A world map illustrating tectonic plates. The plates are color-coded: North America (light brown), South America (light blue), Africa (light orange), Europe (light green), Asia (light green), Australia (light orange), Antarctica (light blue), and the Indian Ocean (light purple). The text "Plate Tectonics: An Unstable Earth" is centered over the map.

# Plate Tectonics: An Unstable Earth

Reading: Alfred Wegener

# Classical Biogeography: Early Perspectives

## Lecture 4 Recap



Alfred Wallace



Sven Ekman

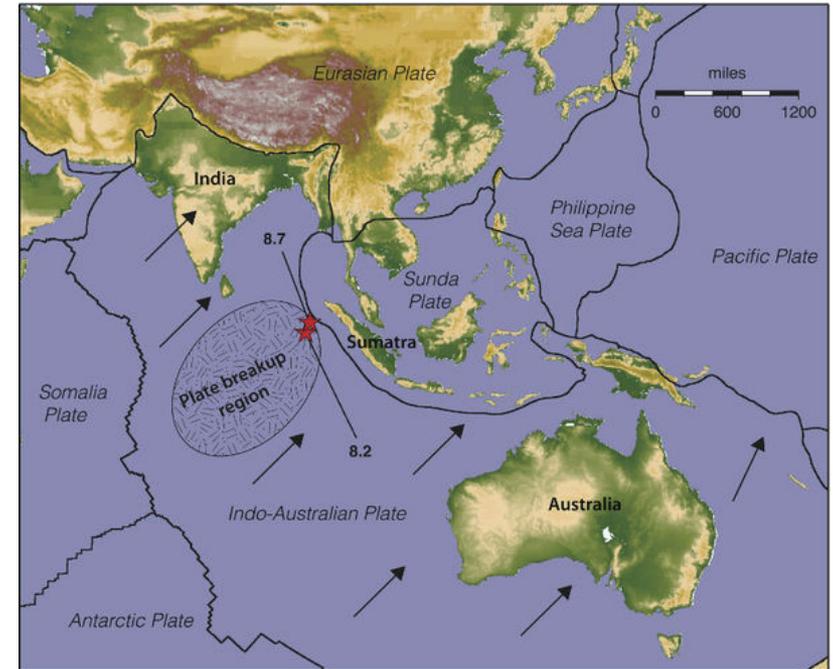
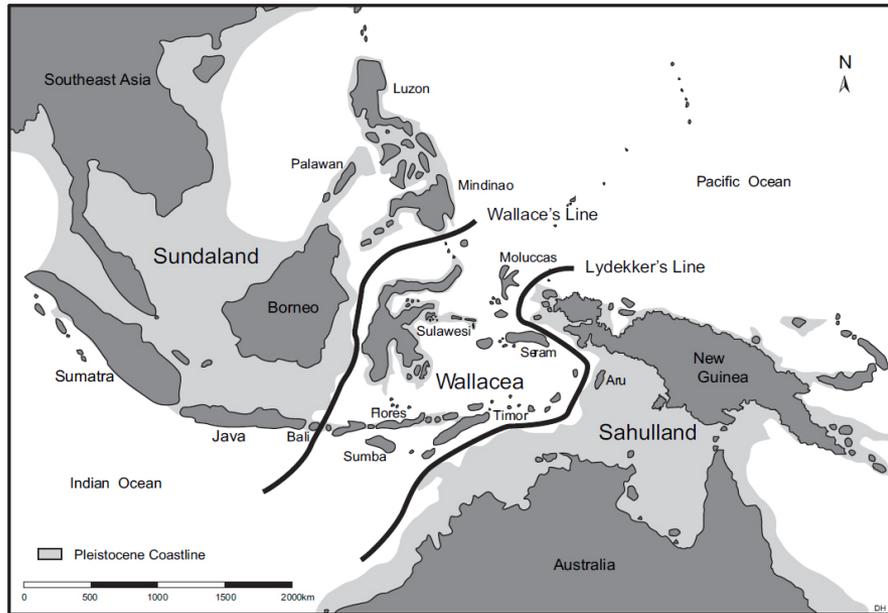


Alfred Wallace

# Classical Biogeography: Early Perspectives



Richard Lydekker



- Lydekker's line follows the marine shelf to the east of Wallacea
- Further importance of geology to biogeography



Alfred Wallace

# Classical Biogeography: Early Perspectives

- **Observed** - Individuals vary within species
- **Observed** - Species come from preexisting, nearby species
- **Observed** - Human populations held in check by famine and disease
- **Mechanism** - Massive death and slight variation, individuals with slight edge will reproduce more and over time outnumber other types



Alfred Wallace

# Classical Biogeography: Early Perspectives

- *Darwinism* (1889)
- Reproductive isolation could be driven by natural selection
- This is a vicariance event outside of geographic isolation and a precursor to *sympatric speciation*
- Known as the *Wallace Effect*



Sven Ekman

# Classical Biogeography: Early Perspectives

- Thus we are interested in the history of the faunas
- We aim to discover the ultimate causes, and the causal connections are historical
- ‘Fourth dimension’ in the whole of nature



