Topic 6: Weathering, Erosion and Erosional-Deposition Systems (workbook p. 95-125)

Workbook Chapter 4, 5

THE BIG PICTURE:

Weathering, erosion and deposition are processes that cause changes to rock material on the Earth's surface, and help create the various landscapes that exist.

Weather conditions (temperature changes, precipitation, etc.) break down rock into smaller pieces called sediment.
Moving water, wind, and other erosional forces carry sediment away. Eventually this sediment is deposited.

WEATHERING

Weathering is the breakdown of rock material on the Earth's surface into smaller fragments. Weathering occurs when rocks are exposed to the atmosphere, hydrosphere and other natural agents (plants, animals).

There are two types of weathering: **physical and chemical**

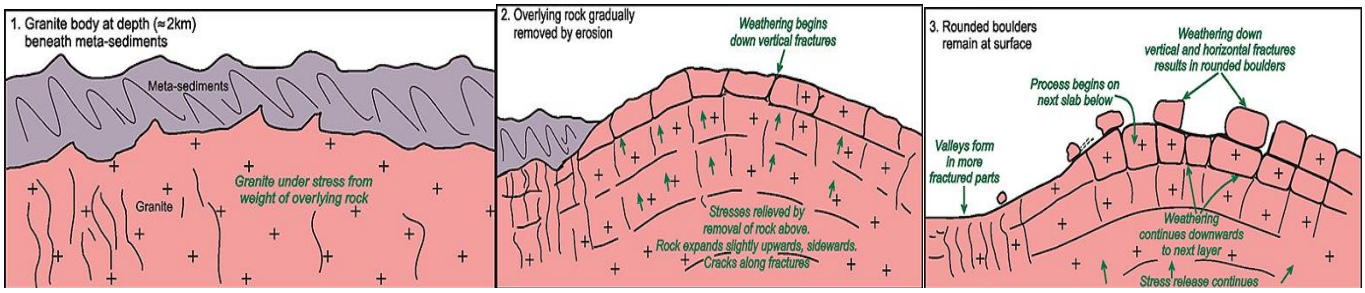
Physical weathering includes the processes of frost action, plant root growth, pressure unloading and abrasion.

Frost action or frost wedging:
--water seeps into small cracks or pores in rock surfaces
--water freezes and expands, increasing the cracks in the rock material; when water thaws, crack is now larger
--the process repeats; over time, rock material breaks apart

Plant root growth:
--plant takes root in tiny cracks in rock material ; as plant grows, its larger roots expand cracks and break the rock apart

Pressure Unloading:

- Buried rock cracks under pressure at weak points
- Natural processes (landslides, earthquakes, melting glaciers) or human intervention (mining) exposes this rock
- No longer under pressure, the cracks in once-buried rock break apart



Abrasion:

- Occurs when rock grinds against other rock surfaces
- Rocks moved by glaciers, running water or wind scrape against other rock and break it apart
- Round, smooth rocks found on river beds or beaches were formed by abrasion

<u>Chemical Weathering</u> occurs when rocks are made of minerals that react with water, carbon dioxide and oxygen in the environment. The reactions weaken rock and help to break it apart.

3 types of chemical weathering**: oxidation, hydration, carbonation**

Oxidation: rock minerals combine with oxygen in the atmosphere (ex.: iron + oxygen = iron oxide (rust))

Hydration: water reacts with or dissolve rock minerals (ex.: water dissolves calcium in feldspar→ clay)

Carbonation: carbon dioxide in the atmosphere dissolves in water and falls as acid rain (carbonic acid). Carbonic acid reacts with certain rock minerals (ex.: carbonic acid dissolves marble and limestone)

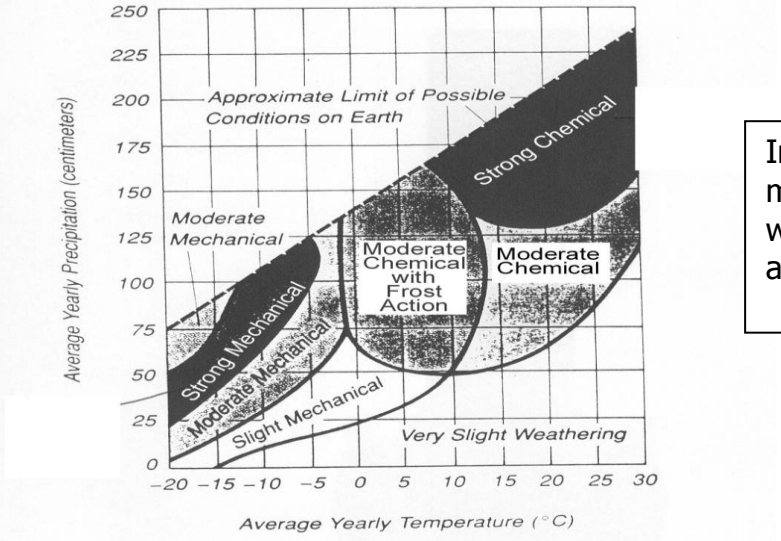
Granite: less chemical weathering

Marble: more chemical weathering

FACTORS THAT AFFECT WEATHERING

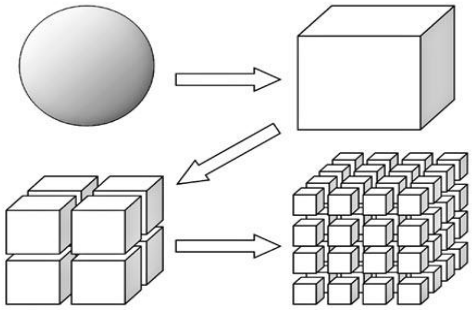
Climate:

--Chemical weathering increases in warm humid climates
--Frost action requires temperature ranges to go above and below freezing
--Increased CO_2 in the atmosphere increases carbonation



In New York State, moderate chemical weathering and frost action occur.

