Earth, the Lively* Planet

* not counting the life *on* the planet!

What We Will Learn Today

- What are planet Earth's features?
- What processes shape planetary surfaces?
- How does Earth's surface move?
- How did the continents form?
- How is Earth's geology unique in the solar system?

Planet Earth Details

Property	Value	
Semi-major axis	149.6 million km (1.00 AU)	
Size (radius)	6,378 km (1.00 R_{Earth})	Largest terrestrial
Mass	5.97 x 10^{24} kg (1.00 M_{Earth})	
Average density	5.52 g/cc	Densest in Solar System
Composition	Rocks, metals	
Average surface temperature	290 K	Liquid water on surface!
Moons	1	Largest moon/planet size
Orbital period	365.242 days (tropical)	
Rotation period (sidereal)	23h, 56m (sidereal)	Fastest terrestrial
Axis tilt	23.5^{o}	
Orbital inclination	0.00^{o}	
Orbital eccentricity	0.007	

Shaping Planetary Surfaces

- Mostly flat
  - Tallest mountains are like grains on sand on a typical globe
- Shaped by
  - Impacts
  - Volcanism
  - Tectonics
  - Erosion
- All four are significant on Earth

Impacting Meteorites

- Remember, speed of Earth around the Sun is 30 km/s (over 65,000 mph!)
- Typical rocks (asteroids) have similar speeds
- Collisions at these speeds are very eventful
  - Typical impact speeds are 10 – 70 km/s!
  - Obliterate the impacter
  - Leave scar marks on Earth
  - Could wipe out all humans!
- A planetary scar
  - Size of crater ~ 10 times impacter
  - Depth of crater ~ 10 – 20% size
- Meteoroid
  - Piece of rock floating in space
- Meteor
  - Visible event when rock enters atmosphere
- Meteorite
  - Piece of space-rock on Earth's surface

