Lecture 2: Sea-floor depth, age, and heat flow

- Why do we have ocean basins?
- Mid ocean ridges and the topography of the sea-floor
- Heat transport in the Earth

We acknowledge and respect the ləkʷəŋən 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.

A volunteer Notetaker is needed for this course.

As a Notetaker, you will be asked to share accurate and timely lecture notes to support the needs of your peers who require equal access to academic programs.

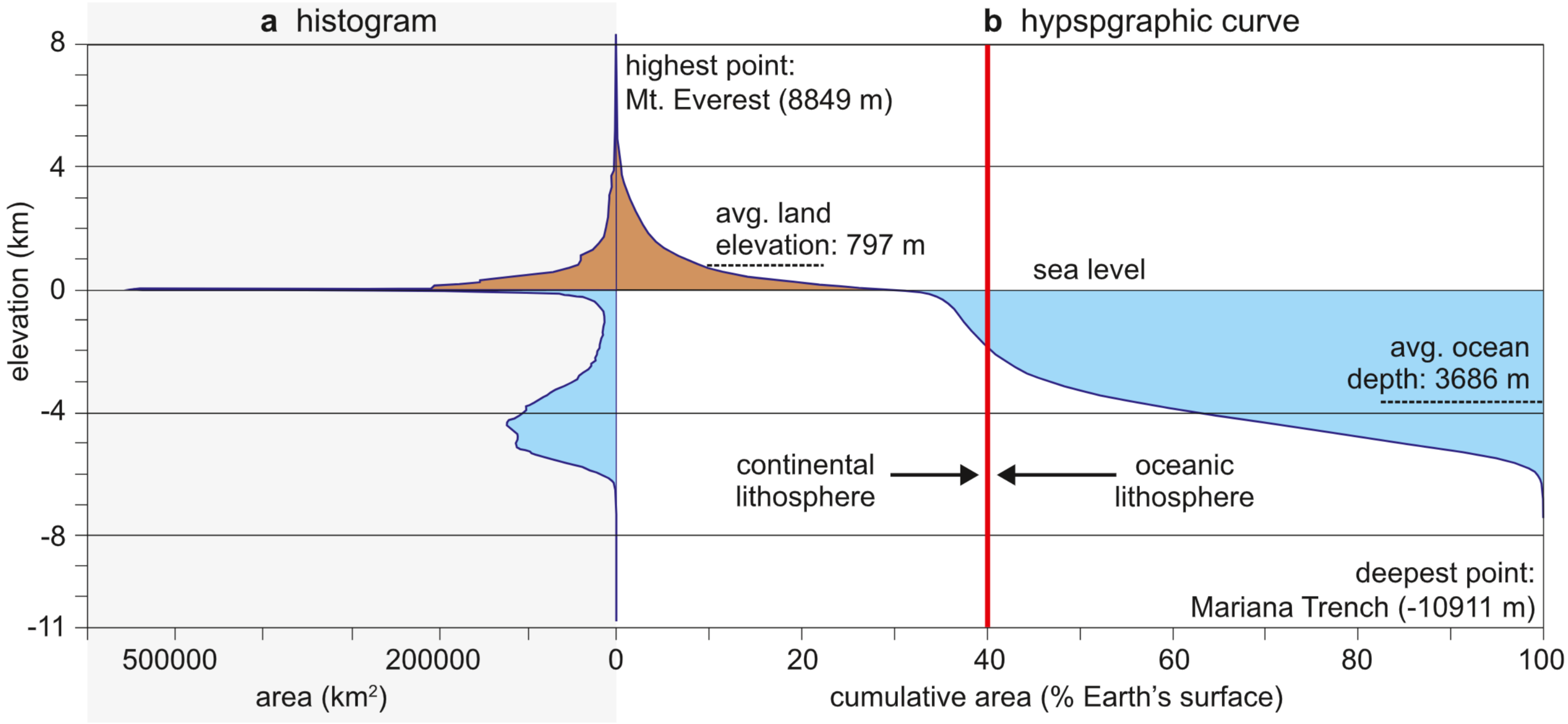
If you would like to volunteer to share your notes in this course, please e-mail me (blakedyer@uvic.ca).
Thank you very much!

What are ocean basins?