Particle size:
the smaller the rock, the faster the weathering (more surface area per volume)

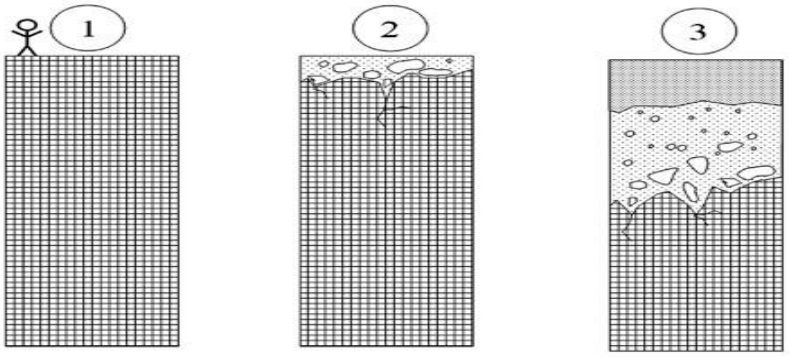


Mineral composition:
Some minerals found in rocks are more resistant to weathering than others
Example: calcite reacts with carbonic acid; quartz is resistant to chemical weathering

Soil is the result of physical and chemical weathering

Soil is composed of weathered rock and organic matter.
The organic part is called **humus**. Humus is composed of decaying plant and animal matter.
Soil development is a process. It develops in a series of layers called a **soil profile**. Each layer is called a soil **horizon.**

Soil profile development:

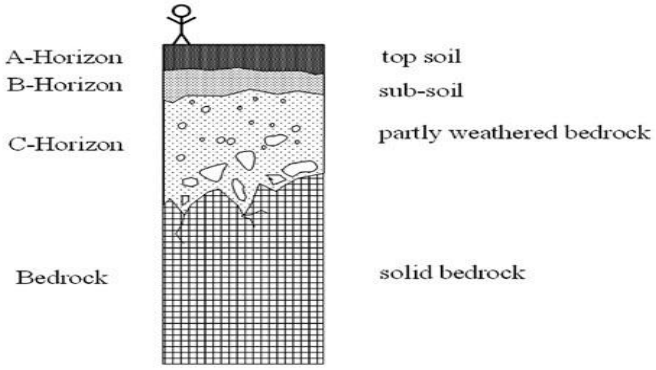


1. Unweathered rock (bedrock)

2. Immature soil: partially weathered rock on top of bedrock

3. Immature soil with 3 horizons: topsoil, partially-weathered rock, bedrock

Mature Soil has 4 horizons: 1) humus-enriched top soil 2) sub-soil with little organic matter 3) partially weathered rock
4) unweathered bedrock



Residual soil: formed from the weathering of bedrock found beneath it (forms in place)
Transported soil: formed elsewhere and moved by wind, water, or glaciers to present location

Soils covering most of New York State were made from material transported and deposited here by glaciers during the last ice age.

EROSION

Erosion is the process that removes sediment from one place to another.

Agents of Erosion
--Gravity: pulls down rock particles loosened by weathering
--Running Water (rivers, streams): moves more material than any other agent of erosion
--**Glaciers:** carry sharp, broken rock fragments that scrape surfaces
--**Wind:** occurs mostly in desert regions
--**Waves:** hit shorelines and transport sand

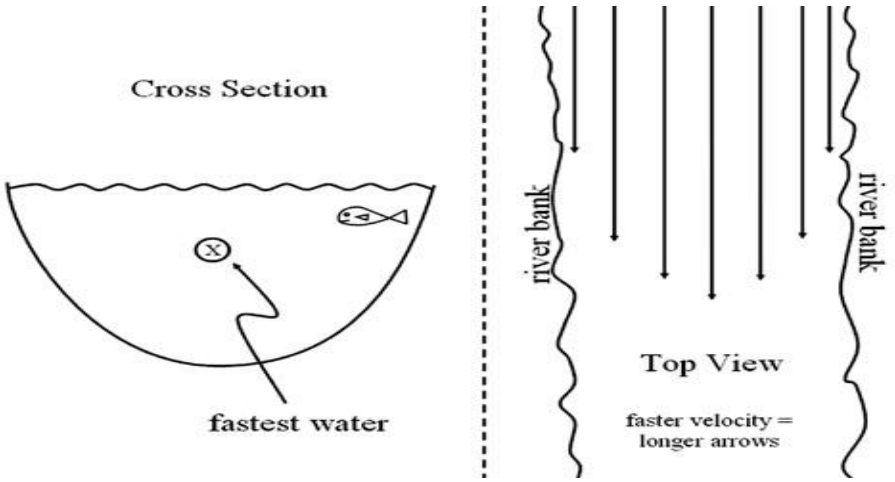
STREAM EROSION

Streams carry loose rock fragments and can pry off rock material weakened by weathering. The size and quantity of rock material a stream can carry depends upon its volume (how much water is in the stream), its slope (high gradient or low gradient) and its speed (velocity).

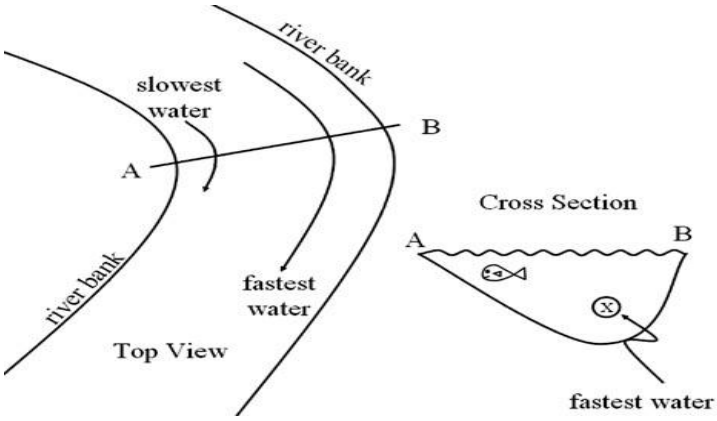
Discharge is the term used for the volume of water a stream carries. **Stream velocity** depends upon discharge and slope:

as slope and discharge increase, stream velocity increases.

