# Regents Earth Science – Unit 9: Weathering, Erosion, and Deposition

## Weathering

**Weathering** - the breakdown of rocks into soil

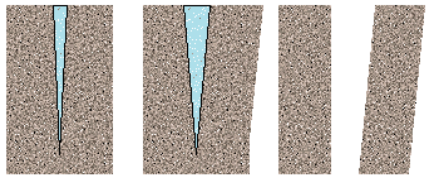
Types of Weathering:

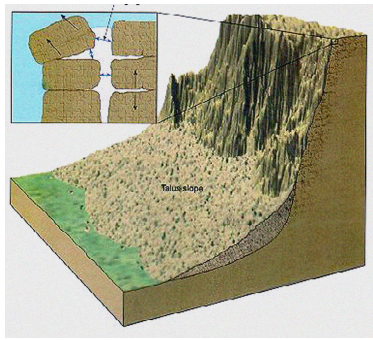
1. **Physical Weathering** - any process that causes a rock to crack or break into pieces without changing it
2. **Chemical Weathering** - any process that causes rocks to breakdown by chemical action
   - results in a change in composition

### Physical Weathering

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



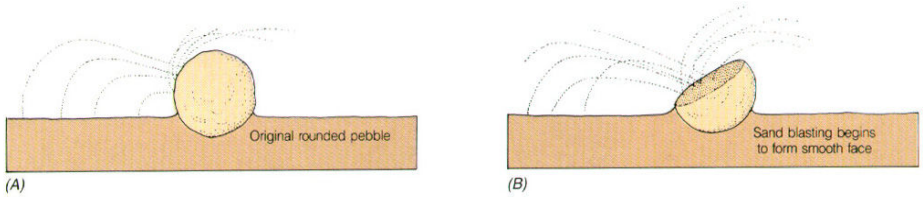




**b.** **Extreme Temperature Changes** (Exfoliation) - rocks are heated by the sun and expand; when temperatures fall, the rock cools and contracts
   - this cycle of heating and cooling (expansion and contraction) causes the rock to break into slabs

**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




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

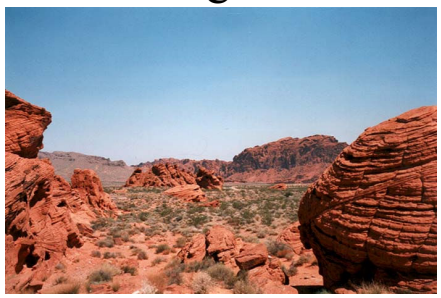
- they release this pressure causing the bedrock to crack

# Chemical Weathering

Types of Chemical Weathering:

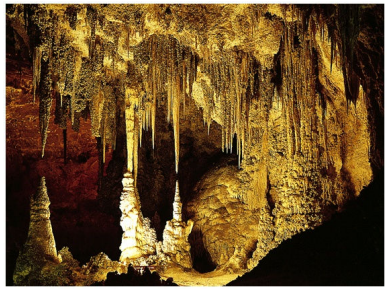
**a.** **Oxidation** - oxygen combines with certain minerals in rocks - the chemical change of the mineral weakens the rock and the rock crumbles

- ex.: rust



**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



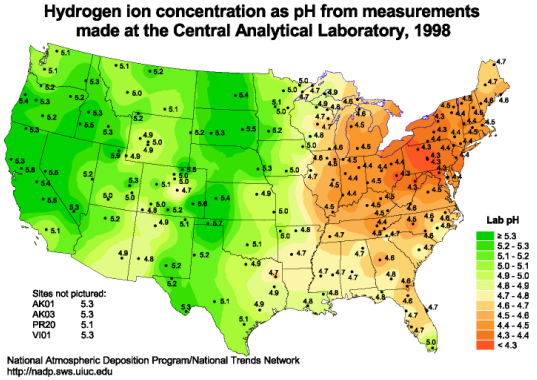
**c.** **Hydration** - certain minerals in rocks will dissolve in water and rock will crumble

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

# 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



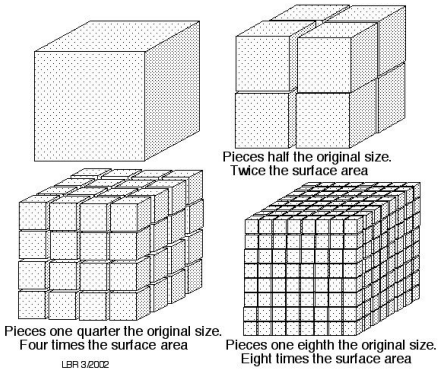

# Weathering

Factors that Effect Weathering:

1. Surface Area/Particle Size
2. Minerals in Rock
3. Climate

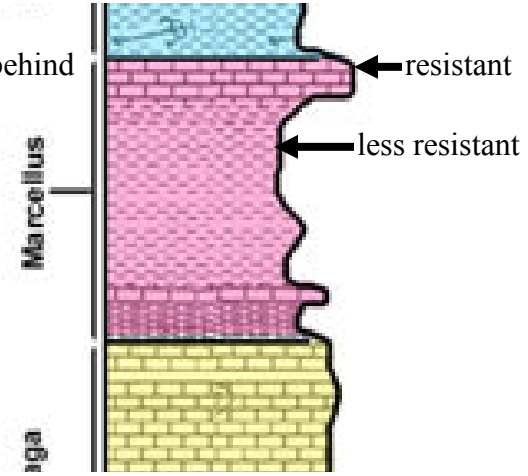
**1.** **Surface Area** - as surface area increases, weathering increases

- small particles have more surface area than large particles



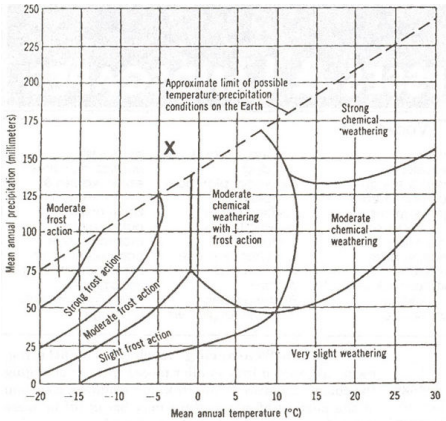

**2.** **Minerals in Rock** - as hardness of minerals increases, weathering rate decreases

- 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

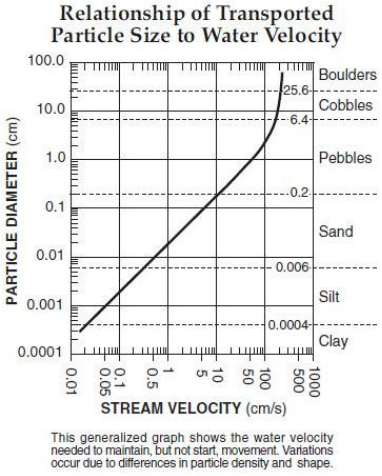
Products of Weathering:

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

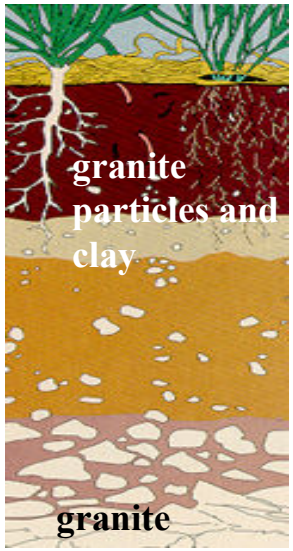
**C-Horizon** - partially weathered bedrock

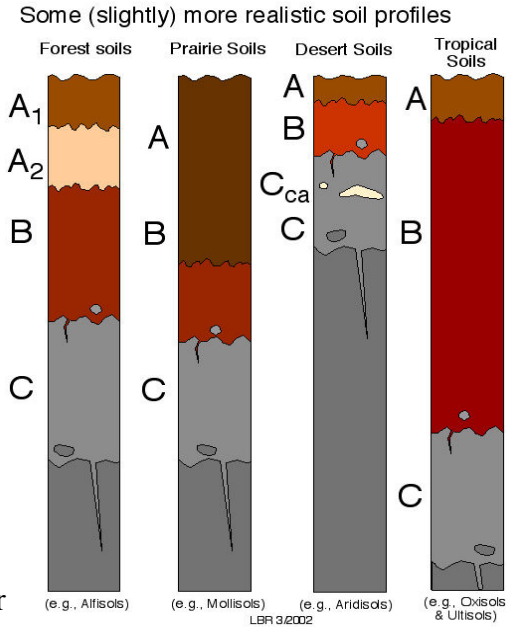
**Bedrock** - often the parent rock of soil above

# Sediments

Types of Soils:

1. **Residual Soils** - weathered rocks/particles are the same as the underlying bedrock
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