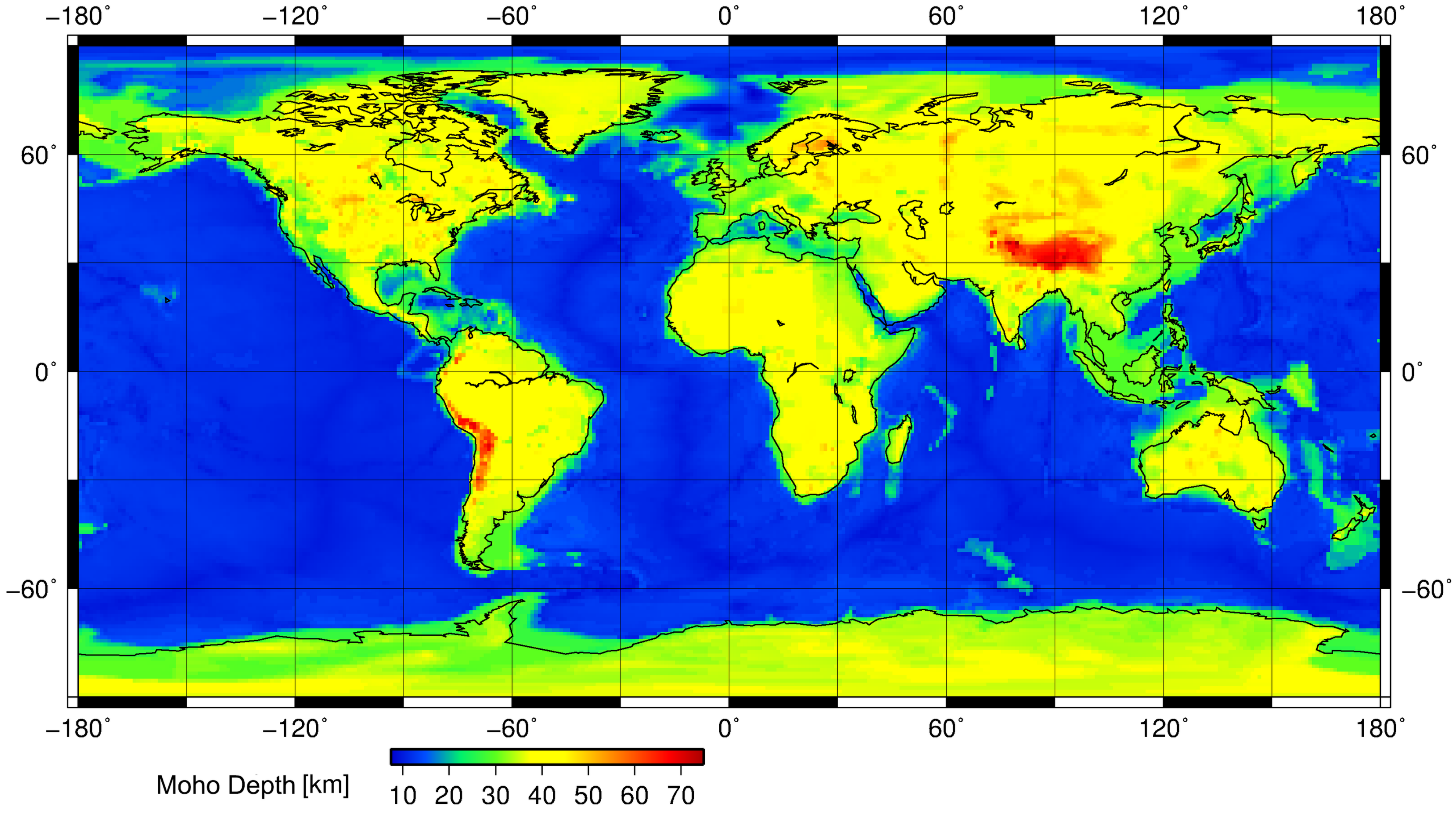
"We can only sense that in the deep and turbulent recesses of the sea are hidden mysteries far greater than any we have solved."

-Rachel Carson, *The Sea Around Us*, 1957

What are ocean basins?



