

**WAS UNINHABITABLE**



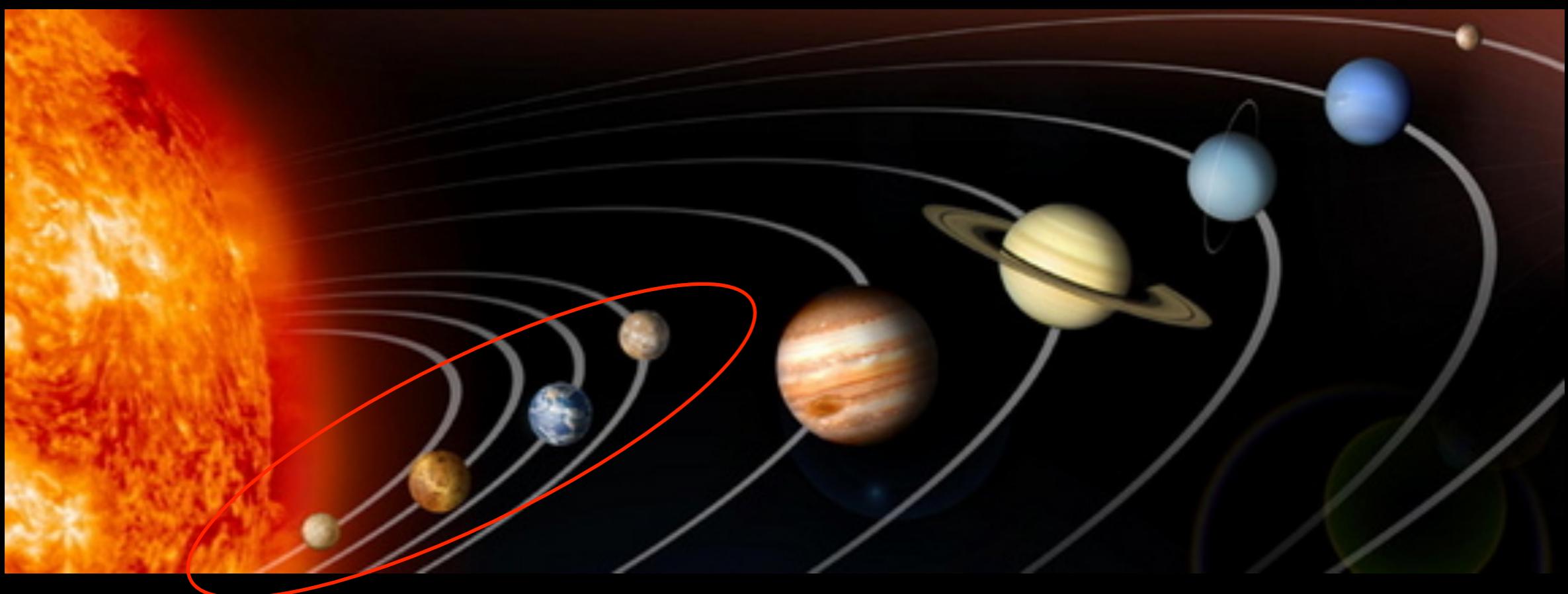
**BEFORE IT WAS COOL**



Our Living Earth  
and the  
atmosphere

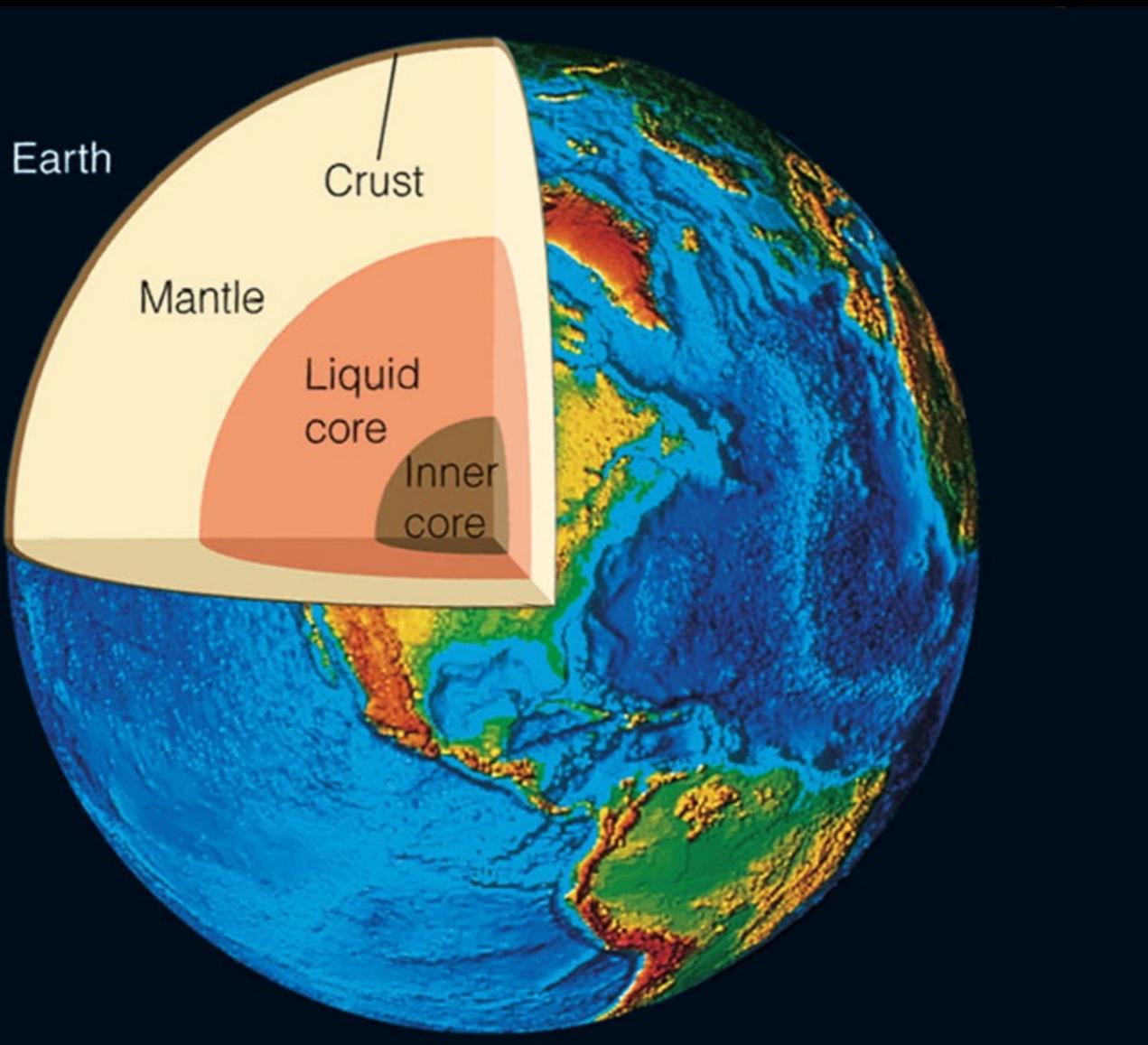
There are multiple aspects of **terrestrial** (or rocky) planets we will focus on

- 1) Interiors
- 2) Surfaces
- 2) Atmospheres
- 3) Magnetic fields



# In general, the **interior** of the Earth has multiple layers

- A metallic core
- A dense rocky mantle
- A thin, low-density crust or lithosphere

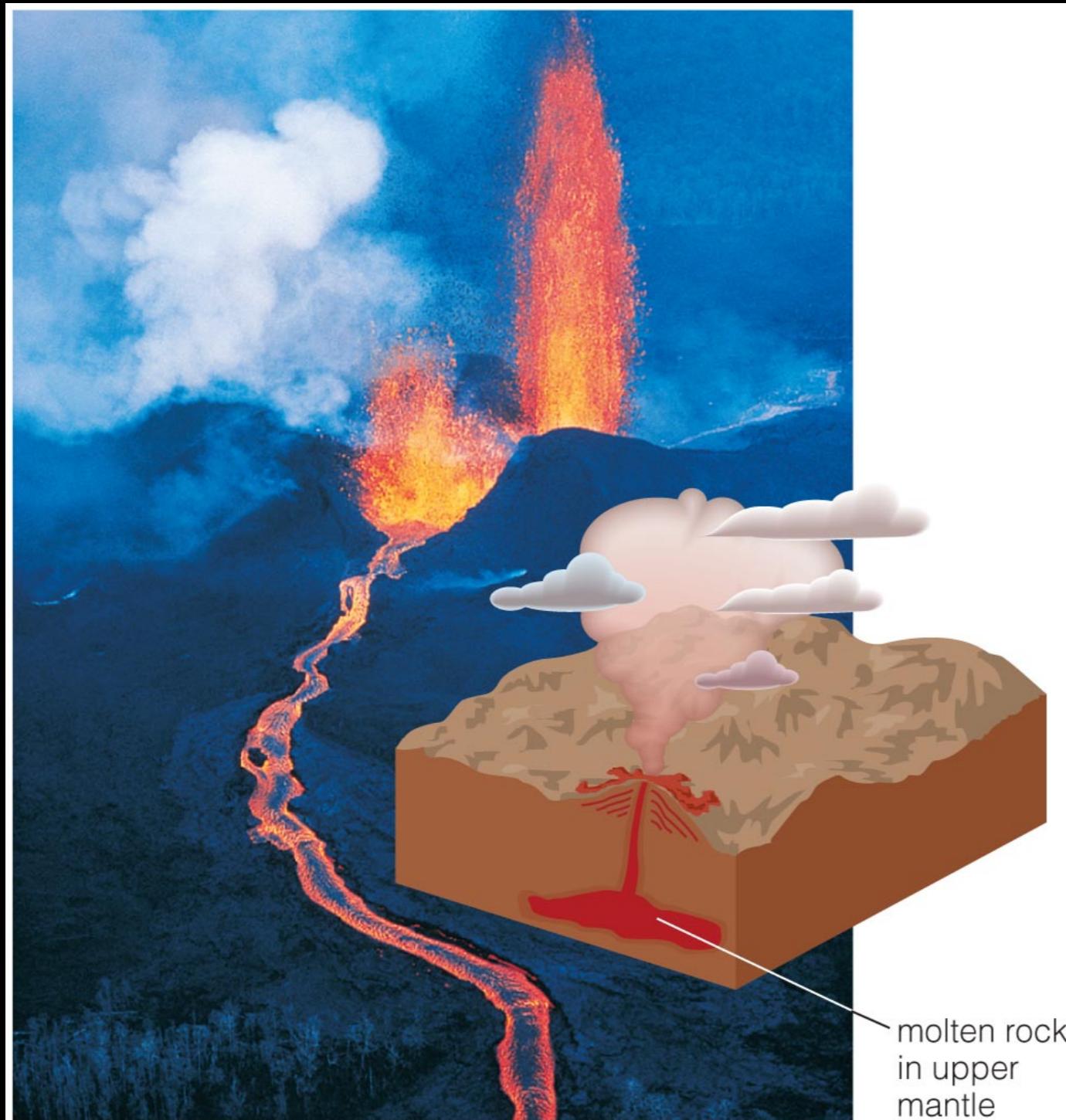


We can study the inside of the Earth from earthquakes

# Processes That Shape Surfaces

- Volcanism
  - Eruption of molten rock onto surface
- Tectonics
  - Disruption of a planet's surface by internal stresses
- Impact cratering
  - Impacts by asteroids or comets
- Erosion
  - Surface changes made by wind, water, or ice

# Volcanism



- Volcanism happens when molten rock (**magma**) finds a path through lithosphere to the surface.
- Molten rock is called **lava** after it reaches the surface.



