The Effects of Rapid Sedimentation upon Continental Breakup:

Seismic imaging and thermal modeling of the Salton Trough, Southern California

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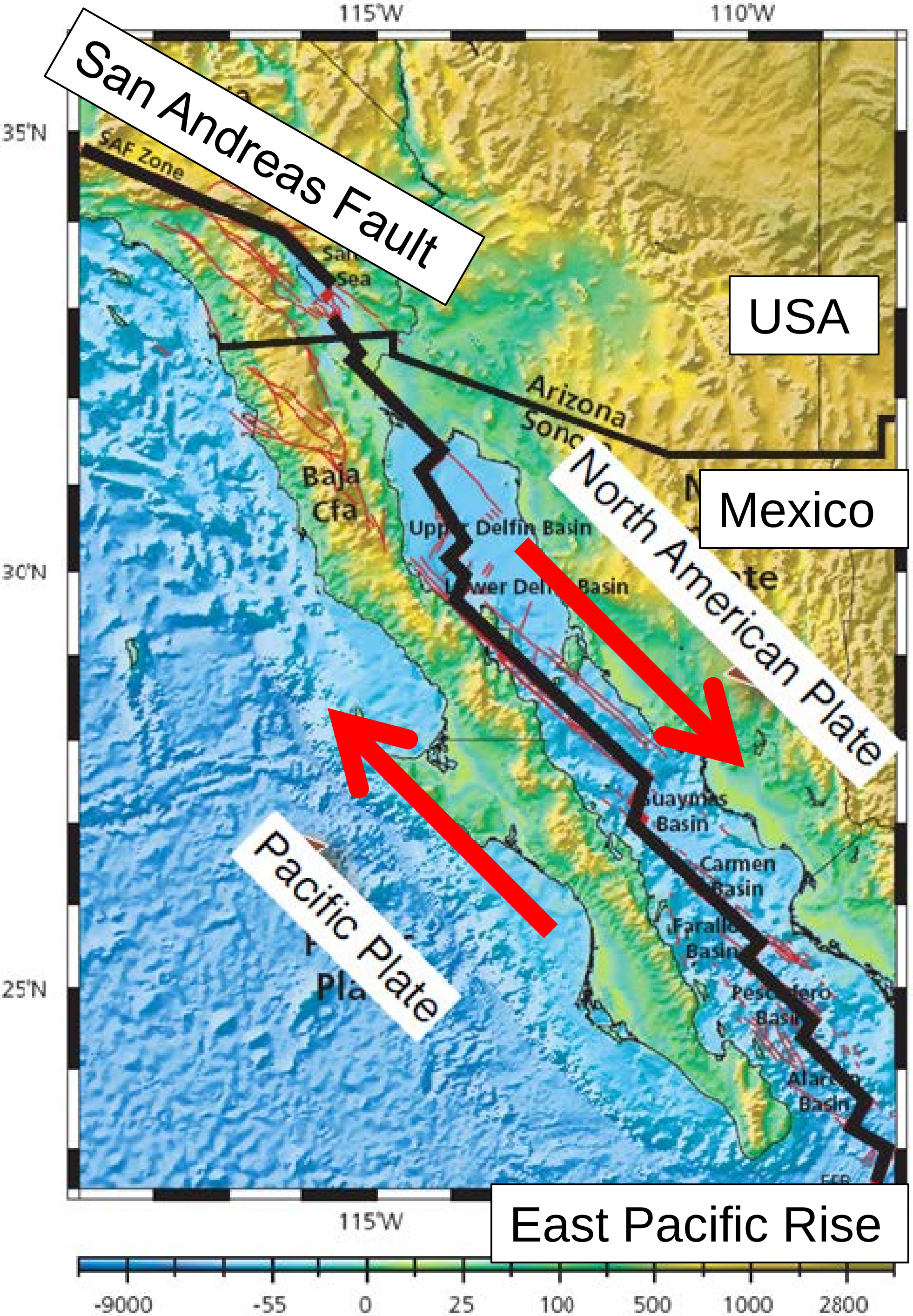
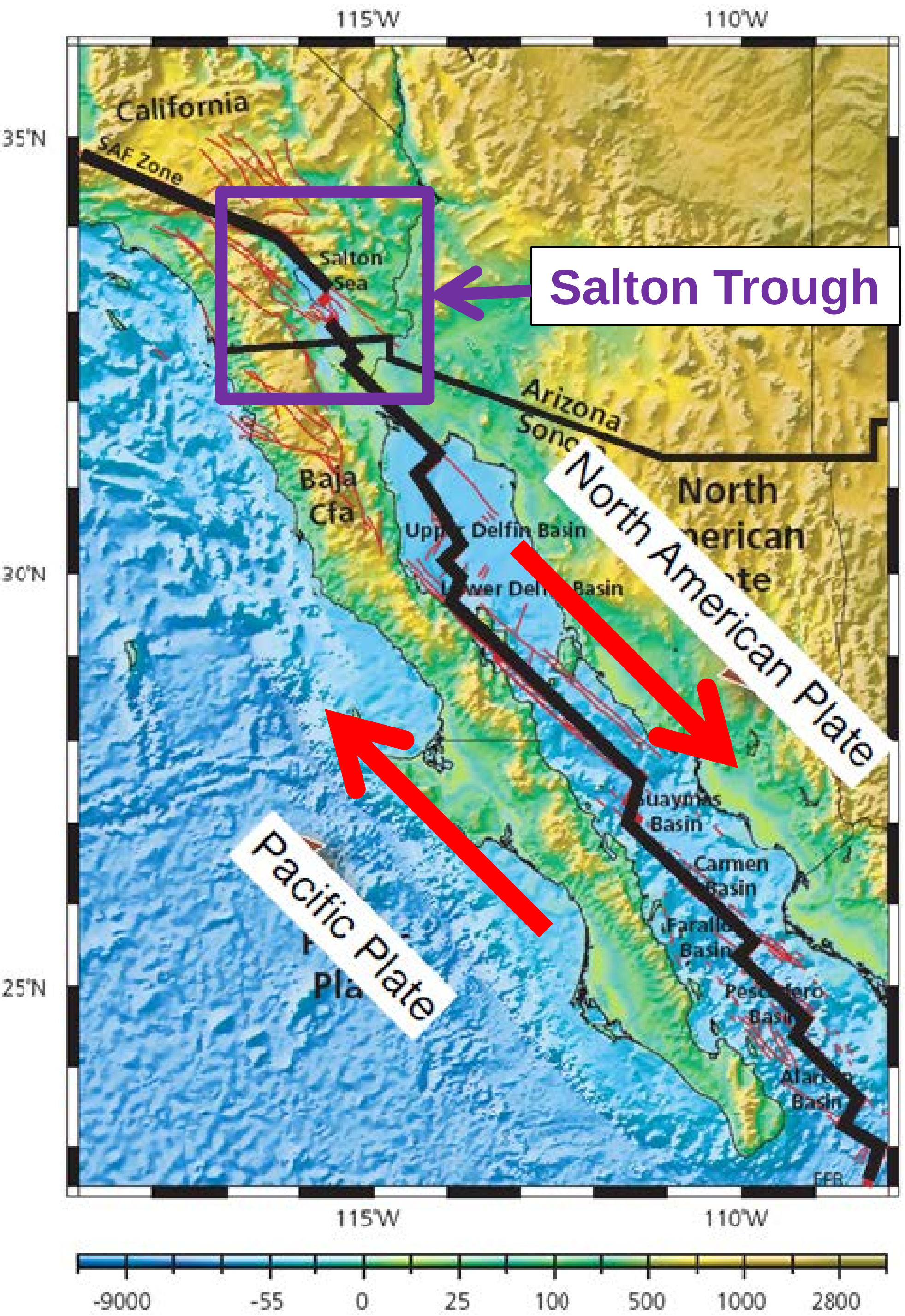
1. UTIG 2. Virginia Tech 3. Caltech 4. USGS Menlo Park 5. Scripps Institution of Oceanography 6. U. Nevada Reno 7. CICESE 8. UABC

Gulf of California Extensional Province



- Same amount of extension along the whole gulf since 6 Ma
- North
  - ➔ Colorado river delta
  - ➔ No seafloor spreading
- South
  - ➔ No sediment
  - ➔ Seafloor spreading

