

GEOLOGY EXAM 1 CHEAT SHEET

1 INTRODUCTION TO GEOLOGY

1.1 Basics

- **Geology:** Science of Earth processes, composition, structure, history.
- **Physical Geology:** Materials & processes.
- **Historical Geology:** Origin & development through time.
- **Uniformitarianism:** "The present is the key to the past." Processes today (erosion, volcanism) operated in the past.
- **Scientific Method:** Observation → Hypothesis (testable) → Theory (well-tested). Data supports/disproves hypotheses.

1.2 Origin of Earth

- **Big Bang:** 13.7 billion years ago (Universe formation).
- **Nebular Theory:** Solar system formed from rotating cloud (solar nebula).
- **Solar System Age:** 4.6 billion years.
- **Earth Formation:** 4.6 billion years ago. Accretion of planetesimals.
- **Differentiation:** Melting caused dense Fe/Ni to sink (Core), lighter mix to float (Crust/Mantle).

1.3 Geologic Time

- Scale: Eons → Eras → Periods → Epochs.
- **Human Appearance:** Very recent (last few mins of "Earth Year").

2 EARTH SYSTEMS & STRUCTURE

2.1 Spheres

- **Geosphere:** Solid Earth (Crust, Mantle, Core).
- **Hydrosphere:** Water (Oceans, rivers).
- **Atmosphere:** Gases. **Biosphere:** Life.

2.2 Internal Structure (Composition)

- **Crust:** Rocky outer skin.
 - **Oceanic:** Thin (~7km), Denser (3.0 g/cm³), Basaltic (Mafic).
 - **Continental:** Thick (35-70km), Less Dense (2.7 g/cm³), Granitic (Felsic).
- **Mantle:** Solid rocky shell (Peridotite). More dense than crust.
- **Core:** Iron-Nickel alloy.
 - **Outer Core:** Liquid (generates Magnetic Field). S-waves cannot pass.
 - **Inner Core:** Solid (due to immense pressure).

2.3 Properties vs Composition

- **Lithosphere:** Rigid outer layer (Crust + Upper Mantle). Forms tectonic plates.
- **Asthenosphere:** Weak, ductile layer below lithosphere (Upper Mantle). Allows plates to move.

3 PLATE TECTONICS

3.1 Key Concepts

- **Hypothesis:** Continental Drift (Wegener) → Plate Tectonics (1960s).
- **Driving Force:** Convection in mantle (ridge push, slab pull).
- **Rate:** ~3 cm/year (fingerprint growth speed).

3.2 Boundaries

- **Divergent** (Move apart):
 - Mid-Ocean Ridges (Seafloor spreading). New crust created.
 - Rift Valleys (e.g., East Africa, Mt. Kilimanjaro).
 - Decompression melting.
 - Example: Iceland, Mid-Atlantic Ridge.
- **Convergent** (Move together):
 - **Ocean-Cont:** Subduction. Volcanic Arc (e.g., Cascades, Andes). Trench.
 - **Ocean-Ocean:** Subduction. Island Arc (e.g., Japan, Aleutians). Trench.
 - **Cont-Cont:** Collision. Mountain Belt (e.g., Himalayas). No subduction/volcanism.
 - Oceanic lithosphere sinks at trenches.
- **Transform** (Slide past):
 - No crust created/destroyed.
 - Example: San Andreas Fault.

3.3 Evidence

- **Hot Spots:** Stationary mantle plumes. Plate moves over them creating track (e.g., Hawaii). Shows direction of plate motion.
- **Paleomagnetism:** Earth's field reverses. Recorded in oceanic crust. Symmetric stripes at ridges prove seafloor spreading.
- **Declination:** Angle to pole. **Inclination:** Angle to horizontal (latitude).

4 MINERALS

4.1 Definition

- Naturally occurring, Inorganic, Solid, Ordered internal structure, Definite chemical composition.
- **Rock:** Aggregate of minerals.

4.2 Formation

- Crystallization from magma.
- Precipitation from water.
- Weathering (secondary minerals).
- Metamorphism (heat/pressure).
- Open space allows good crystal faces.

