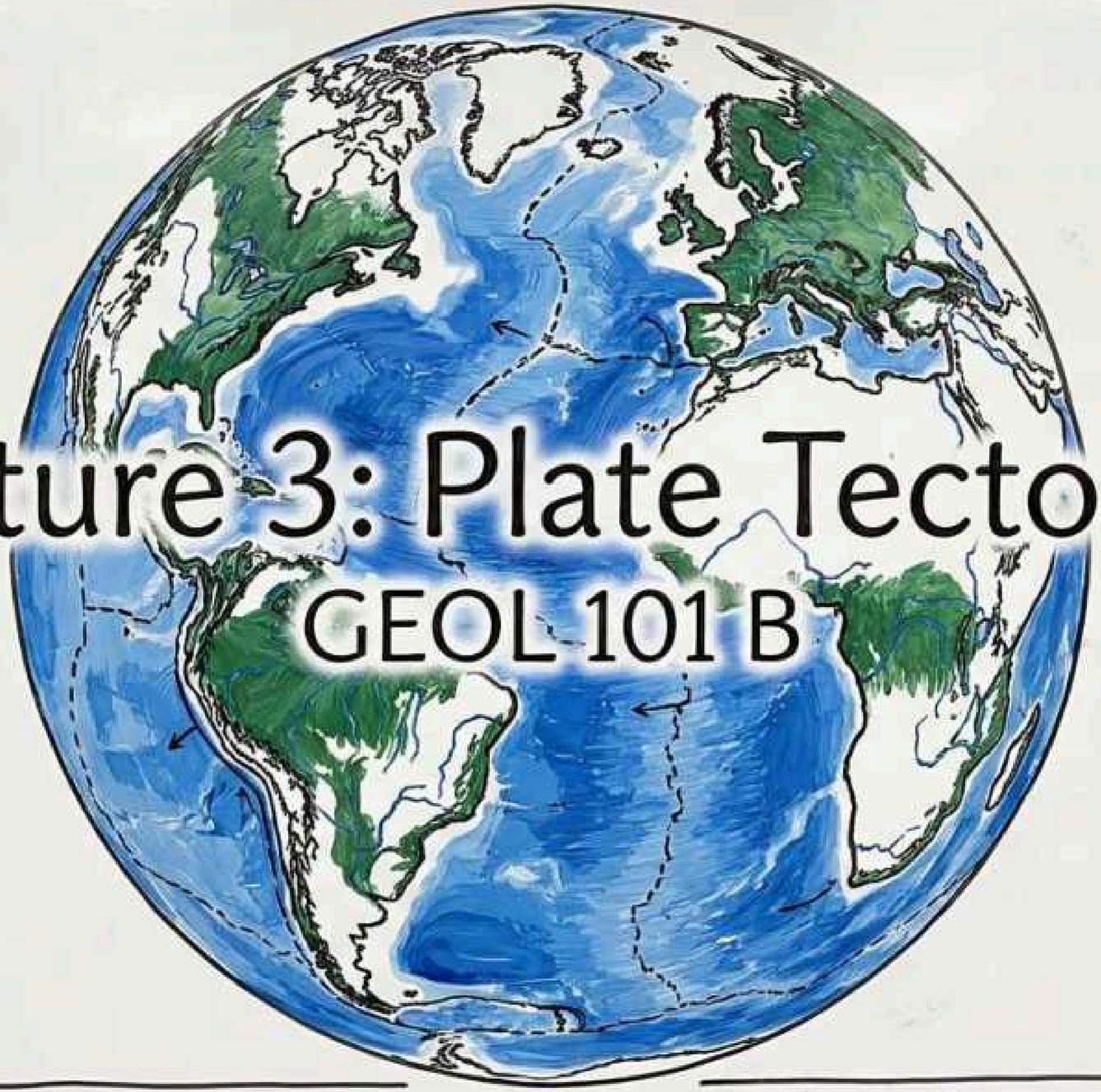
¶ 3.1

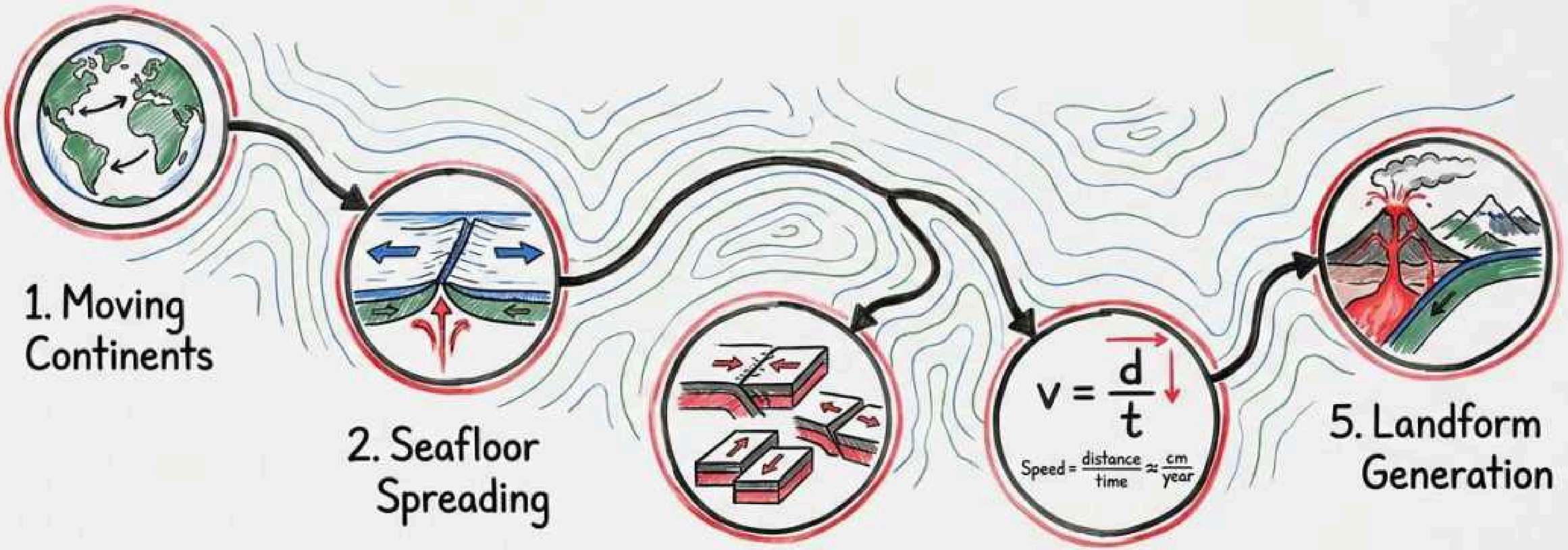


Lecture 3: Plate Tectonics

GEOL 101 B

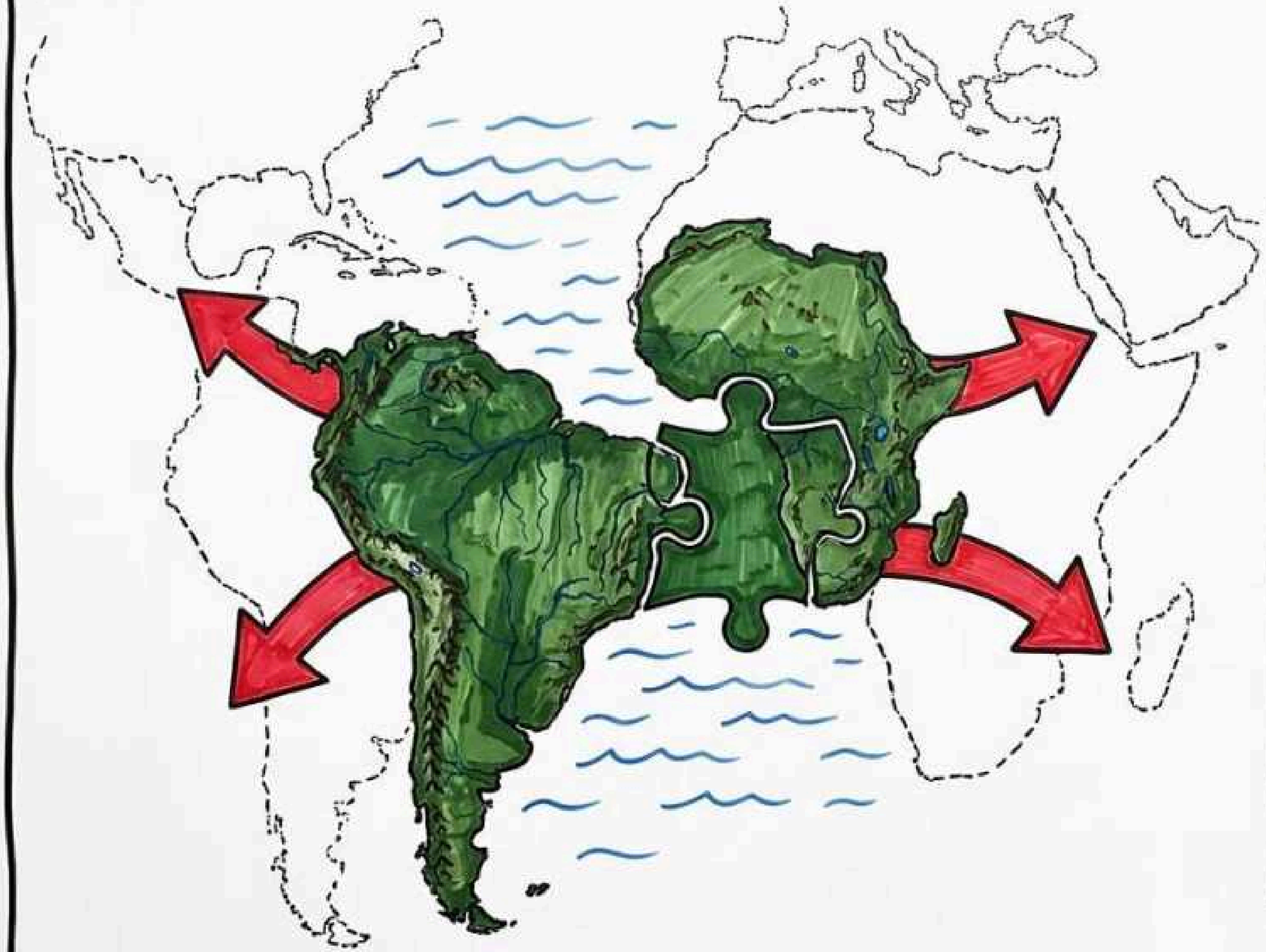
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¶ 3.2



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¶ 3.3



The Proposer

Alfred Wegener (1912)
Alfred Wegener (1913)

The Concept

Continents once joined as a single landmass called **Pangaea**, which later drifted apart.

