Weathering - the breakdown of rocks into soil
Types of Weathering:
1. Physical Weathering - any process that causes a rock to crack or break into pieces without changing it
2. Chemical Weathering - any process that causes rocks to breakdown by chemical action
   • results in a change in composition

Types of Physical Weathering:

a. Frost Action (Ice Wedging) - water seeps into cracks in a rock
   • when water freezes, it expands by 10% causing the rock to split apart

b. Extreme Temperature Changes (Exfoliation) - rocks are heated by the sun and expand; when temperatures fall, the rock cools and contracts
   • this cycle of heating and cooling (expansion and contraction) causes the rock to break into slabs

c. Plant/Animal Action - plants/roots will grow into cracks in rocks causing them to split as they grow
   • moss and lichens produce acids that weaken rock (chemical breakdown)
Physical Weathering

d. **Abrasion** - sediments carried by streams and wind blown sand cause particles to collide into each other and the surrounding rock

![Image of abrasion](image)

(e. **Pressure Unloading** - as a rock is eroded or glacial ice sheets melt, the rocks below are no longer under pressure

- they release this pressure causing the bedrock to crack

Chemical Weathering

Types of Chemical Weathering:

a. **Oxidation** - oxygen combines with certain minerals in rocks - the chemical change of the mineral weakens the rock and the rock crumbles

- ex.: rust

![Image of oxidation](image)

b. **Carbonation** - carbon dioxide dissolves into water and forms a weak acid which reacts with certain rocks and minerals (calcite, limestone, marble, chalk)

- forms sinkholes and caves

![Image of carbonation](image)

c. **Hydration** - certain minerals in rocks will dissolve in water and rock will crumble

- ex.: feldspar in granite - feldspar turns to clay

![Image of hydration](image)
Chemical Weathering

d. Acid Rain - gases released from the burning of fossil fuels dissolve into water droplets in clouds to produce an acid
   • ex.: sulfuric acid

Factors that Effect Weathering:

1. Surface Area/Particle Size
   - as surface area increases, weathering increases
   • small particles have more surface area than large particles

2. Minerals in Rock
   - as hardness of minerals increases, weathering rate decreases
   • softer, less resistant minerals/rocks wear away leaving harder, more resistant minerals/rocks behind

3. Climate - the major factor that effects weathering
   • as humidity increases, weathering increases
   • as temperature increases, chemical weathering increases
     • warm, moist climates (mT)
   • as temperature decreases, physical weathering increases
     • cold, moist climates (mP)
Weathering

Products of Weathering:
1. Solid Sediments
2. Dissolved Minerals
3. Soils

1. Solid Sediments (from largest to smallest):
   - Boulders
   - Cobbles
   - Pebbles
   - Sand
   - Silt
   - Clay
   - Colloids

   Reference Tables p.6

   • colloids are the smallest particles and always remain suspended in water - never settle out

2. Dissolved Minerals - cause "hard" water
   • when water evaporates, dissolved minerals will precipitate out and settle to the bottom

3. Soil - combination of weathered rock and organic matter (humus - decayed plant/animal remains)

   Topsoil - contains humus

   Subsoil - contains leached minerals

   C-Horizon - partially weathered bedrock

   Bedrock - often the parent rock of soil above
Types of Soils:

1. **Residual Soils** - weathered rocks/particles are the same as the underlying bedrock
   - *ex.:* soils in NYS formed from rocks that came from Canada and were transported by glaciers and deposited in NYS during the last ice age

2. **Transported Soils** - weathered rock/particles do not match the underlying bedrock (transported from elsewhere)
   - *ex.:* soils in NYS formed from rocks that came from Canada and were transported by glaciers and deposited in NYS during the last ice age

- soil profiles that form in different environments will have very distinct differences from each other

### Erosion

**Erosion** - the process by which weathered sediments are carried/transported

- agents of erosion are the materials or forces that move sediments from one place to another
- force that causes erosion is gravity

**Agents of Erosion:**

1. Gravity (Mass Movements)
2. Wind
3. Running Water (Streams)
4. Waves
5. Glaciers

- gravity is the underlying force behind all erosion
- gravity may act alone or with a transporting agent
- gravity causes water to flow downhill
- gravity causes glaciers to flow down valleys
- gravity causes winds by pulling heavier (more dense) cold air down beneath lighter (less dense) warm air
Gravity Erosion

**Gravity** - pulls weathered sediments down steep slopes (called **mass wasting**)
- mass movements occur when the force of gravity is greater than the force of friction (keeps weathered sediments from moving)

Types of Mass Wasting:
- Fast – landslides, mudslides
- Slow – soil creep, slump

Factors that Effect Mass Wasting:
1. Gradient (slope) of the land surface
2. Temperature
3. Moisture (amount of water in the soil/ground)
Wind Erosion

**Wind** - heavy winds can move sand, but rarely more than a meter above the ground and only where it is very dry

- light winds can only move the smallest sediments
- occurs in arid climates and coastlines where loose sediments are available

**Deflation** - process where winds blow away loose sediments, lowering the land surface

**Abrasion** - winds blow sand against rocks and other objects causing them to be "sandblasted"
Water Erosion

Streams - running water is the dominant form of erosion
• the amount (volume) of water in a stream is called the stream's discharge

Factors affecting a stream's discharge:
1. **Season** - discharge greatest in the spring
2. **Climate** - greatest in humid climates
3. **Ground/Soil** - greatest when soil is saturated
4. **Weather** - increases after a period of precipitation

