WEATHERING AND EROSION

- Two types of Weathering: PHYSICAL
  (also known as Mechanical Weathering)
  and ...
  CHEMICAL

- PHYSICAL WEATHERING is the "breaking down" of rocks *in place*. No movement of the pieces of broken rock occurs.

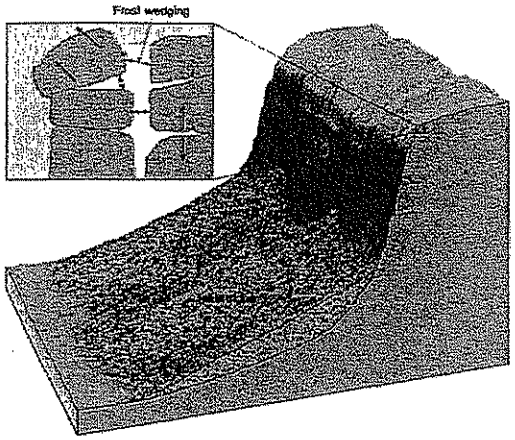
- Types of "Physical Weathering".

  - FROST ACTION: Water enters cracks in rocks, freezes, expands as ice and wedges cracks wider. Eventually pieces of the rocks break off.

    Common in "Mid-Latitudes" where freezing and thawing occur often.

    Climate: Cold and Moist

    Frost Action is the dominant form of weathering in New York!



  - ABRASION – rubbing by other rocks
  - ANIMAL ACTIVITIES: Burrowing animals wear away rocks.

  - PLANTS: plants roots grow into cracks and wedge rocks apart. Acid secreted by roots chemically dissolves rocks.

- **PRESSURE UNLOADING (Exfoliation): As rocks that formed underground become exposed at Earth's surface, they expand and crack. Ex: Granite.**

- **CHEMICAL WEATHERING: the breaking down of rocks due to chemical changes. NEW PRODUCTS are formed!!!**

- **Types of Chemical Weathering:**

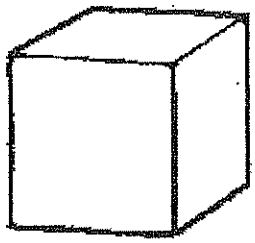
  - **OXIDATION: oxygen combines with iron in rocks to form rust. This breaks down rocks. Water speeds up this process!**

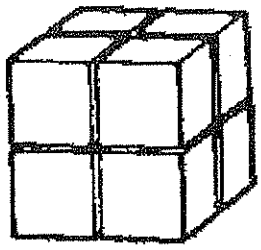
  - **CARBONATION: carbon dioxide in air combines with rain to produce a WEAK acid which dissolves rocks containing CALCITE. Ex: limestone, dolostone, marble.**

  - **Some rocks DISSOLVE in WATER. Example: Rock Salt, which contains the mineral "halite".**

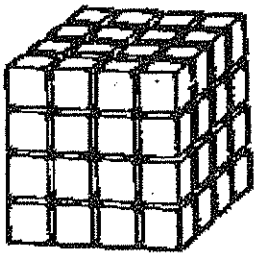
  - **HYDROLYSIS: Some rocks chemically react in water to produce new substances. Example: feldspar and olivine in rocks turn into clay.**

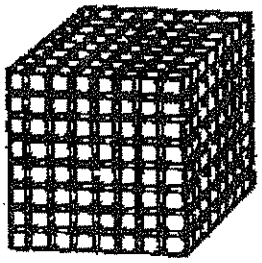
- **An increase in <u>SURFACE AREA</u> speeds up weathering of rocks. In other words: small rocks weather faster than larger-sized rocks.**





A full, solid block
has the least surface area.
The interior is safe from exposure.

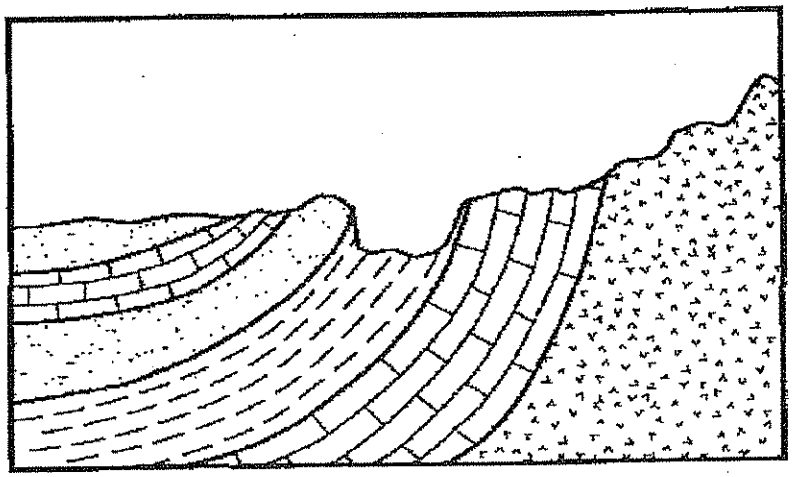




Greater surface area exposed so now the interior can be attacked

- **CLIMATE AFFECTS WEATHERING: Rocks weather faster in <u>WARM, MOIST</u> climates.**

- **Some minerals RESIST weathering more than others.**
  Example: QUARTZ
  Rocks made of quartz take longer to break down than rocks made of softer minerals, like calcite and feldspar.



In the diagram above the different layers of the rock are weathered at different rates depending on the minerals within the rock. The layers sticking up most are the most resistant.

Soil:

The product of weathering

Soil- rocks, minerals (mainly sand and clay), and organic material (regolith and organic matter)

The final outcome of weathering is soil solution. Soil solution is where the minerals have been broken down into ions and mix with ground water.

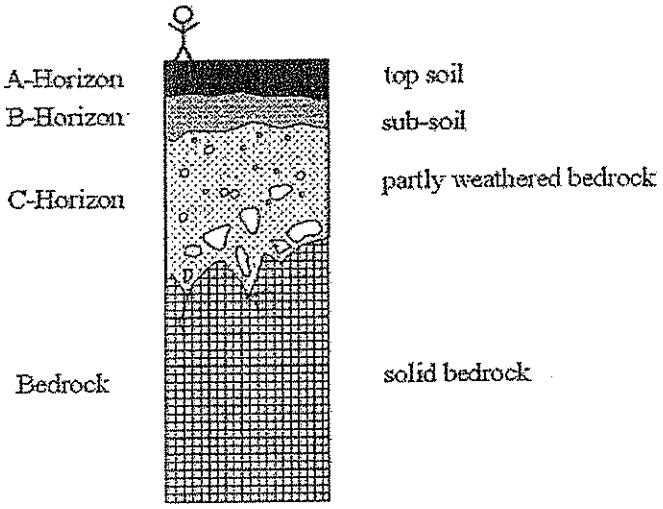
Soil forms layers of different characteristics called horizons.

Residual soil is located above the rock that it is formed from (parent rock).

Transported soil has been moved from an other location.

Most soil on the Earth's surface is transported.

Horizon	Layer	Description
A	Top soil	Small sediments and organic material. Dark in color.
B	Sub soil	Lighter in color- no organic material.
C	Partially weathered bedrock	Larger rocks
Bedrock	Bed rock	Solid rock



<u>EROSION</u>: the MOVEMENT of weathered (broken) rock material from one place to another.

The most important FORCE of erosion is GRAVITY. The most important AGENT of erosion is WATER.

- **<u>AGENTS OF EROSION:</u>**

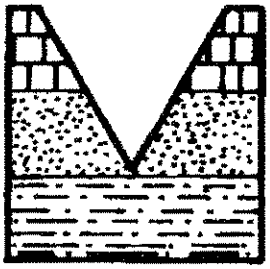
1) **<u>RUNNING WATER:</u> the most important (dominant).**
2) **<u>WIND:</u> mainly in arid (desert) areas.**
3) **<u>GLACIAL ICE:</u> mainly in polar regions or at high elevations.**
4) **<u>GRAVITY:</u> the FORCE that drives 1-3 above AND the force that brings loose rock material at high elevations tumbling down to the ground below.**

<u>STREAMS & RIVERS</u>

- **Chief agent of erosion.**
- **The amount of water in a stream is called the stream's <u>DISCHARGE</u>.**
- **The bottom of the stream channel is called the <u>STREAMBED</u>.**

- **There are 3 stages of stream formation:**

1) **<u>Youthful</u>:**



- **high elevations**
- **V-shaped valleys**
- **rapids and waterfalls present**
- **no floodplain**
- **capable of moving very large sediment (ex: boulders)**

2) **<u>Mature</u>:**

- **"S"-shaped curves in river called MEANDERS are present.**
- **Floodplain exists.**
- **Not capable of moving large-sized sediment.**

3) **<u>Old Age</u>:**

- **Many MEANDERS present.**
- **Very large floodplain.**
- **Oxbow lakes and Meander Scars present.**
- **Yazoo Streams alongside main river.**
- **Capable of carrying ONLY the smallest-sized sediment: silts and clays.**

Streams carry their sediment in several ways:

1) **<u>Rolling and bouncing</u> of large sediment on streambed.**
2) **<u>Saltation</u> of sand-sized pieces.**
3) **<u>Suspension</u> of fine silt and clay-sized pieces.**
4) **<u>Dissolved</u> salts.**
5) **<u>Flotation</u> of very light materials on surface of stream.**

Except for dissolved sediment.....other sediment carried by stream NEVER MOVES FASTER THAN THE STREAM ITSELF DOES !!!!!!!!