# Tectonics: The continents move!



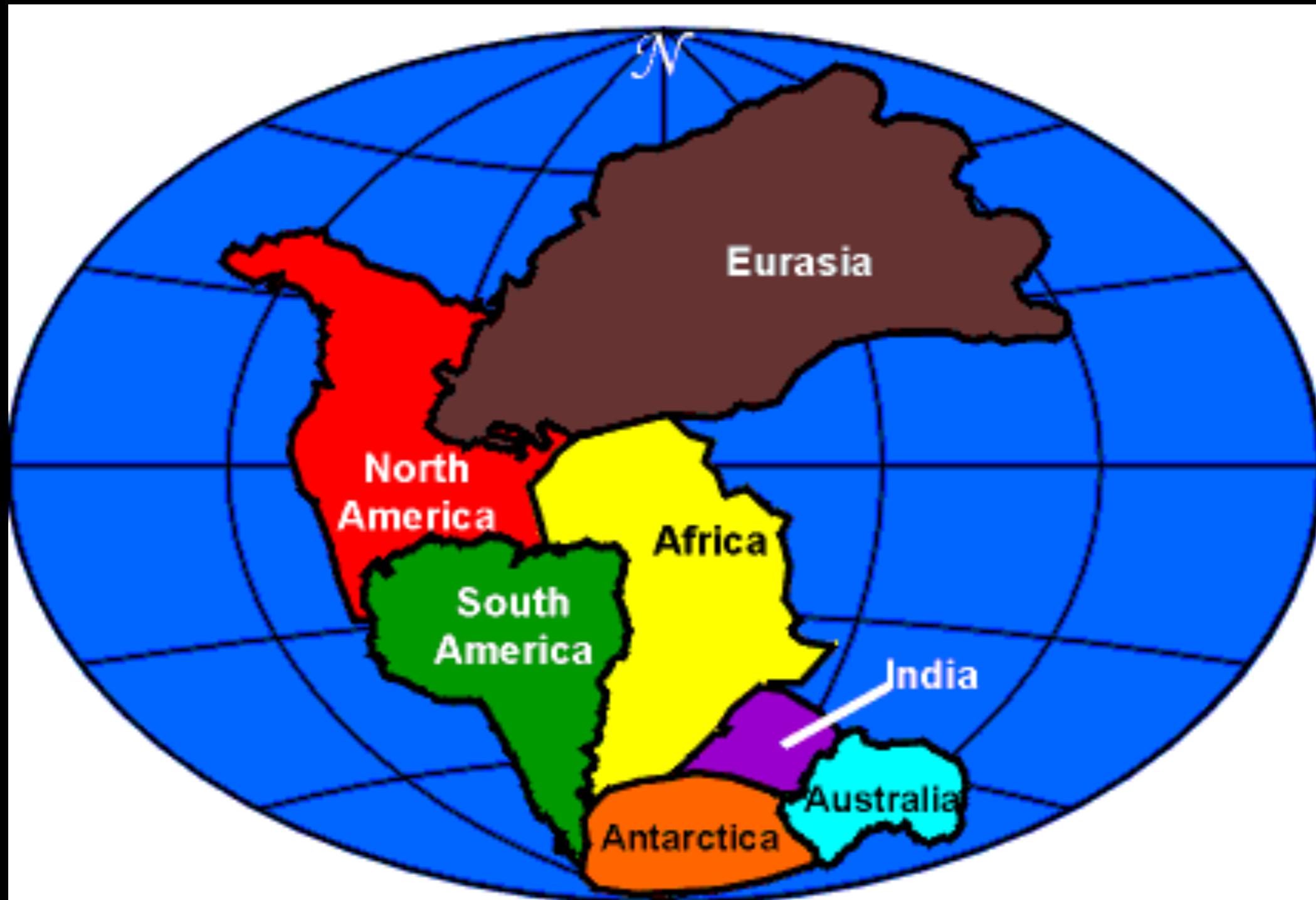
Motion of the continents can be measured with GPS.

# Rifts, Faults, Earthquakes

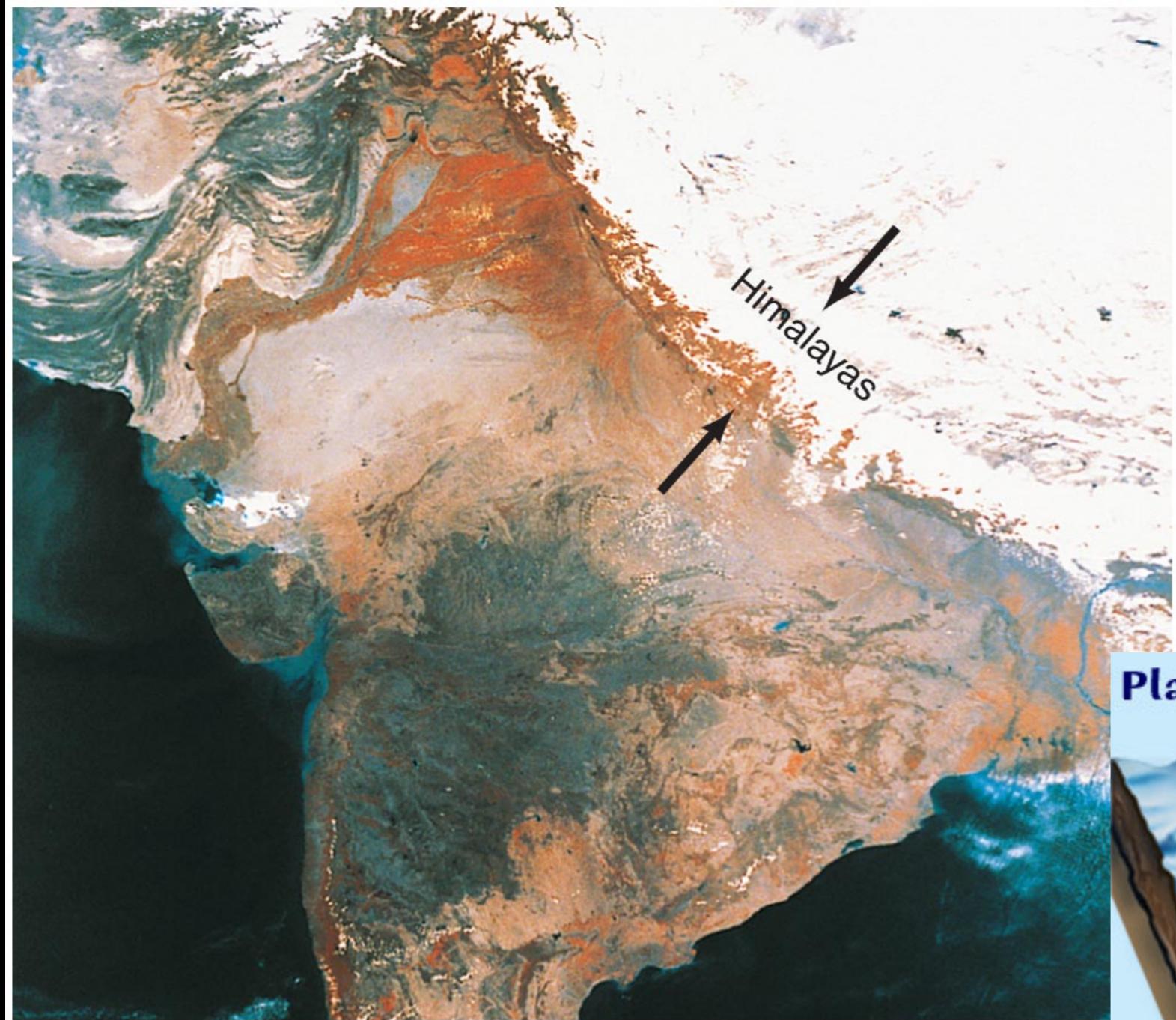


- The San Andreas fault in California is a plate boundary.
- Motion of plates can cause earthquakes

The surface of the Earth looked MUCH different 200 million years ago!

