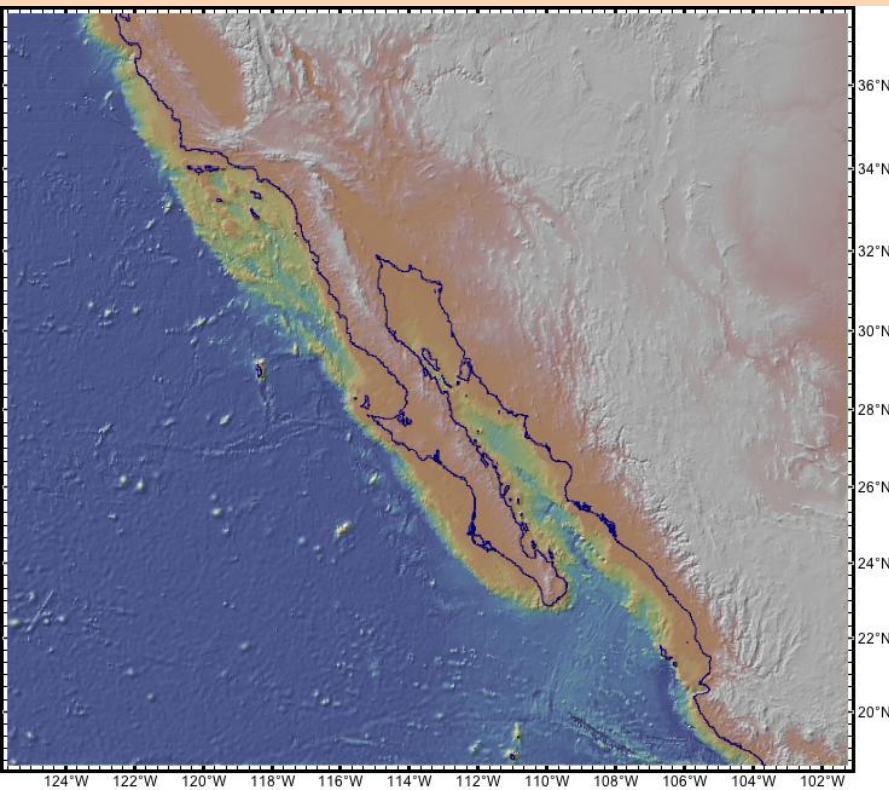


# "Variations in Faulting in the Gulf of California – Salton trough plate boundary"

Paul Umhoefer – Northern Arizona University

NSF support for Gulf of California, Basin and Range



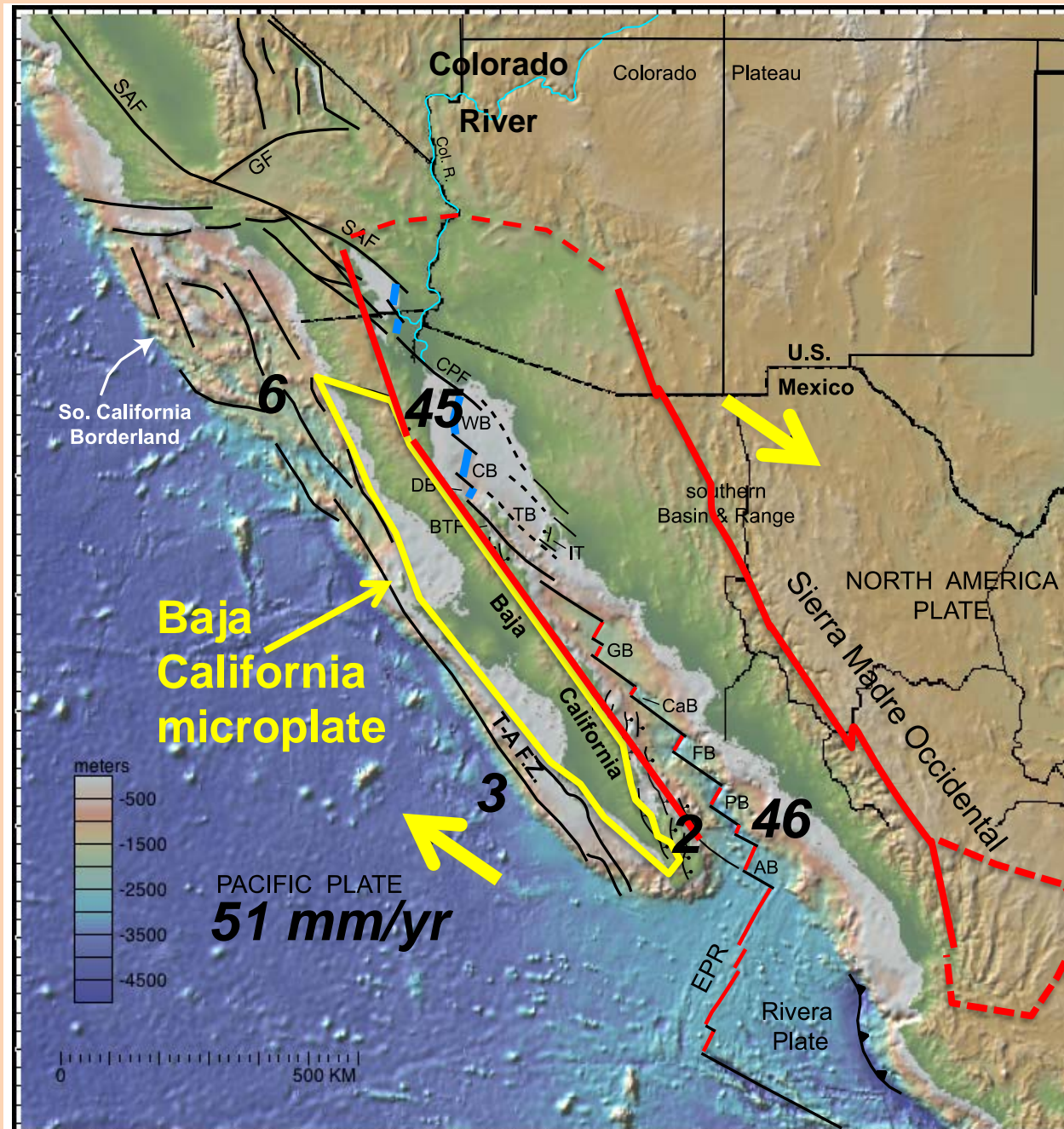
## PREMISE:

*4 main parameters lead to Fault Variability and complexity:*

- 1) Inherited Structures
- 2) Strain Partitioning
- 3) Variable Angle of Obliquity
- 4) Role of Sediment input

# Background on Gulf of California setting:

- long lived convergent margin
- oblique divergent (rift angle  $20^\circ$  &  $30^\circ - 35^\circ$ )
- moderately fast plate motions  
=  $\sim 50$  mm/yr Since 6 Ma  
= slower before
- wide rift on east; narrow on west
- **southern** = sea-floor spreading
- **northern** = localized to diffuse:  
no sea-floor spreading
- **new seaway** by 8 Ma in south  
by 6.3 Ma in north  
(Oskin and Stock, 2001)
- **Colorado River** since 5.3 Ma  
(Dorsey et al 2007; 2010)

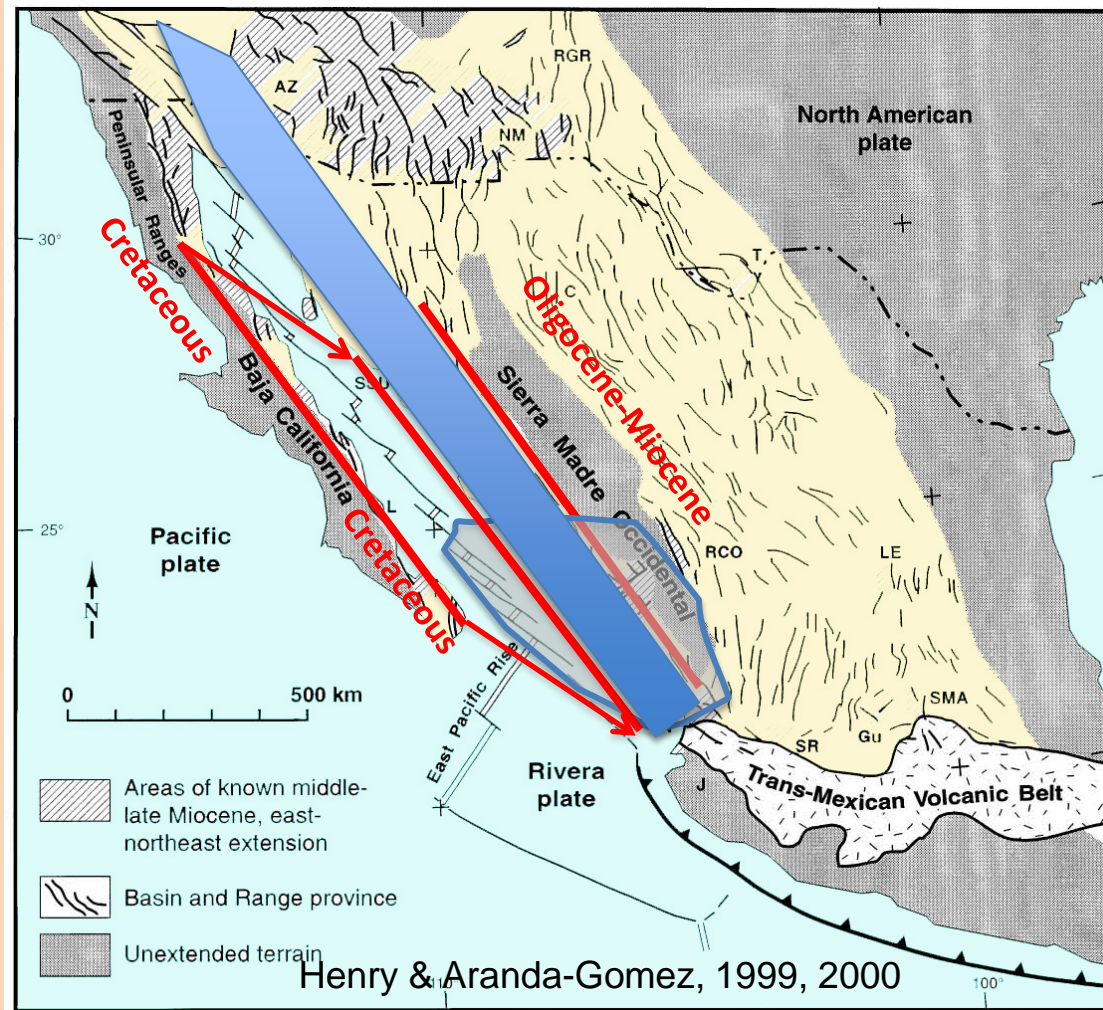
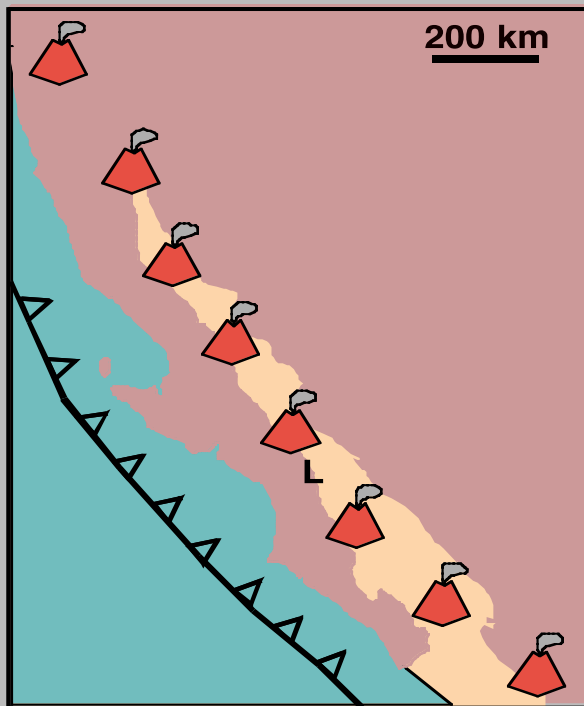


