SATISH CHANDRA MEMORIAL SCHOOL

GEOGRAPHY NOTES CLASS 9

WEATHERING

1. Key Terms & Definitions

Term	Definition
Weathering	The breaking down or dissolving of rocks and minerals at or near the Earth's surface by physical, chemical, or biological processes.
Erosion	The removal and transportation of weathered rock material by agents such as water, wind, ice, or gravity. (Note: Erosion moves material; weathering breaks it down in place.)
Denudation	The overall lowering of the Earth's surface through combined processes of weathering, erosion, and mass movement.
Regolith	The layer of loose, fragmented, and partially weathered solid material overlying bedrock on the Earth's surface.
Abrasion	The wearing away of rock by friction and impact from rock fragments carried by wind, water, or ice.
Soil	The mixture of weathered rock particles, organic matter, water, air, and living organisms that develops on top of the regolith over time.

2. Factors Affecting the Rate of Weathering

Factor	Effect on Weathering Rate
Climate (Temperature)	Higher temperatures speed up chemical reactions (double with every 10°C rise). Cold climates promote frost action. Higher range in temperature results physical weathering.
Climate (Rainfall)	More water = more chemical weathering. Water is essential for hydrolysis, carbonation, and oxidation.
Rock Type	Soft rocks (limestone, chalk) weather faster than hard rocks (granite, quartzite). Soluble rocks dissolve faster.
Vegetation	More vegetation = more biological weathering; roots and organic acids accelerate breakdown.
Time	Weathering is a slow process; longer exposure = more weathering. Tropical soils weathered for millions of years are deeply altered.

3. Types of Weathering

Weathering is classified into three main types:

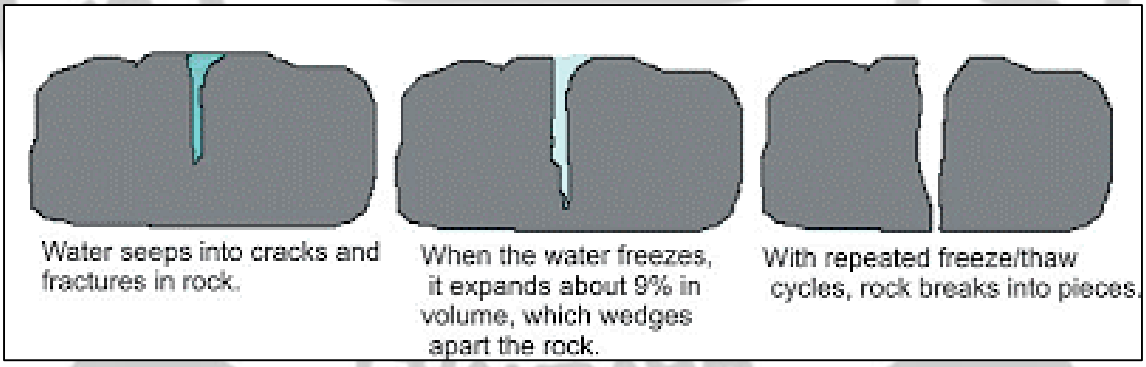
Physical	Chemical	Biological
Rock breaks into smaller pieces without chemical change. Same minerals, just smaller.	Rock minerals chemically altered to form new, weaker compounds. Rock changes composition.	Living organisms (plants, animals, microbes) break down rock physically or chemically.

3A. Physical (Mechanical) Weathering

Physical weathering breaks rocks into smaller fragments without changing their chemical composition.