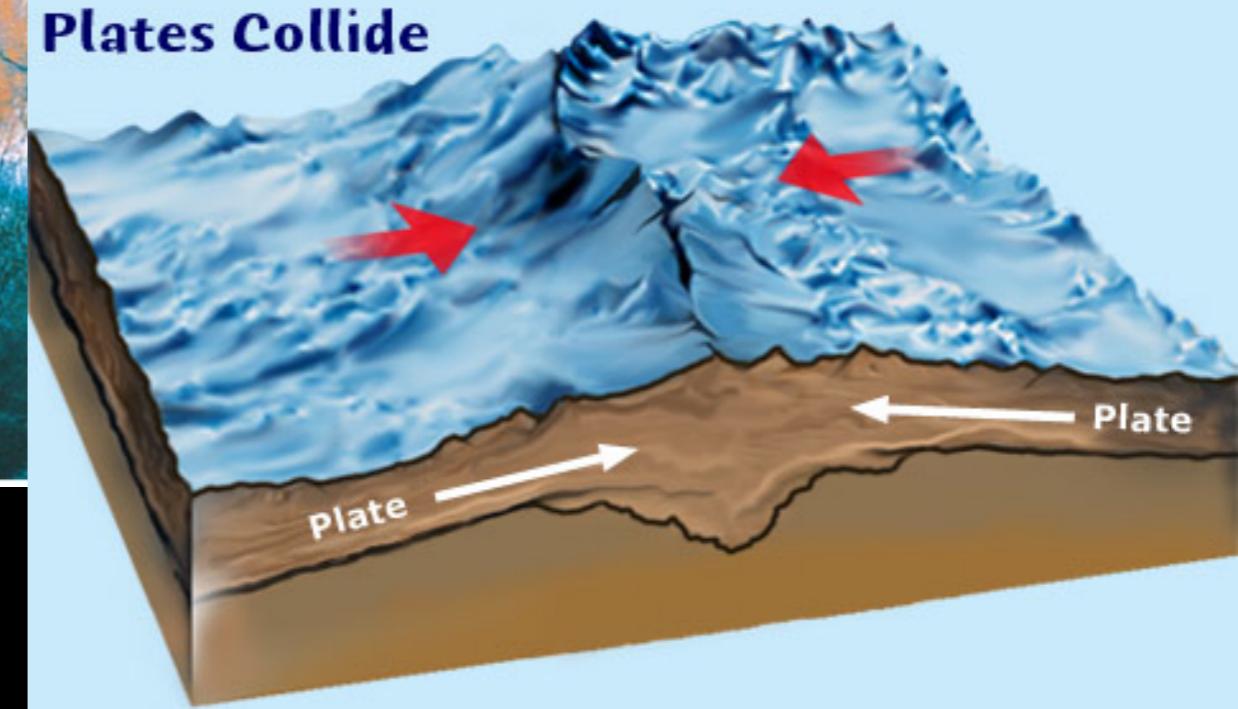


# Surface Features

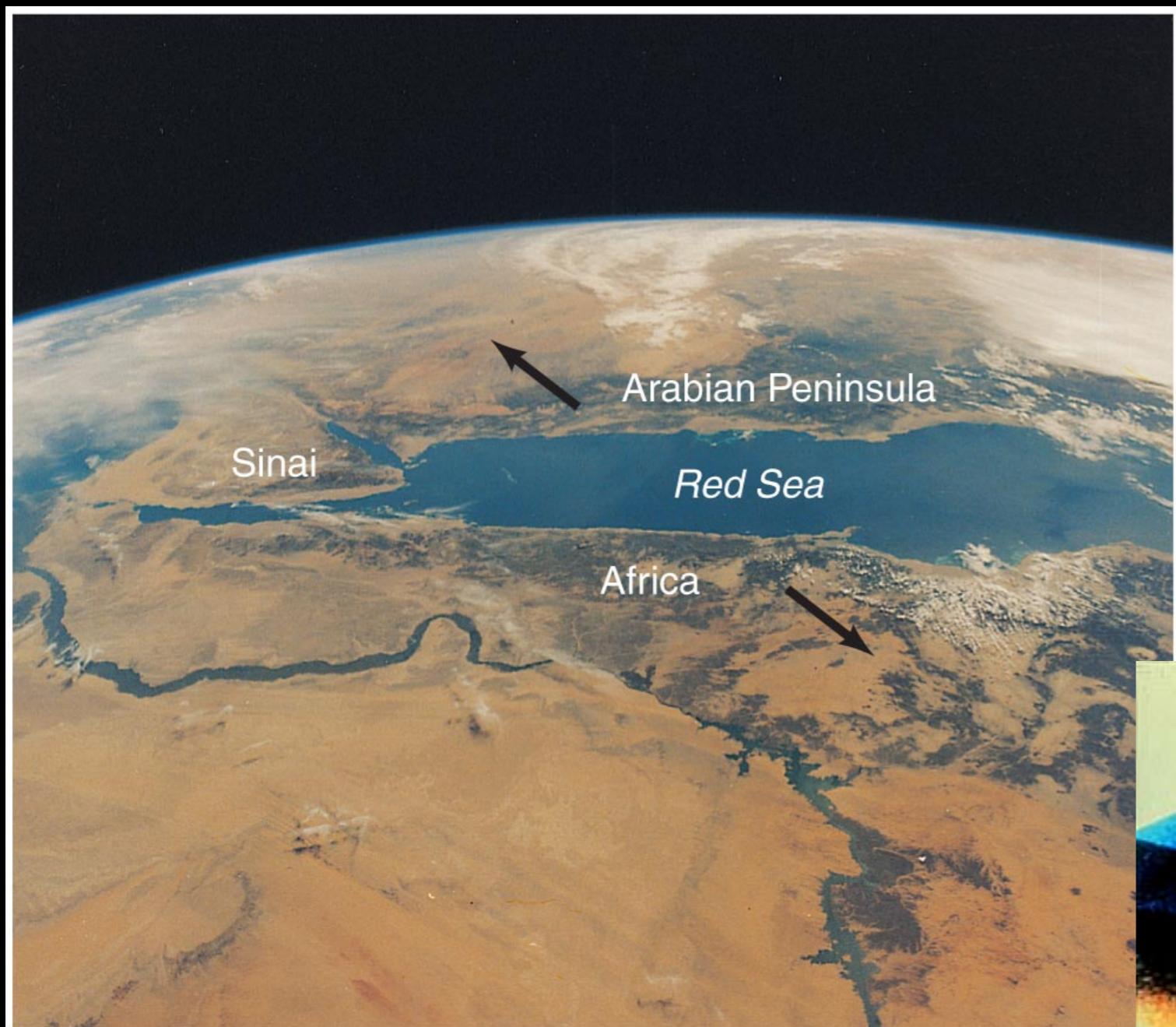


- The Himalayas formed from a collision between plates

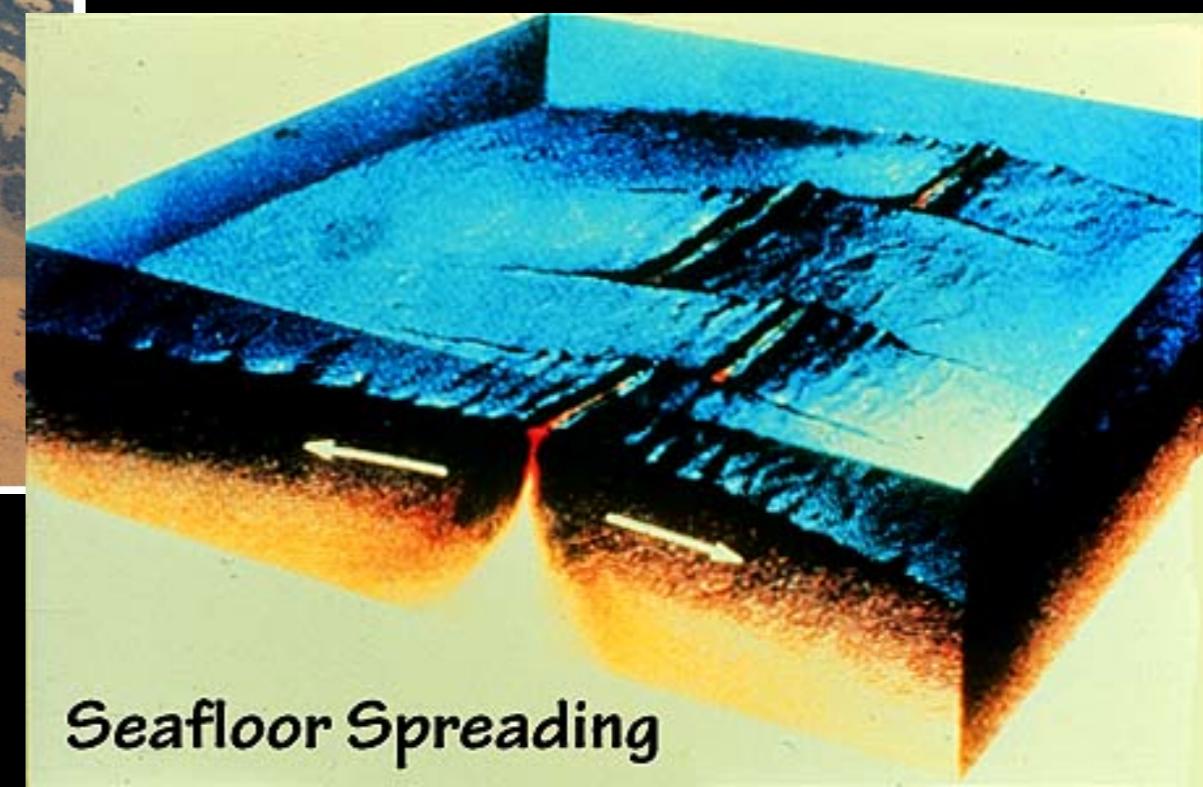
Plates Collide



# Trenches/Seas

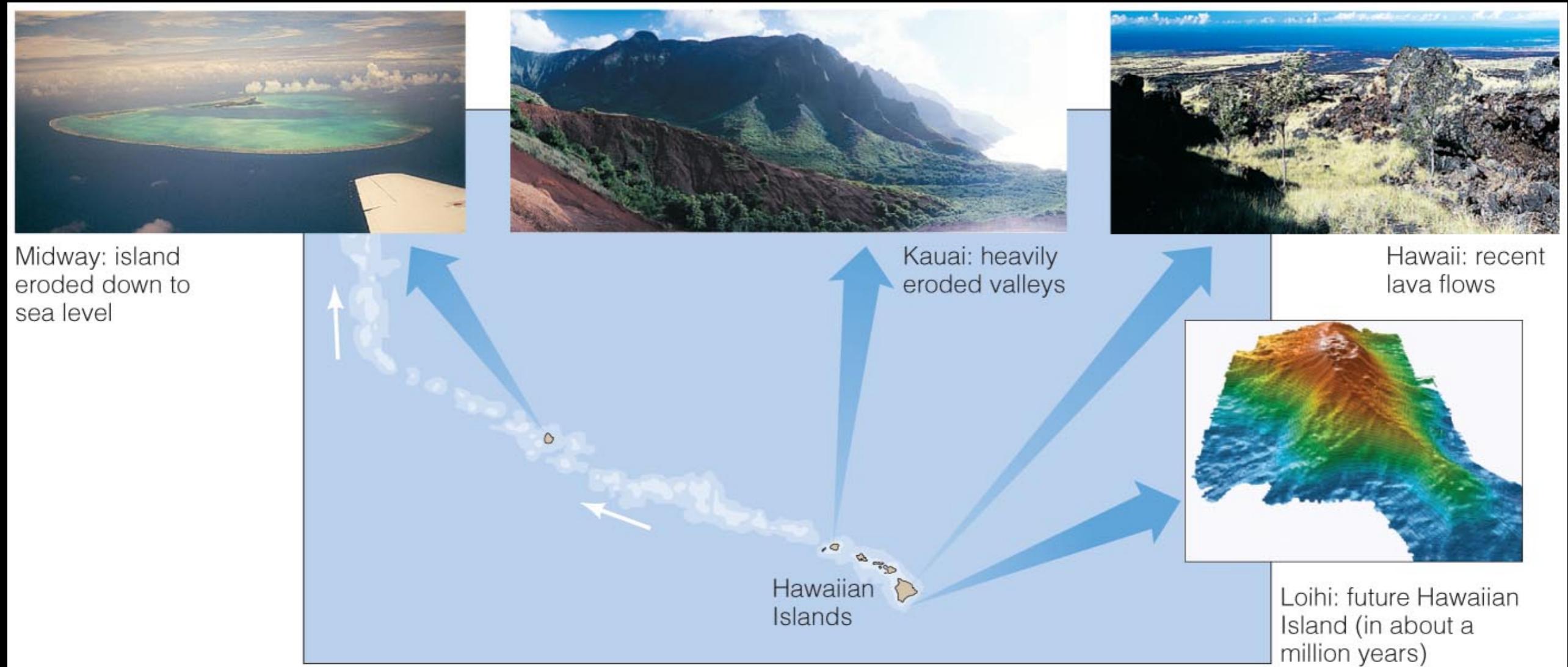


- The Red Sea is formed where plates are pulling apart.



