Raising the Colorado Plateau

Nadine McQurrie and Clement G. Chase
Geology, Jan. 2000, v.28, no.1, p.91-94

Chunpeng Zhao
April 23, 2007
Earthscope Seminar, ASU

Colorado Plateau

- Elevation: ~2km
- Crustal thickness: 45km
- During much of the Phanerozoic, it is near sea level
- In phanerozoic, Colorado Plateau region had a thin crust

Model

- The pressure gradient from an overthickened and overheated hinterland crust of the Sevier orogenic belt drove intracrustal flow that thickened the crust and isostatically raised the Colorado Plateau.

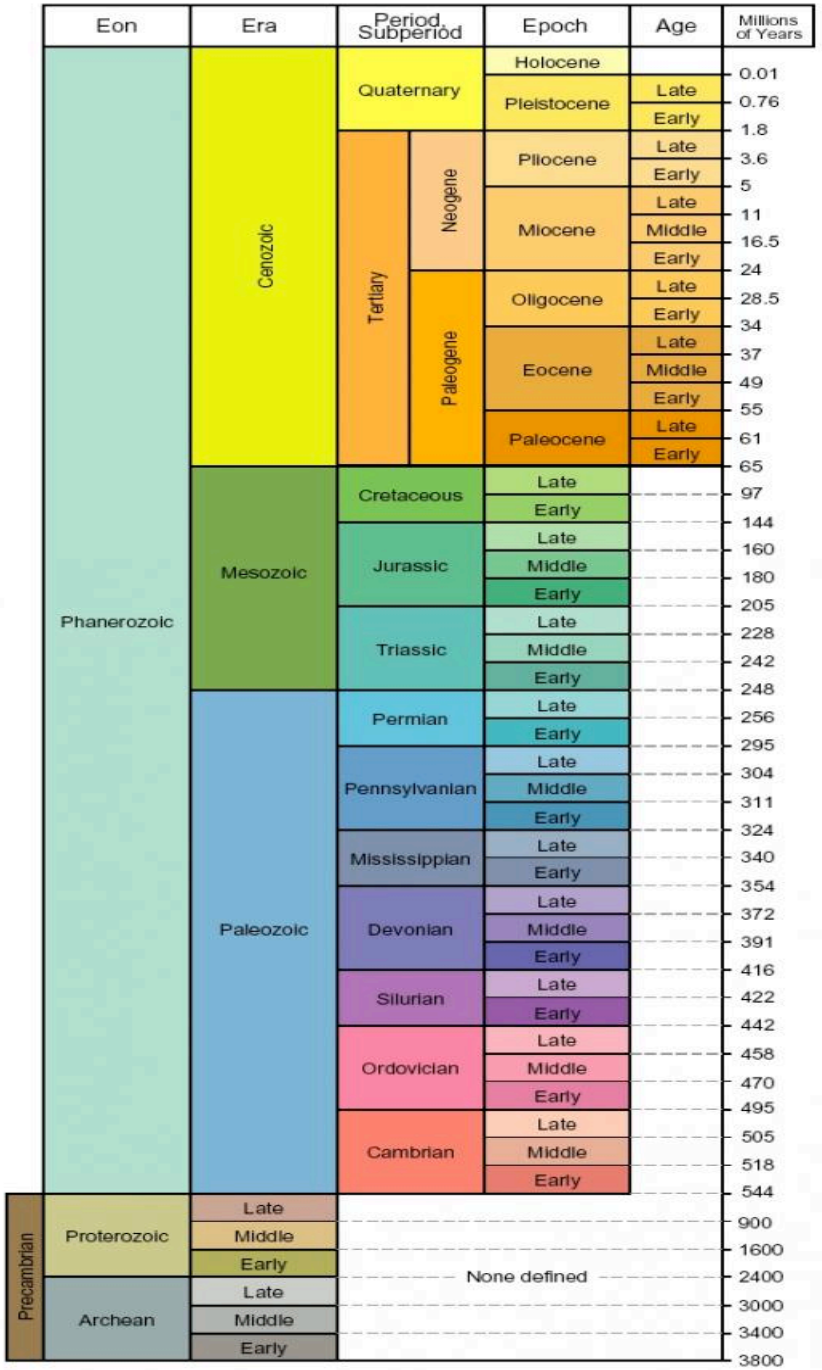


Figure D-1. Divisions of geologic time used to code the database items in this compilation.