A stream flows fastest where there are less frictional forces: below the stream's surface and near its center:



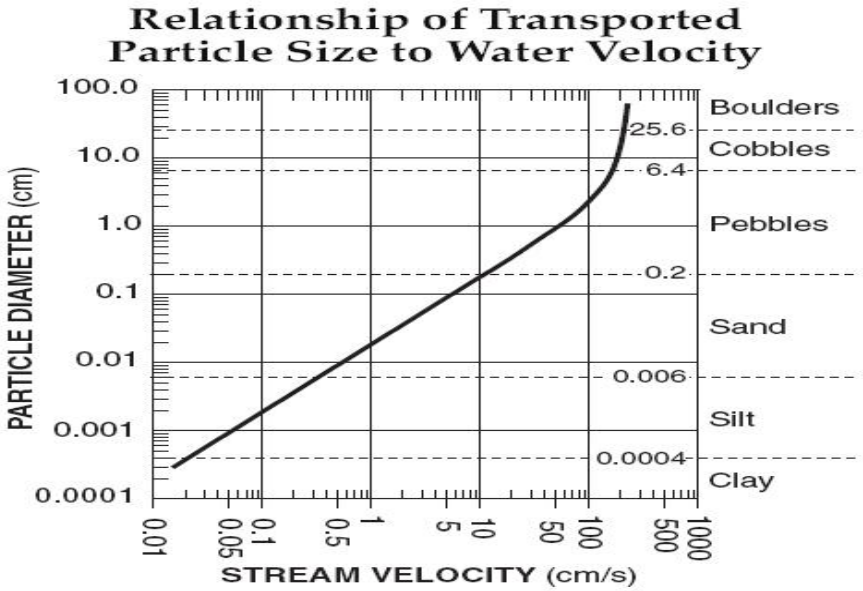
Water flows faster on the outside of a bend or curve in a river, slower on the inside:



HOW STREAMS CARRY SEDIMENT

The greater the stream's velocity, the larger the rock particle it can carry.
The greater the discharge, the more sediment a stream can carry.

Graph in ESRT on page 6

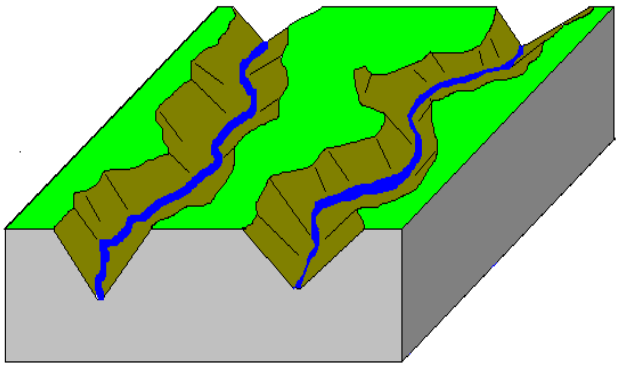


This generalized graph shows the water velocity needed to maintain, but not start, movement. Variations occur due to differences in particle density and shape.

Streams are classified as "youthful," "mature" or "old" based upon their characteristics, <u>not</u> their age. Any one stream can show all of these classifications along the entire distance it runs.

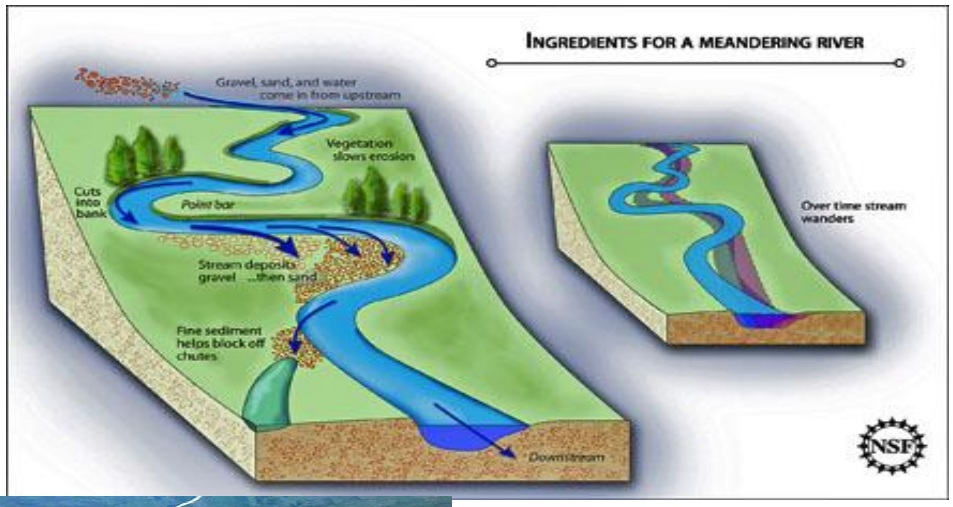
"Youthful" streams:

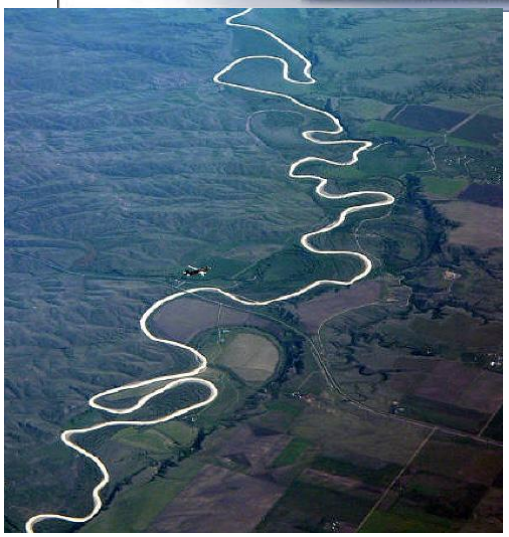
- carry fast-moving water down steep slopes
- have rapids and waterfalls
- carry larger sediment
- **carve out V-shaped valleys** through mountains