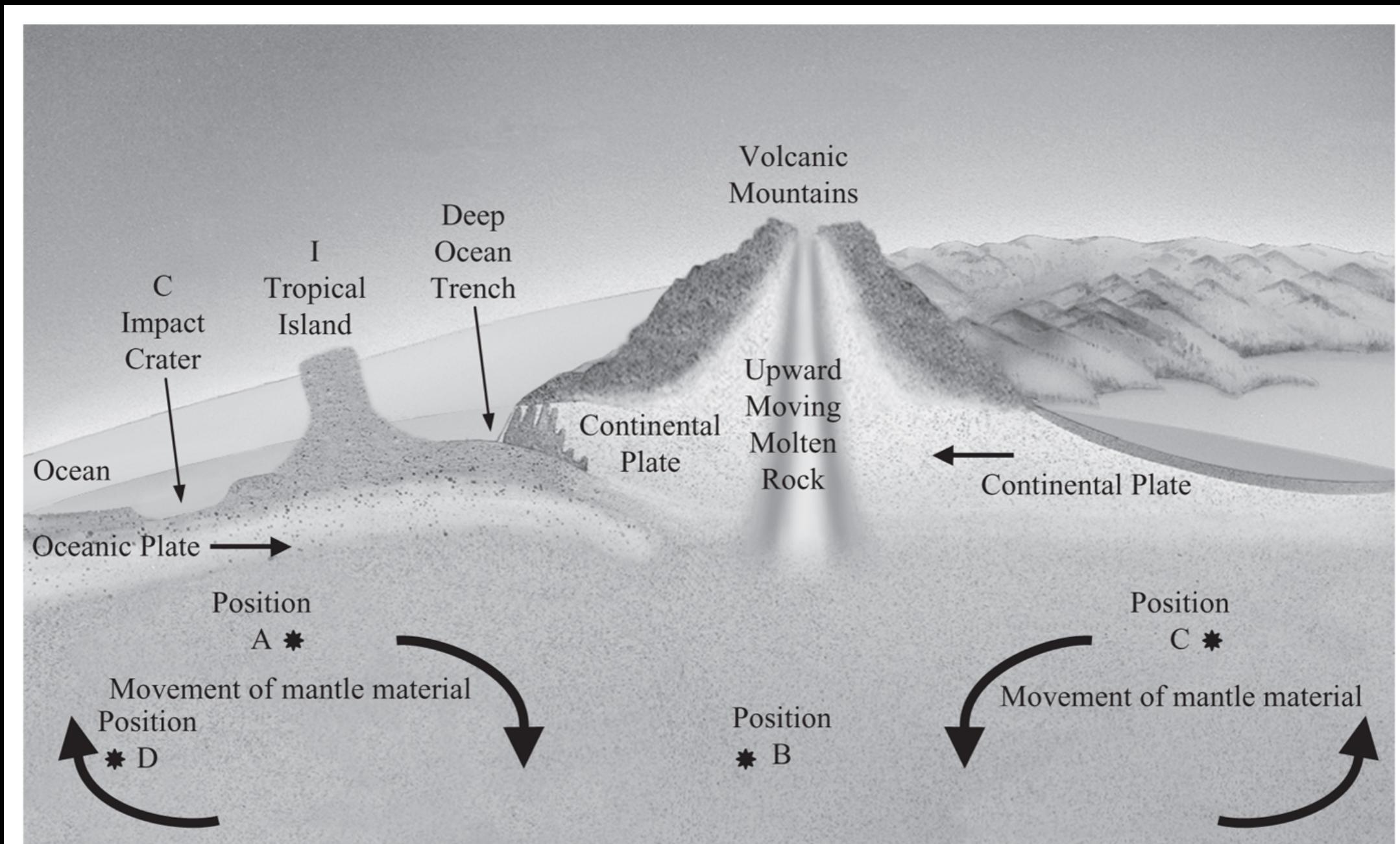
Seafloor Spreading

# Hot Spots

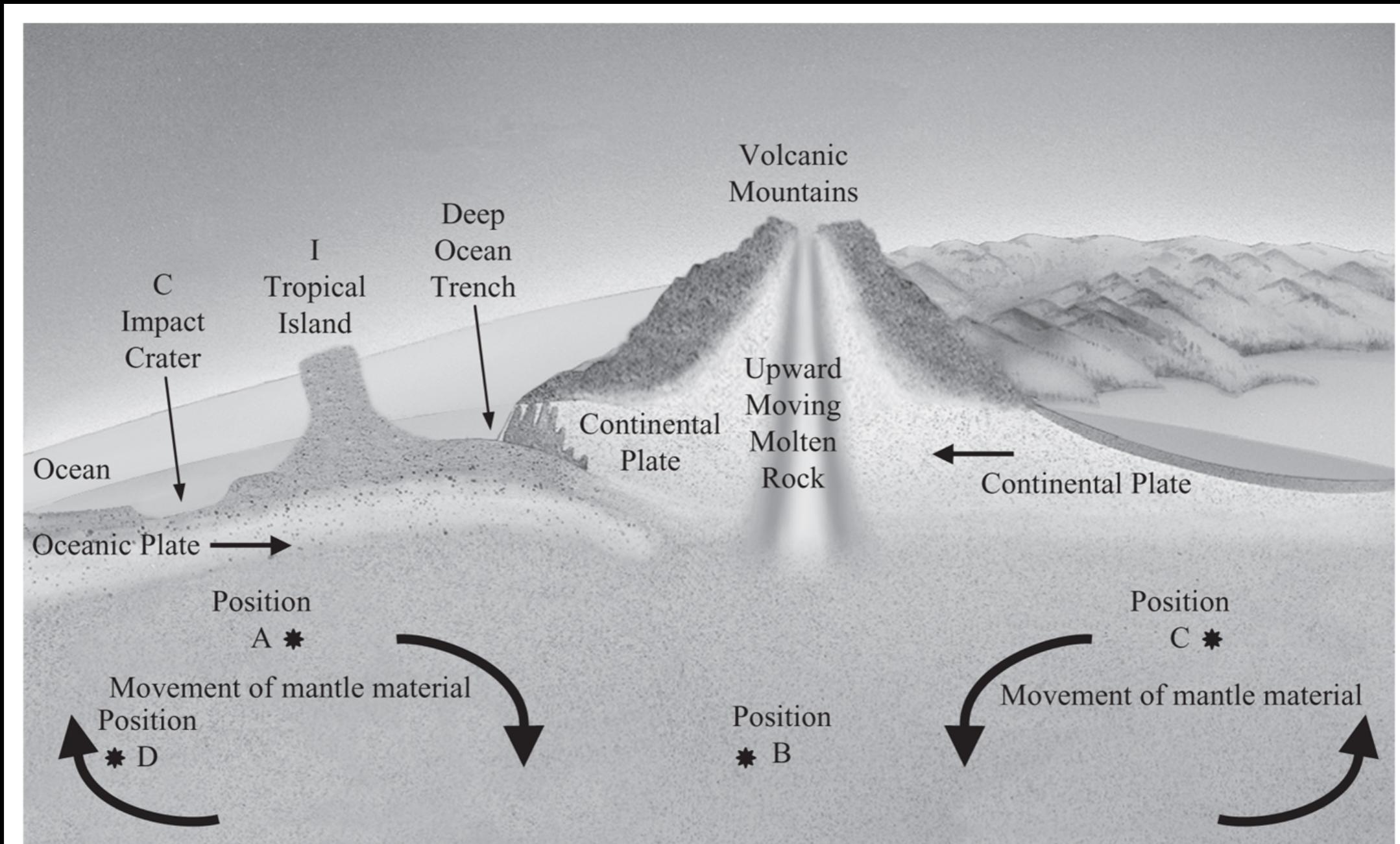


- The Hawaiian islands have formed where a plate is moving over a volcanic hot spot.

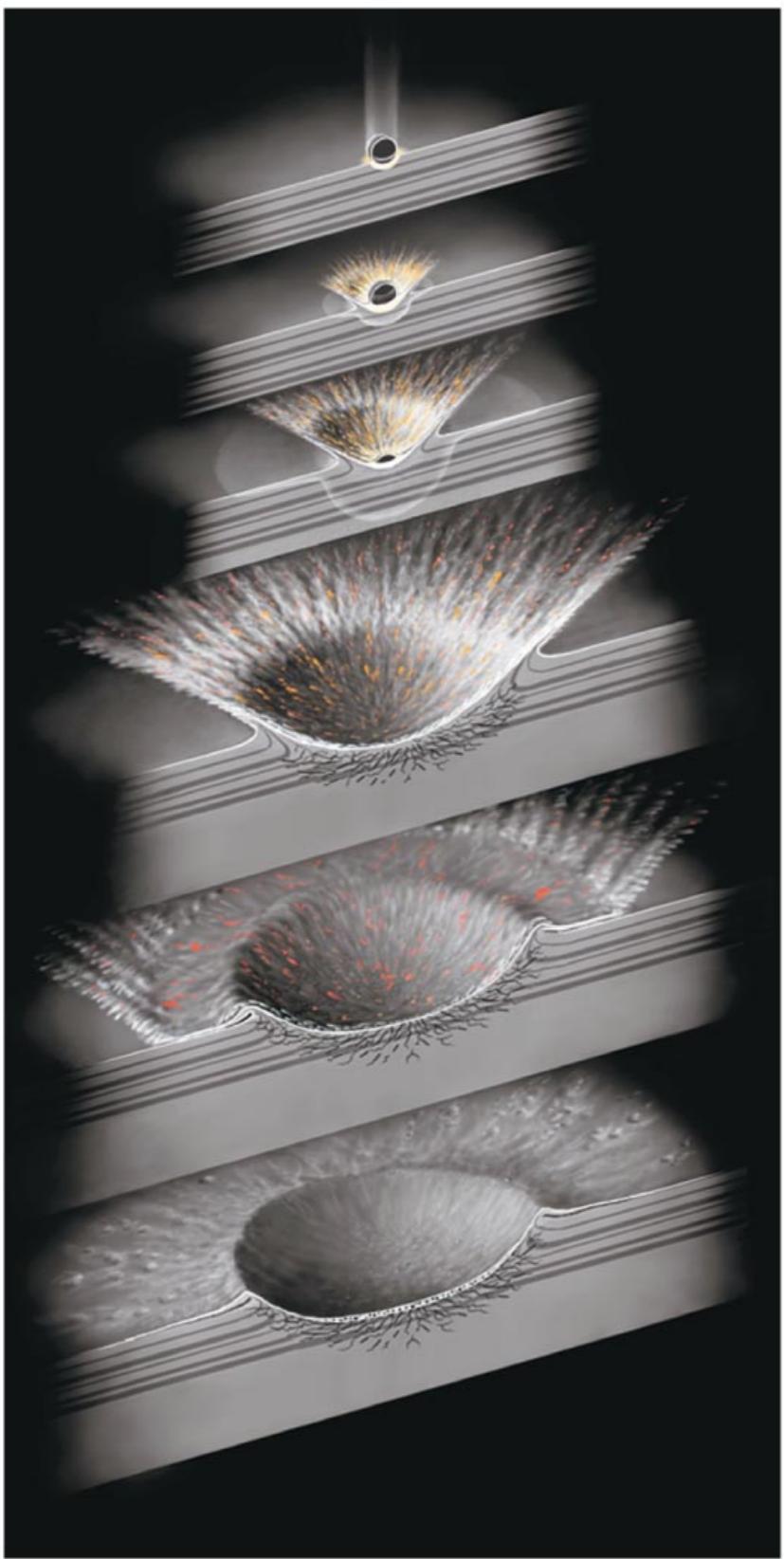
The high temperature of Earth's core causes material in the surrounding mantle to become hot, expand, and rise toward the surface. It then cools and sinks. The circulation causes plates at the surface to drift and collide.



