Weathering

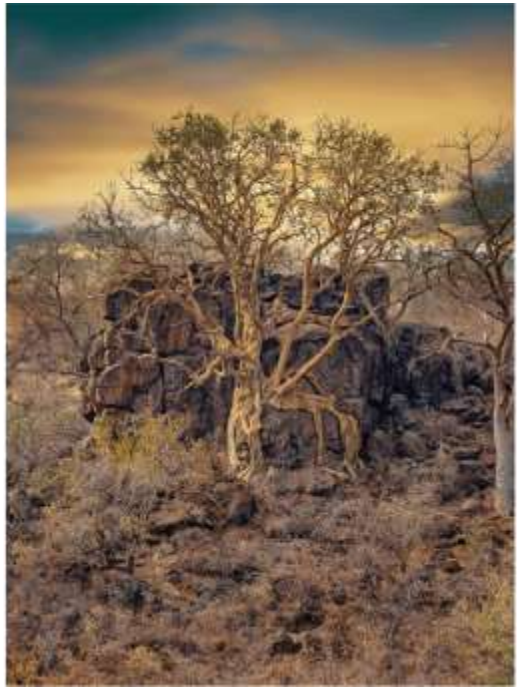
By the end of this lesson, you should be able to:

- **Identify** the causes of physical weathering.
- **Identify** the causes of chemical weathering.
- **Describe** how physical and chemical weathering differ from one another.
- **Explain** the factors that affect weathering.

Physical weathering, also called mechanical weathering and disaggregation, causes rocks to crumble.

This type of weathering only **changes the physical structure** of the rock, i.e. **its shape** and **size.**




Frost wedging, or “ice wedging”or “cryofracturing” is one form of physical weathering.

Water, in either liquid or solid form, is often a **key agent of physical weathering.**

Frost action is the main form of physical weathering in a climate that regularly **cycles above and below freezing point** (e.g. in many parts of Canada).

Frost wedging is the process by which **water seeps into the cracks** of a rock, **expands upon freezing** and thus **enlarges the cracks.** If this cycle continues frequently, the rock **breaks into pieces.**

Water seeps into cracks and fractures of rock.

When the water freezes, it expands in volume, which wedges the rock apart.

Repeated free-thaw cycles, the rock breaks into pieces.

Abrasion, another form of physical weathering, is when one rock bumps against another rock.

Abrasion can take **many forms,** such as:

- **Gravity** causing abrasion as **rocks tumble down** a mountainside or cliff.
- **Strong winds** carrying **pieces of sand** can cause abrasion to rock surfaces (known as "sandblasting").
- **Running or moving water** causing abrasion as particles in the water **collide and bump** against one another.

As mentioned before, running water causes abrasion to rocks. This is certainly the case with rivers!

River water continuously running over rocks causes them to **gradually wear away.** Over geological time, this process creates a **“V” shaped valley.**

Glaciers can be described as a **type of river,** except made of **ice!** They move very slowly from the tops of mountains, **grinding and scraping** the rock to eventually form a **“U” shaped valley.**

Exfoliation is another form of physical weathering that affects massive rocks such as granite or basalt.

Rocks **expand in size from heating** during the day and then **contract from rapid cooling** at night. This **expansion-contraction** causes **separation of thin slabs of rock** from large blocks of rock at the **surface.** This process is commonly referred to as **"onion skin "weathering"** (as seen in the images below).

Plants and animals can also do the work of physical weathering.

A seed of a tree or plant may sprout in the soil that has collected in a cracked rock.

As the roots of the plant grow and become thicker, they widen the cracks, eventually breaking the rock into pieces.

Over time, trees can break apart even large rocks!

Animals that burrow underground, such as moles and prairie dogs, can also break apart rocks as they dig for food or to make living space for themselves.

Frost Wedging

Water seeps into the cracks of a rock and undergoes continual freeze-thaw cycles, causing the rock to eventually break into pieces.

Abrasion

When one rock bumps against another rock, making rocks with sharp edges smooth and round.

Exfoliation

Daily variations in temperature causes rock to contract and constrict resulting in layers to break off the surface of the rock.

Root Wedging

The roots of a growing plant can cause surrounding rocks to break into pieces.

Animal Action

Burrowing animals cause rocks to break apart as they dig for food or make living space for themselves.

Chemical weathering is caused by water and other chemicals reacting with a rock to change its chemical composition.

There are **many types of chemical weathering,** as there are **many agents** of chemical weathering.

For the purpose of this lesson, we will focus on **water, carbon dioxide** and **oxygen** as the important agents of chemical weathering.

When a chemical reaction occurs between a chemical compound and water, this is called hydrolysis.

When this reaction takes place, **water dissolves ions** from the minerals and **carries them away.** These elements are said to have **undergone leaching.**

Through **hydrolysis,** a mineral such as potassium feldspar is **leached of potassium** and changed into a **clay mineral.**

Carbon dioxide from the air or soil sometimes combines with water in a process called carbonation.

This produces a **weak acid,** called **carbonic acid,** that can **dissolve rock.** Carbonic acid is especially effective at **dissolving limestone.**

When **carbonic acid seeps** through **limestone** undergr ound, it can **open up huge cracks or hollow out** vast networks of caves.

Pollutants, such as sulfur and nitrogen, from fossil fuel burning, create sulfuric and nitric acid.

Sulfuric and nitric acids are the two main **components of acid rain,** which **accelerate chemical weathering.**

Acid rain reacts with rocks to **change their chemical composition. Marble,** made up of calcium-rich particles, is a substance that is **easily dissolved** by acid rain!

Another type of chemical weathering works on rocks that contain iron.

These rocks turn to rust in a process called oxidation.

Definition

Oxidation is a chemical reaction that takes place when oxygen reacts with another element.

Rust is a compound created by the interaction of oxygen and iron in the presence of water. Minerals that are rich in iron break down as the iron oxidizes and forms new compounds.

Iron oxide produces the red colour in soils. As rust expands, it weakens rock and helps break it apart.

Just like physical weathering, plants and certain organisms can also be responsible for chemical weathering.

As **plant roots** take in soluble **ions as nutrients,** certain **elements are exchanged** between the plant and soil. Over time, this can cause **chemical weathering** to surrounding rocks.

A specific group of **organisms called lichens** can actually **eat rocks!** Lichens **produce acid to dissolve rocks** and obtain elements such as phosphorus.

The rate of weathering depends on several factors.

These factors include:

1.Climate

2.Rock and mineral type

3.Surface area

A region's climate strongly influences weathering.

The **climate of any region** is determined by the **temperature** and amount of **precipitation** it receives. Essentially the "climate" is the **weather averaged** over a long period of time.

A **cold, dry climate** will produce the **lowest rate** of weathering. In contrast a **warm, wet climate** will produce the **highest rate** of weathering.

Different rock types weather at different rates.

Specific types of rock are **resistant to weathering,** such as **igneous rocks** like granite. These rocks weather slowly because it is **hard for water to penetrate** them.

Other rock types, such as the sedimentary rock **limestone,** are easily weathered because they **dissolve in weak acids.** Since there are **spaces between the grains** of sedimentary rocks, water is able to **penetrate more easily** and cause greater weathering.

The final factor that can influence the rate of weathering is the surface area of a rock.

Surface area refers to **how much of the rock** is actually **exposed to the elements** (i.e. wind and rain).

Large rocks have a **small surface area to volume ratio,** and so weather at a **slow rate.**

Small rocks have a **large surface area to volume ratio,** and so weather at a **fast rate.** For example, **water** is able to get into the cracks of small rocks to **accelerate chemical weathering.**