Model Test 1: Geological Evidence

Paleo-crustal thickness of Western US

McQuarrie and Chase, Geology,2000

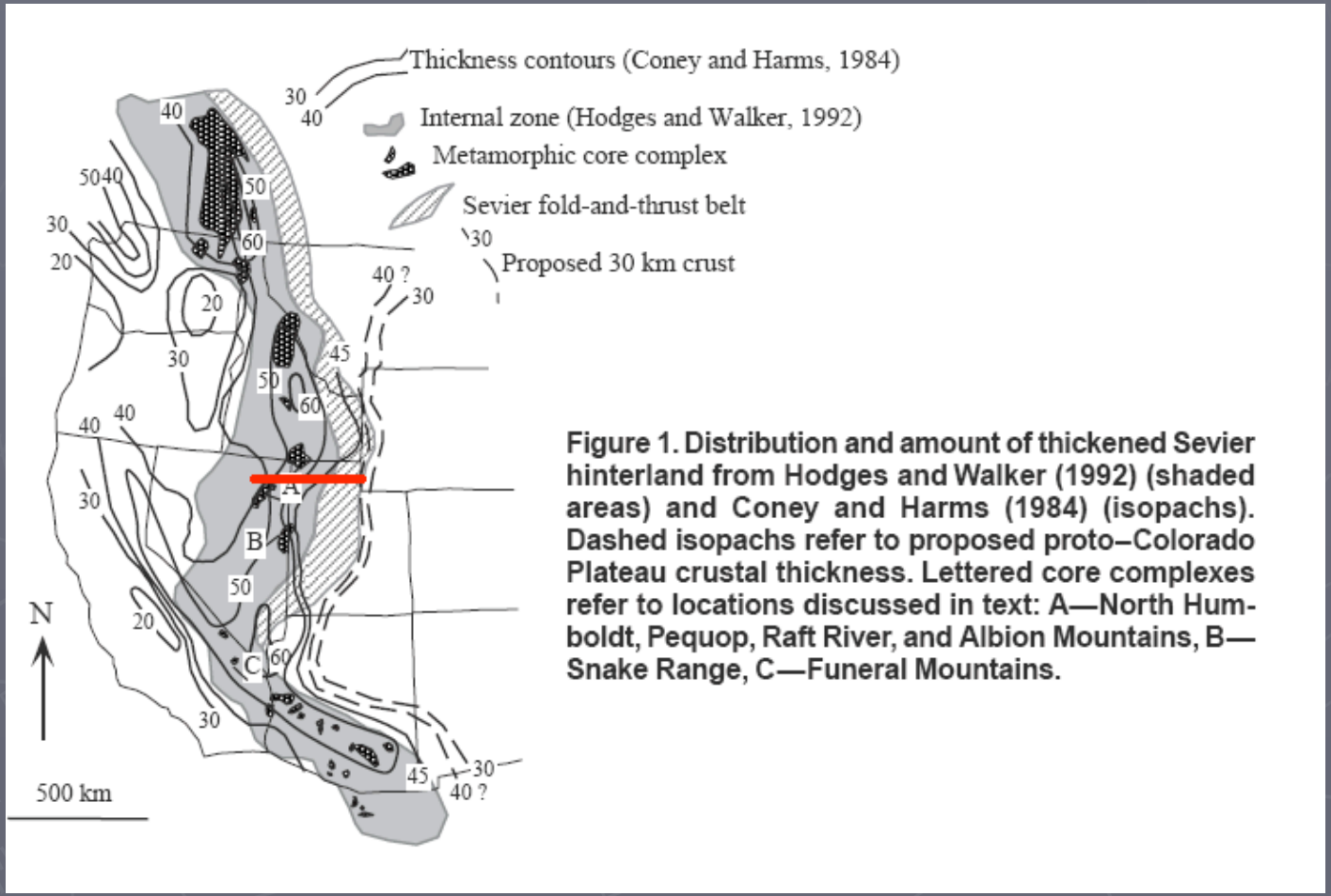
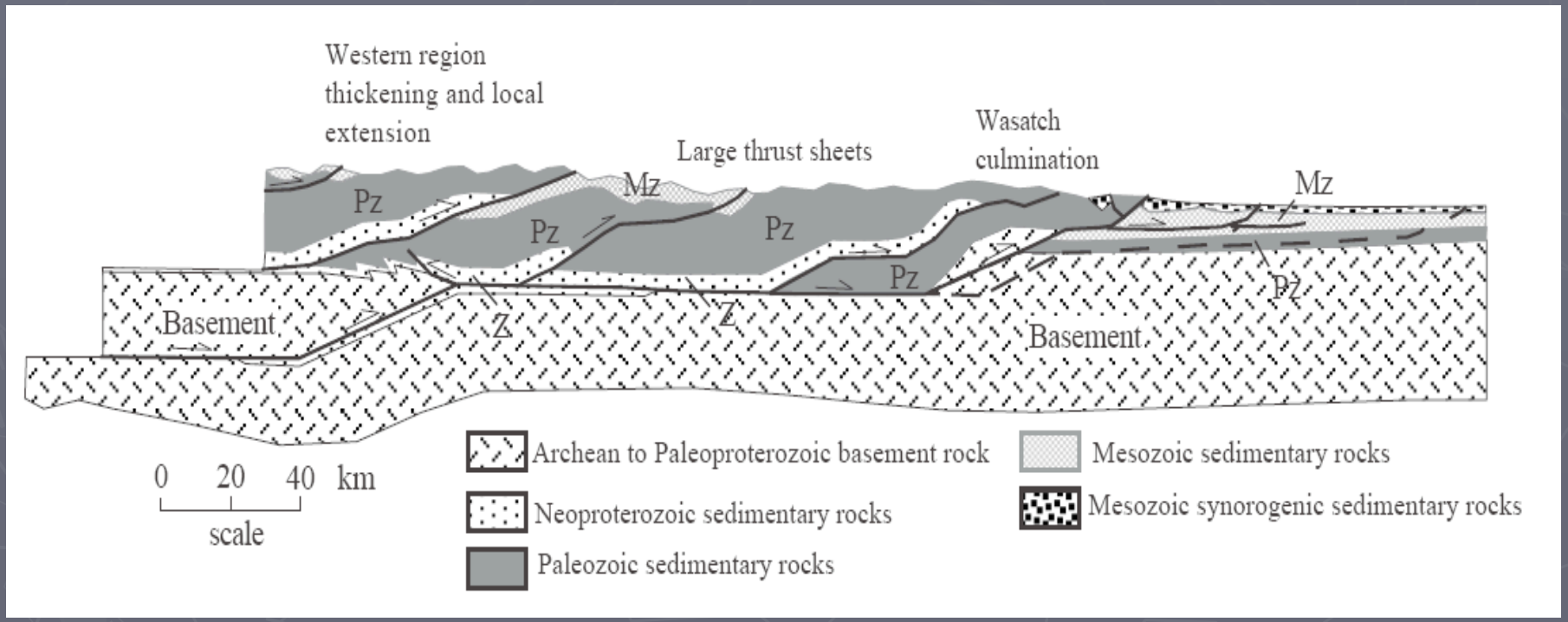