Gulf of California Extensional Province

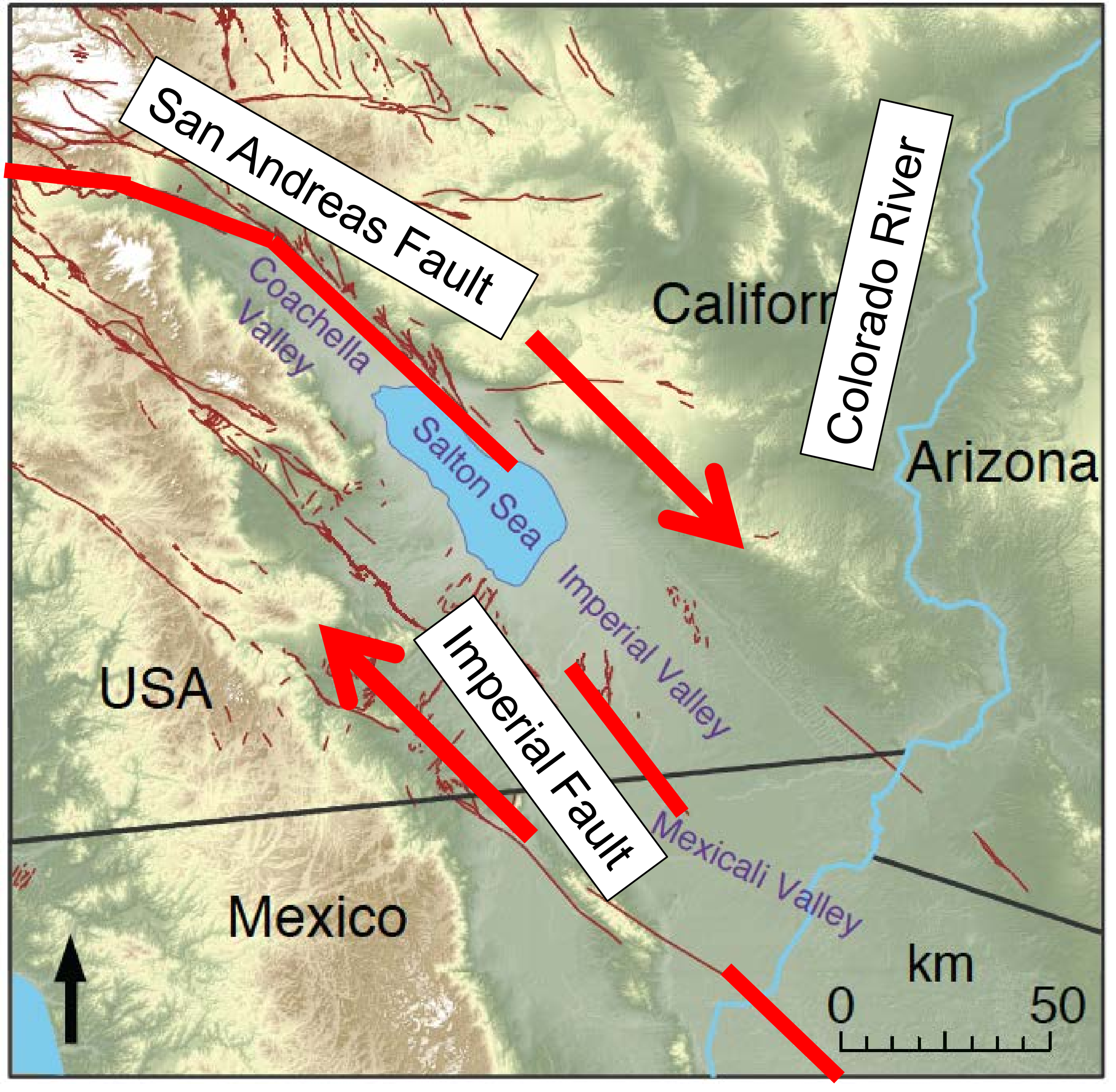


Question:
How rapid sedimentation affects rifting processes

- Same amount of extension along the whole gulf since 6 Ma

- North
  - ➔ Colorado river delta
  - ➔ No seafloor spreading
- South
  - ➔ No sediment
  - ➔ Seafloor spreading

Active Rifting in the Salton Trough



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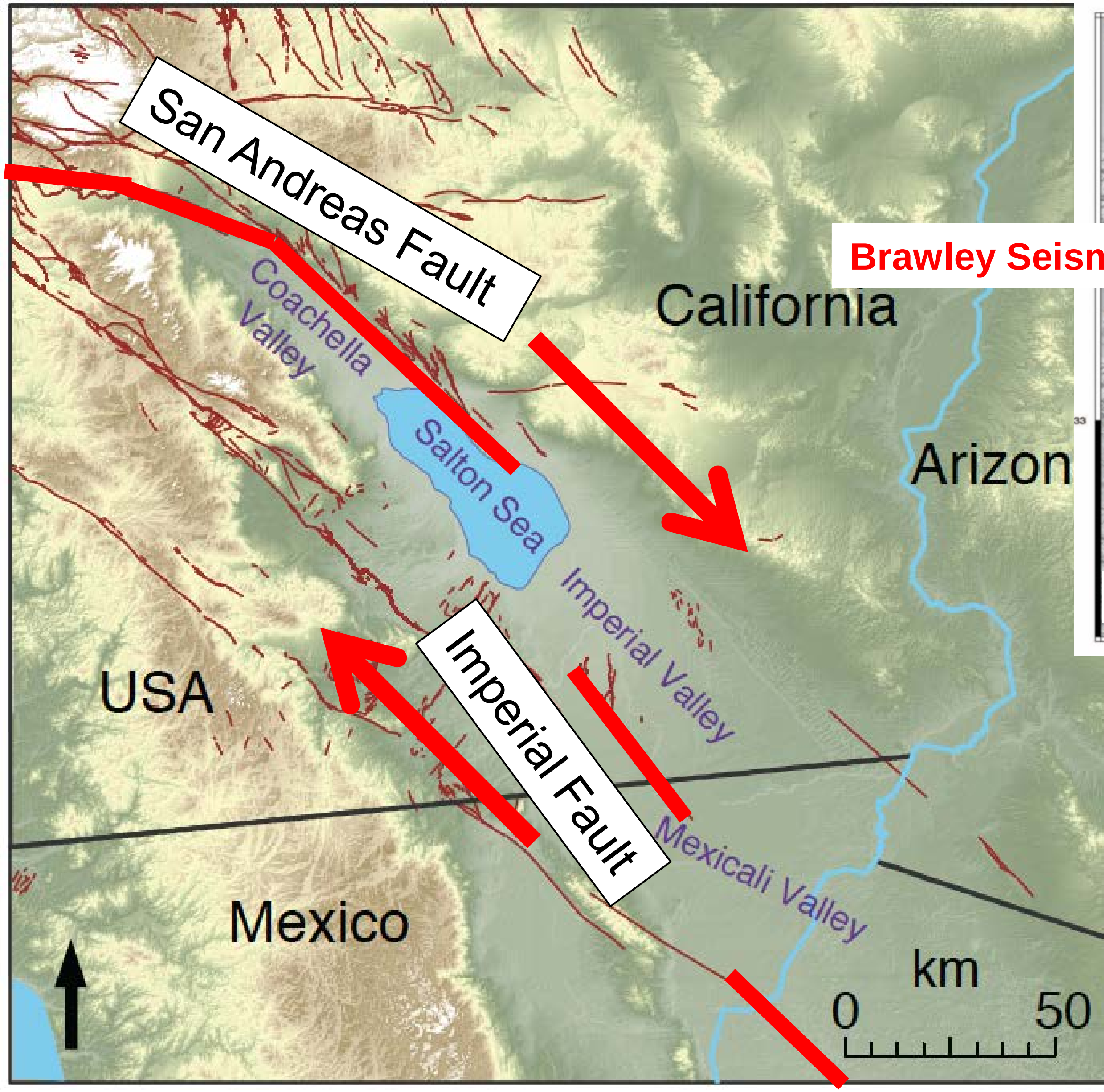