4.3 Properties

- **Color:** Variable (impurities). Unreliable for Quartz.
- **Shape:** Determined by crystal structure (e.g., Quartz pyramid).
- **Polymorphs:** Same composition, different structure (Diamond vs Graphite). Diamond=High P, Graphite=Low P.

4.4 Classes

- **Silicates:** Most common (SiO₄ tetrahedron).
- **Felsic (Light):** Quartz, Feldspar, Muscovite. Low density, low melt temp. Continental.
- **Mafic (Dark):** Olivine, Pyroxene, Biotite, Amphibole. High Fe/Mg, high density, high melt temp. Oceanic/Mantle.
- **Non-Silicates:** Carbonates, Halides, Oxides, Native elements.
- **Economic:** Less abundant, specific uses.
- **Rock-forming:** Abundant.

5 MAGMA & IGNEOUS ROCKS

5.1 Magma Formation (Melting)

- **Decompression:** P drops as rock rises (Divergent, Hot Spots).
- **Volatile (Flux):** Water lowers melting point (Subduction).
- **Heat Transfer:** Rising magma melts crust (Continental rifts/Hot spots).

5.2 Properties

- **Viscosity:** Resistance to flow.
 - High Temp → Low Viscosity.
 - High Silica (Felsic) → High Viscosity.
 - Low Silica (Mafic) → Low Viscosity.
- **Rising:** Magma rises because it is less dense than surrounding rock and under pressure.

5.3 Textures (Cooling Rate)

- **Aphanitic** (Fine): Fast cooling (Extrusive/Volcanic).
- **Phaneritic** (Coarse): Slow cooling (Intrusive/Plutonic).
- **Porphyritic:** Two stages (Slow then Fast). Phenocrysts (large) in matrix.
- **Glassy:** Very fast cooling (Obsidian).
- **Pyroclastic:** Explosive fragments (Tuffs).
- **Vesicular:** Gas bubbles (Pumice/Scoria).

5.4 Composition

- **Felsic:** High Si, Na, K. Granite (Intr) / Rhyolite (Extr).
- **Intermediate:** Andesite (Extr) / Diorite (Intr).
- **Mafic:** High Fe, Mg, Ca. Basalt (Extr) / Gabbro (Intr).
- **Ultramafic:** Peridotite (Mantle).

6 VOLCANOES

6.1 Types

- **Shield:** Broad, gentle slopes. Fluid basalt. Effusive. (Mauna Loa).
- **Stratovolcano (Composite):** Large, cone-shaped. Andesite/Rhyolite. Explosive. (Mt. Rainier, Fuji).
- **Cinder Cone:** Small, steep. Pyroclastic ejecta.
- **Caldera:** Collapsed summit (Crater Lake).

6.2 Hazards

- **Lahars:** Mudflows (Ash + Water). Flow far, follow rivers. Can occur without eruption.
- **Pyroclastic Flows:** Hot gas/ash avalanche. Very fast (>100 km/h), deadly.
- **Lava Flows:** Destroys property, usually slow enough to escape (except fluid basalt).
- **Ash:** Buries landscape, engine failure, respiratory issues.
- **Gas:** SO₂, CO₂. Can suffocate.

6.3 Eruption Styles

- **Effusive:** Low viscosity (Basalt). Pahoehoe (ropy), A'a (jagged).
- **Explosive:** High viscosity (Felsic/Intermediate). Trapped gas builds pressure.
- **Flood Basalts:** Massive flows, low viscosity, fissures (Columbia River).

6.4 Tectonic Settings

- **Ring of Fire:** Subduction zones (Convergent). Most volcanoes here.
- **Mid-Ocean Ridges:** Divergent. Most lava production (underwater).
- **Hot Spots:** Intra-plate (Hawaii, Yellowstone).

7 ROCK CYCLE

- **Igneous:** Melt → Cool/Crystallize.
- **Sedimentary:** Weathering → Sediment → Lithification.
- **Metamorphic:** Heat/Pressure → Solid state change.
- Any rock can become any other rock given the right process.

8 OCEAN FLOOR FEATURES

- **Continental Margin:** Shelf (flooded extension), Slope (drop-off), Rise (sediment wedge).
- **Abyssal Plain:** Flat deep ocean floor.
- **Trench:** Deepest parts, at subduction zones.
- **Seamounts:** Underwater volcanoes (Hot spots/Ridges).