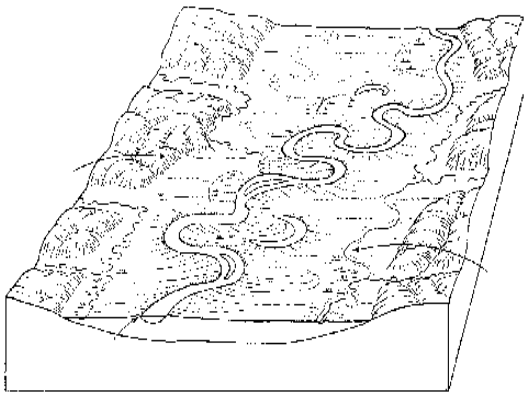
"Mature" streams:

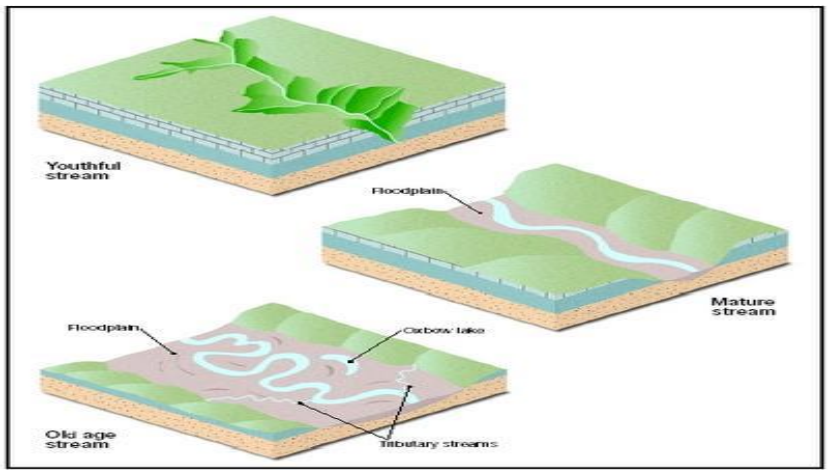
- have less steep gradients
- carry large volumes of sediment, but have less energy
- **as stream velocity decreases, the stream bed widens**
- mature streams move around obstacles in their path, to form large loops called **meanders**





"Old" streams have little gradient, carry only fine sediment. In times of heavy discharge, they overflow their banks, creating a flood plain. Oxbow lakes form.





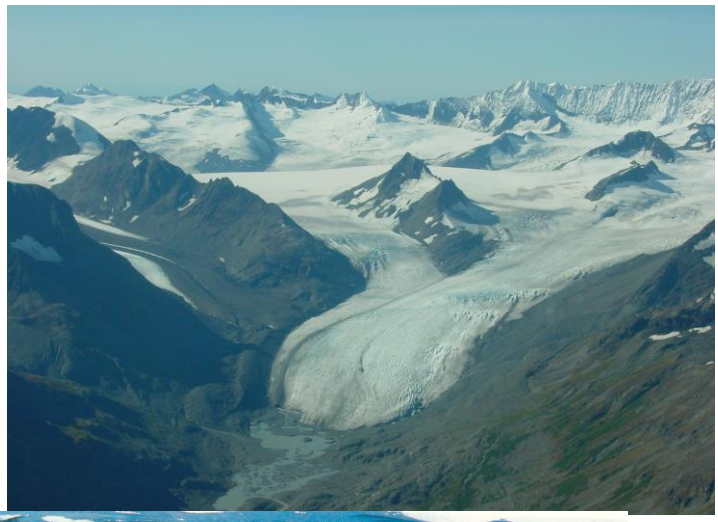
A **drainage basin** is formed when:

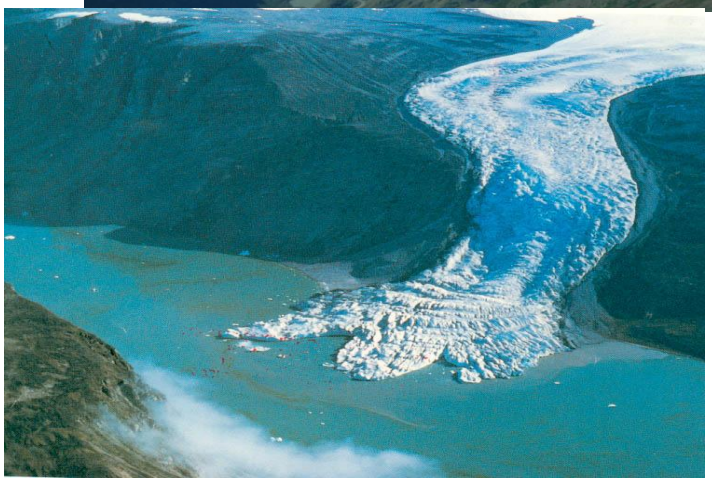
- ❖ precipitation falls on mountains and runs down slopes in small streams
- ❖ streams combine to former larger streams and tributaries
- ❖ tributaries empty into large rivers which drain into larger bodies of water (gulfs, oceans)
- ❖ the drainage basin is the entire land area from which these rivers flow

EROSION BY GLACIERS

How glaciers form:

- snow accumulates in high mountain elevations over many years
- snow piles up and its depth increases
- piled snow exerts pressure, compacts bottom layers, changing snow to ice
- gravity pulls the glacier very slowly down the steep slope