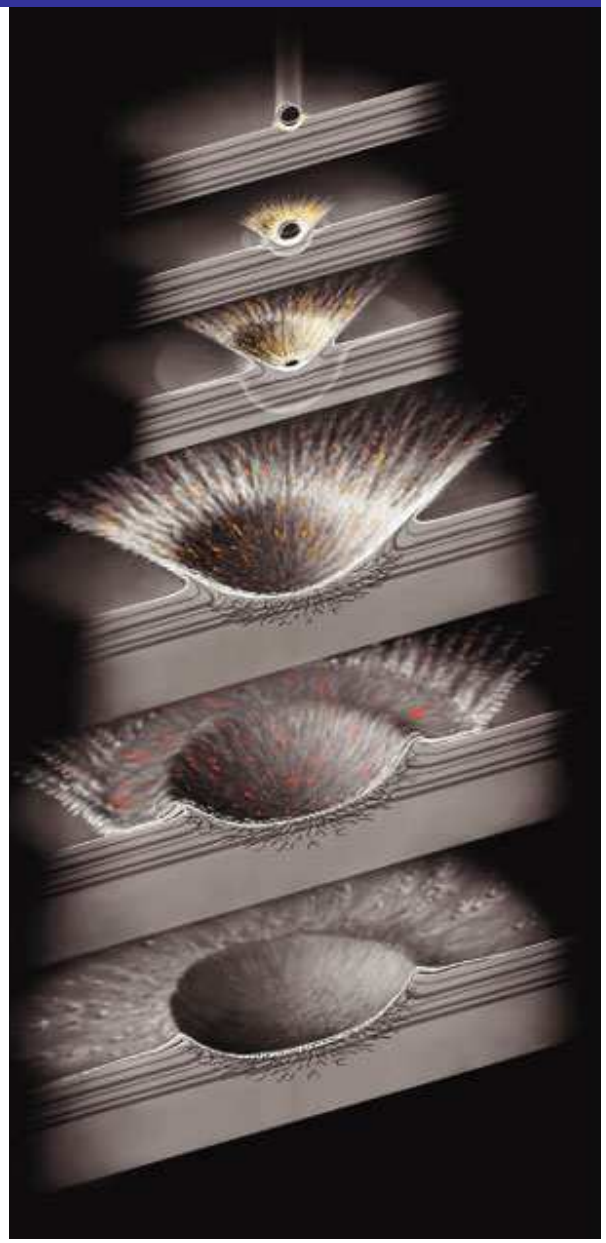


Fig 9.7

Past Impacts on Earth

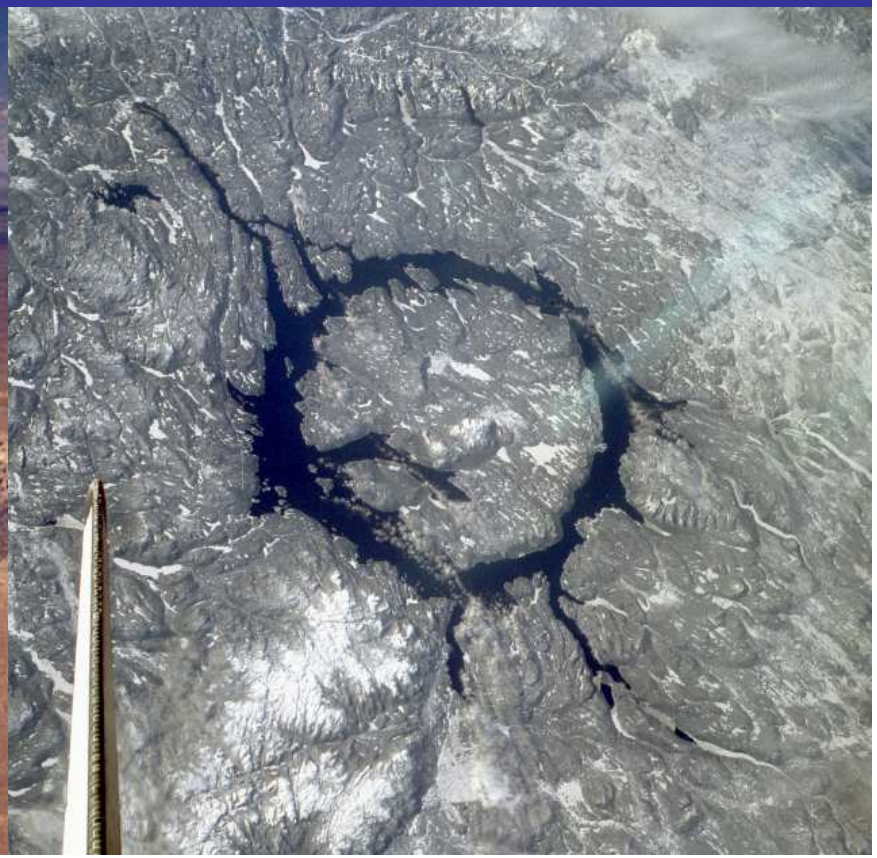


Fig 9.8

Meteor Crater (AZ)

- Created 50,000 years ago
- Asteroid was about 50 m across
- Crater is over 1 km wide
- About 200 m deep

Manicouagan Crater (Canada)

- Created 200 million years ago
- “Crater” is over 70 km wide
- Mostly eroded away
- Picture taken from Shuttle Colombia

Volcanism

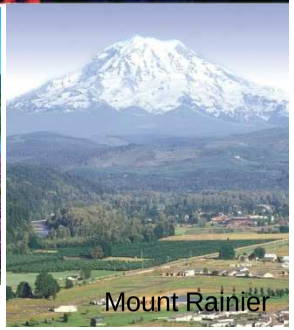
- Molten rock in upper mantle finds its way to the surface
- Thin, cracked lithosphere helps
- Only small pockets of the mantle are molten (magma)
  - Less dense than solid rock
  - Squeezed out walls of chamber
  - Trapped gases help rise & explosion
- Types of volcanic features
  - Volcanic plains
    - Runniest lava, flattens out
  - Shield volcanoes
    - Thicker lava
    - Tall mountains, but not steep (Hawaii)

  } Common in SS

  - Stratovolcanoes
    - Thickest lava – tall, steep mountains (Fuji, Rainier)
    - Unique to Earth

