Weathering, Erosion and Deposition

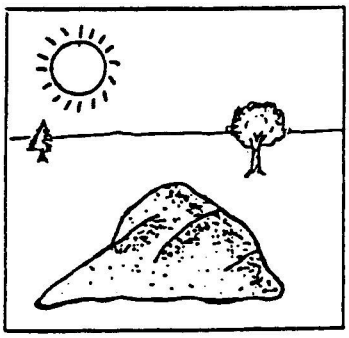
I. Weathering is = the physical and chemical breakdown of rock into smaller particles called sediment.

II. Types of Weathering

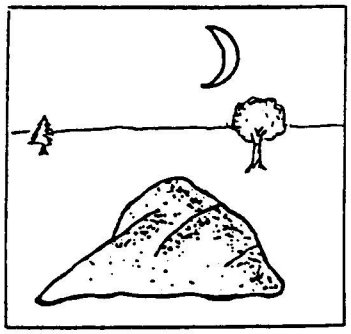
A. Physical weathering = any process that causes a rock to crack or break into pieces without changing it chemically.

1. Temperature Change

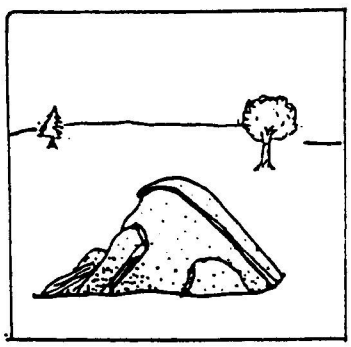
Rocks are heated by the sun. As the outside of the rock heats up, it begins to expand.



When temperatures fall, the outside of the rock cools and contracts.

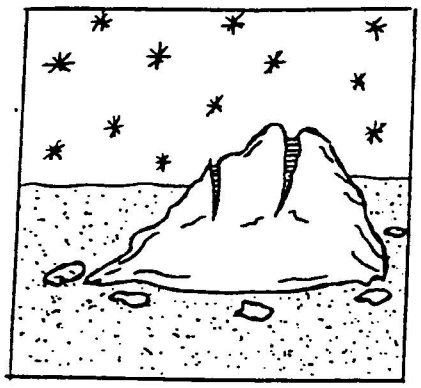


This cycle of heating and cooling causes the surface of the rock to break off in slabs or layers. This process is called exfoliation.



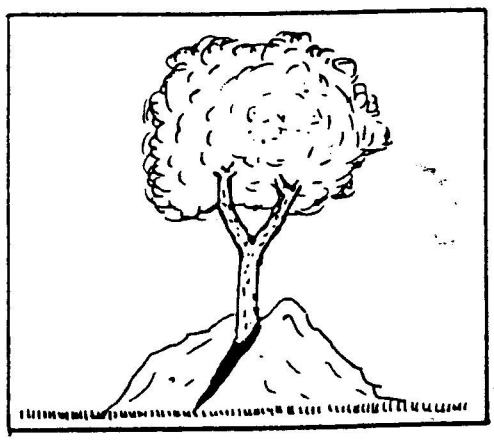
2. Frost Action - also called Frost wedging hydroFracturing

This occurs when water seeps into the cracks in a rock. When water freezes (ice) it expands. The cycle of freezing and melting causes rocks to break apart. This same process happens to our roads and produces what we call potholes in the road.



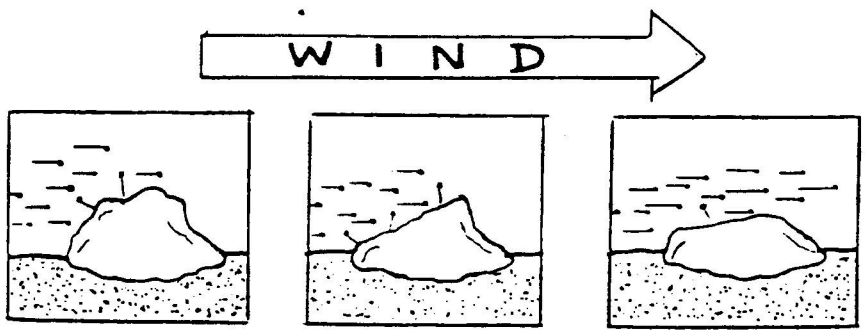
3. Organic Activity

Trees and shrubs can grow through cracks in rocks. Their roots wedge into crevices. Even moss and lichen wedge their hair-like roots between the grains that make-up the rock.



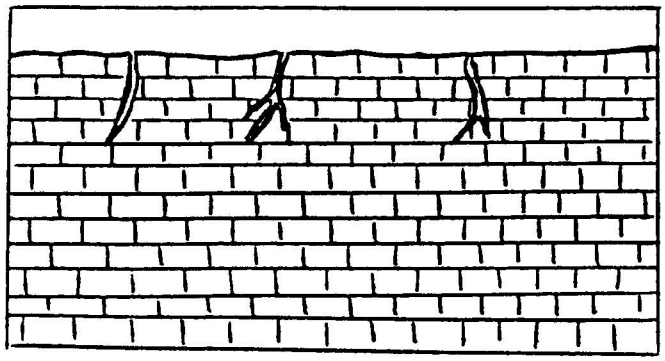
4. Abrasion

This process occurs when sediments carried by streams and wind blown sand causes particles to collide into each other and the surrounding rock.

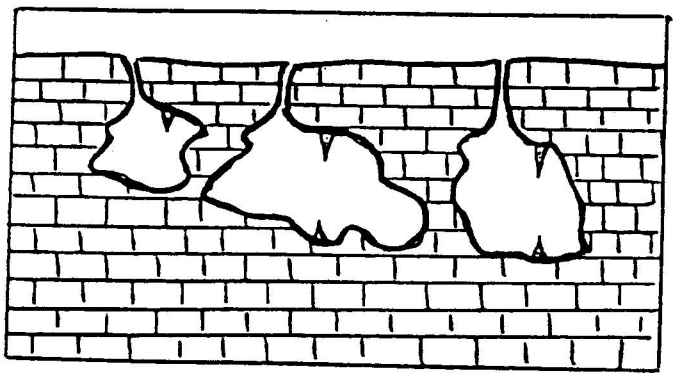


B. Chemical weathering = any process that causes rocks to breakdown by chemical action and results in a change in the mineral/chemical composition

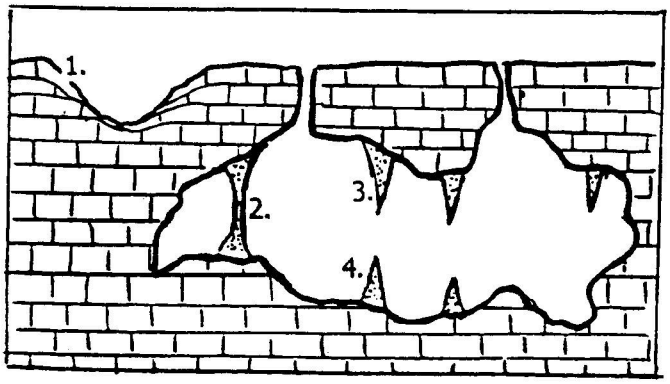
1. Carbonation - occurs when carbon dioxide in the atmosphere dissolves in the droplets of water that make up clouds. This forms a weak carbonic acid. Carbonic acid reacts with certain rocks and minerals that include: calcite, limestone, marble, and chalk.



Limestone
bedrock



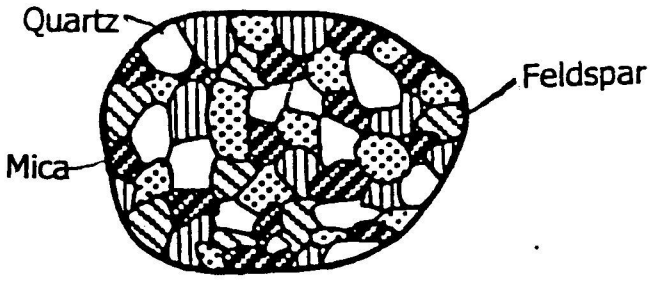
Carbonic acid rain water seeps into the limestone bedrock through cracks. This water dissolves the limestone rock.



A cavern forms. Other features may include:

1. Sinkholes
2. Columns
3. Stalactites
4. Stalagmites

2. Hydration - occurs when water dissolves certain minerals in a rock. For example, granite is very stable in cool dry climates, but in moist climates, rainfall dissolves much of the mineral feldspar. The feldspar becomes clay, which is too weak to keep the rock from breaking apart. The mineral quartz remains behind as sand.

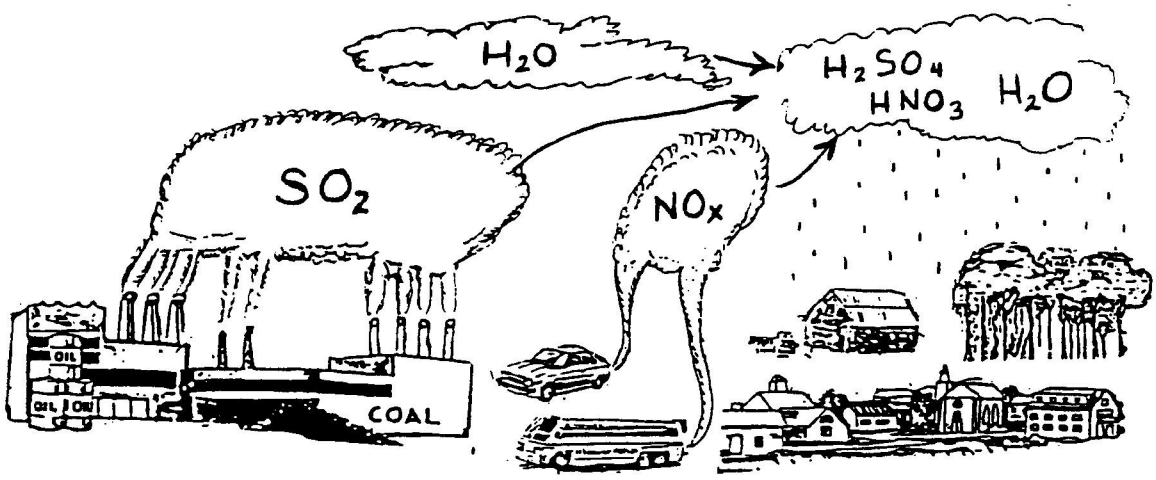


Granite

3. Oxidation - occurs when oxygen in the atmosphere combines with certain minerals in a rock. For example, when oxygen combines with iron minerals, iron oxide (rust) forms. The chemical change of the mineral weakens the rock and the rock crumbles.

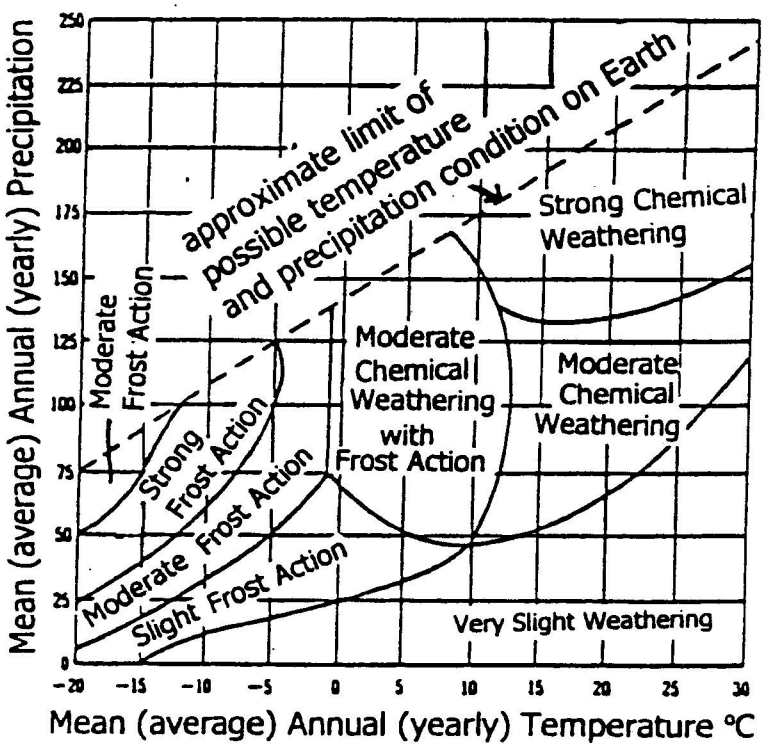
4. Plant Acids - Plants produce weak acids that can dissolve certain minerals in a rock, weakening the rock.

