

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

## Weathering

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

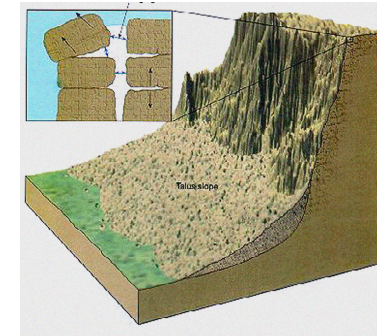
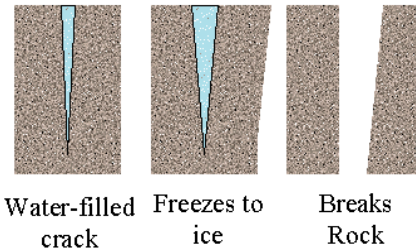
Types of Weathering:

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

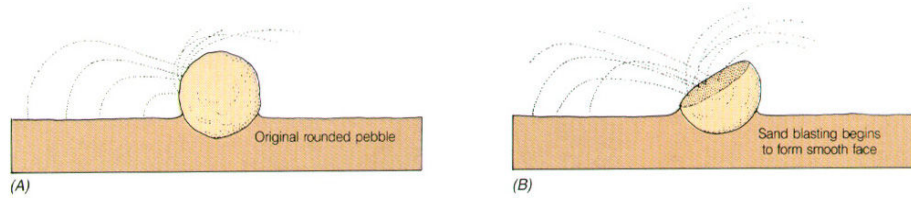
Types of Physical Weathering:

- 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



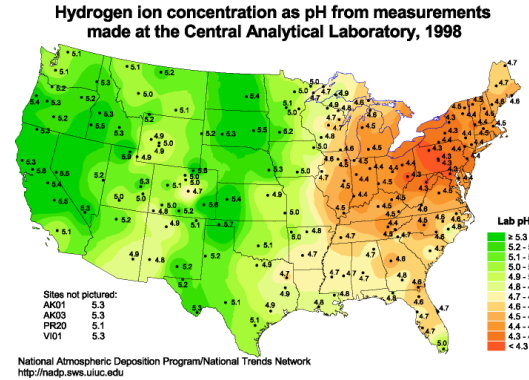
- c. **Hydration** - certain minerals in rocks will dissolve in water and rock will crumble
- ex.: feldspar in granite - feldspar turns to clay



# 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



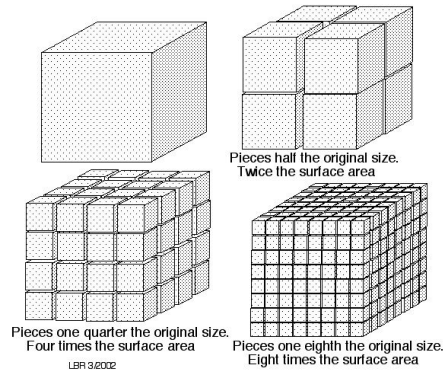
## Weathering

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

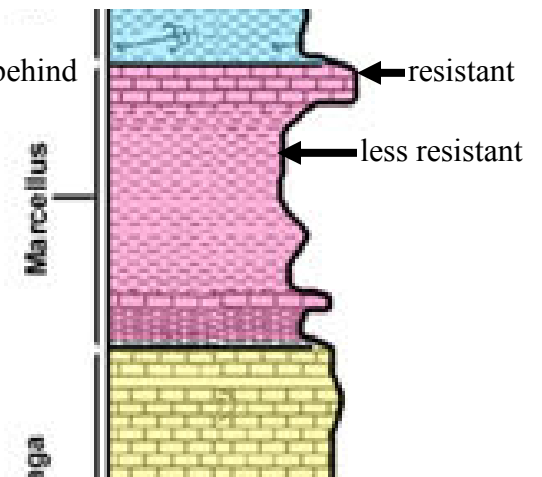
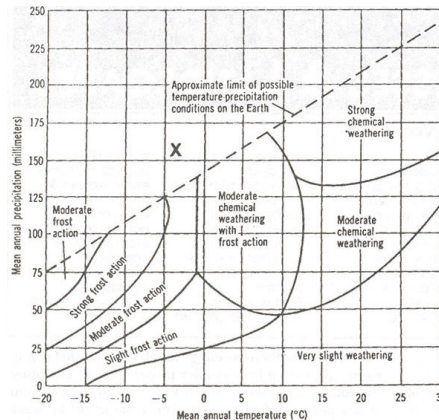


2. **Minerals in Rock** - as hardness of minerals increases, weathering rate decreases

- softer, less resistant minerals/rocks wear away leaving harder, more resistant minerals/rocks behind

3. **Climate** - the major factor that effects weathering

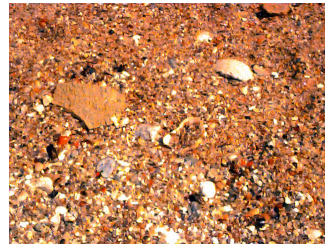
- as humidity increases, weathering increases
- as temperature increases, chemical weathering increases
  - warm, moist climates (mT)
- as temperature decreases, physical weathering increases
  - cold, moist climates (mP)