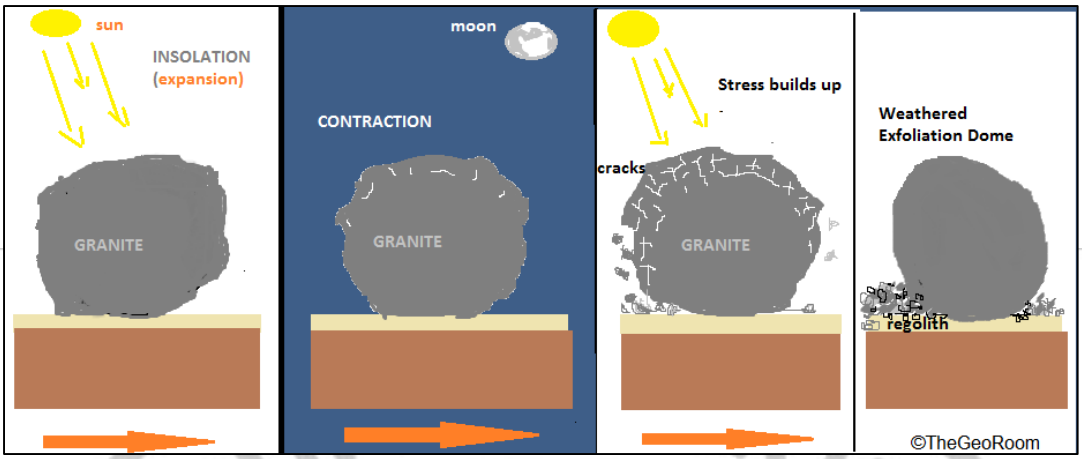
i. Frost Action (Freeze-Thaw / Ice Wedging)

- Occurs in regions where temperatures fluctuate above and below 0°C (freezing point).
- Water seeps into cracks and joints in rock.
- When water freezes, it expands by about 9%, exerting pressure on the crack walls.
- Repeated freezing and thawing widens the cracks until pieces break off.
- Common in: mountains, high latitudes, polar regions.

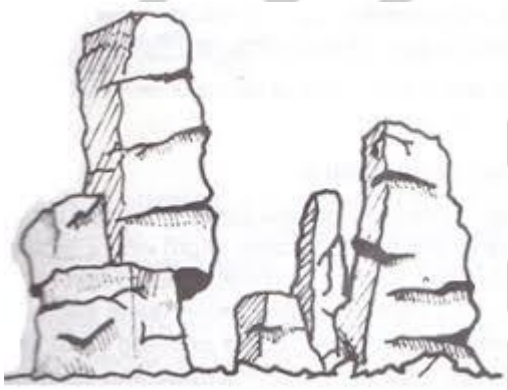


ii. Exfoliation (Pressure Release / Onion Skin Weathering)

- Occurs when overlying rock is removed by erosion, reducing pressure on underlying rock.
- Rock expands and curved sheets peel off like layers of an onion.
- Also caused by temperature changes (insolation weathering) — outer layer expands/contracts faster than inner rock.
- Produces rounded dome-shaped landforms (e.g., bornhardts, inselbergs).



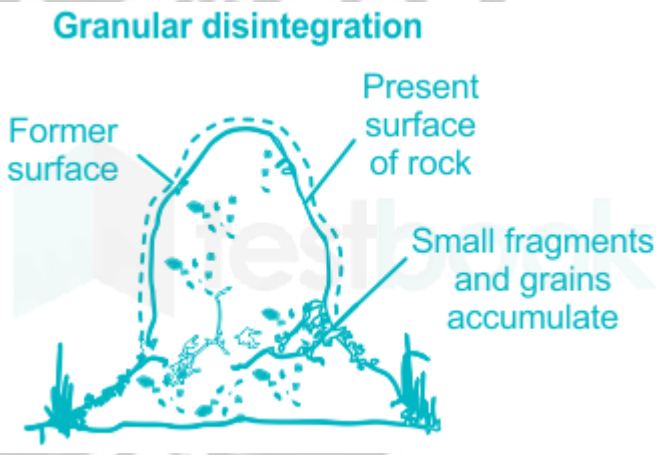
iii. Block Disintegration



- Block disintegration, like granite, occurs in the well-jointed rock.
- It's especially useful in locations with a wide diurnal temperature range of 10-15 degrees Celsius, as well as areas with barrel rocks that lack a protective vegetation cover.
- The joints in the rocks are separated into larger rectangular-shaped blocks in this method.

iv. Granular Disintegration

- Granular disintegration happens in rocks composed of different types of coarse-grained minerals.
- Dark-coloured minerals absorb more heat than the light-coloured minerals.
- This leads to differential expansion and contraction of mineral grains resulting in grain by grain separation from the rock.