5. Man-made Acids - Gases produced by humans can dissolve in the water droplets of a cloud to produce acid rain.
These acids include: H_2SO_4 - sulfuric acid
HNO_3 - nitric acid

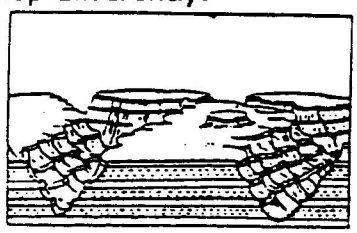


III. Rates of Weathering

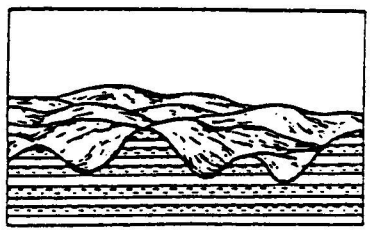
A. Climate is the major factor that affects the rate of weathering.



1. Temperature:
   a. In warm climates chemical action is the dominant type of weathering.
   b. In cold climates frost action is the dominant type of weathering.
2. Precipitation:
   a. As precipitation increases, the amount (or rate) of weathering by frost action will increases.
   b. As precipitation increases, the amount (or rate) of chemical weathering will increases.
3. Chemical weathering is most rapid in warm, moist climates.
4. Due to climate and different weathering processes, landscapes develop differently.



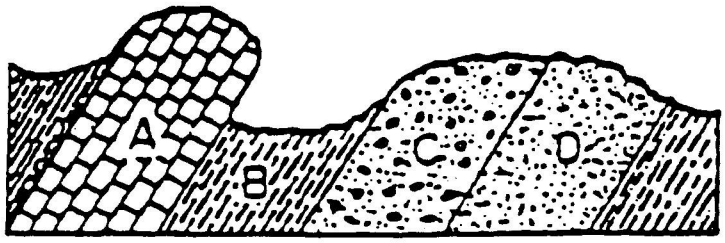
Arid climate



Humid climate

B. Different types of rocks causes differential weathering. Differential weathering is the process by which softer, less weather-resistant rocks wear away, leaving harder, more weather-resistant rocks behind.

KEY
= limestone
= sandstone
= shale
= conglomerate



Which rock type is most resistant to weathering? limestone

Which rock type is least resistant to weathering? shale

C. Particle Size - Weathering takes place on the outside surface of rocks. So the more surface area that is exposed to weathering, the faster the rock will be broken down.
Note: The diagram depicts the same type and mass of rock.

As a rock breaks into smaller pieces, the surface area increases, the therefore, the rate of weathering increases.

IV. Products of Weathering

A. Solid Sediments

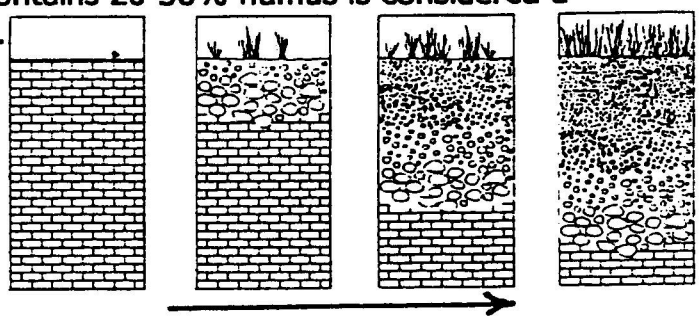
Name of Sediment	Size cm
Boulders	25.6 +
Cobbles	25.6 – 6.4
Pebbles	6.4 – .2
Sand	.2 – .006
Silt	.006 – .0004
Clay	less than .0004
Colloids	less than .00001

Colloids are very small solid particles(sediment) that are too small to be seen with an ordinary microscope, and too light to settle in water. Even in calm water, they remain suspended within the water.

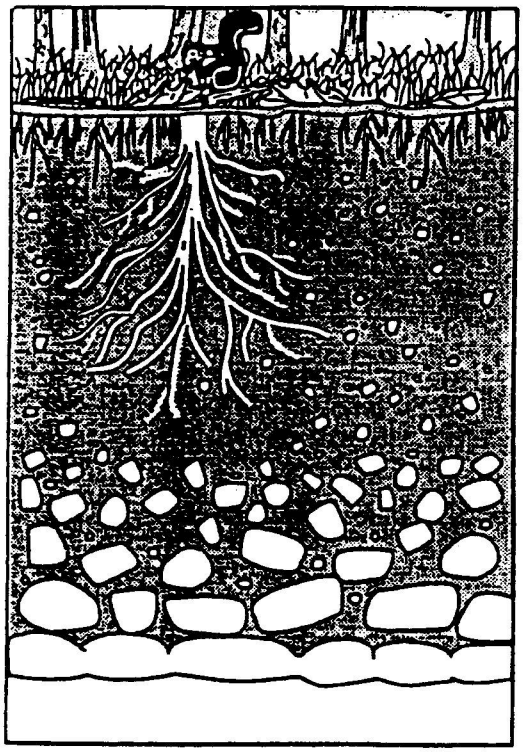
B. Dissolved minerals - dissolved minerals cause the "hardness" in groundwater (and surface water).

C. Soil

1. Soil is a combination of weathered rock and organic matter.
2. Humus = decayed plant and animal material found in soil. Soil that contains 20-30% humus is considered a rich soil for plant growth.
3. Soil development



4. Soil layers – the soil profile



1. Topsoil or A Horizon = the top layer of soil that contains more humus than the layers below.
2. Sub soil or B Horizon = consists of clays and dissolved minerals that have been washed down from above. Contains less humus.
3. C Horizon - consists of weathered rock fragments, usually from the parent rock below.
4. Bedrock = the layer of rock beneath the soil. Frequently the parent rock of the soil above.

5. Residual Vs. Transported
If the bedrock matches the rock fragments of the C horizon, the soil is most likely residual. If it does not, the soil is most likely transported.

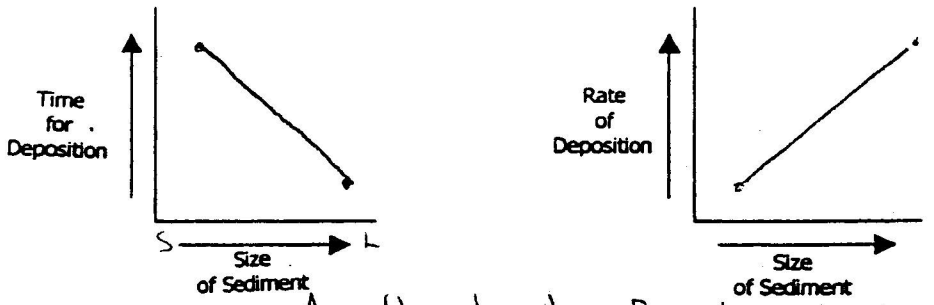
V. Erosion and Deposition

A. Erosion is the process by which weathered sediments are carried / transported.

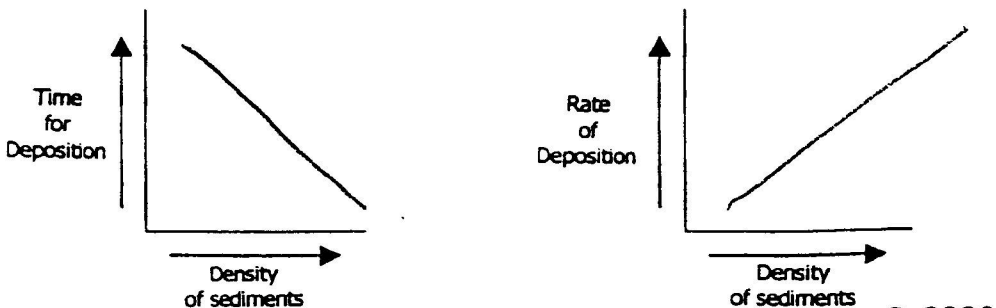
1. An agent of erosion is a material or a force that moves sediments from one place to another place.
2. Agents of erosion include: running water, wind, glaciers, and waves (gravity)

B. Deposition is the process by which sediment is dropped or settles.

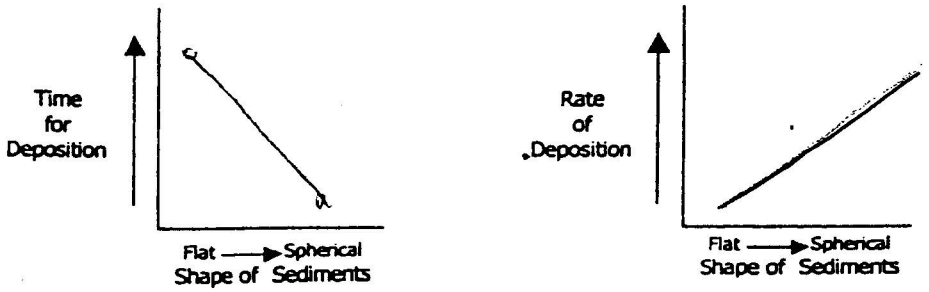
1. Deposition occurs when the velocity (speed), of running water or the wind decreases, and/or when the discharge (volume of water) decreases.
2. Factors the affect the deposition of sediment:
   a. Size - As the size of sediment increases, the rate(speed) of deposition increases.



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

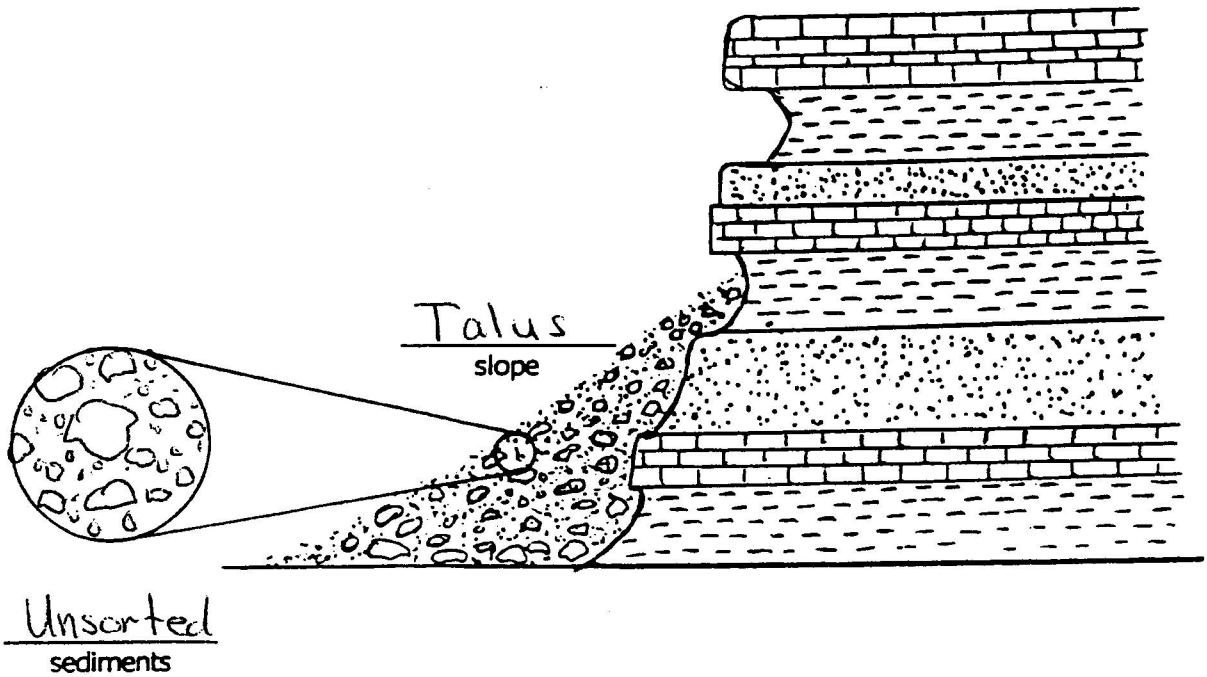


c. Shape - As the shape becomes more spherical, the rate (speed) of deposition of the sediment increases