- When the leading edge of a glacier hits warmer temperatures, it melts, forming erosional streams.
- Glaciers scrape bedrock surfaces as they move, carrying various sizes of broken rock fragments that gouge bedrock and leave parallel scrape marks on rock surfaces that show the direction of glacier movement.
- **Glaciers carve out U-shaped valleys, different from V-shaped valleys formed by rivers.**

WIND EROSION

Wind erosion occurs chiefly in desert regions:

- Sand grains carried by the wind hit rock surfaces
- Surfaces become rounded and smoothed—"polished"
- Base of rocks erode faster than rock at higher elevations because sand carried by wind stays closer to the ground
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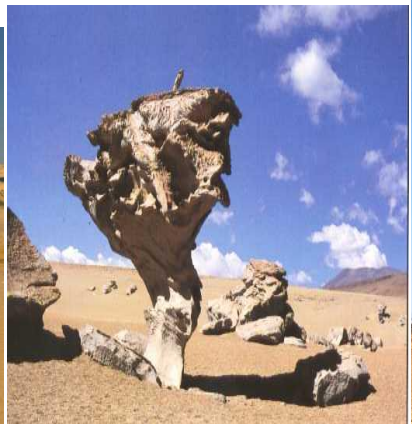
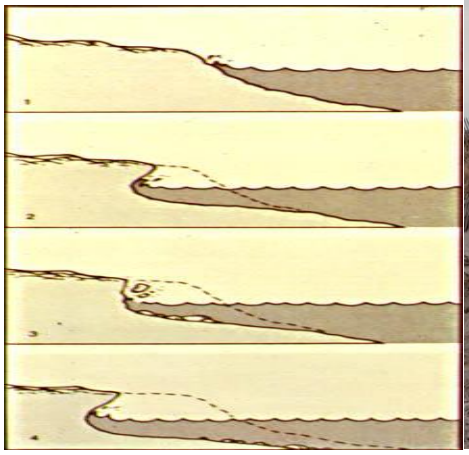



Wave Erosion

Waves hit shorelines, eroding rock surfaces. Waves transport sand, shifting the edges of shorelines.



Deposition

Deposition occurs when transported sediment is dropped off in a new location. The process is also called **sedimentation**.
For example, as a stream enters a lake or ocean, its velocity decreases and the sediment it carries settles out and is deposited.

Factors that affect deposition:

1. SIZE: for particles with the same shape and density: **as particle size increases, settling time decreases**

(larger particles have less surface area relative to their weight, so they fall out faster).

2. SHAPE: in particles with the same maximum diameter--**as particles become flatter, settling time increases**

(more frictional surface relative to weight). A flat piece of paper falls more slowly than one that's crumpled up.

3. DENSITY: if particles are the same shape and size--**as density increases, settling time decreases**

(particle is heavier)

SORTED BEDDING

When unsorted particles (particles of all different shapes and sizes) fall downward through water:

- larger, rounded, more dense particles will fall faster and become the bottom layers of the bedding
- smaller, flatter, least dense particles will fall slower and become the top layers of the bedding
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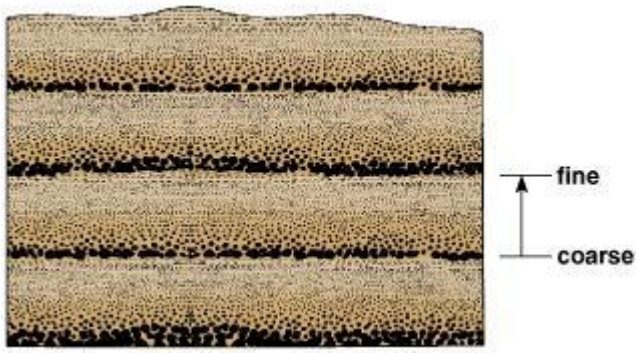
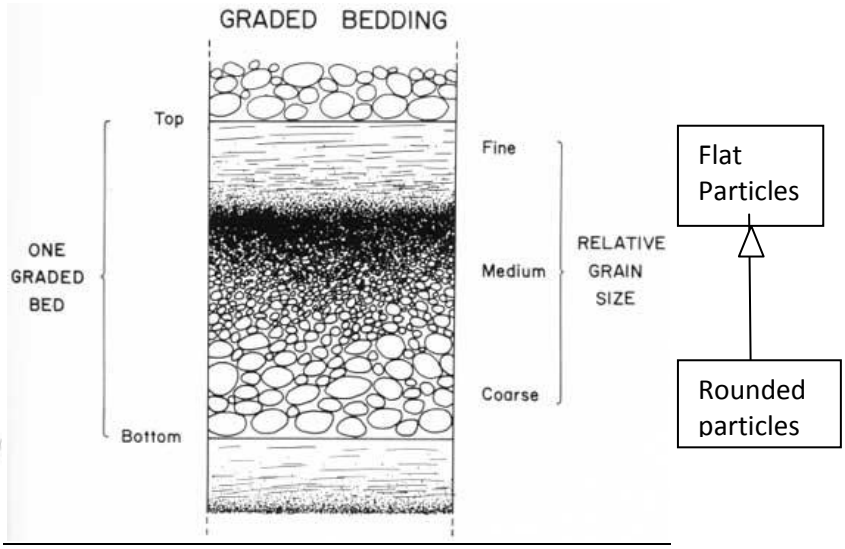
Graded bedding:
The deeper the water through which particles fall, the greater the amount of sorting that occurs