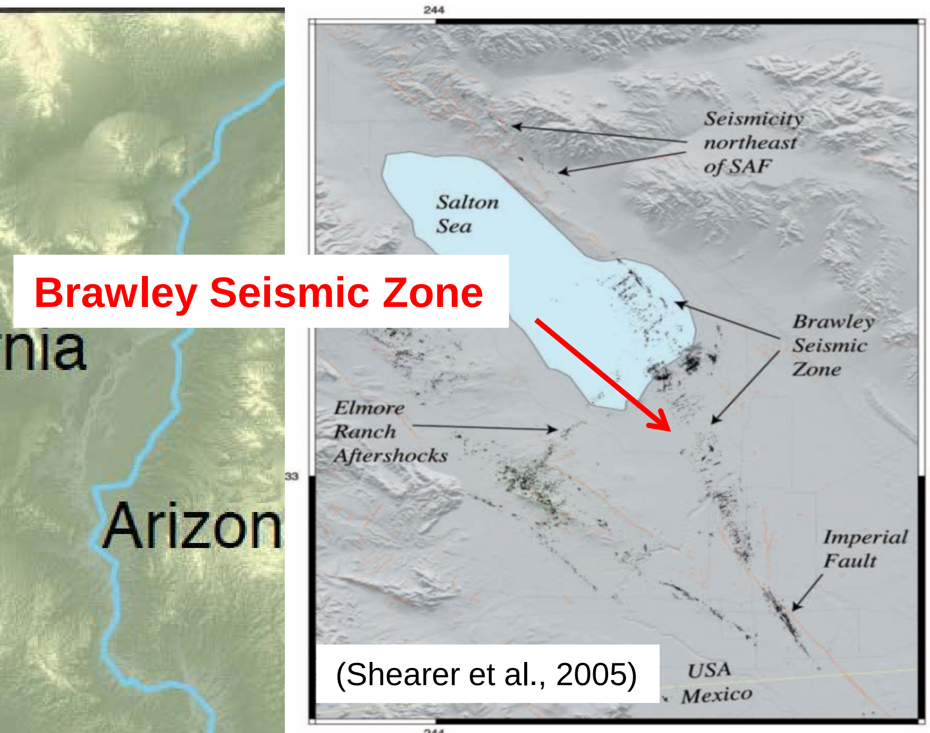

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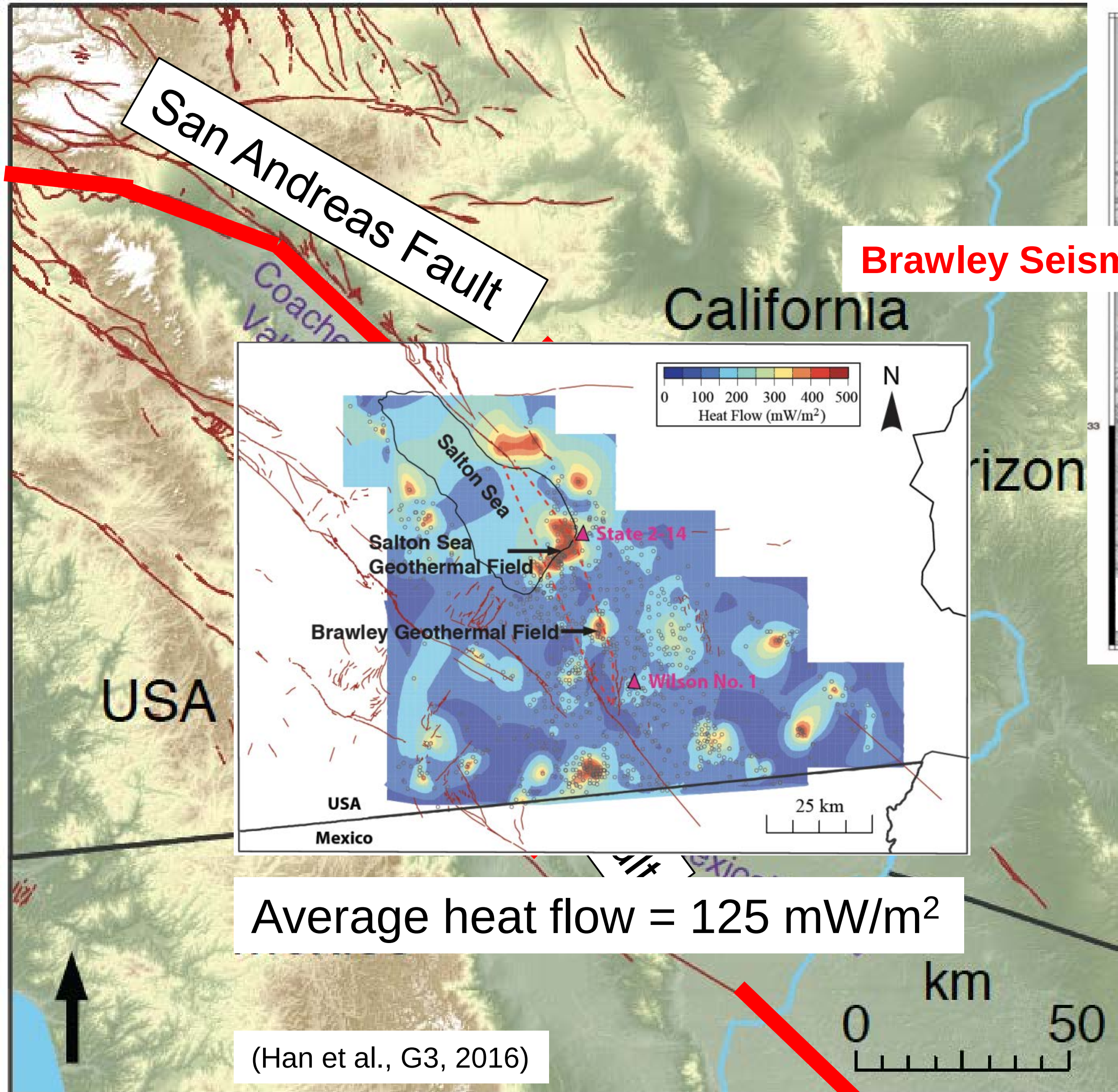
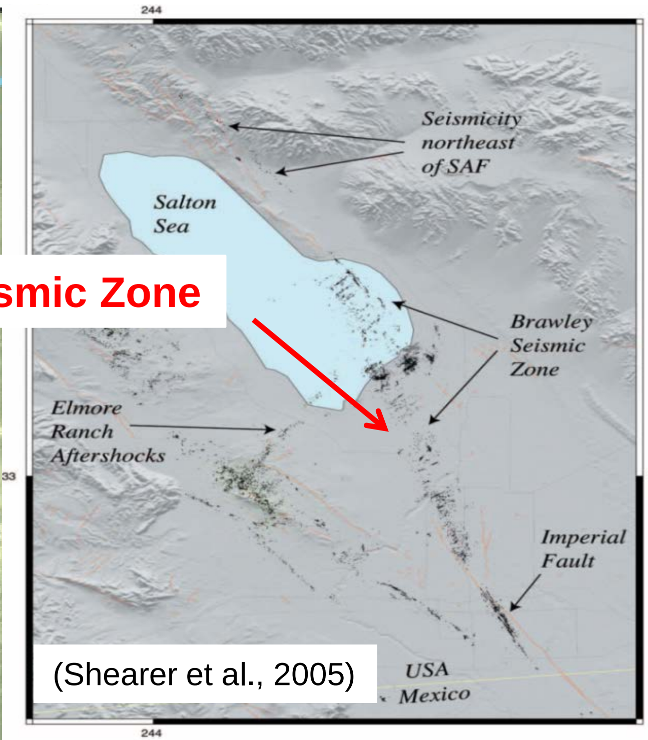
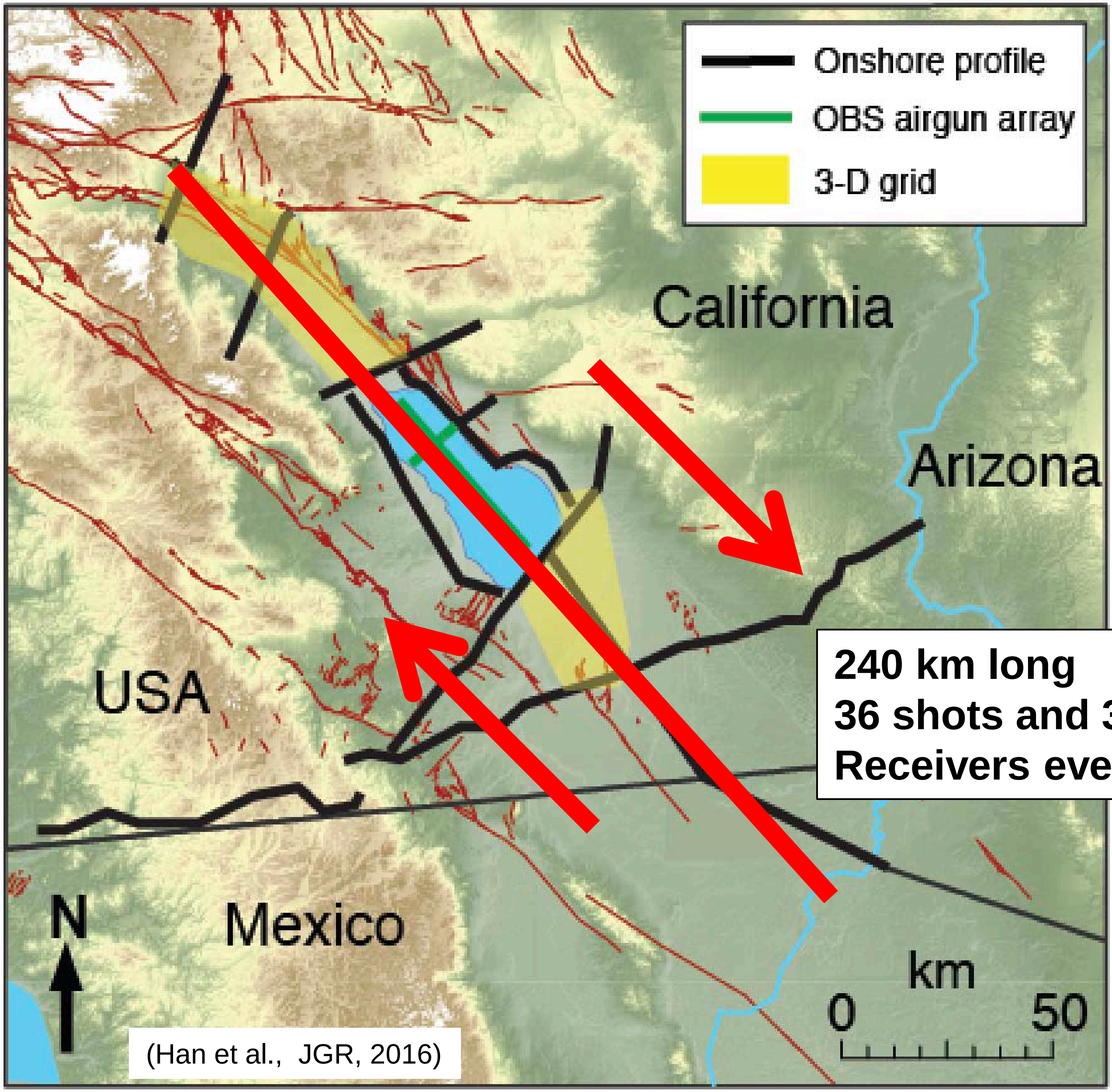