C. Gravity - erosion and deposition

1. Gravity pulls sediments down slopes.
2. The downhill movement of sediments by gravity is called mass wasting.
3. Types of mass wasting include: landslides, mudslides
4. Deposition resulting from gravity

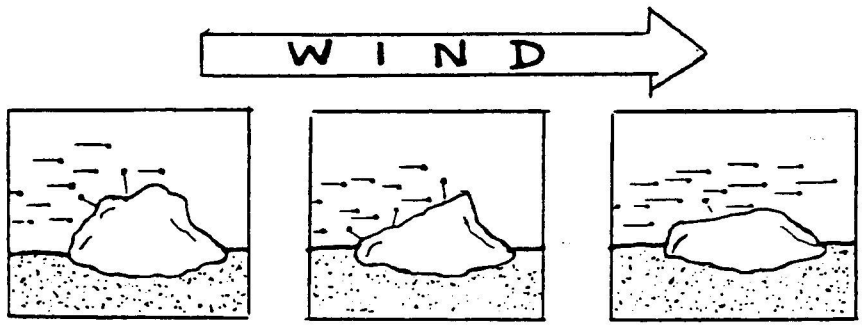


5. Gravity is the underlying force behind all erosion; it may act alone or with a transporting agent:
   a. Gravity causes water to flow downhill.
   b. Gravity causes glaciers to flow down a valley or spread outward.
   c. Gravity causes winds by pulling heavier(more dense) cold air down beneath lighter(less dense) warm air.

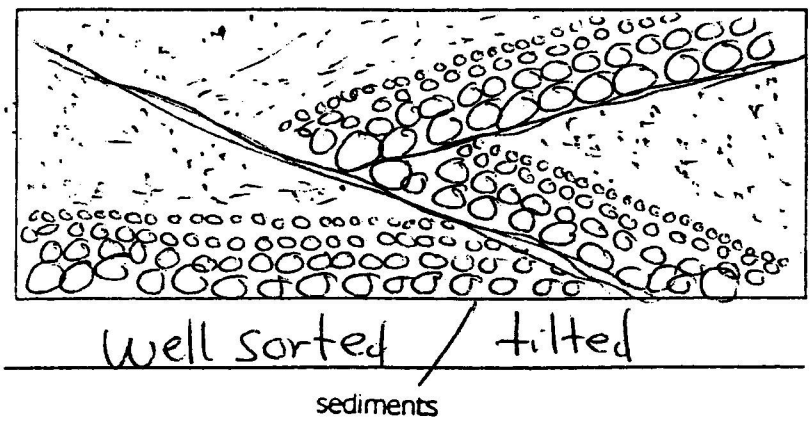
D. Wind - erosion and deposition

1. The amount of erosion caused by the wind depends on:
   a. The size of the sediments being carried.
   b. The speed at which the wind is blowing.
   c. The time that the wind continues to blow.

2.



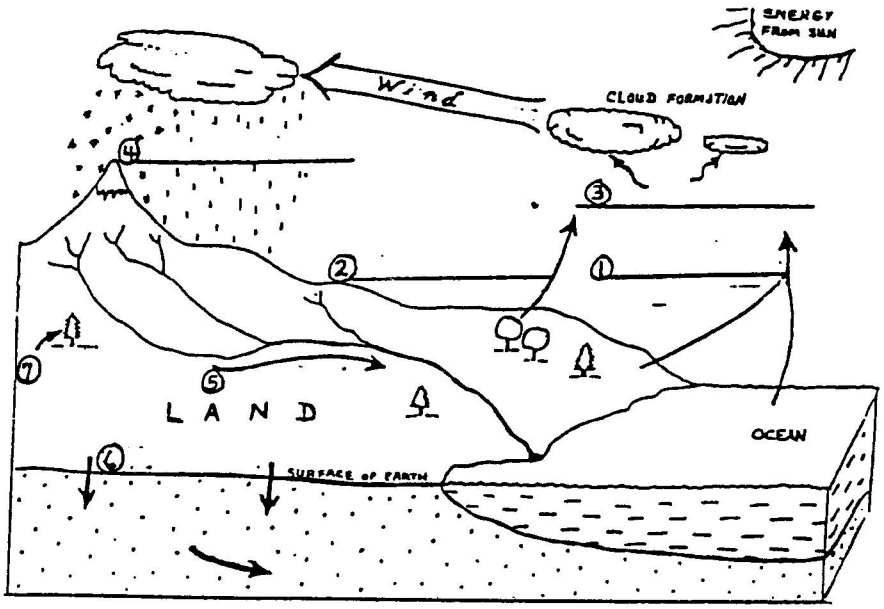
3. Deposition by wind



E. Running Water - erosion

1. Running water is the dominant form of erosion.

2.



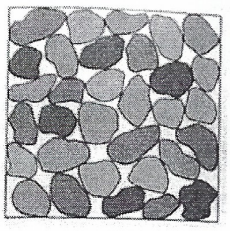
3. When rain falls onto the surface of Earth, several things can happen to the water:
   a. runoff - flow over the land back to ocean
   b. infiltrate (sink) into the ground
   c. evaporate
   d. stored - in ponds, accumulated snow
   e. _____

4. The volume (amount) of water in a stream is called the stream's discharge. Factors affecting a stream's volume are:
   a. Season - spring vs. fall; usually greater in the spring
   b. Climate - arid vs. humid; usually greater in humid climates
   c. Weather - daily changes in precipitation affect the volume of a stream.
   d. Ground/Soil - saturated or not saturated; greater when the soil is saturated

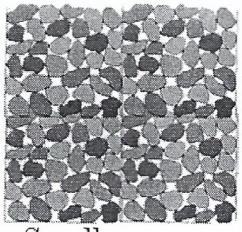
Permeability- The ability of water to flow through soil.

Permeability depends on Soil Composition, (Size and Sorting)

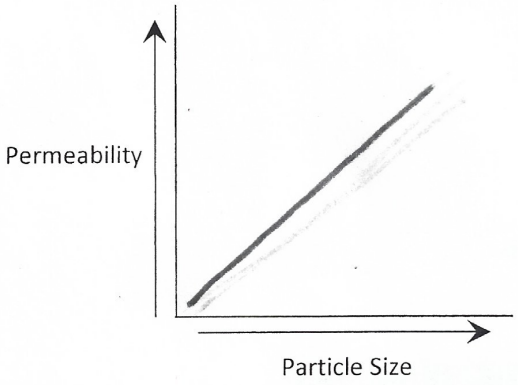
Size



Large Particles have higher permeability

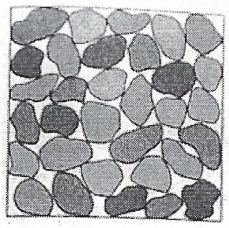


Small Particles have Lower permeability

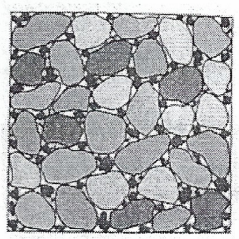


As particle size increases permeability increases.

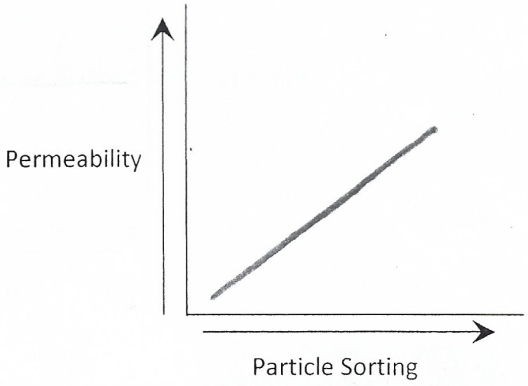
Sorting



Sorted Particles more Permeable



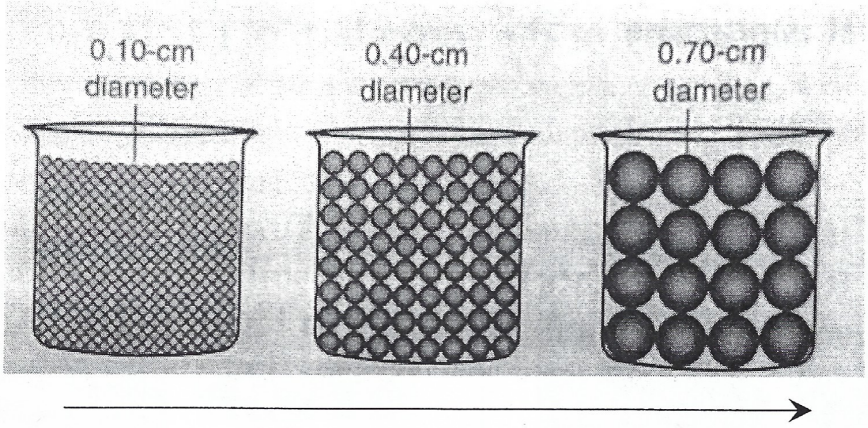
Unsorted Particles less permeable



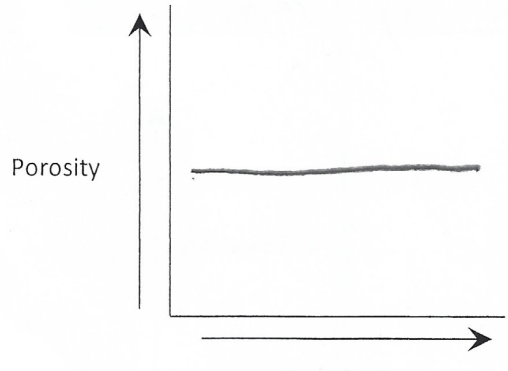
As particle ~~size~~ Sorting increases permeability increases.

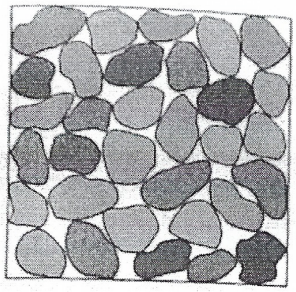
Water retention - To retain (hold) water.

Porosity - The amount of open space between rocks.

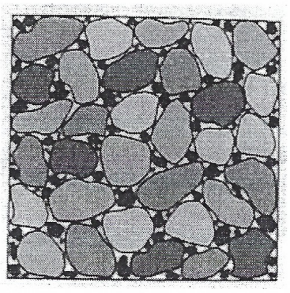


As particle size increases porosity remains the same.