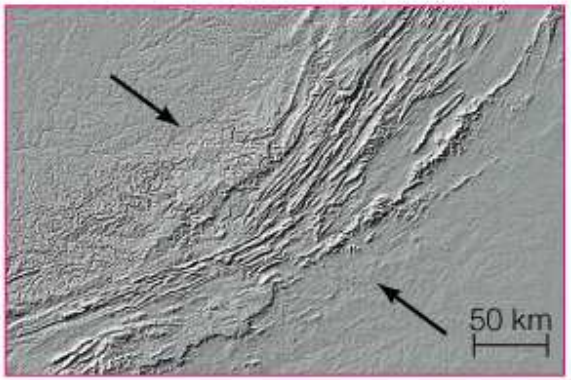

Fig 9.10


Mount Fuji


Mount Rainier

Tectonics

- Mantle convection driven
  - Compression features
  - Spreading cracks & valleys
- New mountain bends & cracks lithosphere
- Rising plume bulges lithosphere
- Fracture of lithosphere into distinct plates (Plate tectonics)
  - Unique to Earth



Appalachian Mountains in eastern United States

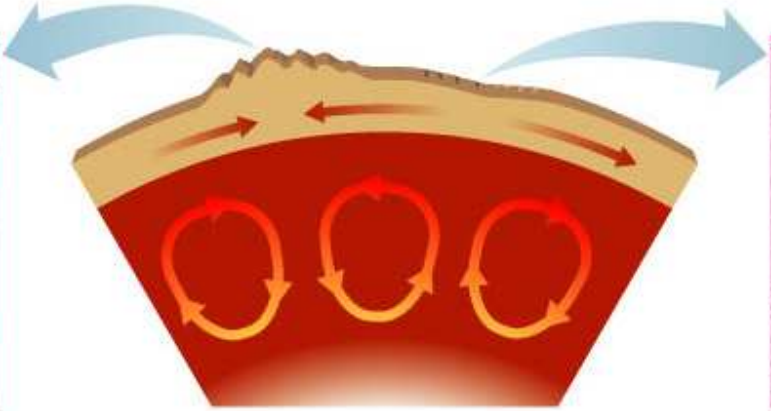
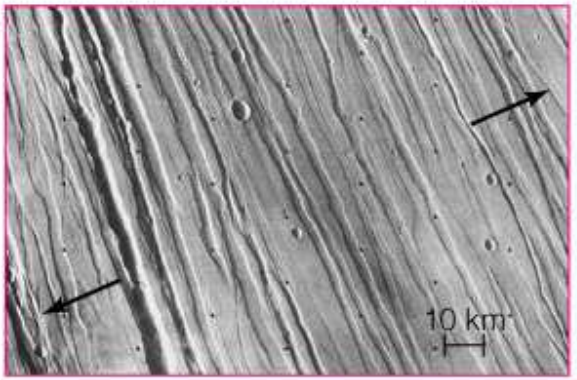


Fig 9.13



Ceraunius Valleys on Mars

Plate Tectonics

- Continental plates
  - Fractured pieces of the lithosphere
  - Move few cm per year