- Which is hotter, the mantle at position A or D?
- Which direction is the mantle moving at A,B,C,D?
- Why do the oceanic and continental plates move?

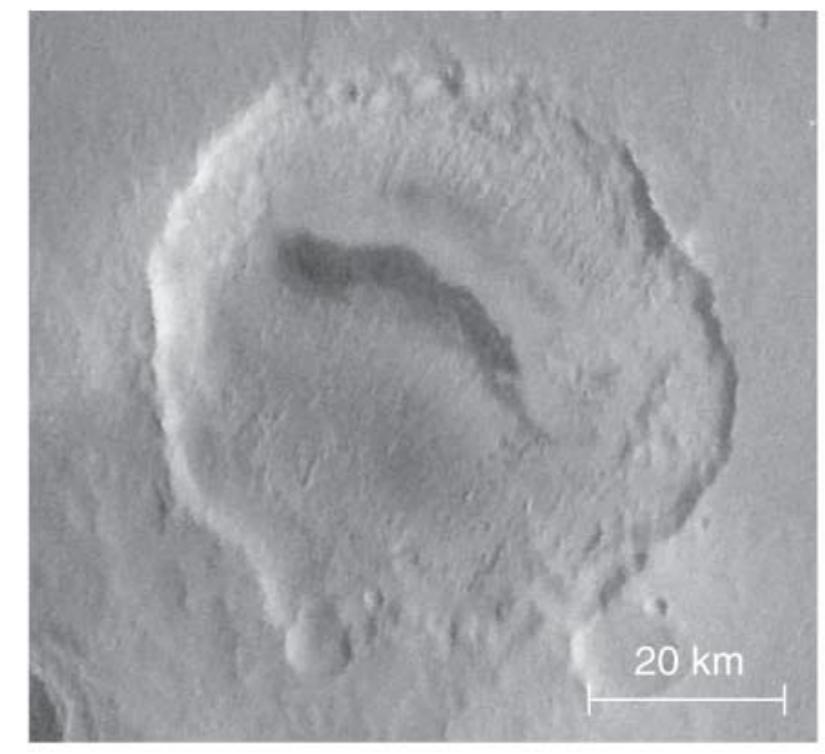
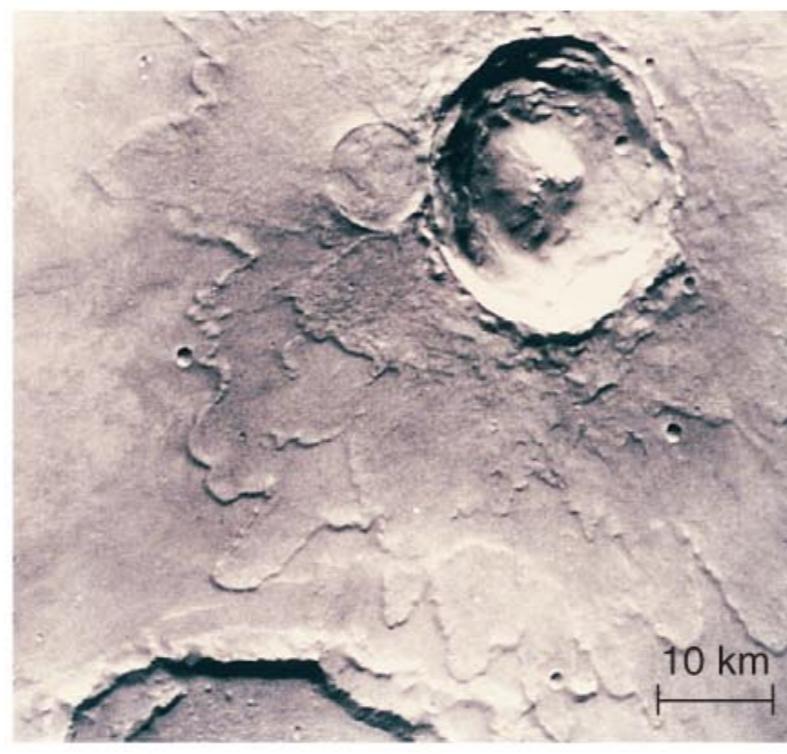
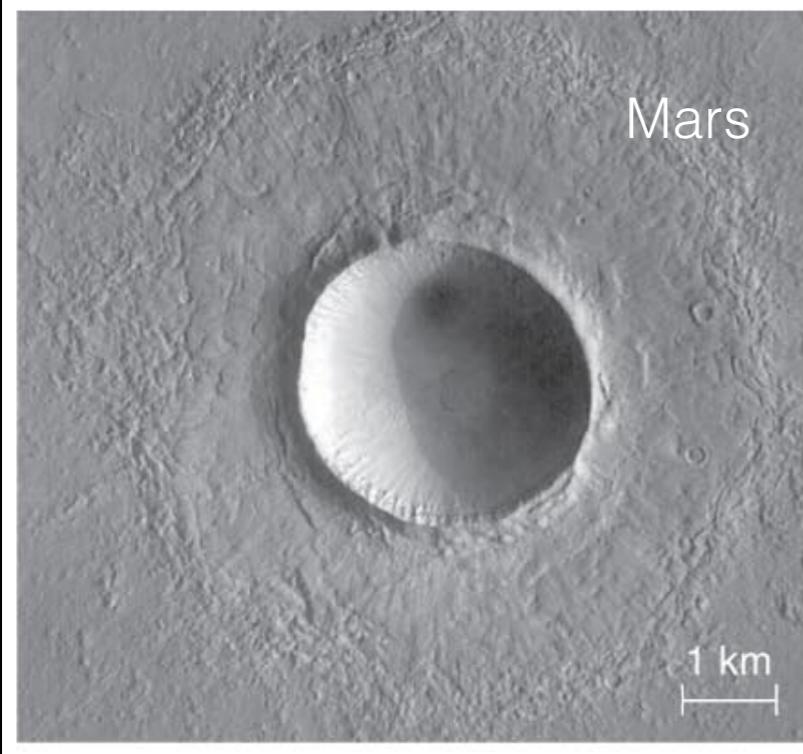


# Impact Cratering



- Most cratering happened soon after the solar system formed.
- Craters are about 10 times wider than object that made them.
- Small craters greatly outnumber large ones.





- **Erosion** is a blanket term for weather-driven processes that break down or transport rock.

- Processes that cause erosion include:
  - glaciers
  - rivers
  - wind



# Erosion by Water



- The Colorado River continues to carve Grand Canyon.

# Erosion by Ice

- Glaciers carved the Yosemite Valley.



# Erosion by Wind



- Wind wears away rock and builds up sand dunes.

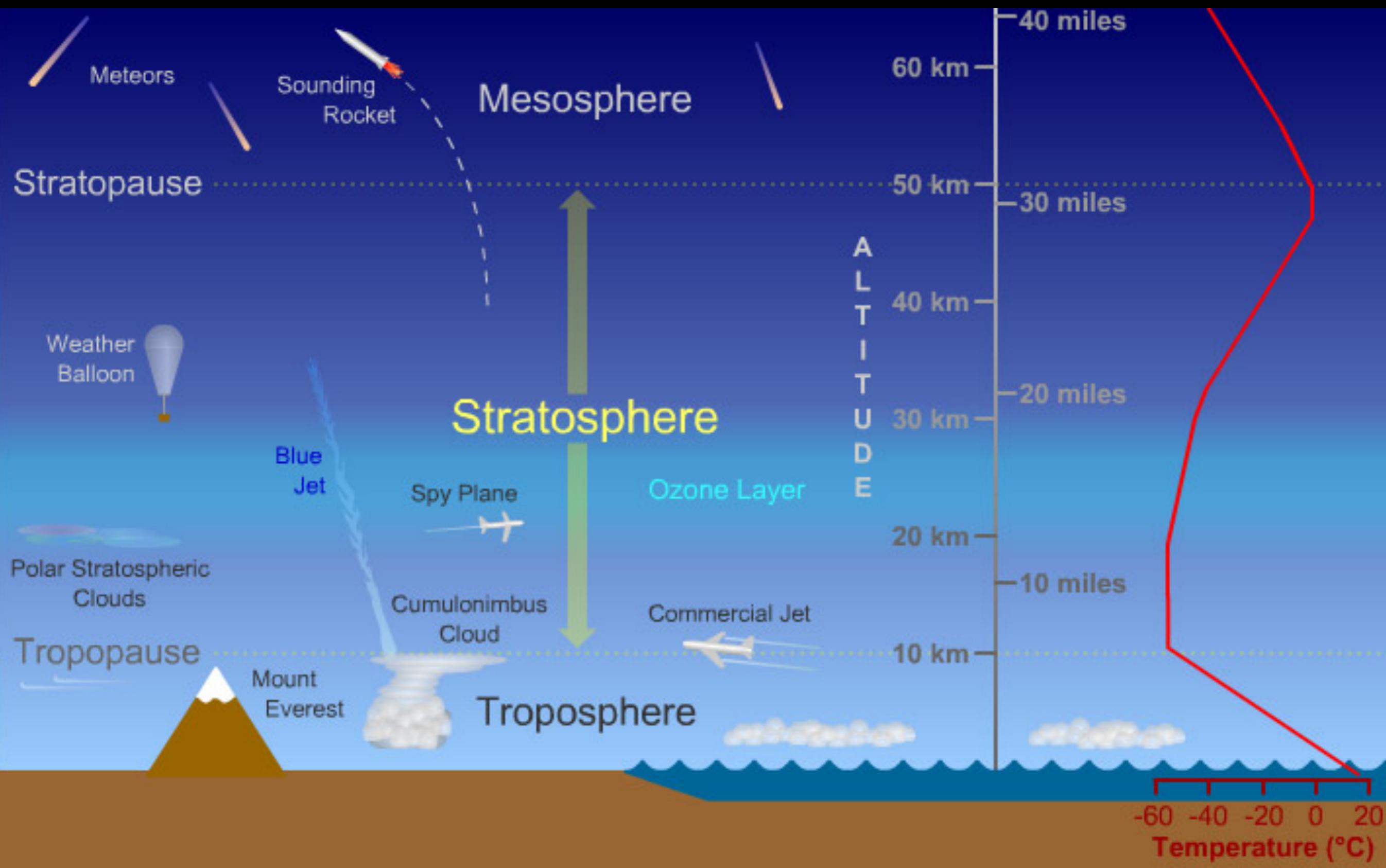


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The layer of gas that surrounds most planets is called an **atmosphere**