# Weathering

Products of Weathering:

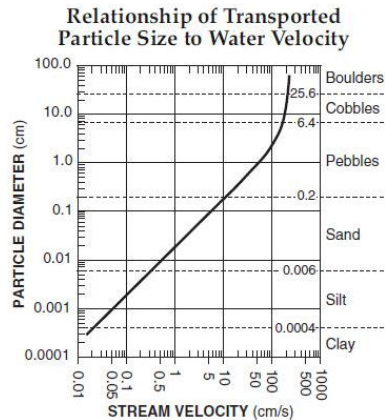
1. Solid Sediments
2. Dissolved Minerals
3. Soils



## 1. Solid Sediments (from largest to smallest):

- Boulders
- Cobbles
- Pebbles
- Sand
- Silt
- Clay
- Colloids

Reference Tables p.6



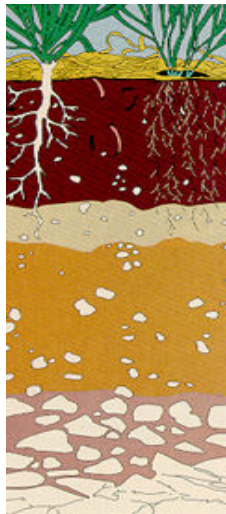
- colloids are the smallest particles and always remain suspended in water - never settle out

This generalized graph shows the water velocity needed to maintain, but not start, movement. Variations occur due to differences in particle density and shape.