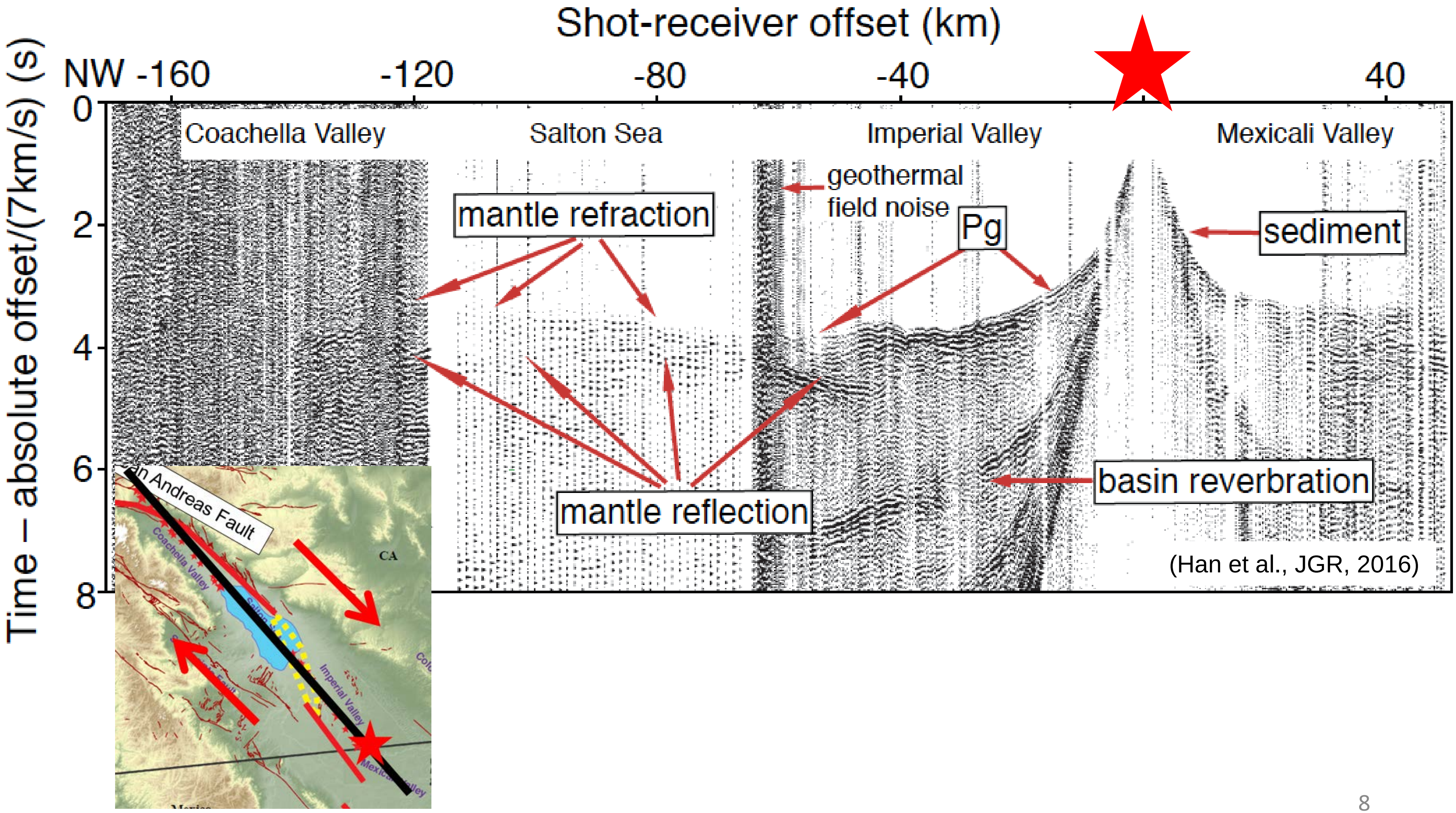
Salton Seismic Imaging Project



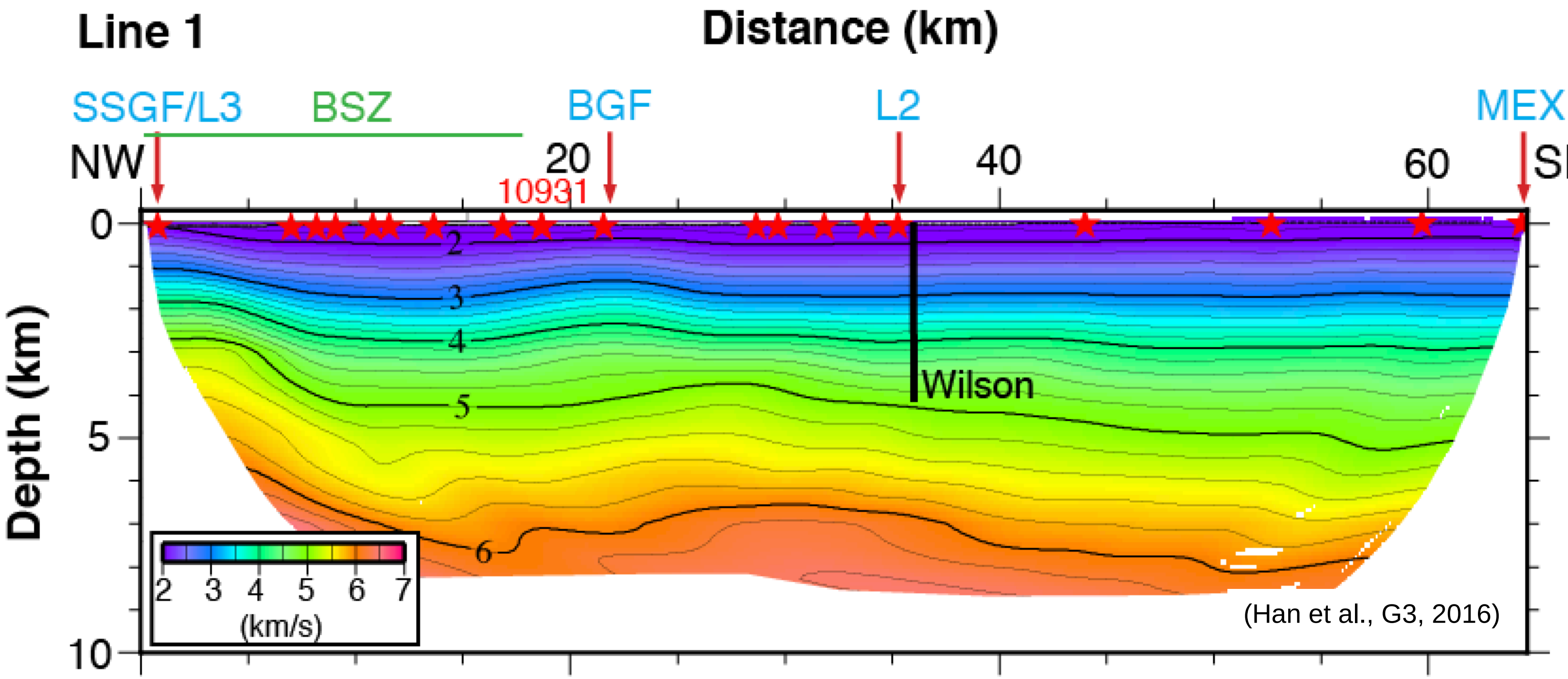
(Han et al., JGR, 2016)

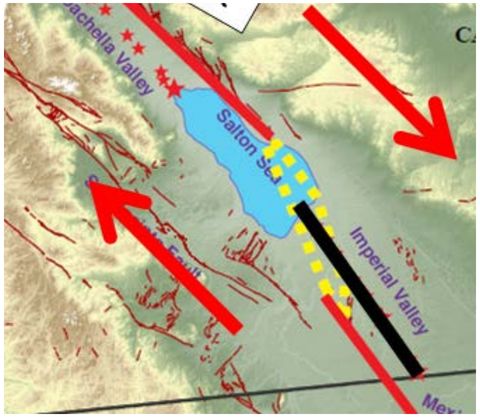
240 km long
36 shots and 38 OBS's
Receivers every 100-200 m