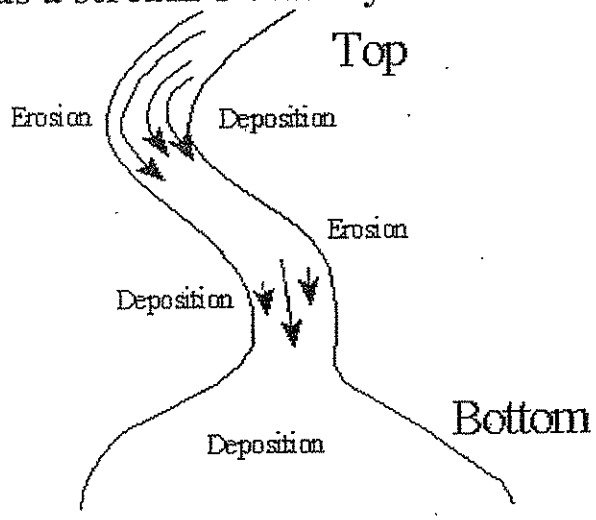
- **The FASTEST moving water in a channel is:**

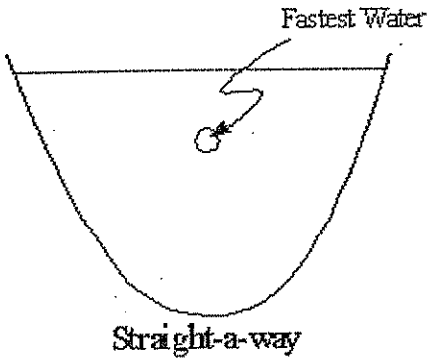
  ***TOWARD THE CENTER of the channel**
  ***Just BELOW THE SURFACE of the water.**

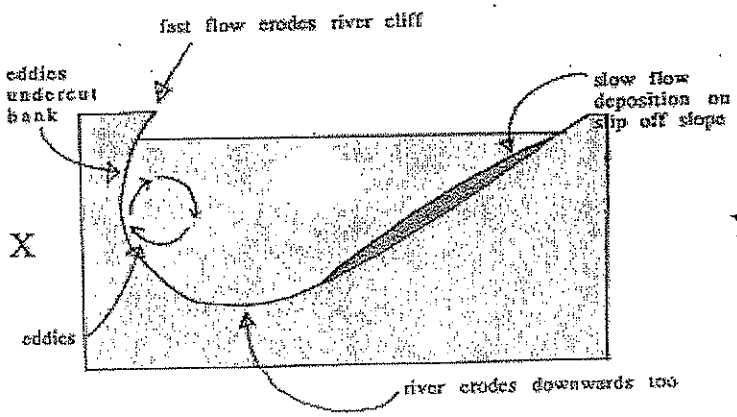
- **There is both EROSION and DEPOSITION of sediments where river MEANDERS exist.**

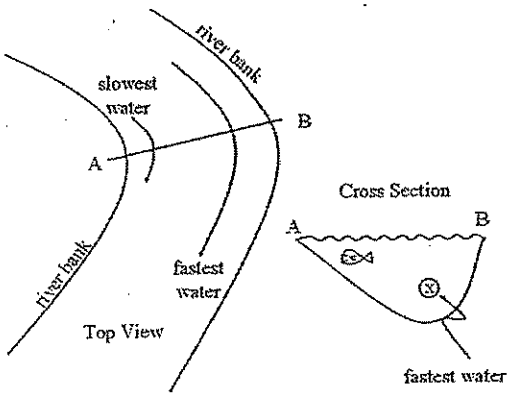
  EROSION occurs on the OUTSIDE CURVES.
  DEPOSITION occurs on the INSIDE CURVES.

- **<u>DEPOSITION:</u> the leaving behind (dropping) of sediment as a stream's velocity slows down.**









- **A Stream's Velocity is affected by:**

  1) **SLOPE**
  2) **DISCHARGE (amount of water in stream)**
  3) **WIDTH AND SHAPE OF CHANNEL**

- **Deposition of Sediments is affected by:**

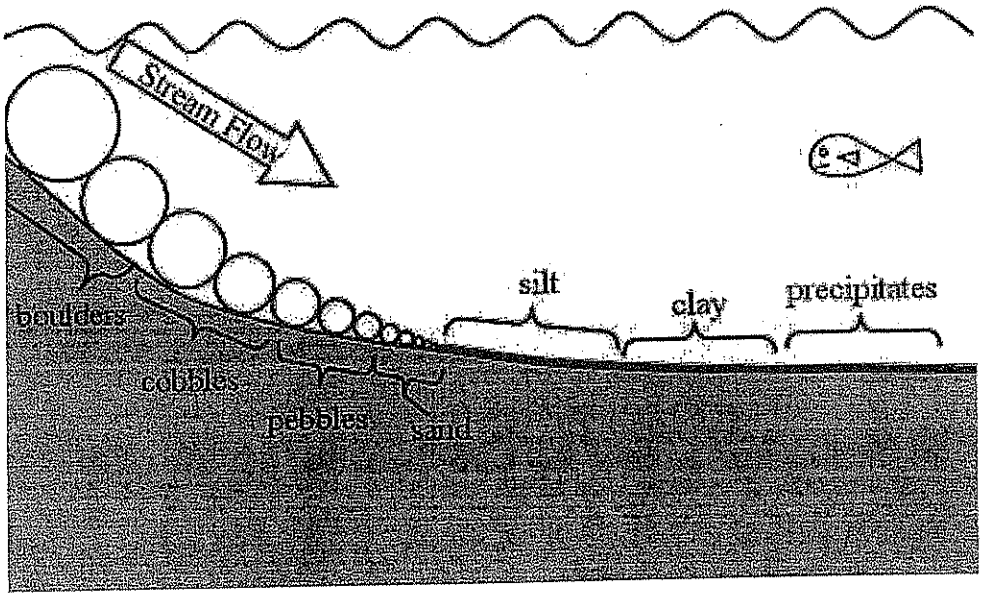
  1) **PARTICLE <u>SIZE</u> (largest particles settle faster).**
  2) **PARTICLE <u>SHAPE</u> (round particles settle faster than flat particles of the same material).**
  3) **PARTICLE <u>DENSITY</u> (if particles are the same size and shape, the heavier particles settle faster).**

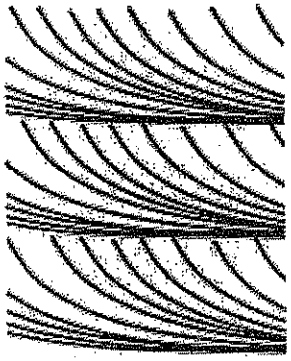
- **As sediment is deposited, particles may be either horizontally or vertically sorted.**

- **<u>HORIZONTAL SORTING</u> occurs when the larger particles fall close to shore and grade to smaller particles farther from shore. Ex: deposition by a stream into an ocean.**

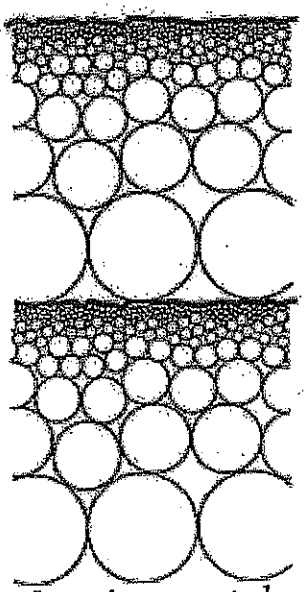
- **<u>VERTICAL SORTING</u> occurs when sediment is deposited into calm, still water. Ex: a lake.**
  Large particles are found on the bottom and smaller particles on the top.