## 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)



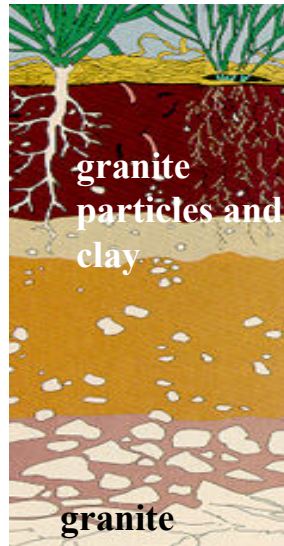
**Topsoil** - contains humus

**Subsoil** - contains leached minerals

**C-Horizon** - partially weathered bedrock

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

## Sediments

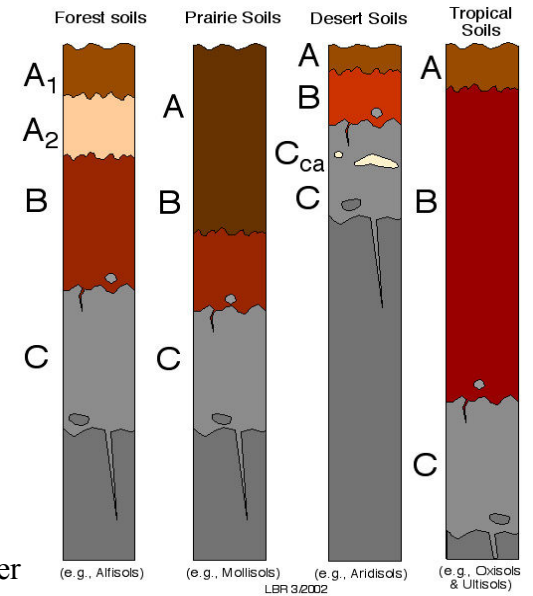


### Types of Soils:

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

### Some (slightly) more realistic soil profiles



## 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

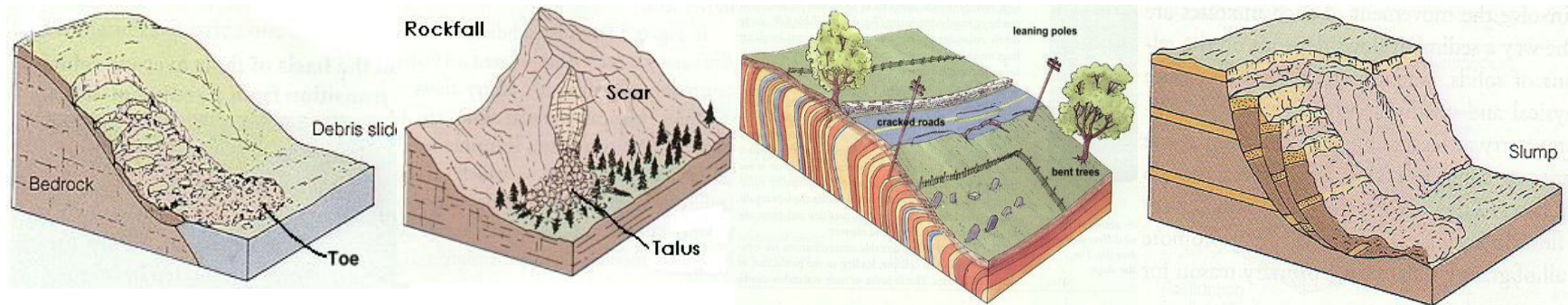
# Gravity Erosion

**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)

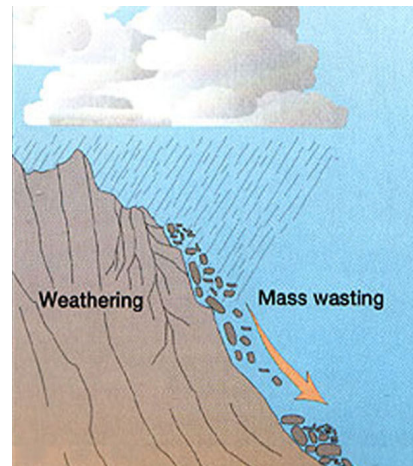
Types of Mass Wasting:

- 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)



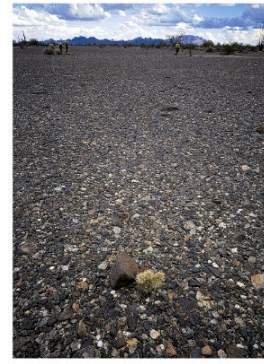
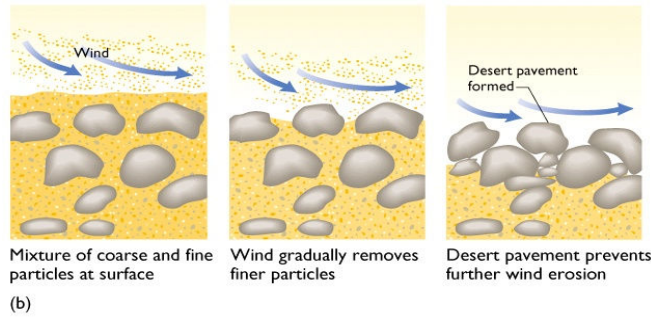
# Wind Erosion

**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"

Arches



Hoodoos

# Water Erosion

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

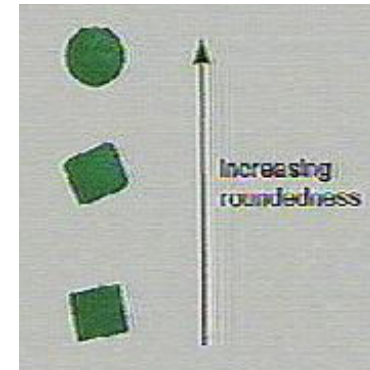
- the amount (volume) of water in a stream is called the stream's **discharge**

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:

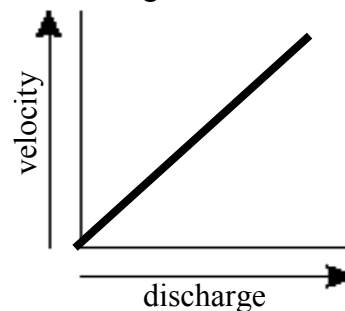
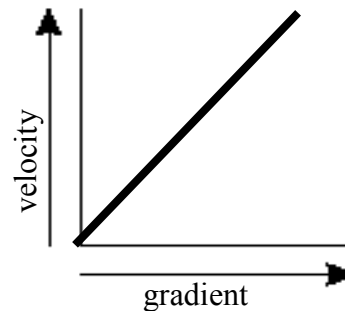
1. **Suspension** - carried within the water column
2. **Bouncing/Rolling** - larger particles along the stream bottom
3. **In-solution** - minerals dissolved in the water
  - as sediments move in the water, they hit rocks, the stream channel, and other sediments - this causes the sediments to become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

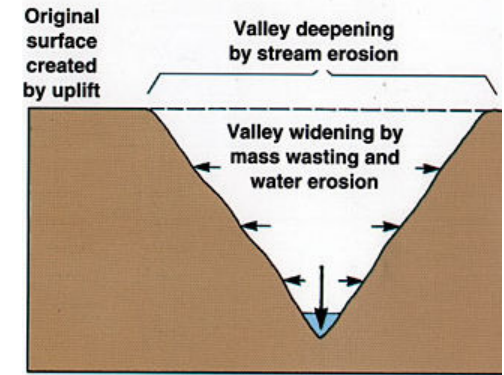




# Water Erosion

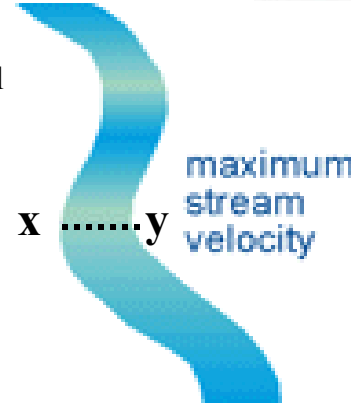
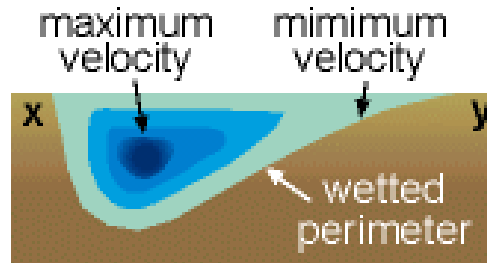
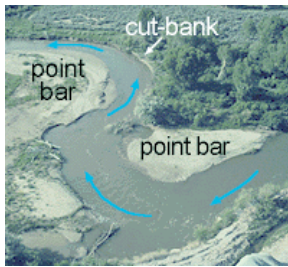
Abrasion will cause streams over time to carve deep channels (downcutting)