Shot Gather Example



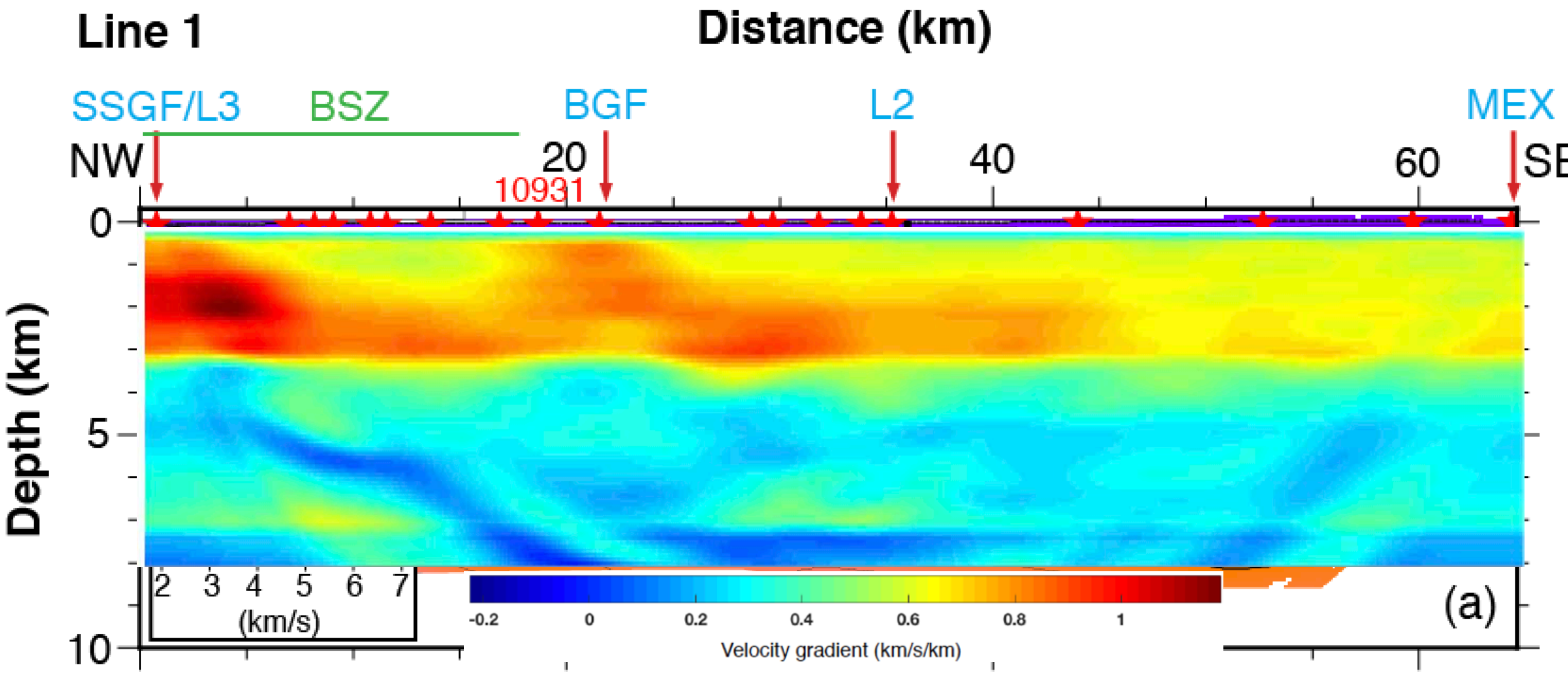
Imperial Valley Upper Crust

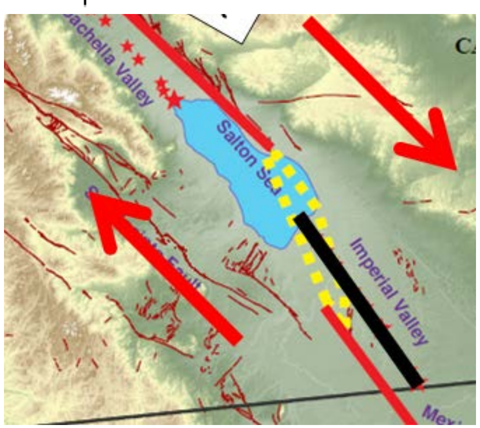




- Velocity smoothly increases with depth
- No sharp boundary between sediment and crystalline rock