Mohorovičić discontinuity



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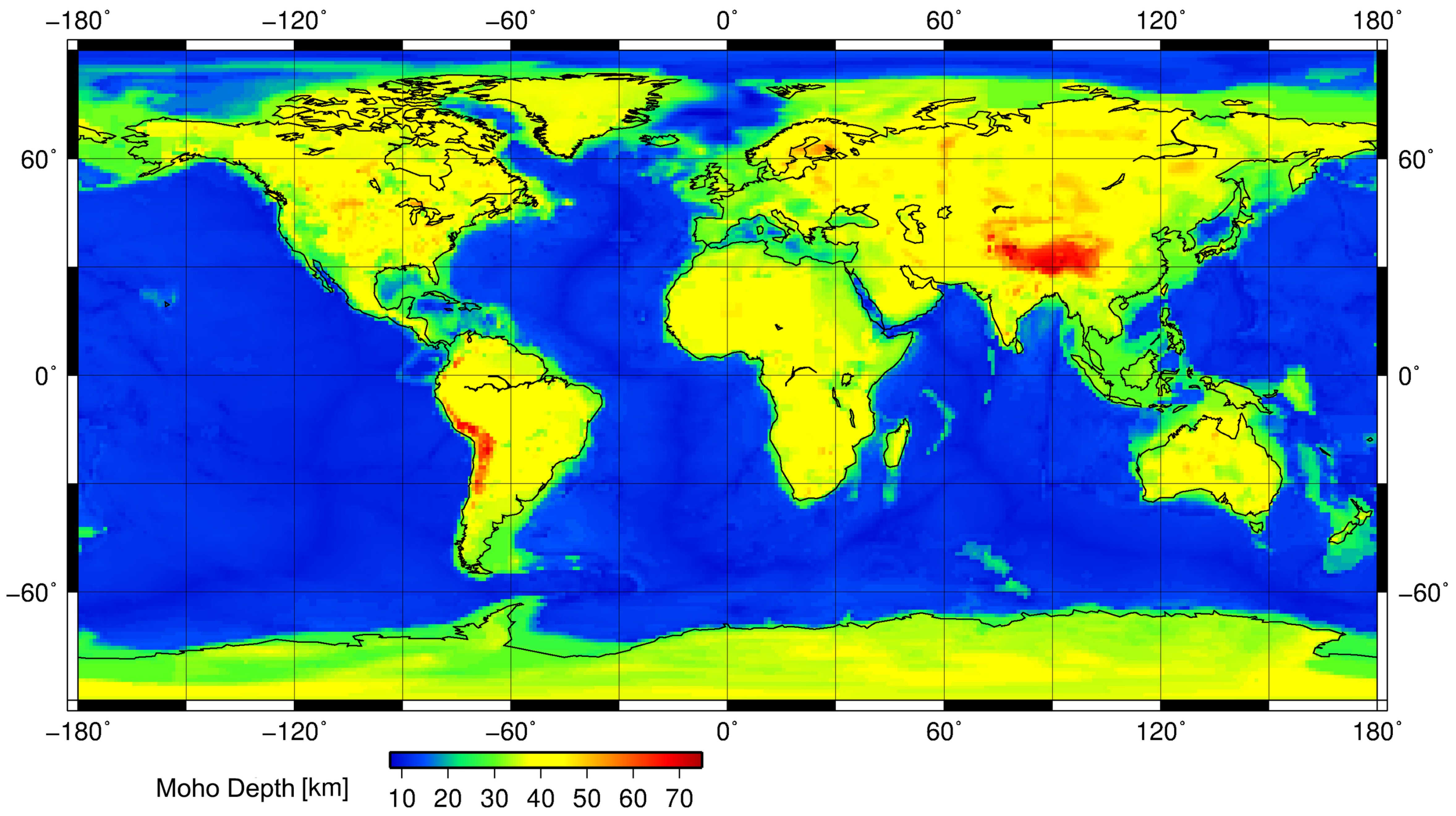

What are the differences between lithosphere and asthenosphere and crust and mantle?

Mohorovičić discontinuity

"Seismic evidence shows that the so-called crustal thickness-depth to the M discontinuity-is 6 km under oceans and 34 km under continents on the average."

-Harry Hess, *History of Ocean Basins*, 1962

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How can we test this assumption?

Testing isostatic equilibrium

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- Continental crust:
  - Mean elevation: 797 m
  - Mean thickness: 34 km
  - Andesite with density: 2.8 g/cm^3
- Oceanic crust:
  - Mean elevation: -3686 m
  - Mean thickness: 6 km
  - Basalt with density: 2.9 g/cm^3
- Density of water: 1 g/cm^3

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What is the density of the mantle in g/cm^3?

