Weathering & Erosion

What differs about these types of weathering?

What is "weathering?"

- **<u>Weathering</u> is the break down of rocks that have been exposed to the atmosphere**

<u>Physical Weathering</u>

rocks are broken down into smaller pieces <u>without</u> changing their composition

<u>Chemical Weathering</u>

rocks break down as their minerals <u>change</u> in composition (they become different substances)

How fast a rock weathers is determined by:

1.)The **amount** of **material exposed** **at surface**

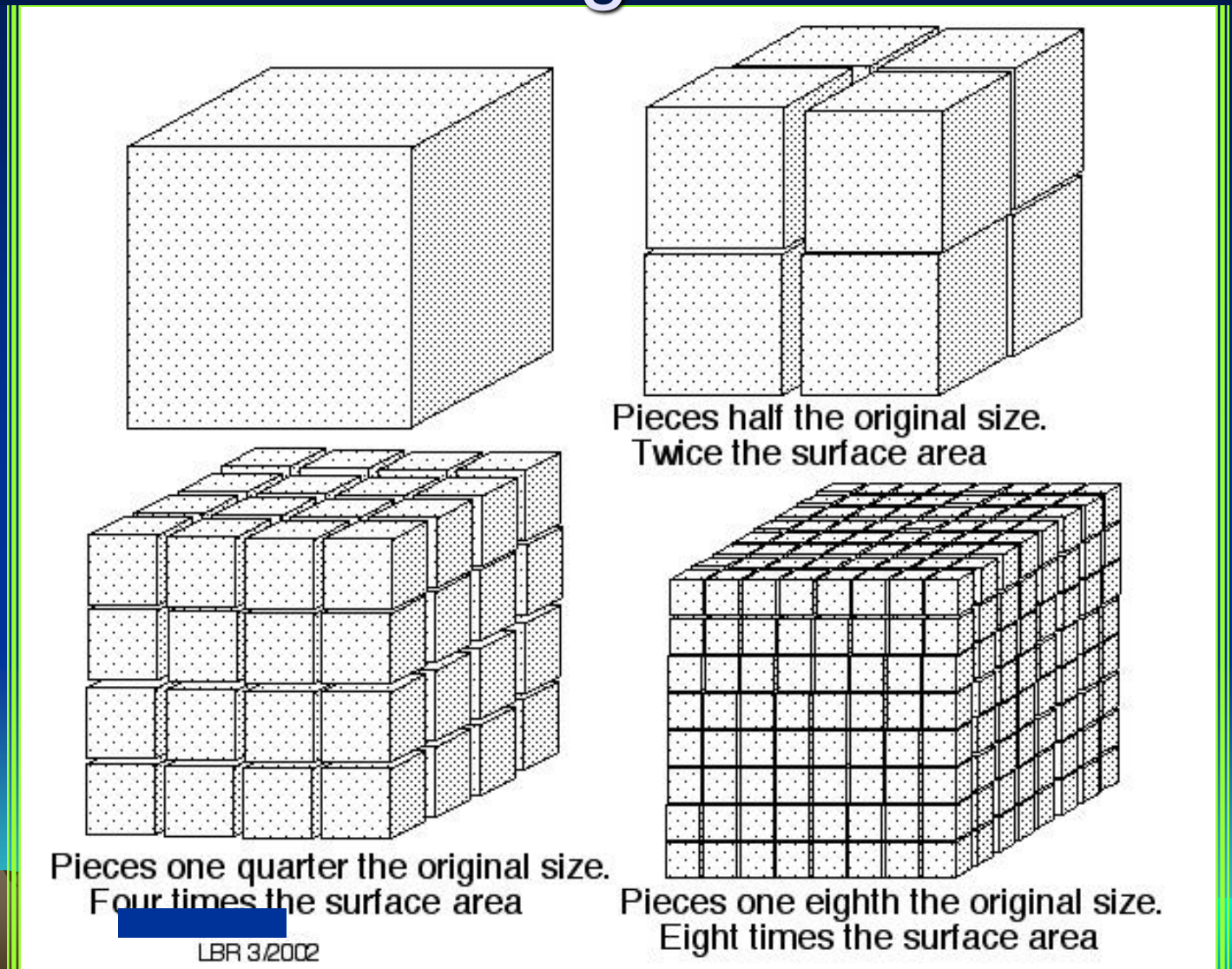
2.)**Climate-** Average moisture and/or heat available over time in a geographic location

3.) **Mineral Composition**:

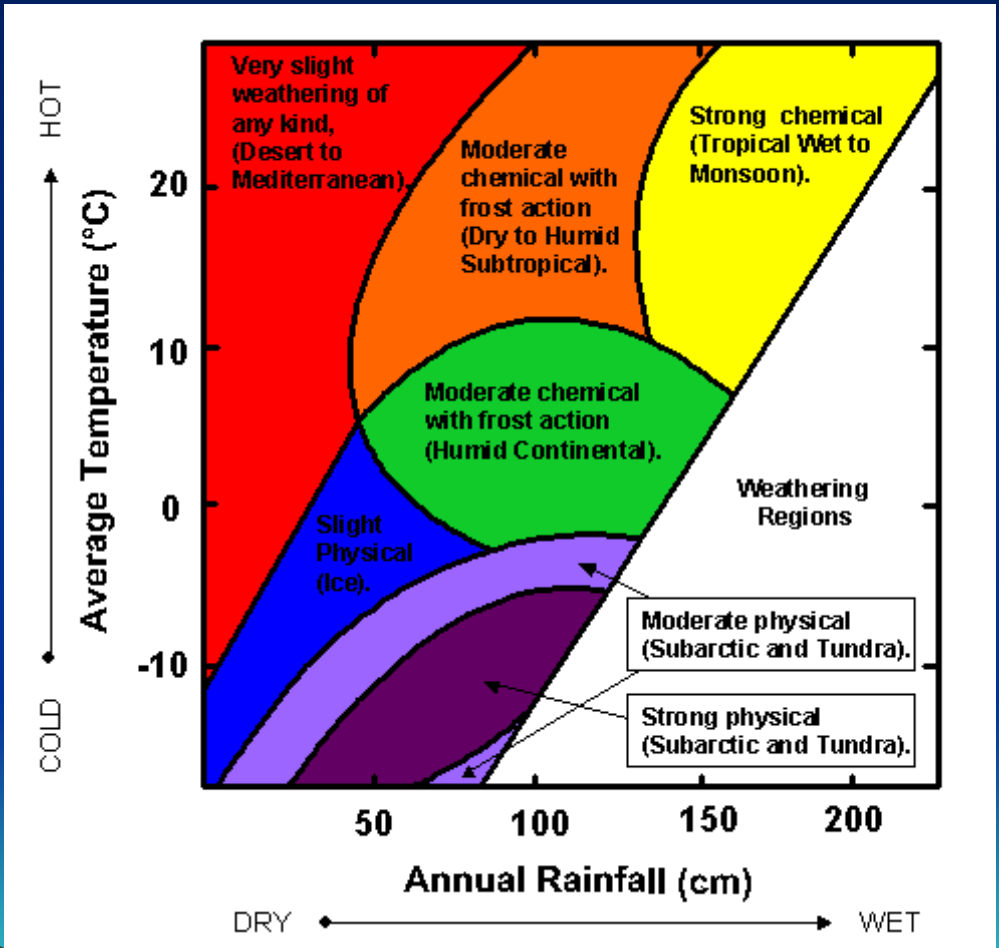
-**Chemical**: some minerals react with natural acids

-**Physical:** Some minerals have a greater hardness and are more resistant

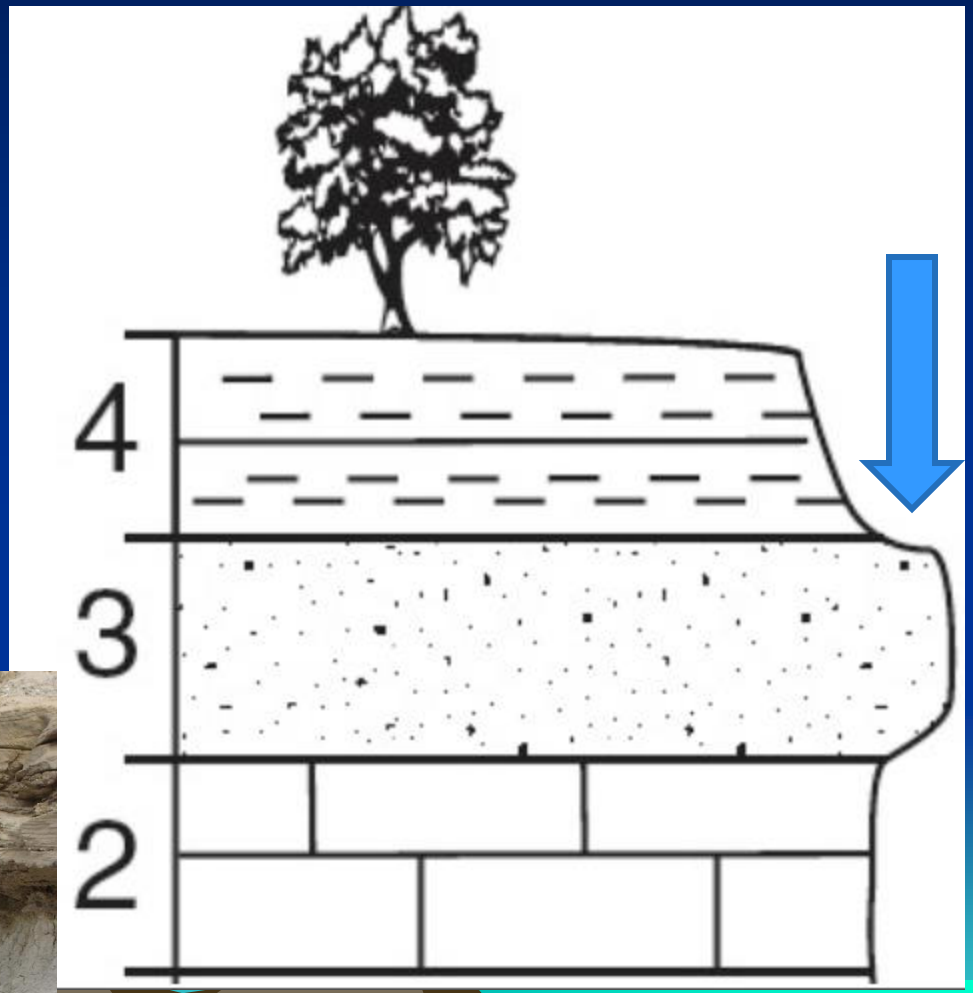
As surface area increases, rate of weathering will increase