Joseph Dalton  
Hooker

# Earth History, Vicariance, and Dispersal

- Early Theories
- *“... the botanical relationship [of the three great areas of land in the southern latitudes] is as strong as that which prevails throughout the lands within the Arctic and Northern Temperature zones, and which is not to be accounted for by any theory of transport or variation, but which is agreeable to the hypothesis of all being members of a once more extensive flora, which has been broken up by geological and climatic causes.”*
- One of Darwin’s confidants



Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

- Born in Germany in 1880
- Son of a clergyman/teacher
- Obtained PhD in 1905 at Friedrich Wilhelms University, which is today called Humboldt University
- First worked under his brother Kurt, where they pioneered the use of weather balloons to track air masses



Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

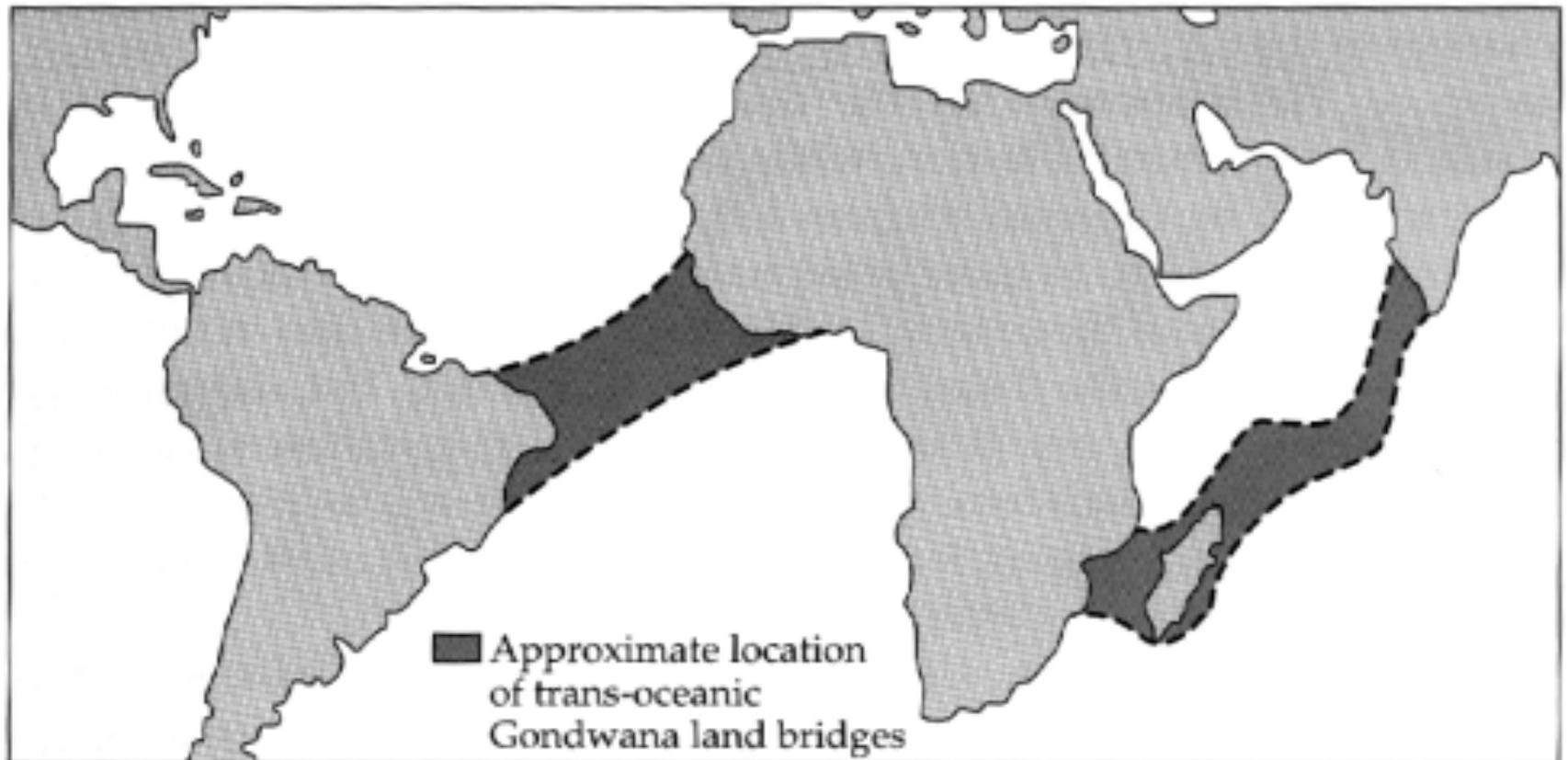
- Well known in his own time for polar and meteorological discoveries
- First to overwinter on an inland Greenland ice sheet
- First to bore ice cores from a moving Arctic glacier
- *The Origins of Continents and Oceans* (1915)



Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

## Earlier theories: Land Bridges





Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

- In late 19<sup>th</sup> and early 20<sup>th</sup> centuries, geologists assumed that Earth major features were fixed
- Assumed these features could be explained by vertical movements of the Earth's crust
- Changes due to loss of heat on a cooling Earth
  - Earth is shrinking due to contraction and wrinkling
- Discovery of radioactivity in 1895 started to change this theory in respect to Earth's age and heat dynamics





Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

- In his book, Wegener described how the continents of SA and Africa fit together (not the first to describe this)
- First to compare the continents with fossil evidence as evidence for being joined
- Also looked at rock strata at the margins of continents which suggested that these continents were formed in the same manner



Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

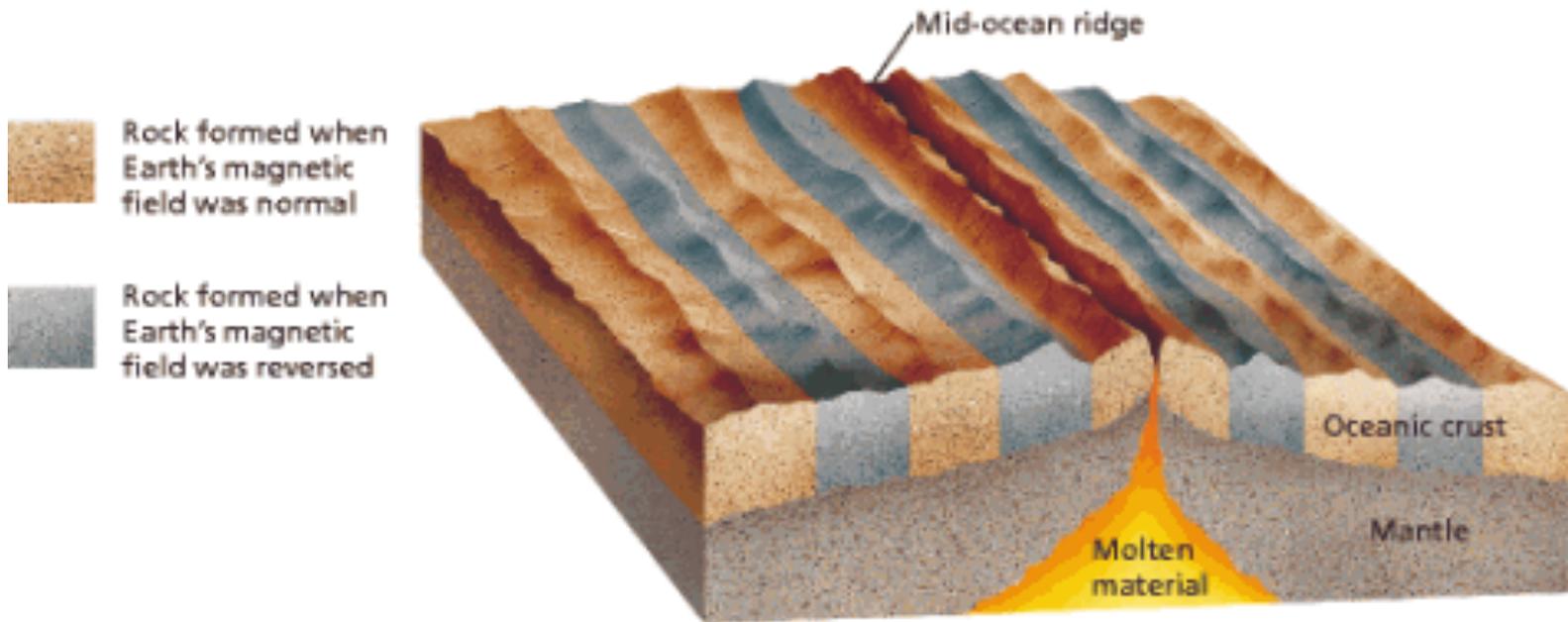
- However, there was no mechanism described and so the idea had to wait for advances in technology and other discoveries
- Sea floor spreading and magnetism
- Differences in rock density between continents and seafloor
- Seismic concentrations, or hotspots



Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

## Sea Floor Spreading

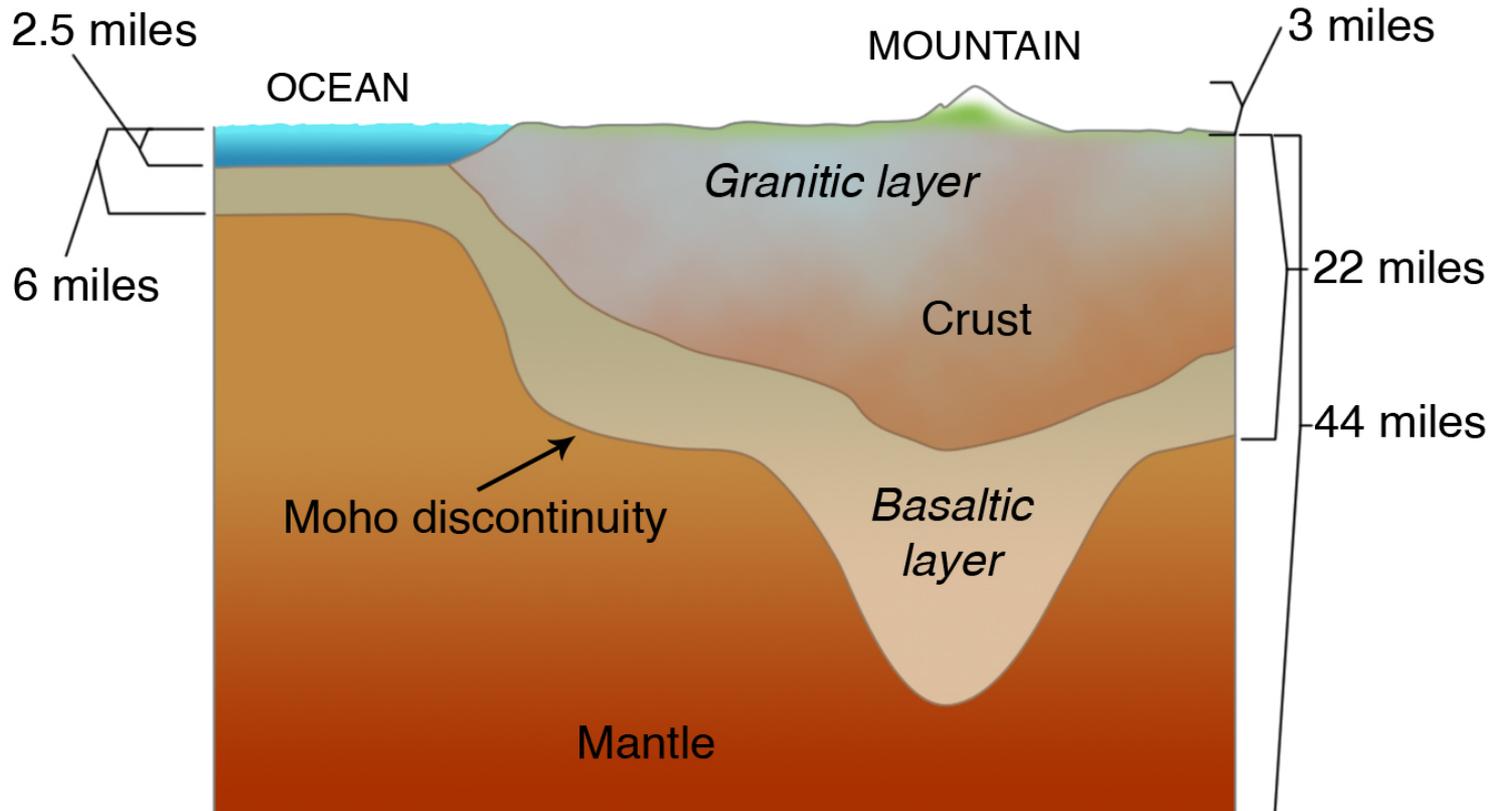




Alfred Wegener

# Earth History, Vicariance, and Dispersal

## Crustal Rock Densities

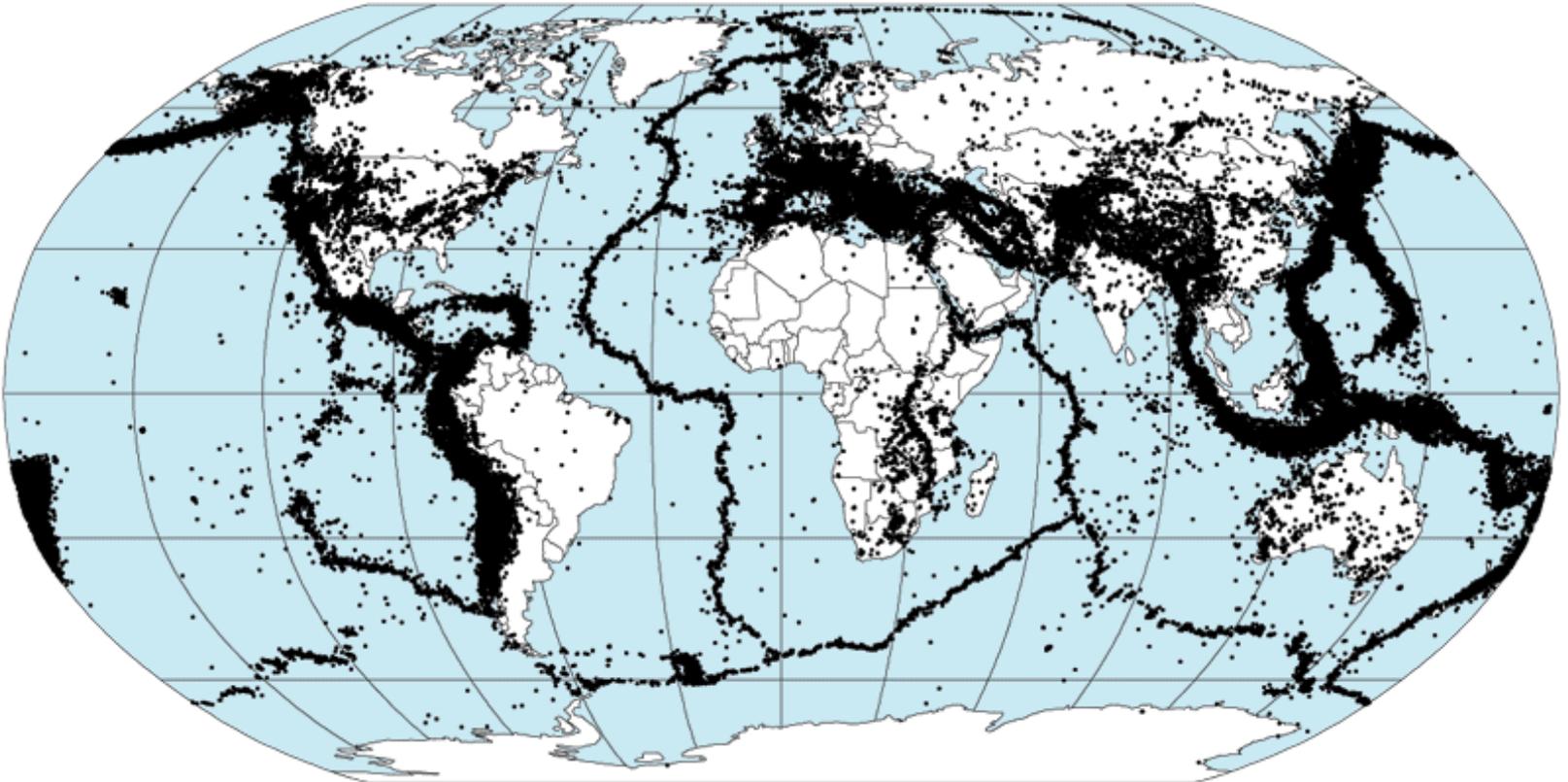




Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

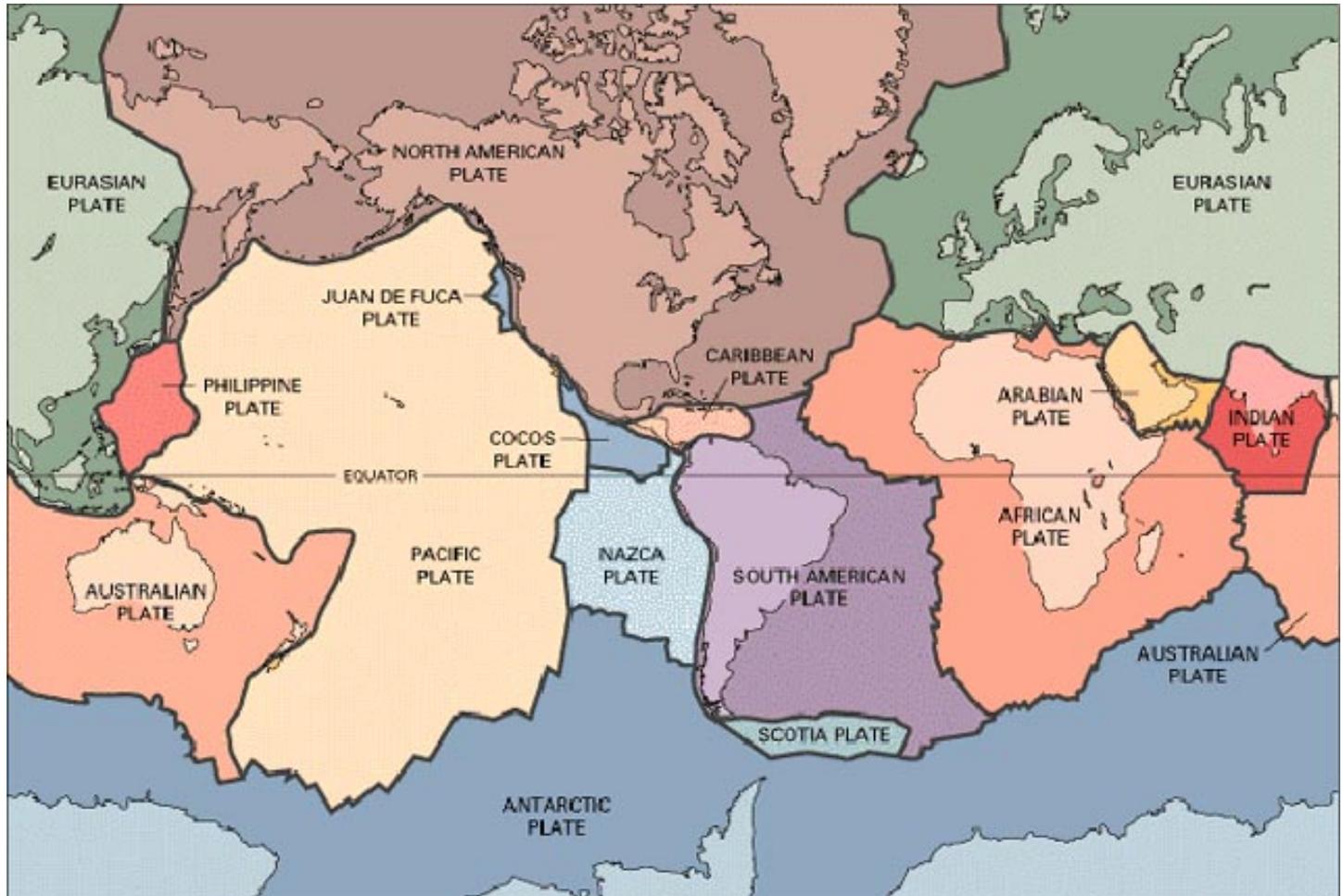
## Seismic Hotspots





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# Earth History, Vicariance, and Dispersal