Testing isostatic equilibrium

You should get **3.46 g/cm^3** (density of peridotite: 3.1–3.4 g/cm^3) using the following mass balance:

$$\Delta \mathrm{H}_{\mathrm{cc}} \rho_{\mathrm{cc}} = \Delta \mathrm{H}_{\mathrm{w}} \rho_{\mathrm{w}} + \Delta \mathrm{H}_{\mathrm{oc}} \rho_{\mathrm{oc}} + \Delta \mathrm{H}_{\mathrm{m}} \rho_{\mathrm{m}}$$

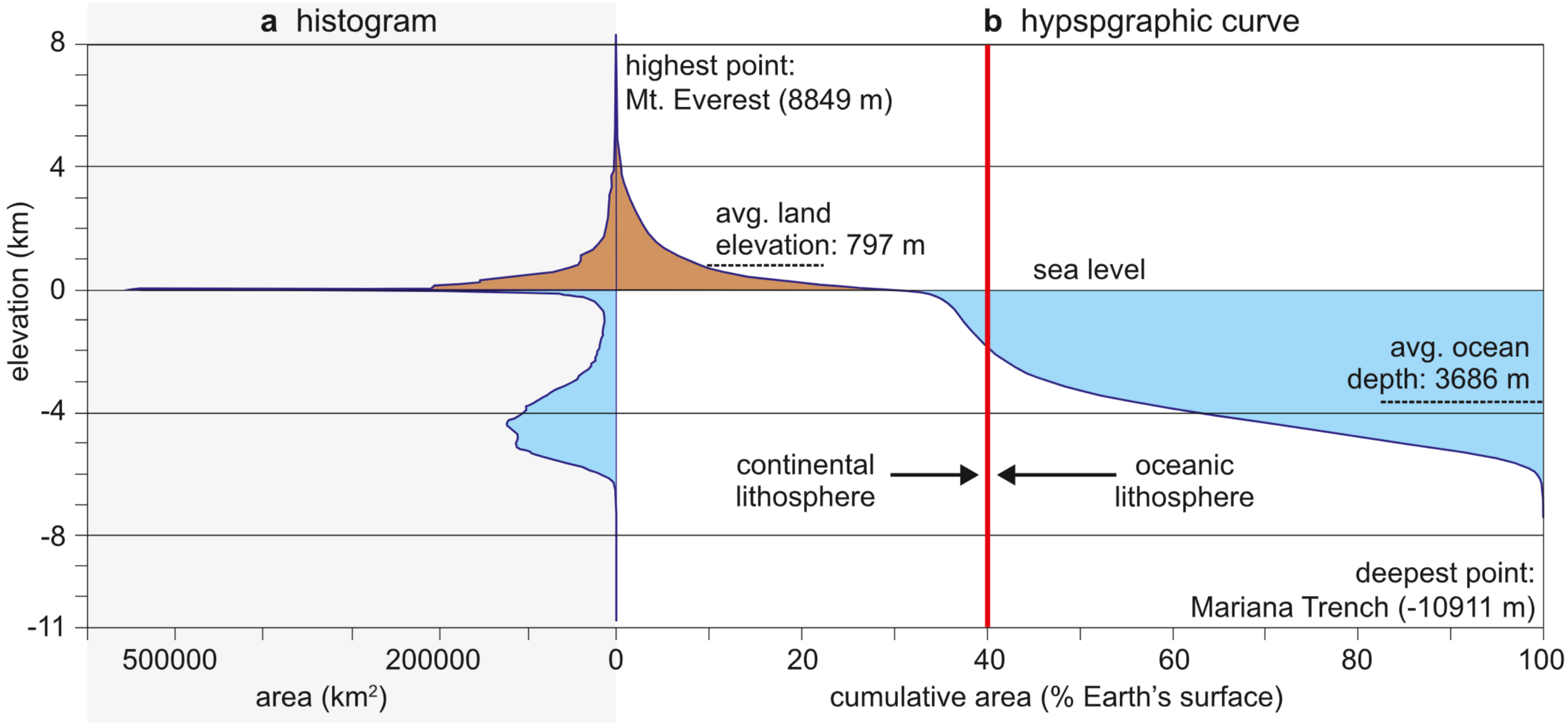
$$\Delta \mathrm{H}_{\mathrm{cc}} \rho_{\mathrm{cc}} - \Delta \mathrm{H}_{\mathrm{w}} \rho_{\mathrm{w}} - \Delta \mathrm{H}_{\mathrm{oc}} \rho_{\mathrm{oc}} = \Delta \mathrm{H}_{\mathrm{m}} \rho_{\mathrm{m}}$$