- characteristic **V-shaped valleys**



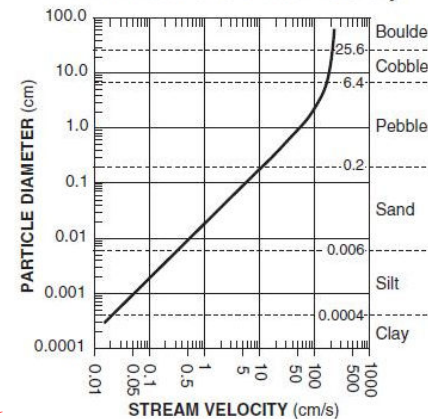
**Meander** - bends in a stream's channel

- 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

Relationship of Transported Particle Size to Water Velocity



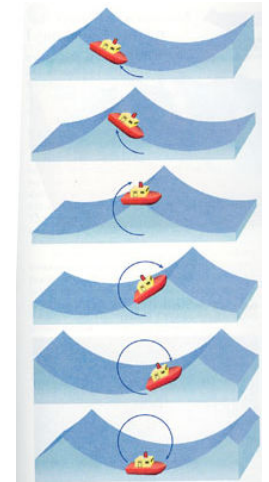
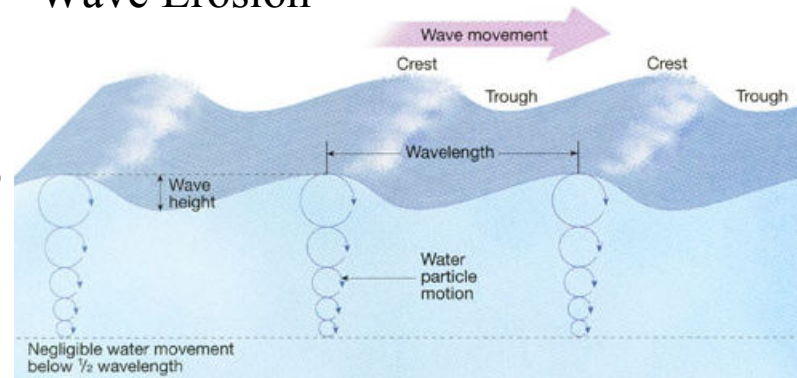
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Reference Tables p.6