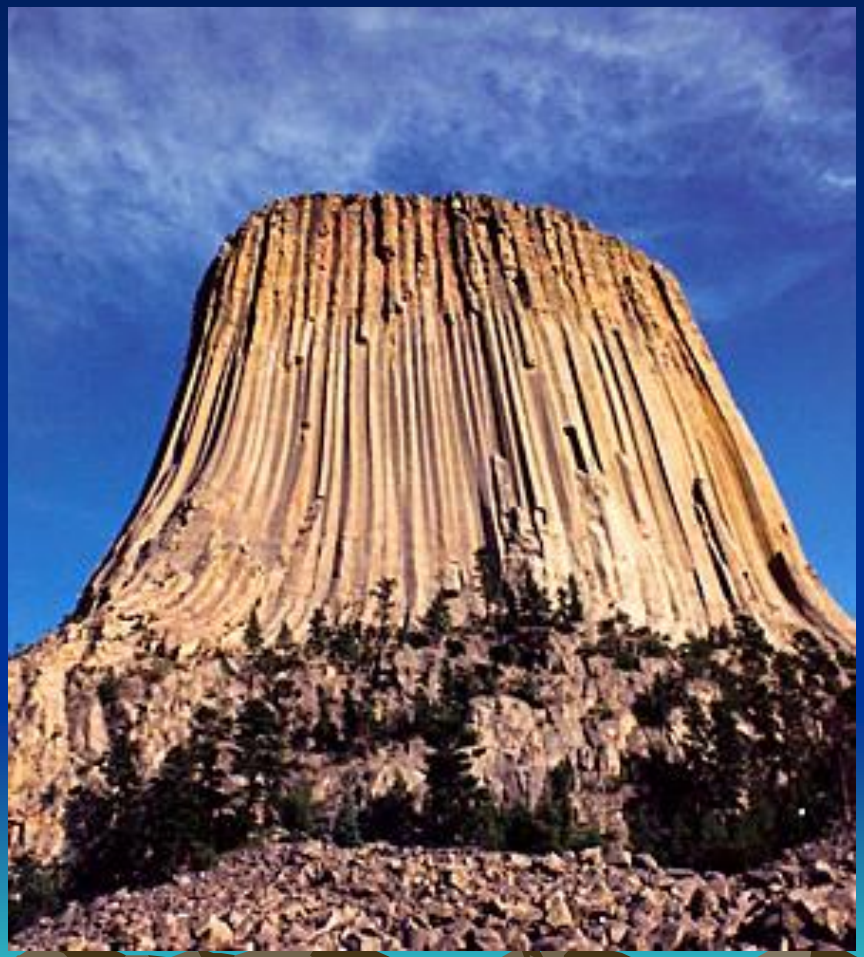
Dominant Physical or Chemical Weathering in an area depends upon the climate



Key Concept: The more resistant rock will be weathered less than the weaker ones



Devils Tower, Wyoming

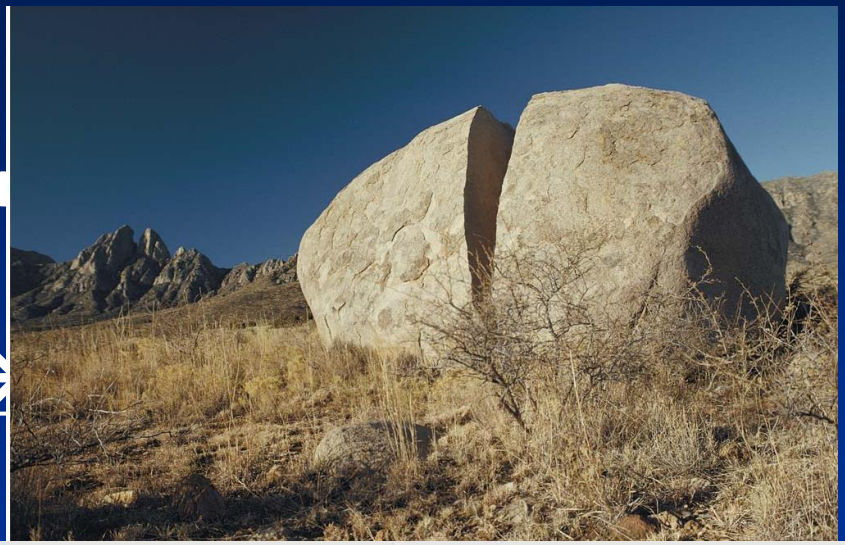


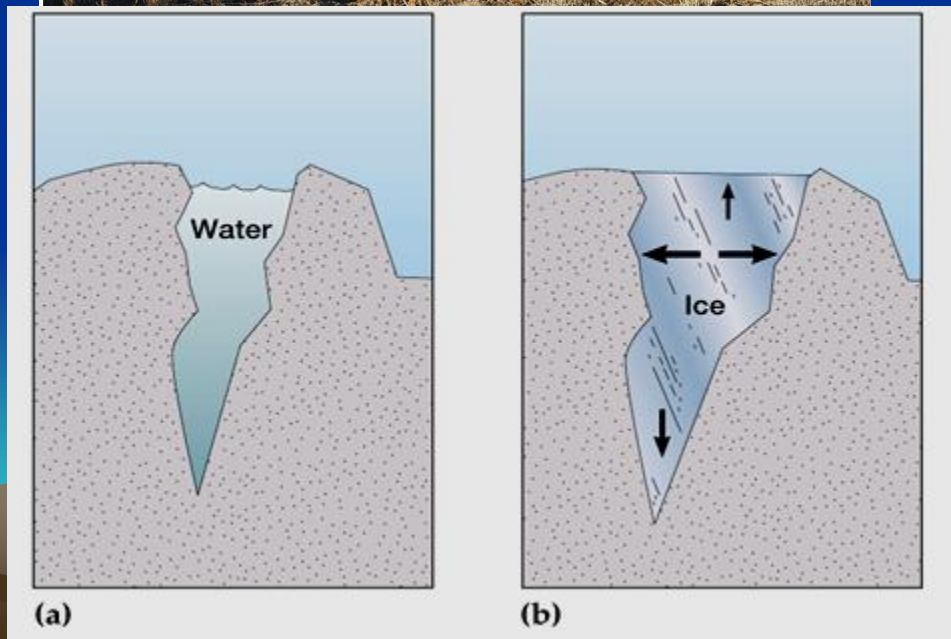
- **All that remains of this ancient volcano is the central “plug” of solidified and very weather-resistant igneous rock**

Types of Physical Weathering:

1.)Ice wedging/frost action

- water enters small cracks i the rock
- Water freezes→ expands→ forces the cracks to open more
- repeats until the rock breaks apart

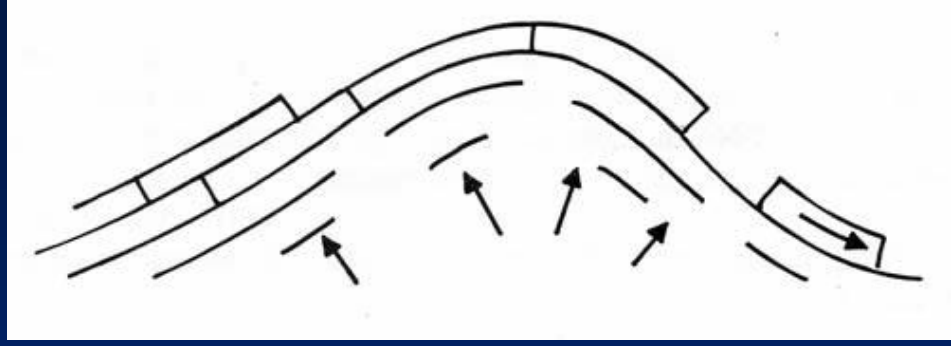




2.) Wetting and drying

- breaks up rocks/Sediment made from clay
- When wet they expand, and as they dry they shrink
- As this repeats over and over, the clay becomes weak and cracks

- 3.) Exfoliation or "Unloading"