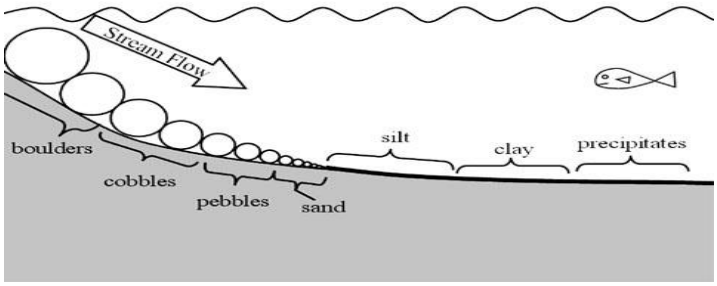
VERTICAL GRADED BEDDING





HORIZONAL GRADED BEDDING

- found along sea floors near continental shelves
- stream velocity decreases as it enters ocean
- larger particles fall out first; finer particles carried farther from the shoreline:

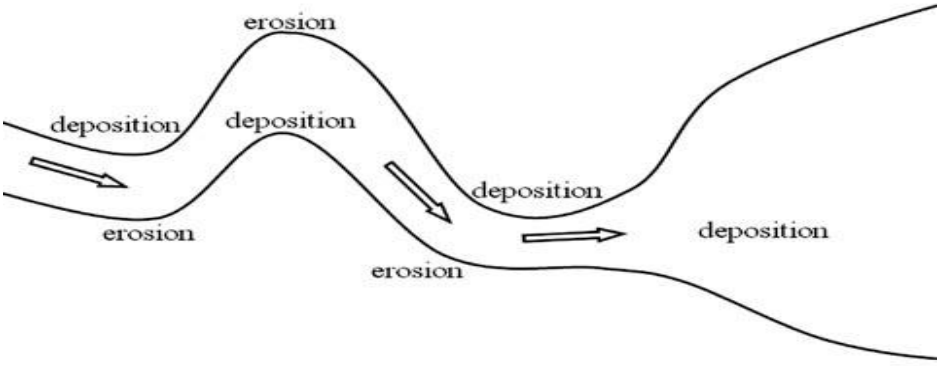


Water becomes saturated with ions from d
sediment. These ions fall out of solution a
crystallize as "precipitates." (Think rock ca

STREAM SYSTEMS

Every stream is part of an erosional-depositional system.
As stream velocity increases, erosion increases and deposition decreases. "Youthful" streams erode more, deposit less.
As stream velocity decreases, erosion decreases and deposition increases. "Mature" and "Old" streams deposit more, erode less.

Stream erosion occurs on the outside curves of a stream where velocity is greatest.
Stream deposition occurs on the inside curve where velocity is lowest.



GLACIERS

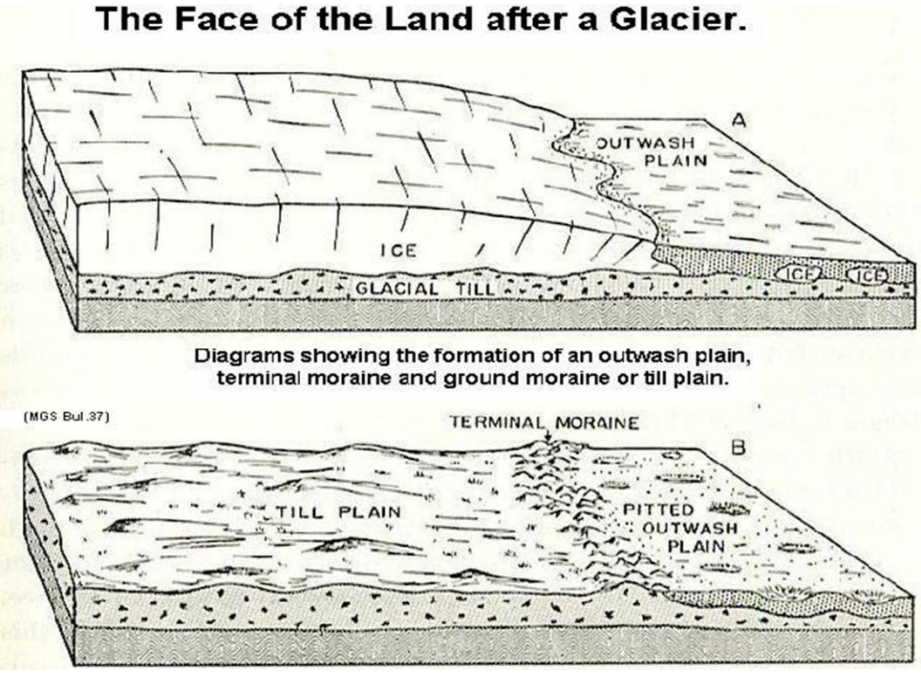
Glaciers carry sediment of all sizes, shapes and densities. When they melt, the material left behind is unsorted sediment called **till.** The pile of unsorted till is called a **moraine.**
The north shore of Long Island was chiefly made from glacial till.

Glacial erratics are large boulders composed of rock material that is different from rock found in the area where it was deposited. As glaciers melt, huge, massive chunks of ice break off and hit the ground, where they melt to form kettle lakes (Lake Success is a kettle lake).