# Our atmosphere has multiple layers ...



**Q: What is the most common gas in our atmosphere?**

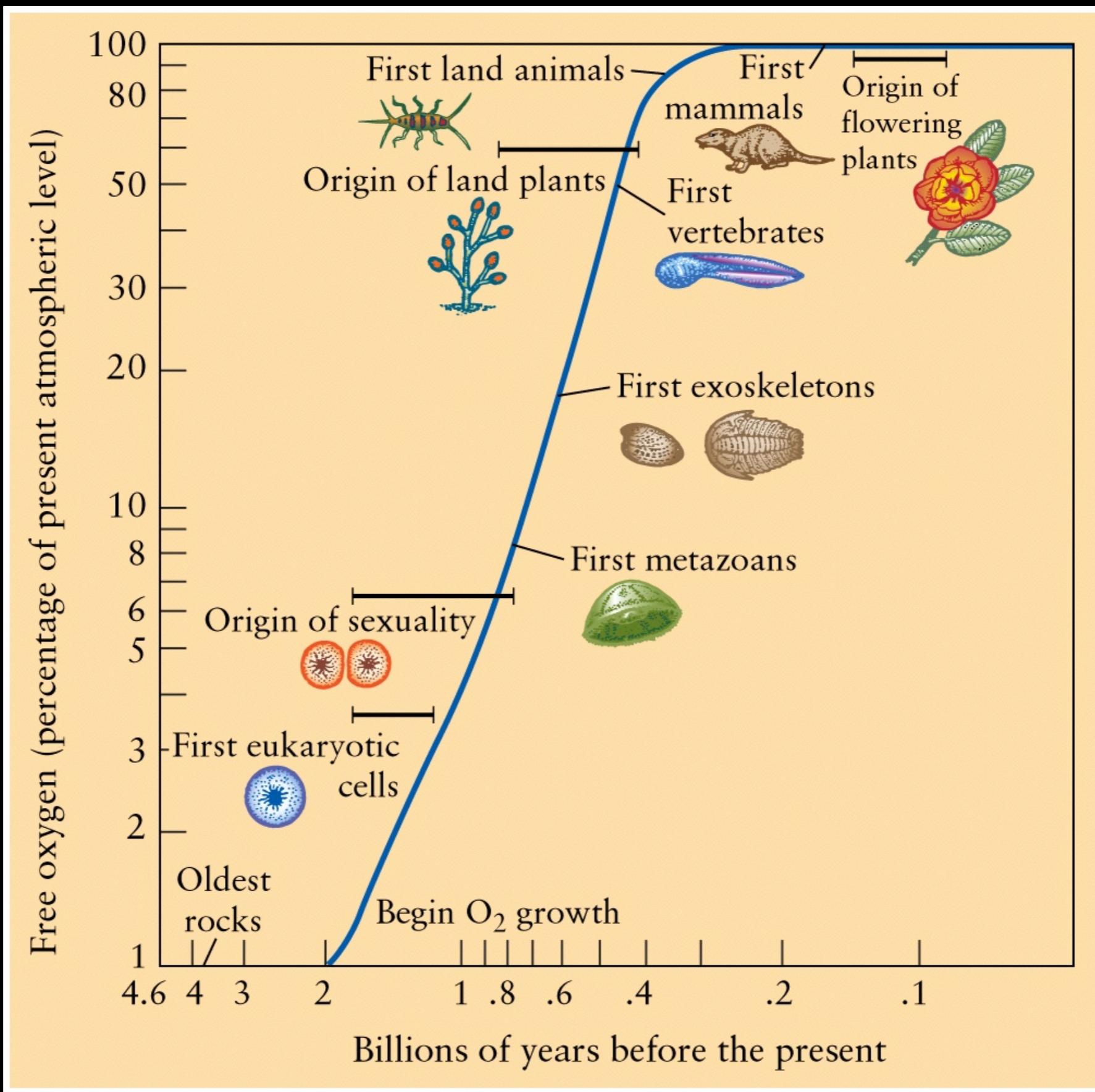
- A) Nitrogen
- B) Oxygen
- C) Methane
- D) Carbon dioxide

# The Earth's Atmosphere has changed!

- Earth's **primary** (or first) atmosphere was once thought to contain gases such as hydrogen, methane and CO<sub>2</sub>
- Soon after Earth formed, it began to cool.
  - Once it cooled enough, oceans began to form, and **carbon dioxide** began to dissolve in the water.
  - The volcanos produce water, carbon dioxide and sulphur dioxide and NITROGEN - outgassing

It is NOW: N<sub>2</sub> (78%), O<sub>2</sub> (21%), Ar (1%), everything else

# The Earth's Atmosphere has changed!



# Examples of Outgassing

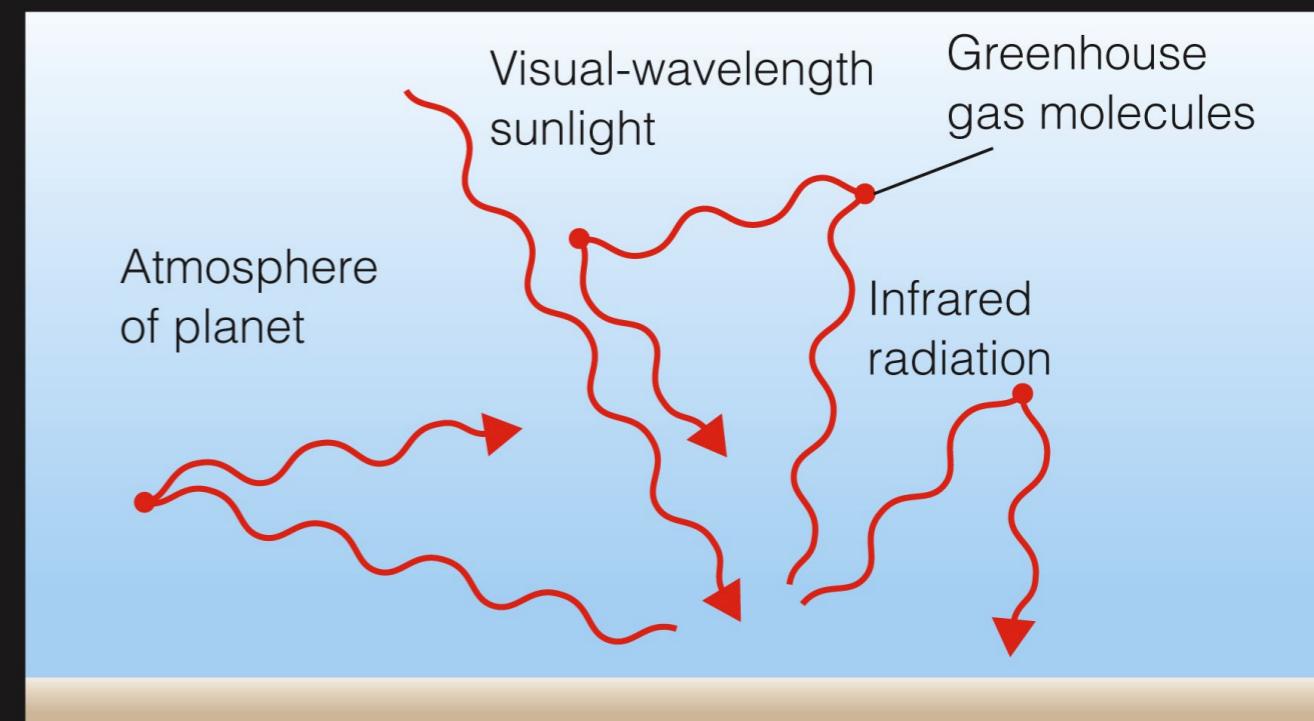
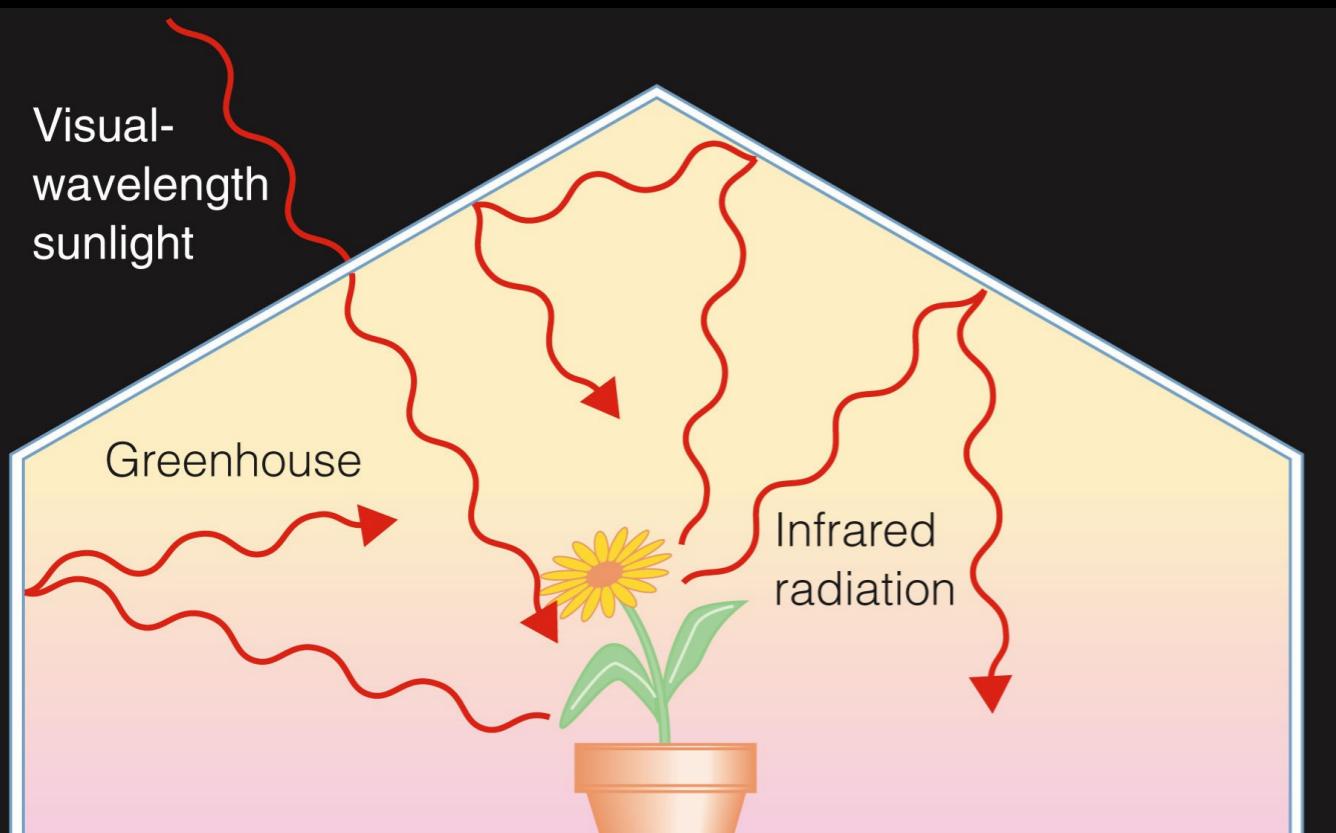