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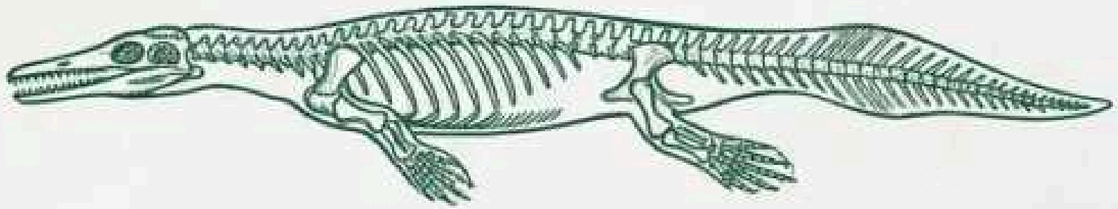
¶ 3.4



Botanical Evidence

Glossopteris fern found across separated continents

Q1

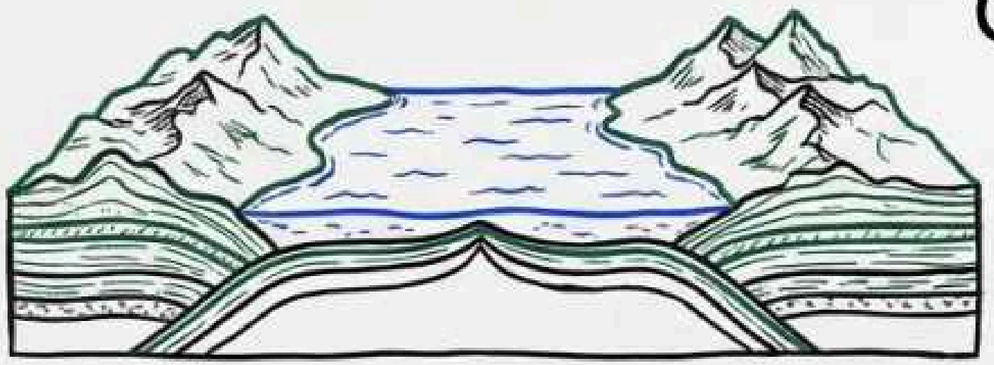


Zoological Evidence

Mesosaurus: A freshwater reptile that cannot swim oceans.

Q2

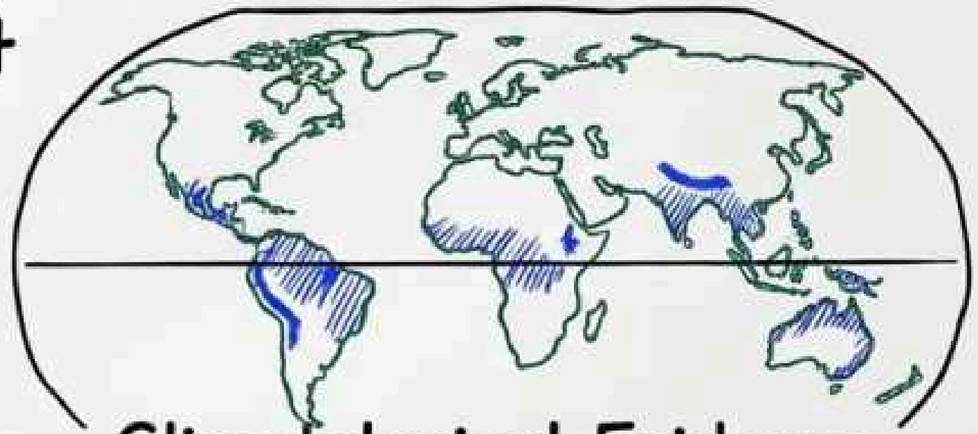
Q3



Geological Evidence

Rock layers and mountain ranges match perfectly across the Atlantic.