# 1) Inherited Structures

## WHY LOCATION OF GULF?

- 1) West edge Basin & Range  
25 – 12 Ma extension
- 1) Along Miocene Arc

## Volcanic arc 19 – 12 Ma



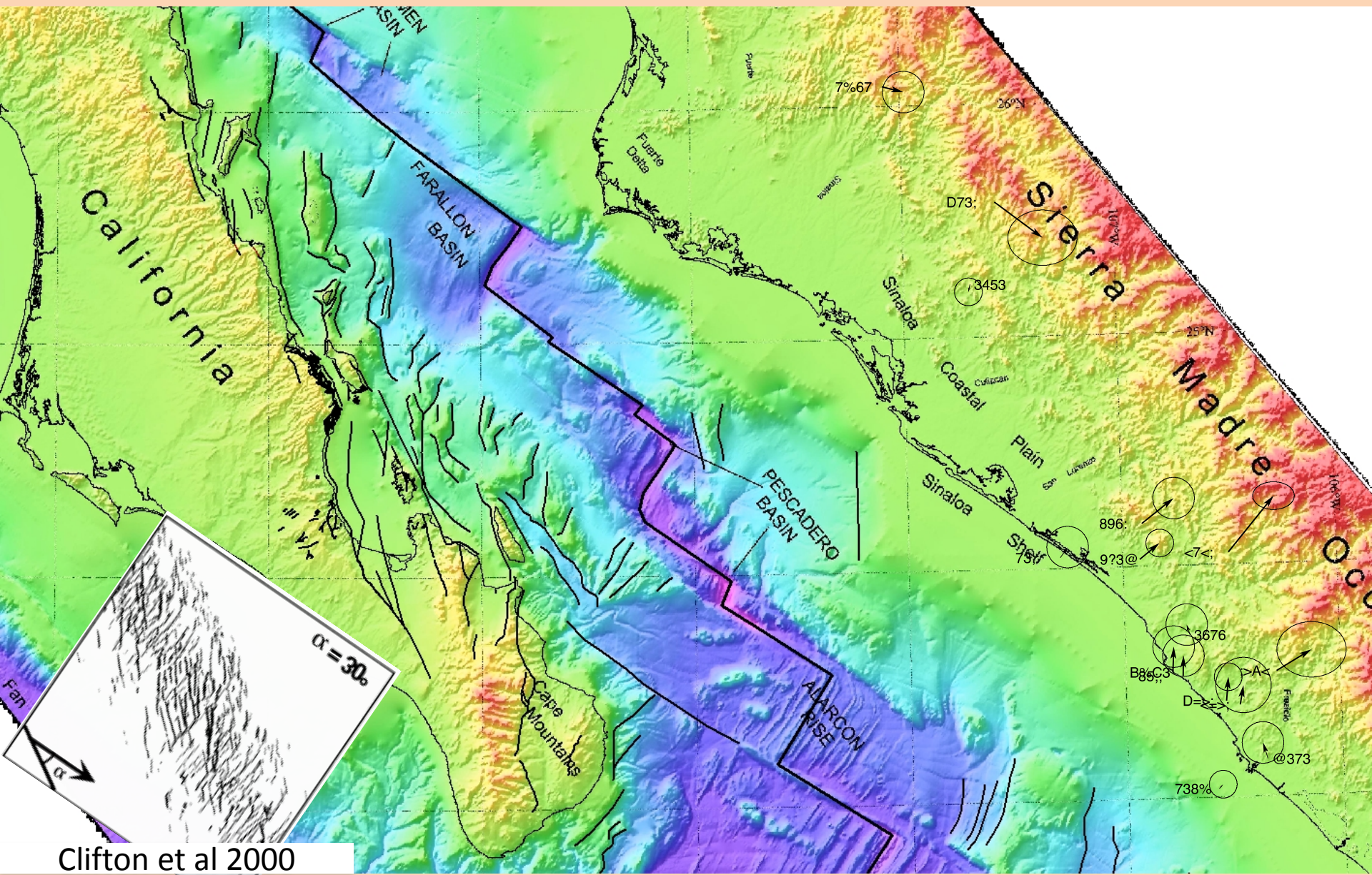
## 3) Between batholiths

\*\* Cretaceous batholith on Baja California

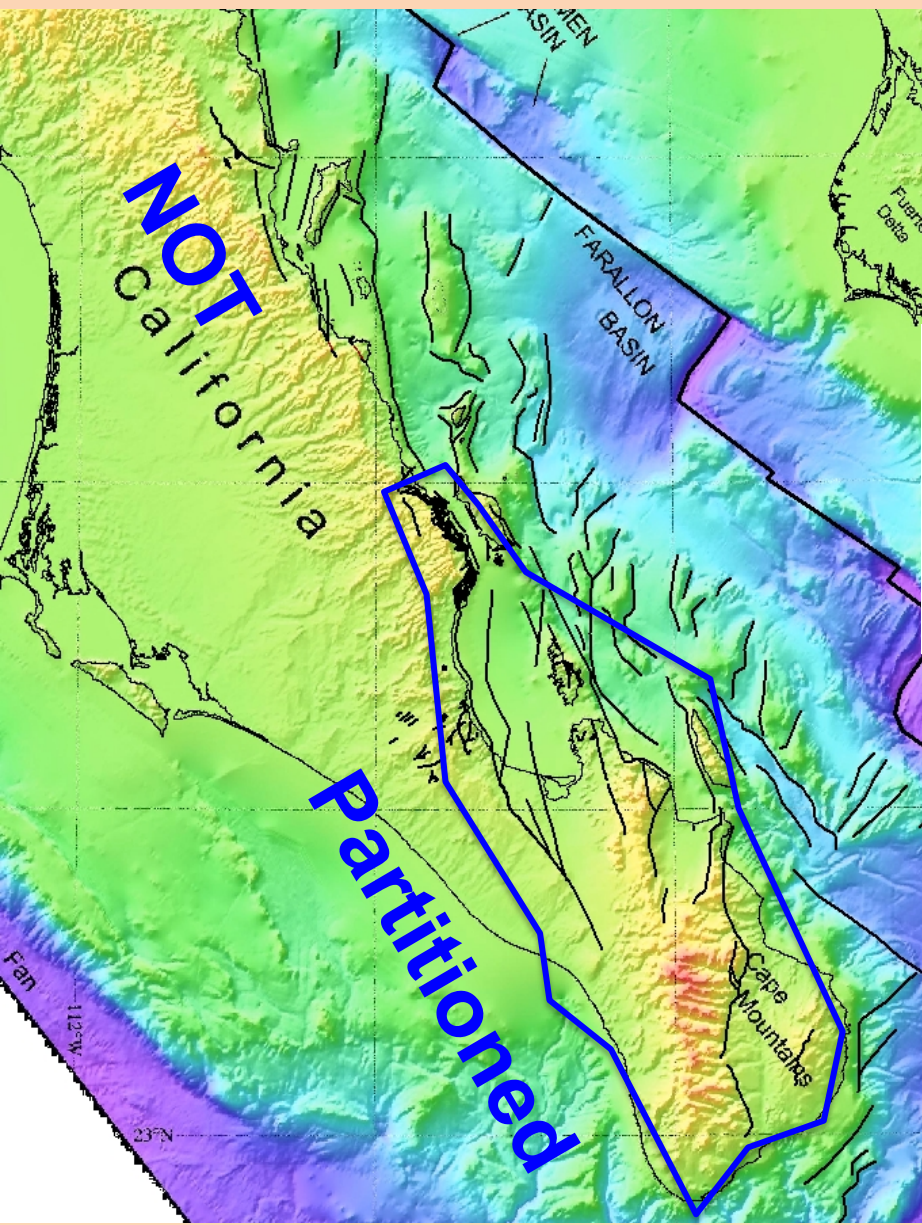
\*\* Oligocene batholith under Sierra Madre Occidental  
AND southern Gulf of California:

*Did depleted and dry mantle resist deformation & melting?*

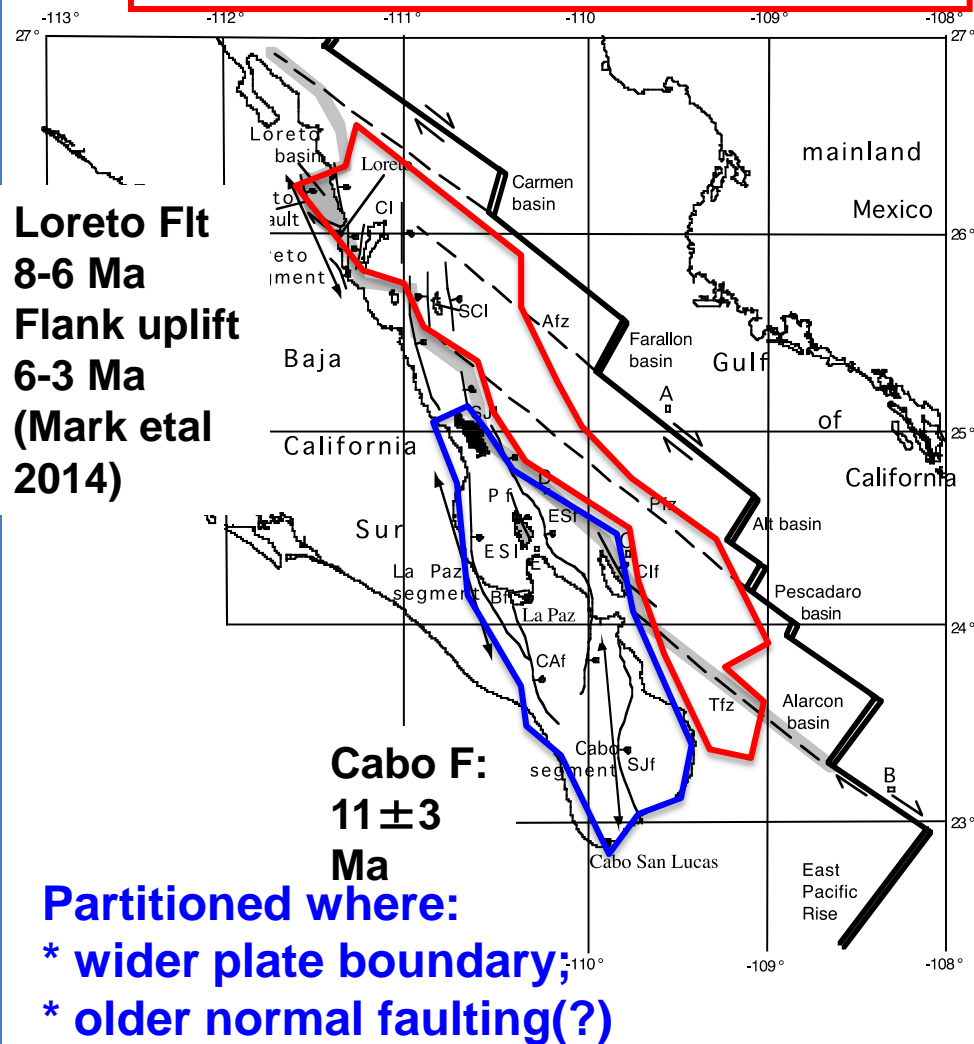
## 2) Strain Partitioning



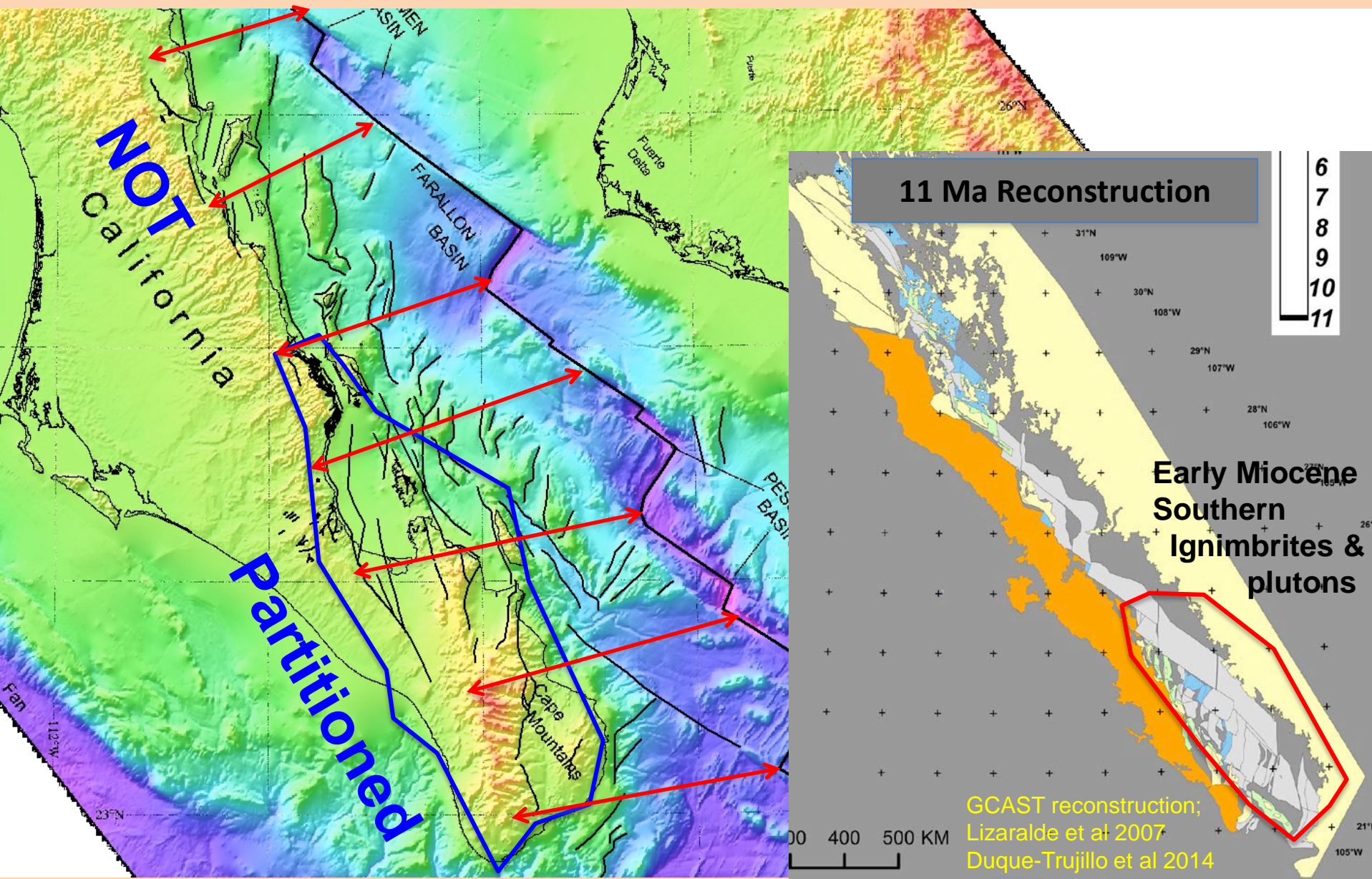
## 2) Strain Partitioning – Why partitioning??



