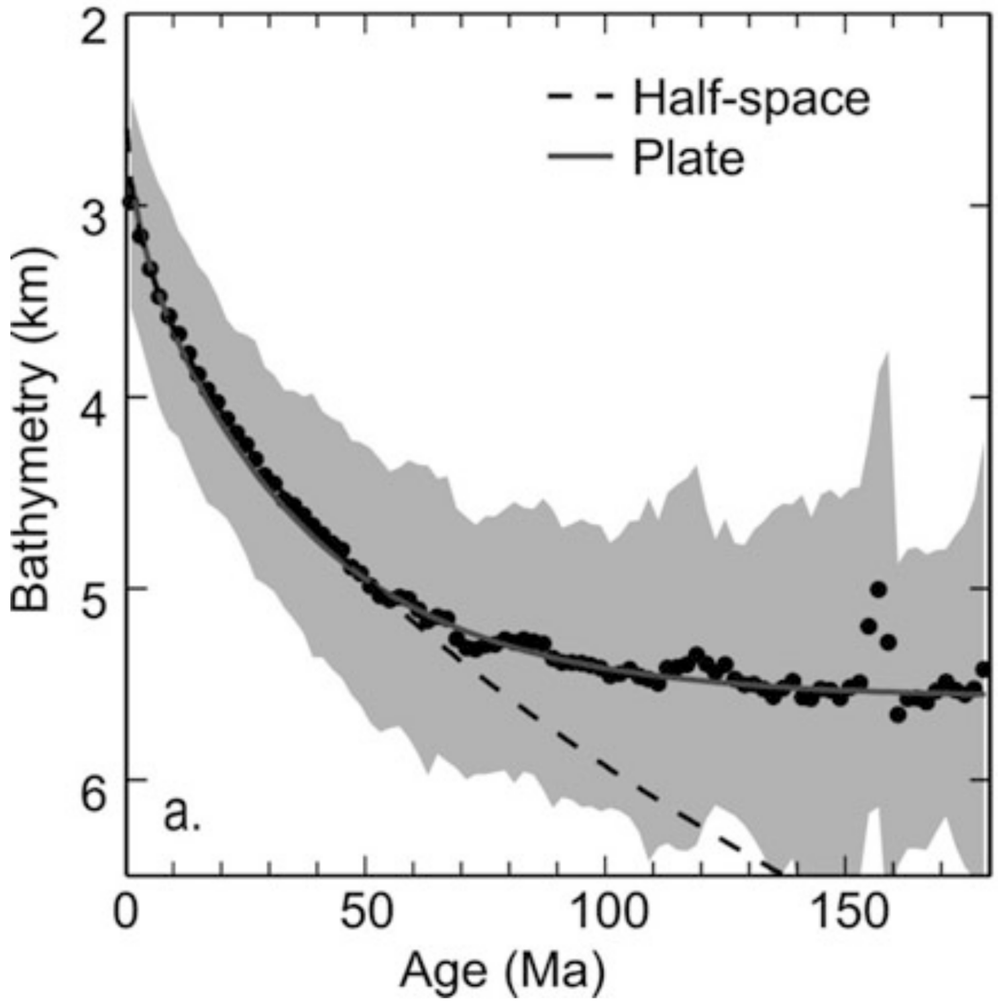
Lecture 3: Sea-floor depth, age, and heat flow

- Mid ocean ridges and the topography of the sea-floor
    - Boundary layer model
    - Plate model
- How do we map the seafloor today?

We acknowledge and respect the lək̓ʷəŋən peoples on whose traditional territory the university stands and the Songhees, Esquimalt and W̱SÁNEĆ peoples whose historical relationships with the land continue to this day.

Boundary Layer Model (cooling of an infinite half-space)



