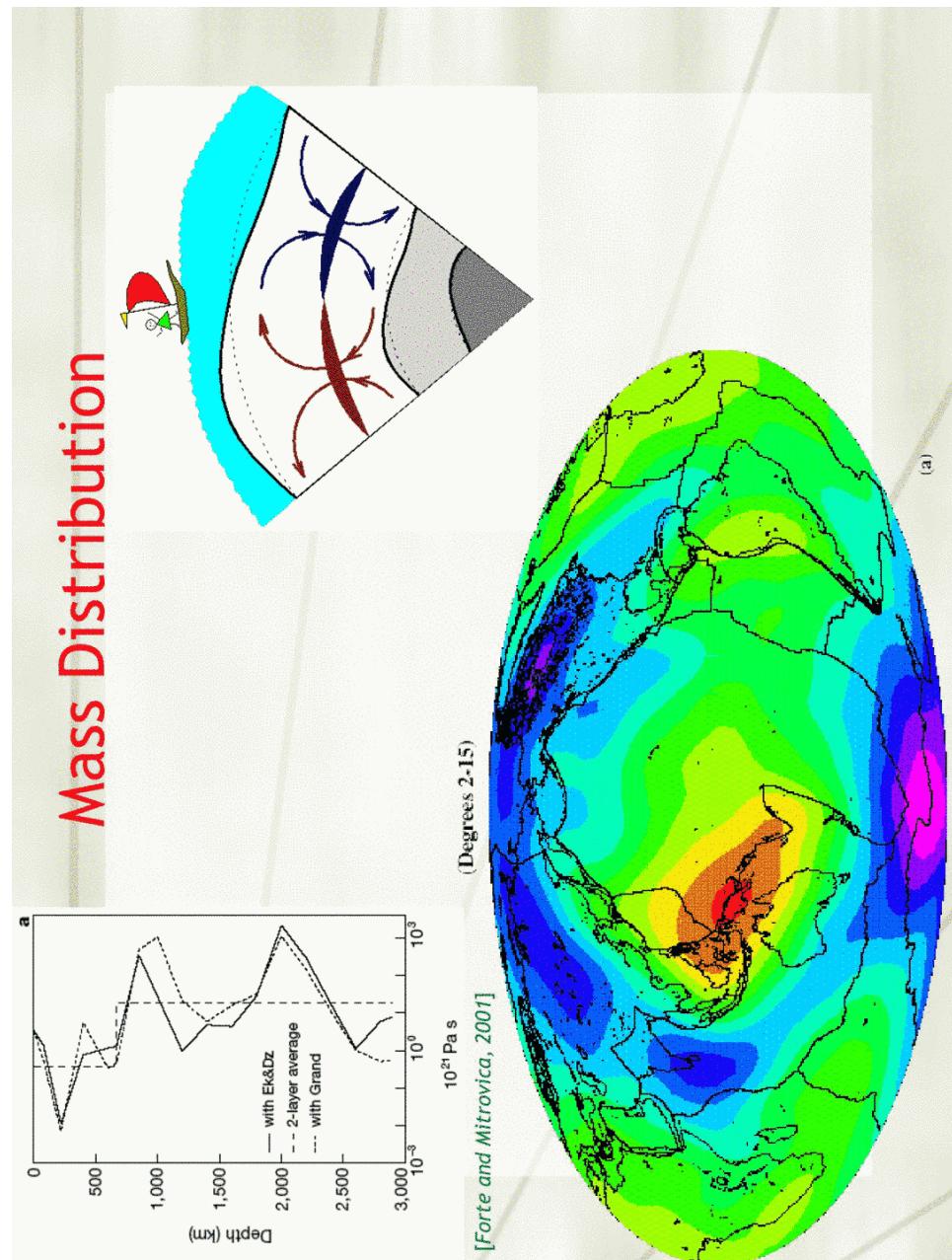


Geological Constraints

Lecture 6: Geodynamics
Carolina Lithgow-Bertelloni

Constraints

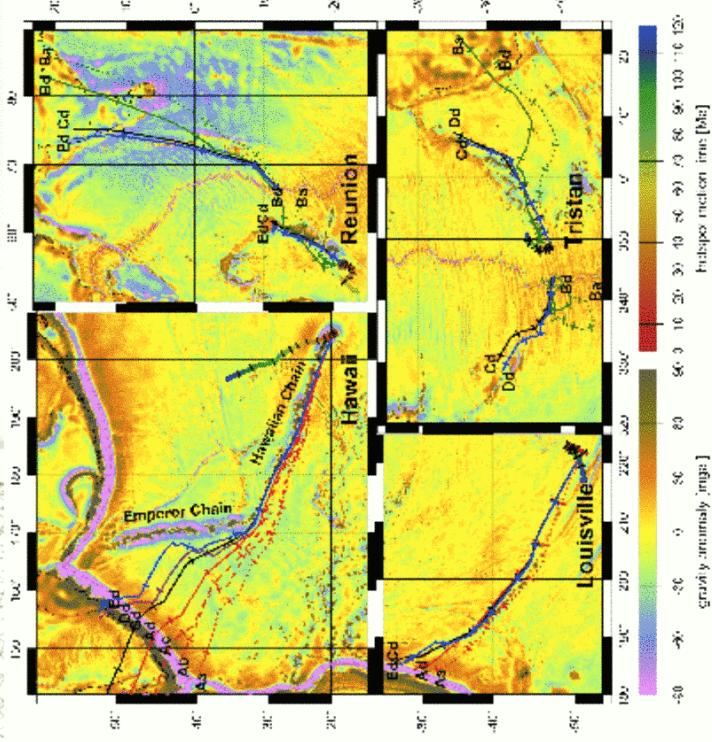
- ♦ Mass distribution and change
 - ♦ Geoid and free air gravity
 - ♦ TPW
- ♦ Plate motions past and present
 - ♦ Magnetic anomalies
- ♦ Topography
 - ♦ Flooding record
- ♦ Stresses
 - ♦ Sources
 - ♦ Measure strain
- ♦ Record of volcanism



Hotspots

Hotspot Tracks

- Taking into account mantle wind
- Letting hotspots move relative to each other
- Taking into account plate deformation