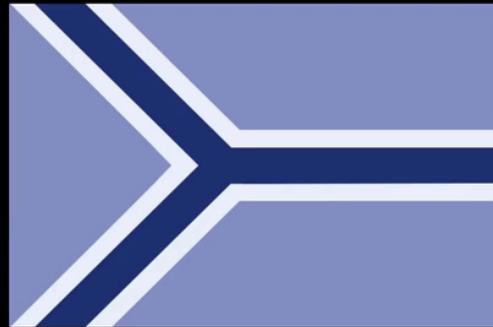




Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

3.3 Billion Years of Continental  
Drift



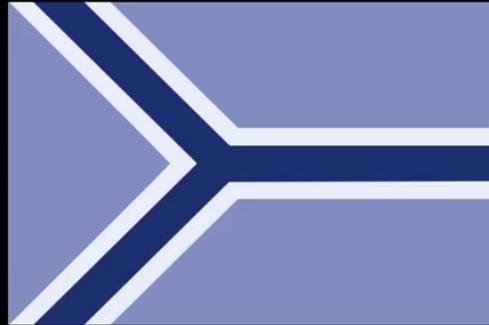
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(Algol)



Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

300 Million Years of the Future World  
(Pangaea Proxima Model)



Created by: Algol



Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

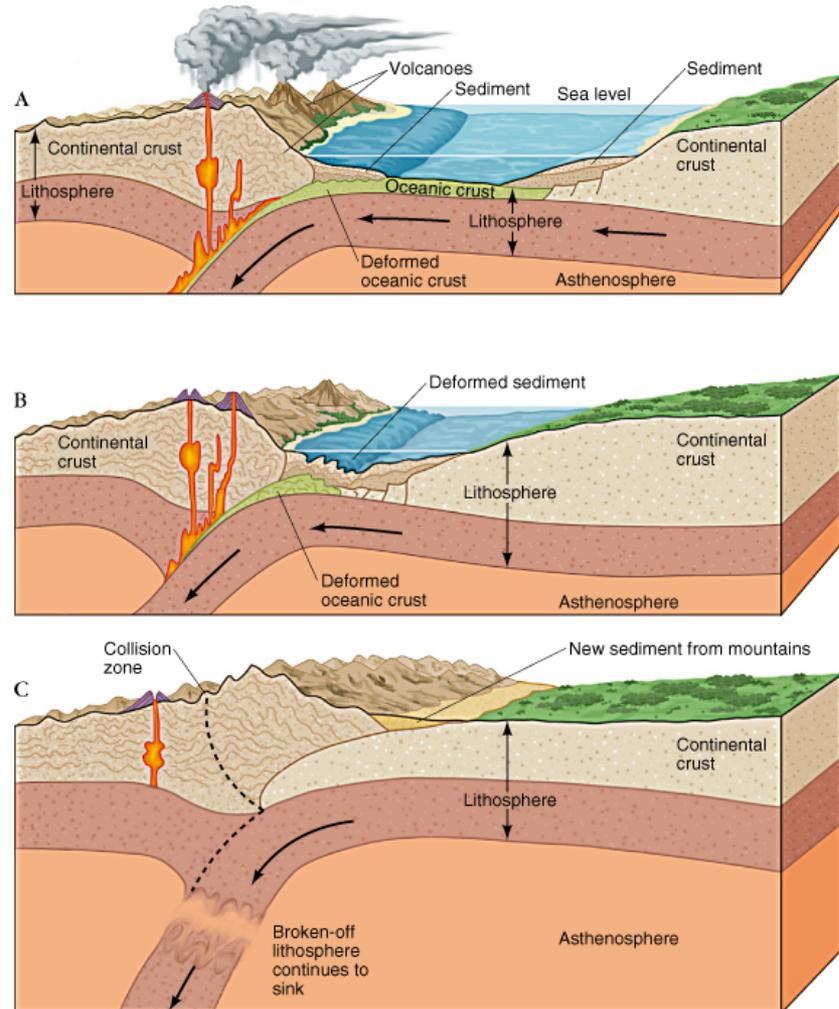
- Subduction Zones
- Takes place at convergent boundaries of tectonic plates
- Process where heavy, dense oceanic plate is moved underneath a lighter, less dense plate (usually a continental plate)
- Without this process plate tectonics could not occur as new seafloor at spreading sites needs older crust to be returned to the mantle



