

Weathering: The Breakdown of Rocks

Mechanical Weathering: Breaks rocks into smaller particles

Chemical Weathering: Alters rock by chemical reactions

Mechanical Weathering

1) Ice Wedging

- *Results from 9% expansion when water turns to ice.
- *High stress (110kg/cm^2 , about the wedge of a sledge)
- *It occurs when:
 - >Adequate supply of moisture
 - >Have preexisting fractures, cracks, and voids
 - >Temperature rises above and below freezing
- *Was even used in some quarry operations to break up rock

2) Sheetting

- *Results from release of confining pressures
- *Has been observed directly in quarries and mines, even in roadways
- *Sheetting from heat results in a rock spalling
- *Spalling: surface of rock expands due to extreme heating but core of rock remains cool

3) Disintegration

- *Breakdown of rock into smaller pieces by critters, plants, etc.

Results of Mechanical Weathering

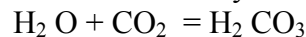
- Talus Cones (From ice wedging mostly)
- Boulder fields (From ice wedging mostly)
- Jointing: Cracks in the rock from ice wedging and sheetting

Chemical Weathering: Rocks are decomposed and the internal structure of the minerals is destroyed, and new minerals are created.

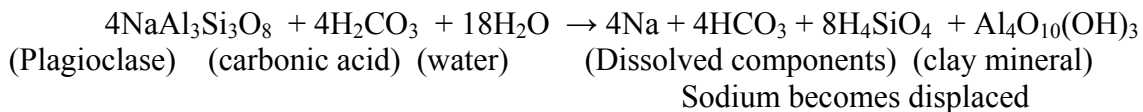
1) Hydrolysis: Chemical union of water and a mineral

- *Ex. Feldspar $\rightarrow$ clay mineral

Water first forms carbonic acid by combining with carbon dioxide in the reaction:



Then the mineral is broken down:



2) Dissolution: Process where by rock material passes directly into solution, like salt in water

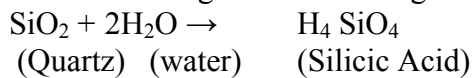
- *Most important minerals to do this: CARBONATES (Calcite;dolomite)

Dissolution (continue)

- Water is a universal solvent due to its polar nature
- Behaves like a magnet
- A good example is limestone which is made of calcite or dolomite
- In wet areas, it forms valleys
- In arid areas, it forms cliffs
- Some rock types can be completely dissolved and *leached* (flushed away by water)
- Best examples are natural salt (halite) and gypsum.
- As a result, guess where you find the best examples of this stuff?

Quartz Dissolution

■ Although Quartz is stable in contact with water, it will also dissolve in common surface water according to the following reaction:

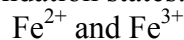


- Each Year, rivers carry 3.9 million metric tons of dissolved minerals to the oceans.
- Not a surprise that seawater contains 3.5% dissolved salts, all of which came from the continents!

3) Oxidation: Combination of oxygen in the atmosphere or dissolved in water, with a mineral to form a new mineral

*One or more of the components of the new mineral will have a higher oxidation state (or ionic charge)

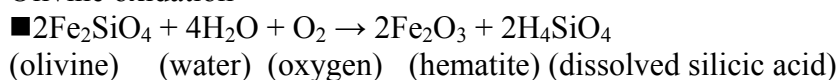
Iron (Fe) has two common oxidation states:



Oxygen prefers Fe^{3+}

Oxidation is especially important in the weathering of iron-rich minerals like olivine, pyroxenes, and amphiboles:

Olivine oxidation



What changes the rates of these reactions?

Temperature, plants, critters

Weathering Characteristics of Common Rocks

1) Granite

- Composed of feldspar, quartz and mica
- Forms at considerable depth, pressure and temperature, therefore out of equilibrium with the surface
- Coarse grained
- Mechanical Weathering: Exfoliation, a form of sheeting from pressure release
- Chemical Weathering: Feldspar to clays, micas to chlorite

2) Basalt

- Composed of feldspar, olivine and pyroxene
- Forms at the surface, extrusively out of a volcano
- Chemical weathering: feldspars to clays, olivine and pyroxene to iron oxides
- Weathering product results in a brown to red soil

3) Sandstone

- Composed mostly of quartz grains with rock fragments, feldspar and clay minerals
- Forms at the surface from a river, beach, as a dune, etc
- Chemical weathering: Largely on the cement of the rock which is usually calcite, iron oxides, or quartz.
- Mechanical weathering: Granular disintegration, one grain at a time

4) Limestone

- Composed of the mineral calcite although it may contain clays and other materials
- Forms in water from mostly dead critter parts
- Chemical weathering: dissolution (soluble in water)
- Weathering products: Cliffs in arid regions, slopes in humid regions.
- Caves, sinkholes, karst topography

5) Shale

- Composed of clays, weathers fast
- Forms in a gentle environment such as a lake, offshore marine
- Mechanical weathering: Due to water content, ice wedging, disintegration
- Chemical weathering: Due to clay mineral structure
- Clays are phyllosilicates which form sheets of atoms, water molecules can break sheets apart easily.

The importance of fractures and joints in weathering

- Almost all rocks are broken in a system of fractures that greatly influence the weathering of rock bodies in two ways:
 - They effectively cut large blocks of rocks into smaller ones, thereby increasing the surface area where chemical reactions take place
 - Joints and fractures act as channel ways through which water can penetrate to break down rock by ice wedging

Geometric Patterns of Rock Disintegration

- Joint Block Separation
- Bedding Plane Separation
- Jointing
- Shattering
- Spheroidal Weathering
 - * The process by which corners and edges of a rock body become rounded as a result of exposure to weathering on all sides, so that the rock acquires a spheroidal or ellipsoidal shape. (Exfoliation)
- Differential Weathering: Different rock bodies or different sections of the same rock that weather at different rates

The Major Products of Weathering

- Regolith, meaning blanket, composed of bedrock
 - * Can range from a few centimeters to hundreds of meters, depending on climate, type of rock, and length of time that weathering processes have been operating.
 - * The uppermost layer of regolith is the soil.
 - * Soil is composed chiefly of small particles of rocks and minerals, plus varying amounts of decomposed organic matter.
 - * Soil Profiles show a constant sequence of layers, or horizons, which are distinguished by composition, color and texture.
- Blanket of loose, layered rock debris>>Rock bodies modified into spheroidal shapes
 - * Through exfoliation, a form of sheeting

Soil Formation

■ Climate is of major importance in the formation of soils

■ Other factors

* Parent rock material

* topography

Soil Facts

■ Thickest soils in the tropics

■ Quartz generally forms thin infertile soils

■ Deserts often form thick eluviation horizons

■ Well-drained areas form rich, thick soils.

Climate and Weathering

■ Climate is the single most important factor influencing weathering

■ It determines not only the type and rate of weathering, but also the characteristics of regolith and weathered rock surfaces.

■ Intense chemical weathering occurs in hot, humid regions and develops thick regoliths

■ Chemical weathering is minimal in deserts and polar regions.

Rates of Weathering

■ The rate at which weathering processes decompose and breakdown a solid rock body depends on three main factors:

- 1) Susceptibility of the constituent minerals to weathering
- 2) Climate
- 3) The amount of surface exposed to the atmosphere

Examples that help determine weathering rates

■ Pyramids in Egypt (Central Park, NY)

■ Krakatoa (Used a variety of types of rock)