"Big drip" explanation for the Big Bend

Big bend: left-step in SA fault trace

Some crustal shortening must occur at such a step.

Mercator projection about PA-NA Euler pole.

An ideal transform fault would be a straight vertical line in this projection.

Regional tomography

fast, cold under Transverse Ranges

slow, hot under Salton Trough
More on the cold mantle feature

- 3% fast $V_p$ indicates that it is 120° to 550° colder than the surrounding mantle, depending on what $V_p/T$ relationship you use.
  
  ($\Delta V_p = 0.5 \times \Delta T$ to $\Delta V_p = 2 \times \Delta T$)

- Yes, that's a large range, but the fact remains that an anomalously cold feature extends to a depth of about 230 km.

- Steep thermal gradients indicate that the thermal anomaly is young (that is, it hasn’t had time to cool off).

Why?

Maybe dense mantle lithosphere is downwelling under the Transverse Ranges.

Different models for lithospheric downwelling
Different models for lithospheric downwelling

OK, that’s plausible.

Probably not.

This would cause too narrow of an anomaly.
Different models for lithospheric downwelling

Maybe.
The tomography does not indicate much asymmetry.

Different models for lithospheric downwelling

Probably not.
This would have severely asymmetric thermal gradients.
Block diagram for the preferred model

A rough model of the system

Fixed thermal structure.
A rough model of the system

(b) NO SLIP HERE

No surface slip, all other surfaces are free.

The result is a maximum downwelling velocity of 3 mm/yr.

30 km in 10 Ma—not OK.

A rough model of the system

(c) 12 mm/yr slip →

12 mm/yr surface slip, all other surfaces are free.

The result is a maximum downwelling velocity of 15 mm/yr.

150 km in 10 Ma—OK.
Deep seismicity in the area

- 15 km to 20 km
- >20 km

Downwelling is aseismic.

Implication: This is not "wholesale subduction of lower crust."

Chicken-and-egg problem

Big bend in the PA-NA plate boundary resulted in extrusion of mantle lithosphere.

- OR -

Downwelling caused crustal convergence, thus resulting in the observed fault configuration.
An aside: Slow anomaly below the Salton Trough

- 4% slow $V_p$ indicates that it is 150° or 650° warmer than the surrounding mantle.
- That implies that there’s partial melt, or there isn’t.

Why?

- Decompression melting?
- Mantle upwelling?

Cartoon

What happened to the crustal lithosphere?