**Walker Lane like transtensional faulting along non-partitioned belt**



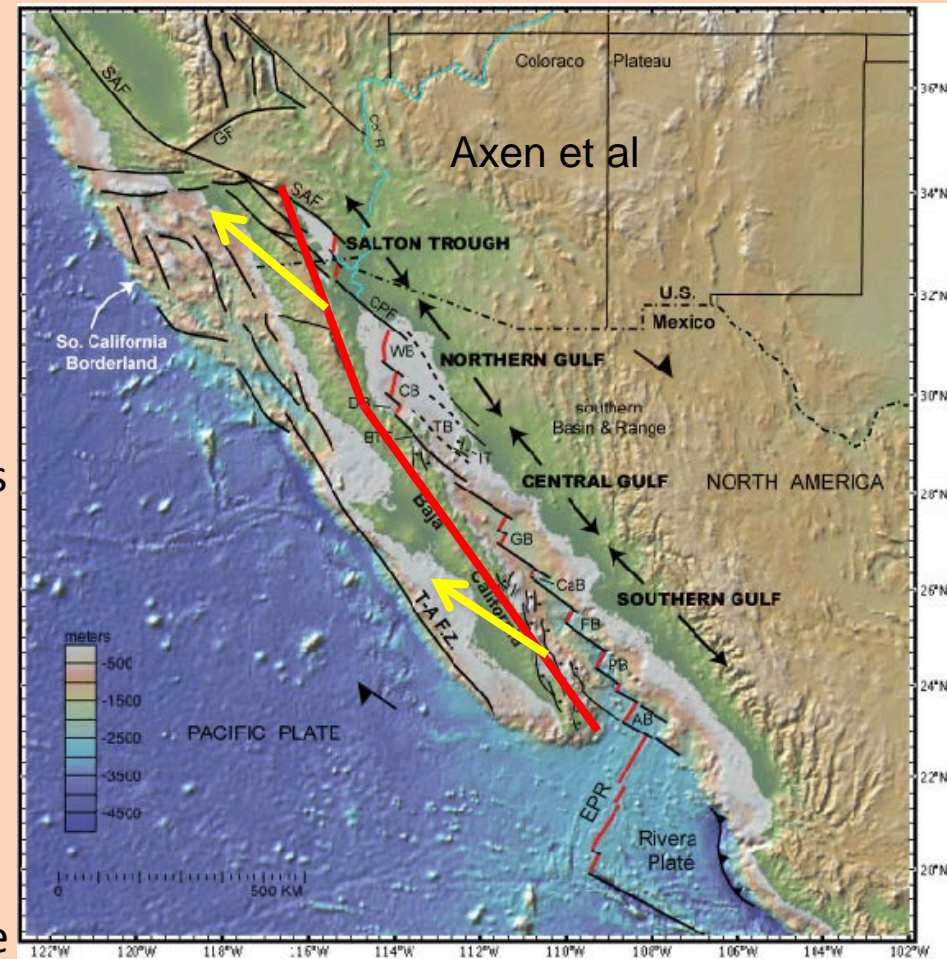
## 2) Strain Partitioning



### 3) Variable Angle of Obliquity of plate margin (rift angle)

## ROLE OF STRIKE-SLIP FAULTING & DETACHMENT FAULTING:

- Southern Gulf
  - wrench dominated =  $20^\circ$  rift angle
  - = transtensional basins & strike-slip faults
  - began as strike-slip faults & pull-apart basins