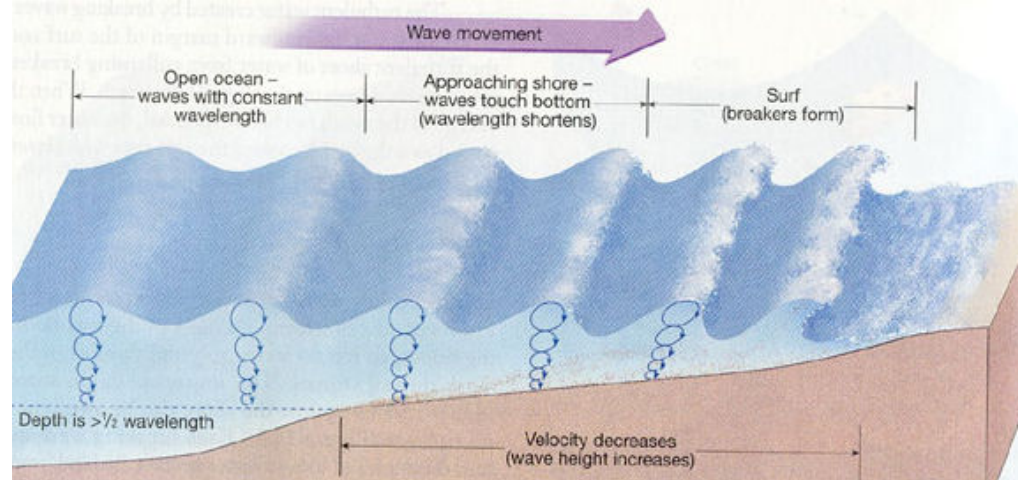
# Wave Erosion

**Waves** - caused by the wind

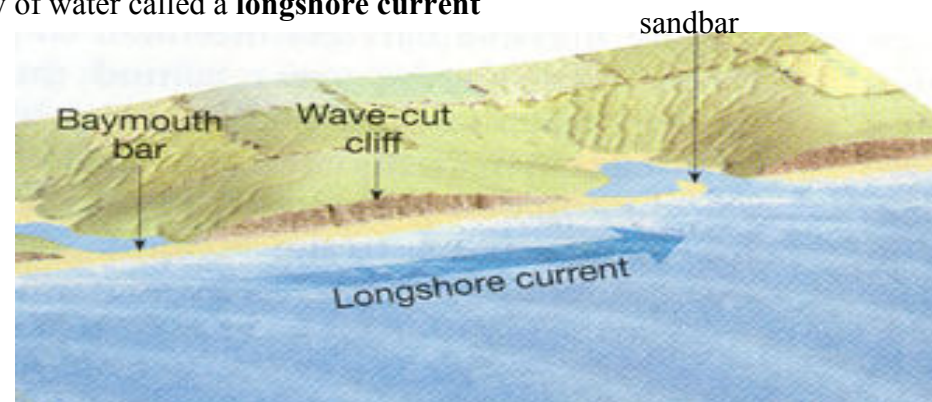
- size of waves depends on how long wind blows in 1 direction
- water particles rise and fall in circular paths over deep ocean water



- 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

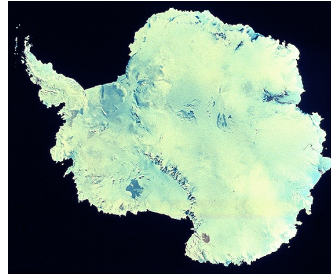


# Glacial Erosion

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

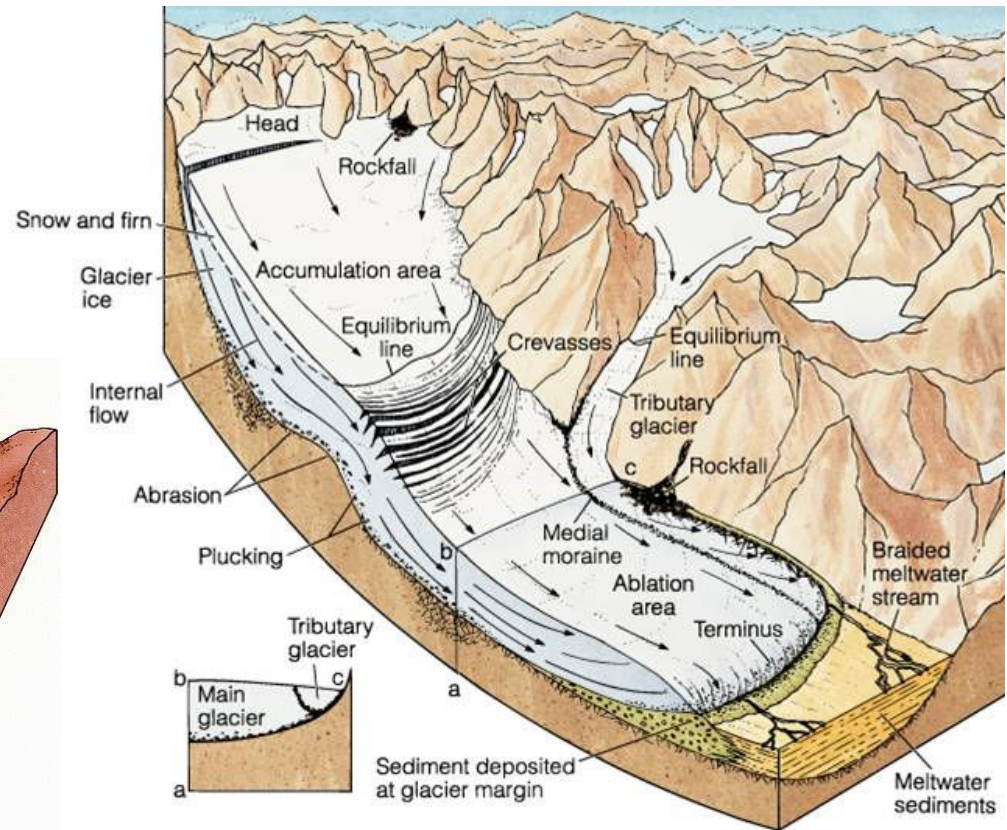
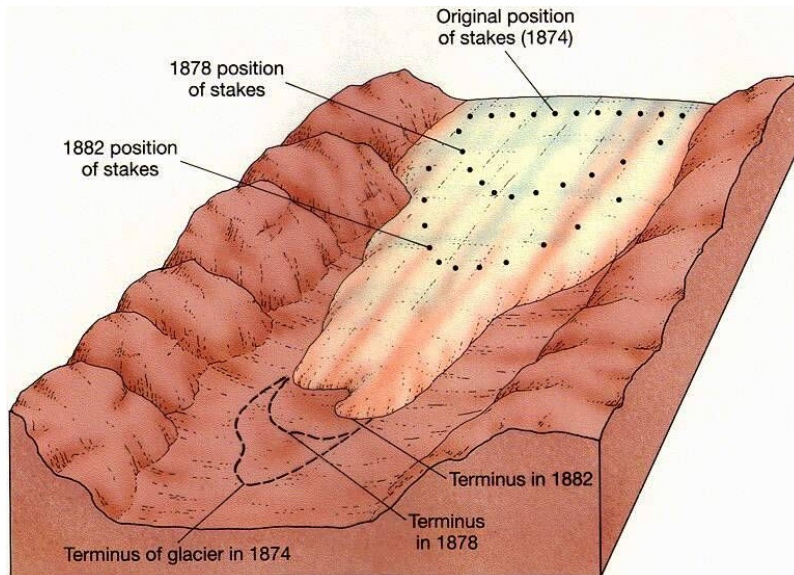
- Types of Glaciers:

- Alpine** (Mountain, Valley) - form in mountain valleys at high elevation
  - Alps, Himalayas, Rockies
- 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



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# Glacial Erosion

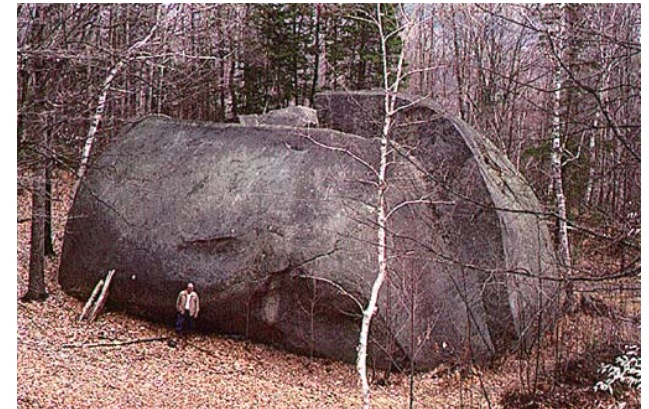
Glaciers pluck rocks/sediments from the surface

- 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

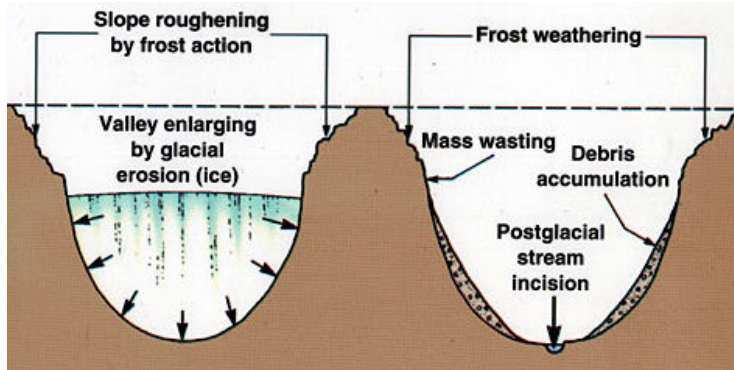


Glaciers transport rocks plucked from the bedrock at one location hundreds of miles to a new location

- the deposited rocks differ from the bedrock in their new location - called **erratics**
  
- 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

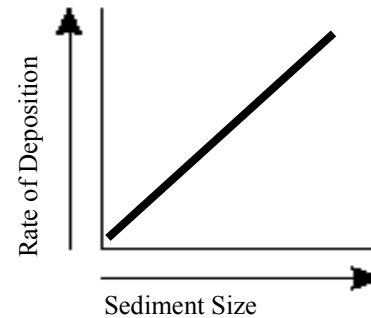
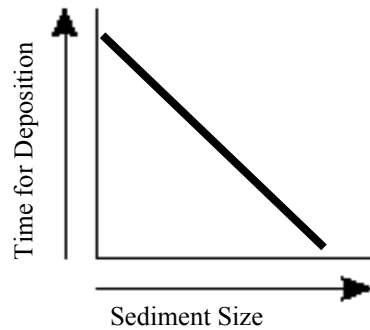
- occurs when the velocity of water, wind, or other erosional system decreases

Factors that Affect Deposition:

1. Size of Sediment
2. Density of Sediment
3. Shape of Sediment

## 1. Size of Sediment

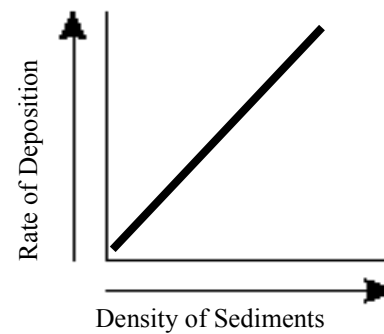
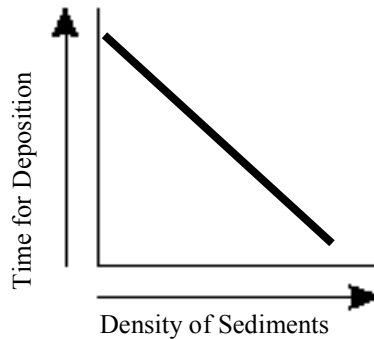
- As the size of sediment increases, the rate (speed) of deposition increases