Q4

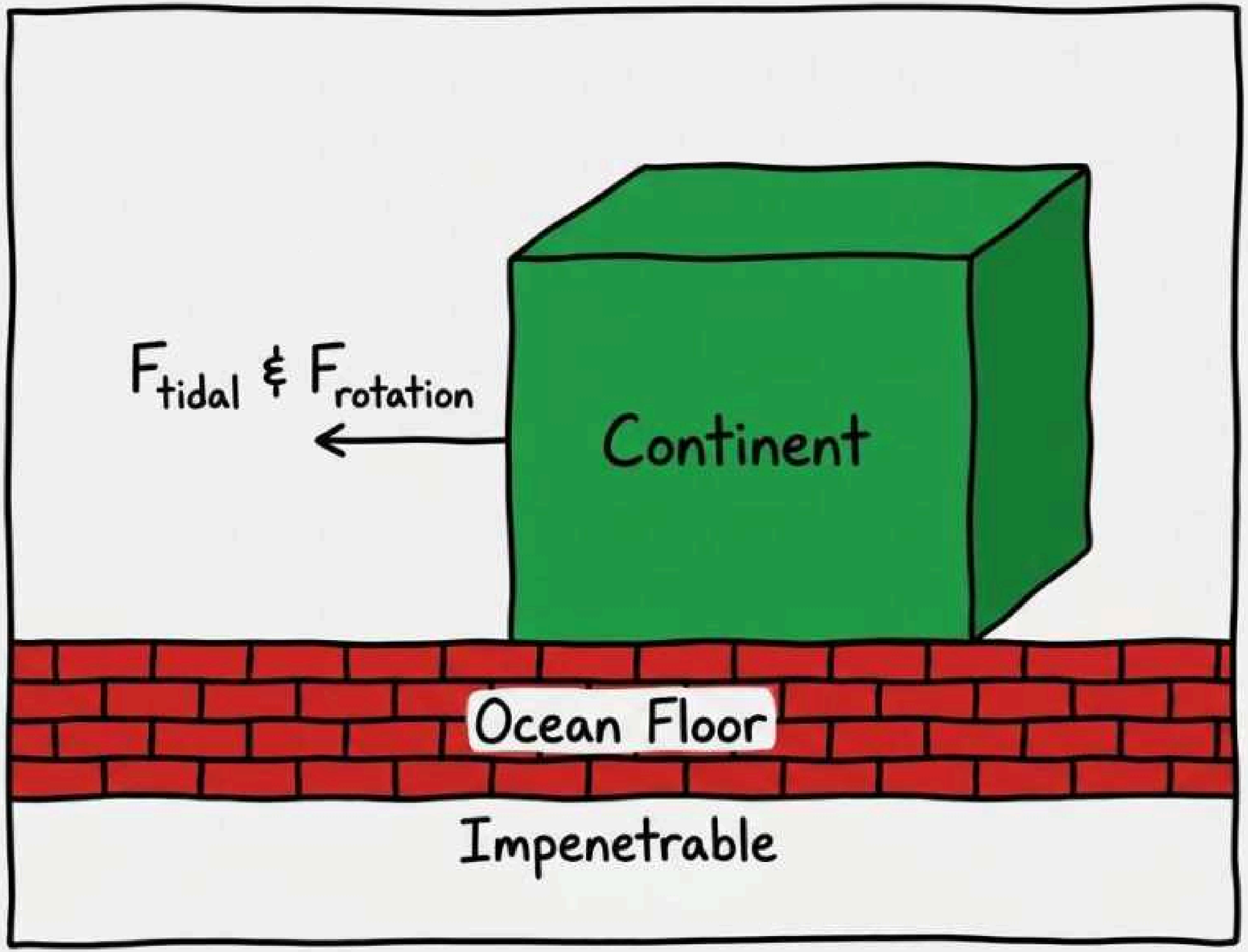


Climatological Evidence

Glacial scratches found in regions that are currently tropical.

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¶ 3.5



Core Concept:

Wegener lacked a mechanism. How could a continent plow through solid rock?

The Verdict:

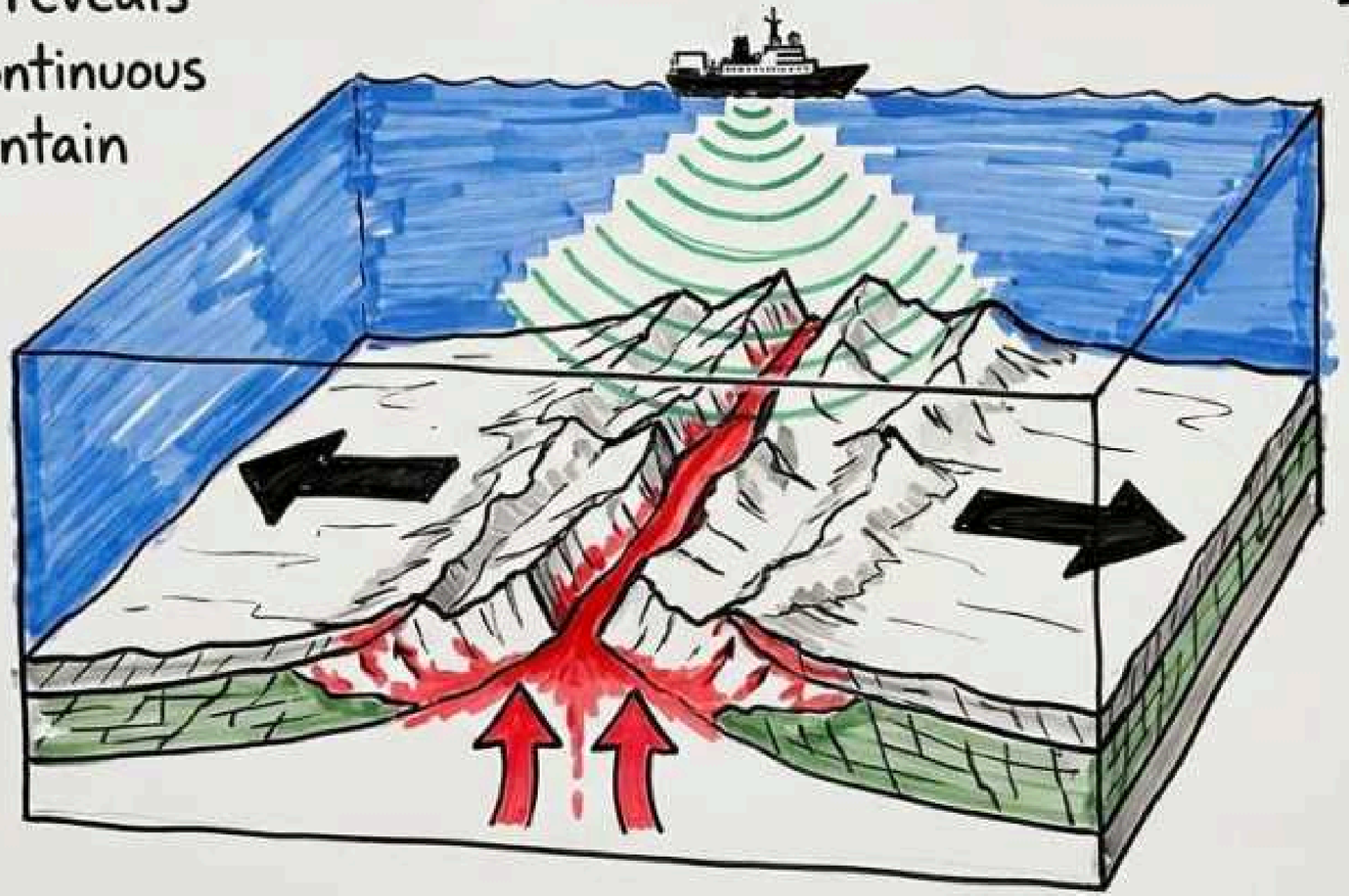
Calculations proved these forces were far too weak. A good idea without a cause is easy to dismiss.

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¶ 3.6

The Discovery:

Sonar mapping reveals a 65,000 km continuous underwater mountain chain.



The Mechanism:

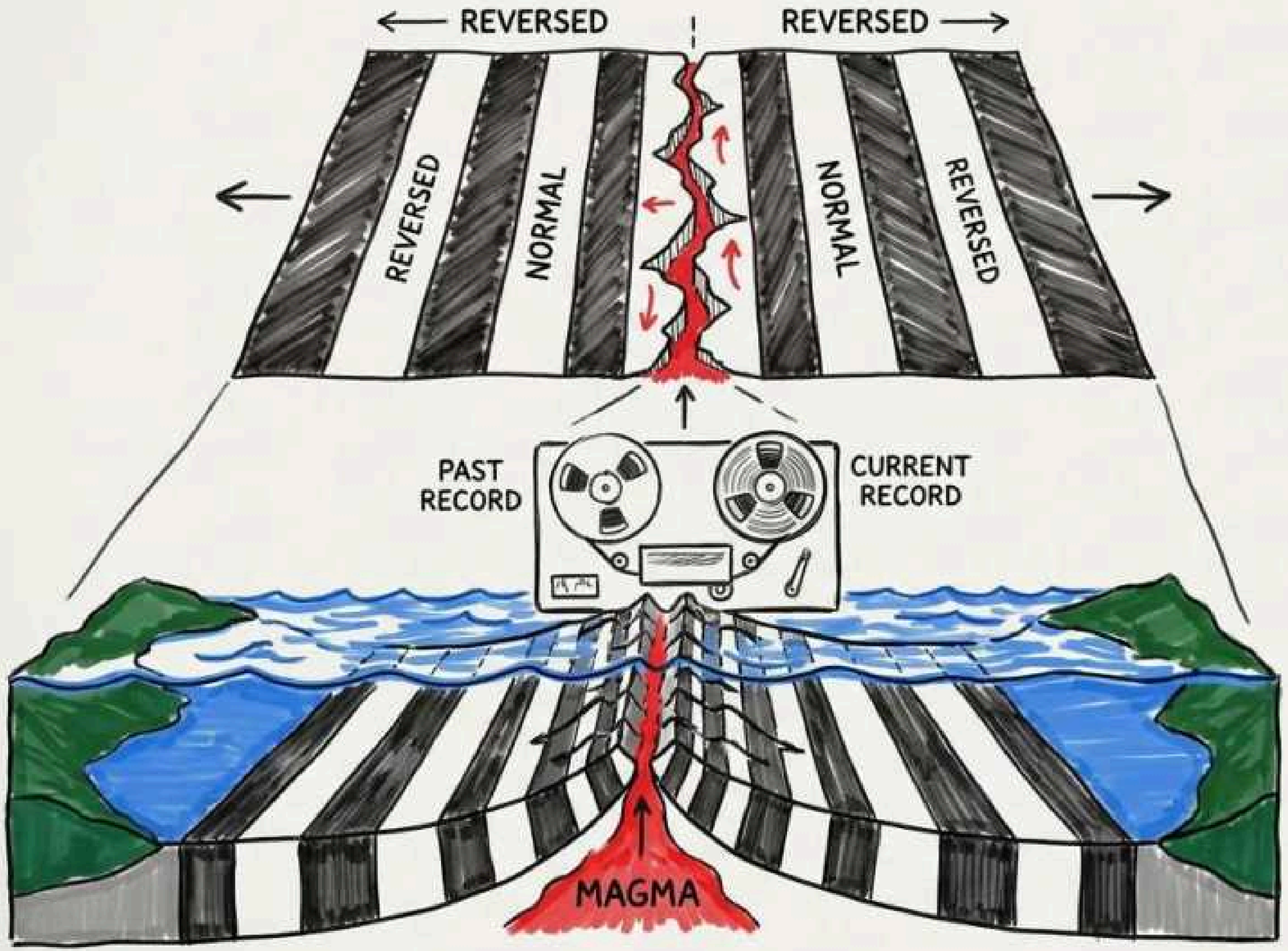
Seafloor Spreading (Harry Hess, 1960s).