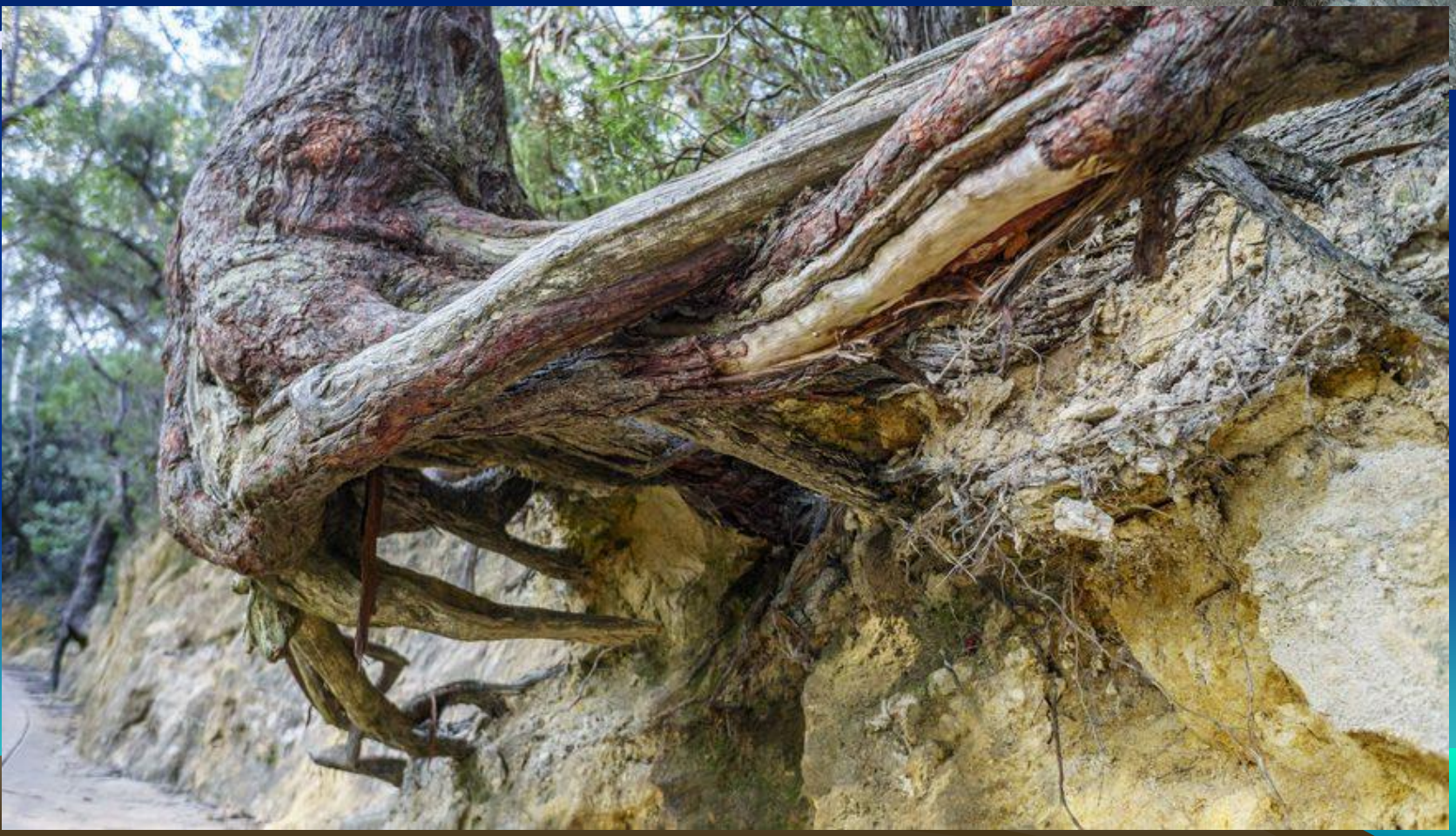


-when rocks are uplifted and exposed the pressure on them ↓

-rock surface then expands and "sheds" its layers

4.)Root Wedging

- Roots Grow and Force Rock Apart



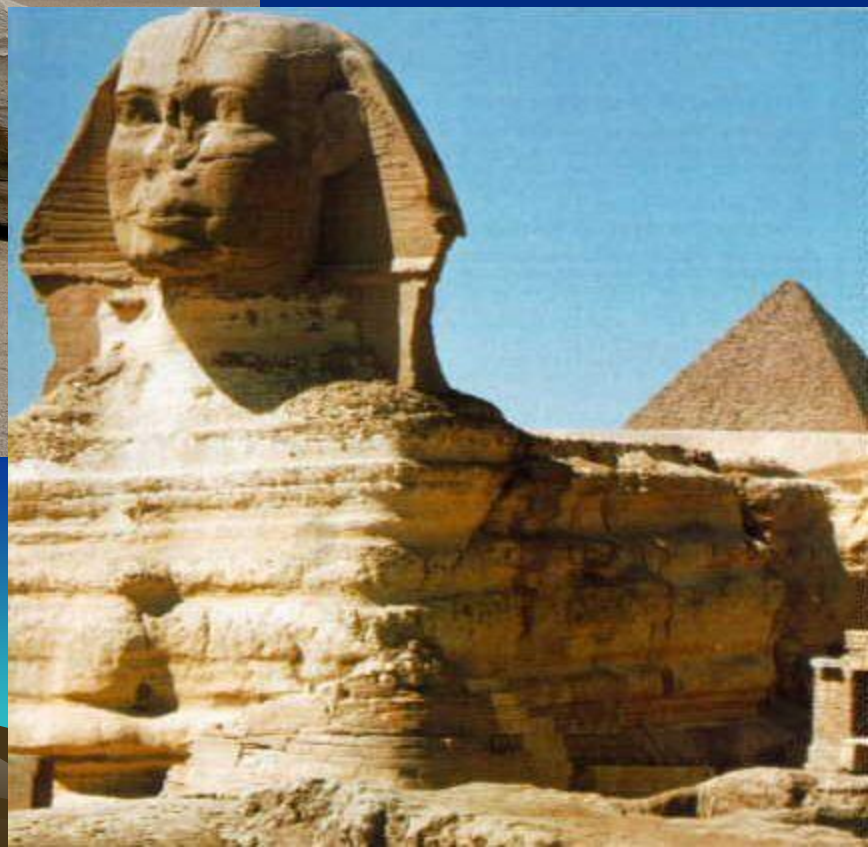
5.) Abrasion by Water: tumbling → Spheroidal pebbles

- Water carries sediments and tumbles them eventually making them smooth. The longer they are carried, the smoother they become

6.) Abrasion by Wind

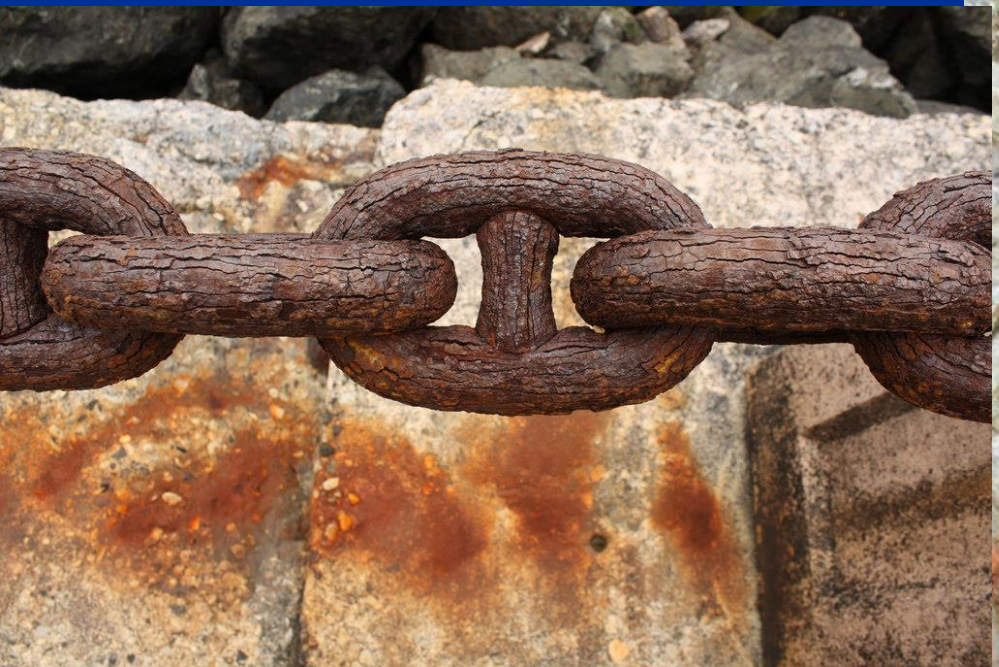
- Arid regions with little or no vegetation carry airborne sediments in wind currents which over time smash and erode the rock surface

Mushroom rocks, pitted rocks, and Ventifacts



Chemical Weathering

- 1.) **Oxidation**
  - **oxygen reacts with some minerals, especially those containing iron (magnetite, hematite) to form rust (iron oxide)**



$CO_2(aq) + H_2O \leftrightarrow H_2CO_3(aq)$

2.)Carbonation from Carbonic Acid aka “Acid Rain”