- big particles settle faster than small particles

## 2. Density of Sediment

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

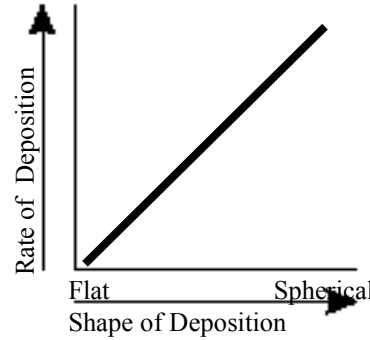
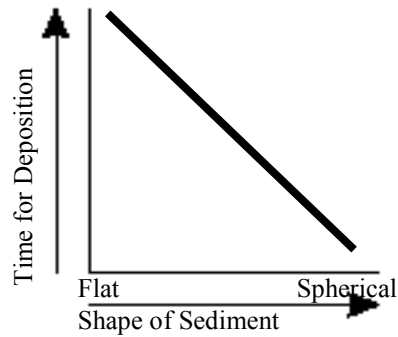


- high density particles settle faster than low density particles

# 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

**Sorted Sediments**



**Unsorted Sediments**

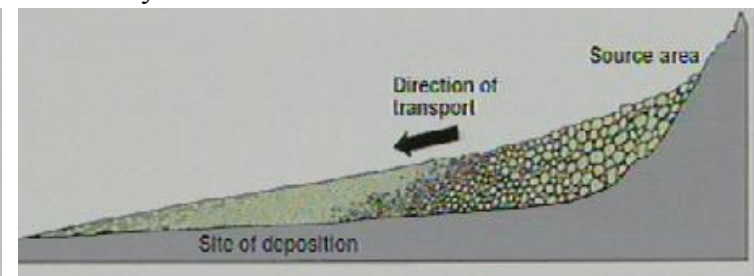
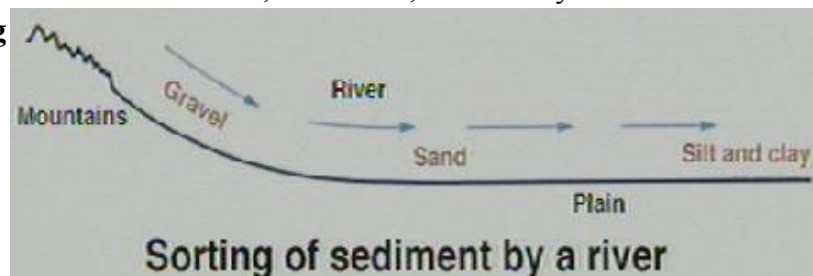


**Unsorted Sediments** - sediments that are mixed in size, shape and density

## Water Deposition

As the velocity of a stream decreases, the heaviest, densest, and roundest particles settle out first

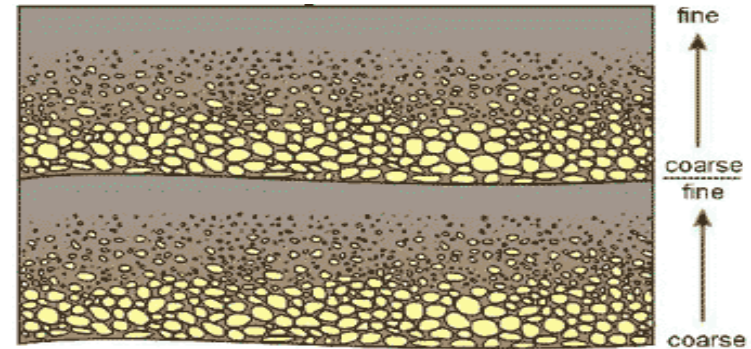
- occurs when streams flow into the ocean or large lake
- results in layers which the sediment size, roundness, and density decreases in the direction away from land
- Horizontal Sorting**



## Water Deposition

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

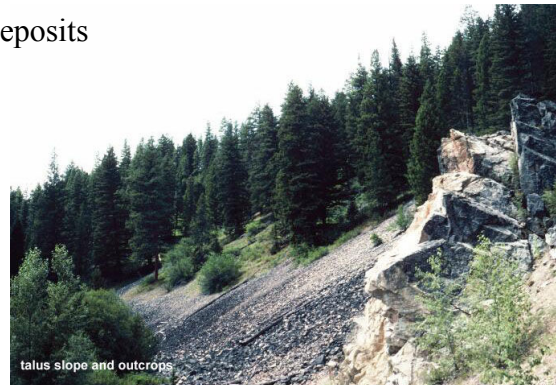
- heaviest, densest, roundest particles settle first and end up at the bottom; lightest, least dense, and flattest particles on top