3B. Chemical Weathering

Chemical weathering involves a chemical reaction that changes the mineral composition of rocks. Warm and wet conditions greatly accelerate chemical weathering.

i. Carbonation

- Rainwater absorbs CO_2 from the atmosphere and soil to form weak carbonic acid (H_2CO_3).
- This acid reacts with calcium carbonate ($CaCO_3$) in limestone and chalk.
- The limestone is dissolved and removed in solution (runoff).

- Creates landforms: limestone pavements, caves, sinkholes, stalactites, stalagmites.

Reaction: $CO_2 + H_2O \rightarrow H_2CO_3$ (carbonic acid) $H_2CO_3 + CaCO_3 \rightarrow Ca(HCO_3)_2$ (dissolved, carried away)

ii. Hydrolysis

- Water reacts with silicate minerals (especially feldspar in granite) to form clay minerals.
- Results in soft, crumbly rock material (kaolinite/china clay from granite).
- Very important in tropical and subtropical regions.

Example: Feldspar (in granite) + water → Clay minerals (kaolinite) + silica + ions

iii. Oxidation

- Oxygen in air or water reacts with iron-bearing minerals in rocks.
- Iron turns to iron oxide (rust), weakening rock structure.
- Gives rocks and soils a reddish-brown or orange colour.
- Accelerated in warm, moist conditions.

Example: $4Fe$ (iron) + $3O_2$ (oxygen) → $2Fe_2O_3$ (iron oxide / rust)

iv. Hydration

- Minerals absorb water molecules and expand (swell).
- Example: Anhydrite absorbs water and swells into gypsum.
- Repeated expansion and contraction weakens the rock.

Example: $CaSO_4$ (Anhydrite) + $2H_2O \rightarrow CaSO_4,2H_2O$

v. Solution (Dissolution)

- Some minerals dissolve directly in water without needing acid.
- Example: rock salt (halite) and gypsum dissolve in rainwater.
- Leaves voids and cavities in the rock.

3C. Biological Weathering

Biological weathering results from the activities of living organisms. It can be both physical and chemical in nature.

i. Root Wedging (Plant Root Action)

- Plant roots grow into cracks and joints in rocks.
- As roots grow thicker, they exert pressure on the crack walls.
- Eventually, the rock splits apart (similar to physical frost action).

- Common in forests and vegetated areas.

ii. Lichen and Moss Action

- Lichens are pioneer organisms that grow directly on bare rock.
- They produce weak organic acids that chemically dissolve minerals on the rock surface.
- Also trap moisture, aiding freeze-thaw and other weathering.
- Moss holds moisture against rock surface, enhancing chemical weathering.

iii. Burrowing Animals

- Earthworms, moles, ants, and rodents burrow through regolith.
- Bring fresh rock material to the surface where it is exposed to air and water.
- Physically disturb and break up rock fragments.

iv. Human Activity

- Mining, quarrying, construction, and agriculture accelerate weathering.
- Acid rain from industrial pollution accelerates chemical weathering of buildings and rocks.
- Deforestation exposes rock to greater temperature extremes and rainfall impact.

4. Role of Weathering

Weathering plays a fundamental role in shaping the Earth's surface and supporting life. Its effects can be studied under several key roles:

→ **Soil Formation**: Weathering is the primary source of soil particles. It releases minerals like potassium, magnesium, and calcium, enriching soil fertility.

→ **Landform Development**: Weathering weakens rock structures, paving the way for erosion and the creation of valleys, cliffs, caves, and plateaus. Unique features such as spires, arches, and mushroom rocks arise from differential weathering.

→ **Nutrient Cycling**: Weathering ensures continuous supply of minerals to ecosystems. Nutrients released enter rivers, lakes, and soils, sustaining life cycles.

→ **Erosion and Sedimentation**: Weathering provides loose material that erosion transports to form deltas, floodplains, sand dunes, and beaches.

→ **Climate Regulation**: Through chemical weathering of silicates, CO_2 is consumed and stored in rocks, reducing greenhouse gas levels and stabilizing Earth's climate.