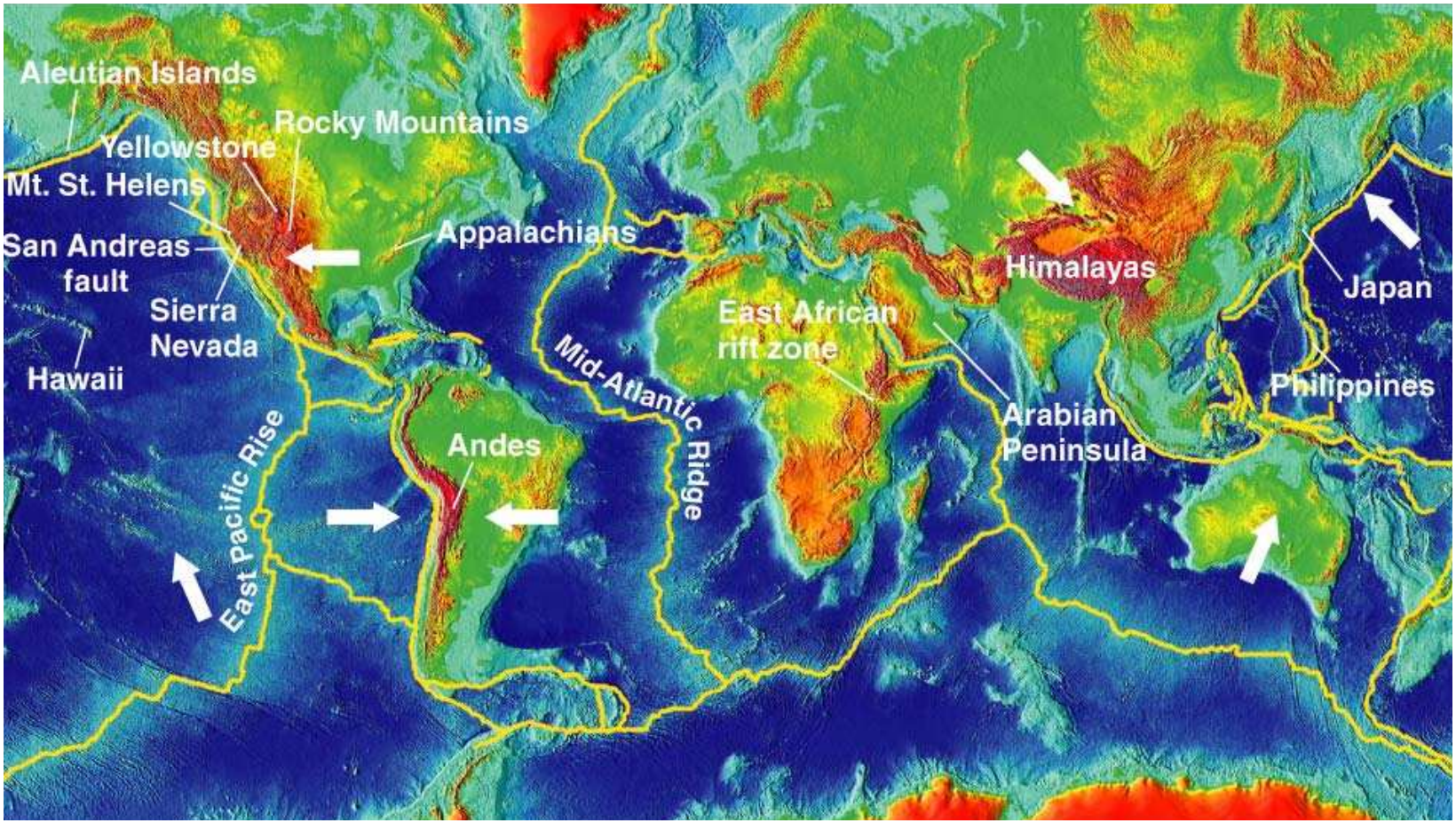


Fig 9.35

Continental Motion

- South America and Africa fit like puzzle pieces
- Similar rocks and fossils found in eastern South America and western Africa
- Mid Atlantic Ridge is moving Europe and Americas farther apart
- Two types of crust
  - Seafloor crust: Thinner, denser (basalt), younger (200 million years old)
  - Continental crust: Thicker, less dense (granite), older (up to 4 billion years old)