- Water in atmosphere mixes with CO2 to form weak acid

$$CO_2(aq) + H_2O \leftrightarrow H_2CO_3(aq)$$

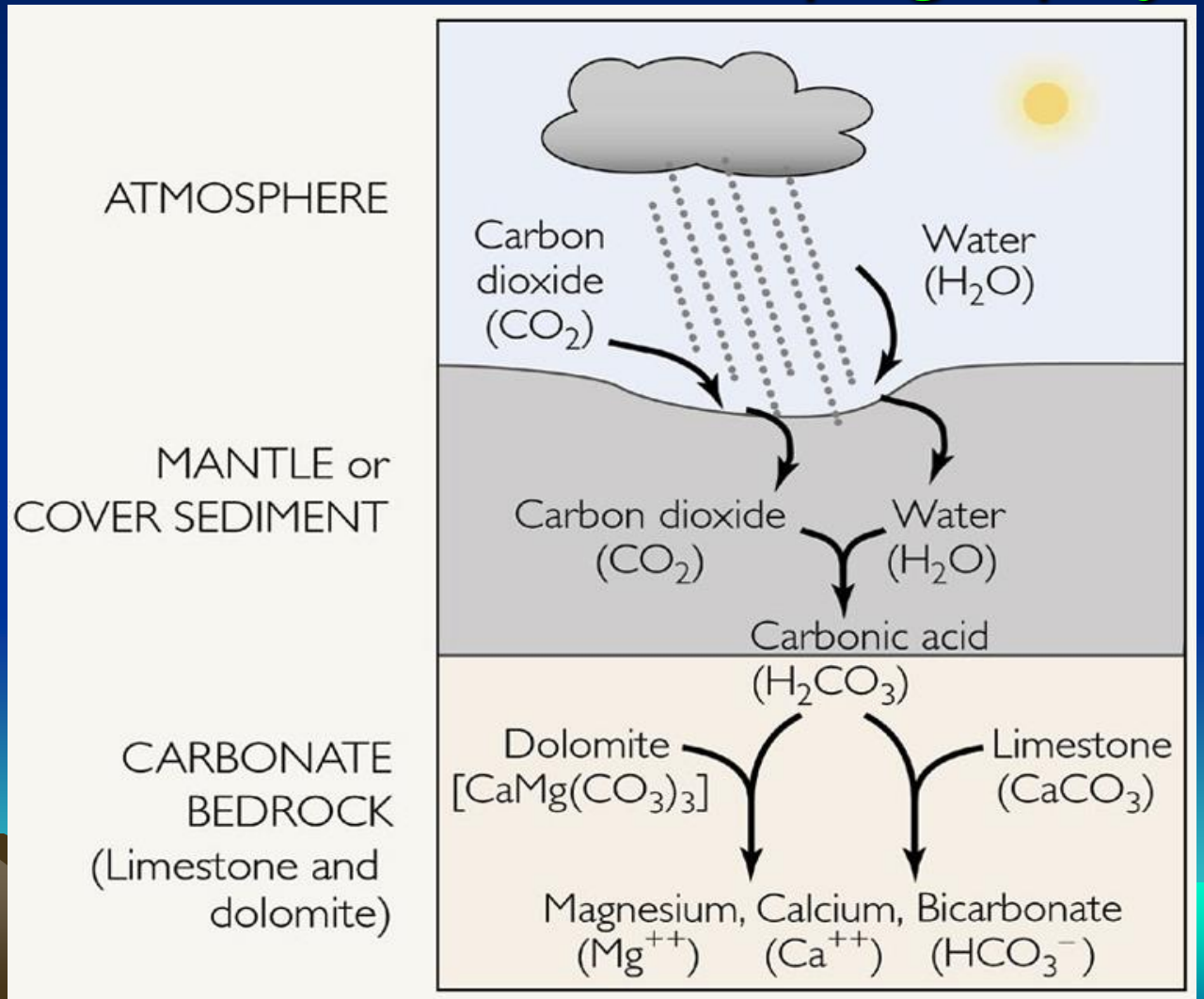
Rocks/ Minerals that weather with acid:

- a.) Calcite (mineral)

- b.) Limestone (made of calcite)

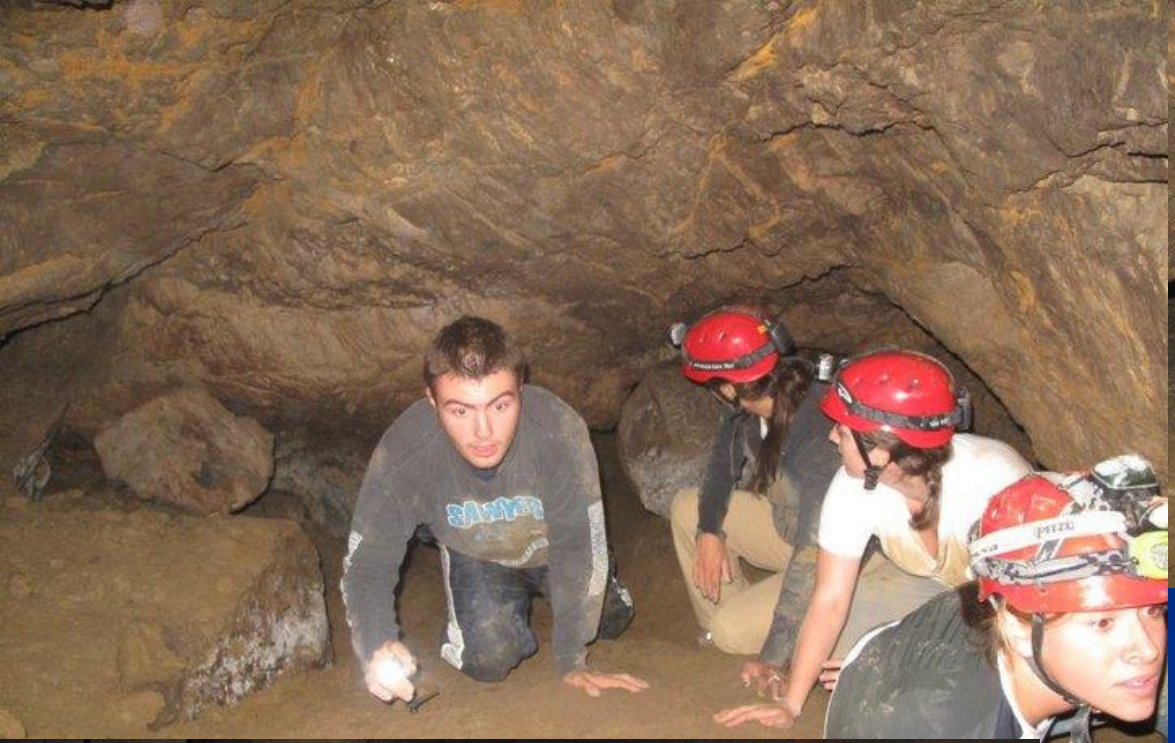
- c.) Marble (made of calcite)

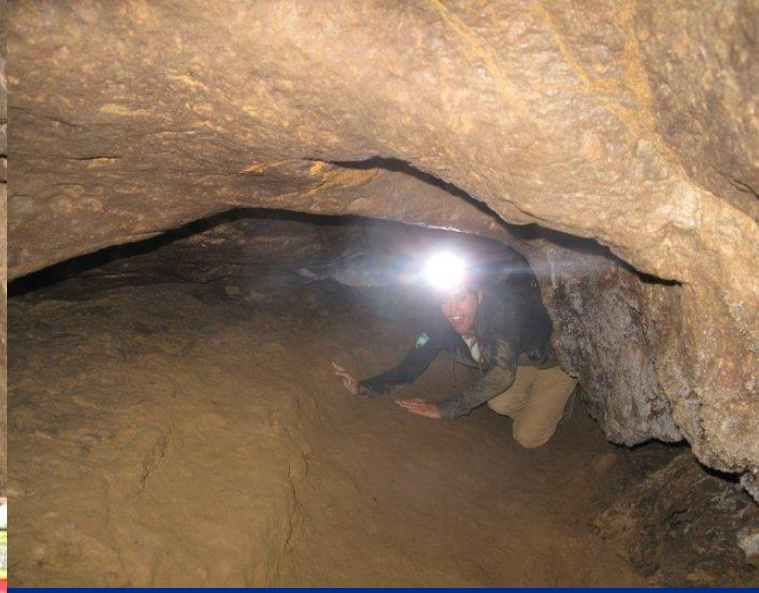
Weathering from Carbonic Acid also creates caves and sinkholes. These areas are referred to as "Karst" topography



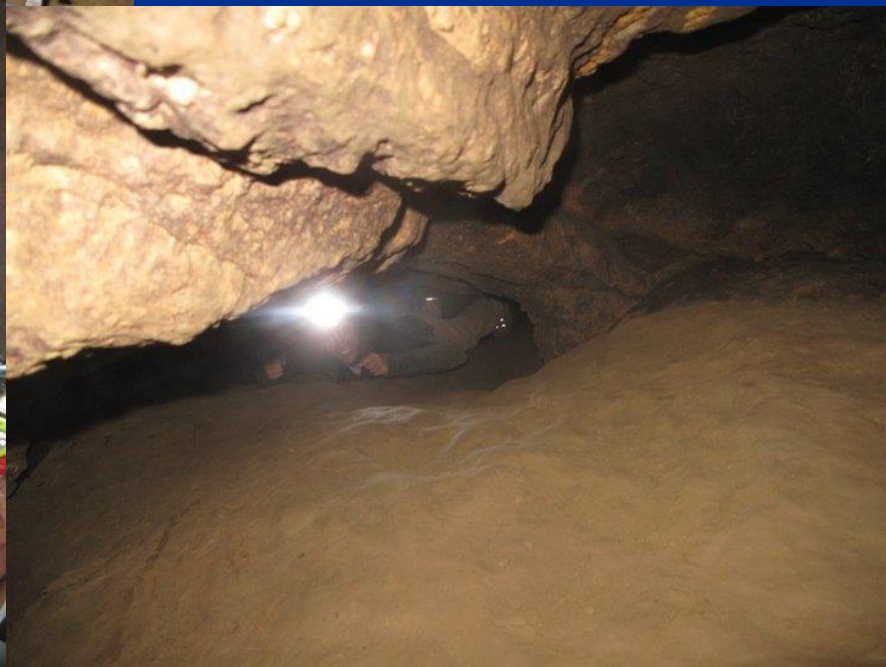
Looking at karst topography from the surface