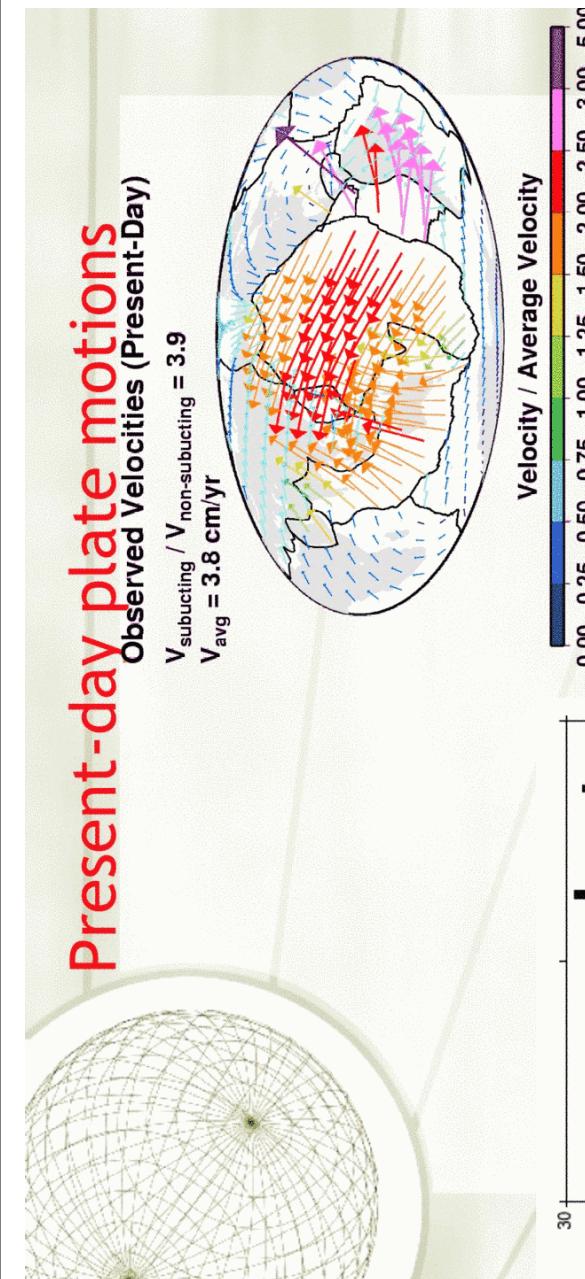


[Steinberger et al., 2004]

Present-day plate motions

Observed Velocities (Present-Day)

$$\begin{aligned} V_{\text{subducting}} / V_{\text{non-subducting}} &= 3.9 \\ V_{\text{avg}} &= 3.8 \text{ cm/yr} \end{aligned}$$



[Forsyth and Uyeda, 1975]