  Such sorting may occur many times during several flood stages of a river's lifetime. We call these separate events: PULSES.



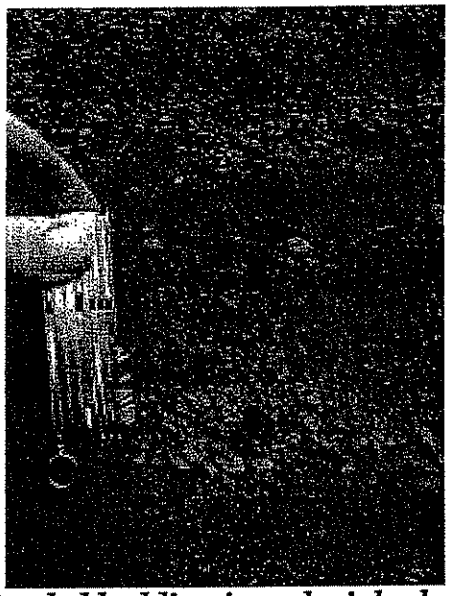


Cross Beds



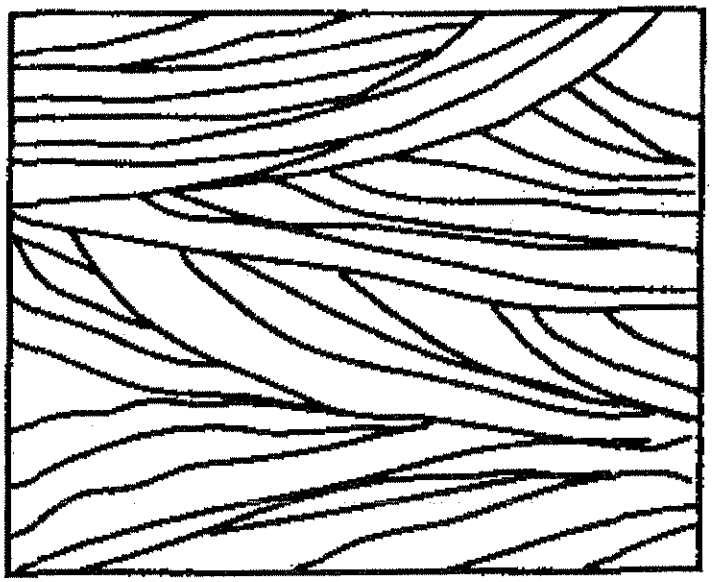
Graded Bedding

Crossbeds are formed when several horizontal sorting events happen on top of each other such as in a river delta as the stream meanders back and forth.



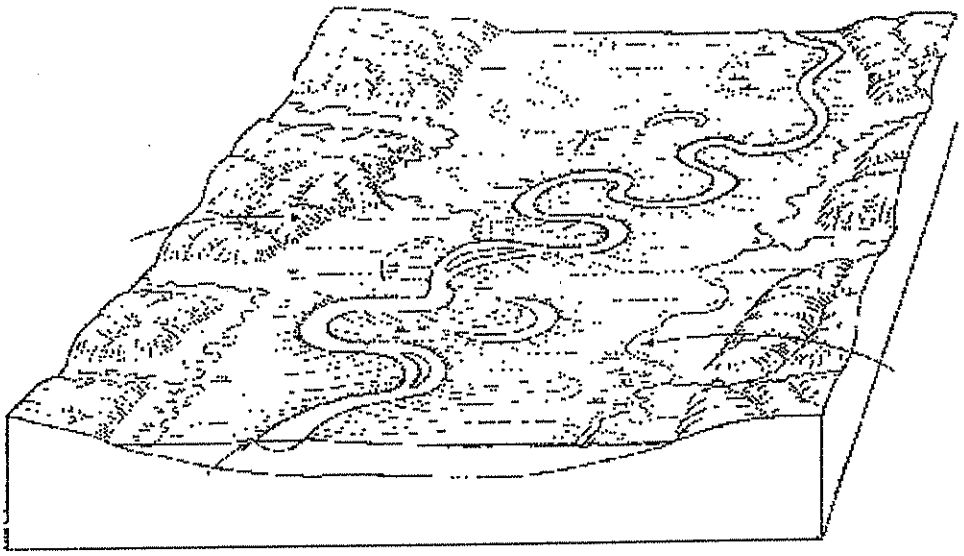
Graded bedding in a glacial esker.
-Medina NY July 2004

Graded Bedding comes from repeated vertical sorting events such as annual spring thaws.

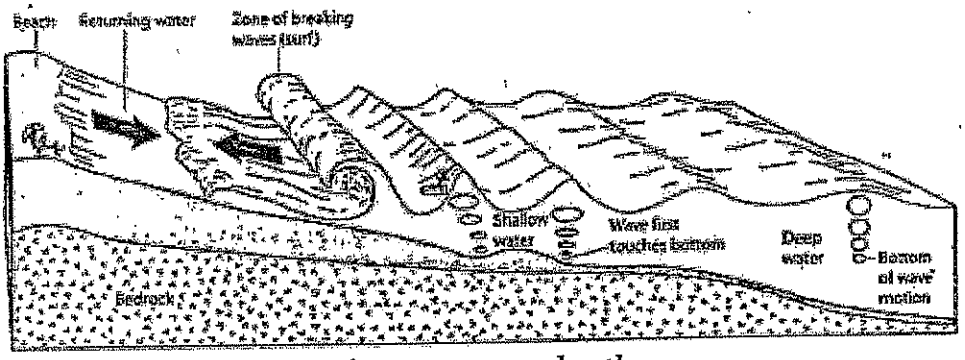


Crossbeds caused by the wandering mouth of a stream.

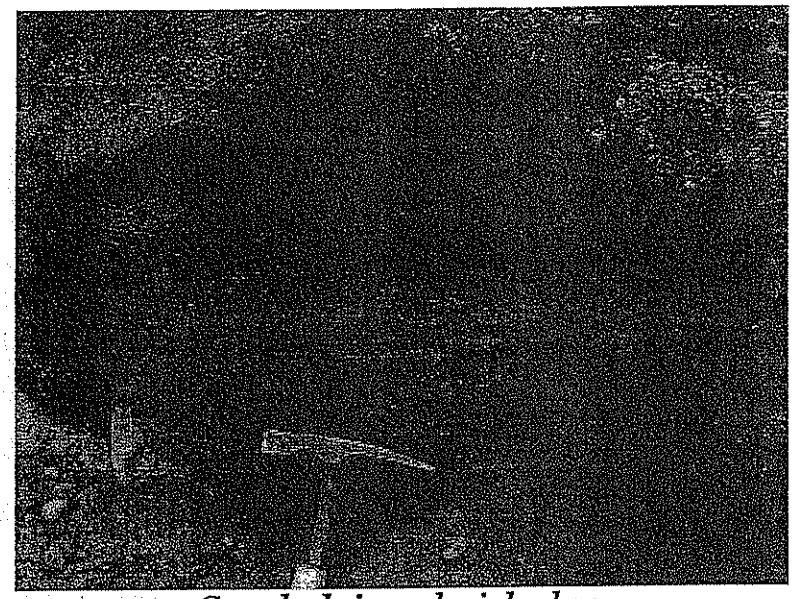
- Wide floodplain
- Low velocity
- Low gradient
- Dynamic equilibrium between erosion and deposition



Waves

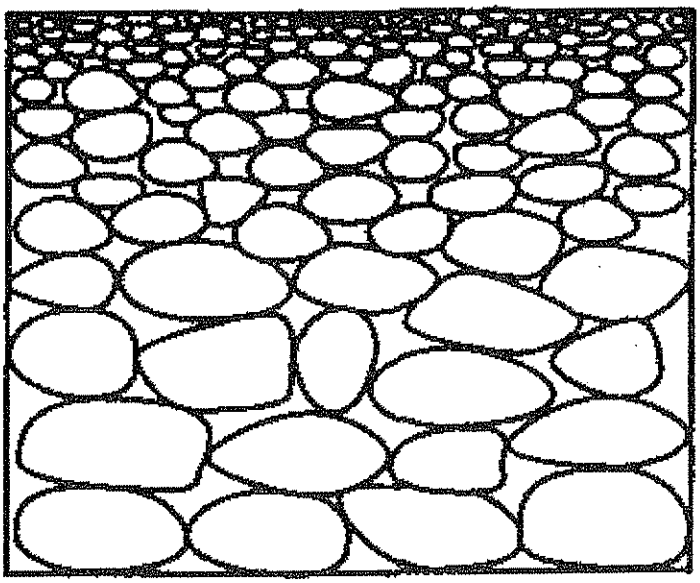


Wave action as seen under the waves



Crossbeds in a glacial esker.
-Medina NY July 2004

Vertical Sorting- caused by larger, rounder, denser sediments settling first.



