MEKI CATHOLIC SCHOOL

Grade 12 Geography Exam Based Short Note

"Success doesn't come from what you do occasionally, but from what you do consistently. Study hard today, so your future self will thank you tomorrow." 🚀📚

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Unit 1: Major Geological Processes Associated with Plate Tectonics

Introduction

Understanding the Earth's movements and the forces behind them is crucial for predicting geological events like earthquakes and volcanic eruptions. This knowledge helps minimize damage and prevent catastrophic losses. Unit 1 builds on previous lessons about Ethiopia's geological history and continental formation, focusing on the theories of continental drift and plate tectonics, plate movements, boundaries, and the resulting geological processes and landforms.

1.1 The Continental Drift Theory

Learning Objectives

- Identify continents forming Laurasia and Gondwanaland.
- Explain geological evidence supporting the continental drift theory.
- Discuss why Alfred Wegener's theory faced resistance.
- Describe the relationship between continental drift and plate tectonics.

Key Terms

- **Continental Drift**: The theory that continents have moved over geological time.
- **Pangaea**: A supercontinent that existed 350 million years ago.
- **Laurasia**: Northern part of Pangaea.
- **Gondwanaland**: Southern part of Pangaea.

Overview

The continental drift theory, proposed by Alfred Wegener in 1912, suggests that continents were once joined in a single landmass called Pangaea, located near the South Pole during the Carboniferous period (350 million years ago). Over time, Pangaea split during the Triassic period of the Mesozoic era into Laurasia (northern continents) and Gondwanaland (southern continents), which further fragmented and drifted to their current positions over millions of years.

Geological Evidence Supporting Continental Drift

1. **Coastline Similarity**:
   - The coastlines of Africa and South America fit together like puzzle pieces across the Atlantic Ocean, suggesting they were once joined.
2. **Rock Type and Structural Similarities**:
   - Similar rock types and ages extend across Africa and South America when aligned.
   - Mountain belts continue from one continent to the other, indicating a shared geological history.
3. **Fossil Evidence**:
   - Identical fossils, like those of Mesosaurus (a small reptile from 250 million years ago), are found in both South America and Africa, implying these continents were once connected.
4. **Paleoclimatic Evidence**:
   - Rock structures show similar ancient climate patterns across continents, supporting their past proximity.

Why Wegener's Theory Was Not Easily Accepted

- **Professional Background**: Wegener was a meteorologist, not a geologist, which undermined his credibility among geologists.
- **Geographical Bias**: Most influential geoscientists were in the Northern Hemisphere, while key evidence came from the Southern Hemisphere.
- **Timing Misjudgment**: Wegener suggested Pangaea broke apart in the Cenozoic era, but scientists doubted such rapid drift in a short time.
- **Lack of Mechanism**: He couldn't explain how continents moved, lacking direct evidence or a driving force.

Legacy and Connection to Plate Tectonics

Despite initial rejection, Wegener's idea of lateral continental mobility shifted scientific thought from fixism (static continents) to mobilism (moving continents). This paved the way for the plate tectonics theory, which provided the mechanism (plate movements) that Wegener's theory lacked.

1.2 Plate Tectonics Theory

Learning Objectives

- Explain the plate tectonics theory.
- Identify major tectonic plates and their boundaries.
- Draw diagrams showing plate movements.
- Distinguish between continental and oceanic plates.
- Analyze how geological processes and plate boundaries impact human life.

Key Terms

- **Plate Tectonics**: Theory explaining the movement and deformation of Earth's outer layers.
- **Plate Boundary**: Edges where plates interact.
- **Asthenosphere**: Semi-fluid layer beneath the lithosphere.
- **Lithosphere**: Rigid outer layer (crust and uppermost mantle).

Overview

Developed in the late 1960s, plate tectonics revolutionized geology by explaining how Earth's lithosphere is divided into about a dozen large plates (and smaller ones) that float and move on the asthenosphere at a few centimeters per year. These plates consist of continental crust, oceanic crust, or both, and their interactions shape Earth's surface features.

Main Concepts

- The lithosphere "slides" over the ductile asthenosphere due to internal heat-driven processes.
- Plates move in different directions, meeting at boundaries, influencing geological events like earthquakes and volcanic activity.
- Unlike continents, plate edges don't always align with continental or oceanic boundaries (e.g., the North American Plate includes part of the Atlantic Ocean floor).

Major Tectonic Plates

1. **Continental Plates**:
    - North American Plate
    - South American Plate
    - Eurasian Plate
    - African Plate

    - Indo-Australian Plate
    - Antarctic Plate
2. **Oceanic Plates**:
    - Pacific Plate
    - Nazca Plate
    - Cocos Plate
    - Philippine Plate
3. **Mixed Plates**:
    - Plates like the Caribbean Plate include both continental and oceanic crust.