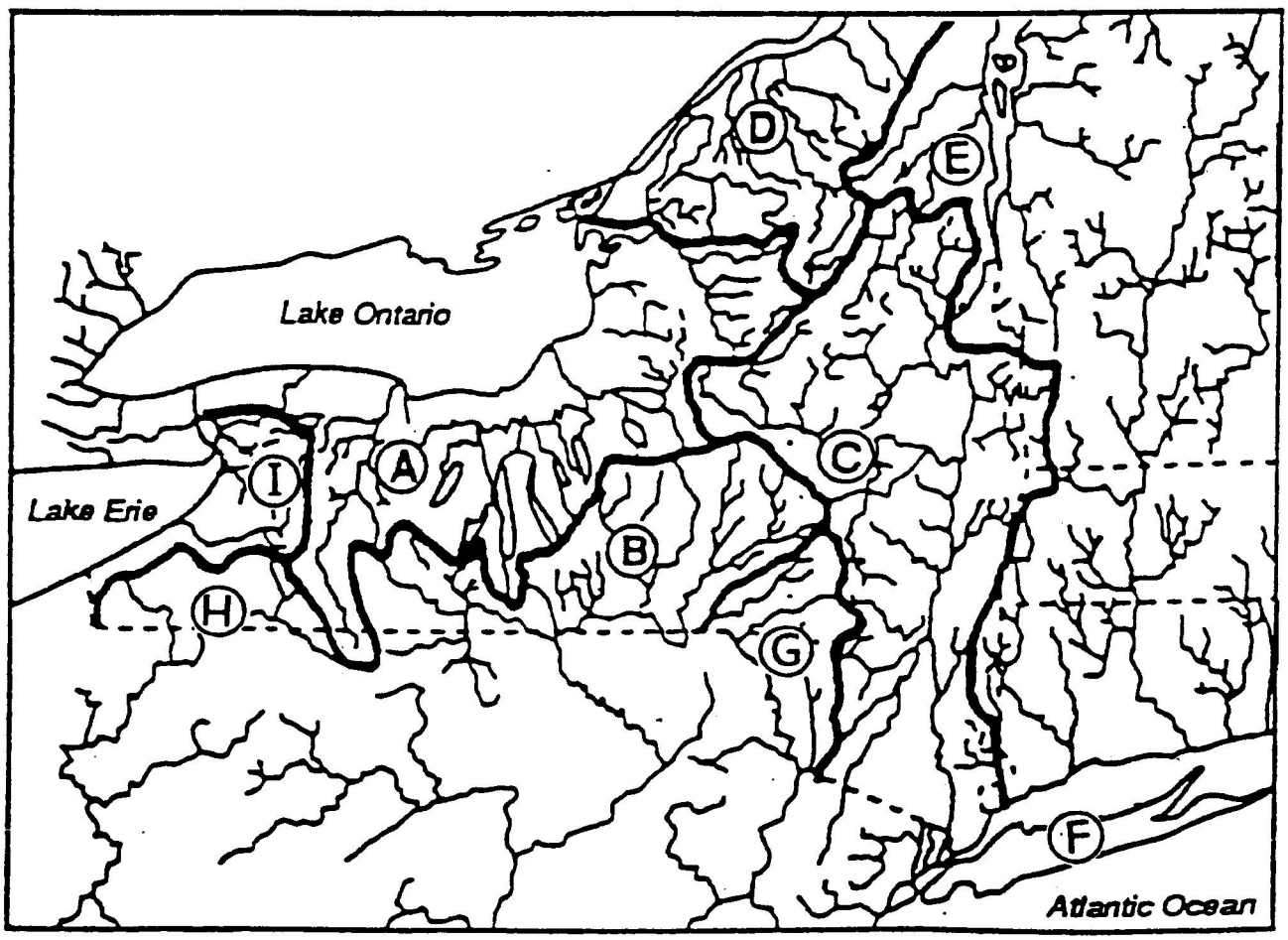
Sorted particles - High Porosity



Unsorted particles – Low Porosity

e. **Drainage Basin** - (watershed) - the area of land drained by a river system — the main river and all of its tributaries.

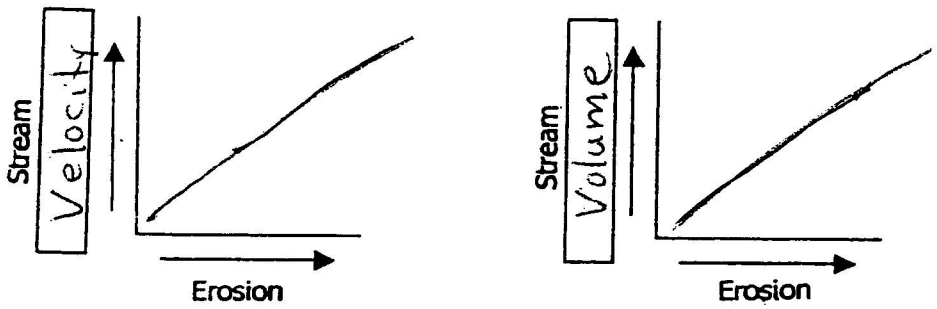
tributary - a smaller stream that flows into a larger one.



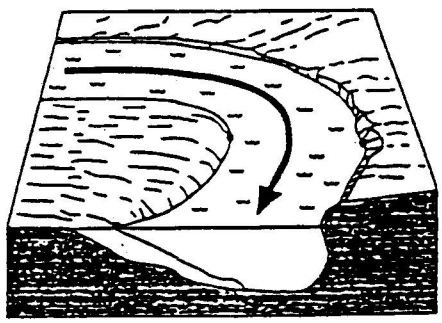
Key

A - Ontario - St. Lawrence
B - Susquehanna - Chesapeake
C - Mohawk - Hudson
D - St. Lawrence
E - Champlain - St. Lawrence
F - Long Island Sound
G - Delaware
H - Allegheny - Ohio
I - Erie - St. Lawrence

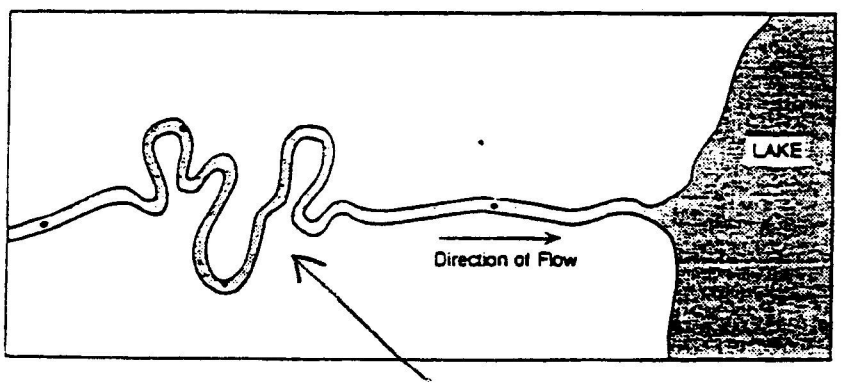
5. Stream factors that cause erosion:
   a. Velocity - As velocity increases, erosion increases.
   b. Volume - As volume increases, erosion increases.
   c.



6. Factors that affect stream velocity:
   a. Gradient - As gradient increases, stream velocity increases.
   b. Volume - As stream volume increases, stream velocity increases.
   c. Channel = the path that a stream follows
   When a stream flows through its channel, its speed will change due to the curvature of the channel.



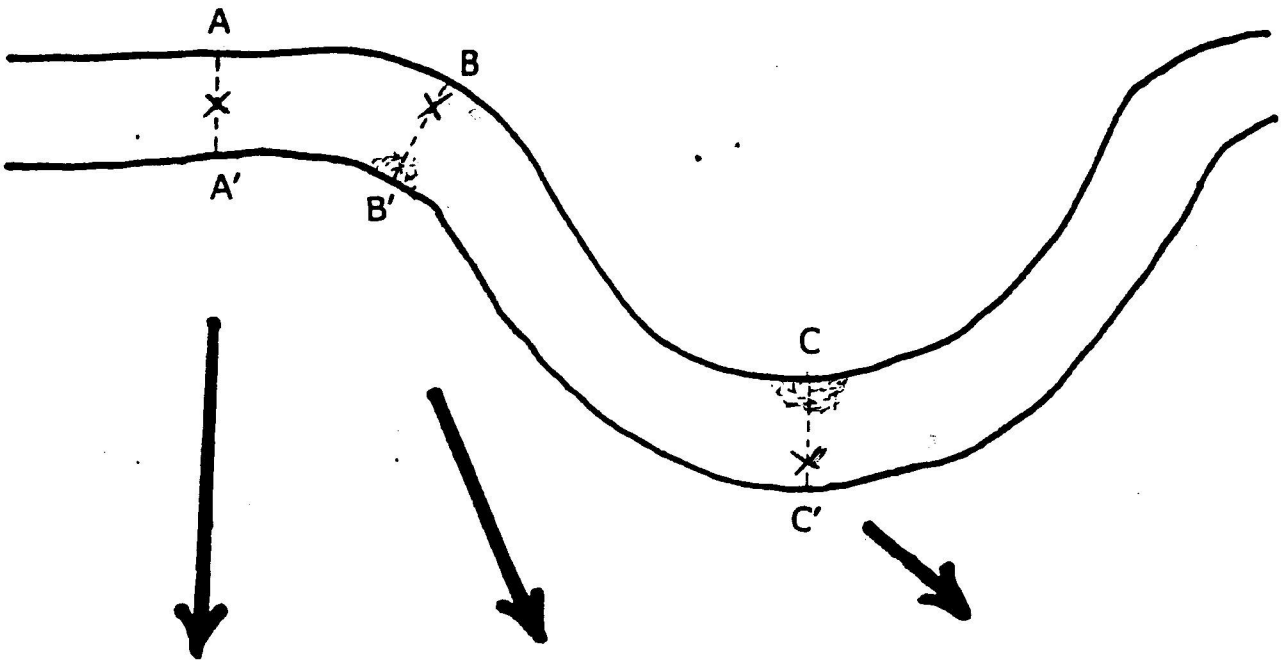
Profile of a stream channel

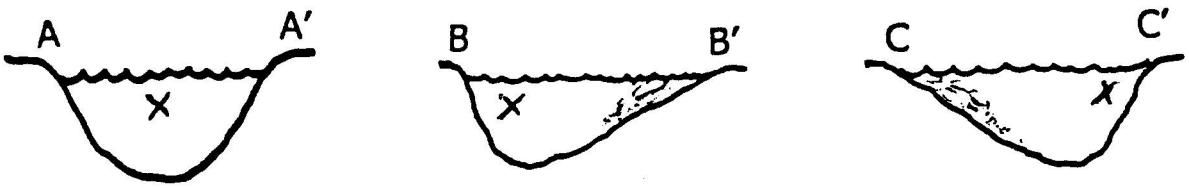


Aerial/map view of a stream channel

The bends in a stream's channel are called meanders

Arial/ Map View of a Stream Channel





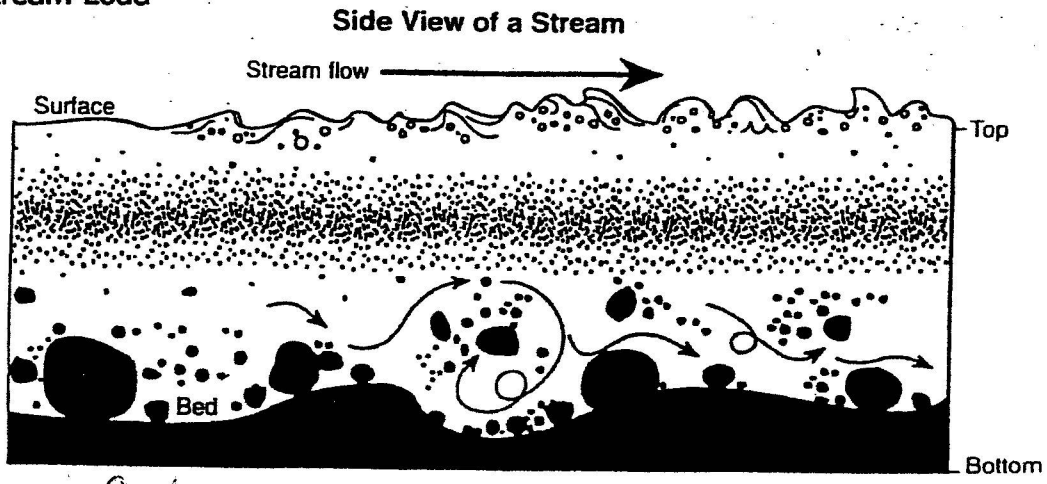
Profile/Side View

Key: = deposited stream sediment

X = location of maximum velocity

At the outside of the curve, the stream velocity *increases*,
therefore, *erosion* occurs.
At the inside of the curve, the stream velocity *decreases*,
therefore, *deposition* occurs.