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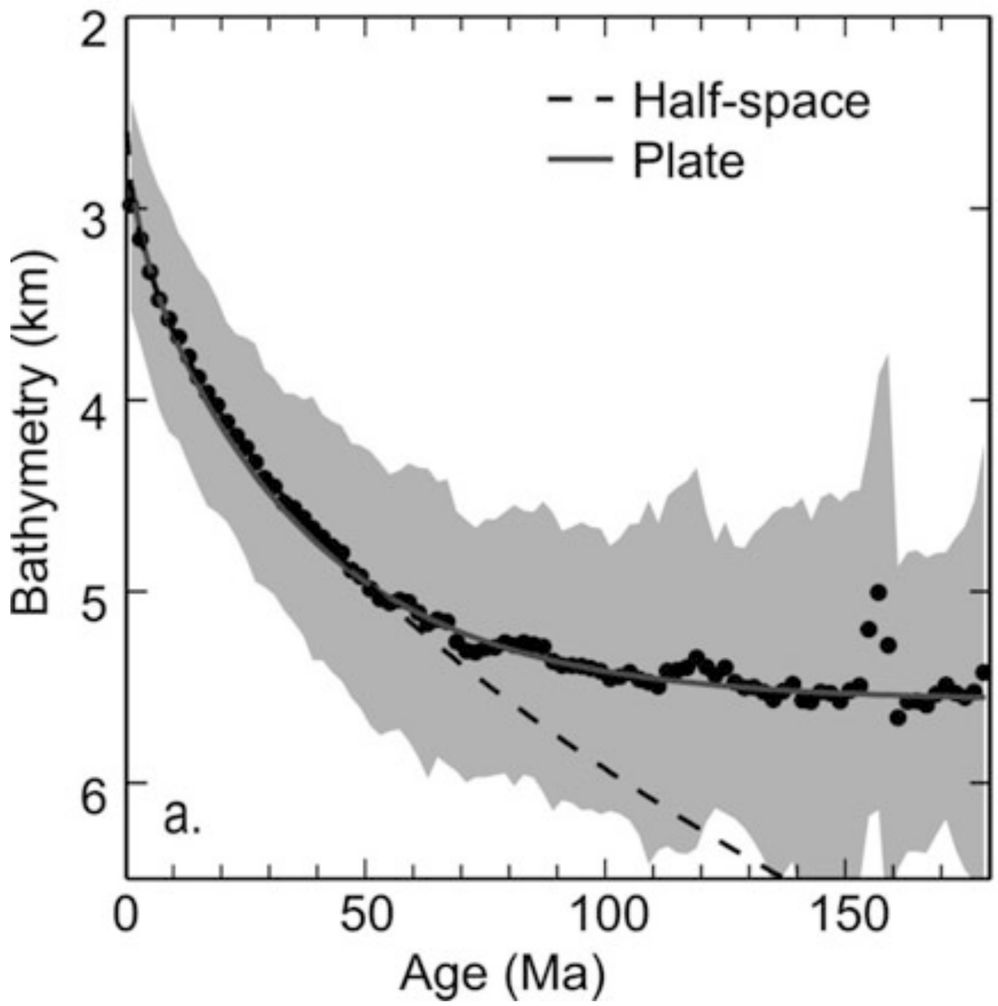

If the sea-floor gets deeper away from a mid-ocean ridge, is the lithosphere density higher or lower than the asthenosphere?

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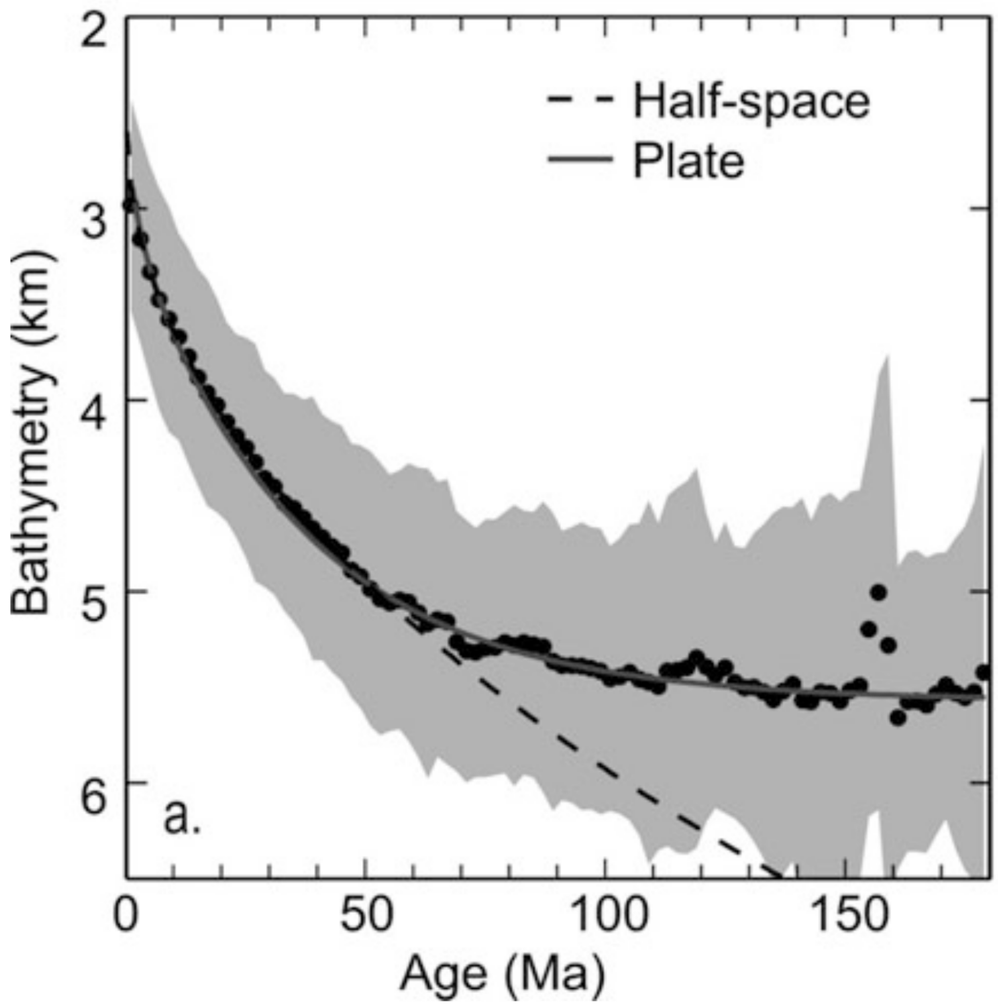

If the sea-floor gets deeper away from a mid-ocean ridge, is the lithosphere density higher or lower than the asthenosphere?