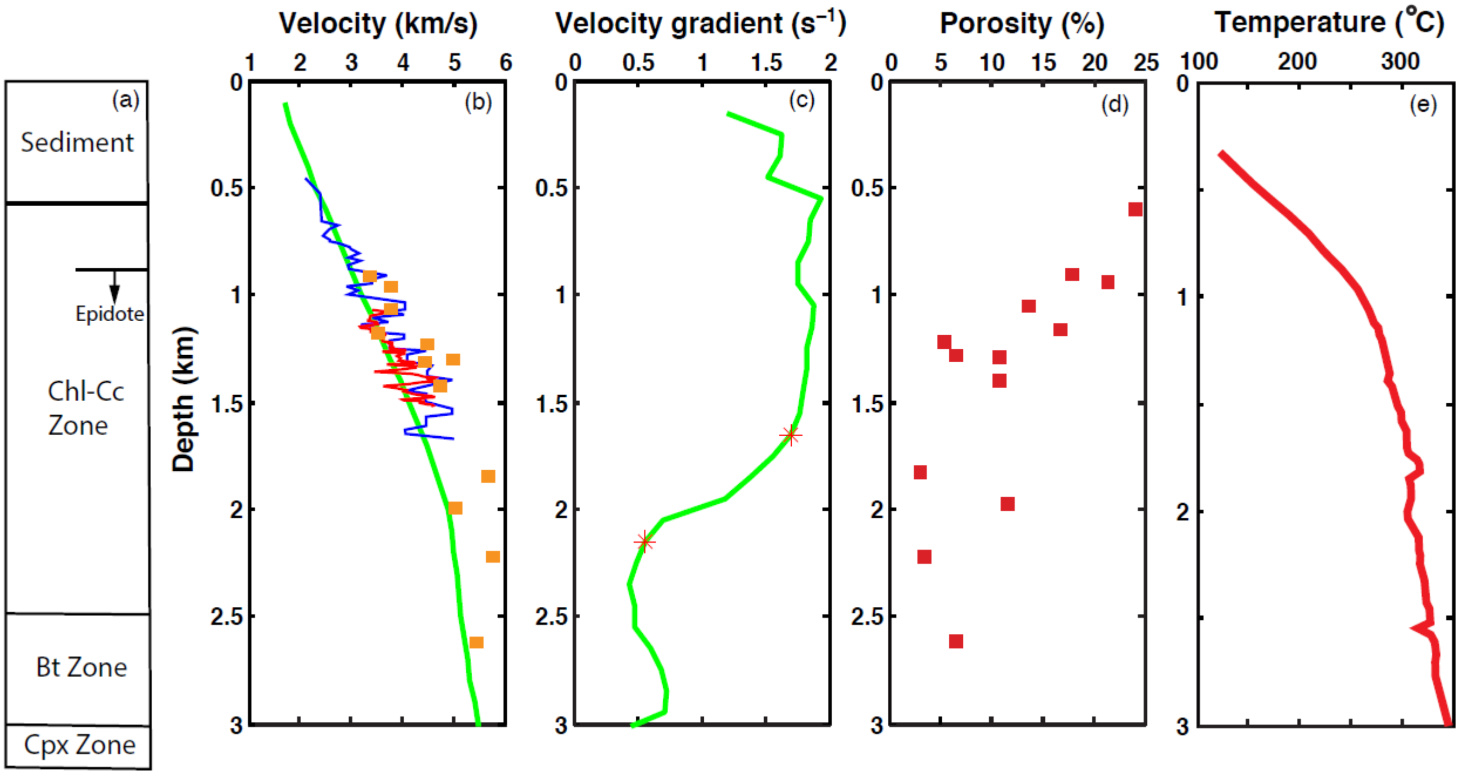
Imperial Valley Upper Crust

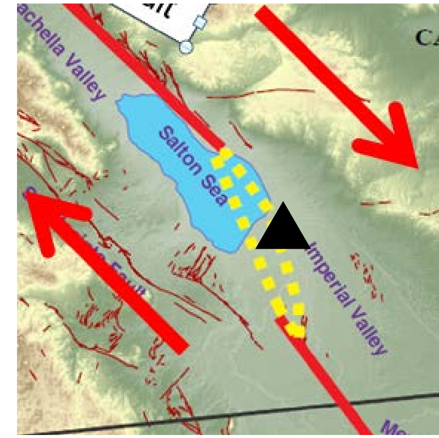




- Velocity gradient decreases sharply at ~3 km depth across the valley

Metamorphism of Sediment

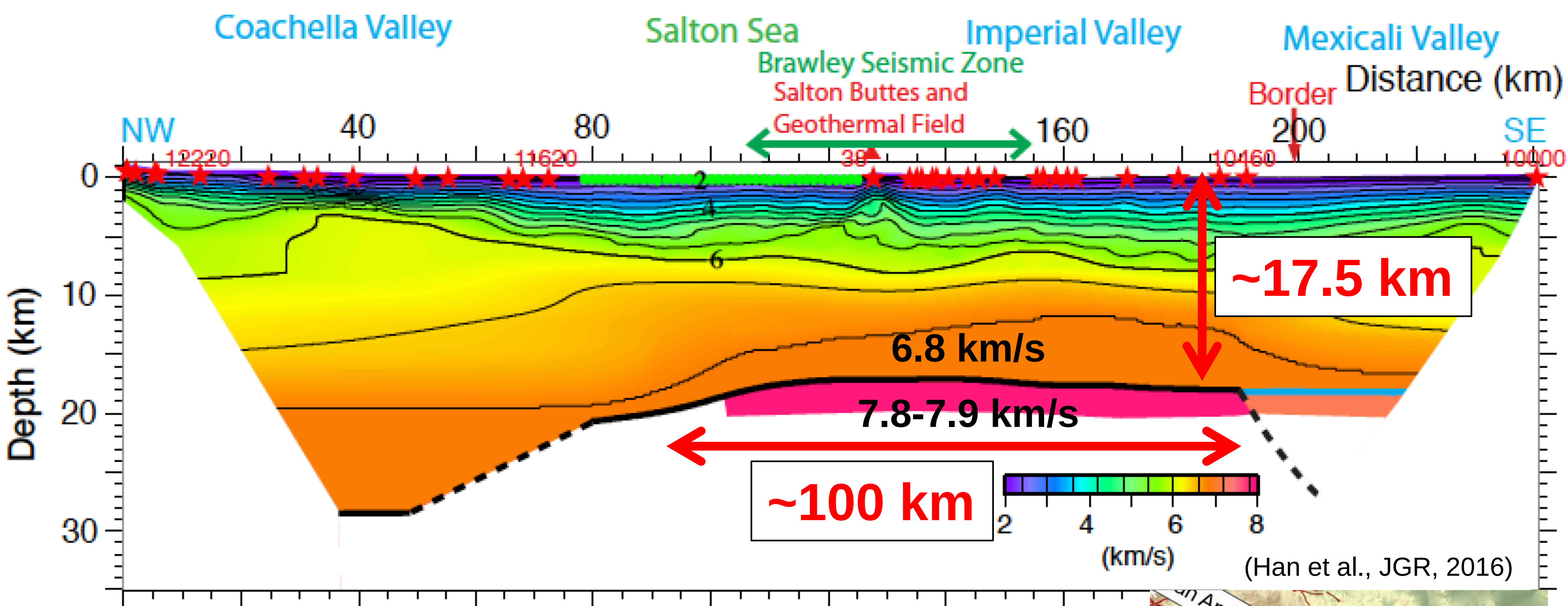




(Han et al., G3, 2016)

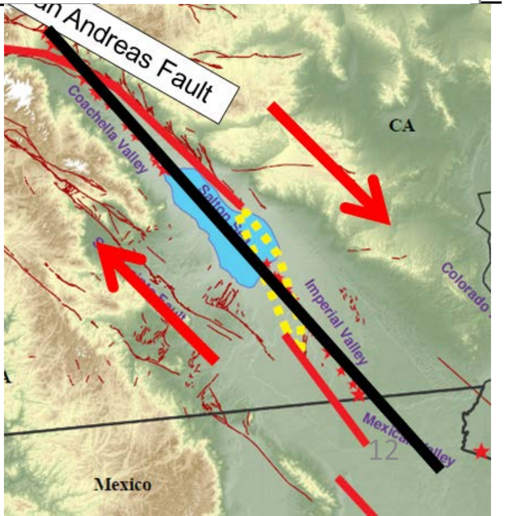
- Upper crust is metamorphosed young sediment by heat and fluid
- Velocity gradient decreases where rock porosity is 5-10%