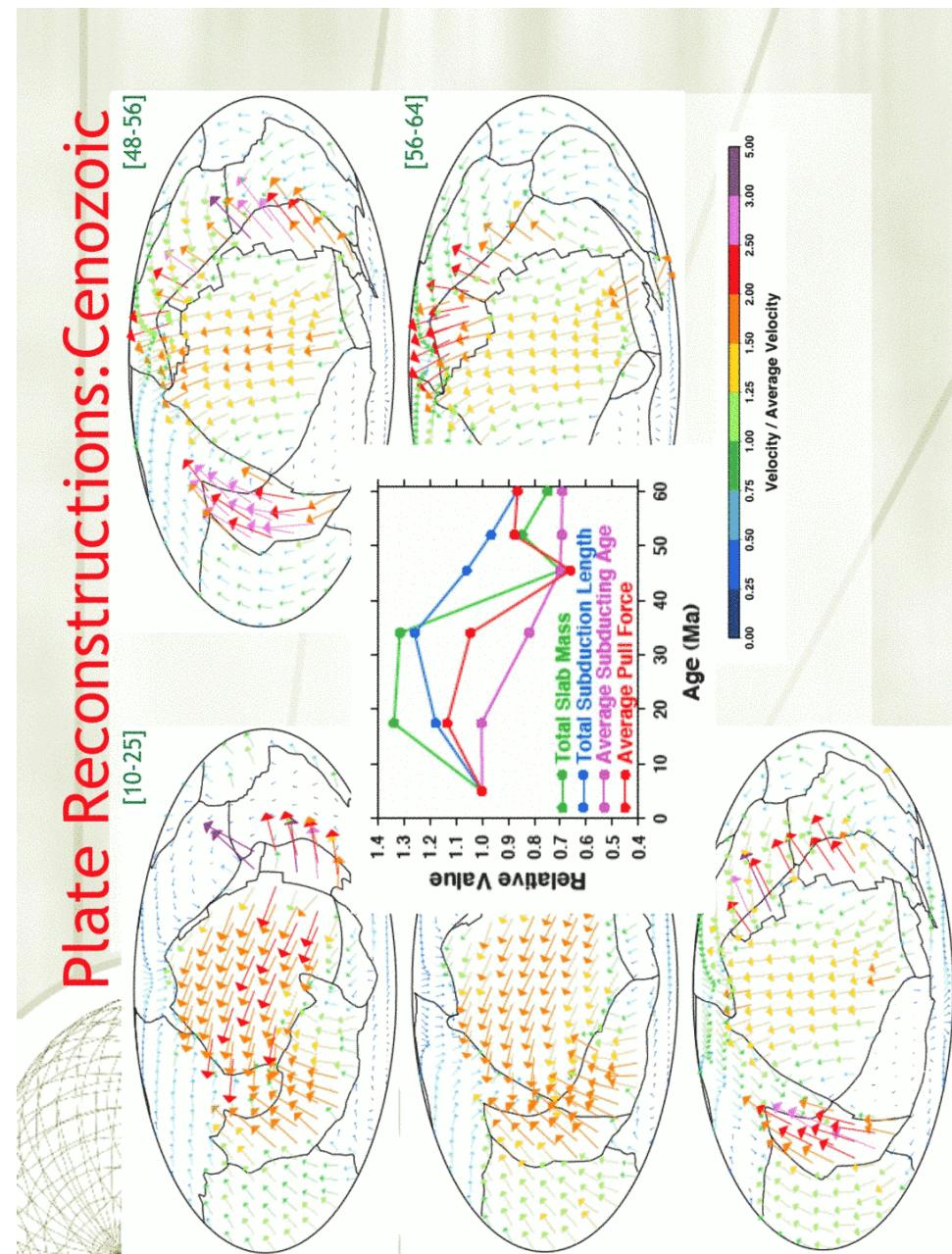
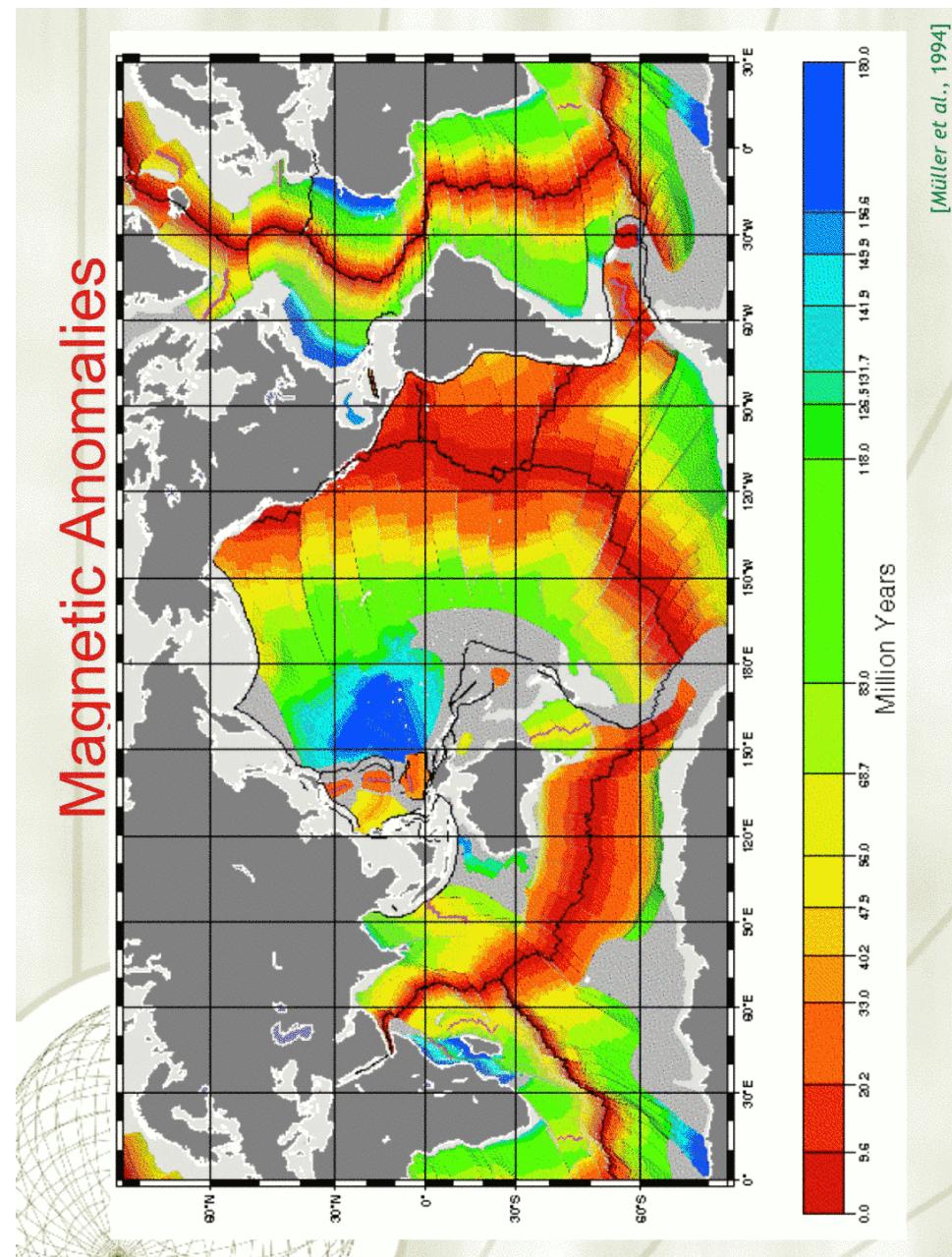
