Weathering

Weathering: is the process which breaks rocks into smaller bits.

Types of Weathering:

A. Physical or mechanical weathering

B. Chemical weathering

C. Biological weathering

Mechanical or Physical Weathering -

the breakdown of rock material into smaller and smaller pieces with no change in the chemical composition of the weathered material.
**Chemical Weathering**

the breakdown of rocks by chemical agents. Obviously the chief chemical agent is water which carries dissociated carbonic acid.

- **Biological Weathering** is when rocks are weakened and broken down by animals and plants.
Physical or mechanical weathering

Physical weathering is a physical action which breaks up rocks.

This involves:
- disintegration,
- *no chemical alteration* occur.

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Physical or mechanical weathering

- **Frost wedging**
  water expands when it freezes.

- **Thermal expansion**
  repeated daily heating and cooling of rock;
  - heat causes expansion;
  - cooling causes contraction.
• **Exfoliation or unloading**
  caused by expansion of rock due to uplift and erosion; removal of pressure of deep burial;

• **Organic activity**
  Cracking forces exerted by growing plants and roots in voids of rock can force fragments apart (also insect and worms).

**Physical Weathering**

• Block disintegration
• Crystallization of salts
• Exfoliation
• Frost action
• Pressure release
• Slaking
• Tree roots
Physical Weathering

- **Block disintegration:**
  Block disintegration involves *sharp temperature changes*, making desert rocks expand and contract.

- **Crystallization of salts:**
  Crystallization of salts as a result of *dissolved salts expanding* as they dry *split the rocks* and honeycomb its surface.

- **Exfoliation:**
  Exfoliation is the *flaking of intensely heated surface rock* as it *expands* more than the cooler rock below. Rounded, isolated rock masses called *exfoliation domes* result.

- **Frost action:**
  Frost action causes *water to freeze* and *expand in winter* or at night, thus *widening crevices*. Piles of sharp-edged debris, known as *talus* form below steep peaks.
• **Pressure release:**
Pressure release follows the **removal of overlying rock** and its pressure on the rock below. **Expansion** of that rock then forms curved joints, creating sheeting of rock shells from the inner mass.

• **Slaking:**
Slaking is the **crumbling of clay-rich sedimentary** rocks as they **dry out** during drought.

• **Tree roots:**
Tree roots **widen cracks** in rocks as they grow.
Chemical weathering

Rock reacts with:
water,
gases and
solutions (may be acidic);

will add or remove elements from minerals.

Chemical weathering

It may include the following processes:

- Dissolution (or solution)
- Oxidation
- Hydrolysis
- Carbonation
- Hydration
- Organic weathering
Dissolution (or solution)

• **Acids** - Chemical attack minerals of rock and dissolve.

• **Carbon dioxide** in water acts as an acid.

Dissolution (or solution)

Solution is the process whereby water dissolves rock salt.

• Several common minerals dissolve in water
  – halite
  – calcite

  *Limestone and marble* contain calcite and are soluble in acidic water.

• Feldspar is converted to clay in such a way. (eg. chalk in vinegar).
Formation of caves

– Dissolution occurs when rocks and/or minerals are dissolved by water.

– The dissolved material is transported away leaving a space in the rock.

– One consequence of this process is the formation of caves in limestone areas.

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\text{rain + carbon dioxide (from air) \rightarrow carbonic acid (reacts with rocks)} \\
H_2O + CO_2 \rightarrow H_2CO_3
\]
• Carbon dioxide (CO₂) from the air is dissolved in rainwater to create a weak acid, carbonic acid (H₂CO₃), that preferentially dissolves certain rocks and minerals, e.g. limestone, marble.

• Caves form when dissolution occurs along a series of fractures in limestone to create a larger opening.

• Water passing through the rock enlarges the cave and associated re-precipitation can form a variety of features.

Stalactites & Stalagmites

The dissolved limestone is transported through the cave and may be precipitated to form new features such as

stalactites - that grow downward from the cave ceiling (hang from ceiling) and

stalagmites that grow up from the floor.

If they meet they form a compound cave formation such as a column.
Caves and caverns typically form in limestone

- *speleothems* are cave formations they are made of calcite
- form a rock called *travertine*
Marble tombstones and carvings are particularly susceptible to chemical weathering by dissolution.
Sinkholes

Karst topography forms on limestone terrain and is characterized by: sinkholes.

Pamela Gore, 1996
Oxidization

- Oxidization - bonding of oxygen to rock minerals (rusting).

- Oxidized iron forms rust

- Iron-bearing silicate minerals:
  - olivine
  - pyroxene
  - amphibole
  - biotite

- Iron oxides:
  - limonite
  - hematite
  - goethite
    are produced.

- It is readily noticable as the brown to red staining of the weathered surface in rocks containing iron.

- Iron oxides are red, orange, or brown in color.
As many minerals contain iron, it is not unusual to see red-colored rocks (Arches National Park).

**HYDROLYSIS**

- Hydrolysis: chemical reaction between the minerals in the rock and hydrogen in rain water.

For example, during hydrolysis, the feldspar in granite changes to clay mineral (kaolinite) which crumbles easily, weakening the rock and causing it to break down.
Carbonization is the **dissolving of limy rocks** by **percolating rainwater** which contains **carbon dioxide** from the atmosphere or the soil.

**CARBONATION**

dissolved carbon dioxide in rainwater in surrounding air forms carbonic acid and reacts with the minerals in the rock.

This process **weakens the rock** thus **breaking it down** in the process.

e.g.: Calcium Carbonate + Water + Carbon Dioxide --->
Calcium Carbonate (soluble)
**HYDRATION**

Hydration is the process where minerals in the rock absorb water and expand, creating stress which causes the disintegration of rocks.

This breaks shells from the rock containing them.

Example:

Unhydrated Calcium sulphate + Water → Hydrated Calcium Sulphate (expands)

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**Organic (Biological) Weathering**

Organic weathering involves organic acids produced by plant organisms. The acids attack rock-forming minerals.

- Roots of trees and other plants
- Lichens, fungi, and other micro-organisms
- Animals (including humans)