- Northern Gulf – Salton trough
  - extension dominated =  $30-35^\circ$  rift angle
  - major detachment faults
  - (Axen & Fletcher 1998; Martin et al 2013)
  - wider boundary north of Baja Cal Microplate



# 4) Role of Sediment input

Vast differences N to S along Gulf of California

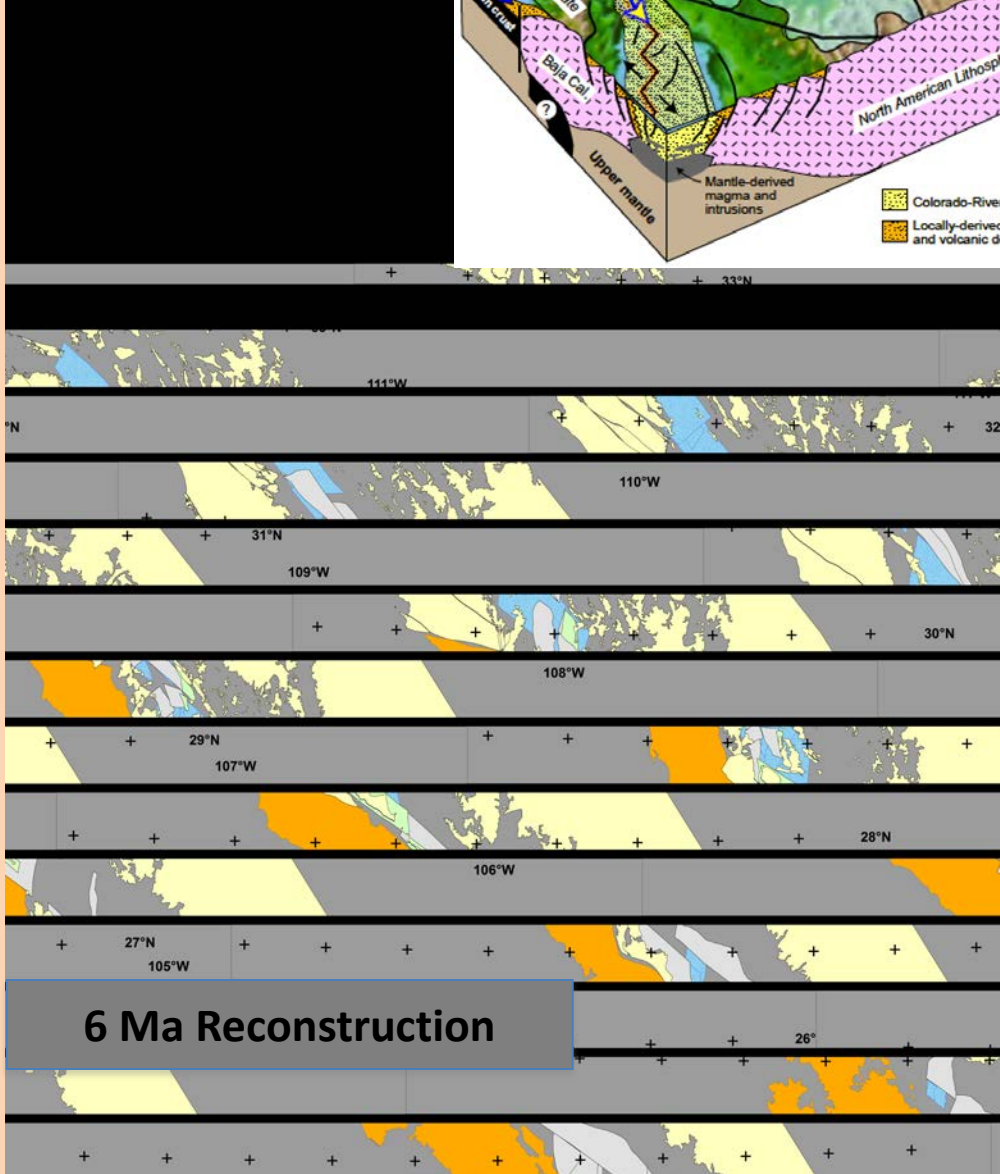
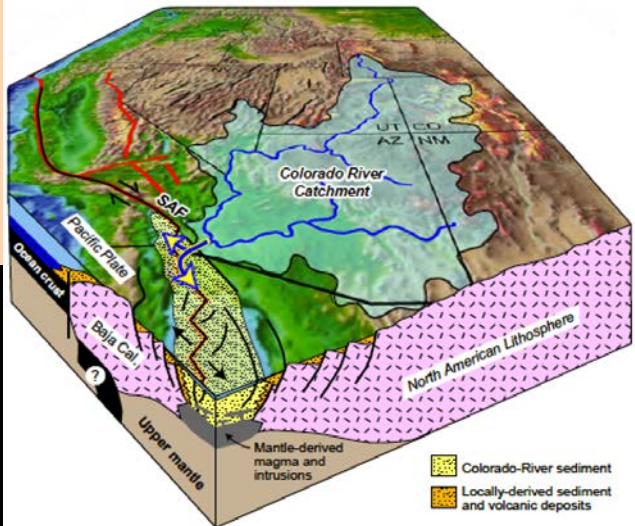
Colorado River prevents or delays sea floor spreading