Figure 1. Distribution and amount of thickened Sevier hinterland from Hodges and Walker (1992) (shaded areas) and Coney and Harms (1984) (isopachs). Dashed isopachs refer to proposed proto–Colorado Plateau crustal thickness. Lettered core complexes refer to locations discussed in text: A—North Humboldt, Pequop, Raft River, and Albion Mountains, B—Snake Range, C—Funeral Mountains.

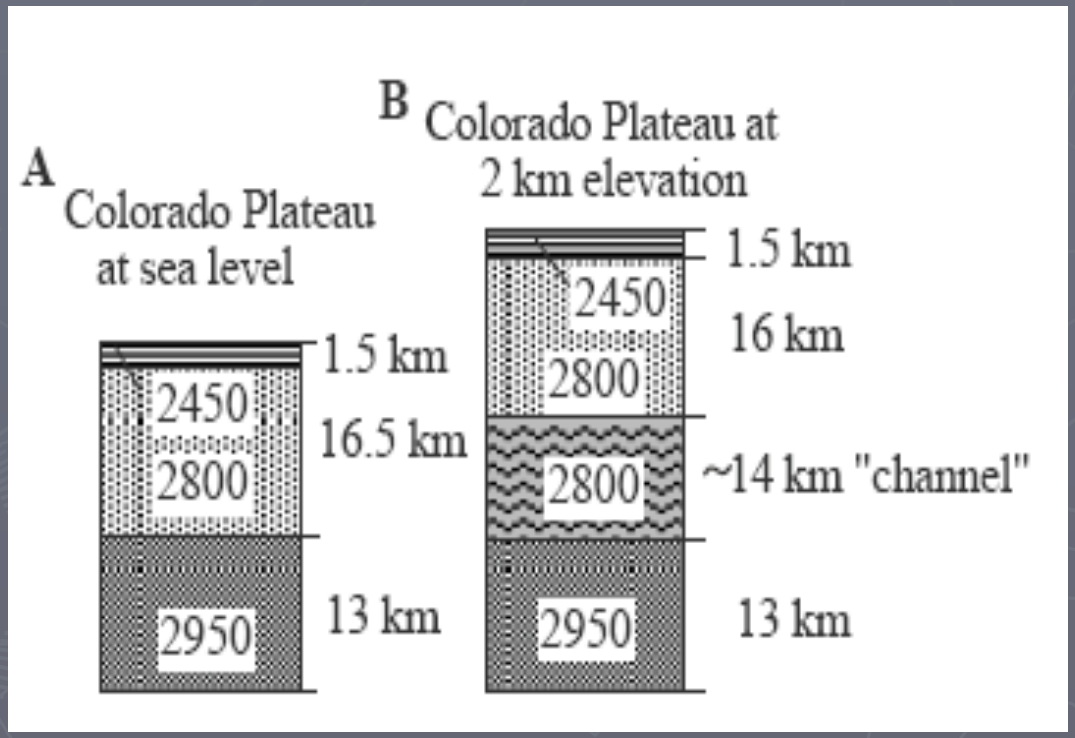
Cross section of Sevier fold-and-thrust belt

McQuarrie and Chase, Geology, 2000



Model Test 2: Isostatic Balance

McQuarrie and Chase, Geology, 2000



Model Test 3:

Viscosity and Topographic Gradient

$$q = \frac{D^3}{12\mu}\frac{dp}{dx}, \qquad (1)$$

$$\frac{dp}{dx} = \frac{\rho_{mc} g\, h}{L/2}, \qquad (2)$$

$$q = \frac{hL}{4\,t}. \qquad (3)$$

$$\mu = \frac{D^3 \rho_{mc} g\, t}{3L^2}, \qquad (4)$$

$$\frac{dh}{dx} = \frac{12\mu L}{tD^2 \rho_{mc} g}\frac{(\rho_m - \rho_{mc})}{\rho_{mc}}. \qquad (5)$$

- Input:

  density_crust=2800 kg/m^3
  density_mantle=3300 kg/m^3
  g=10 m/s^2
  L=700~1400 km
  h=4 km
  D=15 km
  t=35 m.y.

- Result:

viscosity= $10^{19} \sim 10^{20}\, Pa \cdot S$

temperature= $600 \sim 700^{\circ} C$

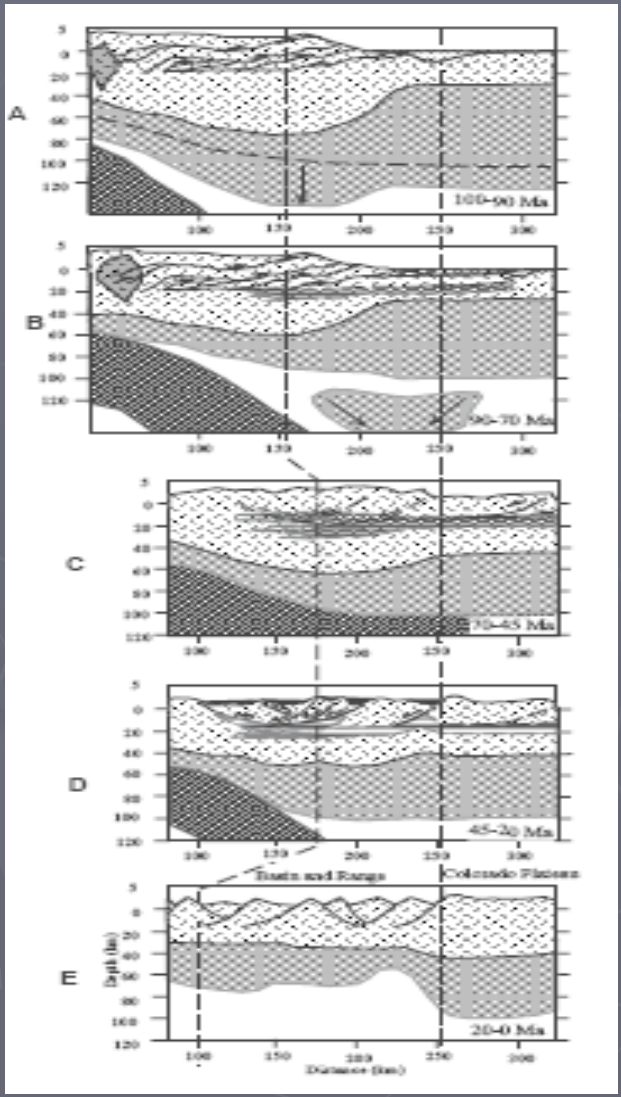
Topographic Slope= $0.1 \sim 0.5^{\circ}$