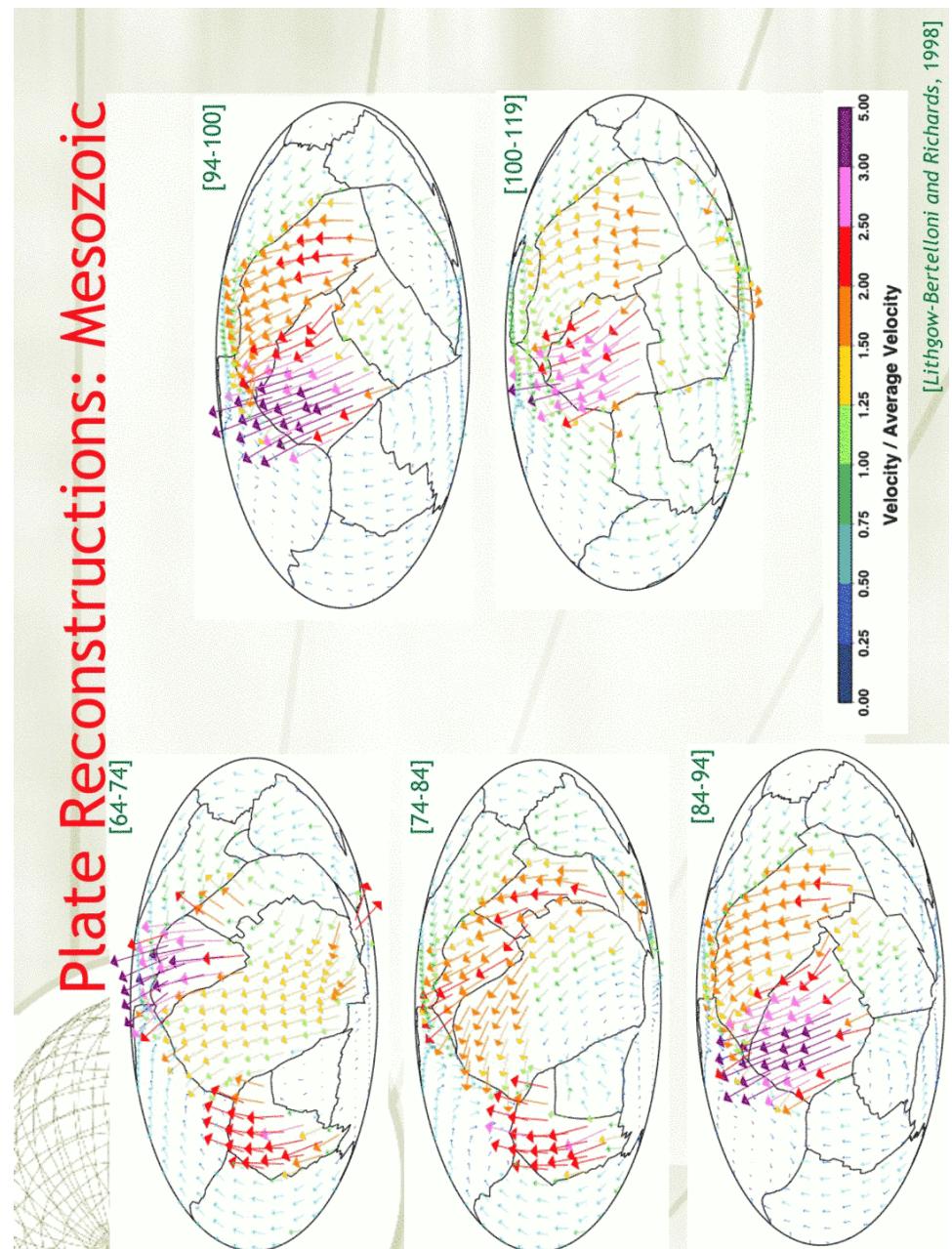
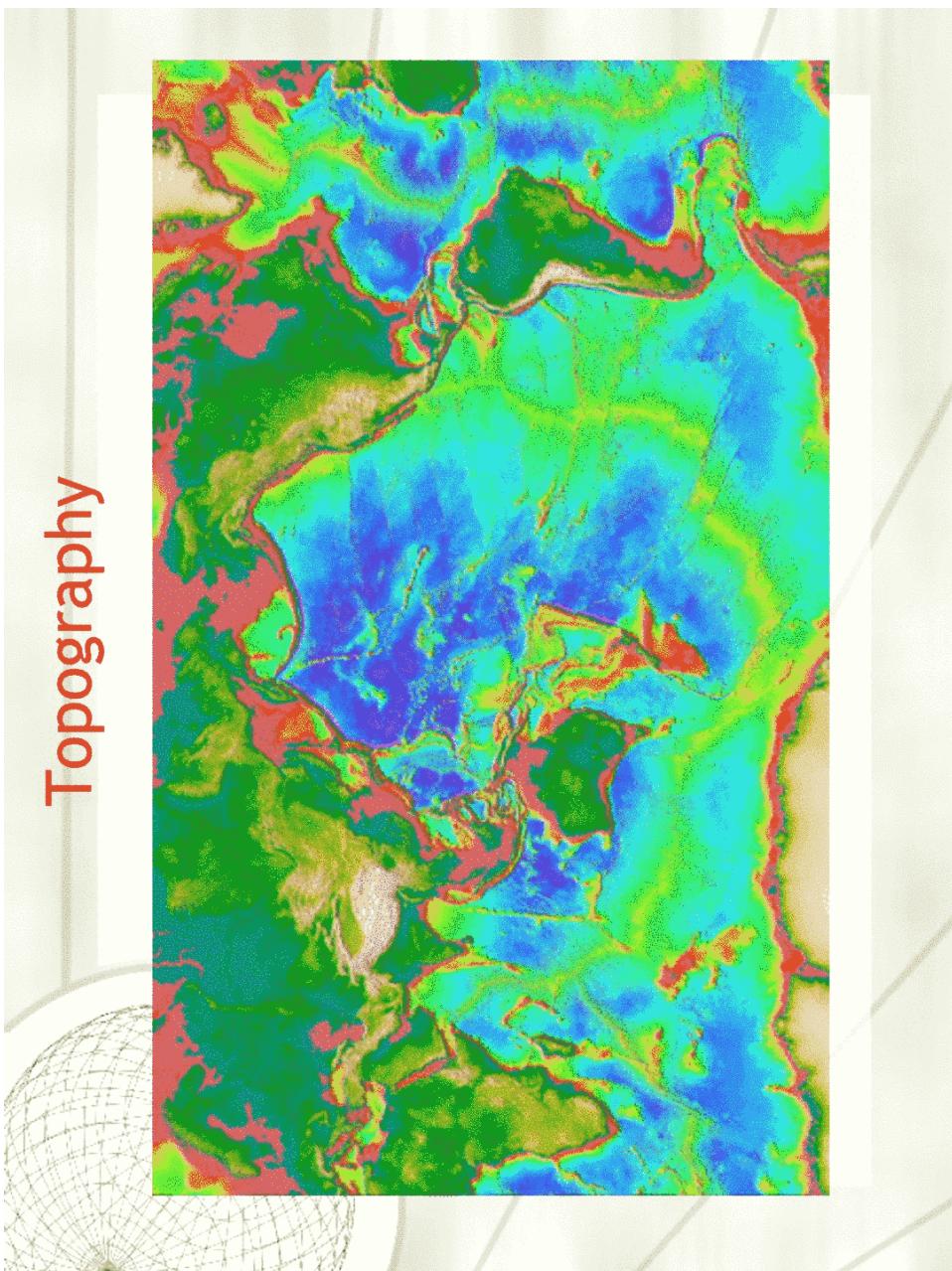