- Volcanism releases gases from Earth's interior into the atmosphere

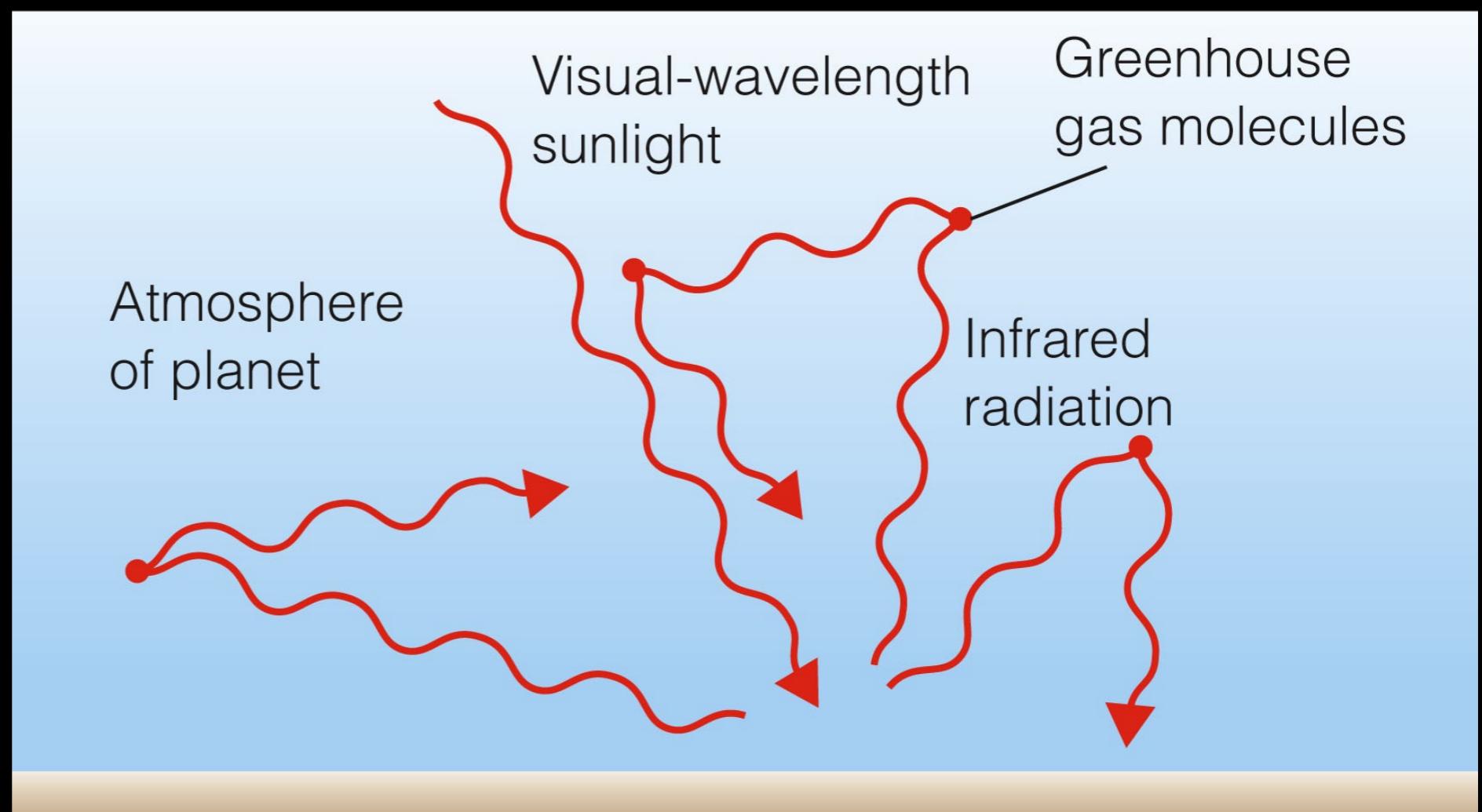
- The removal of carbon dioxide is critical to Earth's history.
  - This is because an atmosphere rich in carbon dioxide can trap heat—by the **greenhouse effect**



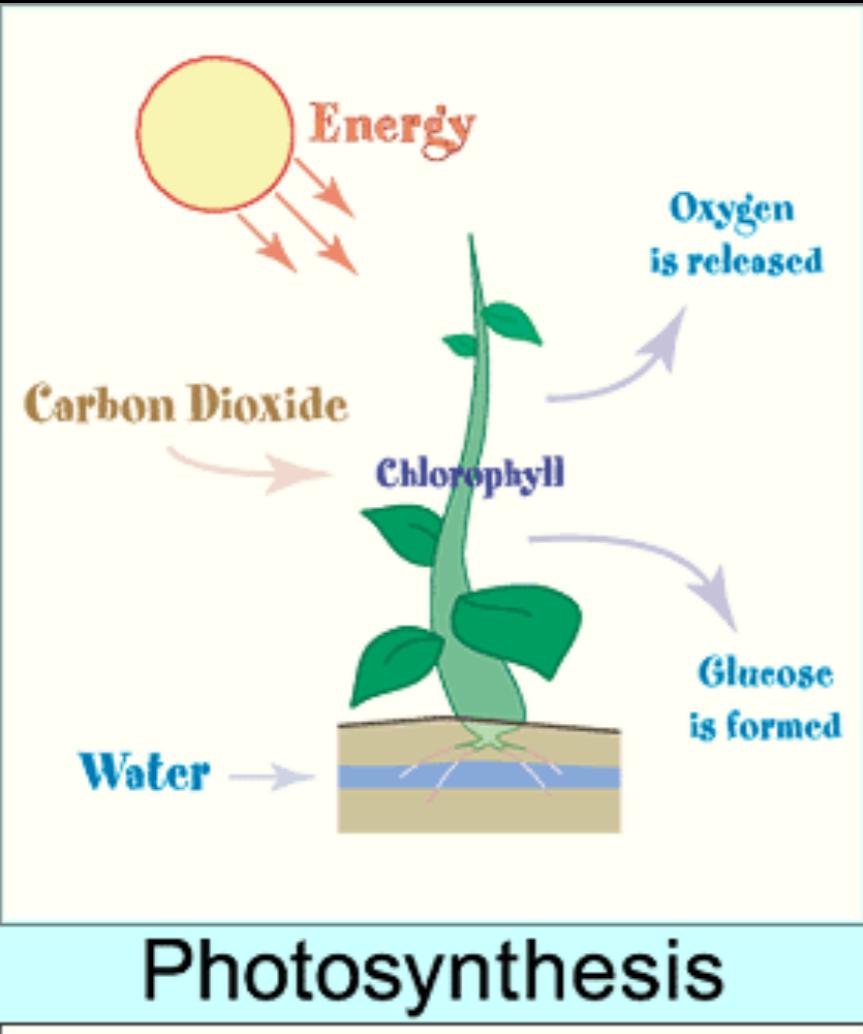
Like the glass roof of a greenhouse, a planet's atmosphere can allow sunlight to enter and warm the surface.



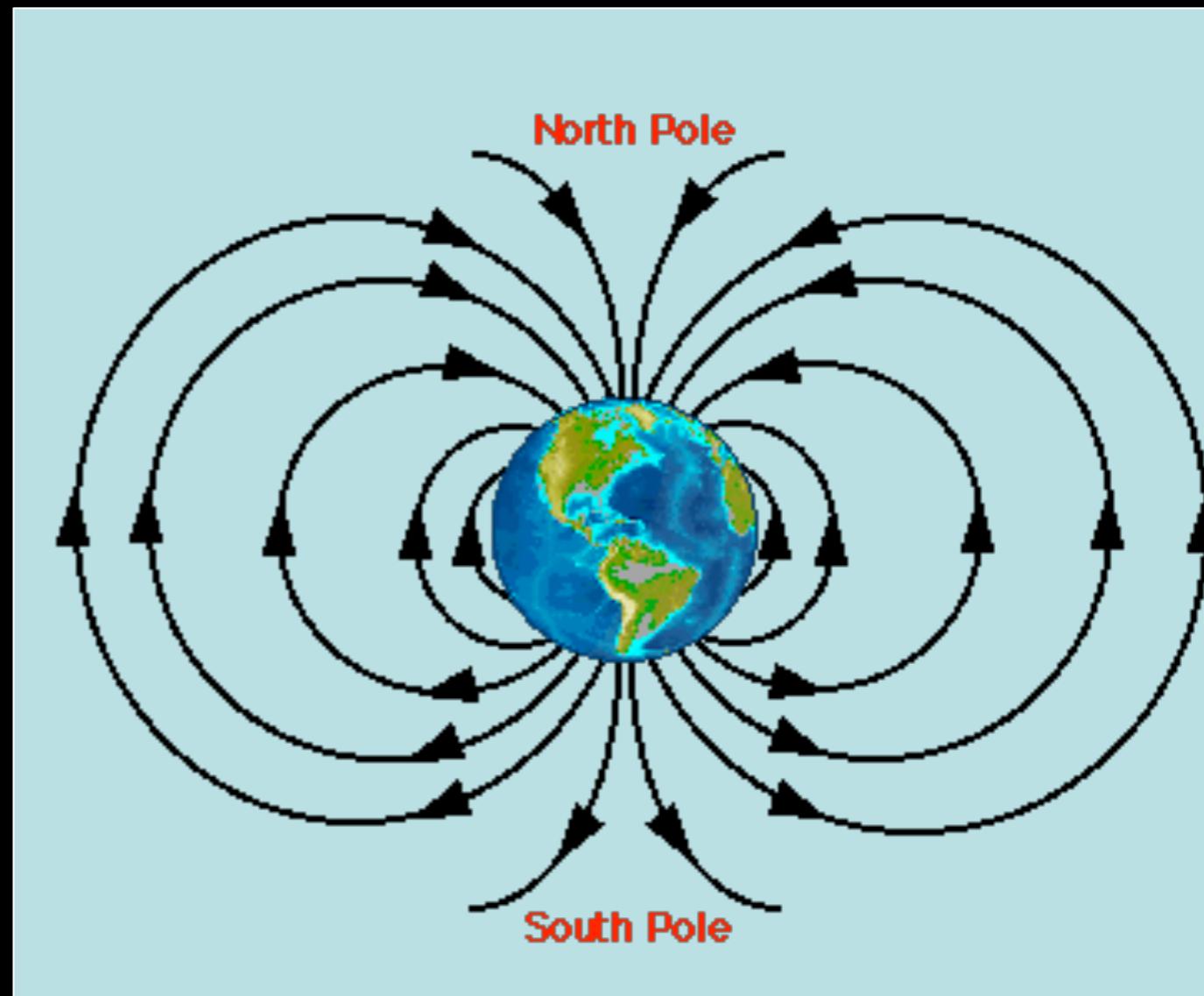
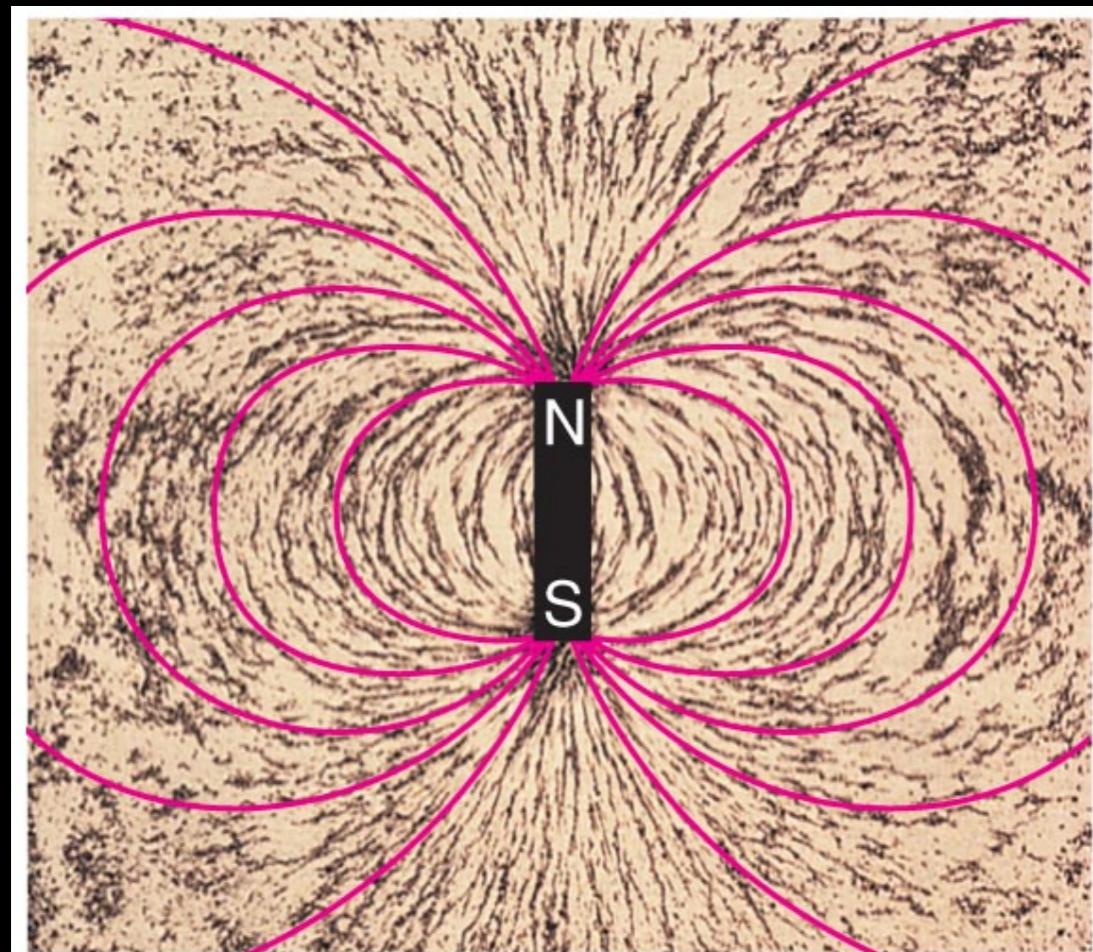
However, CO<sub>2</sub> and other greenhouse gases such as water vapor and methane are opaque to infrared radiation.