Analogy:

The ocean floor acts as a very slow conveyor belt.

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¶ 3.7

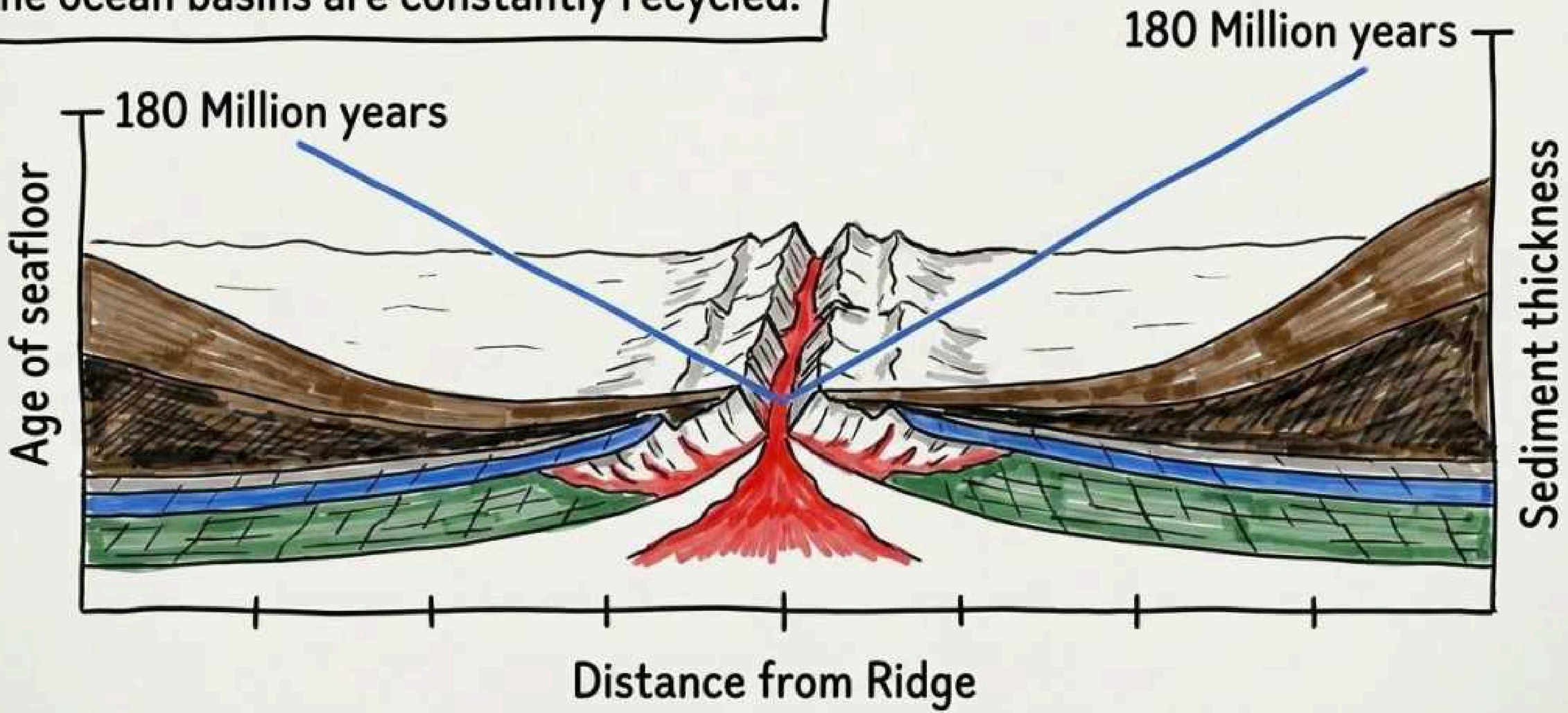


- **The Proof:** Cooling basalt records the direction of Earth's flipping magnetic field.
- **The Pattern:** Symmetric magnetic stripes on both sides of the ridge.
- **Credit:** Vine, Matthews, Morley (1963).

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¶ 3.8

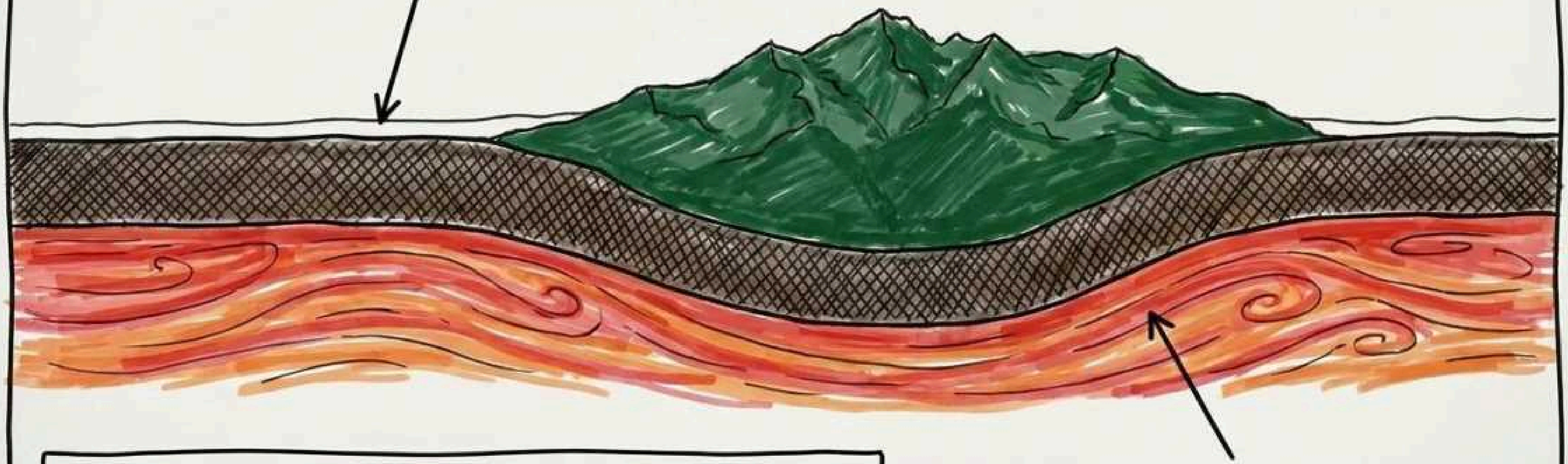
Ocean crust is young (max 180M yrs) vs.
Continental rocks (up to 4 Billion yrs).
The ocean basins are constantly recycled.



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¶ 3.9

Lithosphere: The brittle outer shell (~100km thick).
Broken into 7 major plates (and many smaller ones).

