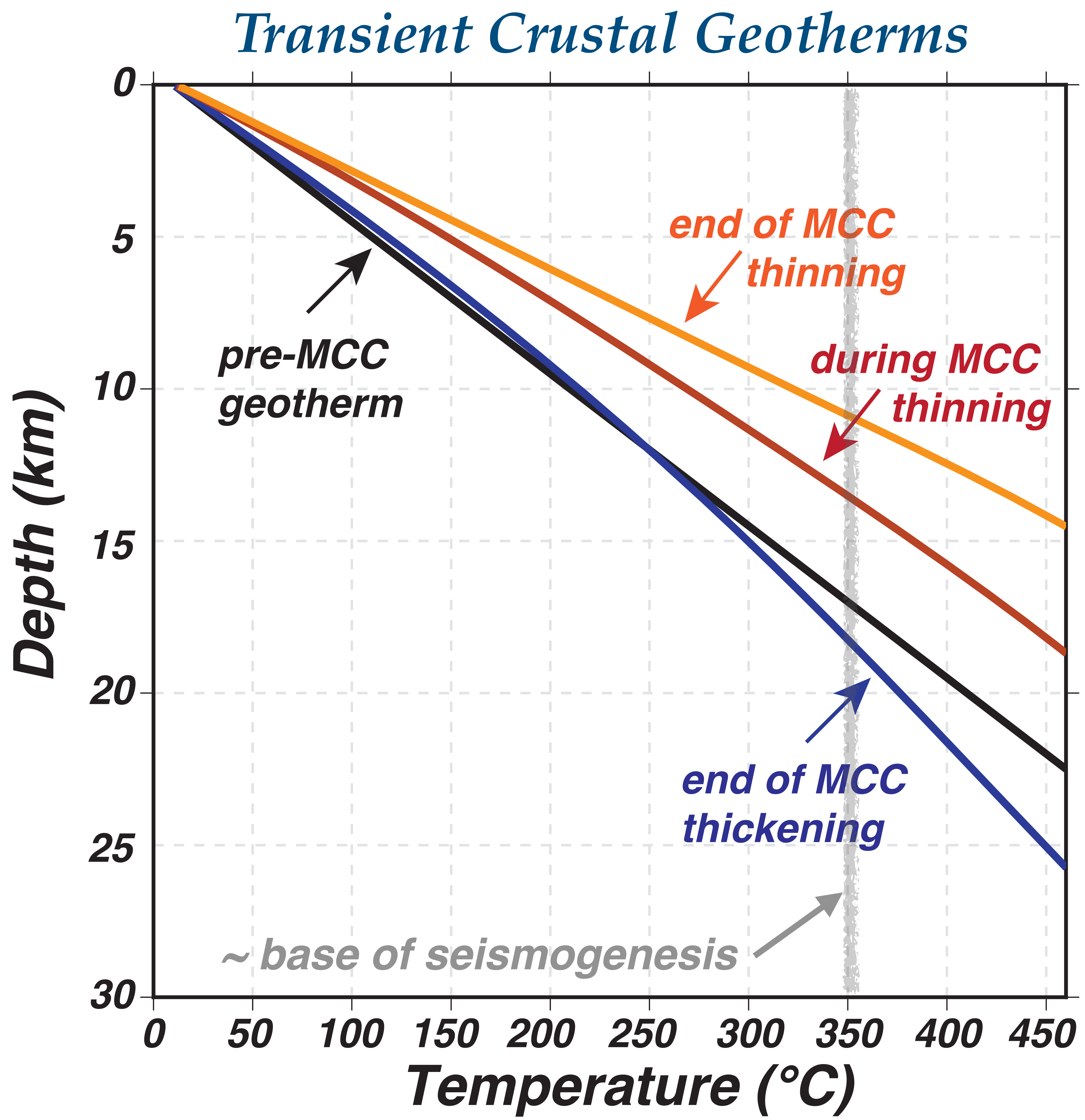


Competing Tectono-Thermal Processes

1. **Straddling the MTJ Region:** MCC Crustal Thickening will depress the heat flow and geotherm; offset by effects of exhumation increasing heat flow
2. **South of MTJ:** MCC switch to crustal thinning coupled with continued exhumation drives rapid increase in heat flow
3. **Further South :** MCC Thinning declines and exhumation slows down - decrease in heat flow increase rate.

MCC Corridor Thermal-Tectonic Evolution





1. Along MCC Corridor the 'thermal' competition between crustal thickening/thinning and elevation/relief driven exhumation produces a complex thermal regime both spatially and with depth
2. Can have a large effect on crustal rheology, seismogenic depth, and crustal metamorphism

Active Tectonics and the Thermal Structure of Northern California

1. *An ~ 200 km wide swath along the Pacific-North America plate boundary undergoes T-modifying tectonics as the plate boundary develops*

2. *Thermal perturbations are significant, producing spatial and temporal T contrasts affecting crustal rheology, seismicity, petrology…*

3. *Tectonics are getting better understood allowing improved estimates of T-structure and it evolution - critical to incorporating active tectonic processes in our analyses*

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