- Calculate the thickness of the lithosphere
  - at 0 Ma (3 km bathymetry)
  - at 20 Ma (4 km bathymetry)
  - at 50 Ma (5 km bathymetry)
- Using the following densities:
  - Cool peridotite (lithosphere): 3400 kg/m^3
  - Hot peridotite (asthenosphere): 3300 kg/m^3
  - Water: 1000 kg/m^3

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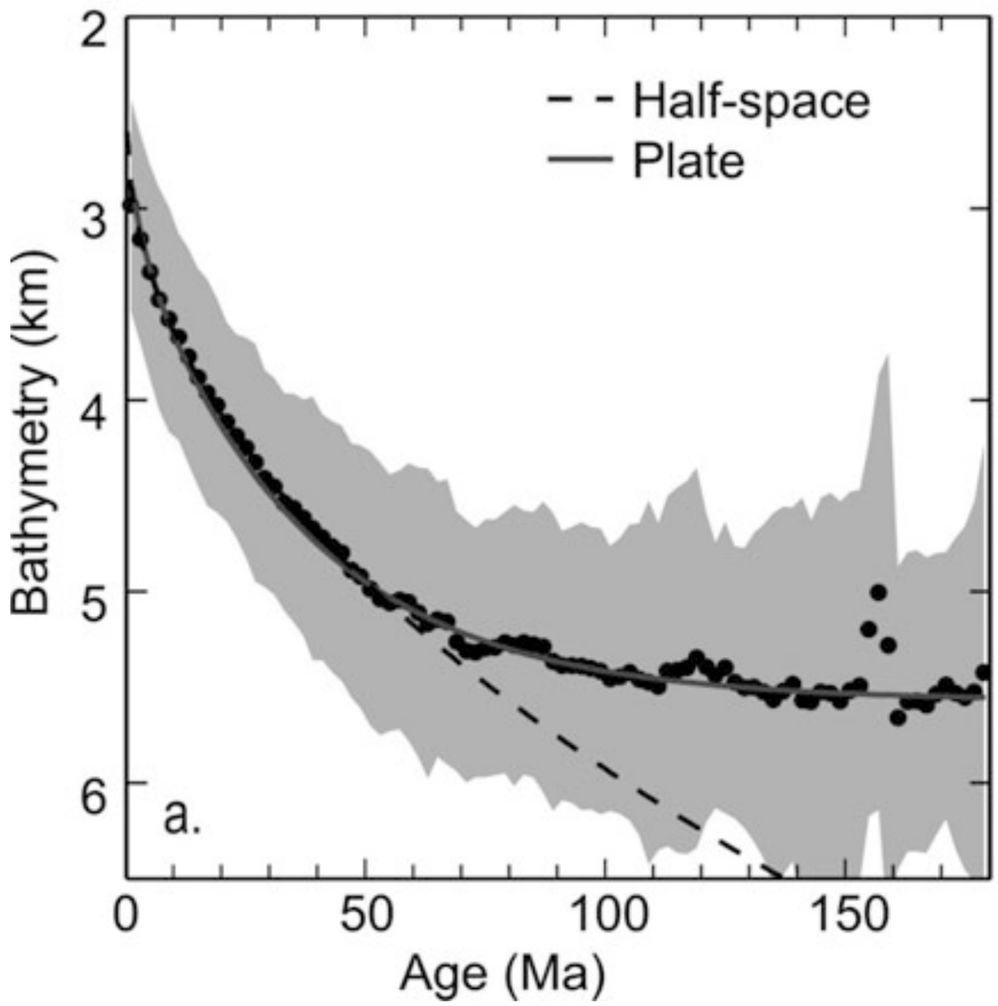

The dashed line is the predicted topography of the sea-floor using the diffusion equation and measured thermal conductivities of mantle material. Why do you think the model fails for older crust?

The denser lithosphere thickness stops increasing (maximum plate thickness). Why?