Range of Elevation= 1~5 km

Implications

- Changes of foreland-basin geometry.
- The process should also be applicable to the Rocky Mountain region.
- Sevier fold-and-thrust belt and Laramide uplifts are different expression of strain produced by same driving mechanism.
- The uplift and outward growth of the east margin of Tibet may be also caused by same mechanism.

Discussion:



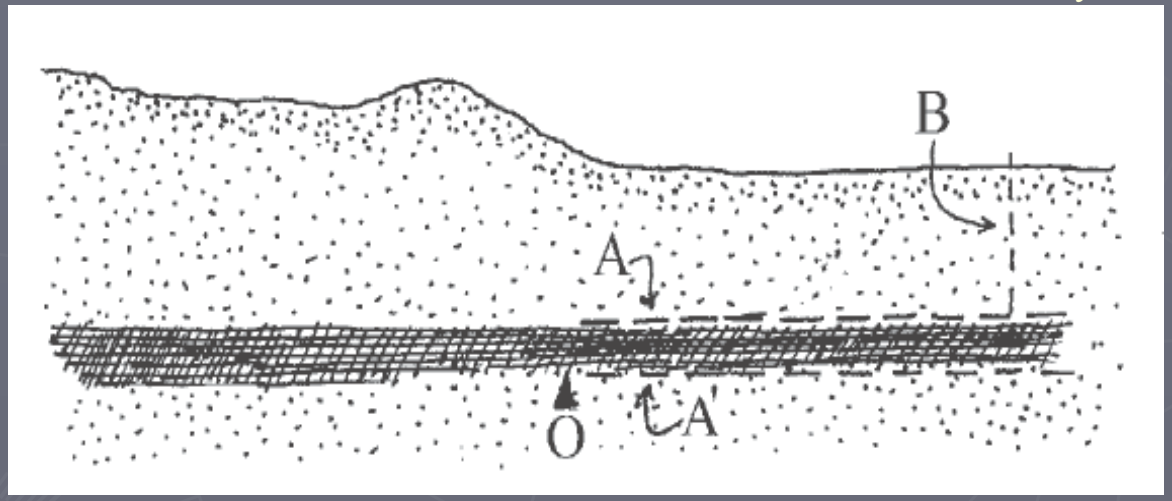
- A: Sevier Plateau with a thickened crustal root
- B: Removing of Mantle Lid
- C: Crustal Flow Propagation
- D: Extension
- E: Basin and Range, Colorado Plateau

McQuarrie and Chase, Geology, 2000

Comment:

by Kevin T. Kilty

Kevin T. Kilty



- Laramide uplifts as a response of ductile flow should cause the Colorado Plateau to resist gargantuan normal Forces.
- There is no recent uplift following this ductile flow mechanism occurring in the western US.

Reply to the Comment:

by Nadine McQuarrie and Clement G. Chase

- Kilty's calculation of upper crust stresses is inconsistent with the geology of the Laramide and Colorado Plateau region.
- The curstal flow process is not limited to the Colorado Plateau.

Additional Thoughts:

- If Sevier Plateau is thick and high, it will prevent the sea to cover the Colorado-Plateau region. So, it should have been covered by shallow sea before Sevier Plateau formed. Right?