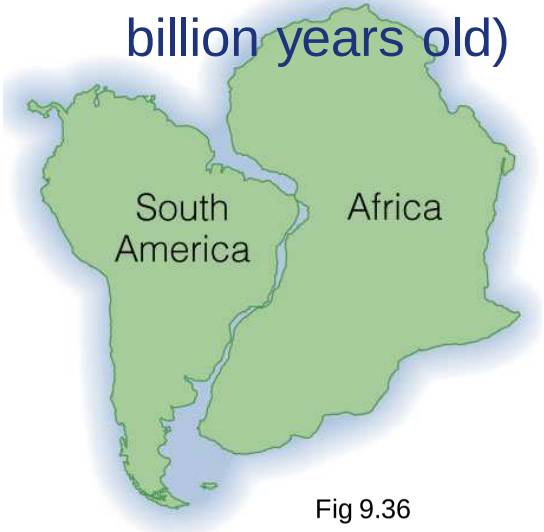


Fig 9.36

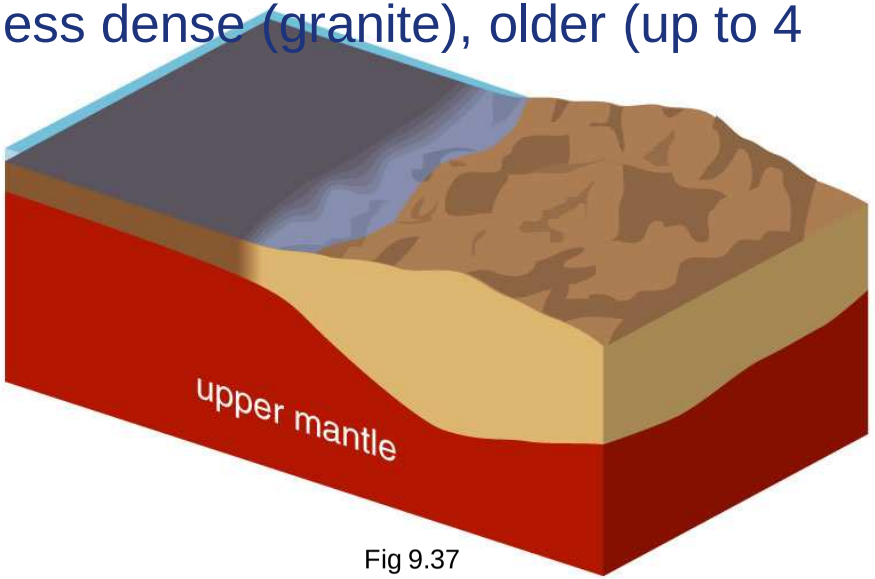


Fig 9.37

Shaping of Earth's Surface

- Seafloor recycling
  - Mid Atlantic Ridge covers up 2 km^2 every year
  - Will recycle entire ocean floor in 200 million years
  - Eventually bumps into continental plate and goes below it: *subduction zone*
  - Returns crust material into the mantle at deep ocean trenches
  - Leads to stratovolcanoes unique to Earth

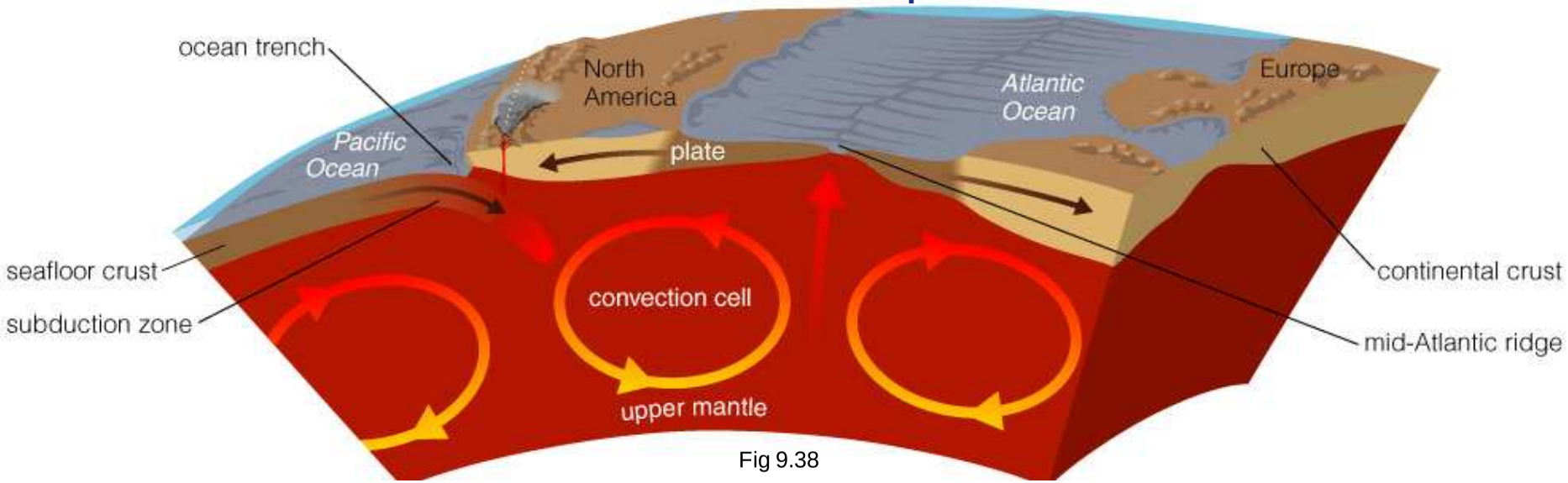


Fig 9.38

Volcanoes & Earthquakes

- Rifts: Plates moving apart
- Faults: Plates sliding sideways
  - Sliding plates move in jerks
    - Stress builds up over time
    - When friction gives up to building stresses, an earthquake occurs
    - In 20 million years, LA and SFO will be together
- Hot Spots
  - Plume of hot mantle erupt periodically to create a chain of islands (Hawaii)
  - Islands form, move with the plate, erode over time