Wind

- sediments are rounded and have a frosty appearance (tiny pits from impacts of flying sand) sorting occurs.
- particles are small

Ice (glaciers)

- Sediments are sharp-edged

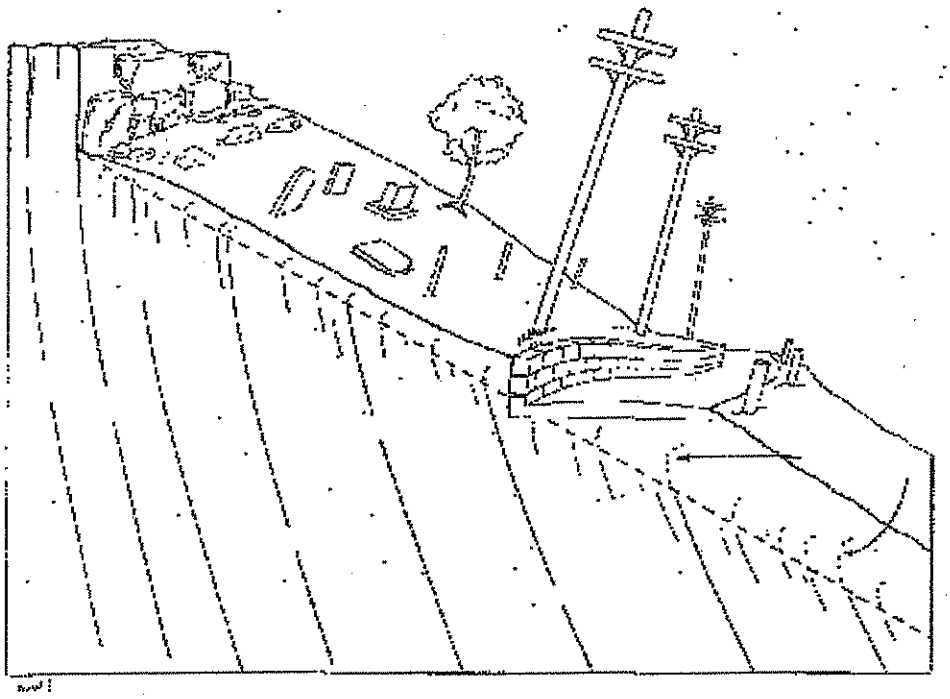
- May have scratches or a polished side where they came in contact with the ground
- Deposits are unsorted and can be very large.

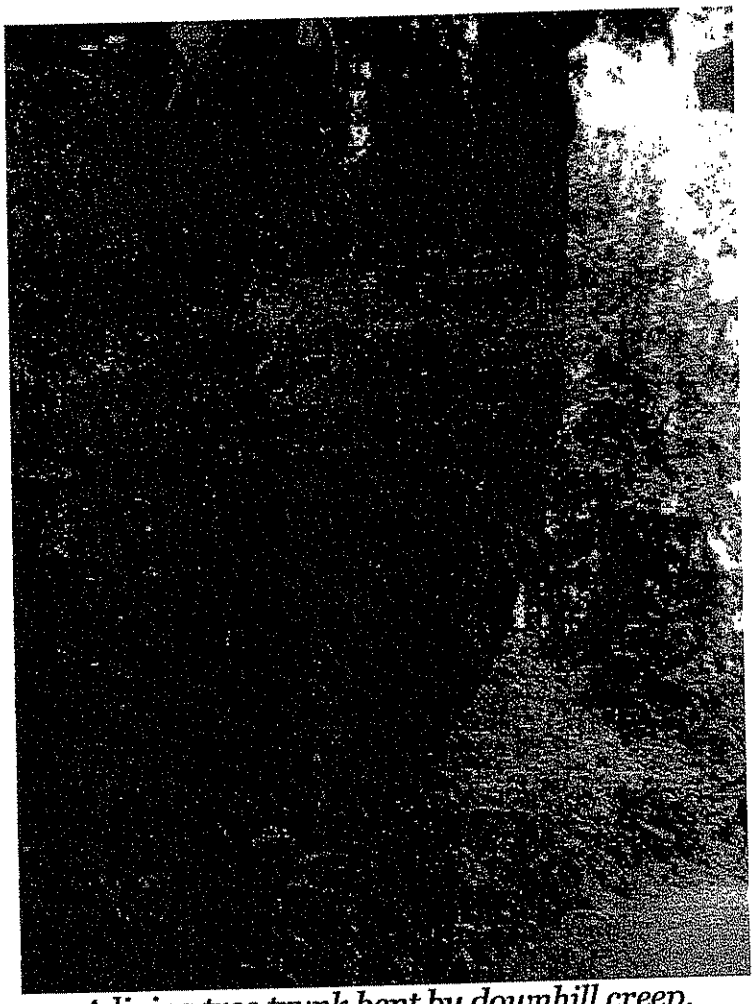
Parallel scratches in bedrock caused by the passage of a glacier.

Gravity by itself can transport sediments.

- Sharp-edged
- unsorted
- no limit in size
- often causes "mass wasting" such as landslides and downhill creep