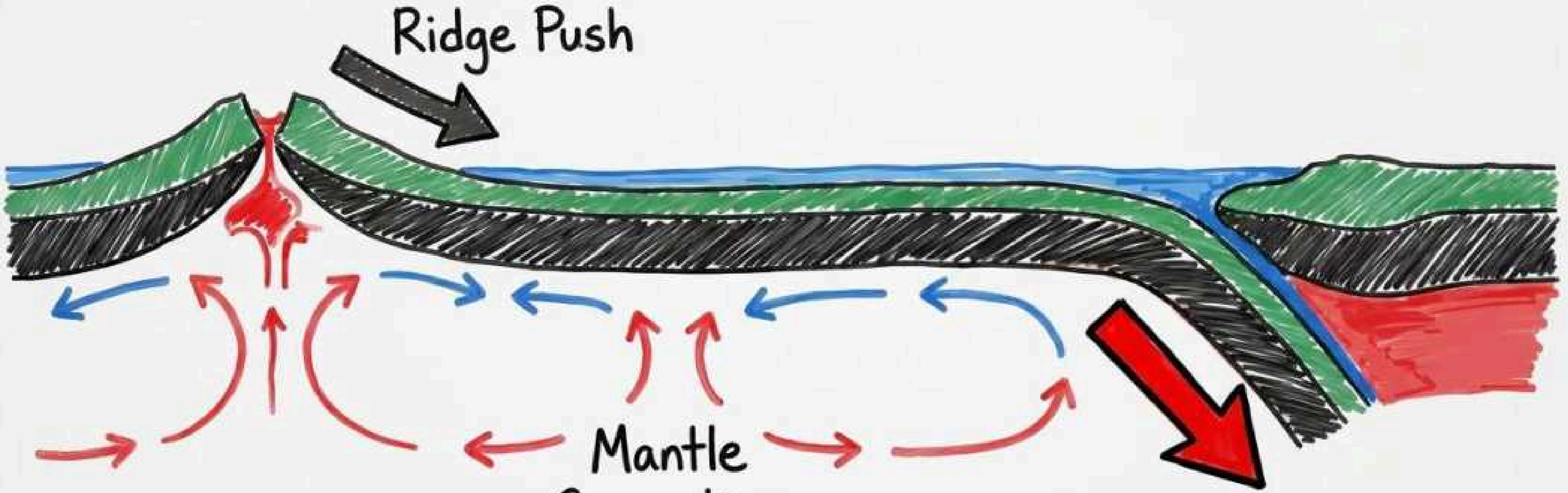


Asthenosphere: The softer, flowing layer beneath.

Key Insight: Continents do not plow through the ocean floor. They ride embedded in the lithosphere like passengers on a raft.

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¶ 3.10

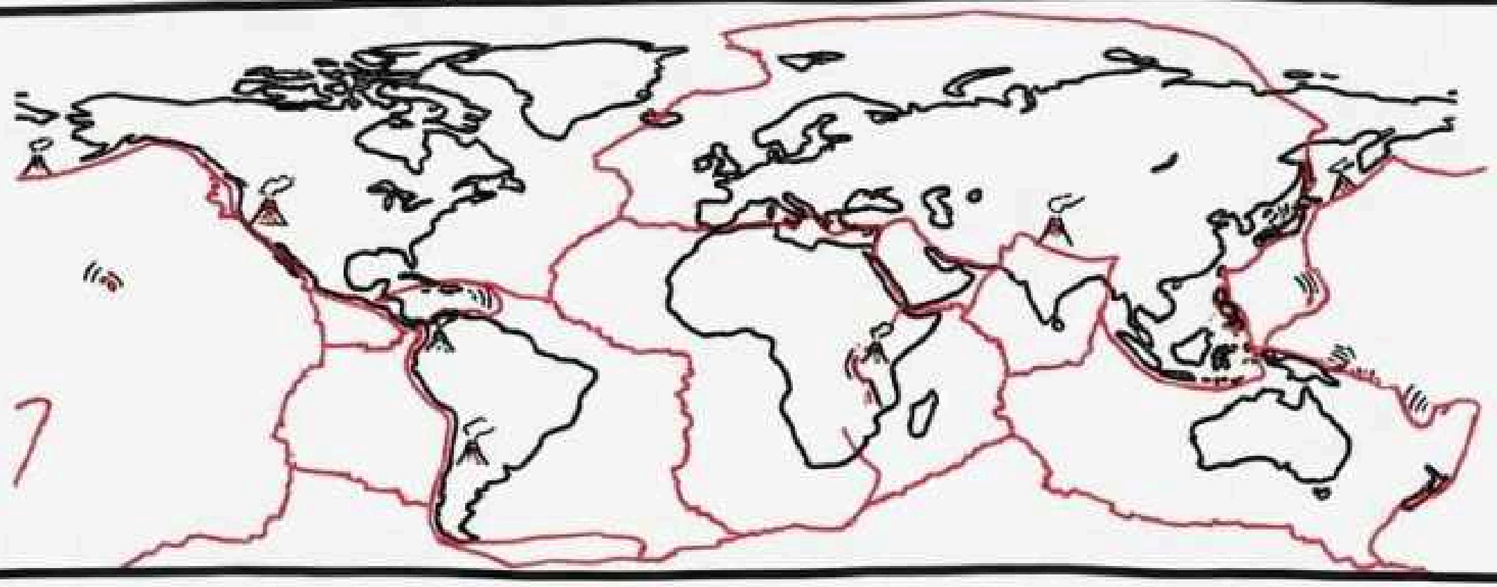


The strongest force.

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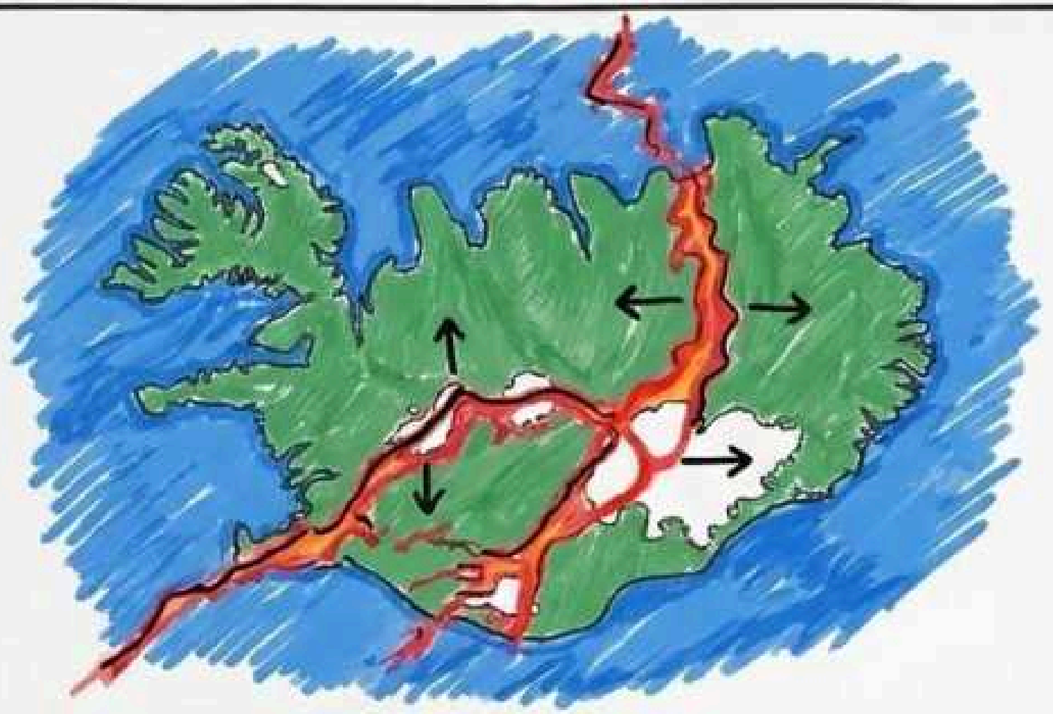
¶ 3.11

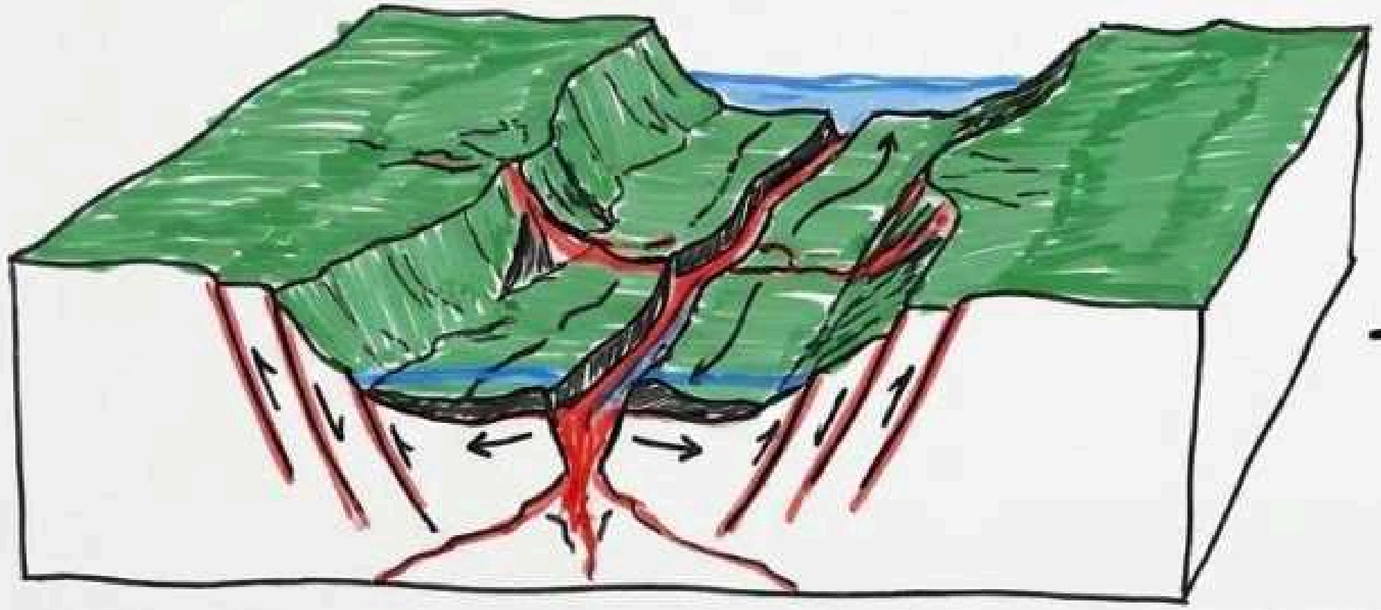
Divergent	Convergent	Transform
← →	→ ←	↑↓
Plates move apart, new crust forms.	Plates collide, crust is destroyed or deformed.	Plates slide past each other sideways.