Fig 9.42

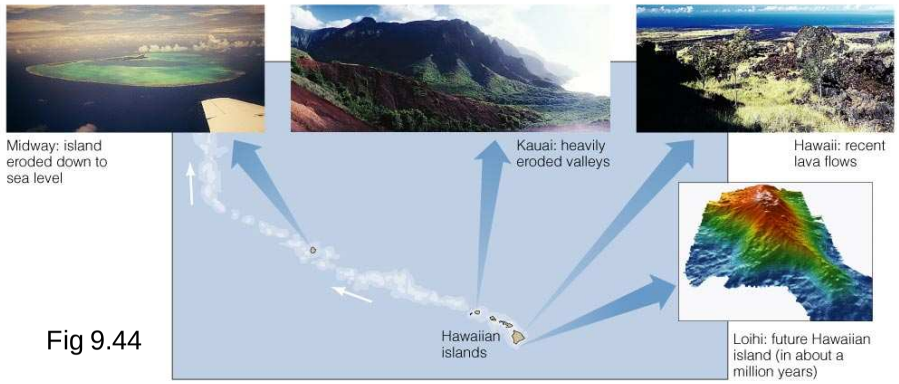


Fig 9.44

The Ever-Changing Landscape

- 2 cm per year = 2,000 km in 100 million years
- Had a single continent 200 million years ago
  - Pangaea
- Over billions of years drastic changes occur
  - Studies based on magnetized rocks and fossils
  - Central Africa was once at the South pole
  - Antarctica was once at the equator