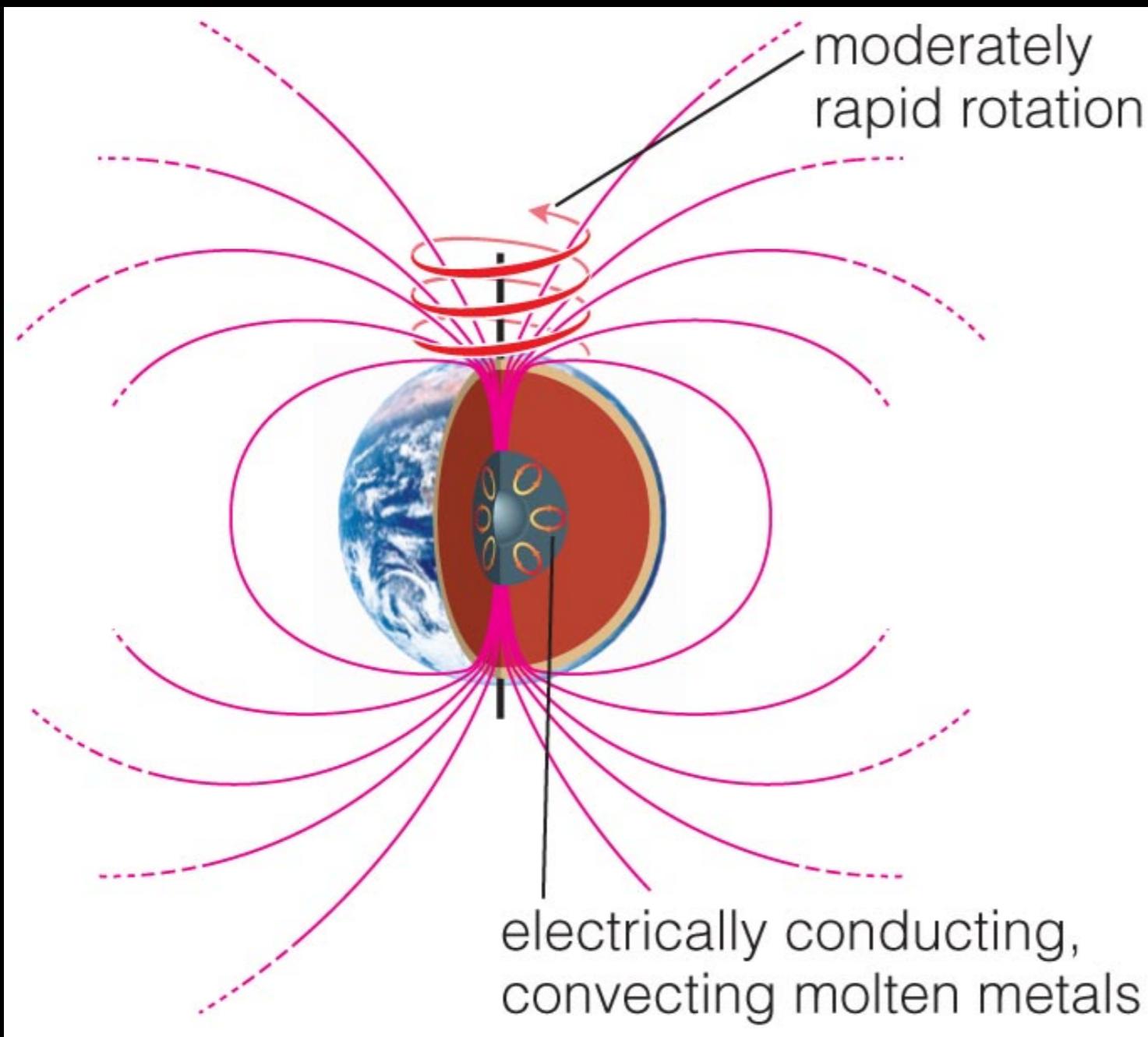
- Photosynthesis makes energy for the plants—by absorbing carbon dioxide and releasing free oxygen.
- As there is oxygen in the atmosphere now, there is also a layer of ozone ( $O_3$ ) at altitudes of 15 to 30



# Magnetic Fields

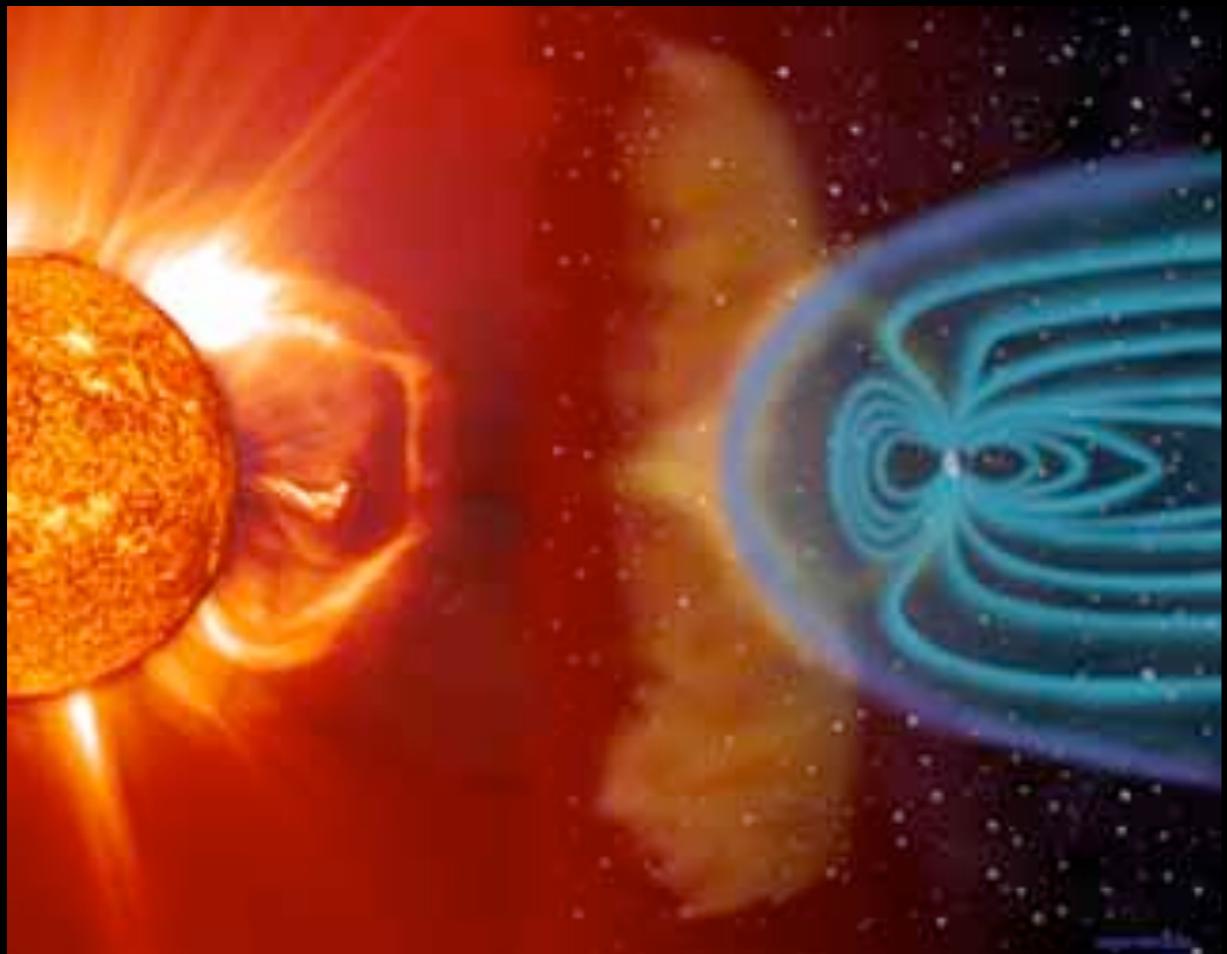


# Sources of Magnetic Fields



- A world can have a magnetic field if charged particles are moving
- **Three requirements:**
  - Molten interior
  - Convection
  - Moderately rapid rotation

# Earth's magnetic field



- It protects us from the solar wind
- It's the source of the aurora borealis