DOWNHILL CREEP OF SOIL

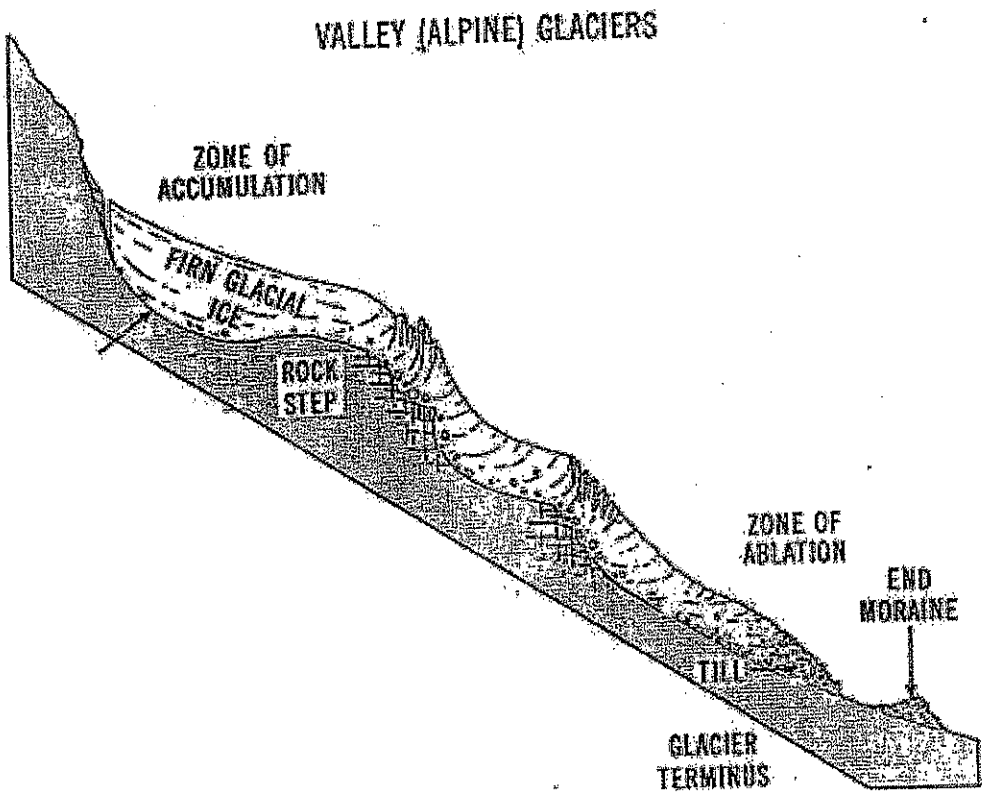




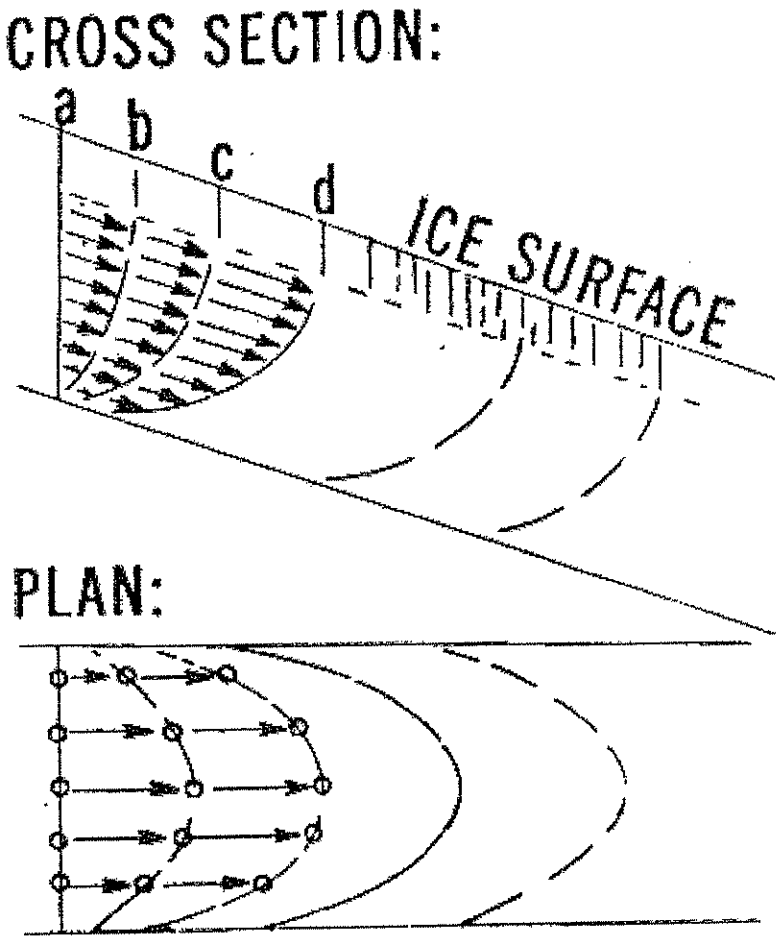
A living tree trunk bent by downhill creep.
-Medina Seattle August 2004

Erosional/Depositional Systems

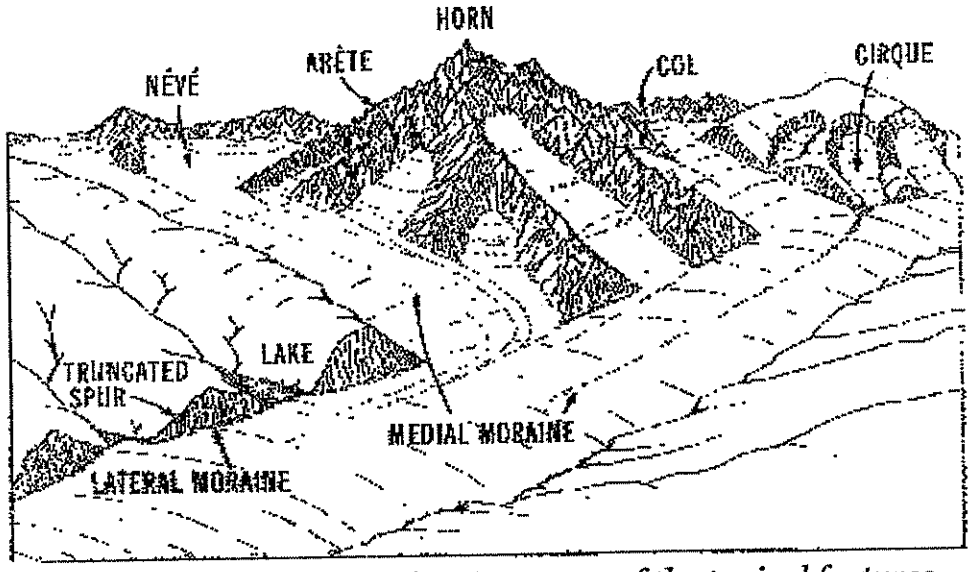
Glaciers- There are two types of glaciers: Alpine (or valley) and Continental (Ice Caps).



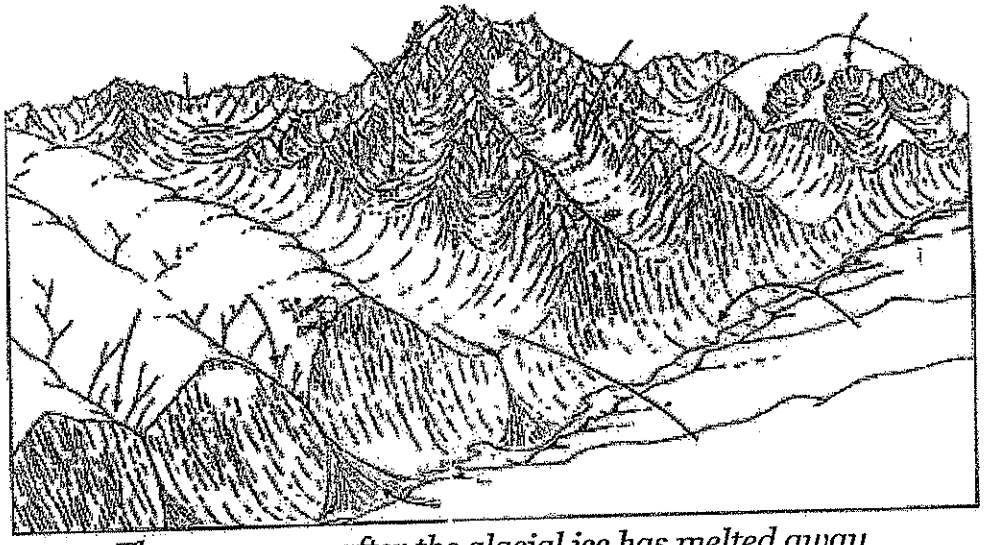
A side view of an alpine glacier.



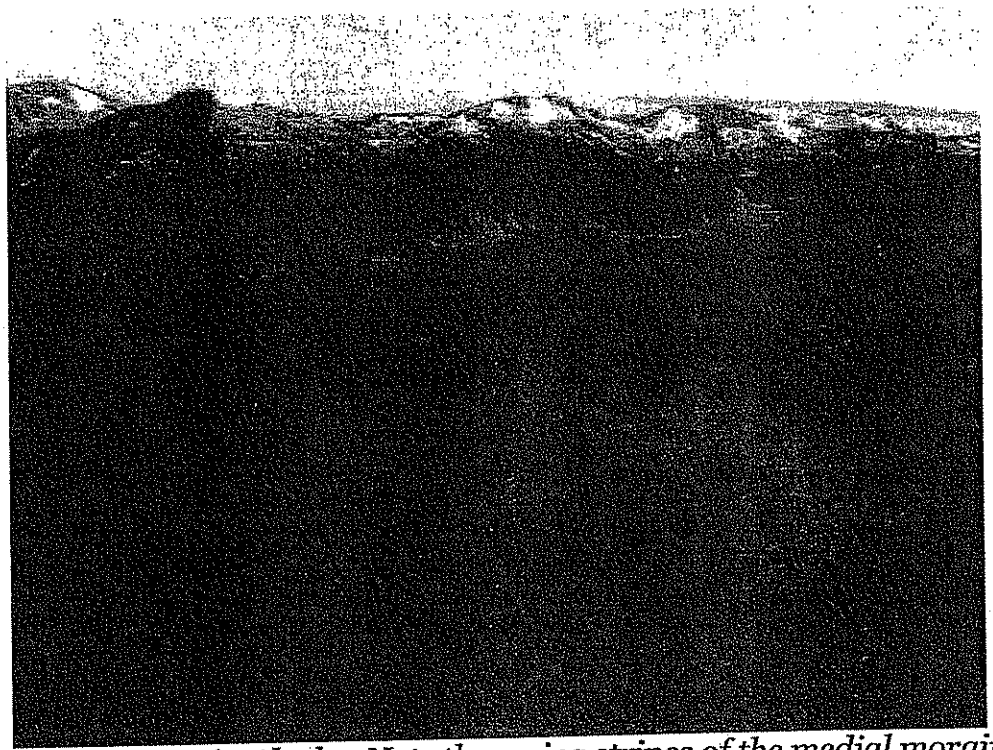
The slow motion flow of a glacier is similar to that of a river- fastest in the middle and slowest along the banks.