Evidence and Importance

- Supported by geological and geophysical data (e.g., seafloor spreading, fossil distribution).
- Explains mountain formation, earthquakes, volcanoes, and long-term climate change.
- Predicts geological events, aiding disaster preparedness.

Impact on Human Life

- Earthquakes and volcanoes at plate boundaries threaten lives and infrastructure.
- Resource distribution (e.g., minerals, oil) is influenced by tectonic activity.
- Understanding plate movements helps mitigate risks through better planning.

1.3 Plate Movements and Plate Boundaries

Learning Objectives

- Understand types of plate boundaries and their movements.
- Classify plates as oceanic or continental.

Key Terms

- **Convergent (Destructive)**: Plates move toward each other.
- **Divergent (Constructive)**: Plates move apart.
- **Transform (Conservative)**: Plates slide past each other.

Types of Plate Boundaries

1. **Convergent Boundaries**:
    - **Process**: One plate subducts (sinks) beneath another, with the denser plate (usually oceanic) forced under the less dense one (continental or oceanic).
    - **Examples**:

        - Oceanic-Continental: Nazca Plate subducts under South American Plate, forming the Andes Mountains and volcanoes.
        - Oceanic-Oceanic: Mariana Trench and volcanic island arcs.
        - Continental-Continental: Indo-Australian Plate collides with Eurasian Plate, forming the Himalayas.
    - **Features**: Volcanoes, mountain ranges, deep trenches.
    - **Mechanism**: Subducted crust melts into magma, rising to form volcanic features.
2. **Divergent Boundaries**:
    - **Process**: Plates move apart, allowing magma from the asthenosphere to rise, cool, and form new crust (seafloor spreading).
    - **Examples**:
        - Oceanic: Mid-Atlantic Ridge (Atlantic Ocean).
        - Continental: East African Rift Valley.
    - **Features**: Oceanic ridges, rift valleys, shallow earthquakes.
    - **Mechanism**: Rising magma creates new seafloor or fractures continents.
3. **Transform Boundaries**:
    - **Process**: Plates slide past each other horizontally along faults, with no crust created or destroyed.
    - **Examples**: San Andreas Fault (California).
    - **Features**: Earthquakes due to sticking and slipping.
    - **Mechanism**: Friction along faults causes seismic activity.

Driving Force

- **Convection Currents**: Heat from Earth's interior drives mantle convection, with rising currents at divergent zones and sinking currents at subduction zones, dragging plates along.

Plate Classification

- **Oceanic**: Pacific, Nazca, Cocos (basalt, denser).
- **Continental**: African, Eurasian, North American (granite, less dense).
- **Mixed**: South American (includes oceanic and continental crust).

1.4 Major Geological Processes

Learning Objectives

- Differentiate between endogenic and exogenic forces.
- Explain folding, faulting, and their surface effects.
- Map major young fold mountains.

- Diagram horst mountains and rift valleys.
- Locate the Ring of Fire and affected countries.
- Assess how internal and external forces shape land surfaces.

Key Terms

- **Folding**: Bending of rock layers.
- **Faulting**: Fracturing and displacement of crust.
- **Anticline**: Upward fold.
- **Syncline**: Downward fold.
- **Vents/Fissures**: Openings for magma.
- **Craters/Calderas**: Volcanic features.
- **Tsunamis**: Seismic sea waves.

Overview

Geological processes, driven by natural forces, shape Earth's surface. They are studied to understand planetary history, locate resources, and predict disasters. Forces are classified as:

1. **Endogenic (Internal)**: Originate inside Earth (e.g., folding, faulting, earthquakes, volcanism).
2. **Exogenic (External)**: Act on the surface from outside (e.g., weathering, erosion).

1.4.1 Internal (Endogenic) Forces

Folding

- **Process**: Rock layers bend due to lateral compression from plate movements.
- **Types**:
  - **Anticline**: Upward arch.
  - **Syncline**: Downward arch.
  - **Asymmetrical Fold**: One limb steeper.
  - **Overfold**: One limb overrides another.
  - **Overthrust Fold**: Fracture allows one limb to thrust over another.
- **Fold Mountains**:
  - **Young Fold Mountains** (Alpine Orogeny): Himalayas, Andes, Alps, Rockies, Atlas (recent, high peaks).
  - **Old Fold Mountains**: Appalachians, Urals, Scandinavian (older, weathered, lower).

Faulting

- **Process**: Crust fractures due to tension or compression, displacing rock.