$$\frac{\Delta \mathrm{H}_{\mathrm{cc}} \rho_{\mathrm{cc}} - \Delta \mathrm{H}_{\mathrm{w}} \rho_{\mathrm{w}} - \Delta \mathrm{H}_{\mathrm{oc}} \rho_{\mathrm{oc}}}{\Delta \mathrm{H}_{\mathrm{m}}} = \rho_{\mathrm{m}}$$

$$\Delta \mathrm{H}_{\mathrm{m}} = \Delta \mathrm{H}_{\mathrm{cc}} - \Delta \mathrm{H}_{\mathrm{oc}} - \mathrm{E}_{\mathrm{cc}} - \mathrm{E}_{\mathrm{oc}}$$

where ΔH is thickness, E is elevation, ρ is density, and the subscripts w, cc, oc, and m correspond to the water in the ocean, the continental crust, the oceanic crust, and the mantle, respectively.

The topography of the sea-floor



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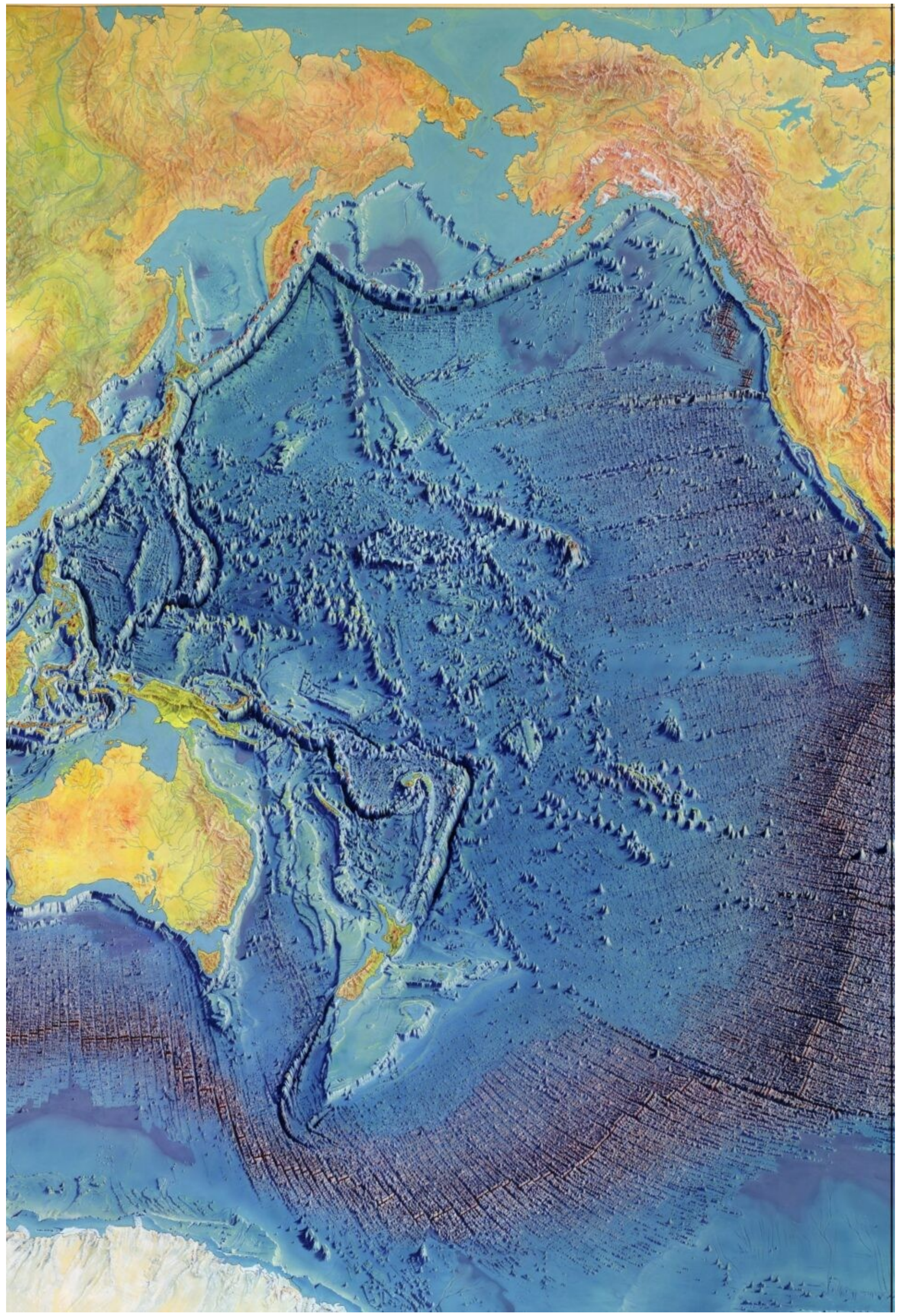