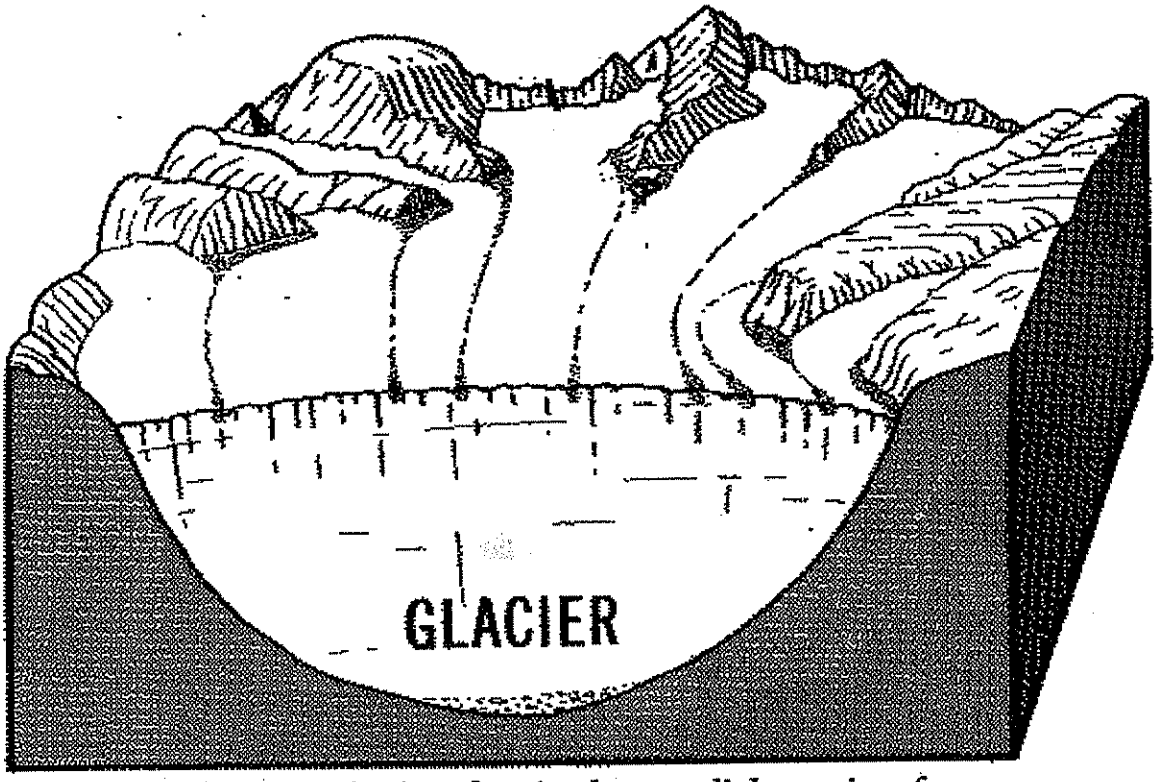
An alpine glaciated area showing many of the typical features.



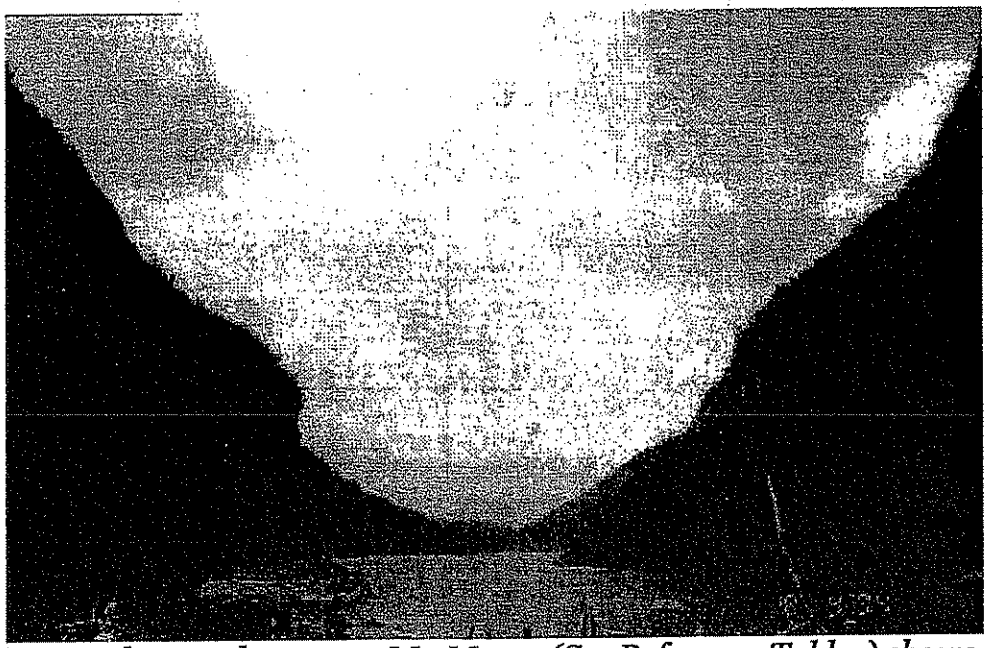
The same area after the glacial ice has melted away.



An alpine glacier in Alaska. Note the racing stripes of the medial moraines.
-Medina Aug 2004

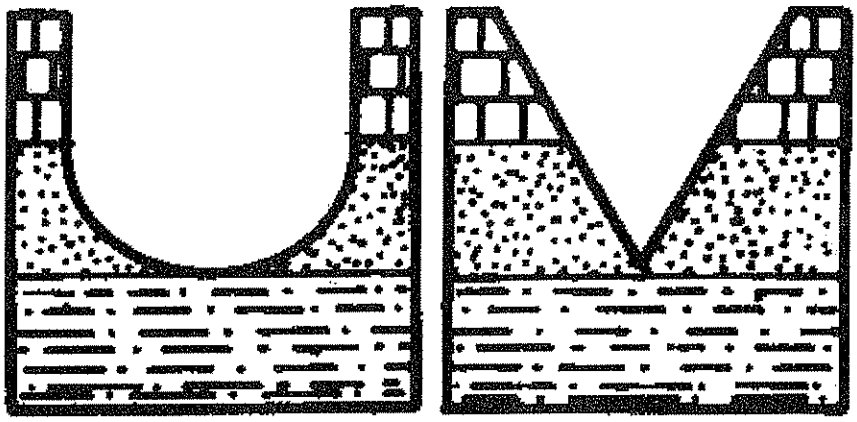


A diagramatic view showing how medial moraines form.



This picture taken on the way to Mt. Marcy (See Reference Tables) shows classic U-shaped valleys of a glaciated region.
-Medina 1994

Another U-Shaped Valley in Alaska.
-Medina August 2004



The U-shaped Valley on the left was made by a glacier while the V-shaped valley on the right was made by running water.

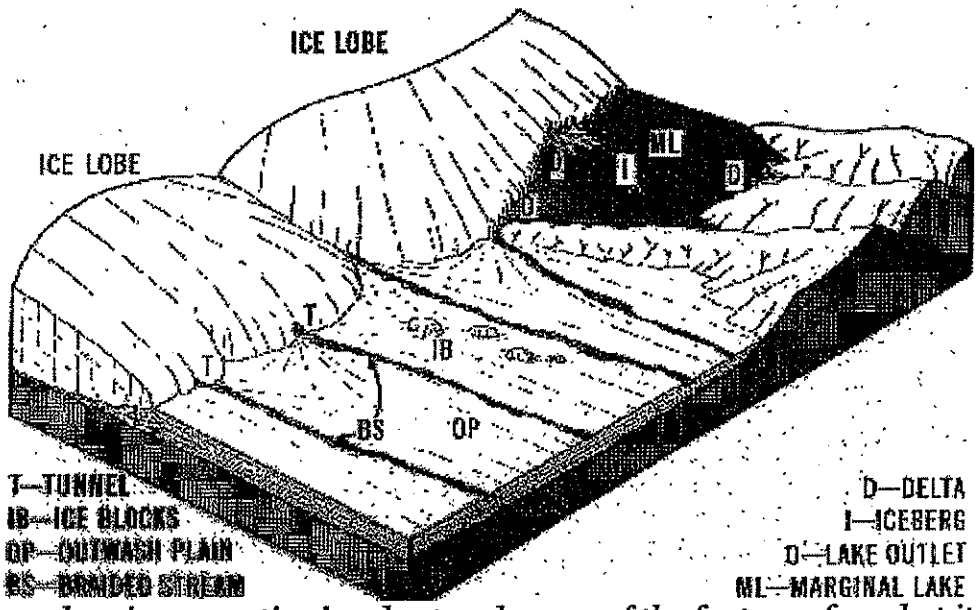
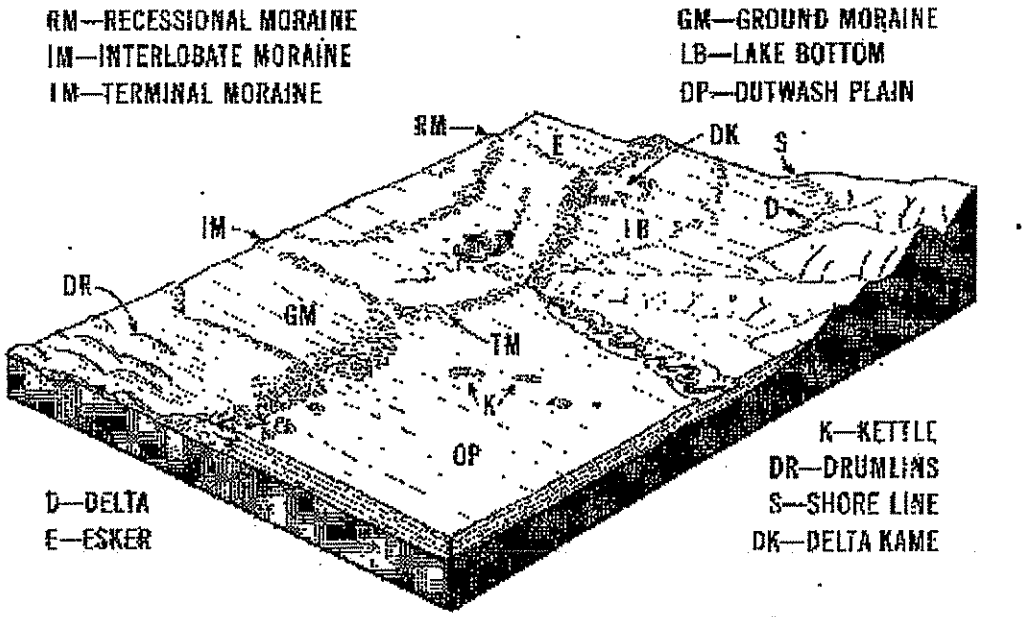