7. Stream Load

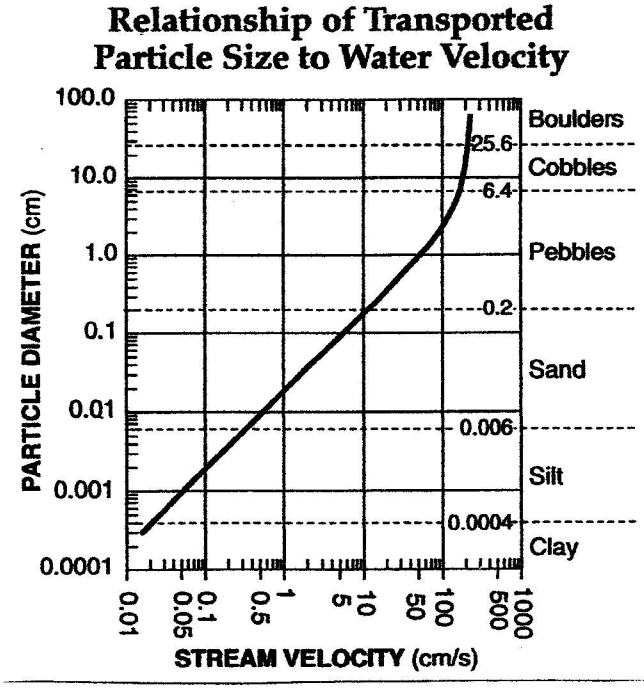


a. Solution - minerals dissolved in the water

b. Suspension - small particles carried within the water

c. Saltation - larger particles rolling and bouncing along the bottom

8. Particle Size vs. Stream Water Velocity



What is the largest size sediment that can be transported by a stream in which the water velocity is:

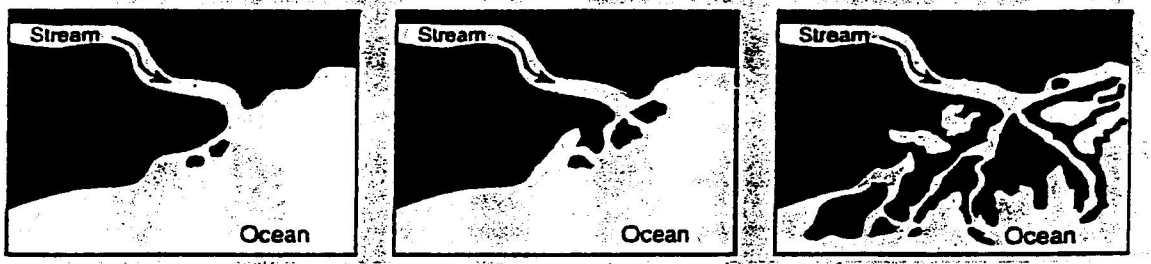
a. 50 cm/sec Sand (small pebbles)

b. 150 cm/sec pebbles

c. 250 cm/sec cobbles

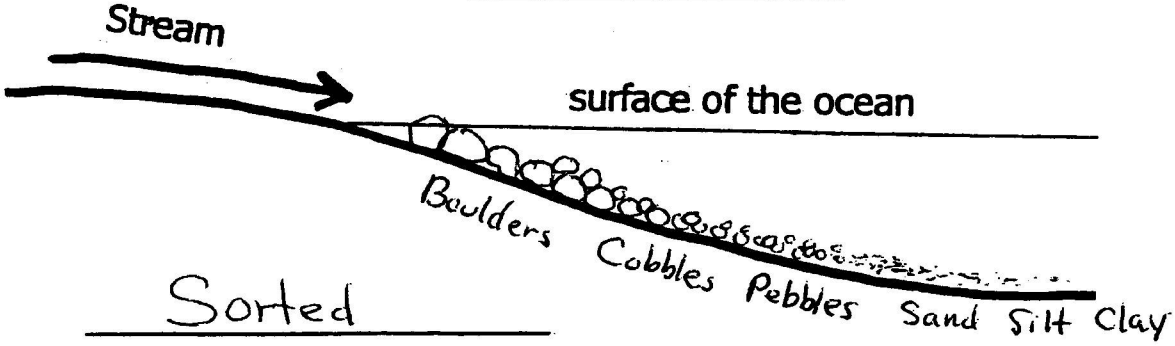
F. Running Water - deposition

1. When a stream enters a body of water, its speed will decrease, and therefore, the deposition of sediments occurs.
   A deposit at the mouth of a stream where it enters a large body of water is called a(n) delta.



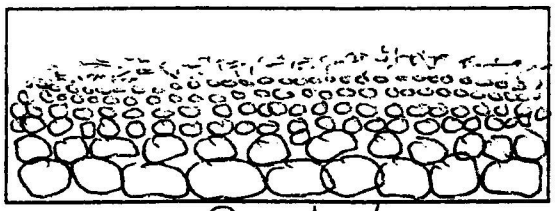
2. A delta is an example of the horizontal deposition of sediments in water.