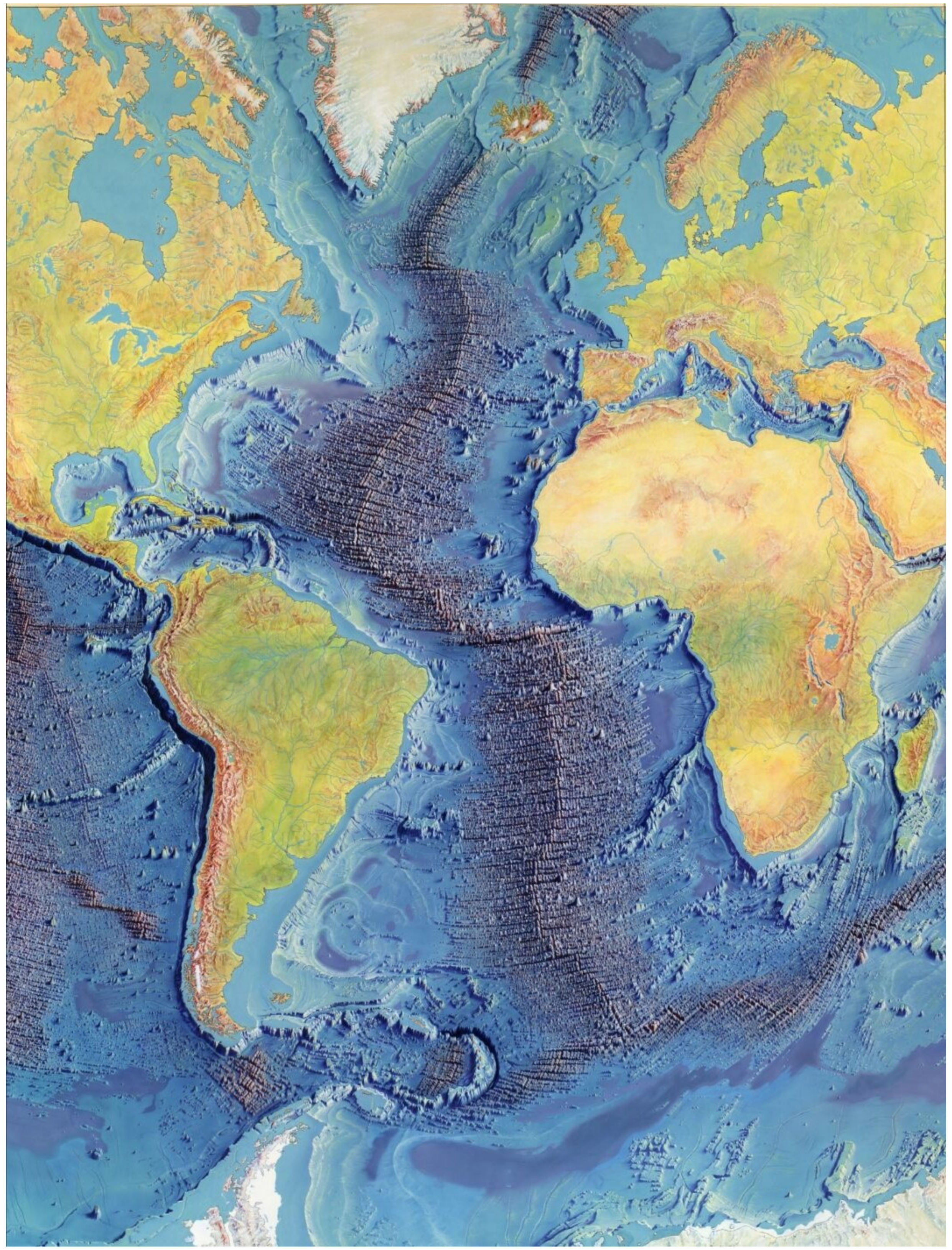

The topography of the sea-floor

Consider at least two ways that the topography of the sea-floor (mid-ocean ridges and the increase in depth away from ridges) can be in isostatic equilibrium. Draw a sketch for both.

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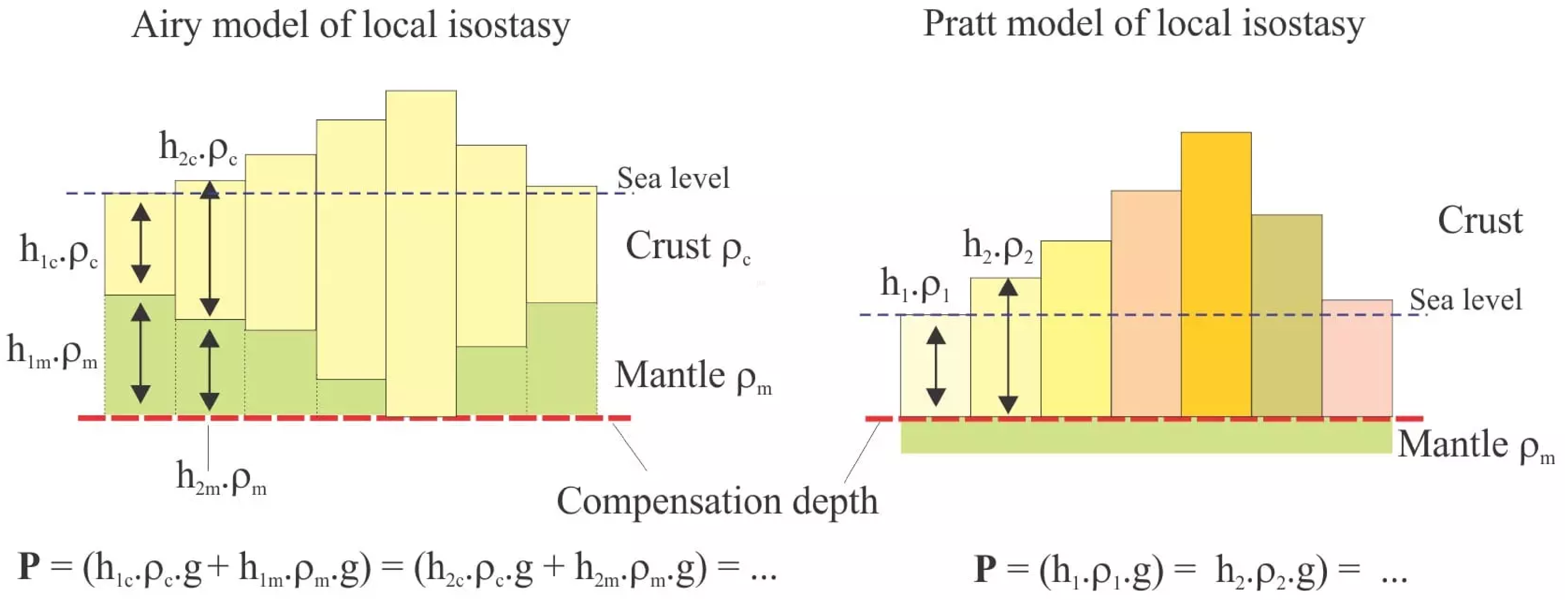

Which model is better at explaining sea-floor topography? Why?

The topography of the sea-floor

"Nevertheless, mantle convection is considered a radical hypothesis not widely accepted by geologists and geophysicists. If it were accepted, a rather reasonable story could be constructed to describe the evolution of ocean basins and the waters within them. Whole realms of previously unrelated facts fall into a regular pattern, which suggests that close approach to satisfactory theory is being attained."

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What observations supported this radical hypothesis?