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¶ 3.12





The Process:

Continental rift →
Valley formation →
New ocean opens
over tens of millions
of years.

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¶ 3.13

Rate = 2.5 cm/yr (Roughly the speed of fingernail growth)

(2.5 cm/yr) → 25 km / Million yrs

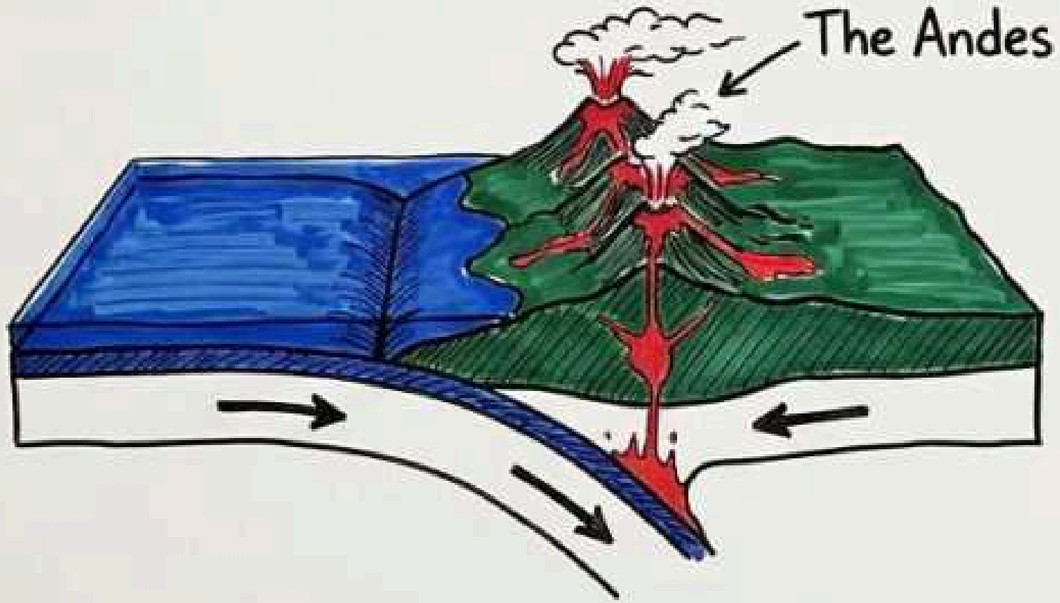
25 km/Myr x 180 Myr (age of floor) = 4,500 km

Conclusion: The calculation perfectly matches the measured width of the Atlantic Ocean.

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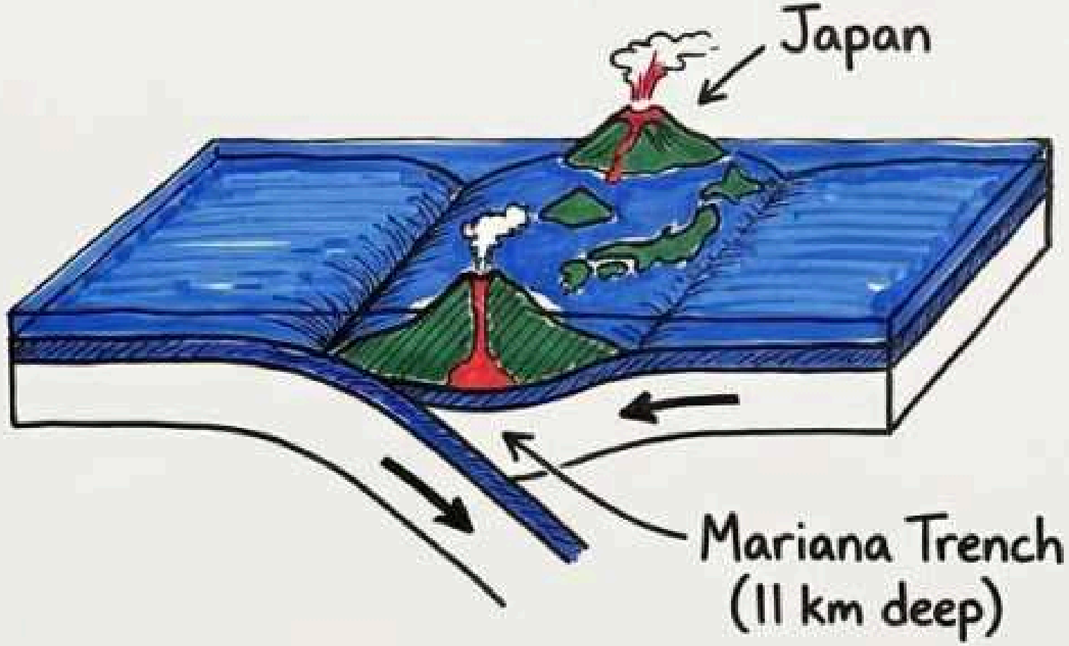
¶ 3.14

Ocean meets Continent



Denser oceanic plate dives under.

Ocean meets Ocean



Older/denser plate sinks.

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¶ 3.15







The Physics: Two light (buoyant) continental plates collide. Neither sinks; they crumple upward.

The Collision: India moving north at 5 cm/yr for roughly 50 million years.

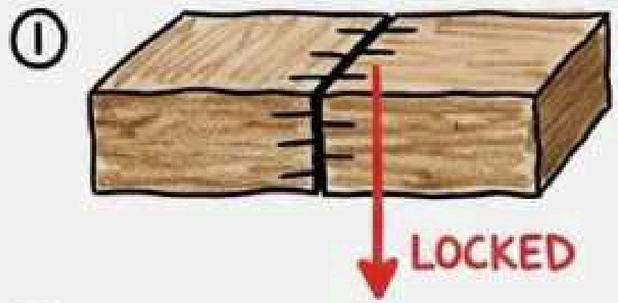
The Anomaly: Fossil seashells near the top of Mount Everest exist because that rock was once ancient seabed pushed to the sky.