Plate model

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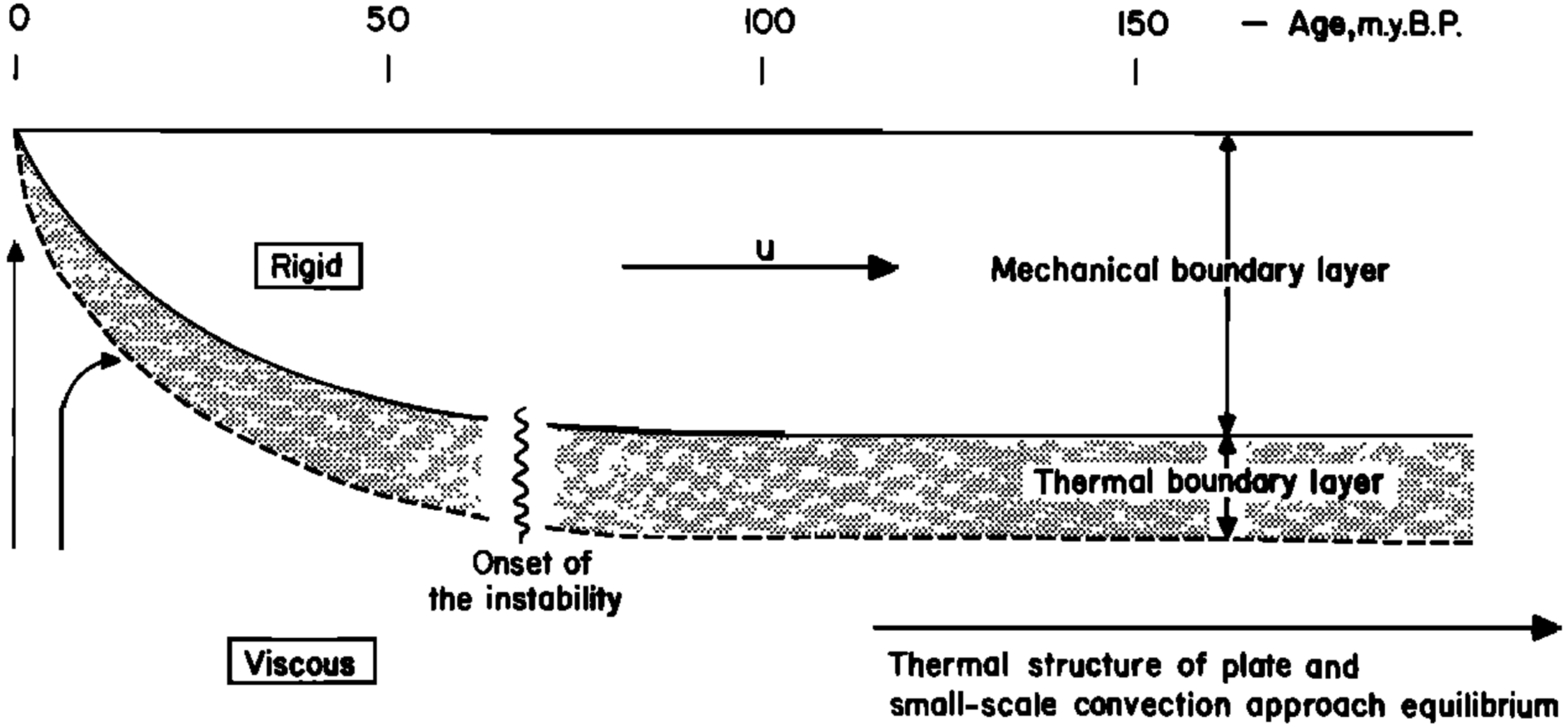

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Parsons and McKenzie are specifically describing a layer near the lithosphere-asthenosphere boundary where the combined viscosity contrasts and temperature contrasts lead to small scale convection.

Thermal boundary layers

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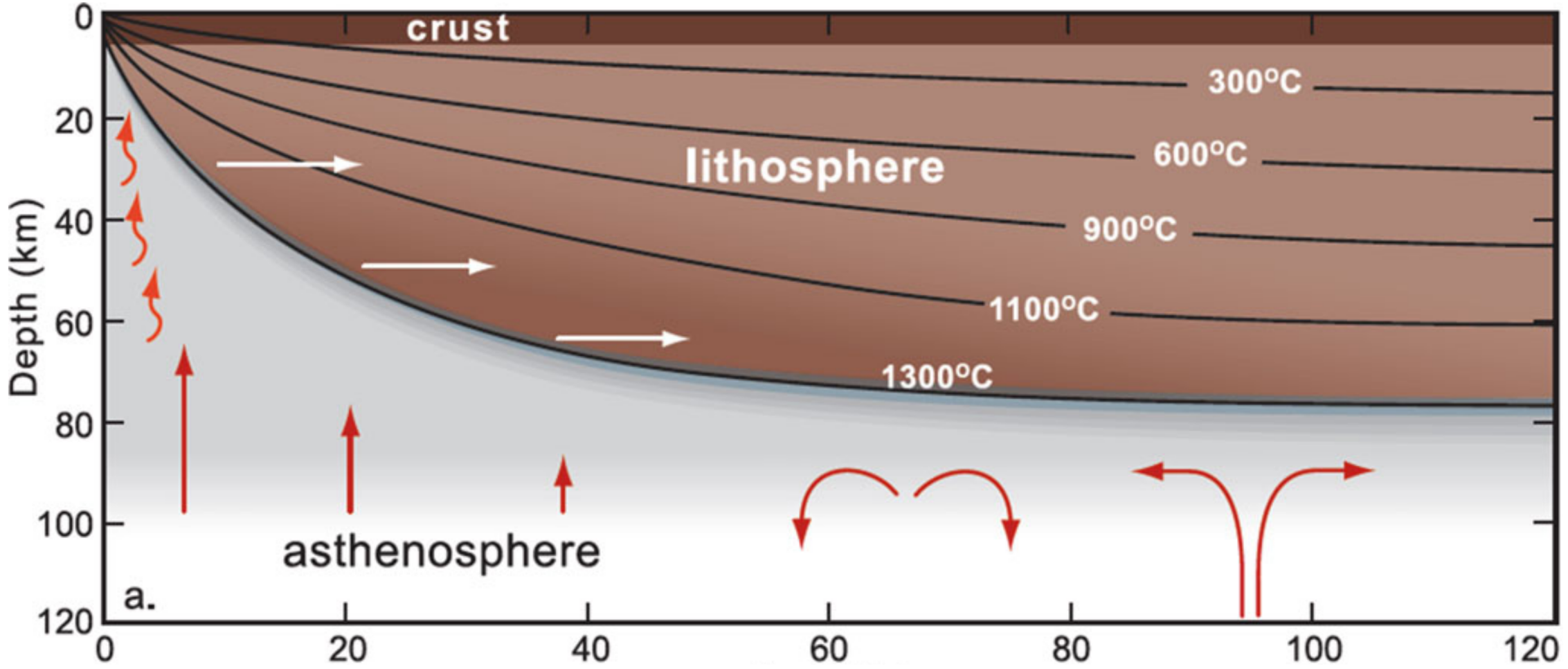

