- **Plate Tectonics Overview**
    - Earth's outer lithosphere is divided into rigid plates.
    - Plates move relative to one another, driven by mantle convection.
    - Results in geological phenomena: earthquakes, volcanic eruptions, landslides, and tsunamis.
    - Understanding tectonics is crucial for studying geological hazards.
- **Historical Development**
    - Early theories of continental drift (early 20th century).
    - Plate tectonics developed in the 1960s.
- **Evidence for Continental Drift**
    - **Geological Fit**: Continents fit together like a jigsaw puzzle.
        - Noted by Abraham Ortelius in the late 16th century.
        - Notable fits: Eastern Brazil and Gulf of Guinea, North America and North Africa/Europe, Antarctica and surrounding continents.
    - **Alfred Wegener (1912)**: Proposed the existence of Pangaea.
        - Pangaea = "all land"; Panthalassa = "all sea".
        - Suggested continents drifted into current positions.
    - **Geological Clues**:
        - Similar geological features on opposing Atlantic sides (e.g., Appalachian Mountains and Caledonian Mountains).
        - Fossil evidence: Specific fossils (e.g., Misosaurus, Cynognathus) found on matching continental margins.
    - **Glacial Evidence**:
        - Glacial striations and roche moutonnées indicating past ice flow directions.
        - Evidence found in non-glaciated regions when continents restored to Pangaea.
- **Supercontinent Cycle**
    - Pangaea existed from 330 to 180 million years ago.
    - Split into Laurasia (North) and Gondwanaland (South) around 180 million years ago.
- **Plate Boundaries**
    - **Divergent Boundaries** (e.g., Mid-Atlantic Ridge): Plates move apart, creating new lithosphere.
    - **Convergent Boundaries**: Plates move toward each other; results in subduction or continental collision.
        - Subduction zones (e.g., Cascadia subduction zone).
        - Continental collision examples: Himalayas from the India-Eurasia collision.
    - **Strike-Slip Boundaries**: Plates slide past one another (e.g., San Andreas fault).
- **Plate Tectonics Mechanism**
    - Rigid tectonic plates move due to mantle convection.
    - Plates move along boundaries, resulting in earthquakes and volcanoes.
- **Seafloor Spreading**

- New oceanic crust is formed at mid-ocean ridges via magma eruptions (basalt).
- Symmetric magnetic anomalies detected on either side of the mid-ocean ridge.
- Decompression melting occurs at mid-ocean ridges.

- **Geophysical Evidence**
  - Bathymetric data: mapping of ocean floor revealed seafloor spreading and mid-ocean ridges.
  - Magnetometry: shows magnetic striping pattern in oceanic crust.
  - Paleomagnetism: studies past changes in Earth's magnetic field and geomagnetic reversals.

- **Subduction Zones**
  - Old, cold, dense oceanic lithosphere subducts below buoyant lithosphere, forming trenches.
  - Release of water from the subducting oceanic crust causes melting and volcanism.
  - Volcanic arcs (continental arcs and island arcs) are located above subduction zones (e.g., Cascades, Aleutians).

- **Earthquake Distribution**
  - Seismological data shows earthquake epicenters along plate boundaries.
  - Wadati-Benioff zones: deep seismic activity in subduction zones.

- **Volcanism Differences**
  - Mid-ocean ridges: decompression melting; relatively peaceful eruptions.
  - Subduction zones: addition of water leads to lower solidus and explosive eruptions.

- **Future Projections**
  - Models speculate future continental drift, including the formation of a new supercontinent.

Plate Boundaries

- **Types of Plate Boundaries**
  - **Continental Collision Zones**
    - Occurs when two continental plates converge.
    - Neither plate can be subducted due to buoyancy; crust thickens instead.
    - Example: Himalayas and Tibetan Plateau formed by the collision of India and Eurasia (~50-60 million years ago).
    - Average convergence rate of India towards Eurasia: ~50 mm per year.
    - Crustal thickening beneath Tibet: ~70-80 km leads to high surface elevation (~5 km).
    - Wider than subduction zones (e.g., India-Eurasia collision zone ~3,000 km wide).
  - **Continental Rifts**
    - Formed by the initiation of rifting due to mantle temperature anomalies.
    - Uplift of continental crust can lead to gravitational instability and subsequent rifting.
    - Formation results in rift valleys (e.g., East African Rift).
    - The rift propagates southward, featuring a spectrum of landforms and volcanism.

    - Double branches characterize the rift with notable volcanoes like Mount Kenya and Mount Kilimanjaro.

  - **Strike-Slip Faults**

    - Neither create nor consume lithosphere; plates slide past each other laterally.
    - Example: San Andreas Fault (right-lateral strike-slip).
    - Important for connecting mid-ocean ridge segments (transform faults).

- **Hotspots and Mantle Plumes**

  - Regions of volcanism above rising mantle plumes.
  - Not classified as tectonic plate boundaries.
  - Example: Hawaiian hotspot formed linear chain of islands due to plate movement over a stationary plume.
  - Yellowstone hotspot on continental crust causes different rock types compared to oceanic hotspots.

Isostasy

- **Definition and Principle**

  - Gravitational equilibrium where crust floats on denser plastic asthenosphere.
  - Similar to objects floating on water; elevation depends on thickness and density.

- **Isostatic Adjustments**

  - Addition/subtraction of mass leads to elevation changes (e.g., glaciers adding mass during ice ages causing land to sink).
  - **Post-Glacial Rebound**
    - After melting of ice sheets, the crust rises back over thousands of years.
    - Continued uplift observed via GPS studies in formerly glaciated areas (e.g., eastern North America).
    - Rates of uplift can be higher in areas of active deglaciation (e.g., northwestern BC and southwestern Yukon, up to 3 cm/year).

Geological History and Plate Motion

- **Continental Drift and Rifting**
  - Movement of tectonic plates on Earth's surface (e.g., Africa and North America once fused as Pangaea).
  - Evolution of passive and active continental margins aligning with plate tectonics.
  - Example: Passive margins in Eastern North America match with coastal Africa, formed after rifting.

Conclusion

- Understanding these concepts is vital for assessing seismic and volcanic hazards, and characterizing geological features shaped by plate tectonics.