Alfred Wegener

# Earth History, Vicariance, and Dispersal

Creation of new continental crust





Alfred  
Wegener

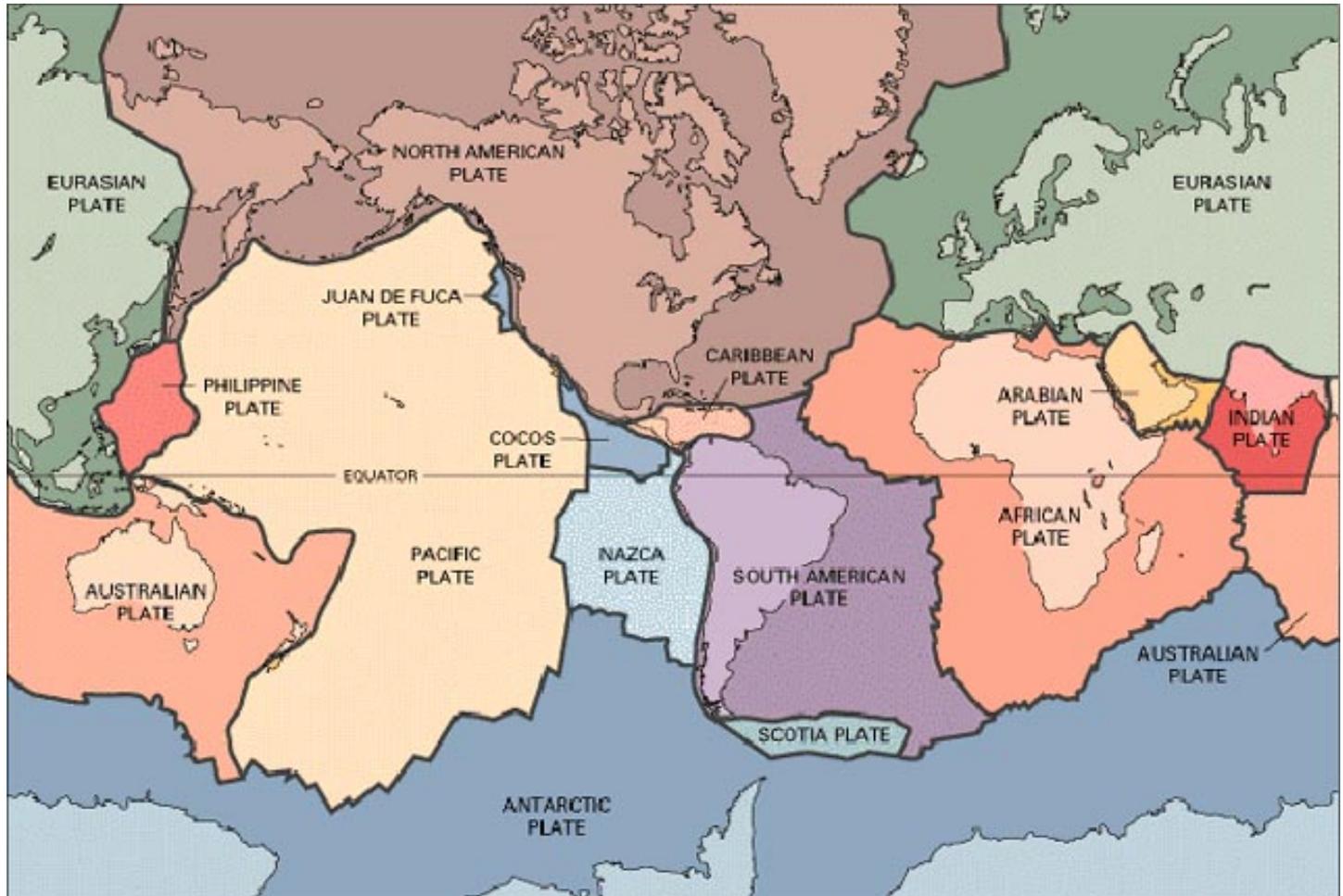
# Earth History, Vicariance, and Dispersal





Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

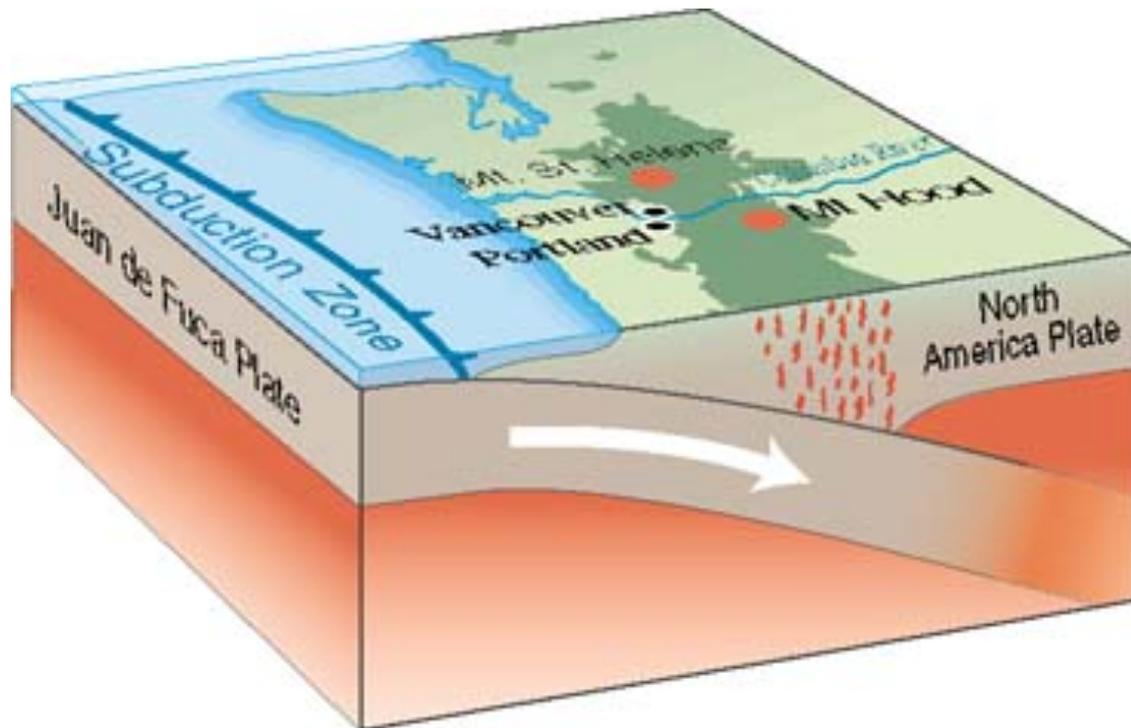




Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

- Cascadia Subduction Zone





Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

- Neskowin Ghost Forest





Alfred  
Wegener

# Earth History, Vicariance, and Dispersal

## Main Points

- Three main discoveries that led to the acceptance of continental drift theory were seismic hotspots, seafloor spreading (magnetism), difference in rock density
- Three points that Wegener described to introduce the hypothesis were similar coastline shape, fossil evidence, similarities in rock strata
- The subduction process where heavy, dense basaltic rock is subducted under lighter granitic rock

Questions on the reading?



Alfred  
Wegener

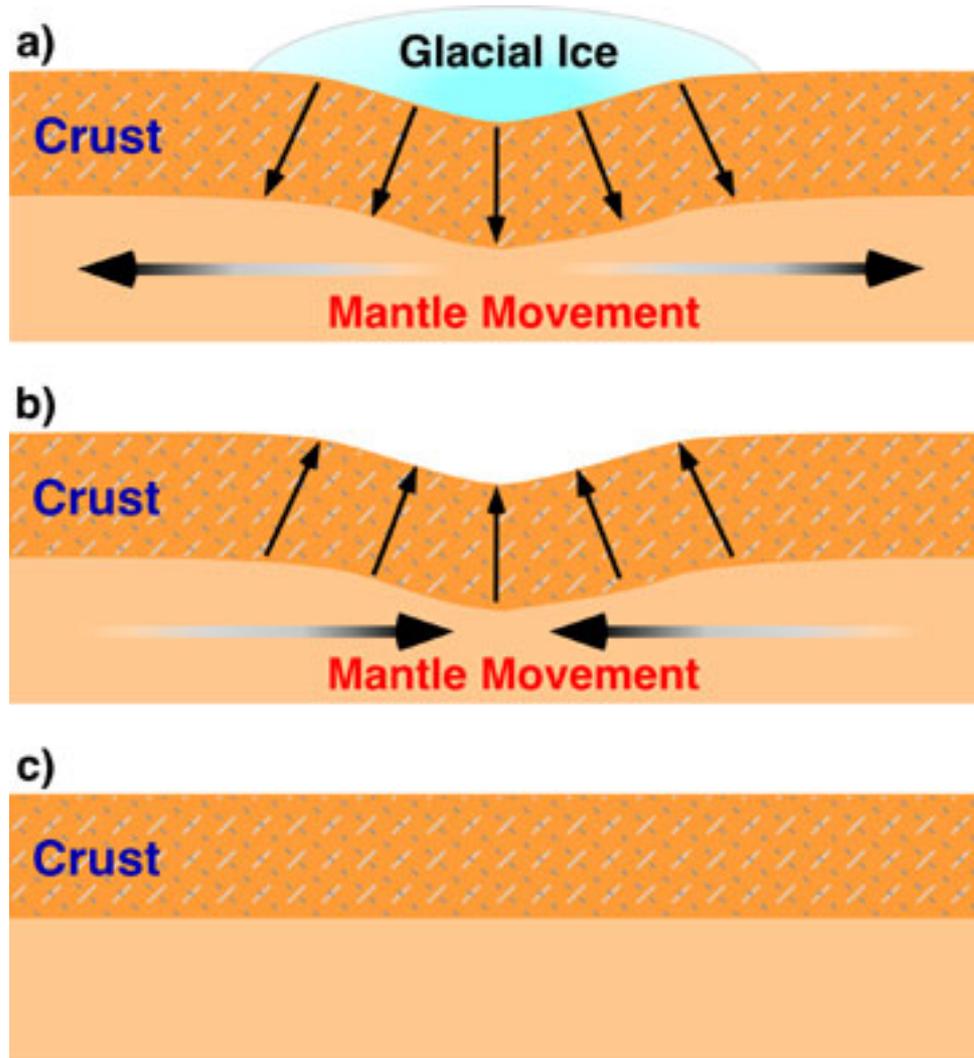
# Discussion Point 1

- *“Isostasy is therefore in contradiction not only to contraction theory, but in particular also to the theory of sunken land bridges as derived from the distribution of organisms.”*
- What does Wegener mean when he refers to ‘Isostasy’?
- How was a land bridge hypothesis a contradiction to this theory?



Alfred Wegener

# Discussion Point 1





Alfred  
Wegener

# Discussion Point 1

- *“In particular, it seems impossible, in the view of the isostatic principle, that a continental block the size of a land bridge of require size could sink to the ocean bottom without a load or that the reverse should happen.”*