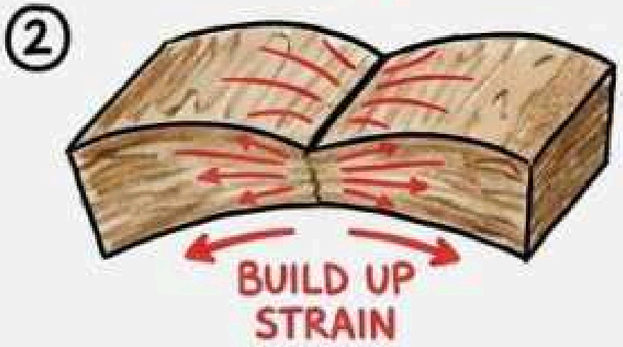
Gemini Notebook

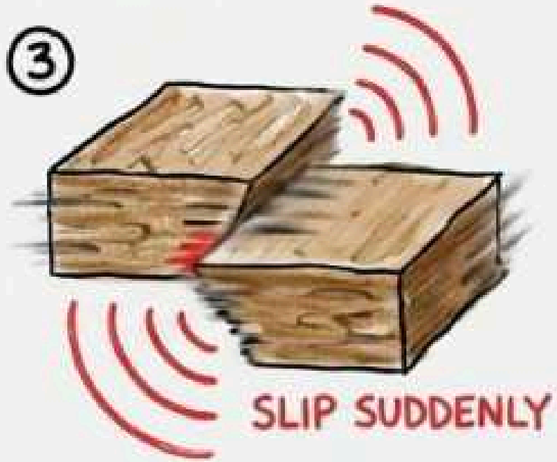
¶3.16



San Andreas Fault:
A Transform Boundary



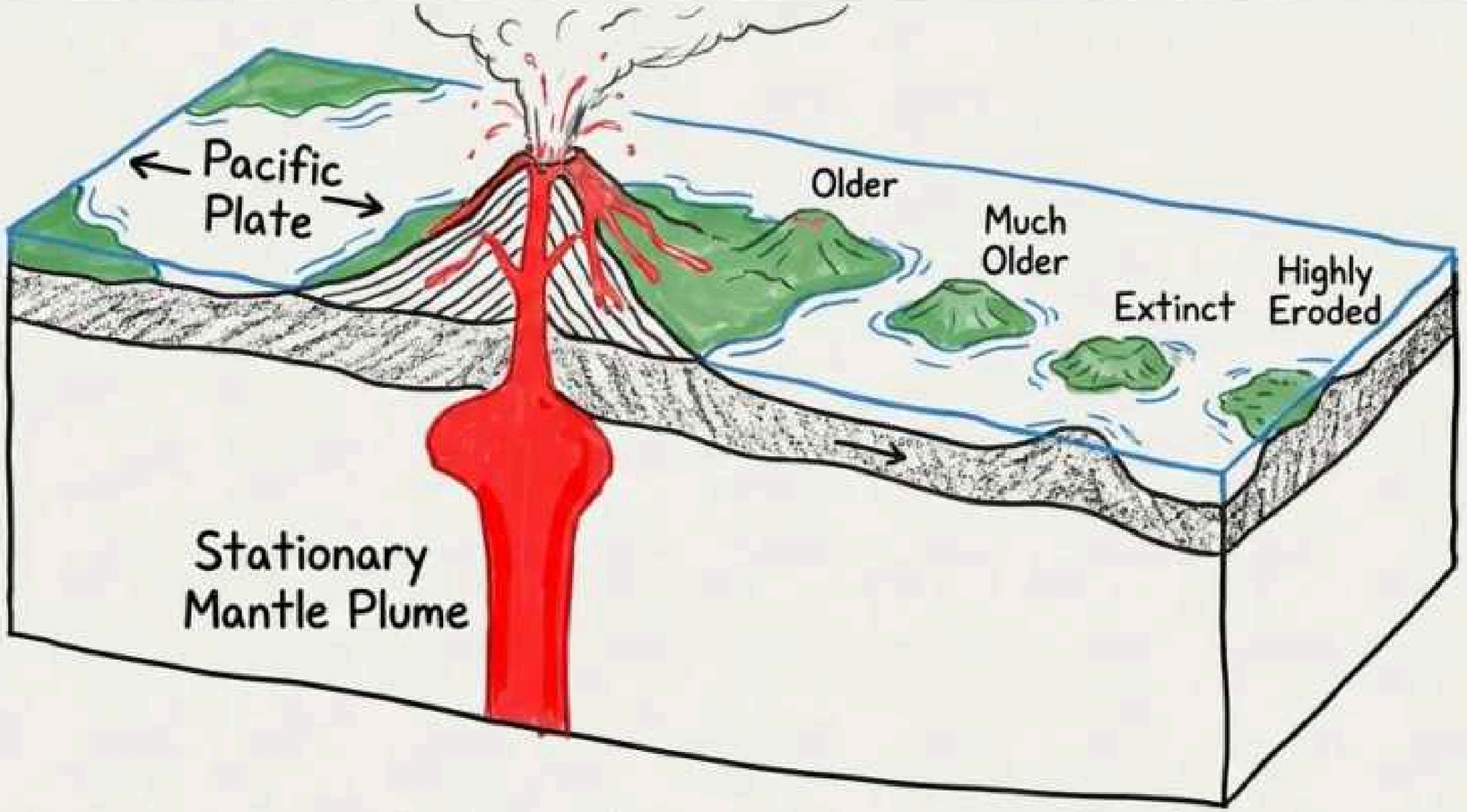




- The Boundary: Transform (neither making nor destroying crust).
- The Motion: Pacific plate sliding NW past the North American plate at 3 - 4 cm/yr.
- The Mechanism (Earthquakes): Lock → Build up strain → Slip suddenly.

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¶ 3.17



The Anomaly:

- Volcanoes not on a boundary (The Hawaiian Islands).

The Mechanism:

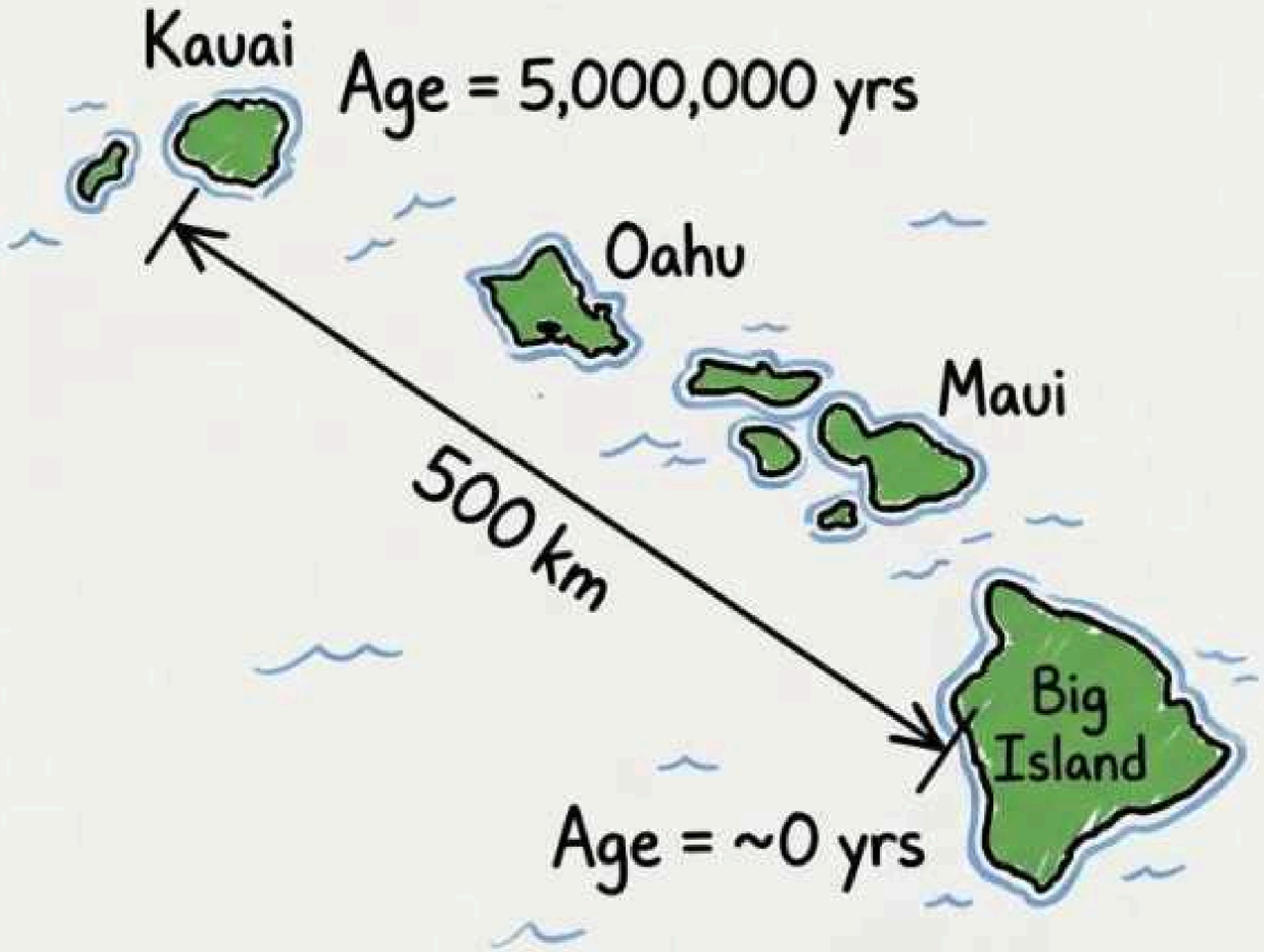
- A long-lived plume of hot rock rising from deep in the mantle.

The Result:

- As the plate moves, the active volcano is carried away, goes extinct, and a new one forms and a new one forms in a chain, with the youngest at the end.