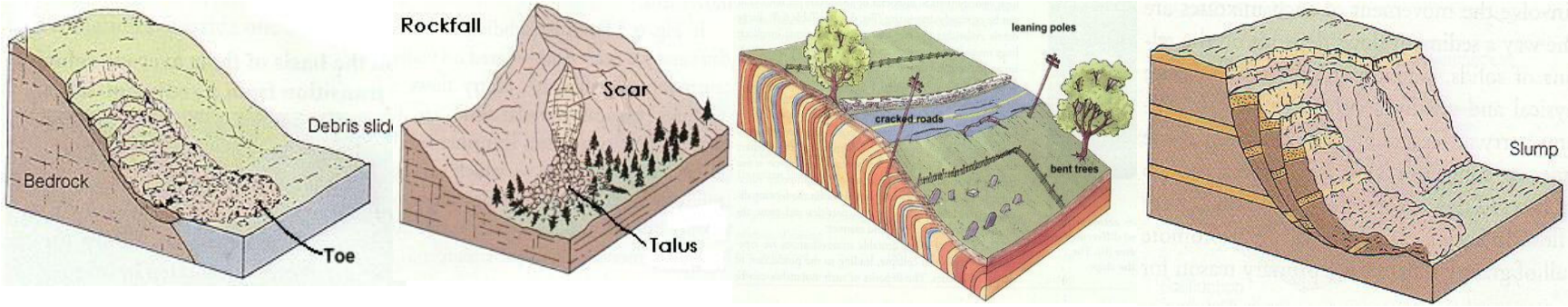
# Gravity Erosion

**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)

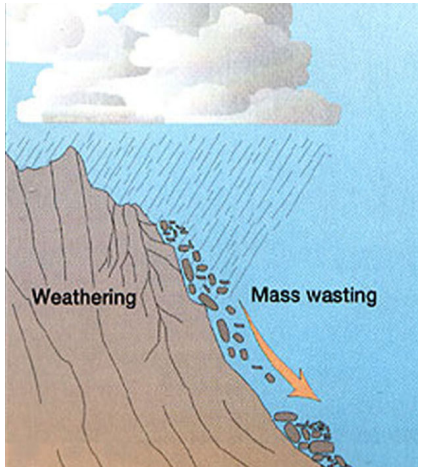
Types of Mass Wasting:

- 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)

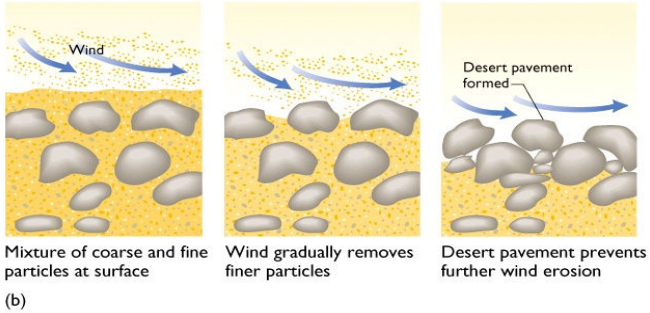


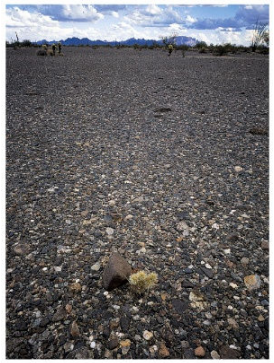
# Wind Erosion

**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 where loose sediments are available

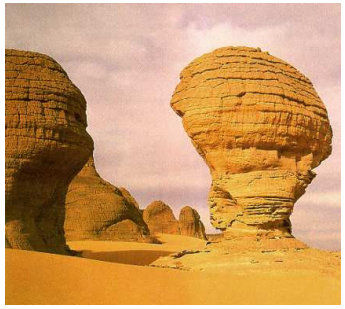
**Deflation** - process where winds blow away loose sediments, lowering the land surface





(a)

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

Arches



Hoodoos

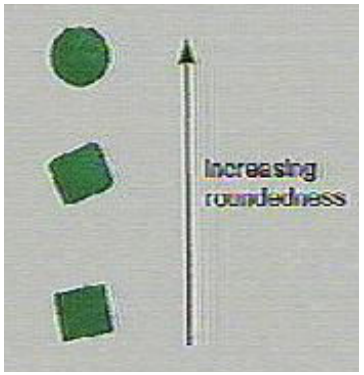
# Water Erosion

**Streams** - running water is the *dominant* form of erosion

- the amount (volume) of water in a stream is called the stream's **discharge**

Factor's 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



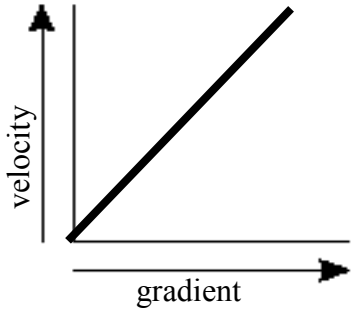

Streams carry sediments by:

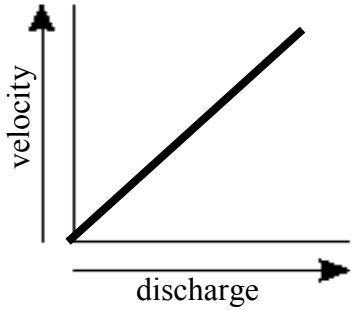
1. **Suspension** - carried within the water column
2. **Bouncing/Rolling** - larger particles along the stream bottom
3. **In-solution** - minerals dissolved in the water
    - as sediments move in the water, the hit rocks, the stream channel, and other sediments - this causes the sediments to become 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