## Gravity Deposition

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

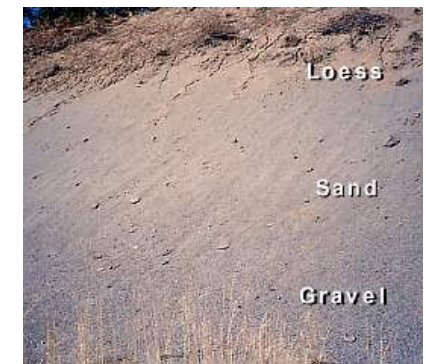
- deposits have a random mixture of sizes shapes and densities as the sediments deposit quickly



## Wind Deposition

Winds deposit sediments as:

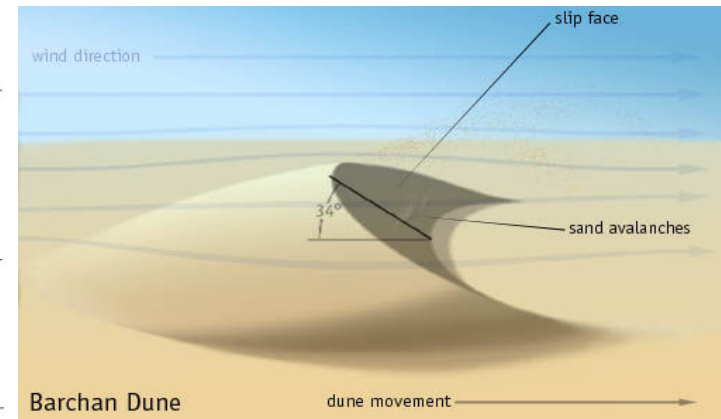
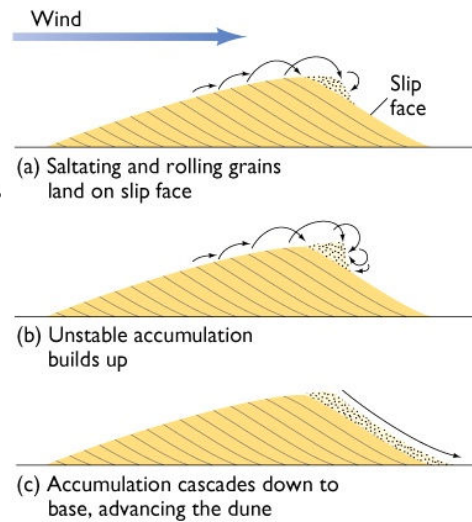
1. Sand Dunes
2. Loess



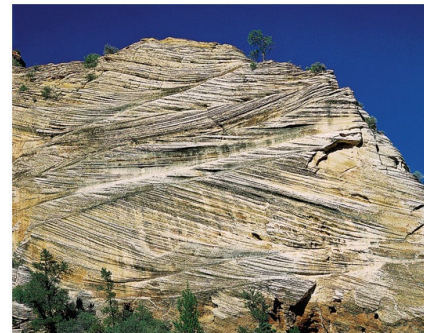
## Wind Deposition

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

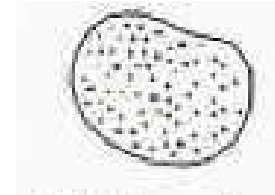
- occur in arid/dry climates and along coastlines
- sand dunes show the direction of wind movement



**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**



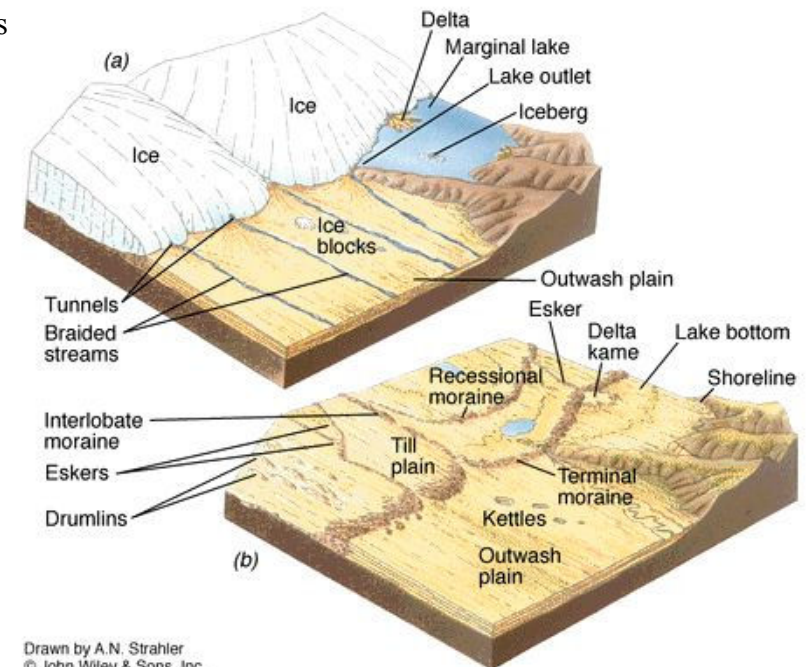
## Glacial Deposition

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



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