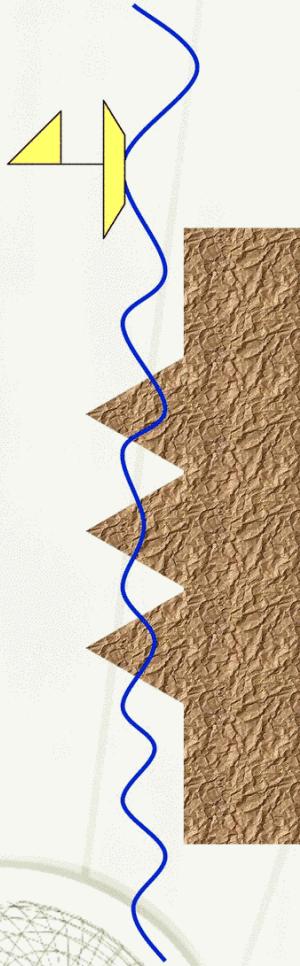
Plate Reconstructions: Mesozoic



Topography

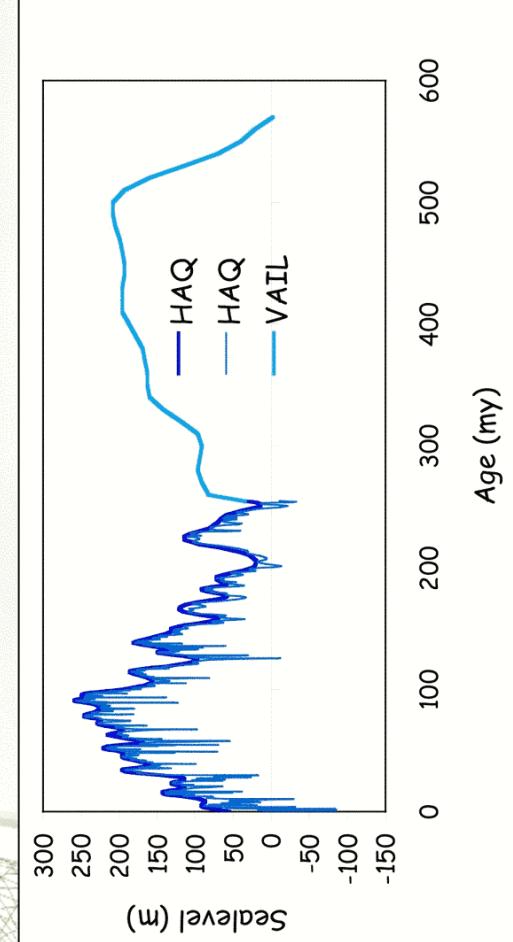


Continental flooding

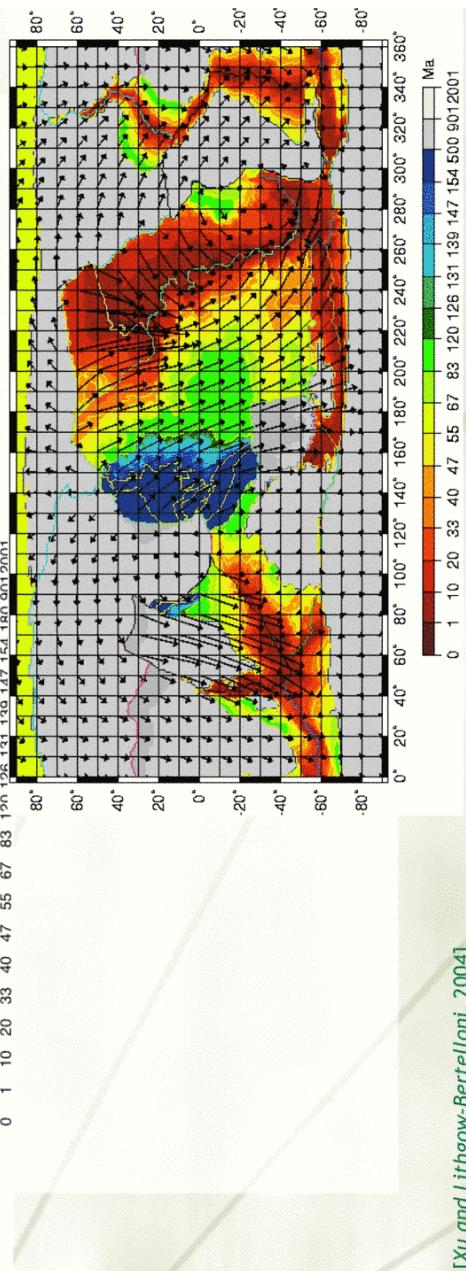
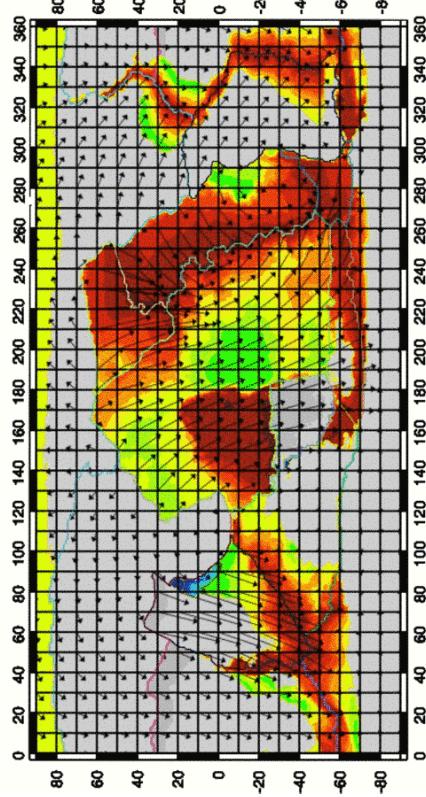


- Ocean-volume variations
 - ice cap melting
 - **Changes in volume of ocean basins**
 - spreading rates
- Isostatic balance of crust
- Orogenesis (short uncompensated λ)
- **Epeirogeny**
 - long λ **dynamic topography**; tectonic uplift; post-glacial rebound

Sea-level

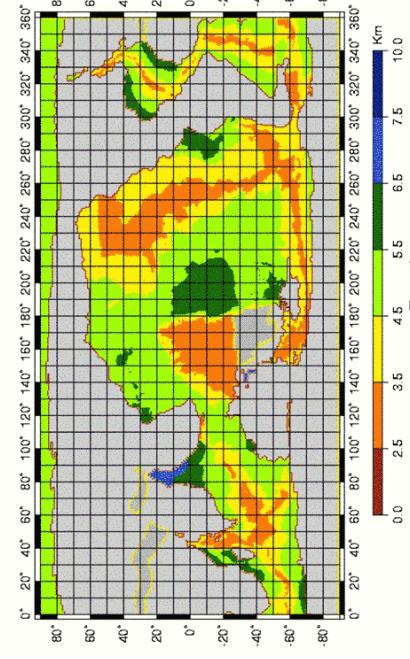


Ages: 64 Ma

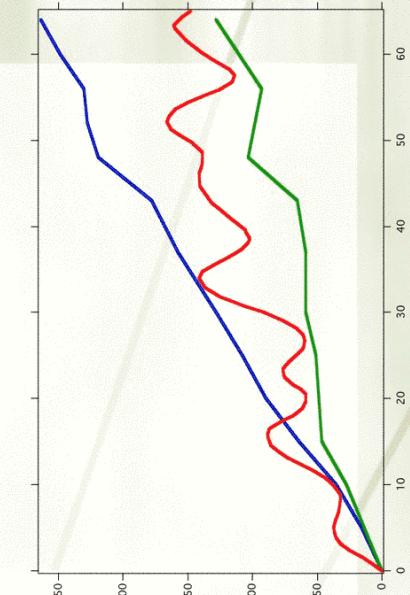


Bathymetry and sea-level

age = 64 Ma

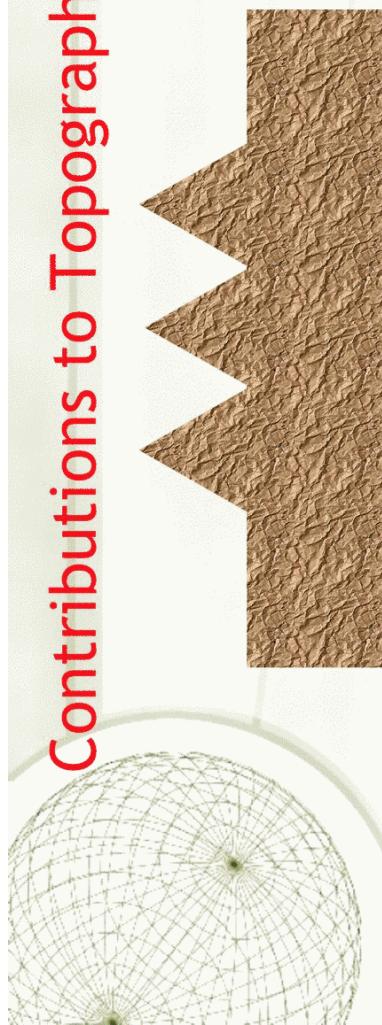


Following Pitman (1978)



- [Haq et al.] —
- [Using G&J, 1986] —
- [Using Hall (2000) for Philippine plate] —