(you can see the rock dissolved along the joints)

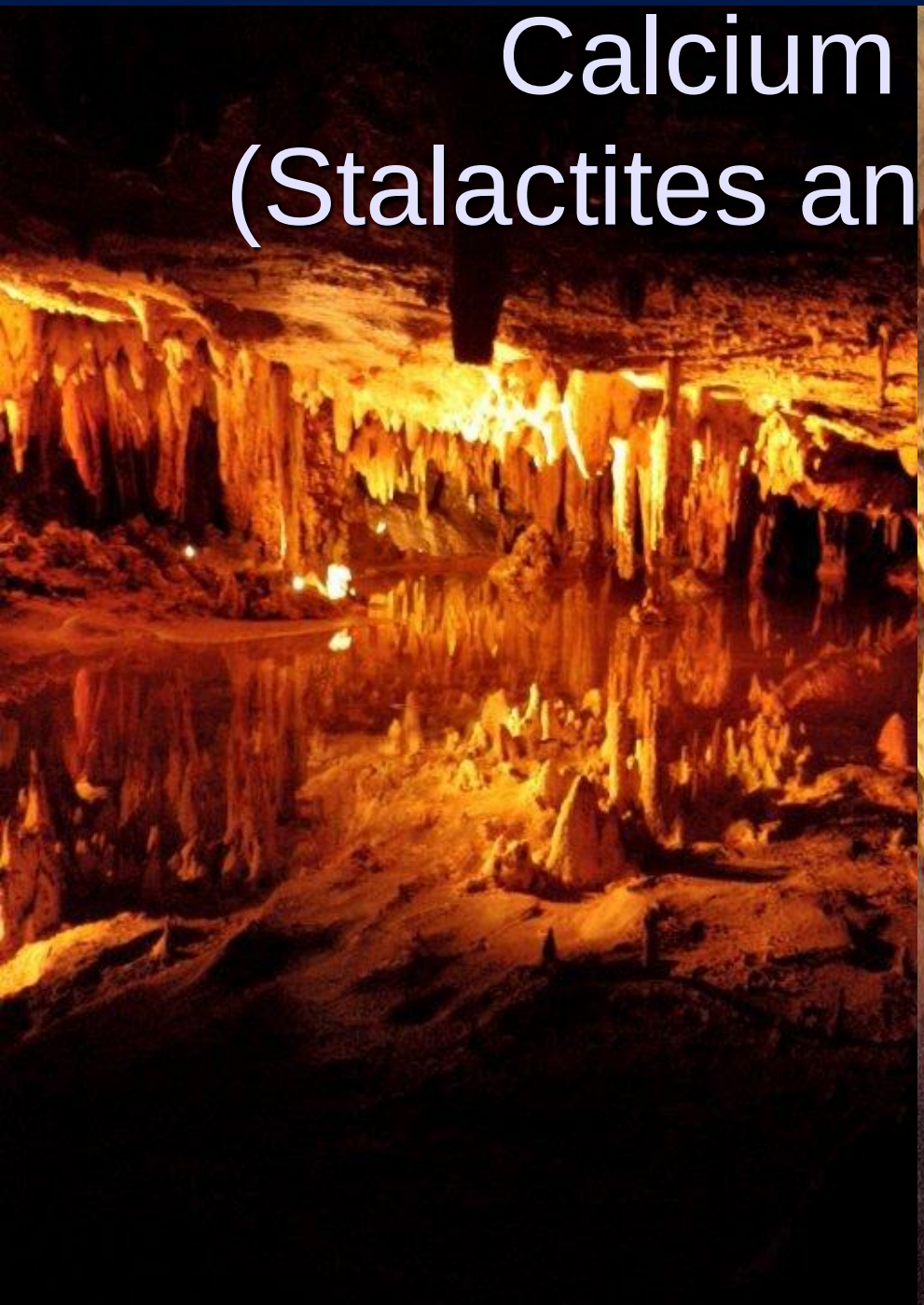


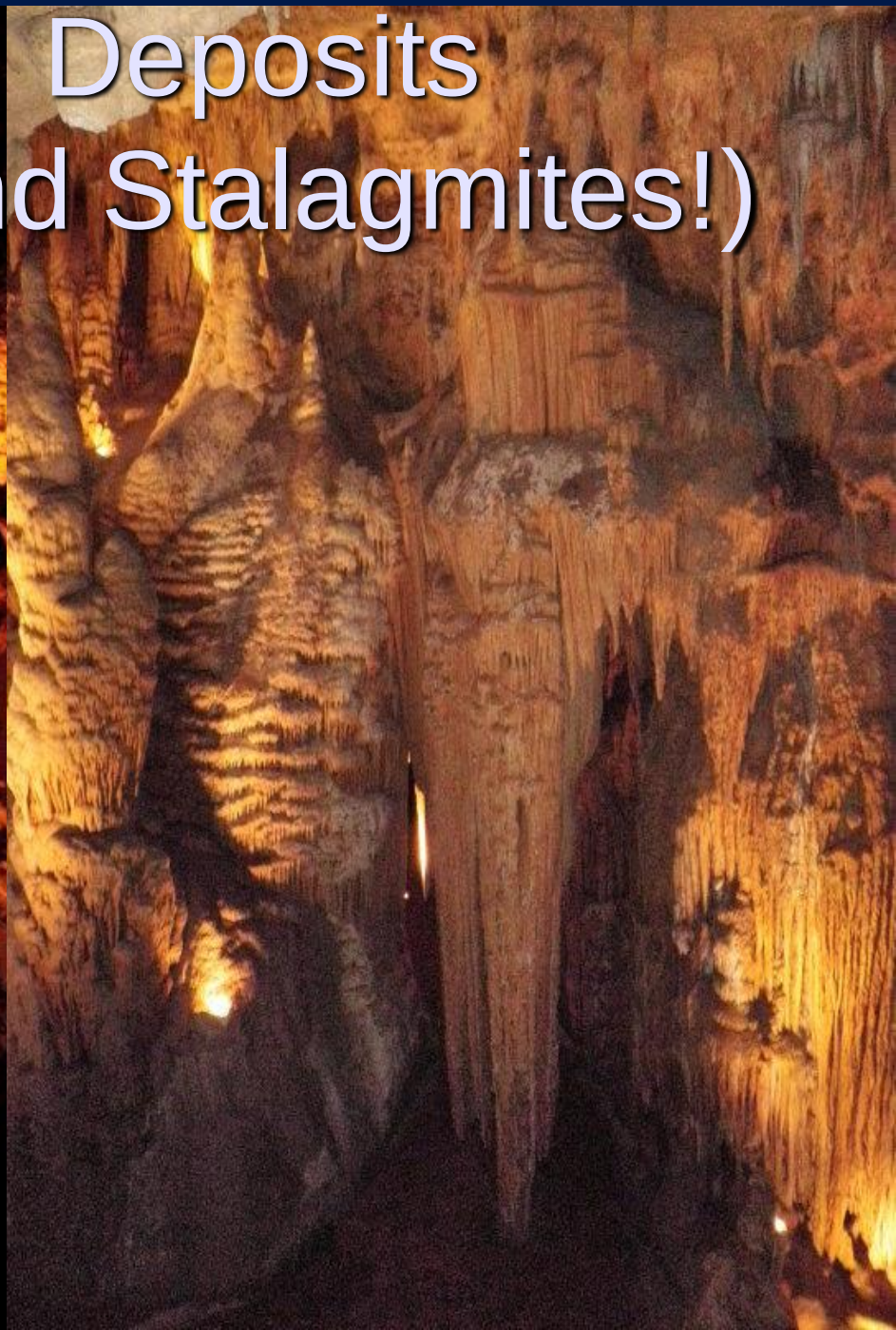



NEW PALTZ



Calcium Deposits (Stalactites and Stalagmites!)