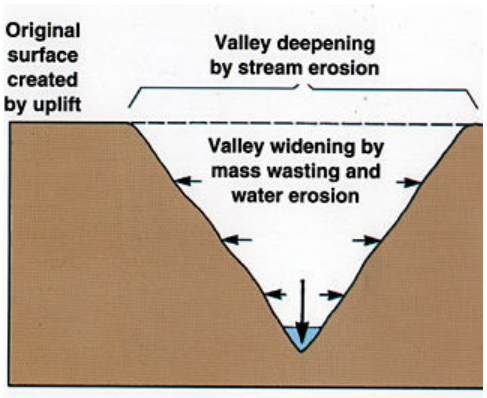


# Water Erosion

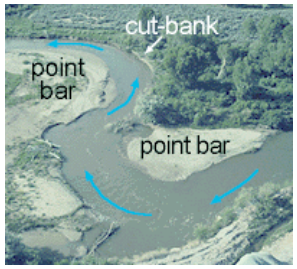
Abrasion will cause streams over time to carve deep channels (downcutting)

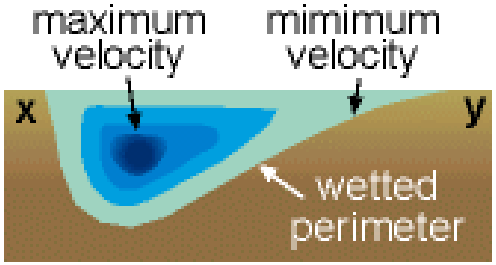
- characteristic **V-shaped valleys**

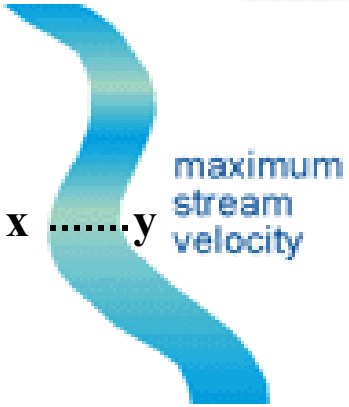



**Meander** - bends in a streams channel

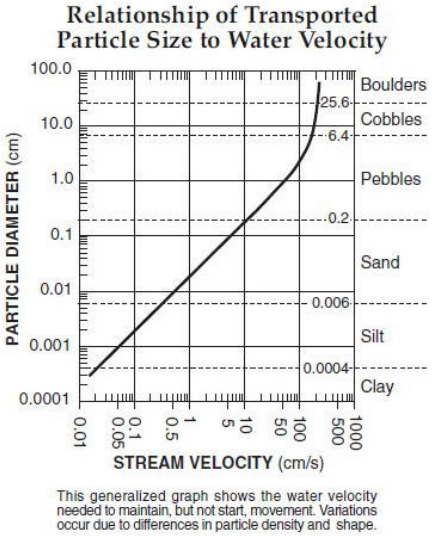
- stream moves fastest along the outside of a curve; slowest along the inside
- erosion occurs where the stream is moving fastest - causes the shape of the channel




