TECTONICS TOPIC 1

1.1 PLATE TECTONIC THEORY

3 layers of Earth: Crust → Mantle → Core

Layer	Thickness	Depth (approx)
Crust	Thinnest, 6–70km	Outermost
Mantle	2900km	In between
Core	Thickest, 3300km	Innermost

- **Lithosphere** = crust + uppermost mantle (rigid, makes up tectonic plates)
- **Asthenosphere** = semi-solid layer below lithosphere; heat from core melts rocks here

3 types of plate boundaries:

1. Divergent — plates move apart
2. Convergent — plates move towards each other
3. Transform — plates slide past each other

How convection currents cause plate movement:

- Heat from core → mantle material rises, becomes less dense
- Rising material spreads towards surface, drags plates apart
- Material cools, sinks back down → causes divergent plate movement

Slab-pull force:

- When 2 plates converge, denser oceanic crust subducts due to gravity
- Pulls rest of the plate with it, contributing to further convergence

Keywords: Lithosphere, Asthenosphere, Convection currents, Slab-pull force

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1.2 SEAFLOOR SPREADING

What is seafloor spreading? = magma rises from deep within Earth through mid-ocean ridges → cools/solidifies → forms new oceanic crust

- Rocks near crest of mid-ocean ridge = youngest
- Rocks progressively older further away from ridge

Evidence of seafloor spreading:

1. Rocks at ridge = youngest, get progressively older further away
2. Little sediment accumulation at oceanic ridges; more sediment further away (older crust = more time to accumulate)
3. Oceanic crusts are younger than continental crusts

Why evidence supports plate tectonic theory:

- Shows how new oceanic crust is created at mid-ocean ridges + destruction of older oceanic crusts at trenches
- Proves new crust moves laterally away from ridge on both sides

Keywords: Seafloor spreading, Mid-ocean ridge, Oceanic trench

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1.3 MAGNETIC STRIPING

What is magnetic striping? = zebra-like pattern where there are strips of rock w/ alternating magnetic properties (normal & reversed polarity) on the seafloor, symmetrical on both sides of mid-ocean ridge

Geographic vs Magnetic North/South:

- Geographic North/South = fixed point (Pole); does NOT change
- Magnetic North/South = direction compass needle points to; CAN shift, reversed multiple times over geological time

Normal polarity: magnetic North/South point towards geographic North/South (roughly)
Reverse polarity: magnetic North/South point towards geographic South/North (flipped)

How striping forms (explain in order!):

1. Magma rises at mid-ocean ridge → cools → forms new oceanic crust
2. Iron particles in the rock line up with Earth's magnetic field at that time

3. Earth's magnetic field flips polarity every so often over time
4. New crust keeps forming at ridge → pushes older crust outward on both sides → creates matching stripes of normal/reversed polarity on both sides of ridge

Why does this prove plate tectonics:

- Stripes symmetrical on both sides → shows crust is made at ridge and moves apart in both directions = seafloor spreading
- Stripes get older further from ridge → shows direction + speed of plate movement
- = a "recording" of magnetic history in rock → lets scientists measure/date plate movement, not just guess

Keywords: Geographic North, Geographic South, Magnetic North, Magnetic South, Normal polarity, Reverse polarity

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1.4 TECTONIC PROCESSES AT DIFFERENT PLATE BOUNDARIES

DIVERGENT (plates move apart)

Oceanic-oceanic:

- Lava cools/solidifies to form new basaltic rocks
- Extensive underwater mountain chain — mid-ocean ridge — forms
- Magma rises through weak areas as plates move apart, forming submarine volcanoes
- After many eruptions, volcanoes may break the surface of the ocean to form volcanic islands
- Earthquakes occur due to stress/tension released when plates move
- Eg: Mid-Atlantic Ridge — American Plate & Eurasian Plate move apart; Surtsey Island, Iceland

Continental-continental:

1. Two continental plates move apart
2. Rocks eventually fracture to form parallel faults
3. Rock between these faults collapses to form a deep rift valley
4. As plates move apart, decrease in overlying pressure causes parts of underlying mantle to melt, forming magma
5. Magma rises through weak areas in the crust to the Earth's surface, forming volcanoes

- Earthquakes occur as stress and tension are released when plates move
- Eg: Great Rift Valley — Nubian Plate & Somalian Plate; Mount Kenya, Mount Kilimanjaro
- **Fault** = a fracture along which rocks on either side are displaced
- **Rift valley** = linear lowland region formed w/ steep sides, formed when 2 plates move suddenly apart

CONVERGENT (plates move towards each other)

Oceanic-oceanic:

1. Two oceanic plates collide
2. Denser plate subducts beneath the other, forming an oceanic trench
3. Friction along the subducting plate causes earthquakes
4. Water out of subducting plate sinks into the mantle, lowering melting point of overlying mantle
5. Magma rises through weak areas in crust, causing volcanoes
6. This forms a chain of volcanoes, known as a volcanic island

- Eg: Pacific Plate & Philippine Plate → Mariana Trench, Mariana Islands (incl. Guam)

Oceanic-continental:

1. Denser oceanic plate subducts beneath continental plate at oceanic trench
2. Friction causes earthquakes
3. Water from subducting plate lowers melting point of mantle, forming magma
4. Magma rises through weak areas, forming volcanoes on the continental plate
5. Enormous pressure causes rocks to be uplifted and buckled to form fold mountains

- Eg: Nazca Plate subducts beneath South American Plate → Peru-Chile Trench, Andes Mountains, Nevado del Ruiz volcano, 2010 Chile earthquake

Continental-continental:

1. Two continental plates collide
2. Subduction does not take place — continental plates too buoyant to subduct
3. Enormous pressure causes rocks to be uplifted and buckled to form fold mountains
4. Friction causes earthquakes
5. No volcanoes are formed — no crust subducts, no melting occurs

- Eg: Indian Plate converges with Eurasian Plate → Himalayas (fold mountain range), 2015 Nepal earthquake

TRANSFORM (plates slide past each other)

- Tectonic plates slide past each other, resulting in NO crust created or destroyed
- Stress caused by plate movement produces a fault, which is a zone of fractures
- Earthquakes occur here as one plate suddenly slips past another; there are no volcanoes
- Eg: San Andreas Fault — Pacific Plate sliding past North American Plate, California, USA; 1989 Loma Prieta earthquake

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SUMMARY TABLE

Boundary type	Tectonic phenomena	Example
Divergent — oceanic-oceanic	Mid-ocean ridge, volcanoes, rift valleys, earthquakes	Mid-Atlantic Ridge (American + Eurasian Plate)
Divergent — continental-continental	Rift valley, volcanoes, earthquakes	East African Rift Valley (Nubian + Somalian Plate); Mt Kenya, Mt Kilimanjaro
Convergent — oceanic-oceanic	Oceanic trench, volcanoes, earthquakes	Pacific Plate + Philippine Plate → Mariana Trench, Mariana Islands (Guam)
Convergent — oceanic-continental	Oceanic trench, fold mountains, volcanoes, earthquakes	Nazca Plate + South American Plate → Peru-Chile Trench, Andes, Nevado del Ruiz, 2010 Chile earthquake
Convergent — continental-continental	Fold mountains, earthquakes (NO volcanoes)	Indian Plate + Eurasian Plate → Himalayas, 2015 Nepal earthquake
Transform	Faults, earthquakes (NO crust created/destroyed, NO volcanoes)	San Andreas Fault — Pacific Plate + North American Plate, 1989 Loma Prieta earthquake