When enough of the limestone is dissolved under the ground, it will collapse forming a sinkhole

Anywhere that's underlain by large volumes of limestone is a risky area to build on

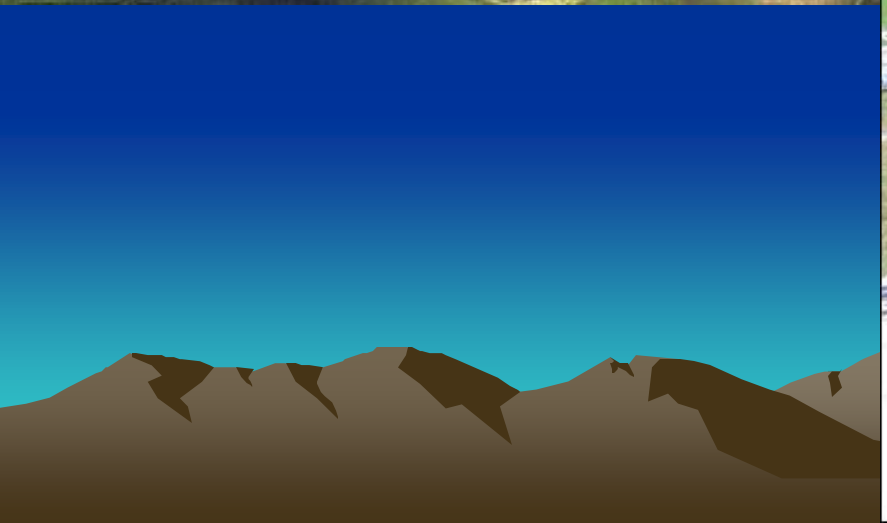


Photo courtesy of Doug Gouzie, 2006

3.) Hydrolosis

- water (hydro) reacts with minerals such as feldspar→forms clay

EROSION PART II

- Erosion: is the transport of weathered materials over time

AGENTS OF EROSION

- The forces or materials that transport or move sediments are:

1. Gravity
2. Wind
3. Running water (streams/ rivers)
4. Glaciers
5. Waves

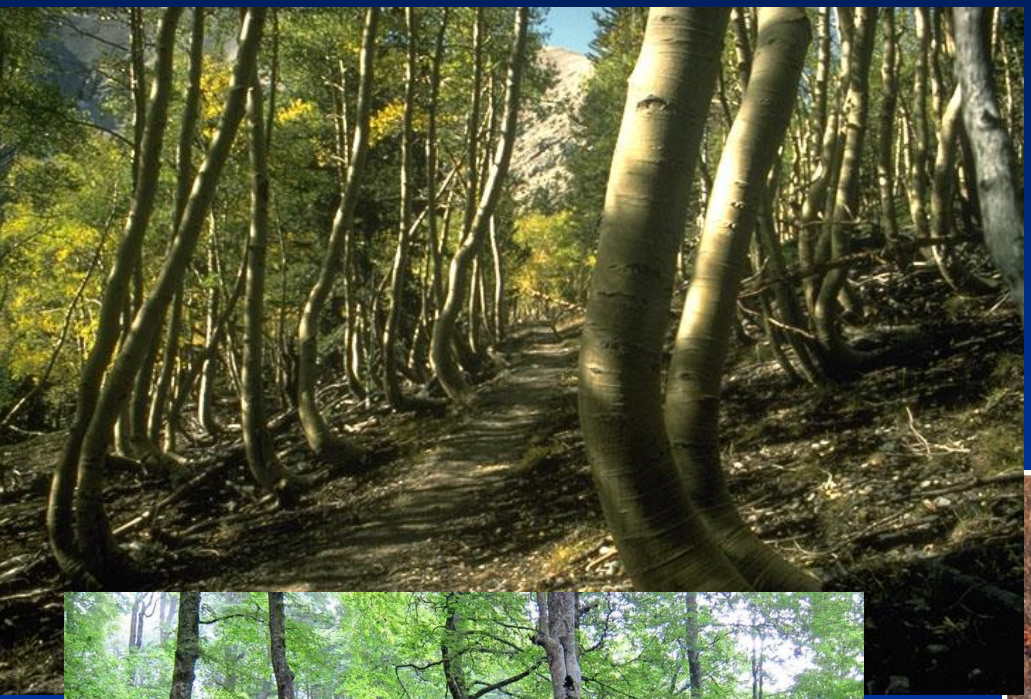
Erosion by Gravity

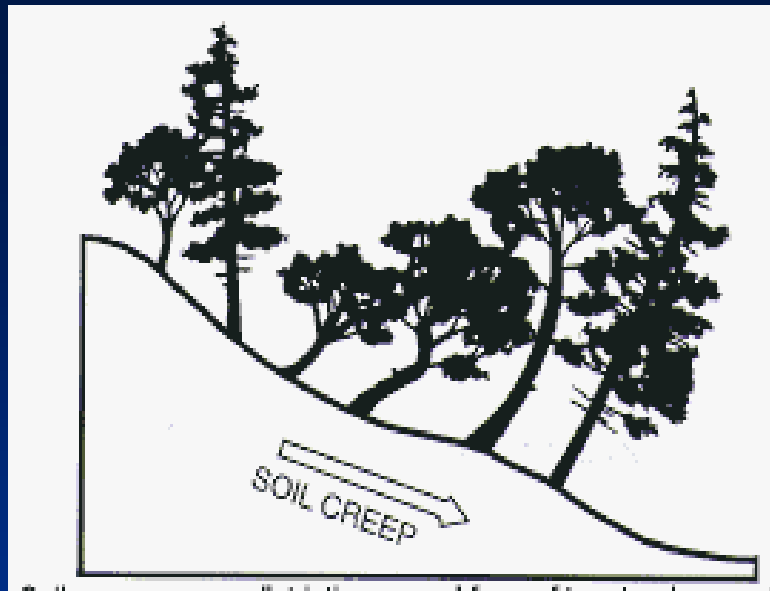
When gravitational force is greater than the force of friction of the land, movement occurs!

These are called : Mass Movements

- **-Soil creep**
- **-Landslides**
- **-Mudflows**
- **-Avalanches**
- **-Rock Falls/Slides**

Soil Creep (slow movement)





Soil creep causes distrinctive curved form of tree trunks over time.

Illustration 5:
Indications of Soil Creep

Rock Slide in TN

Mudslide in Afghanistan

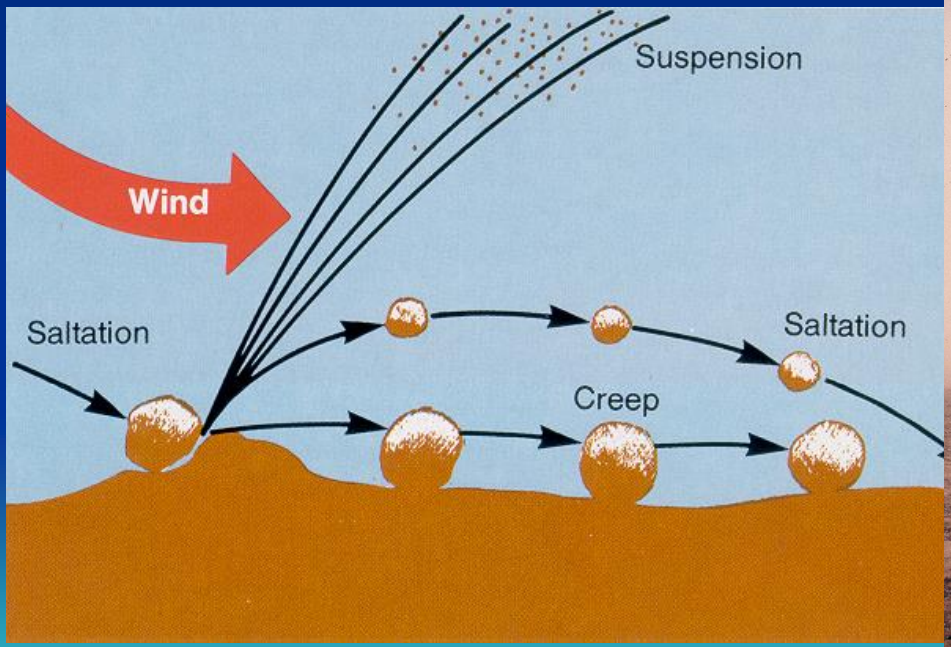
Avalanche in Alps

Mass Movements can occur due to heavy rainfall OR can be due to an **EARTHQUAKE!**

Erosion by Wind

Dependent on: Wind Velocity and size of the sediment

- As sediment size decreases, the amount of erosion by wind increases (more sediment can be carried)