- 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

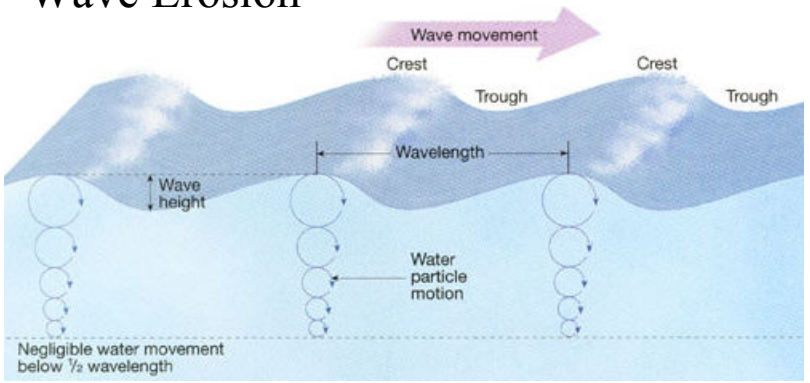


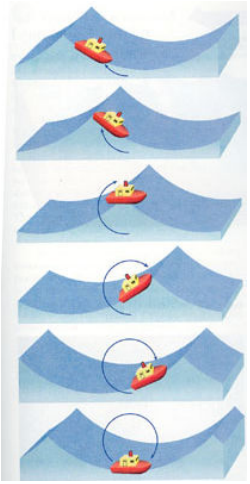

Reference Tables p.6

# Wave Erosion

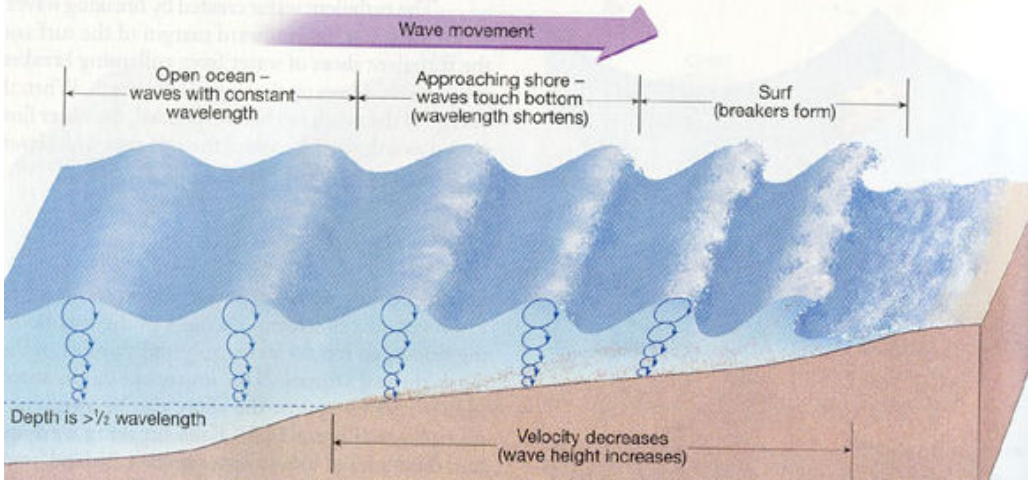
**Waves** - caused by the wind

- size of waves depends on how long wind blows in 1 direction
- water particles rise and fall in circular paths over deep ocean water

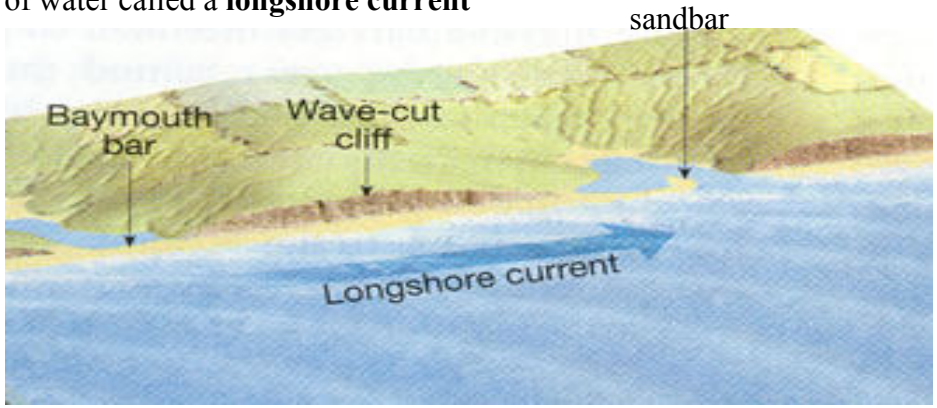


- when wave reaches shallow water near shore, friction causes the bottom of the wave to move more slowly ("breaks")




- waves usually hit the shore at an angle - this causes a flow of water called a **longshore current**
- sand moves along the beach in a zig-zag pattern
- creates sandbars

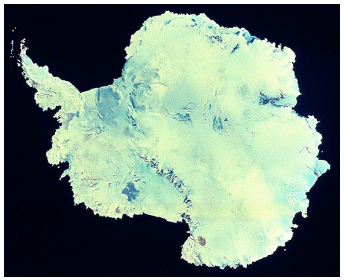


# Glacial Erosion

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

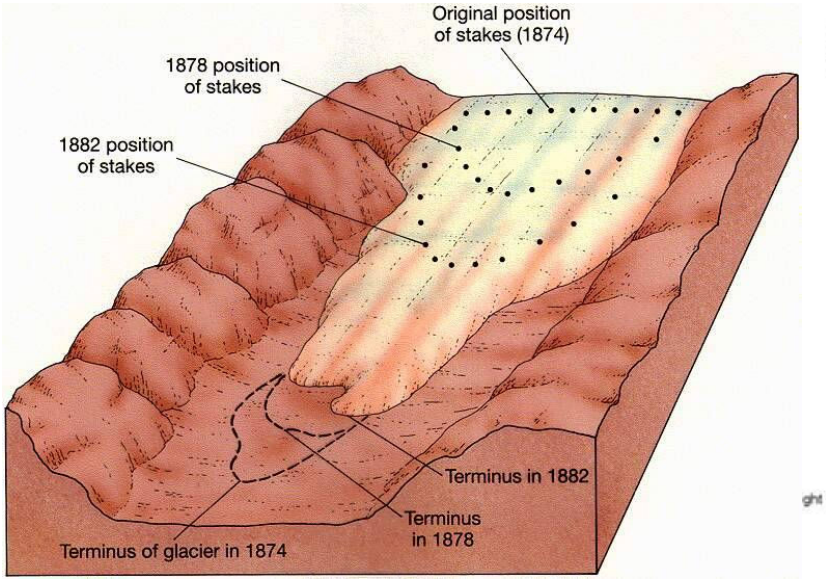
- Types of Glaciers:

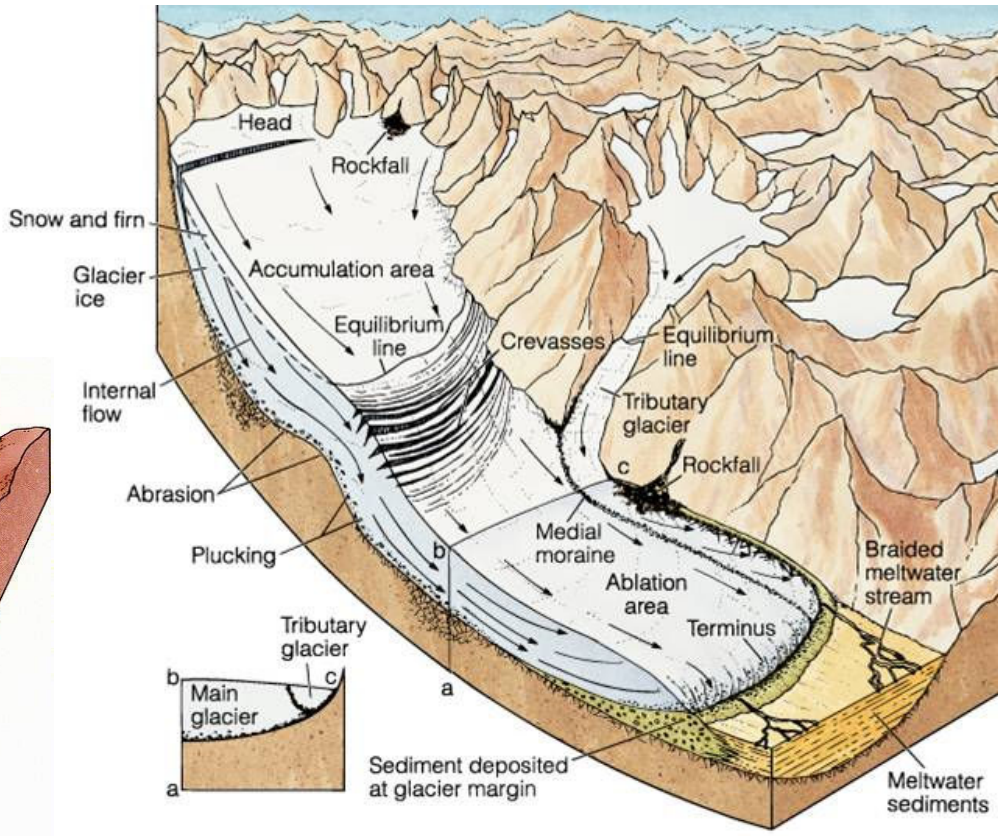
1. **Alpine** (Mountain, Valley) - form in mountain valleys at high elevation
   - Alps, Himalayas, Rockies
2. **Continental** - form over vast areas of land at high latitudes
   - Antarctica, Greenland



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



# Glacial Erosion

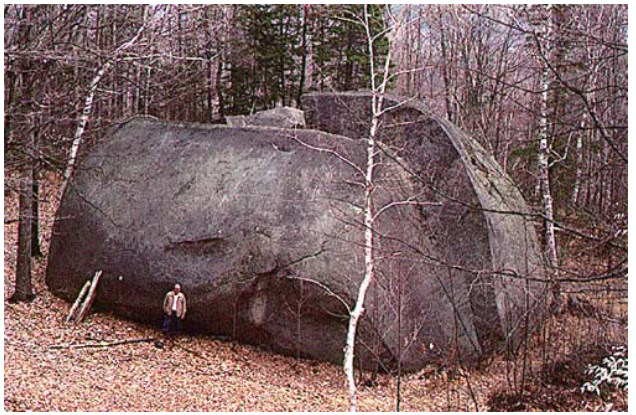
Glaciers pluck rocks/sediments from the surface

- 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

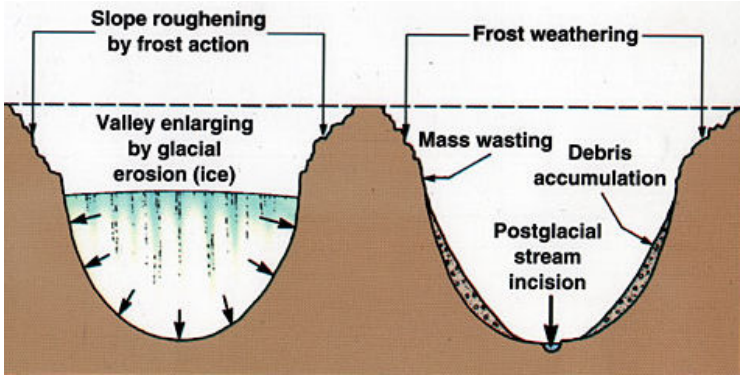
Glaciers transport rocks plucked from the bedrock at one location hundreds of miles to a new location