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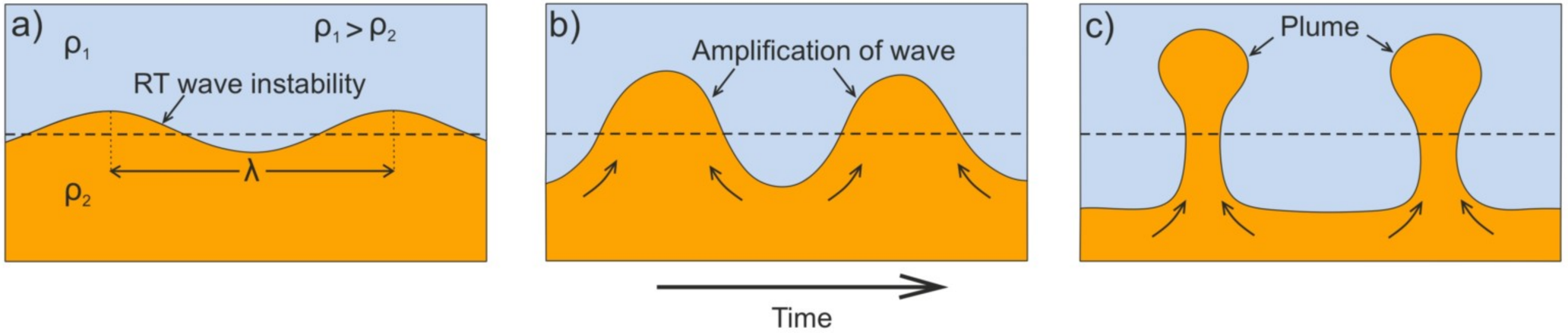

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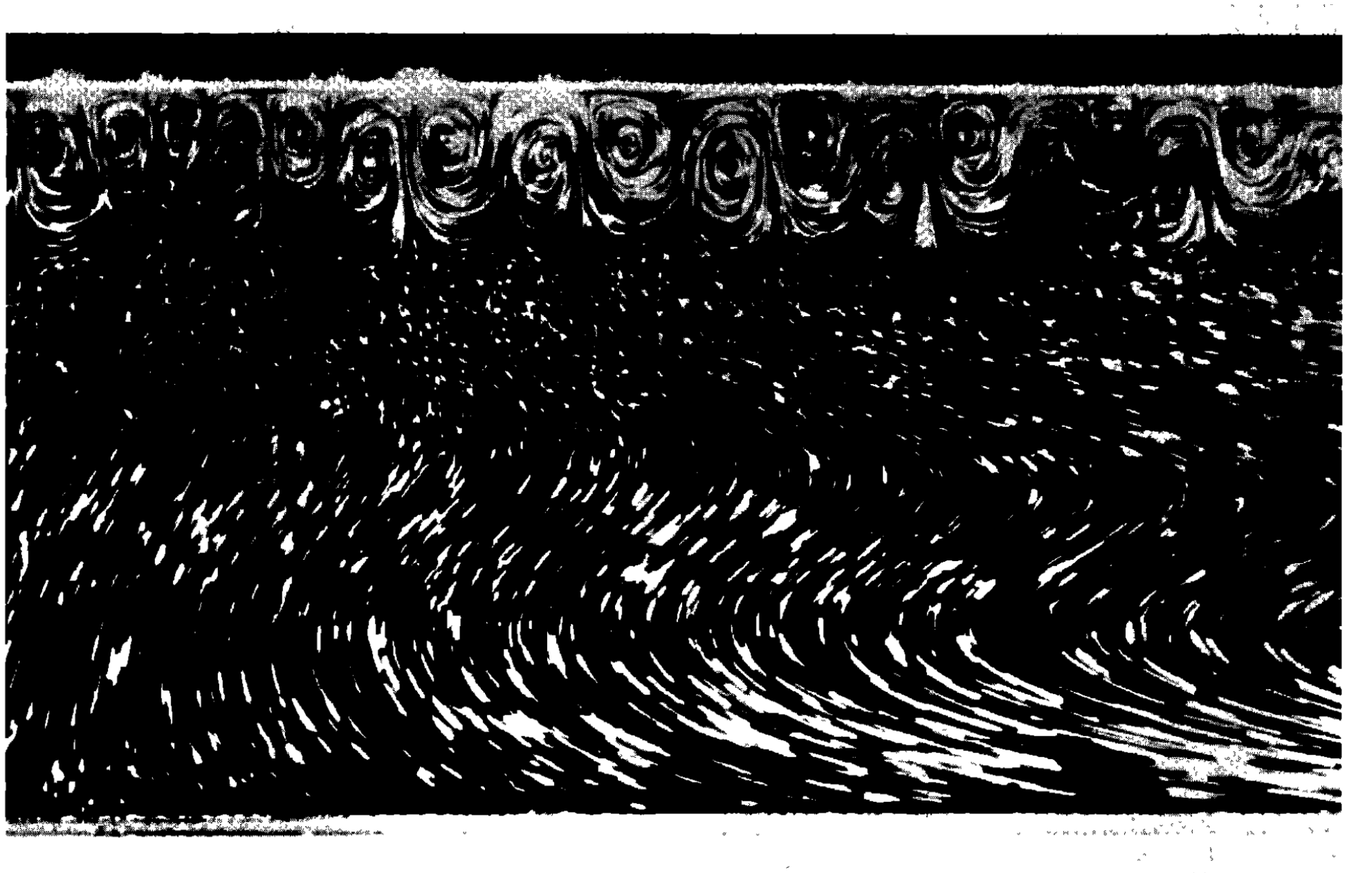