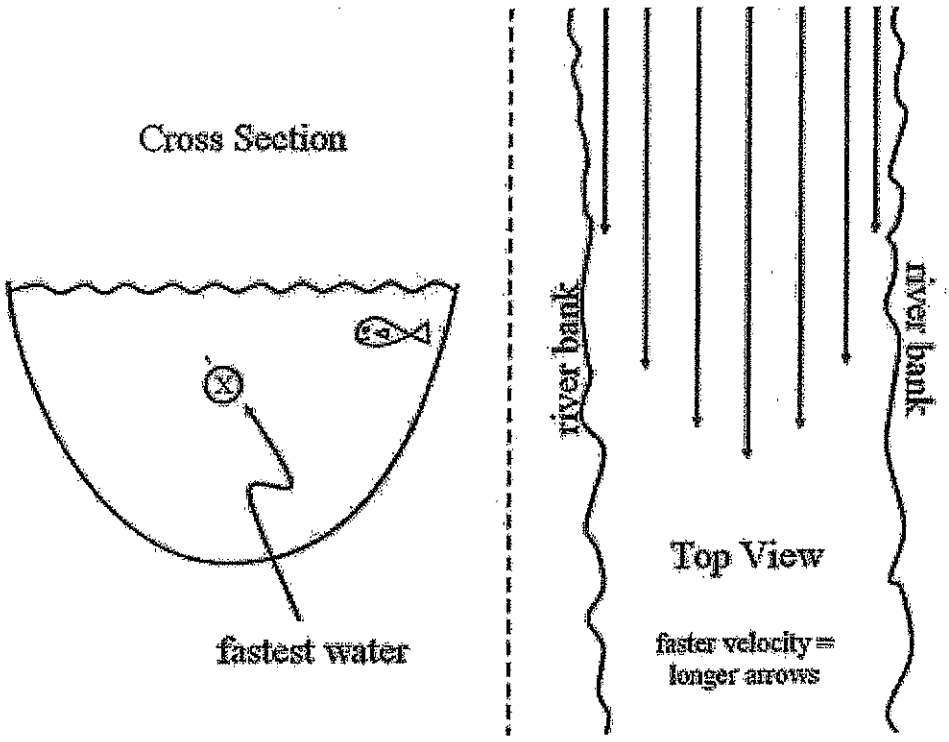
Diagram showing an active ice sheet and many of the features found at its edge.



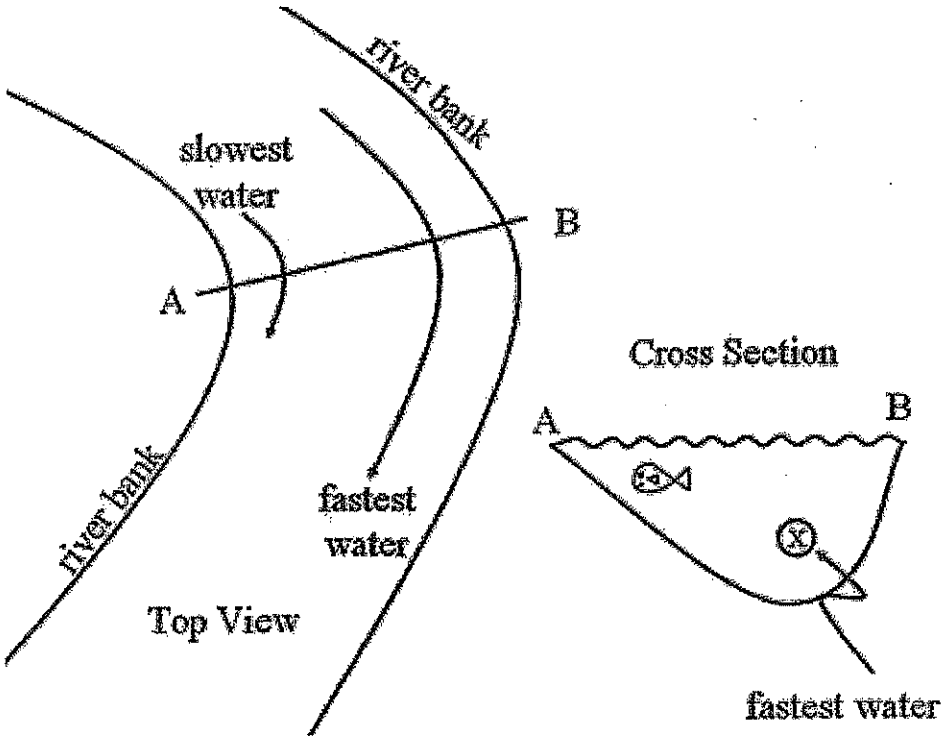
The same are after the glacire retreated.

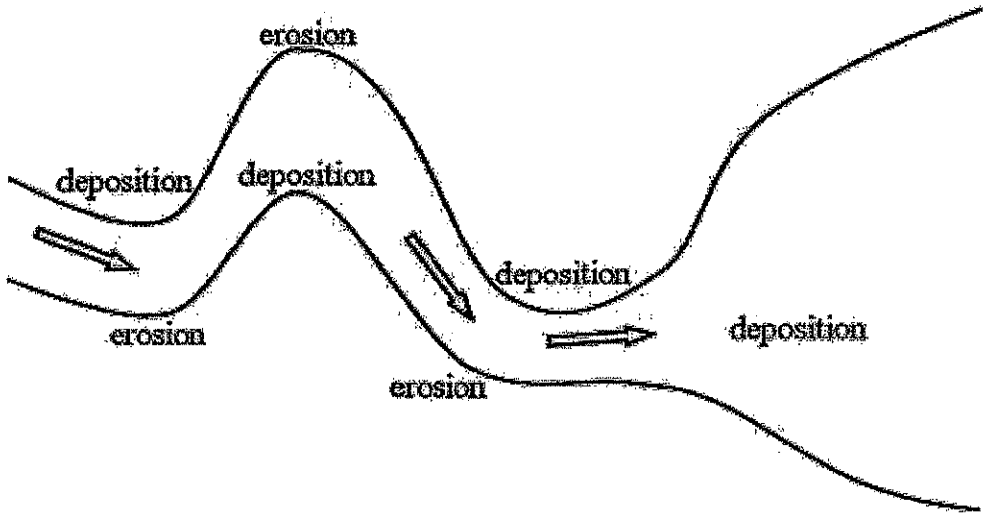
Streams

In a straight section of a stream, the fastest water is in the middle above center.



On a curve, the fastest water gets thrown to the outside and that's where erosion will happen. The slowest water huggs the inside of the stream and that is where deposition takes place.