- 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

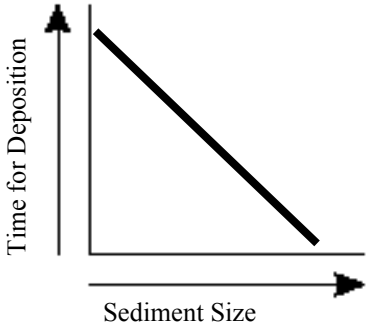
- occurs when the velocity of water, wind, or other erosional system decreases

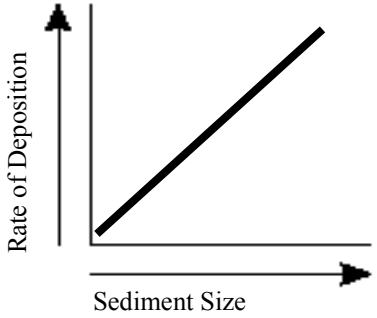
Factors that Affect Deposition:

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

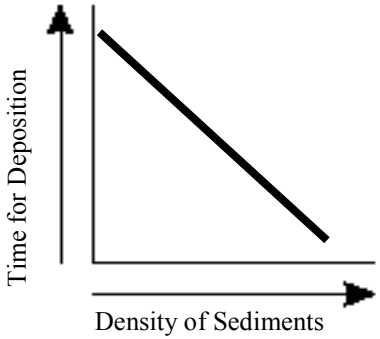


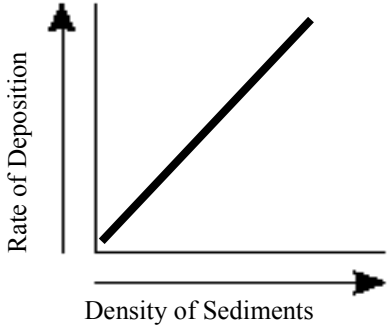




- big particles settle faster than small particles

**2. Density of Sediment**

- As the density of sediment increases, the rate (speed) of deposition increases



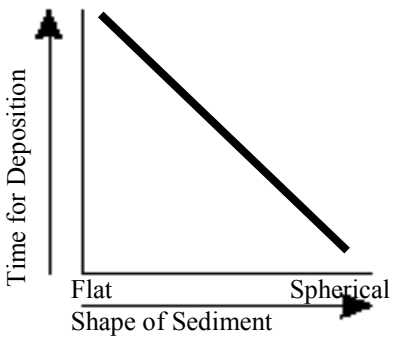



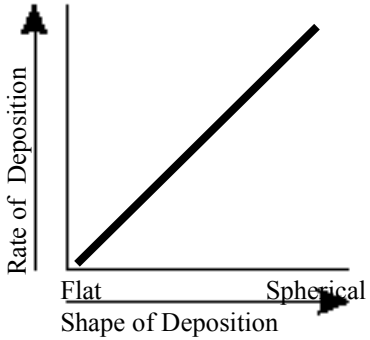

- high density particles settle faster than low density particles

# Deposition

**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

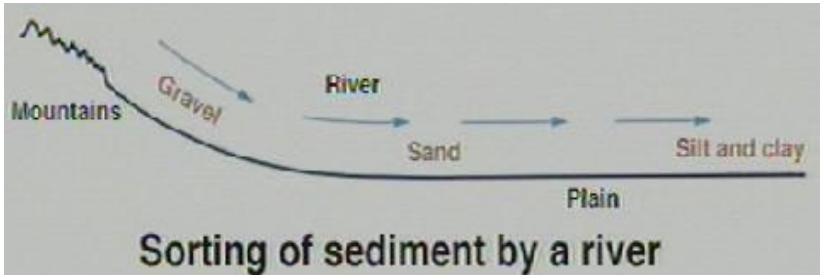
**Sorted Sediments**

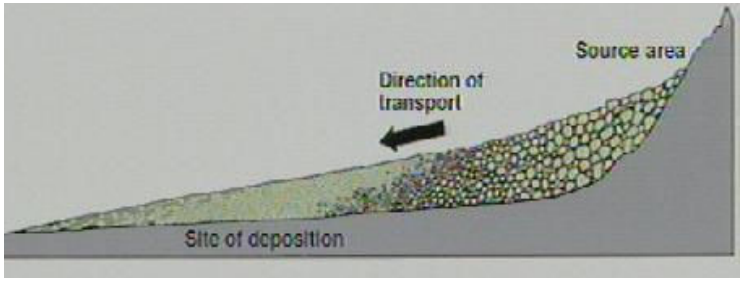
**Unsorted Sediments**

# 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**

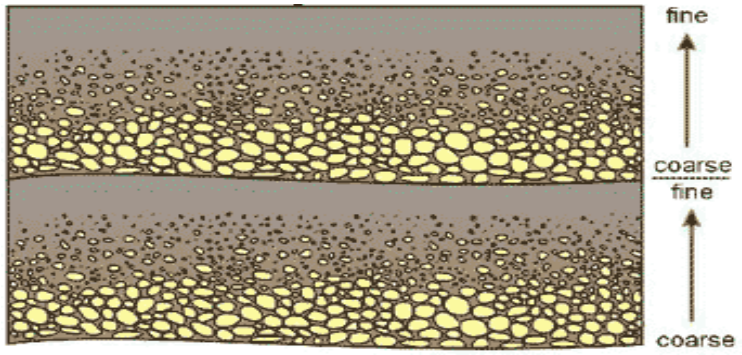