**Northern Gulf =** narrow rift at 6 Ma  
Evolves to detachment faults,  
Lower crustal flow;

all below widening upper crust of Colorado River sediments

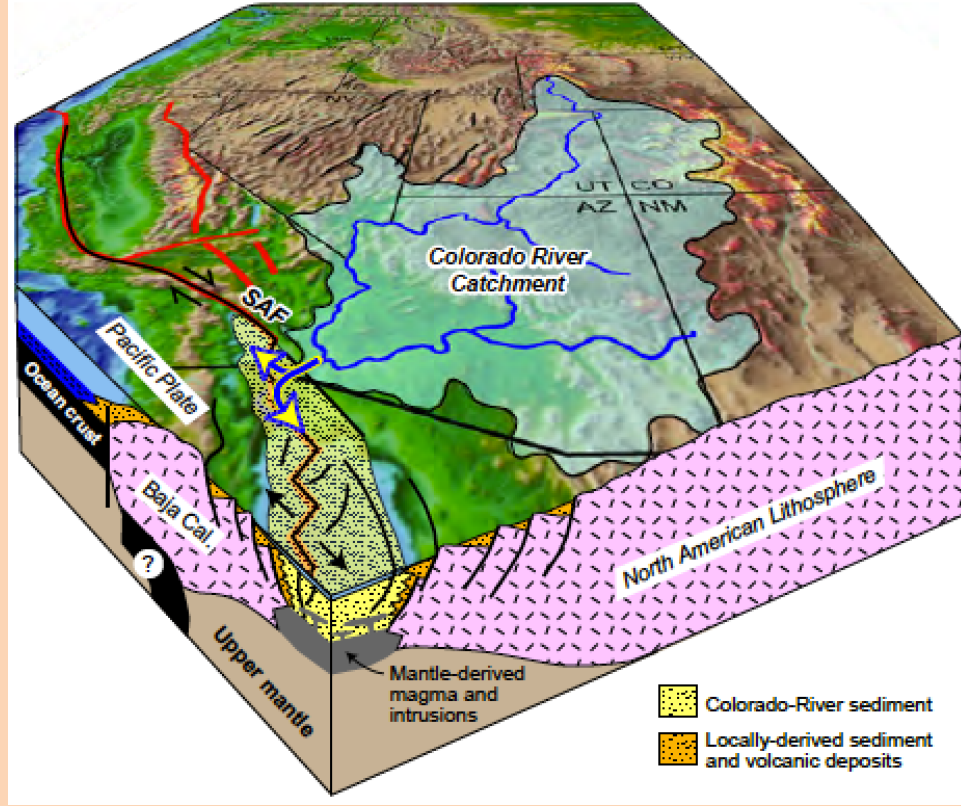
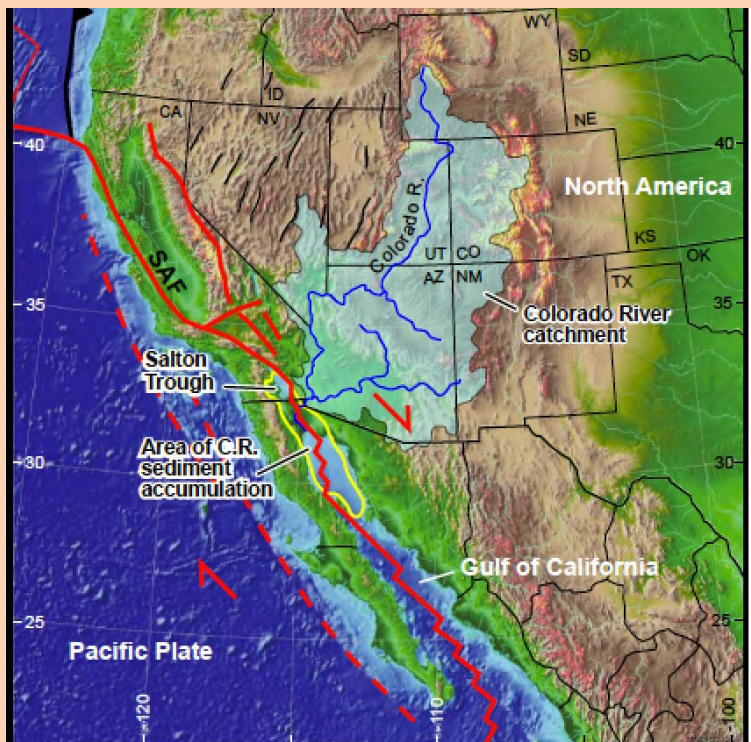
**Southern Gulf =**  
Starved to semi-starved;