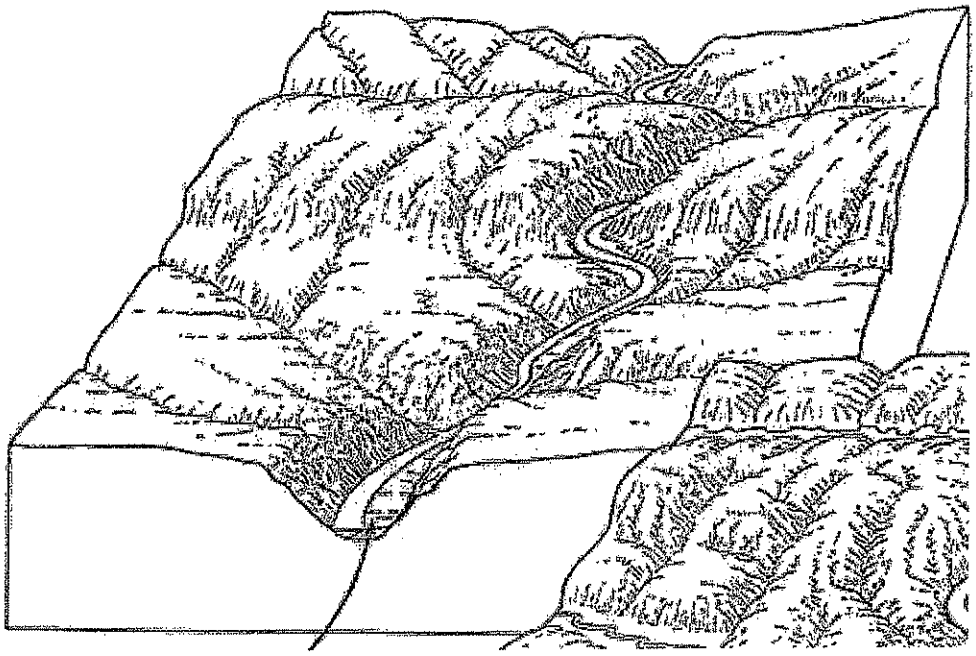




The meander widens from erosion on the outside and deposition on the inside.
The two sides of the meander erode into each other.
Water slows in the outside loop causing deposition . The loop gets cut off into an "**Oxbow Lake**" while the stream returns to a straighter course.

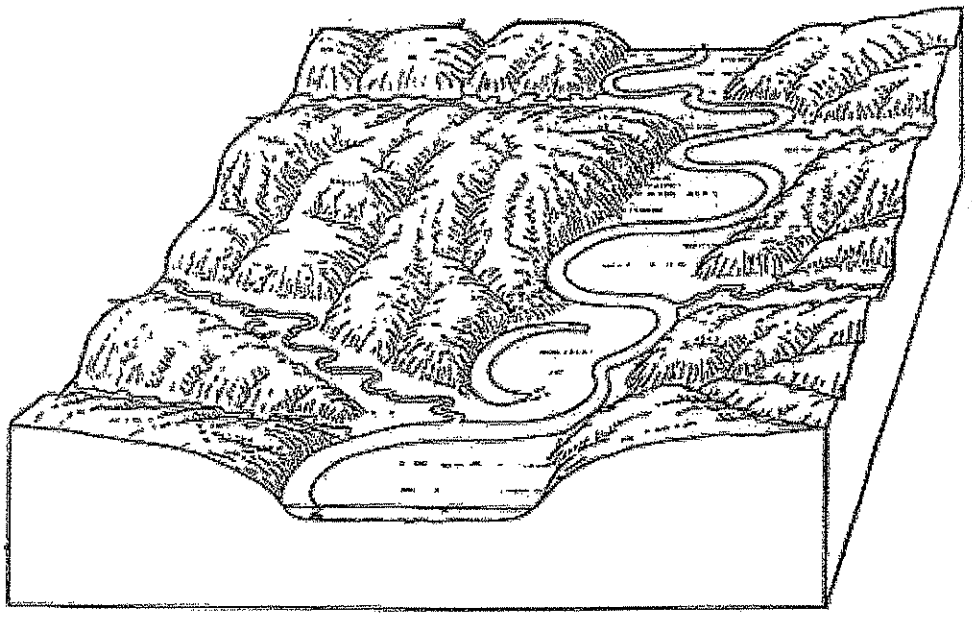
A Youthful Stream

- Narrow V-shaped
- Downcutting
- Swift water
- Steep gradient
- Erosion is dominant



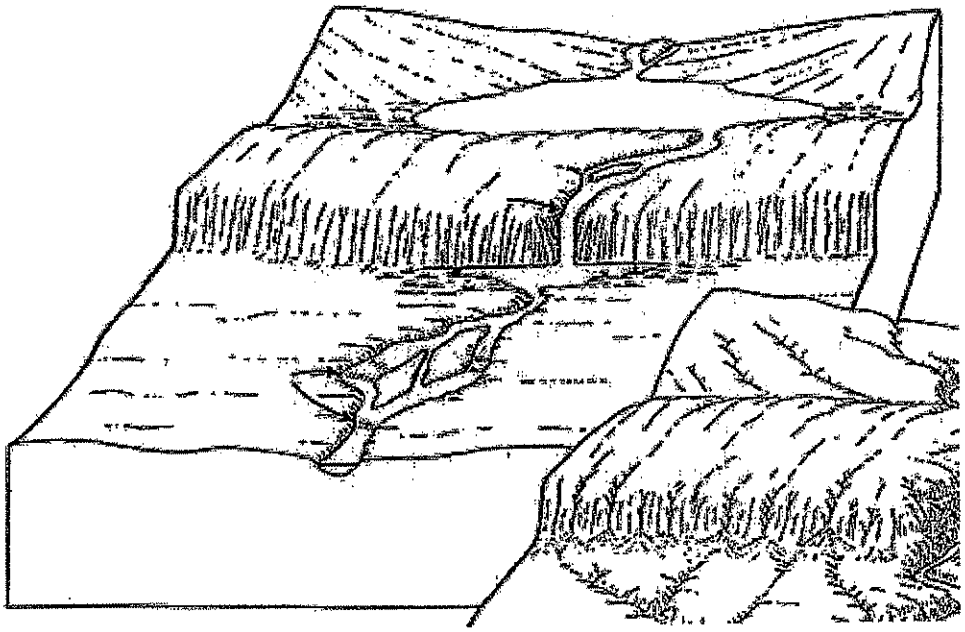
Mature Stream

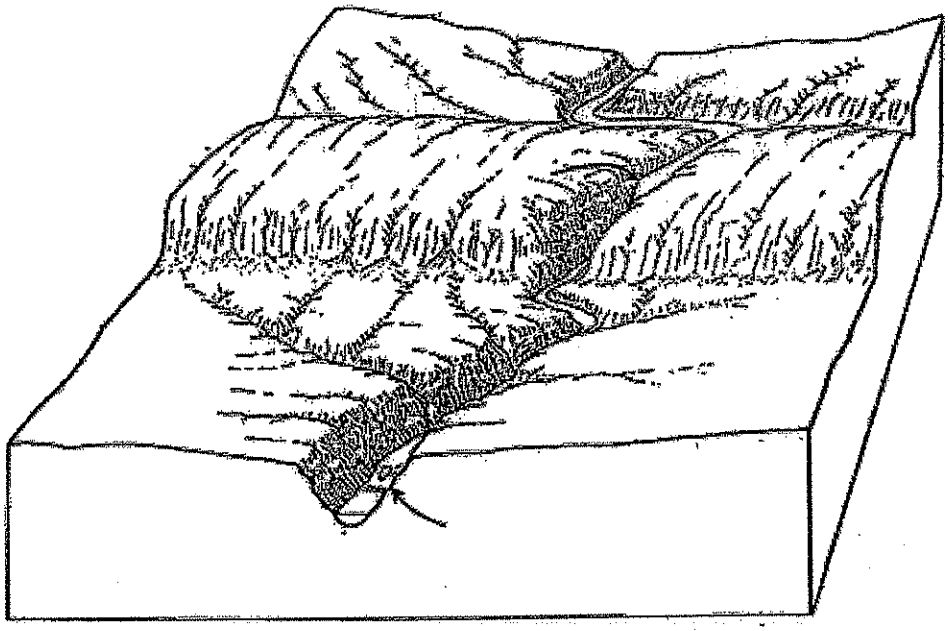
- Lateral Erosion begins
- Meanders develop
- Floodplains develop
- Gradient lowers



Old Age

- Wide meanders and oxbow lakes





Valley continues to deepen.