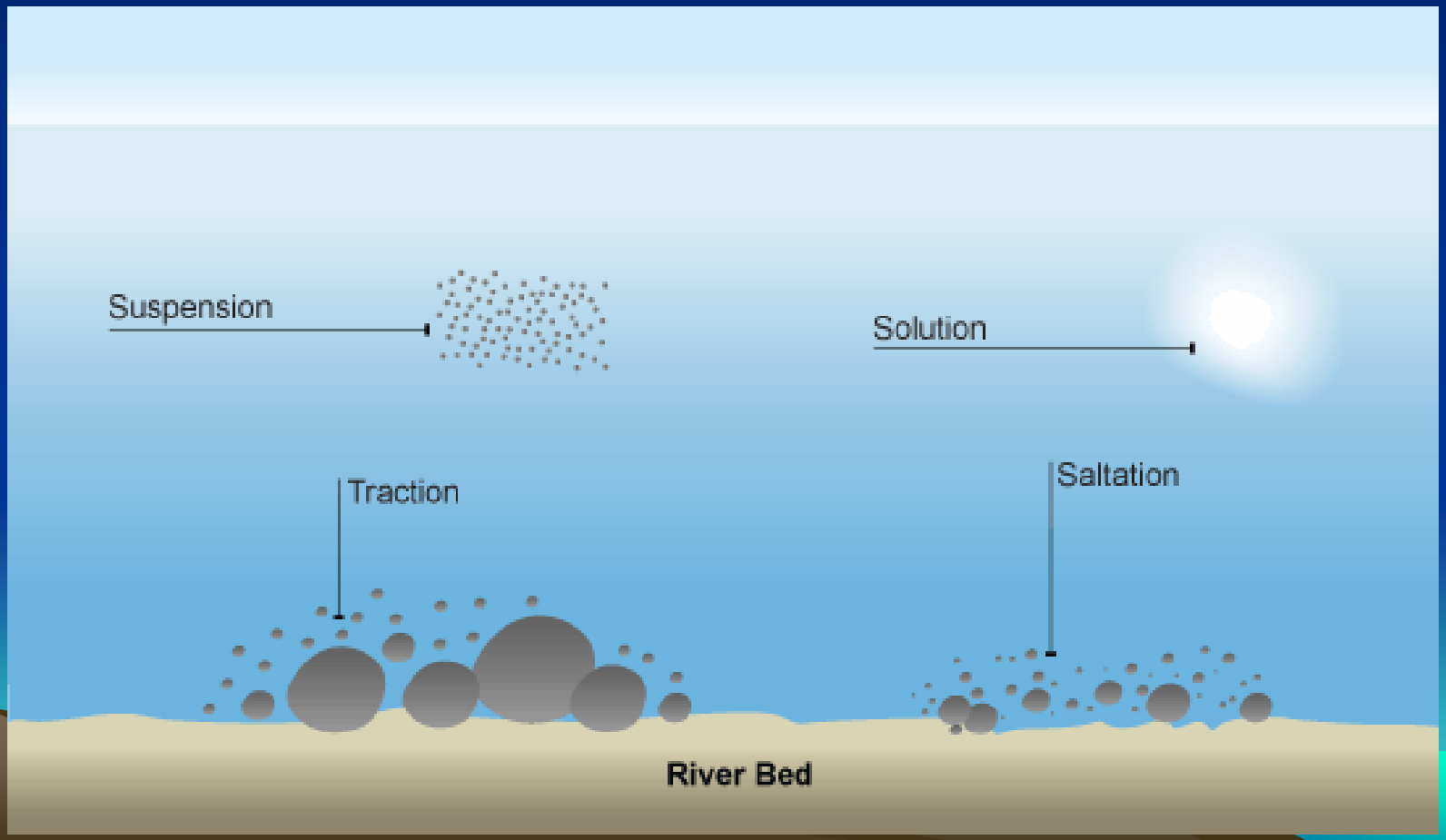
Wind Erosion: Arid Climates

Formation and Migration of a Sand Dune

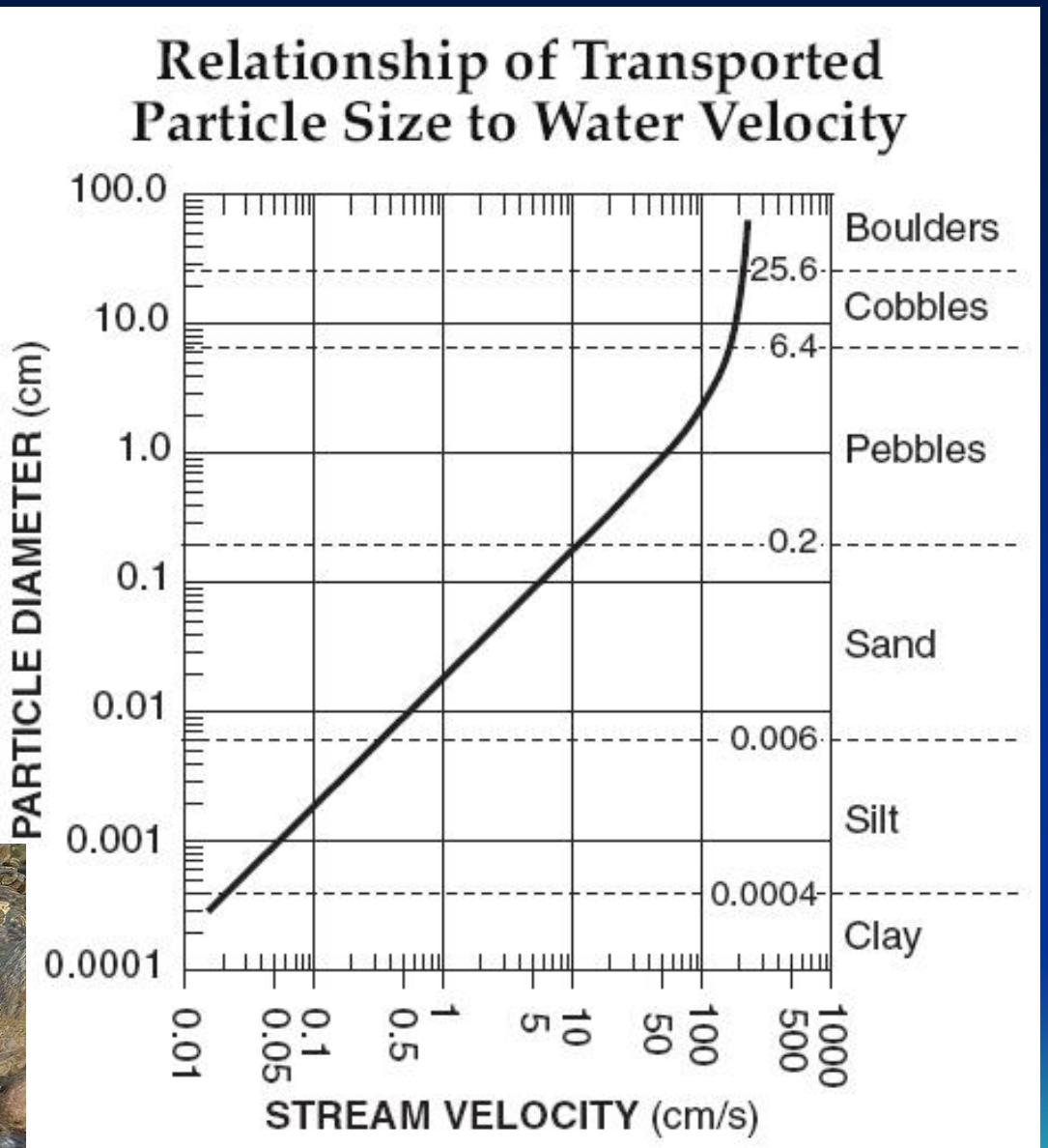
Erosion by Water

Stream Erosion

a. Small Particles can be suspended, larger particles bounce along the stream bed (Saltation), even larger Particles are rolled (Traction)



b. The greater the velocity of a stream, the larger sized particle it can carry (erode). Below this speed, *deposition* will occur.



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

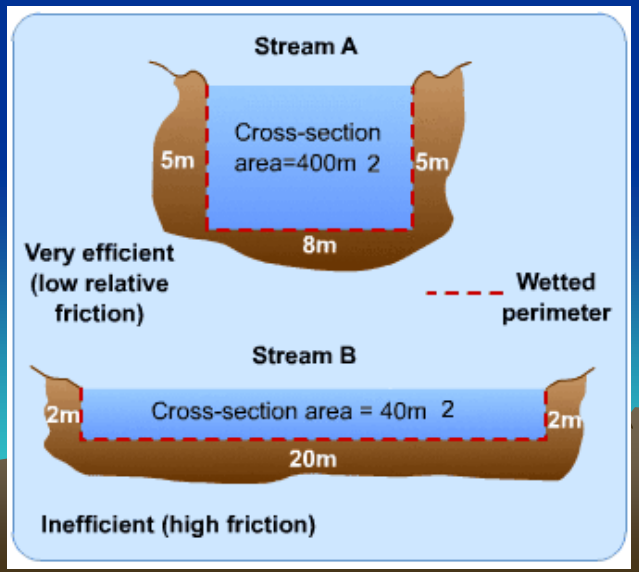
Stream Velocity

Stream Velocity determined by:

a. Slope of land : steeper slope= faster moving water

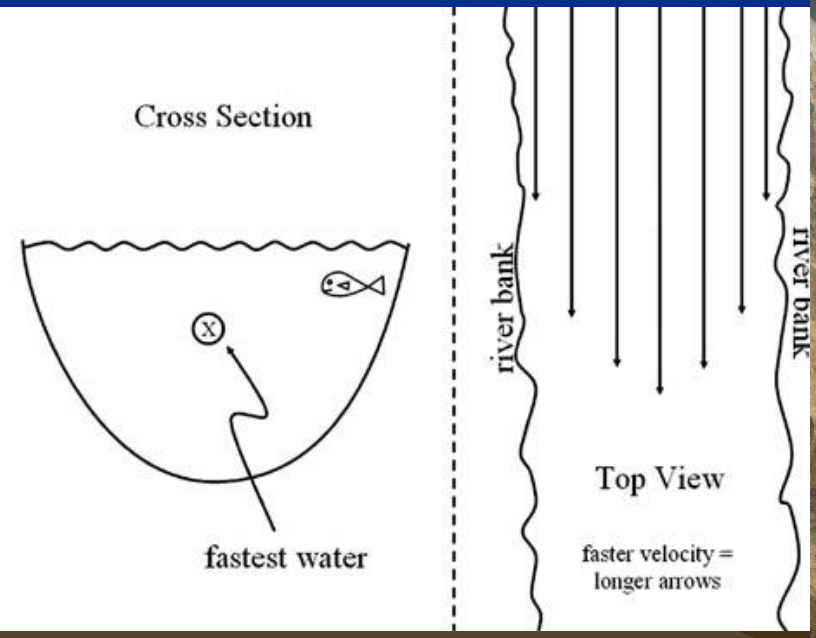
b. Volume of water instream: Increased rainfall will cause increase in stream discharge