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¶ 3.18



Distance = 500 km

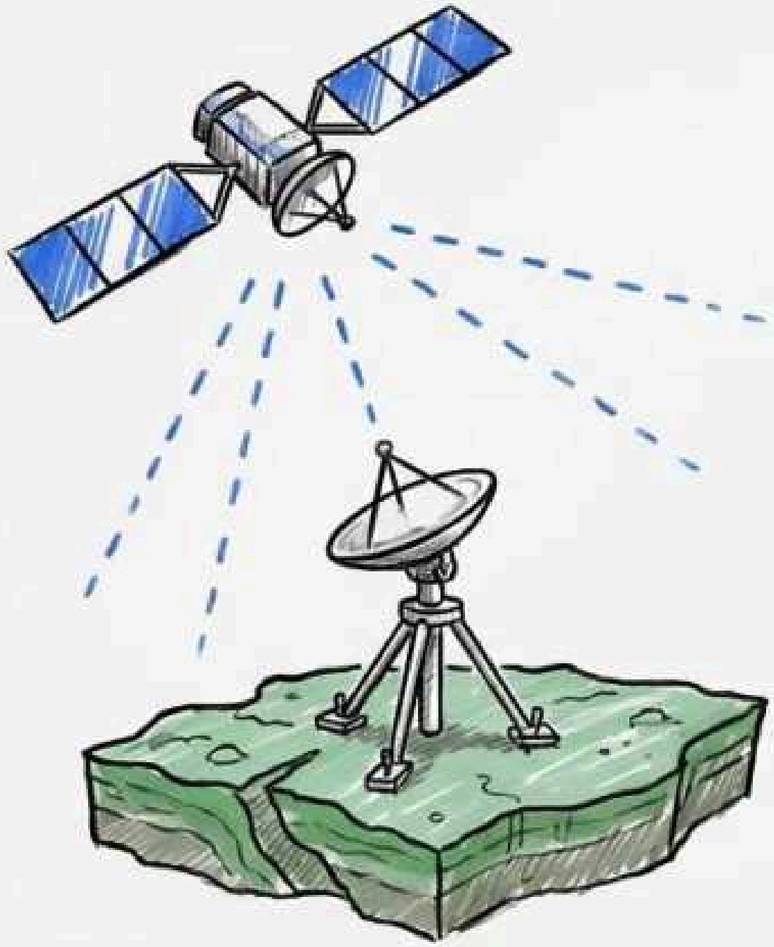
$$v = \frac{d}{t} = \frac{500\ \text{km}}{5\ \text{Million yrs}} = 100\ ^{\text{km}}/_{\text{Myr}}$$

$$100\ ^{\text{km}}/_{\text{Myr}} = \boxed{10\ \text{cm/yr}}$$

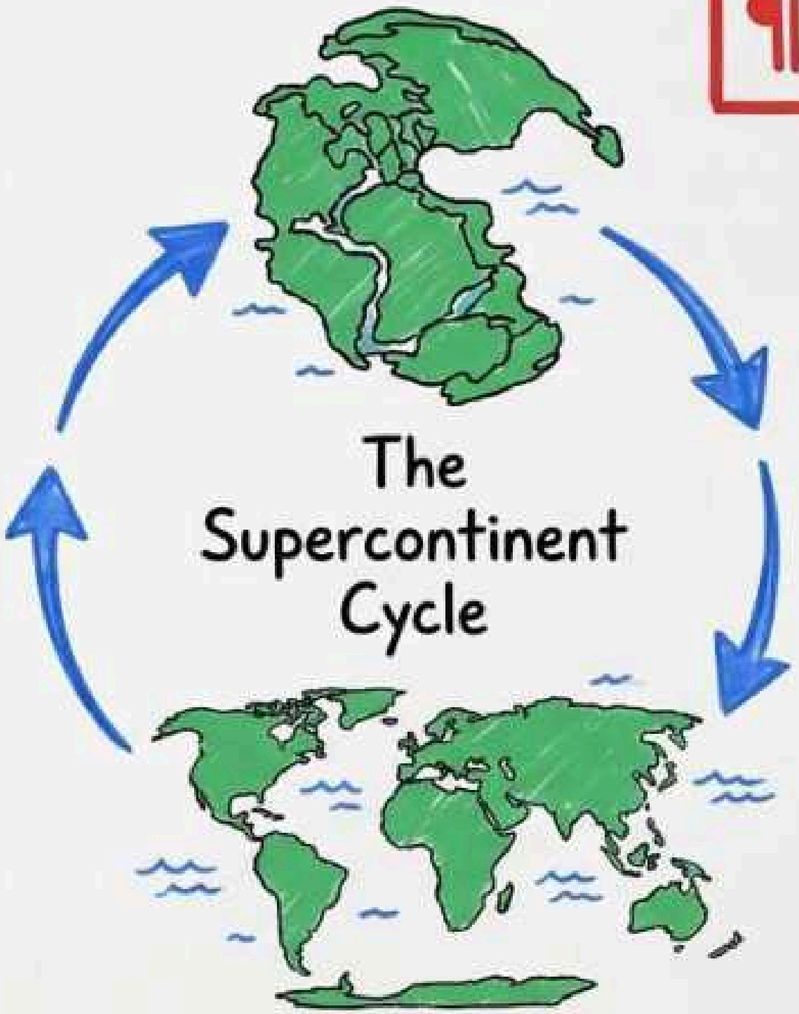
Conclusion: Matches the measured speed of the Pacific plate.

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¶ 3.19



Modern Validation: Satellites and GPS track stations to within millimeters per year, perfectly confirming geologic rates without needing rocks.



Continents assemble and break apart every few hundred million years. Pangaea was merely the most recent cycle.

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¶ 3.20



Mars & Venus: Appear to have a single rigid shell.

Earth: The only known planet in our solar system with plate tectonics.

The Hypothesis: Water in Earth's rocks helps keep the lithosphere weak enough to break into plates. Oceans and moving crust are inherently linked.

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¶ 3.21

Question 1 (Math): If the Atlantic spreads at 2.5 cm/yr, how far will it have widened in 50 million years?

Question 2 (Synthesis): Why was Wegener right about the facts yet widely rejected? What specific evidence finally changed the minds of geologists?

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¶ 3.22

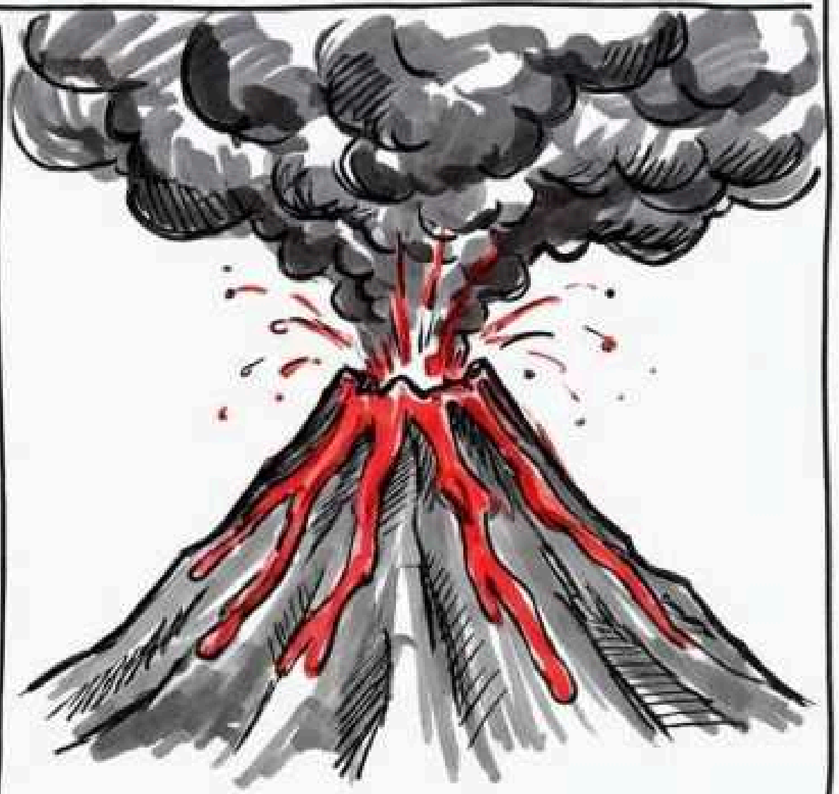
Looking Ahead: Lecture 4: When boundaries release their stored energy.



Earthquakes



Tsunamis



Volcanic Eruptions

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