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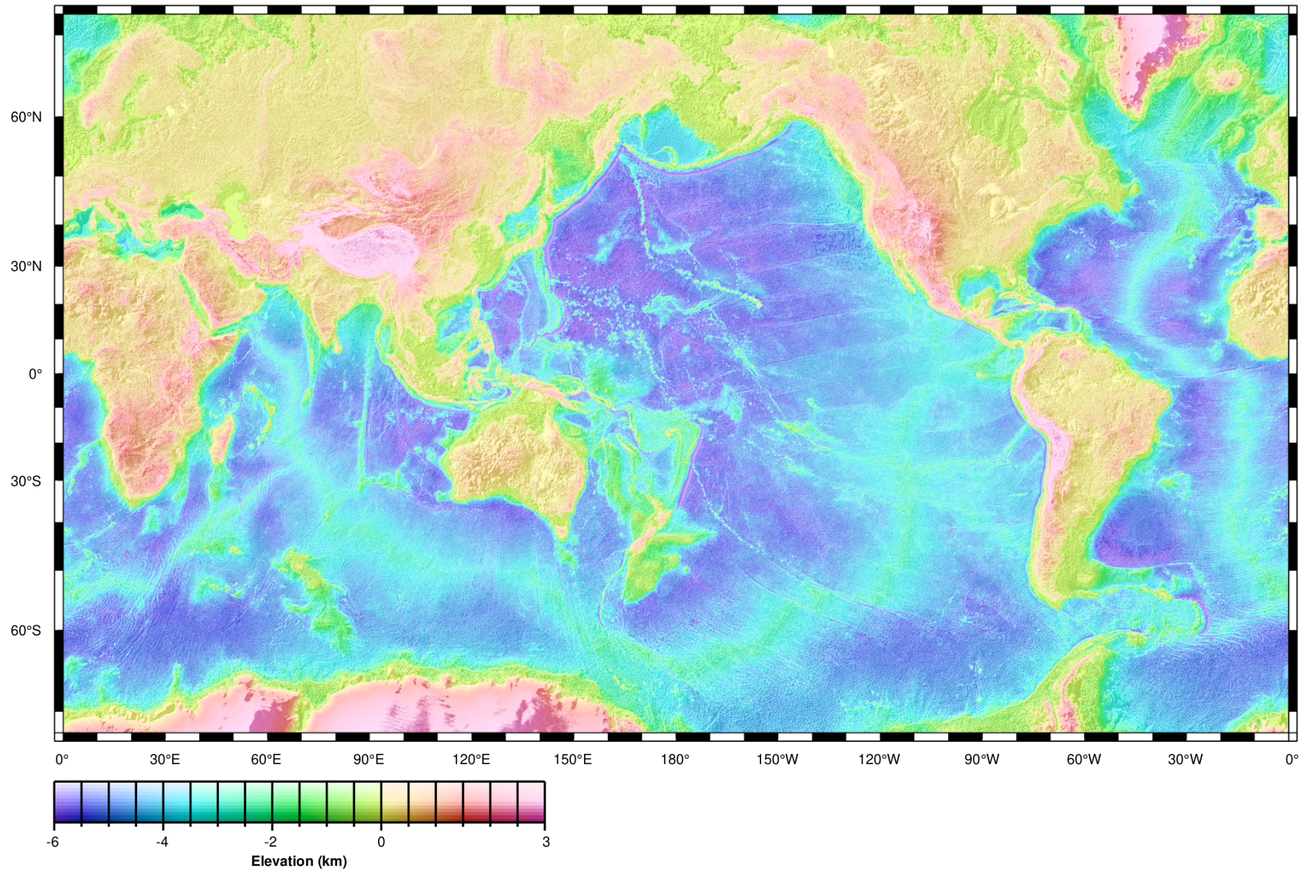
Recall our drawings of thermal profiles earlier, how does a fixed boundary condition at 100 km change the temperature profile in the lithosphere?