# Water Deposition

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

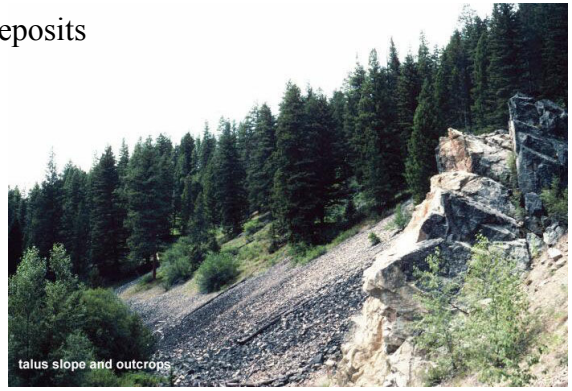
- heaviest, densest, roundest particles settle first and end up at the bottom; lightest, least dense, and flattest particles on top




# 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:

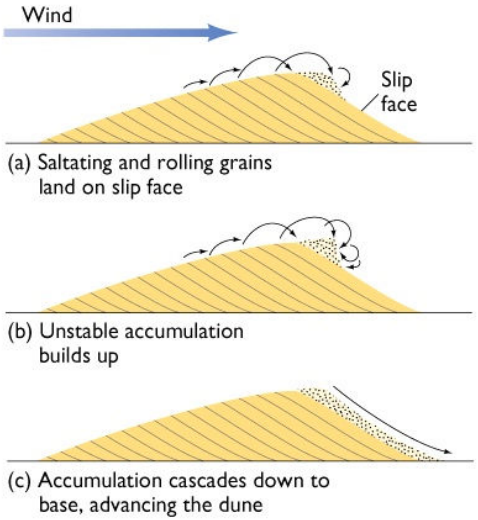
1. Sand Dunes

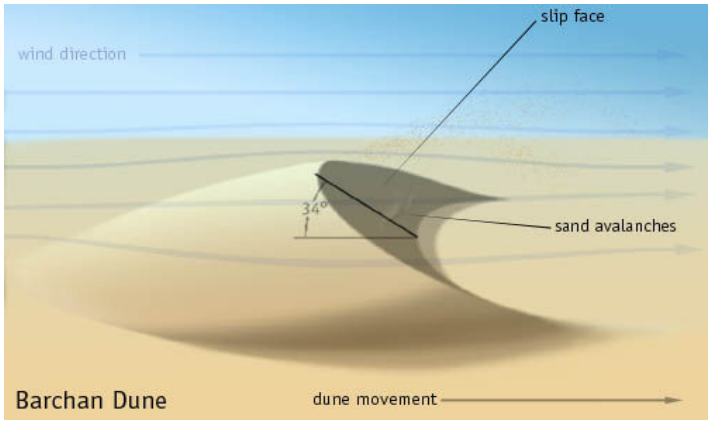
2. Loess

# Wind Deposition

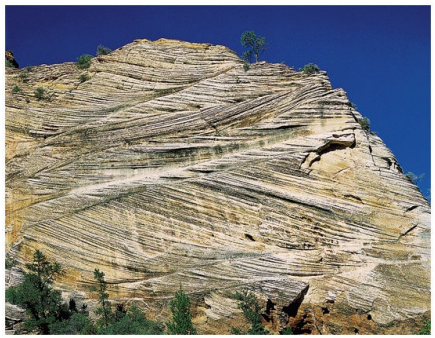
Wind deposits are **sorted** and **layered**

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

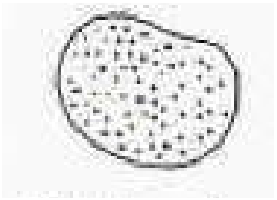



**Cross-Bedding** occurs if the wind direction changes - sediments are deposited at different angles



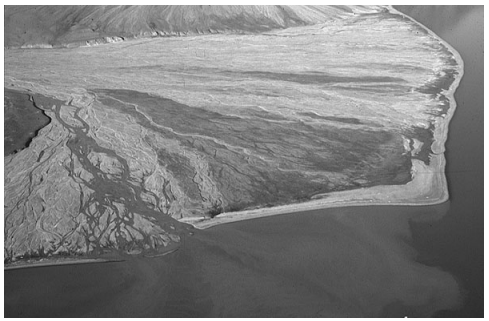
- wind deposits have a **pitted** (**frosted**) and **rounded** appearance



# 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