Profile View of a Delta



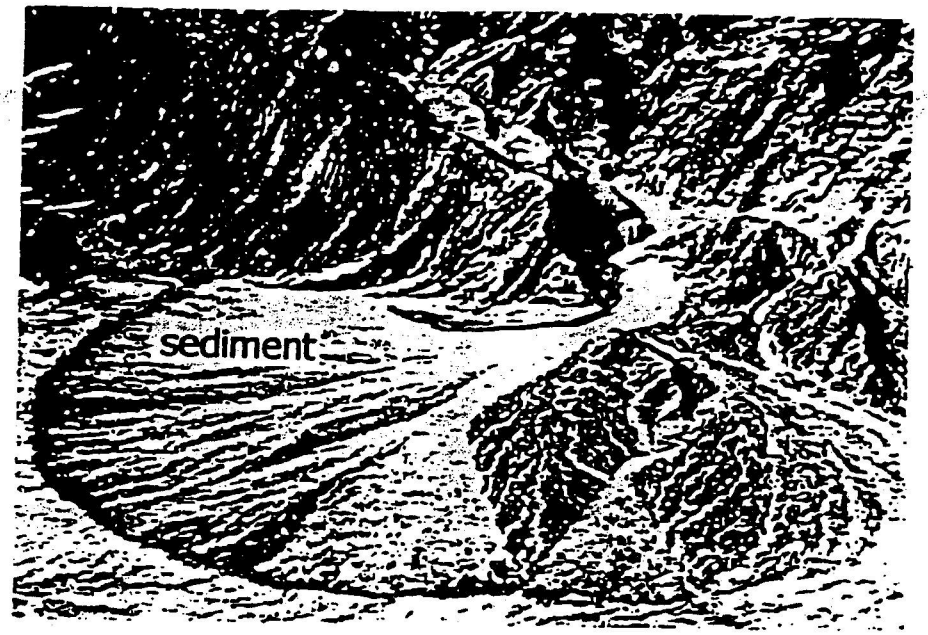
Sorted
sediment

3. Deposition can also occur vertically. This results in vertical sorting.



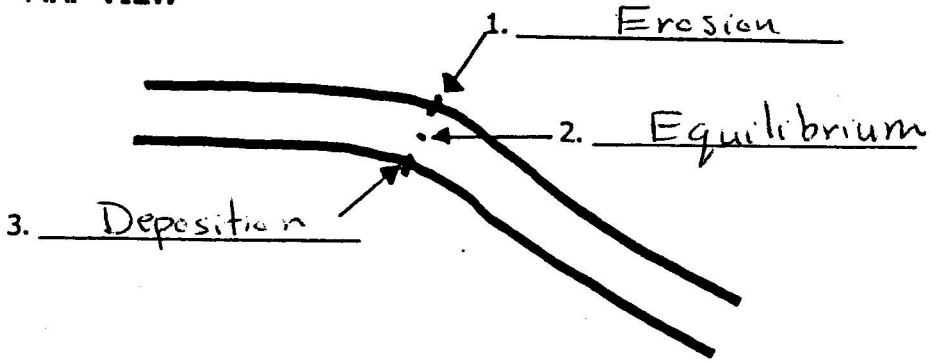
Sorted
sediment

4. Stream deposition on land can also occur. This deposit is called a(n) alluvial fan.

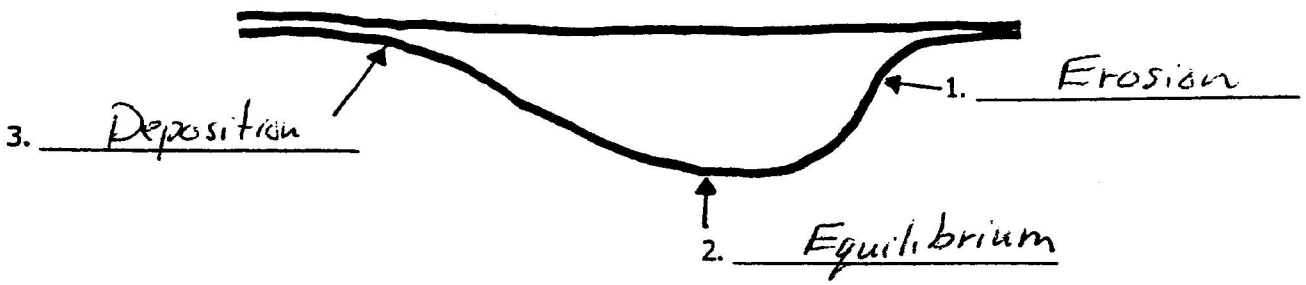


5. Equilibrium: Erosion = Deposition

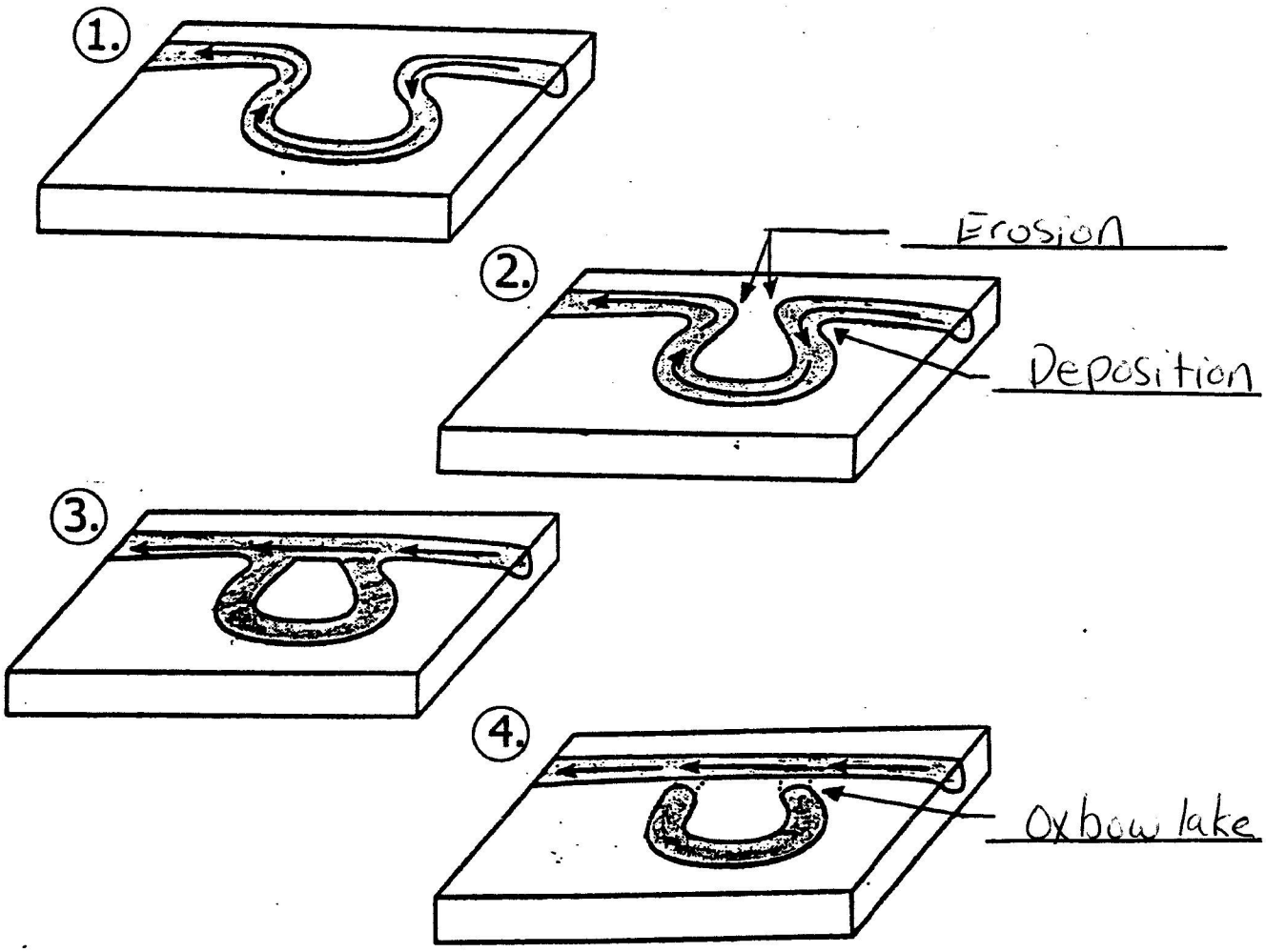
MAP VIEW



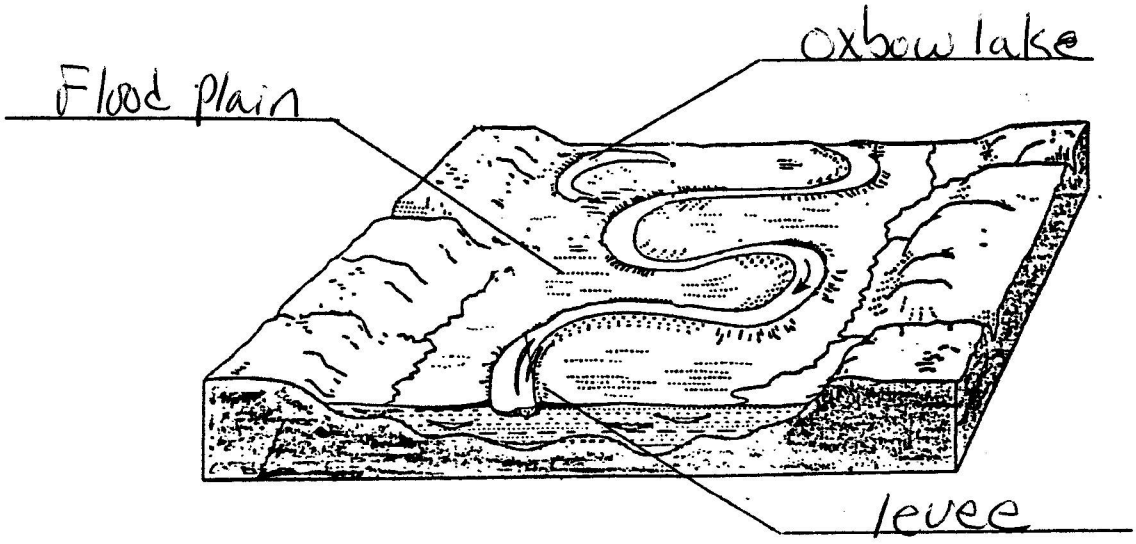
PROFILE VIEW



6. Formation of an Oxbow Lake – the work of erosion and deposition



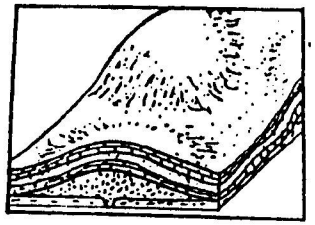
7. Stream Landscape Features:

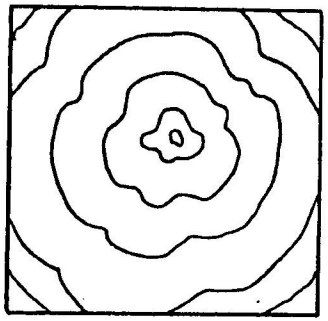


8. Stream Drainage Patterns and Landscapes

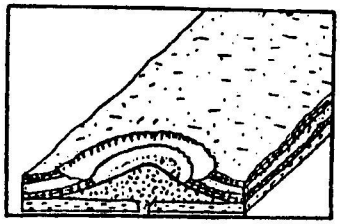
Landscape | Topographic Map

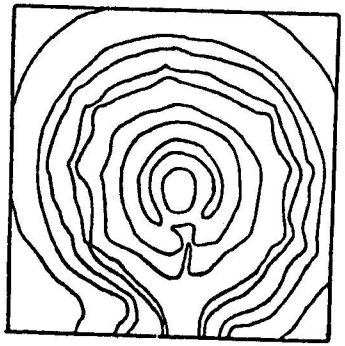
1.





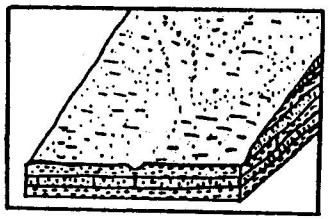
2.

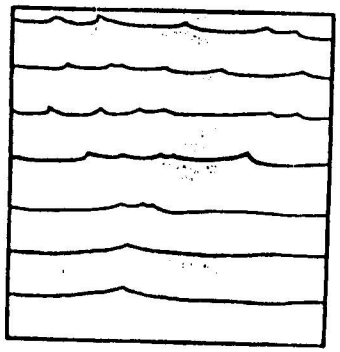




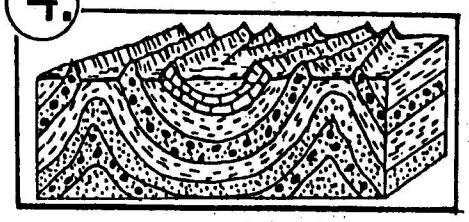
Landscape | Topographic Map

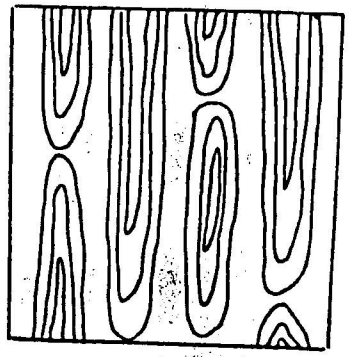
3.

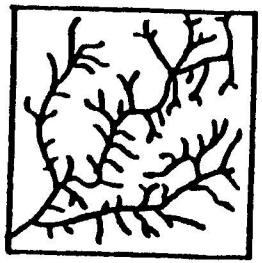




4.

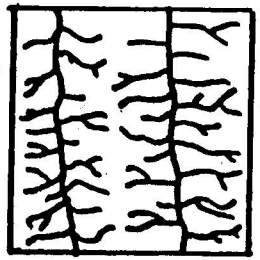






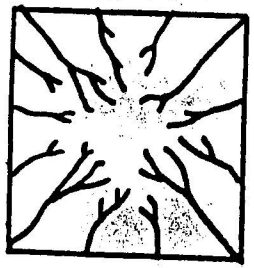
Dendritic

3



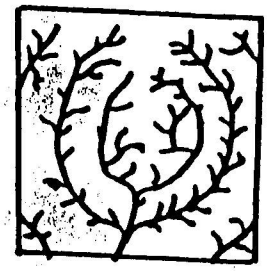
Trellis

4



Radial

1



Annular

2

G. Glaciers – erosion and deposition

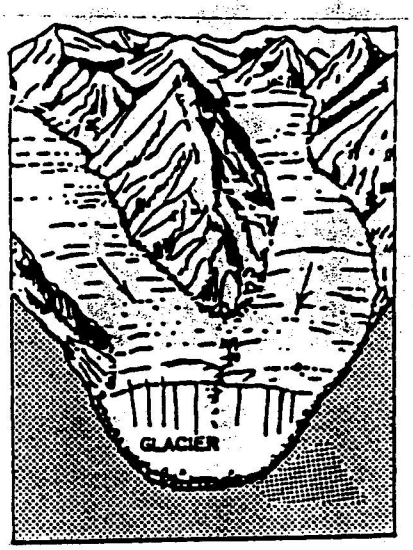
1. A glacier is a large mass of moving ice and snow

2. Types of Glaciers

a. Valley/alpine glaciers form in mountain valleys at high elevations.

example locations:

Alps (of Europe)
Rockies
Himalayas
Andes

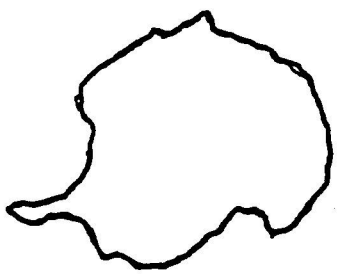


b. Continental glaciers form over vast areas of land.

example locations:

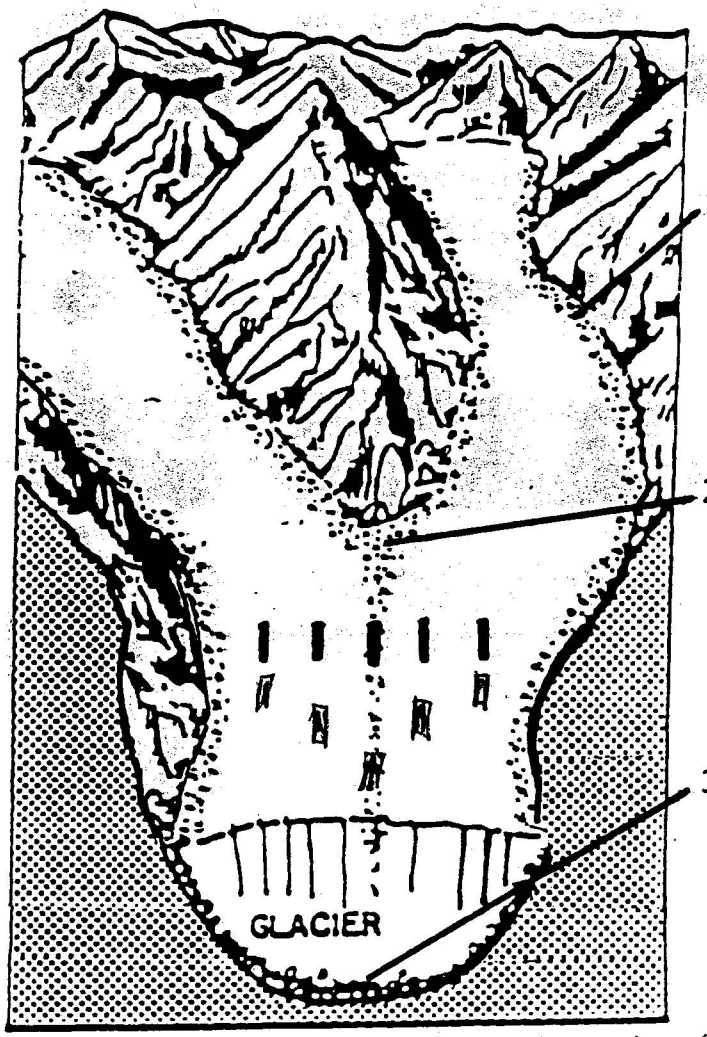
Greenland

Antarctica



3. Valley Glaciers and Erosion

a. Movement of a valley glacier – the center moves faster than the sides.