Mapping the sea-floor



How do we map the bathymetry of the sea-floor?

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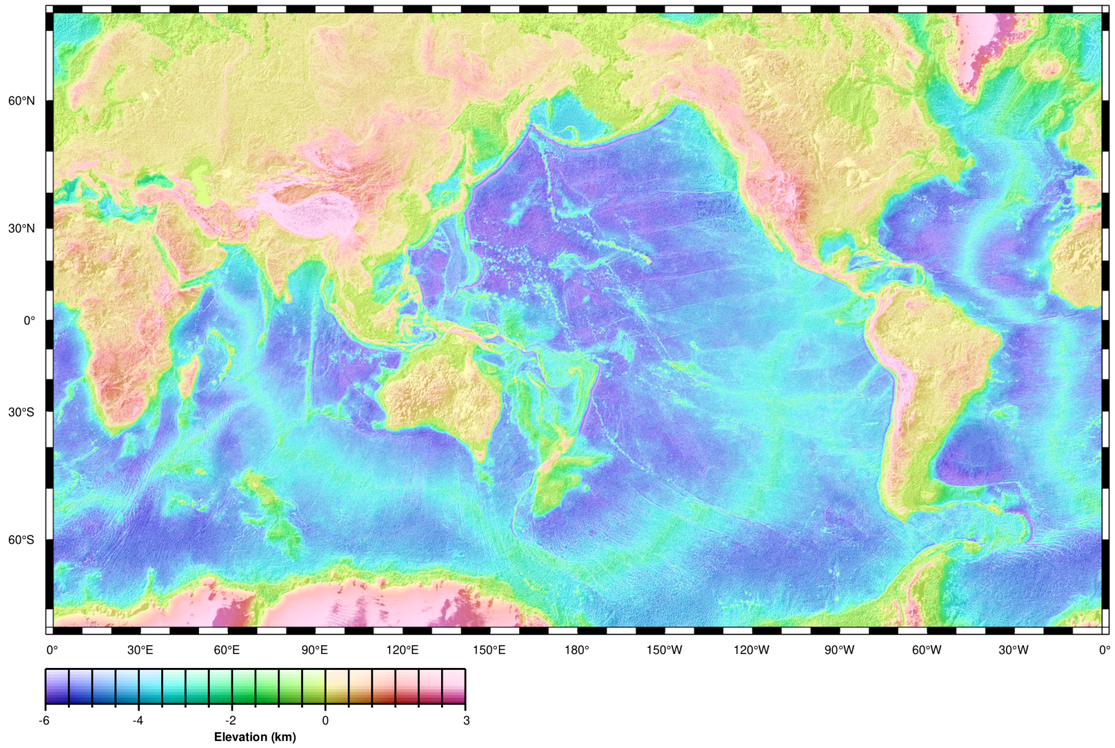
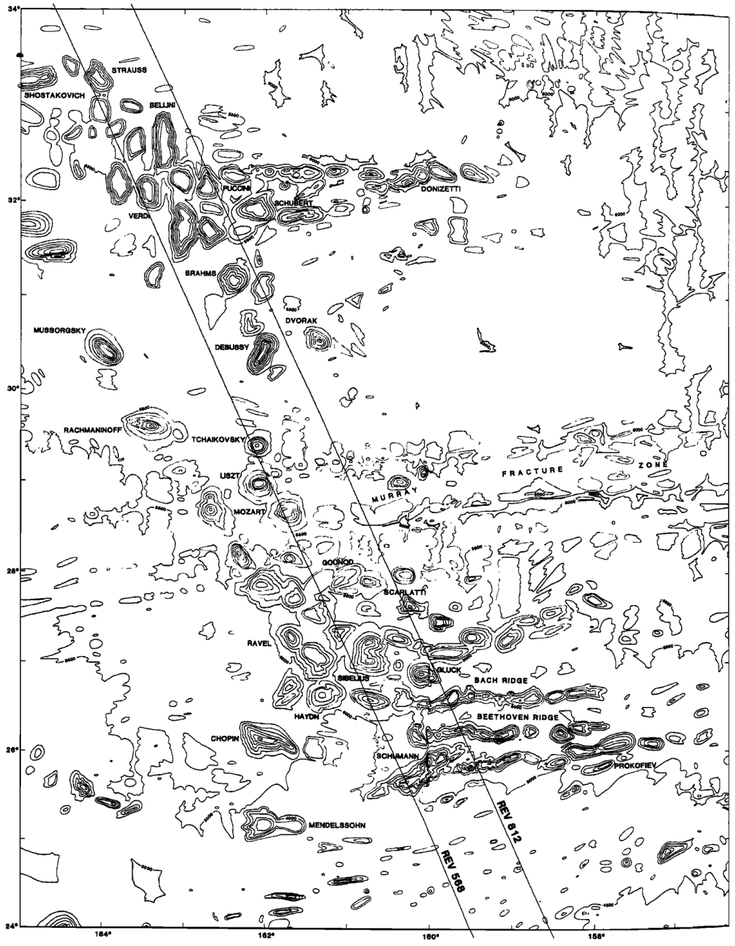


How do we map the bathymetry of the sea-floor?