- **Landforms**:
  - **Rift Valleys**: Land sinks between parallel faults (e.g., East African Rift Valley).
  - **Block Mountains (Horst)**: Land rises between faults (e.g., Afar Horst).

Earthquakes

- **Definition**: Sudden ground shaking from rock displacement along faults.
- **Causes**: Strain energy release along faults due to plate movements.
- **Seismic Waves**:
  - **Body Waves**:
    - **P-Waves**: Compress and expand rock, fastest.
    - **S-Waves**: Vibrate perpendicular to travel direction.
  - **Surface Waves**: Love and Rayleigh waves, slower but destructive.
- **Key Terms**:
  - **Focus**: Point of rupture underground.
  - **Epicenter**: Surface point above focus.
- **Measurement**: Richter Scale (0-9, logarithmic).
- **Effects**: Ground rupture, landslides, tsunamis, fires (e.g., 1906 San Francisco fire).
- **Occurrence**:
  - **Ring of Fire**: Pacific Ocean belt (80% of energy).
  - **Mediterranean-Asian Belt**: 15% of energy.
  - **Mid-Oceanic Ridges**: Along divergent zones.

Volcanism

- **Definition**: Eruption of magma, gases, and solids onto Earth's surface.
- **Openings**:
  - **Vents**: Pipe-like, form volcanoes.
  - **Fissures**: Cracks, form lava plateaus.
- **Volcano Types**:
  - **Shield**: Broad, fluid lava (e.g., Hawaiian Islands).
  - **Strato**: Steep, explosive (e.g., Mount Fuji).
  - **Cinder Cone**: Small, pyroclastic hill.
  - **Craters**: Collapse or explosion features.
  - **Calderas**: Large depressions from magma chamber collapse.
- **Intrusive Forms**:
  - **Batholith**: Large igneous intrusion.
  - **Sill**: Horizontal sheet.
  - **Dike**: Vertical sheet.
- **Occurrence**: Mostly at plate boundaries (90% in Ring of Fire).

- **Status**: Active (e.g., Erta Ale), Dormant (e.g., Kilimanjaro), Extinct (e.g., Zuqualla).

Ring of Fire

- **Location**: Encircles Pacific Ocean, includes western Americas, eastern Asia, and island arcs.
- **Countries**: Japan, Indonesia, Philippines, Chile, USA, New Zealand.
- **Features**: High volcanic and seismic activity.

1.4.2 External (Exogenic) Forces

Weathering

- **Definition**: Breakdown of rocks into smaller pieces.
- **Types**:
  1. **Physical (Mechanical)**:
     - **Thermal Expansion/Contraction**: Exfoliation from temperature changes.
     - **Frost Action**: Water freezes, expands cracks (forms screes).
     - **Plant/Animal Action**: Roots and burrowing break rocks.
  2. **Chemical**:
     - **Rain Action**: Dissolves minerals (e.g., limestone caves like Sof Omar).
     - **Plant/Animal Action**: Organic acids weaken rocks.
- **Features**: Stalactites (ceiling), Stalagmites (floor), pillars in caves.

Erosion and Deposition

- **Agents**: Running water, wind, glaciers, sea waves.
- **Running Water Erosion**:
  - **Sheet Erosion**: Even removal of topsoil.
  - **Rill Erosion**: Small channels form.
  - **Gully Erosion**: Deep ditches from floods.
- **River Course Landforms**:
  - **Upper Course**: V-shaped valleys, gorges, waterfalls.
  - **Middle Course**: Wider valleys, confluences.
  - **Lower Course**: Flat valleys, deposition features.

Unit Summary

Unit 1 explores how plate tectonics drives geological processes. The continental drift theory explains past continental movements, supported by evidence like fossil distribution and coastline fit. Plate tectonics details current plate interactions at convergent, divergent, and transform boundaries, shaping Earth through endogenic processes (folding, faulting, earthquakes, volcanism) and exogenic

processes (weathering, erosion). These processes create diverse landforms, from mountains to rift valleys, and influence human life through resource availability and disaster risks.

Review Questions Preparation

1. Define Pangaea, Laurasia, and Gondwanaland, and explain their breakup.
2. List four pieces of evidence supporting continental drift.
3. Why was Wegener's theory initially rejected?
4. Describe the plate tectonics theory and its significance.
5. Name five major tectonic plates and classify them.
6. Differentiate between convergent, divergent, and transform boundaries with examples.
7. Explain folding and faulting, including resulting landforms.
8. Locate the Ring of Fire and name three countries within it.
9. Compare endogenic and exogenic forces with examples.
10. Discuss the types of volcanoes and their formation processes.

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