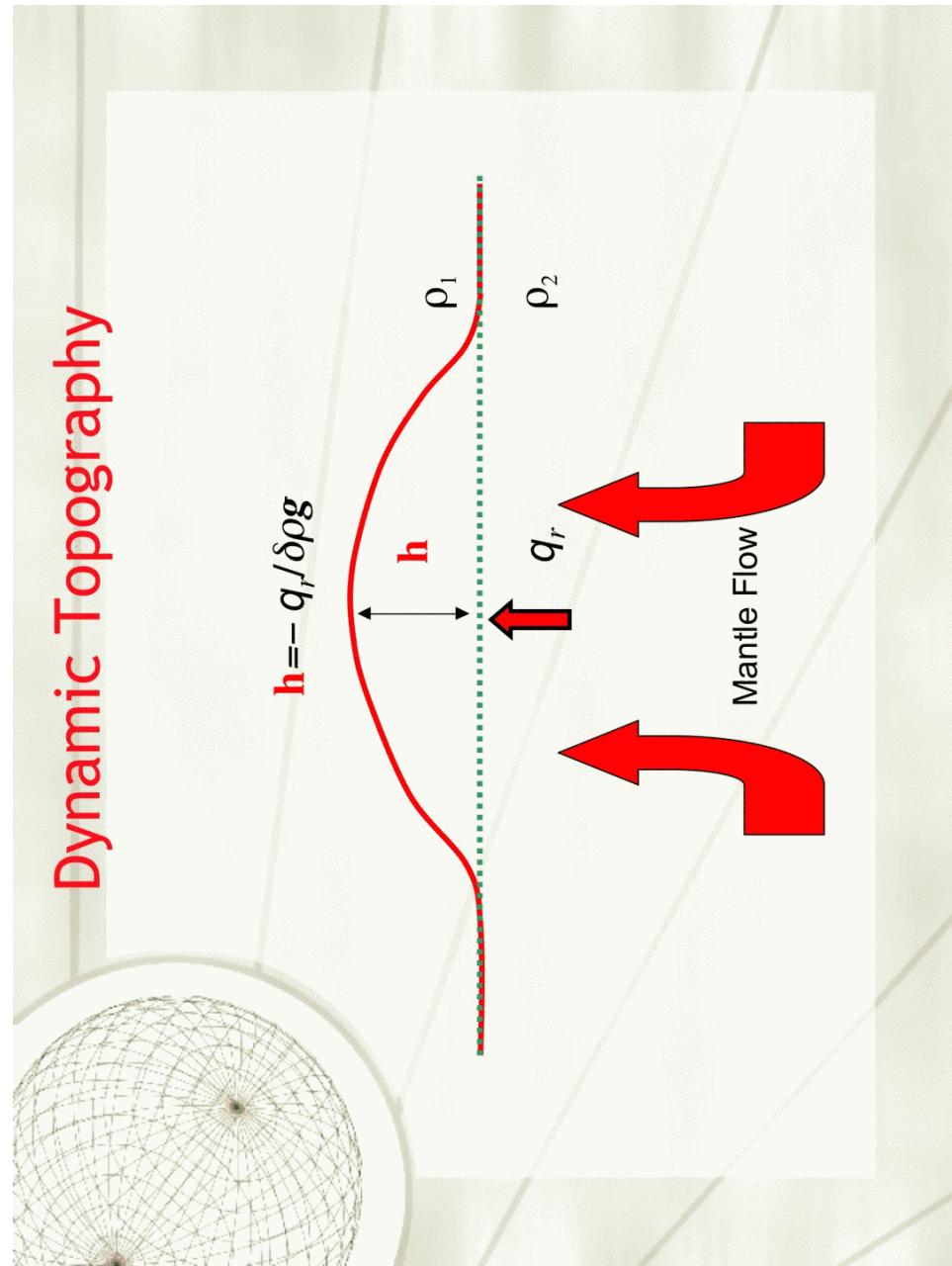
Contributions to Topography



Factors:

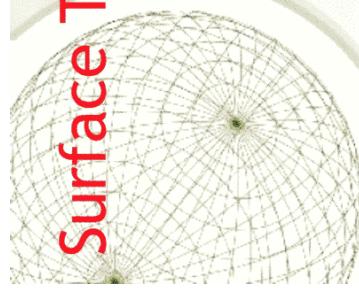
- ♦ Isostatic balance of crust
- ♦ Orogenesis
 - short λ , uncompensated
 - Long λ
 - Tectonic uplift; post-glacial rebound; dynamic topography (Mitrovica et al., 1989; Gurnis, 1993)
- ♦ Epeirogeny