A combination of:

- Depth Soundings
- Satellite Altimetry

Bathymetric Prediction From SEASAT Altimeter Data (Dixon et al. 1983)



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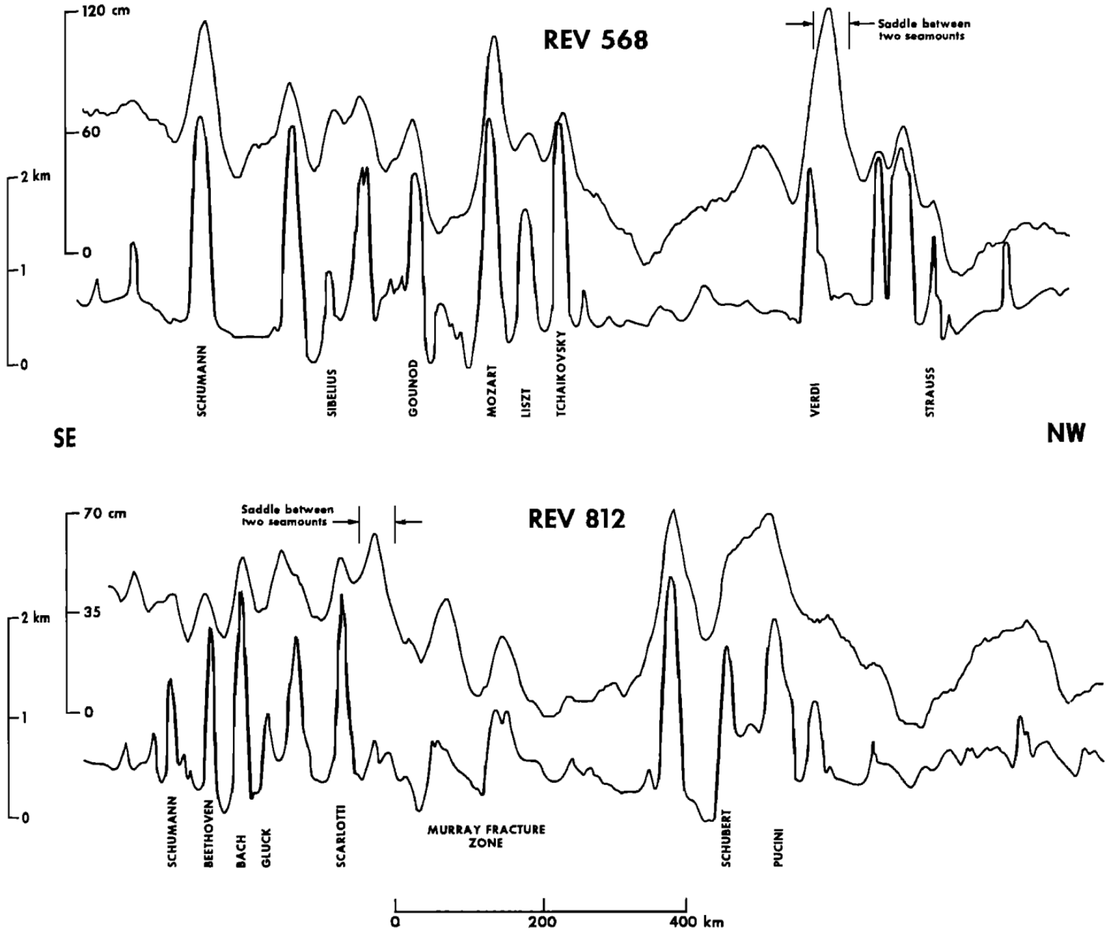

Gravitational potential

Gravitational potential is the the work (energy transferred) per unit mass that would be needed to move an object to that point from a distance infinitely far away. Recall that: $\text{work} = \text{force} \times \text{displacement}$

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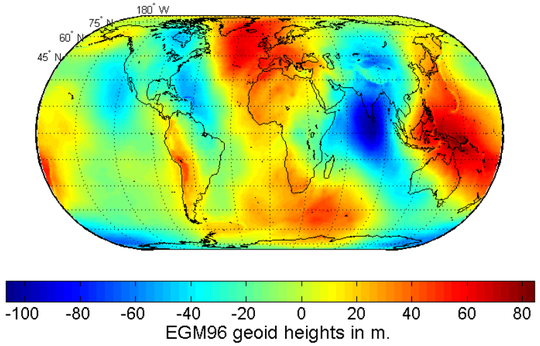

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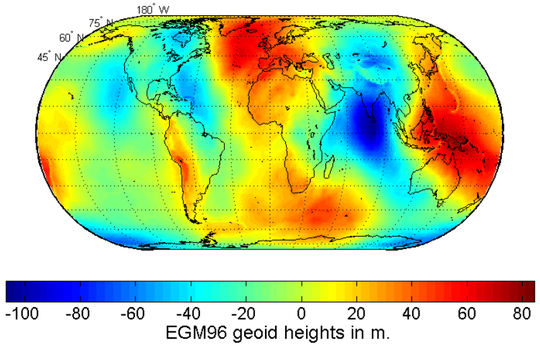

The **geoid** (a model) is the ocean surface elevation if winds and tides were absent.