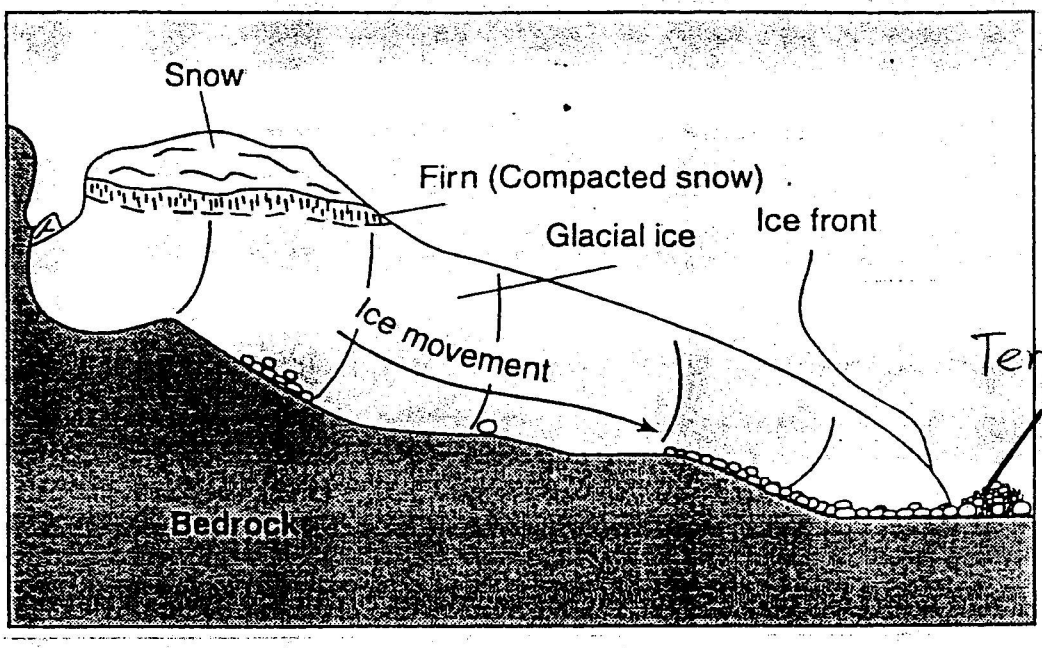
1. Lateral moraine
2. Medial moraine
3. Ground moraine

b. Moraine - unsorted rock material carried + deposited by a glacier

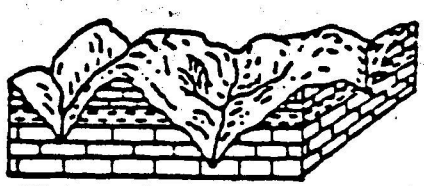
1. Lateral moraine - unsorted rock on the glacier along the valley walls.
2. Medial moraine - unsorted rock on the glacier in the central region resulting from the merging of two smaller valley glaciers.
3. Ground moraine - unsorted rock trapped at the bottom of the glacier.

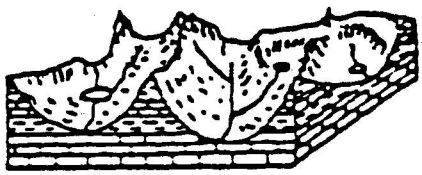
4. Terminal/End moraine - unsorted rock trapped at the leading edge or "end" of the glacier.

Profile of a Valley Glacier



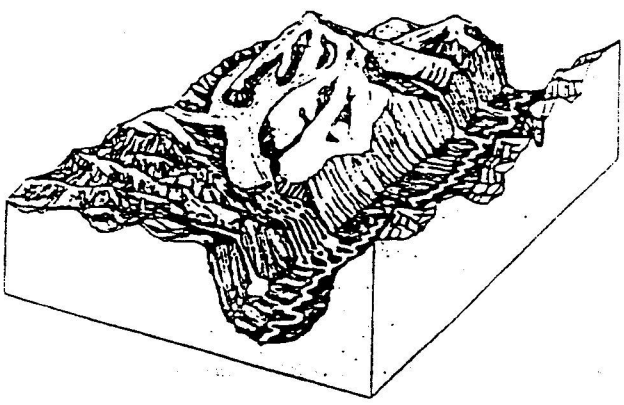
c. Glacier Valleys:





Stream eroded valley Glacier eroded valley

Examples of U - shaped glacier valleys:



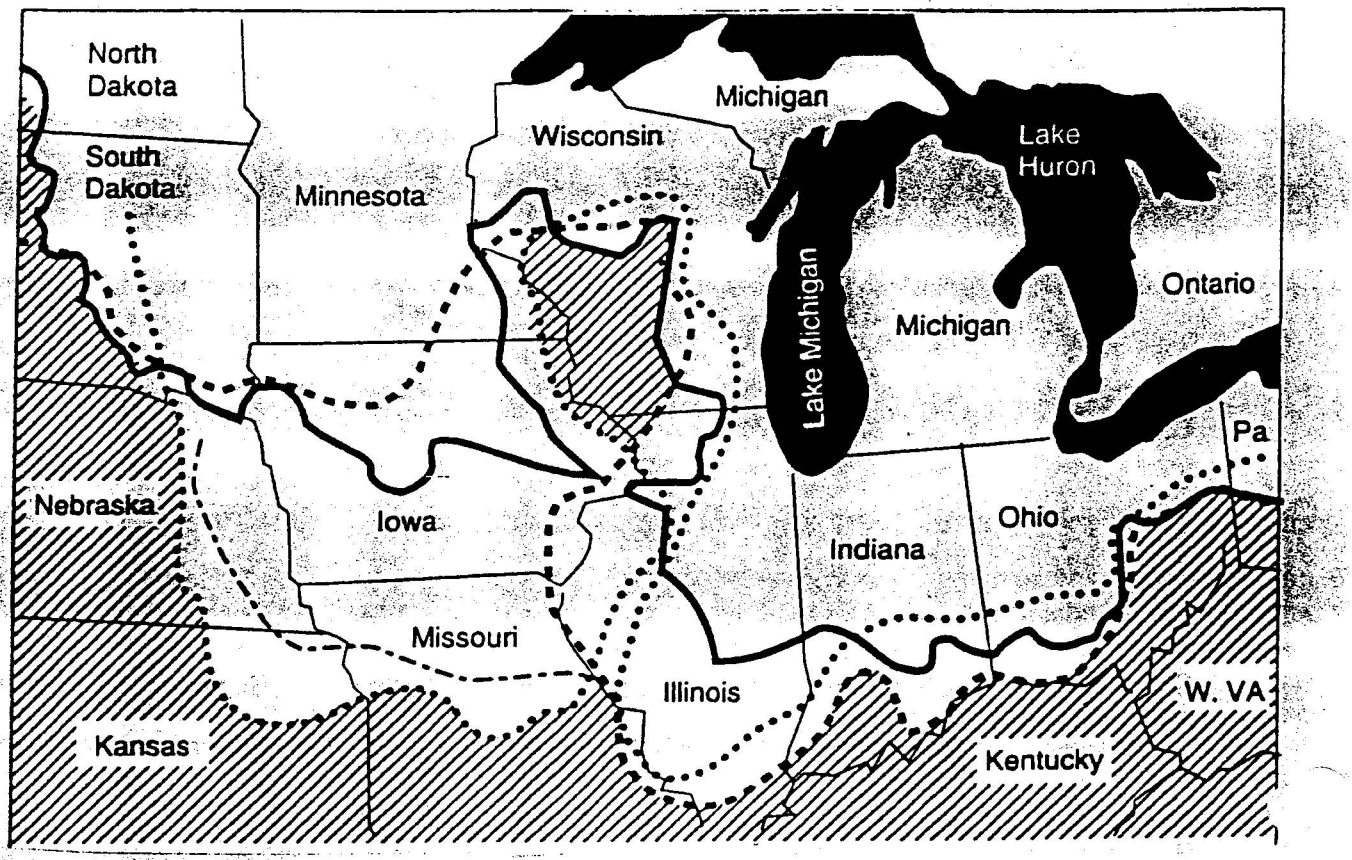
4. Ice Age Continental Glaciers

In the geologic past, a much colder climate resulted in ice sheets covering much of Earth's surface.

There is evidence of at least 4 major ice ages

a. The time period between ice ages is called interglacial periods

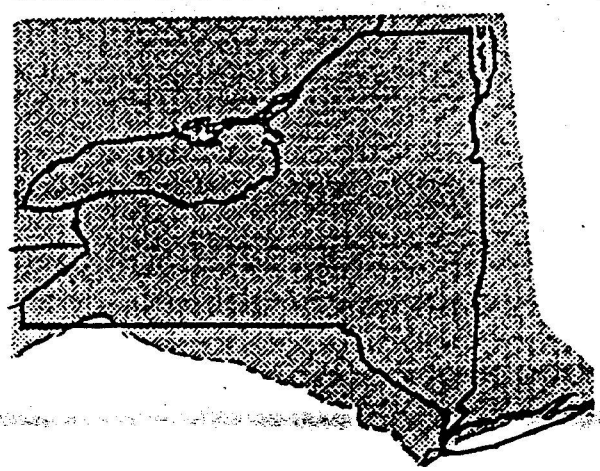
c. Four stages of glaciation during the last Ice Age