rapidly ruptured lithosphere evolved to sea-floor spreading

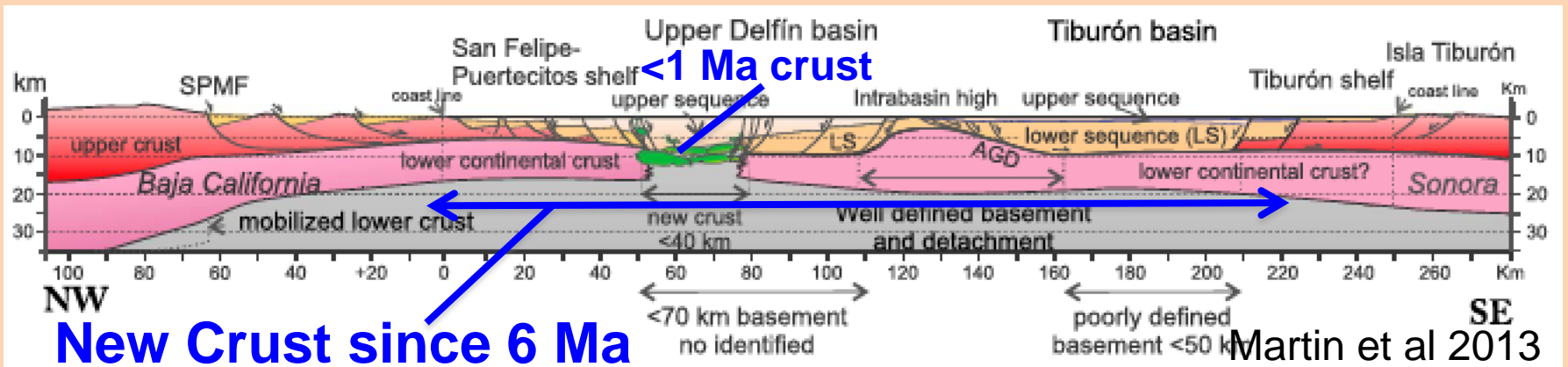




# 4) Role of Sediment input



Dorsey 2010



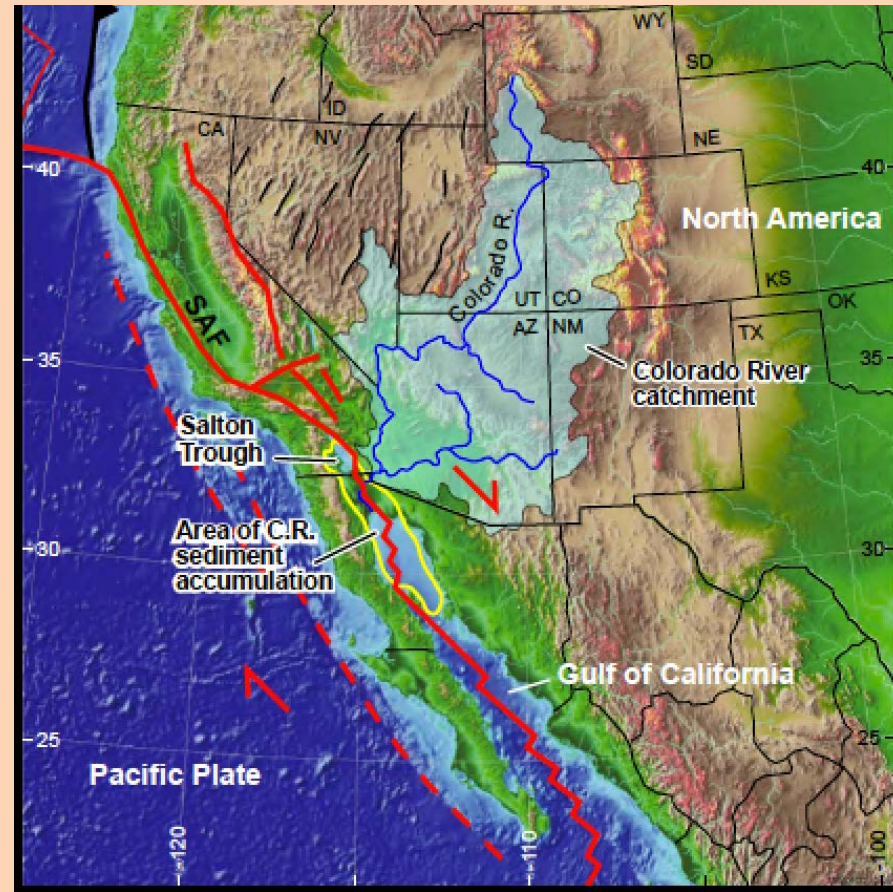
Martin et al 2013

# CONCLUSIONS I:

4 main parameters lead to Fault variability & complexity along the Gulf of California – Salton trough:

(are these universal traits?)

- 1) Inherited Structures
- 2) Strain Partitioning
- 3) Variable Angle of Obliquity
- 4) Role of Sediment input



# CONCLUSIONS II:

- Oblique-divergent boundaries variable on rift domain scale (many 10's km to few 100 km)
- Are magmatism, obliquity, and overall strain rate the fundamental parameters of variability between rifts?
- Along strike variability sets up natural experiments for testing controls on processes.