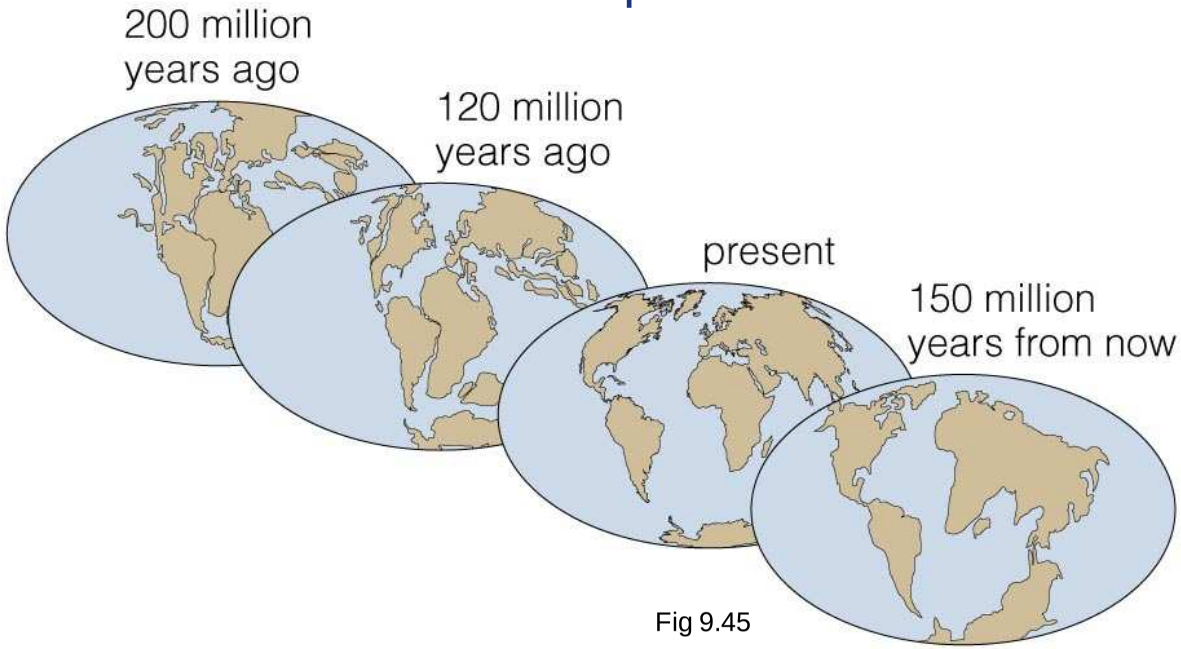


Fig 9.45

Erosion

Fig 9.14

Driven by wind & water

- Breaks down mountains
- Builds river deltas, sedimentary rocks, sand dunes

Key Drivers of a Planet's Geology

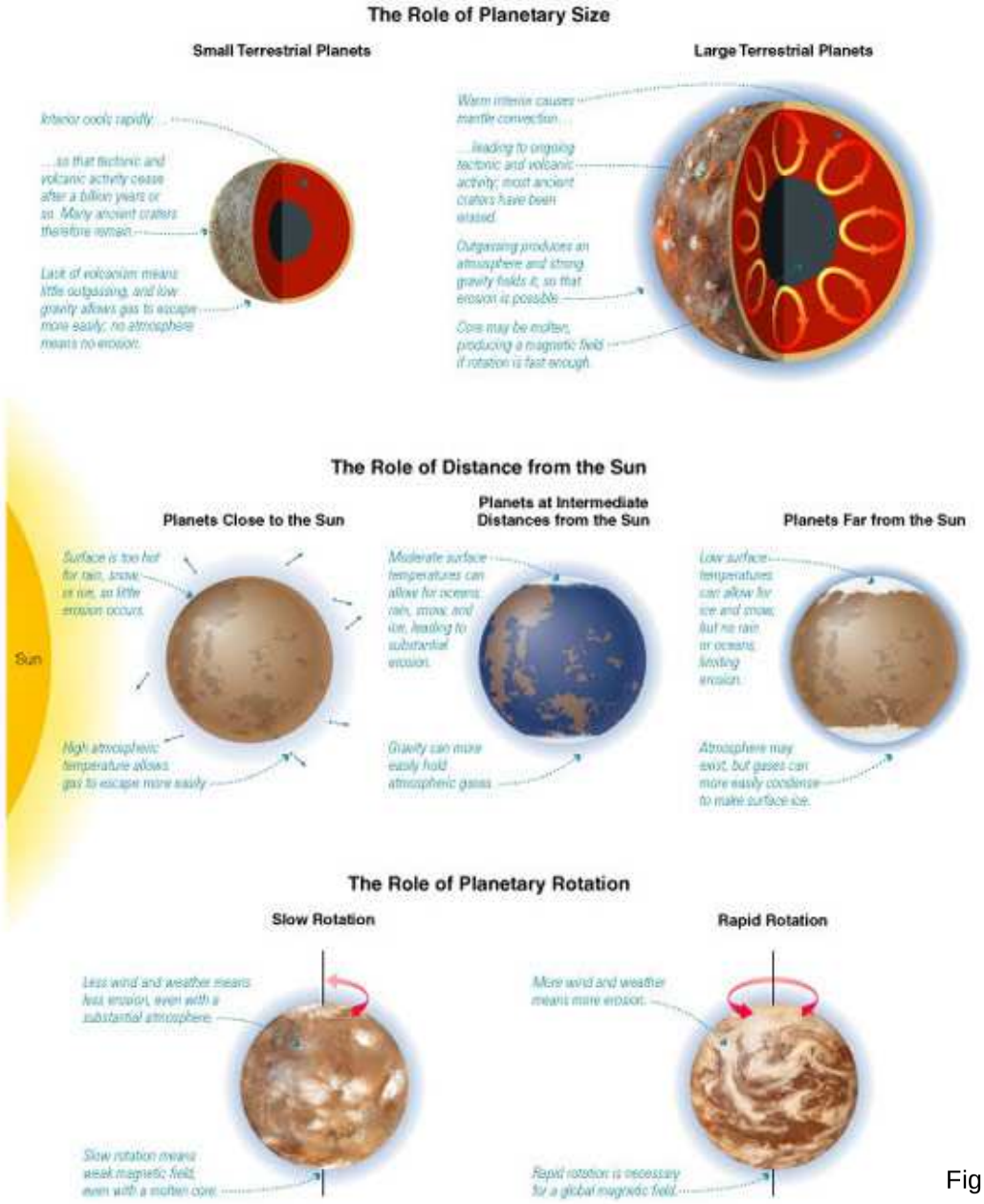


Fig 9.15

Unique Features of Earth's Geology

- Largest terrestrial planet
- Densest planet in the Solar System
- Liquid water on surface
- Plate tectonics
  - Earthquakes
  - Continental drift
- Stratovolcanoes: steep high mountains
- Constant erosion
  - Youngest surface among terrestrial planets