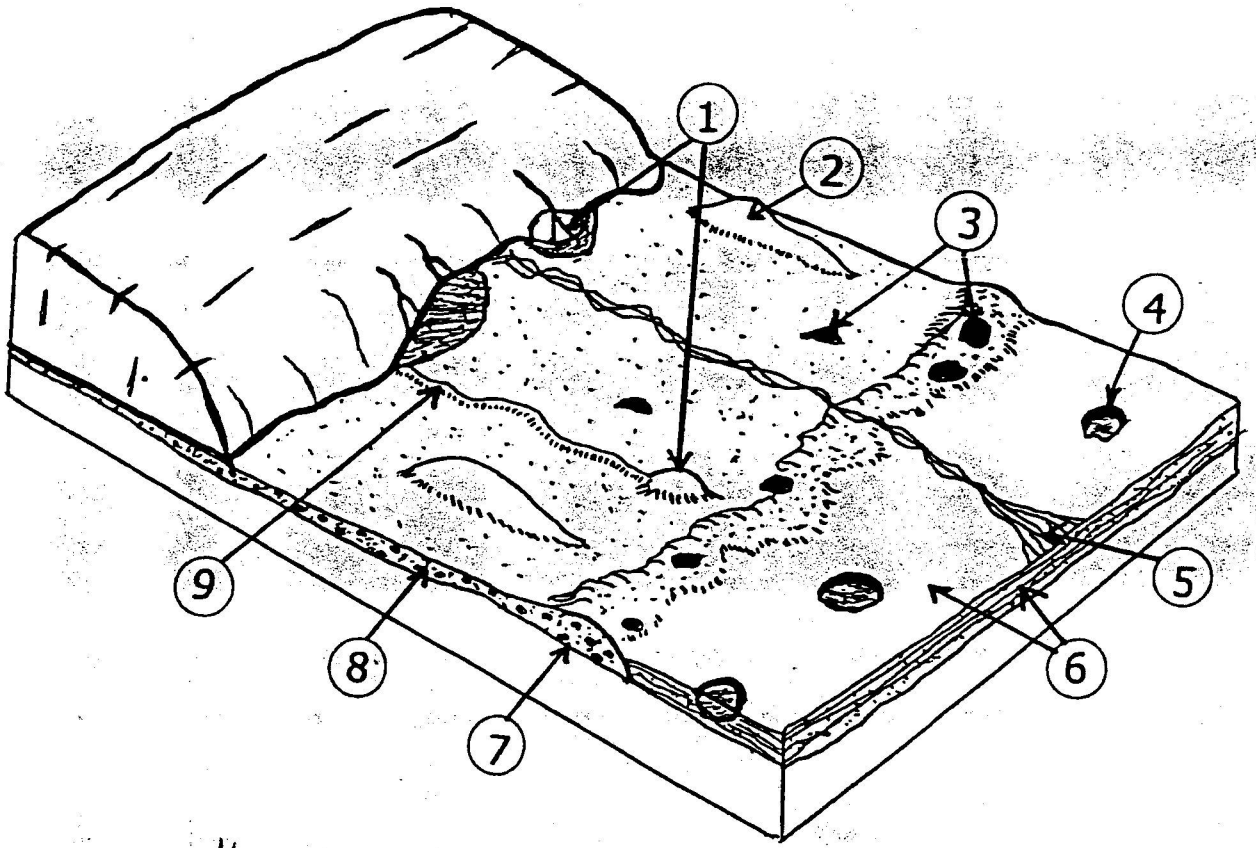
KEY Stages

1. ——— Wisconsin
2. - - - - - - - Illinoian
3. ..... Kansan
4. — — — Nebraskan

Extent of Glaciation in New York State

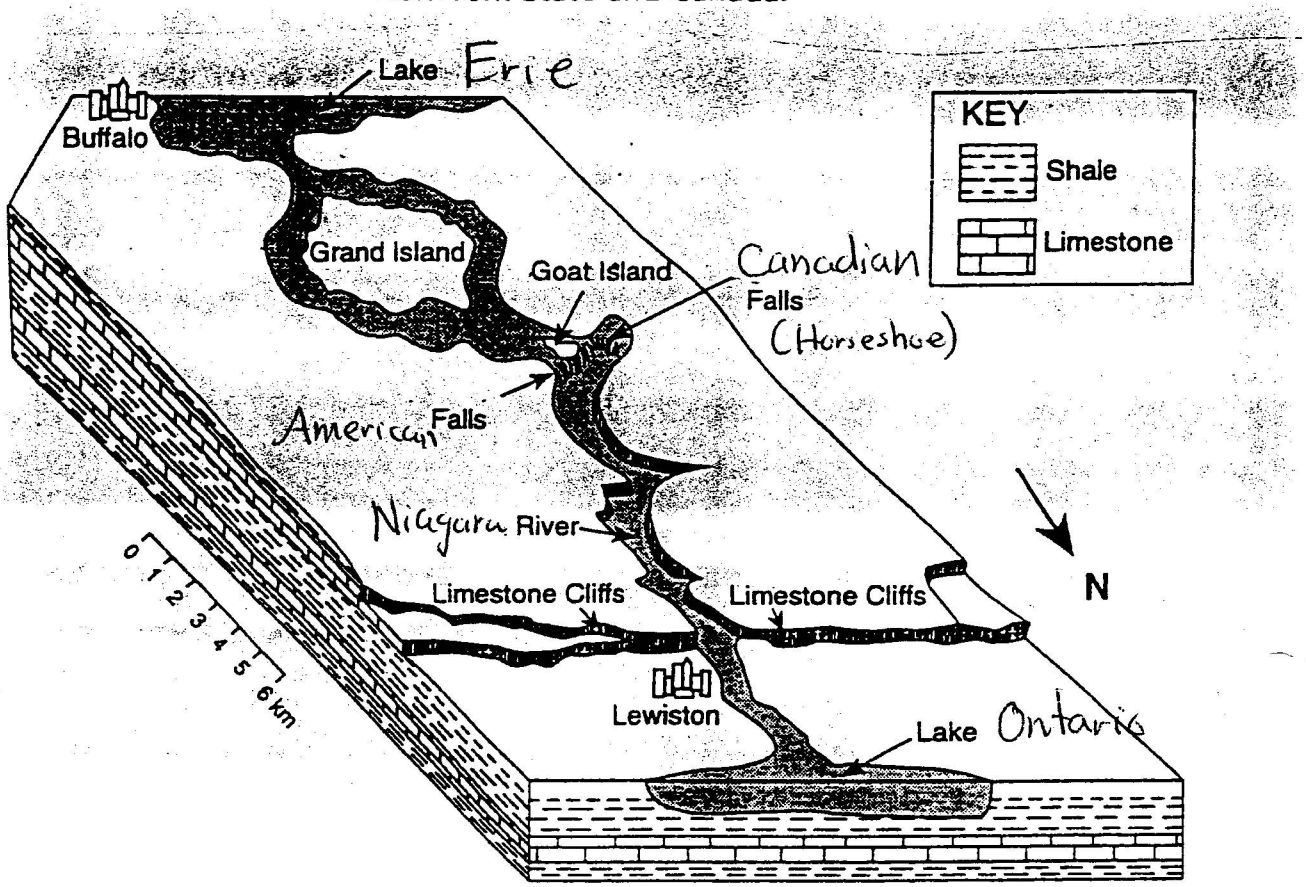


5. Landscape Features of Continental Glaciers

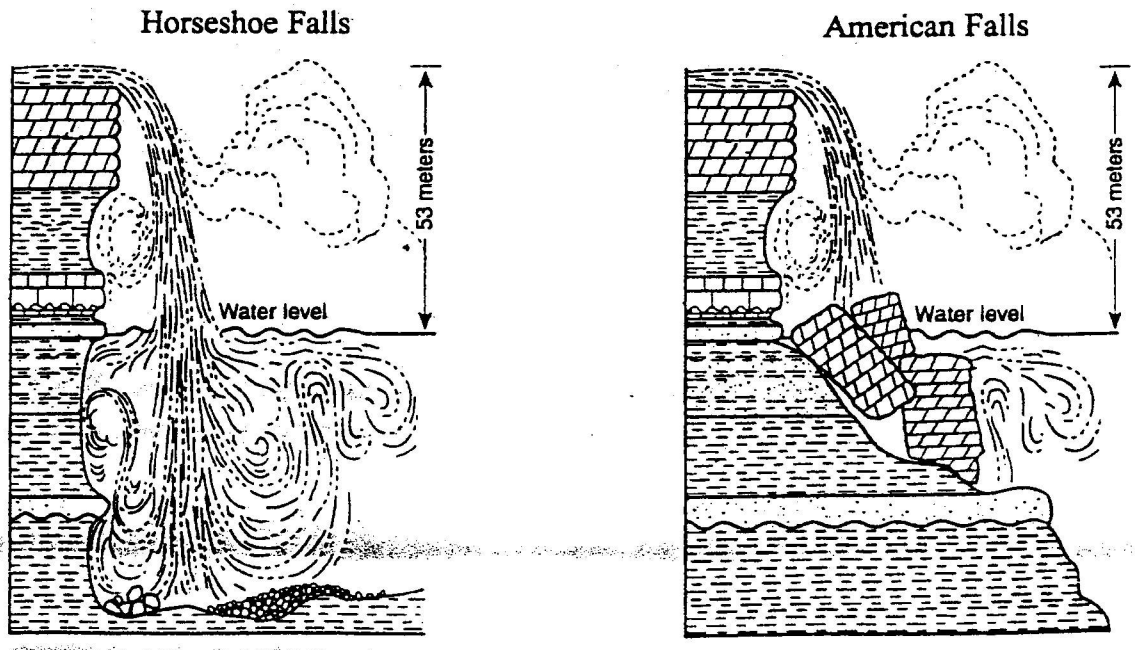


1. Kame - a cone-shaped hill made of sediment carried to the edge of a glacier by meltwater
2. Drumlin - an oval-shaped hill of glacial moraine
3. Erratic - large boulder deposited by the ice
4. Kettle Lake - a lake formed when a block of glacial ice melts
5. Braided Stream - a stream that is divided into an interlocking system of channels
6. Outwash Plain - layers of sediment deposited by the meltwaters of glacial ice
7. Terminal Moraine - a mass of loose rock carried by a glacier and finally deposited in the form of a belt or ridge. It marks the farthest position reached by a glacier
8. Ground Moraine - glacial material deposited as the glacier retreats
9. Esker - a ridge-like hill of deposits resulting form a stream flowing in a tunnel under the glacier

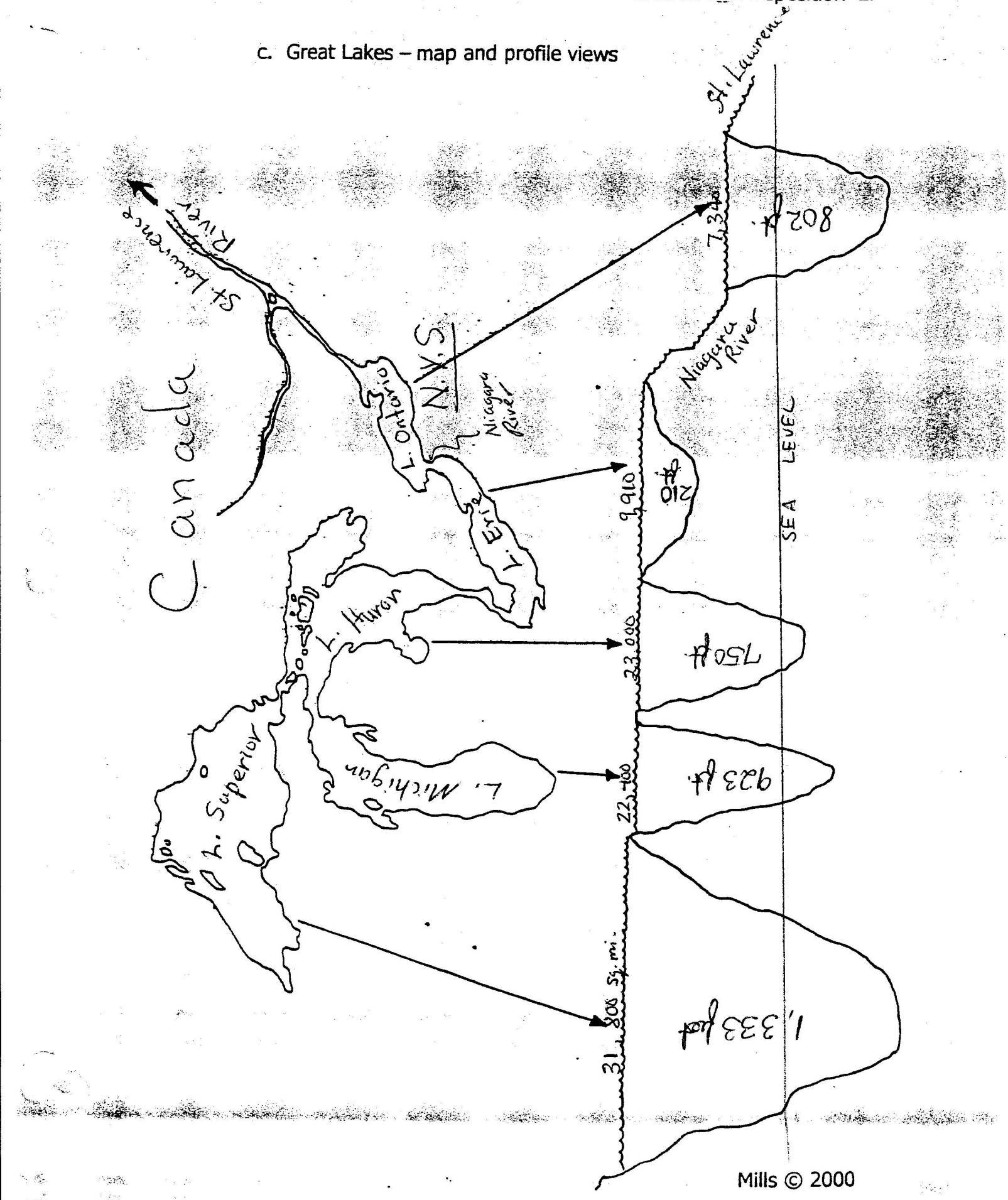
6. Other Landscape Features from the Last Ice Age
   a. Niagara Falls – the block diagram shows the generalized underlaying geology of an area in western New York State and Canada.



b. Profile of Niagara Falls



c. Great Lakes – map and profile views



d. Finger Lakes – The map shows the shapes and locations of New York State's 11 Finger Lakes and the locations of some major glacial deposits (moraines) left behind by the last ice age. The cross section shows surface elevations, valley depths, and water depths of the Finger Lakes.