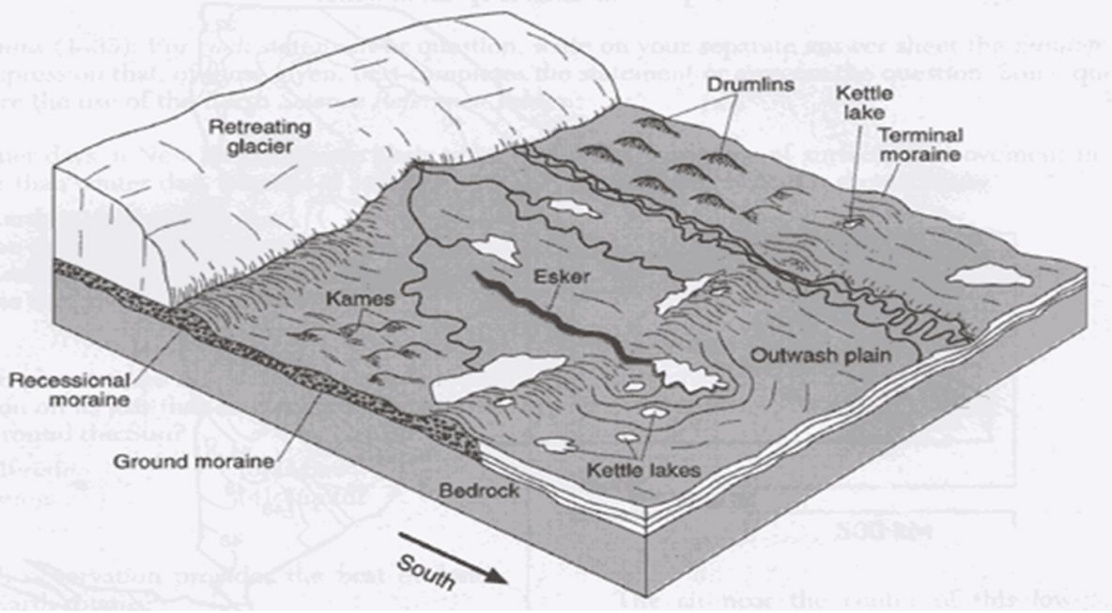
glacial erratic

kettle lake

Glacial melt water forms streams that move through the moraine, transporting sediment of various sizes. The velocities of these streams slow as the spread out over the land.
The material they carry is deposited and sorted horizontally: cobbles →pebbles→sand→silt-→clay
This sorted deposition is called **glacial outwash.**



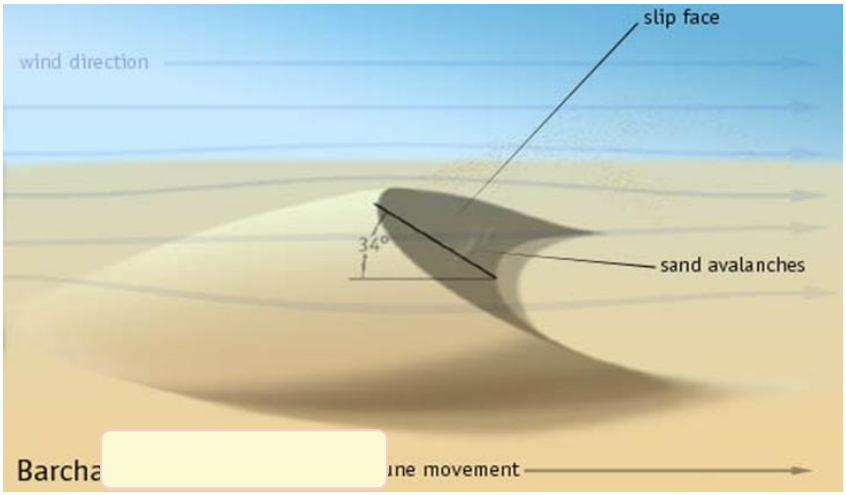
The diagram below shows the various types of depositional land forms left by a retreating glacier.

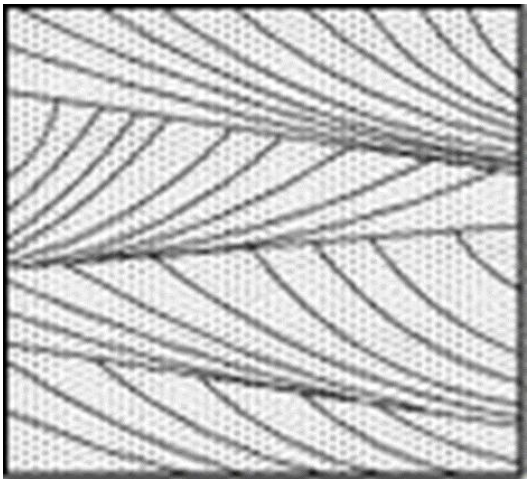


WIND DEPOSITION

Wind deposition shows vertically sorted grading, with larger particles at the bottom and finer particles in layers above. Wind deposition graded beds are tilted or cross-bedded due to changes in wind direction.

