4. Ocean Basin Shape: Contraction and Isostasy


- Cooling and contraction increases the density of the older oceanic lithosphere, making it "want" to ride lower in the mantle.

- An isostatic balance can be performed to account for the fact that the older, denser, lithosphere rides lower in the mantle, which results in the characteristic *droop* of the ocean basin floor with distance from the spreading center.

- This process is thought to have been demonstrated (quite notably) in the Cretaceous, when seafloor spreading rates were rapid, leaving little time to cool sufficiently to make a deep ocean.
Evolution of Thermal Structure in Cooling Rock Column

- Early rapid cooling
- Late slow cooling

Temperature:
- 0°C
- 1200°C
- 1600°C

Heat flow into base of element
Heat flow out top of element

Depth
Lithosphere thickness

Time
The equation for volumetric change can be converted to an equation for density contrast.
Cooling Oceanic Lithosphere

\[ \rho_w D_0 g + \rho_{m,hot}(D + L)g = \rho_w D_0 g + \rho_w D g + \rho_{m,cool} L g \]
\[ \rho_{m,hot} D + \rho_{m,hot} L = \rho_{m,cool} L + \rho_w D \]
\[ D/L = (\rho_{m,cool} - \rho_{m,hot})/(\rho_{m,hot} - \rho_w) \]
Why the droop?

The mean temp. of the lithosphere is cooler, and hence more dense, than the mantle.

This urge to sink increases with lithospheric thickness, which increases with time subjected to cooling.
Age Distribution of the Sea Floor
Oceans of Kansas
Introduce Problem Set #1