Streams carry sediments by:
1. **Suspension** - carried within the water column
2. **Bouncing/Rolling** - larger particles along the stream bottom
3. **In-solution** - minerals dissolved in the water
   • as sediments move in the water, the hit rocks, the stream channel, and other sediments - this causes the sediments to become rounded in a process called **abrasion**

As the velocity of a stream increases, its kinetic energy increases and the amount of erosion it does will increase

Factors that Affect Stream Velocity:
1. **Gradient** - as gradient (slope) increases, stream velocity increases
2. **Discharge** - as discharge (volume of water) increases, stream velocity increases
3. **Channel Shape** - the path that a stream follows
   • a stream's velocity will change due to the curvature of the channel
**Water Erosion**

Abras ion will cause streams over time to carve deep channels (downcutting)
- characteristic **V-shaped valleys**

**Meander** - bends in a stream's channel
- stream moves fastest along the outside of a curve; slowest along the inside
- erosion occurs where the stream is moving fastest - causes the shape of the channel

- Solid sediments transported by a stream move more slowly than the stream itself
- the greater the velocity of the stream, the larger the sediment particles it can carry

Reference Tables p.6
Waves - caused by the wind
  • size of waves depends on how long wind blows in 1 direction
  • water particles rise and fall in circular paths over deep ocean water

• when wave reaches shallow water near shore, friction causes the bottom of the wave to move more slowly ("breaks")

• waves usually hit the shore at an angle - this causes a flow of water called a \textbf{longshore current}
• sand moves along the beach in a zig-zag pattern
• creates sandbars
Glacial Erosion

Glacier - a naturally formed, large mass of ice that moves downhill under the influence of gravity

• Types of Glaciers:
  1. Alpine (Mountain, Valley) - form in mountain valleys at high elevation
     • Alps, Himalayas, Rockies
  2. Continental - form over vast areas of land at high latitudes
     • Antarctica, Greenland

Glaciers form as snow and ice accumulate over time

• ice within the glacier always moves down-slope (it flows)
• flow of glacial ice is fastest in the middle and slowest at the sides (due to friction)
• if more snow/ice accumulate than melt away, the glacier will advance
• if opposite occurs, the glacier will retreat
• ice within the glacier continues to flow down-slope
Glaciers pluck rocks/sediments from the surface
• they freeze into the ice and act like sandpaper as the glacier moves
• produces **polished bedrock, parallel scratches and grooves**

• direction of the scratches and grooves shows the direction of glacial movement

Glaciers transport rocks plucked from the bedrock at one location hundreds of miles to a new location
• the deposited rocks differ from the bedrock in their new location - called **eratics**

• found in most of NYS
• ex.: granite - not native to NY

• Alpine glaciers erode valley walls/floor into a characteristic **U-shaped valley**
Deposition

Deposition - the process by which sediment is dropped or settles
• occurs when the velocity of water, wind, or other erosional system decreases

Factors that Affect Deposition:
1. Size of Sediment
2. Density of Sediment
3. Shape of Sediment

1. Size of Sediment
• As the size of sediment increases, the rate (speed) of deposition increases
  - big particles settle faster than small particles

2. Density of Sediment
• As the density of sediment increases, the rate (speed) of deposition increases
  - high density particles settle faster than low density particles
3. **Shape of Sediment**
   - As the shape of sediment becomes more spherical (round), the rate (speed) of deposition increases
   - Round particles settle faster than flat particles!!

**Sorted Sediments** - a deposit of sediment that has particles of the same size (and shape and density)
   - sorting occurs during deposition
   - the greater in similarity in size (or density or shape), the more sorted the sediments are

**Unsorted Sediments** - sediments that are mixed in size, shape and density

**Water Deposition**

As the velocity of a stream decreases, the heaviest, densest, and roundest particles settle out first
   - occurs when streams flow into the ocean or large lake
   - results is layers which the sediment size, roundness, and density decreases in the direction away from land
   - **Horizontal Sorting**
Water Deposition

When deposition is fast, **Vertical Sorting** (graded bedding) occurs

- heaviest, densest, roundest particles settle first and end up at the bottom;
  lightest, least dense, and flattest particles on top

Gravity Deposition

Mass movements (gravity) result in **unsorted** and **non-layered** deposits

- deposits have a random mixture of sizes shapes and densities as the sediments deposit quickly

Wind Deposition

Winds deposit sediments as:

1. Sand Dunes

2. Loess
Wind Deposition

Wind deposits are **sorted** and **layered**

- occur in arid/dry climates and along coastlines
- sand dunes show the direction of wind movement

**Cross-Bedding** occurs if the wind direction changes - sediments are deposited at different angles

- wind deposits have a **pitted** (frosted) and **rounded** appearance

Water Deposition

Streams deposit sediment when the kinetic energy (velocity) of the stream decreases

- occurs when a stream enters a large body of water (**delta**) or dry land (forms a deposit called an **alluvial fan**)
Water Deposition

Stream velocity is faster on the outside of a meander and slower on the inside
- deposition occurs on the inside curve of a stream
- erosion and deposition cause the meanders to "grow"
- results in the formation of **oxbow lakes**

Wave Deposition

Waves along shorelines will deposit sand and form beaches
- water currents will create sand dune-like features called **ripple-marks**

Glacial Deposition

Glaciers deposit sediment along the ice front (end of the glacier) as the glacier melts
- depositional features created by glaciers are called **moraines**
- sediment is **unsorted** and **angular** (sediment deposited from a glacier is called **till**)
- When a glacier melts, sediment is deposited from meltwater (called “fluvial” for running water deposits)
- these deposits are **sorted** sediments