Dynamic Topography



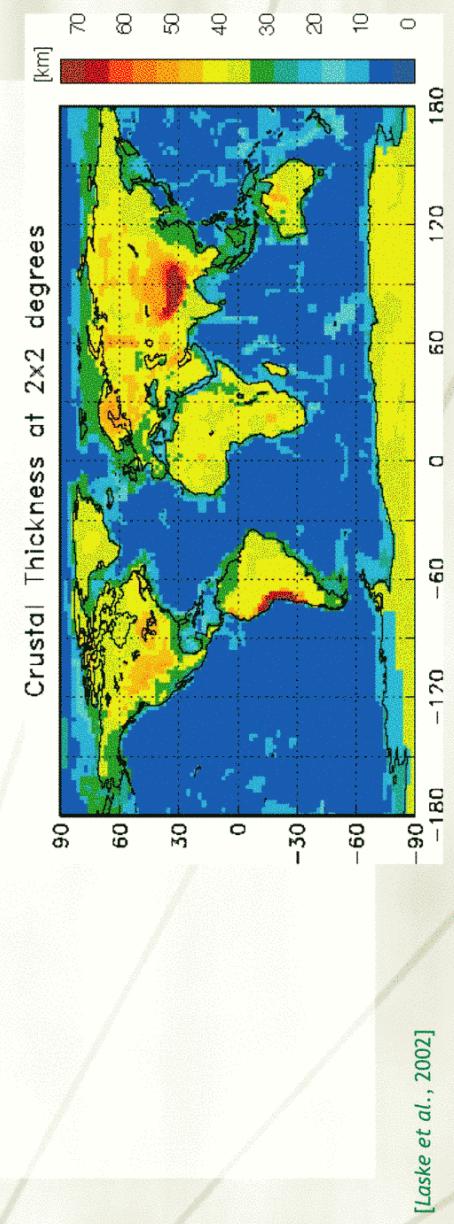
$$h = -q_r / \delta \rho g$$

Surface Topography



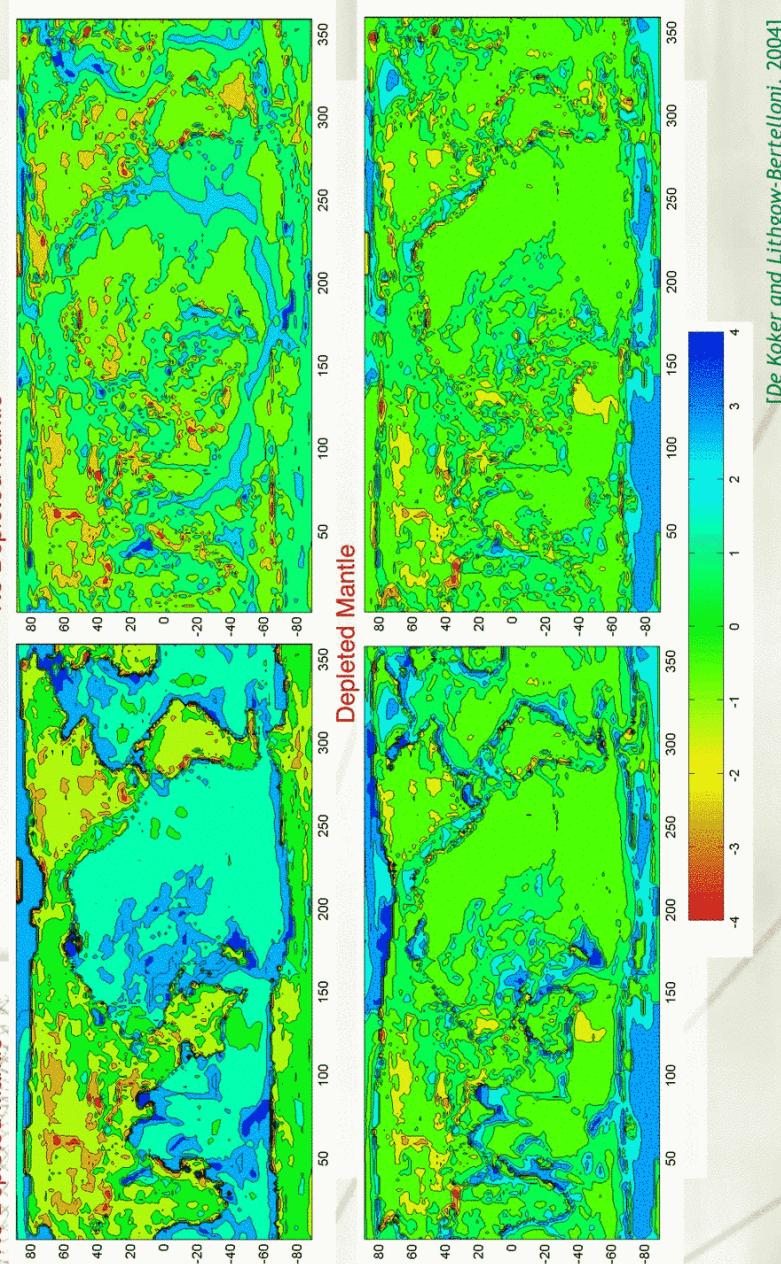
Crustal Structure

Crustal Thickness at 2x2 degrees

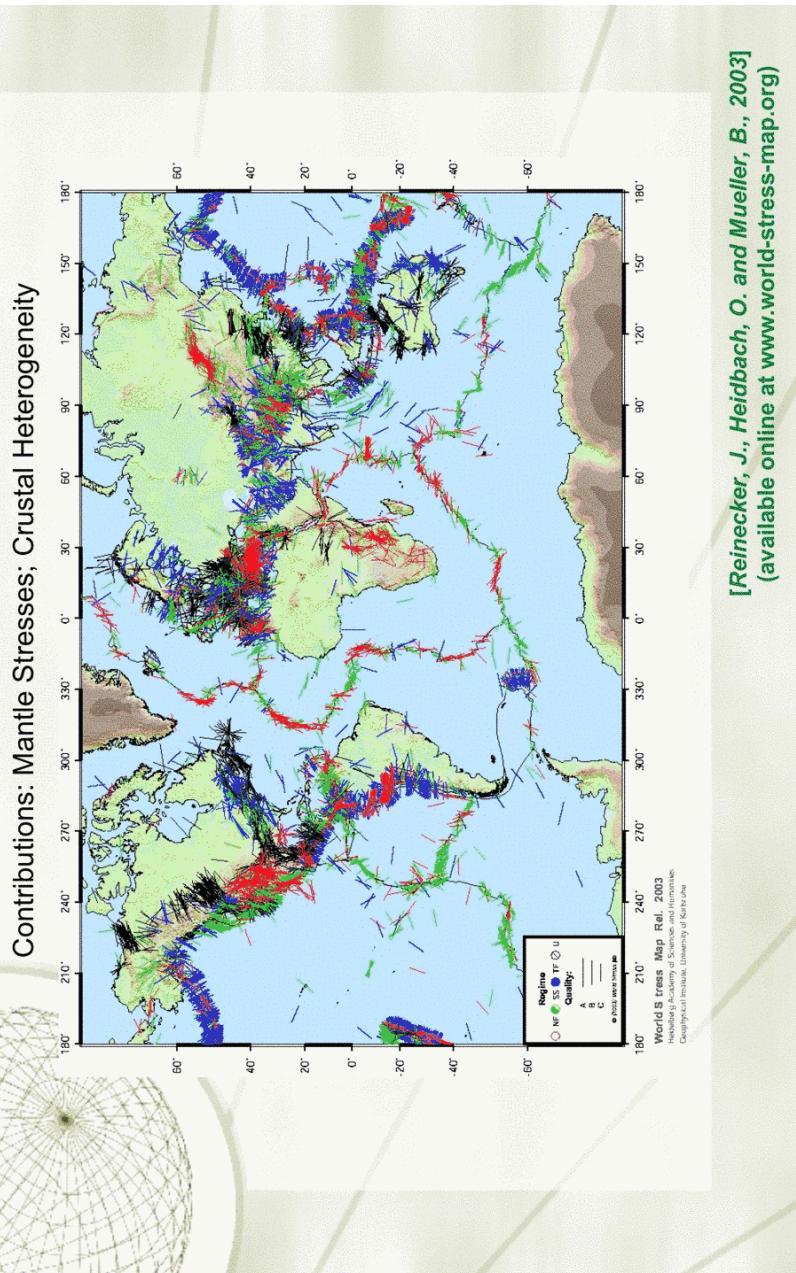


Residual Topography

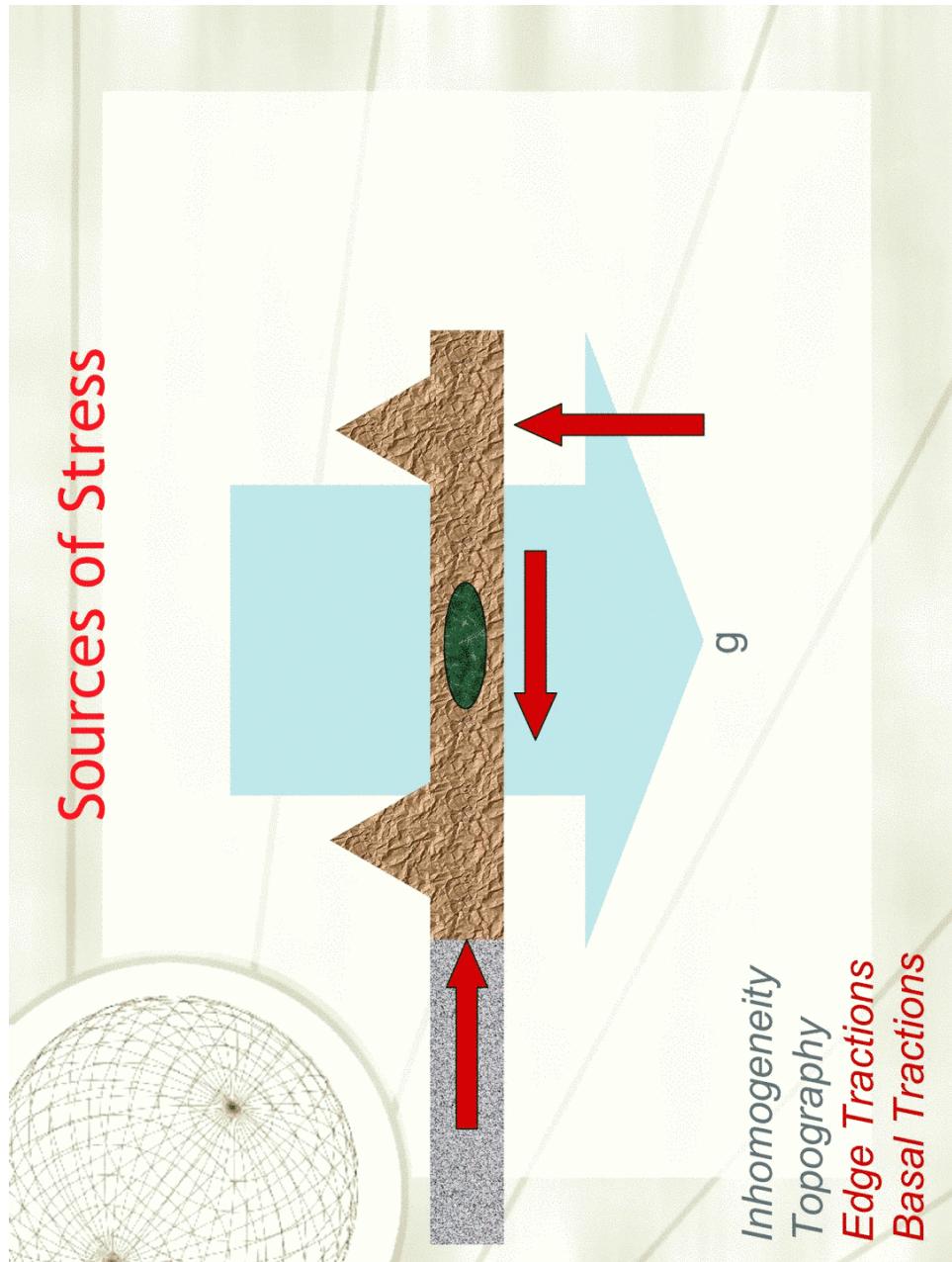