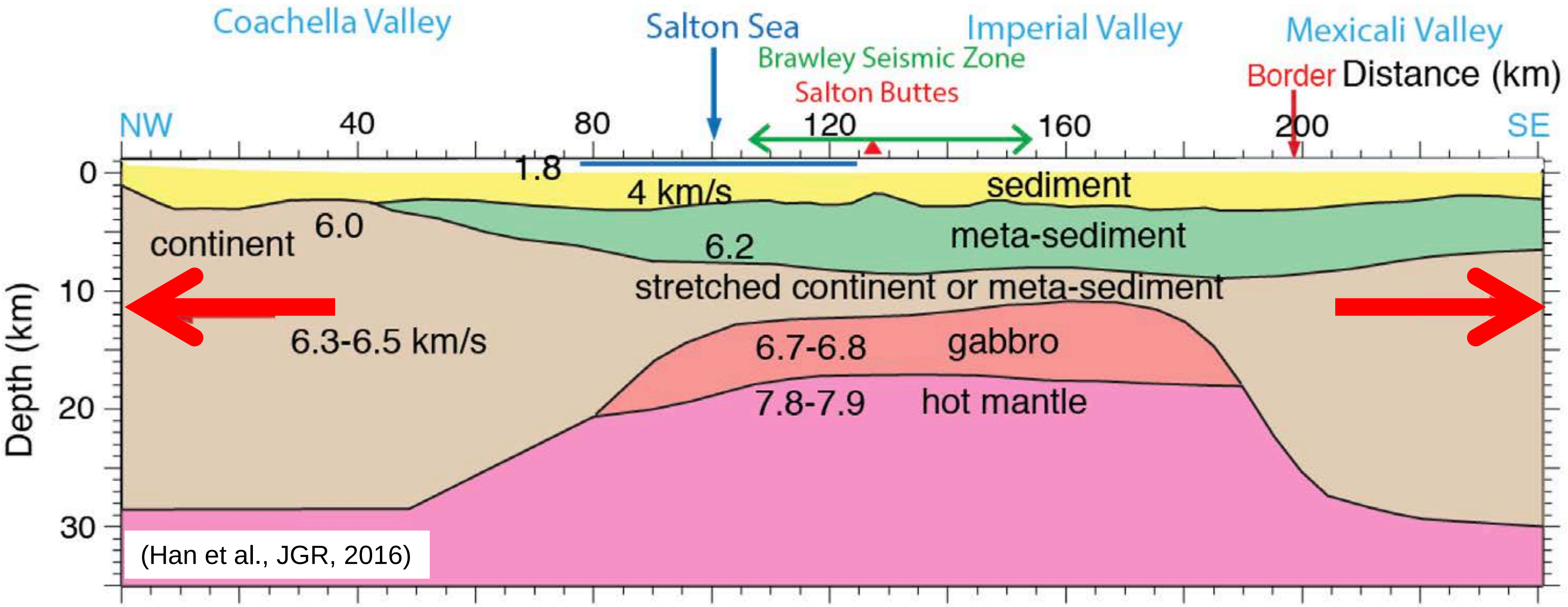
Whole Crust Velocity Model



(Han et al., JGR, 2016)

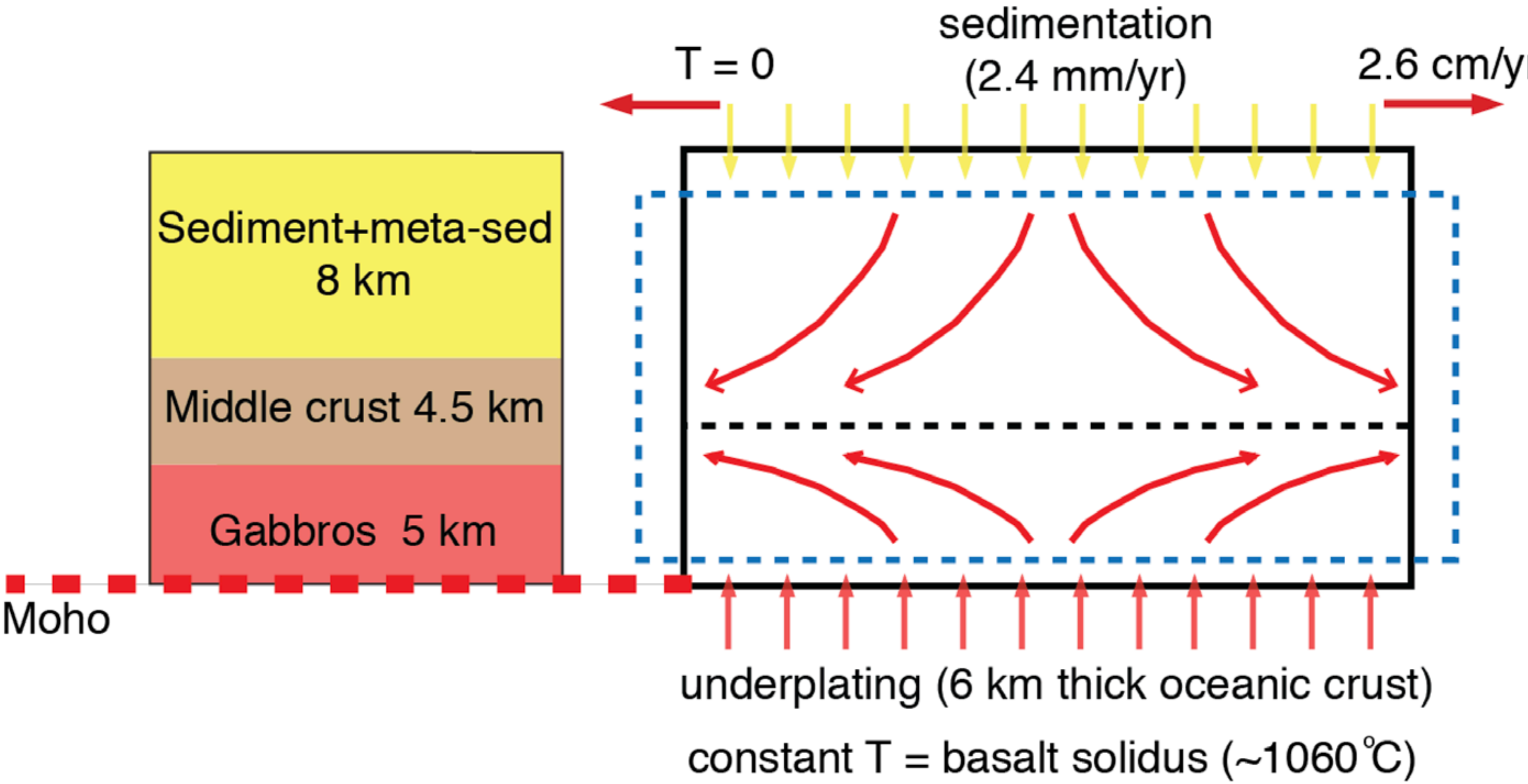
- lower crust
  ➔ gabbros by underplating
- upper mantle
  ➔ hot





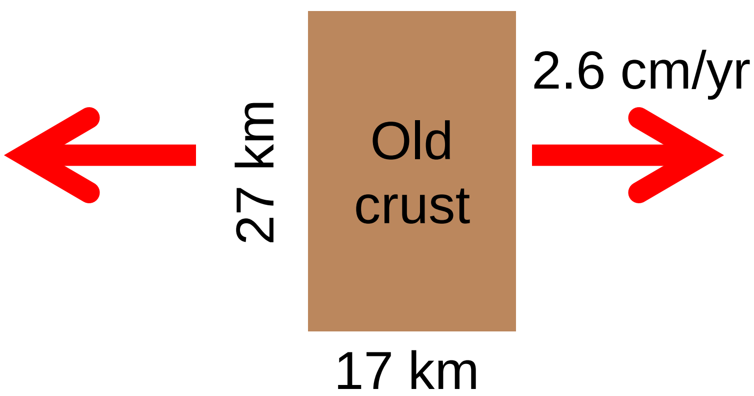
Old continental lithosphere has almost rifted apart, but no seafloor spreading;
~100 km wide new crust has been created by sedimentation and magmatism in last 2-4 Myr;