Wind direction----------→

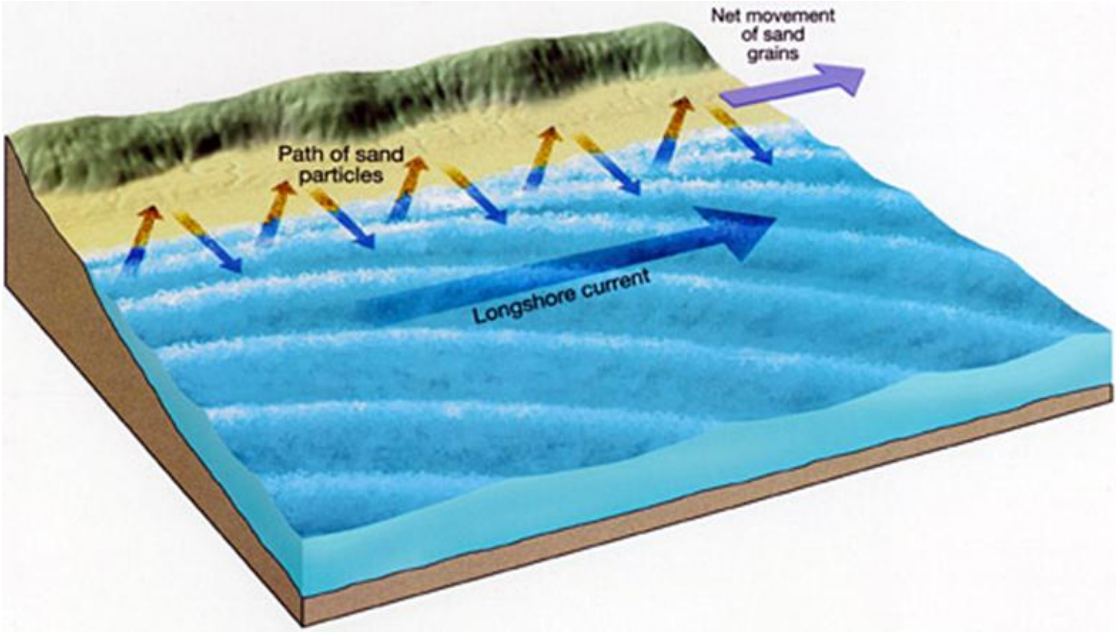




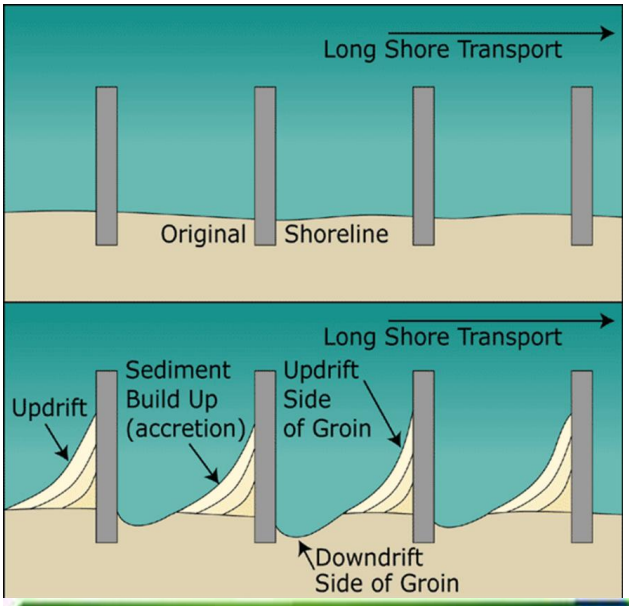
Windward side: gentle slope; leeward side steeper slope **cross-bedded layers**

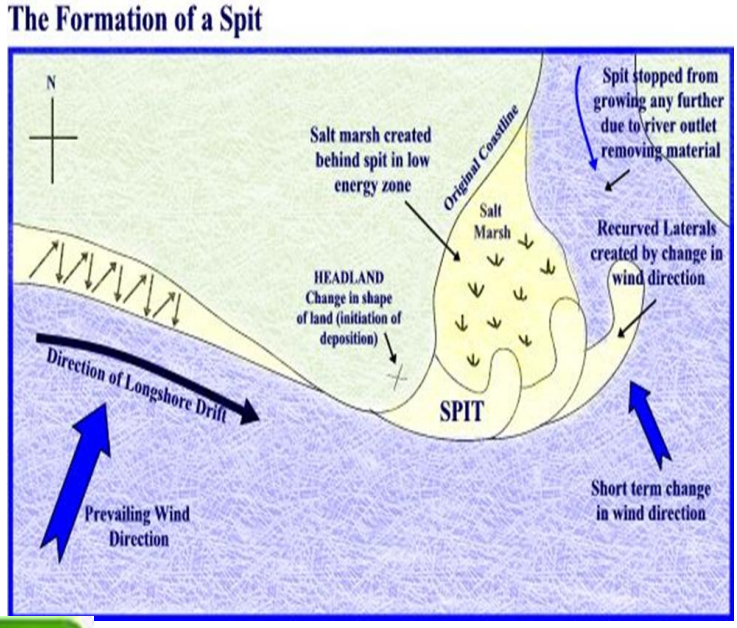
WAVE DEPOSITION

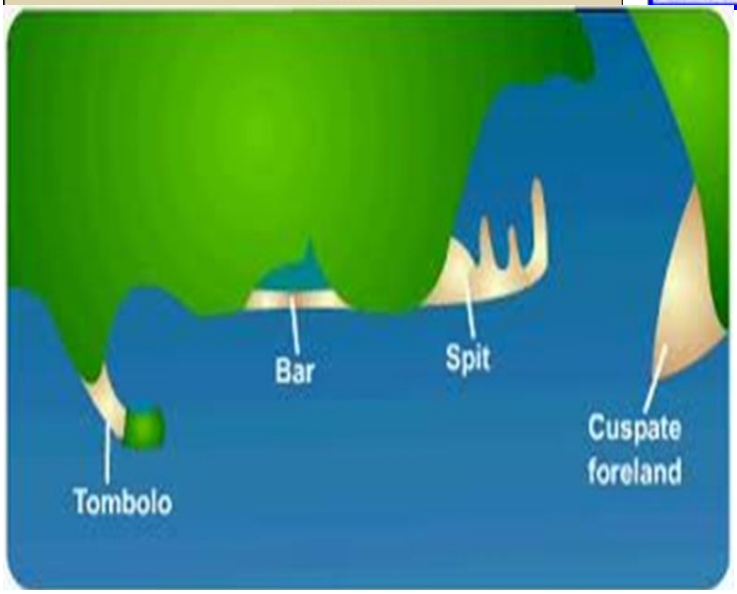
Waves are the dominant force of erosion in coastal areas. **Longshore currents** are formed when waves hit the shoreline at an angle, creating a current of sand sediment that move parallel to the shore:



This movement of sediment is called **longshore drift**, and creates the land forms shown:


Long Shore Transport
Original Shoreline
Long Shore Transport
Updrift
Sediment Build Up (accretion)
Updrift Side of Groin
Downdrift Side of Groin


The Formation of a Spit
N
Salt marsh created behind spit in low energy zone
Original Coastline
Spit stopped from growing any further due to river outlet removing material
Salt Marsh
Recurved Laterals created by change in wind direction
HEADLAND Change in shape of land (initiation of deposition)
Direction of Longshore Drift
SPIT
Prevailing Wind Direction
Short term change in wind direction


Bar
Spit
Cuspate foreland
Tombolo