Continents-Crust 2.0; Oceans-Bathymetry from Isostasy
No Depleted Mantle



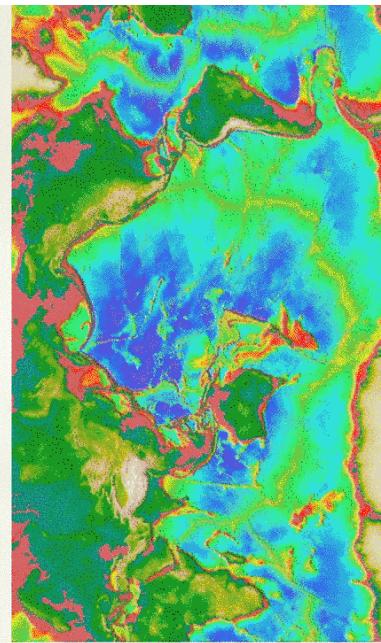
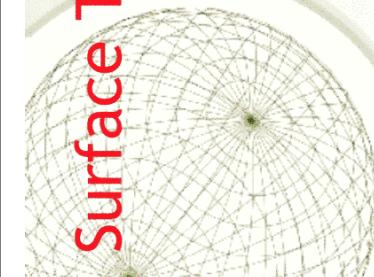
Lithospheric Stress Field



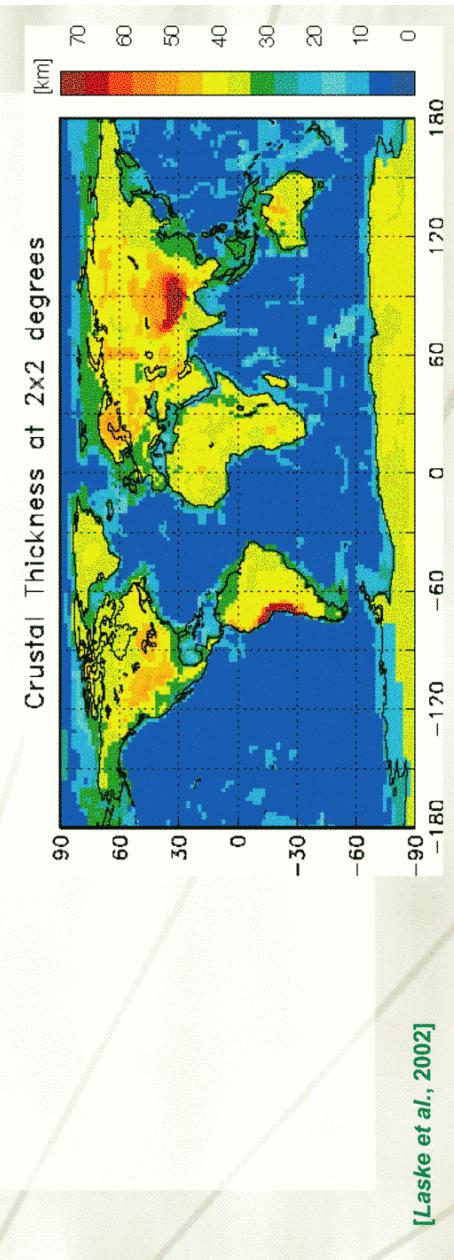
Sources of Stress



Surface Topography



Crustal Structure



Mantle Traction