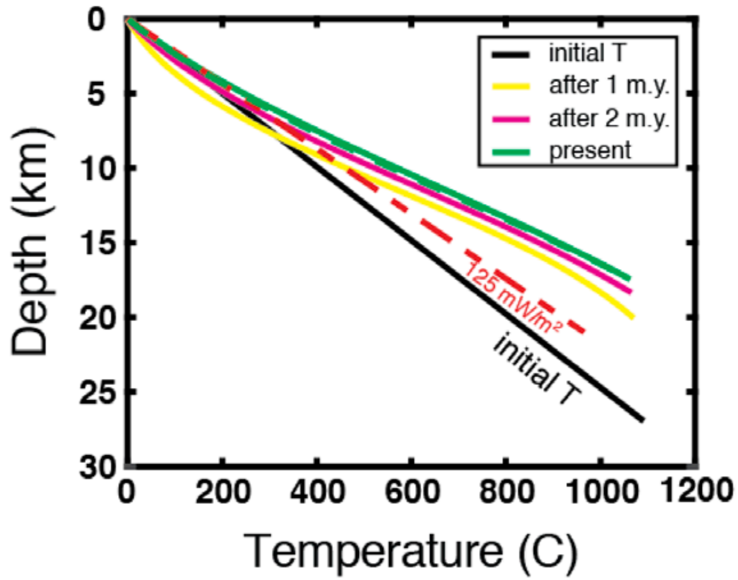
Thermal model

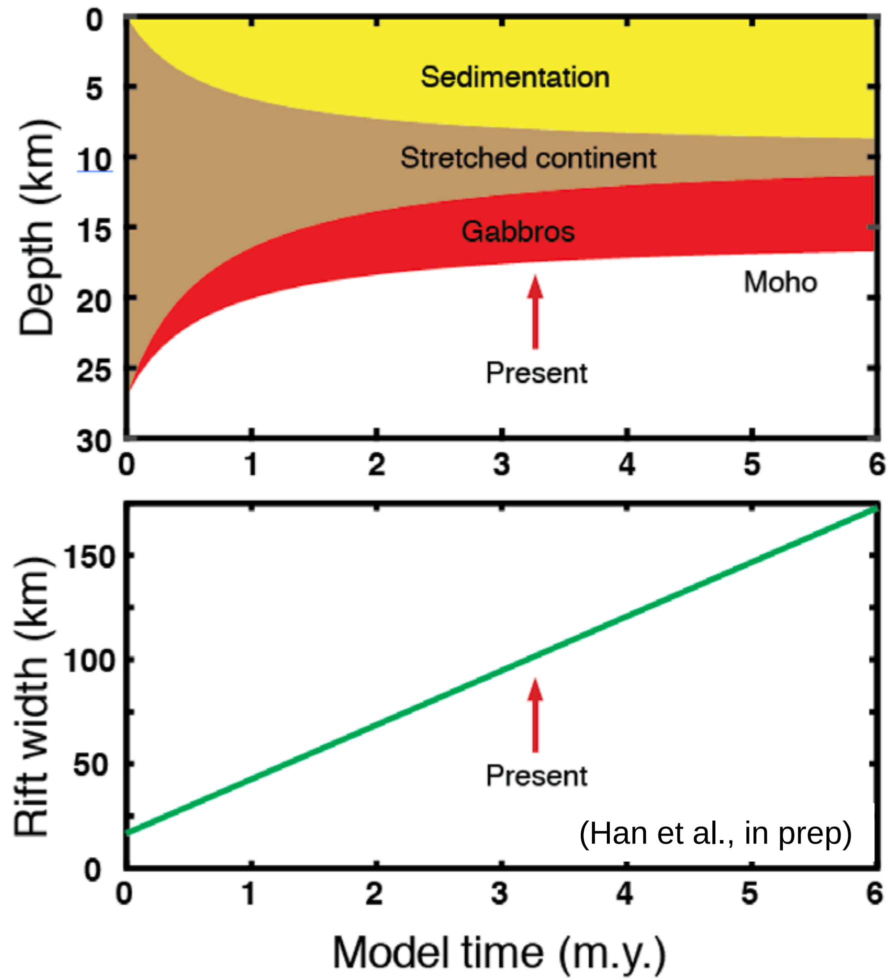


- Uniformly extension
- Sedimentation and magmatism compensate the crust thinning
- Heat transfer = conduction + advection

Initial time = 0

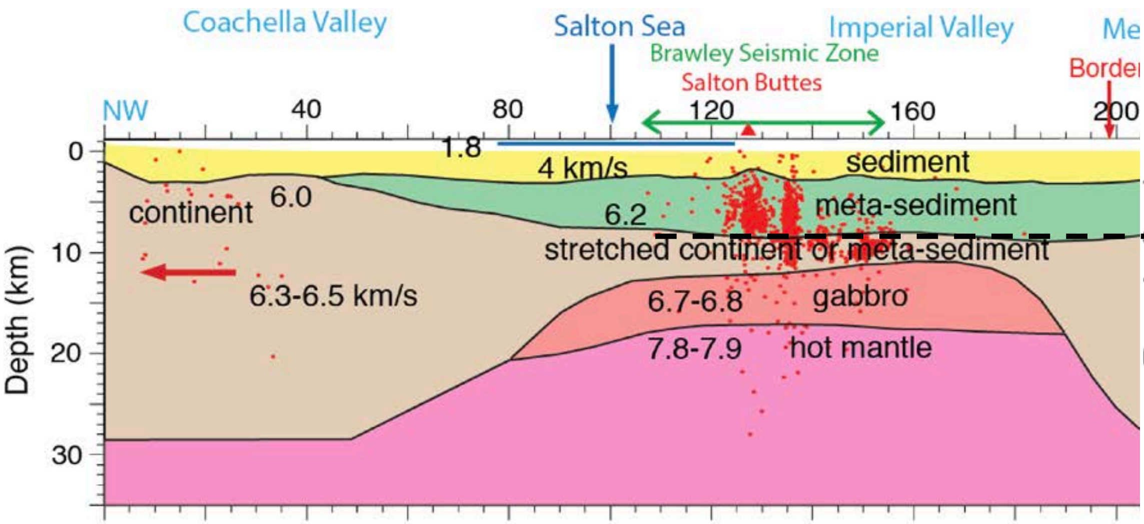




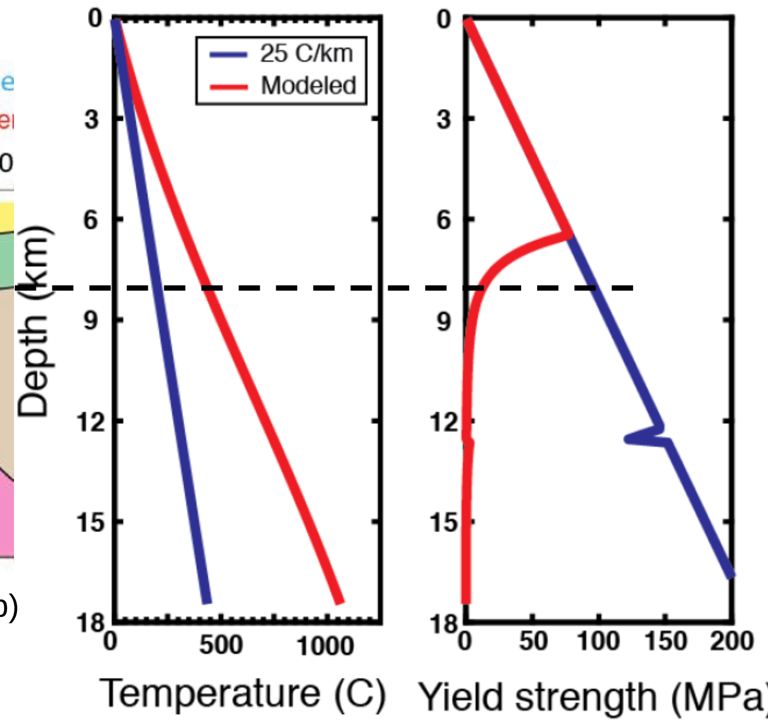


- Sedimentation + magmatism maintains crust thickness
- Modeled temperature consistent with observed heat flow

Temperature and Rheology



(Han et al., in prep)



- Earthquakes, volcanic activity and heat flow
  ➔ localized **brittle** deformation in the upper crust (in meta-sediment)

- 1D lower crust, Moho and upper mantle
  ➔ distributed **ductile** deformation in the lower crust

The Effects of Rapid Sedimentation upon Continental Breakup

- North American continental lithosphere has almost rifted apart, but no seafloor spreading

- New crust (~100 km wide) has been created by sedimentation, metamorphism and magmatism

  ➔ *future continental margin*

- Rapid sedimentation keeps crust thick and ductile

  ➔ *delays continental breakup and initiation of seafloor spreading*

Sedimentation & Continental Rifting

Late-stage rifts: - rivers flow into them (if sediment > 4 km)
- high heat flow

Metamorphism of sediment

➔ probably a common, under-recognized process

➔ *builds new felsic continental-margin crust*

➔ delays final breakup and seafloor spreading