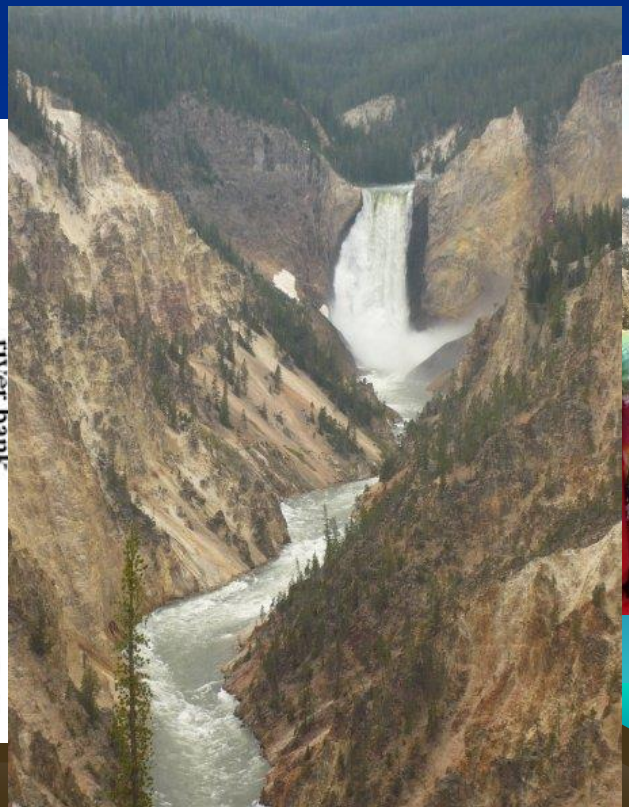
c. Channel shape and area : Wide shallow streams move slower than deep and narrow streams



The Young Stream: High Altitude

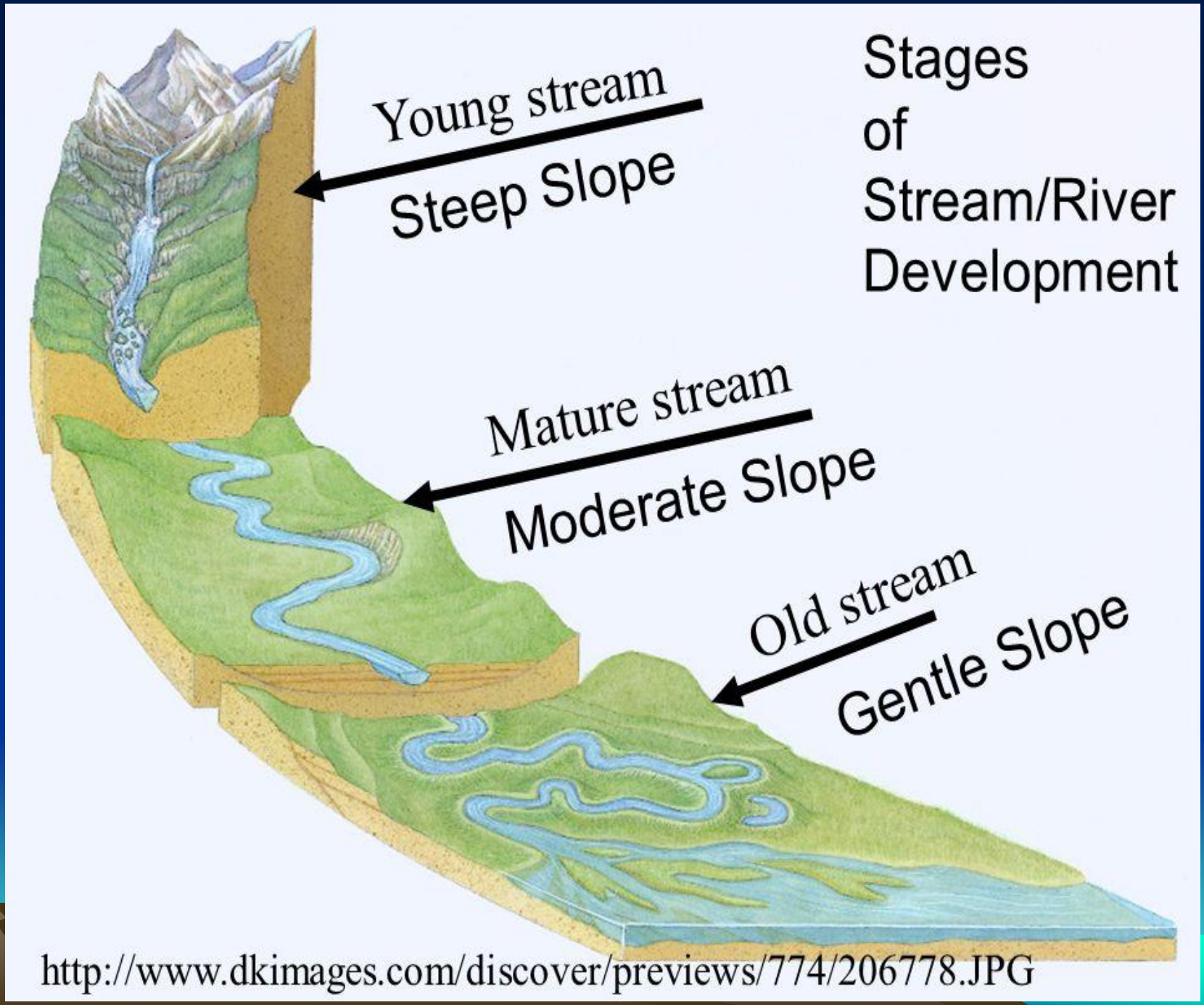
- Water flows fastest in the center and just below the top of the stream if the stream is Straight. Erosion will create a V-shaped Valley.





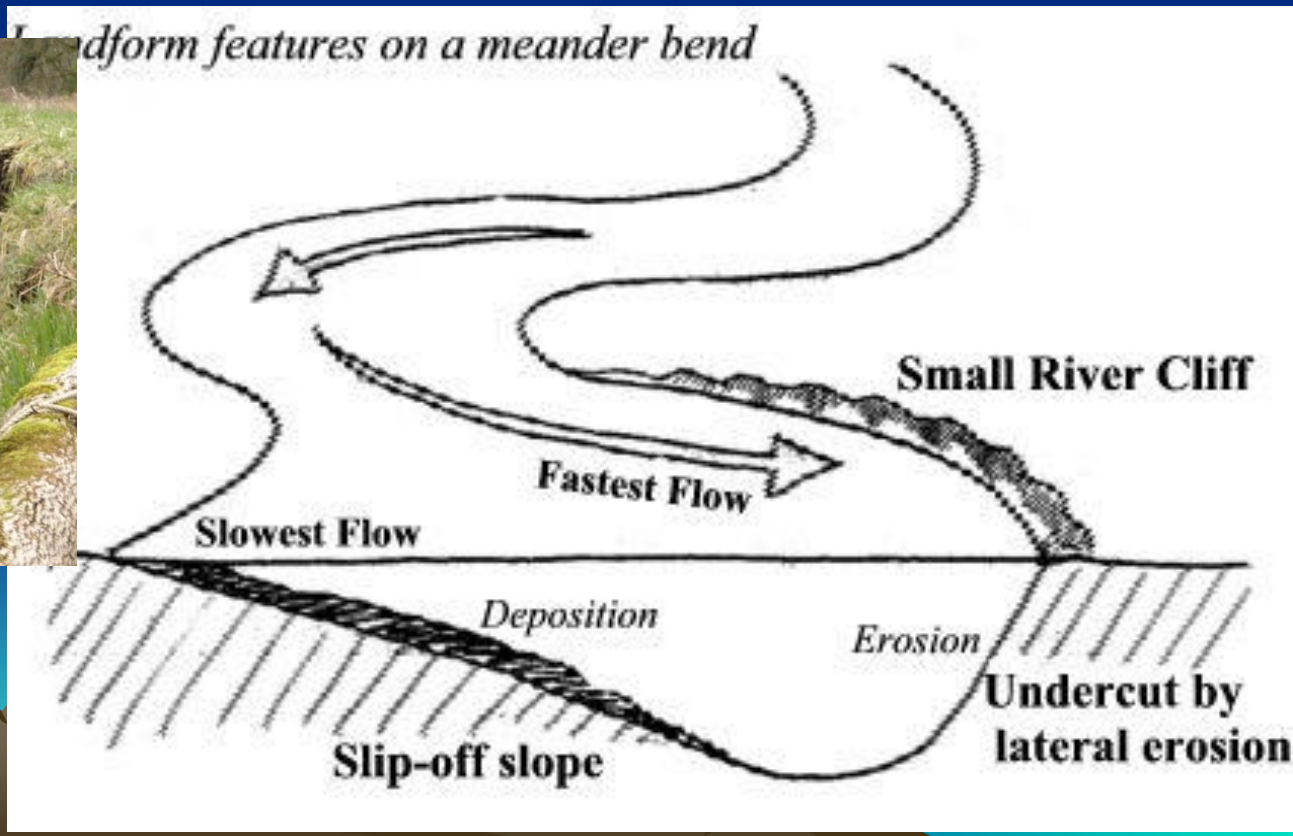
The Old Stream: Meandering Rivers/Flat Landscape

- The older a stream is, the more S-shaped curves it develops, called "Meanders" (Amazon and Mississippi river)
- meander formation simulation


Stages
of
Stream/River
Development
Young stream
Steep Slope
Mature stream
Moderate Slope
Old stream
Gentle Slope
http://www.dkimages.com/discover/previews/774/206778.JPG

- Because of variations in velocity, there is deposition & erosion in different areas along a river
- This means river profiles differ according to the velocity

Profile Depth: A stream is deepest where the current is the fastest

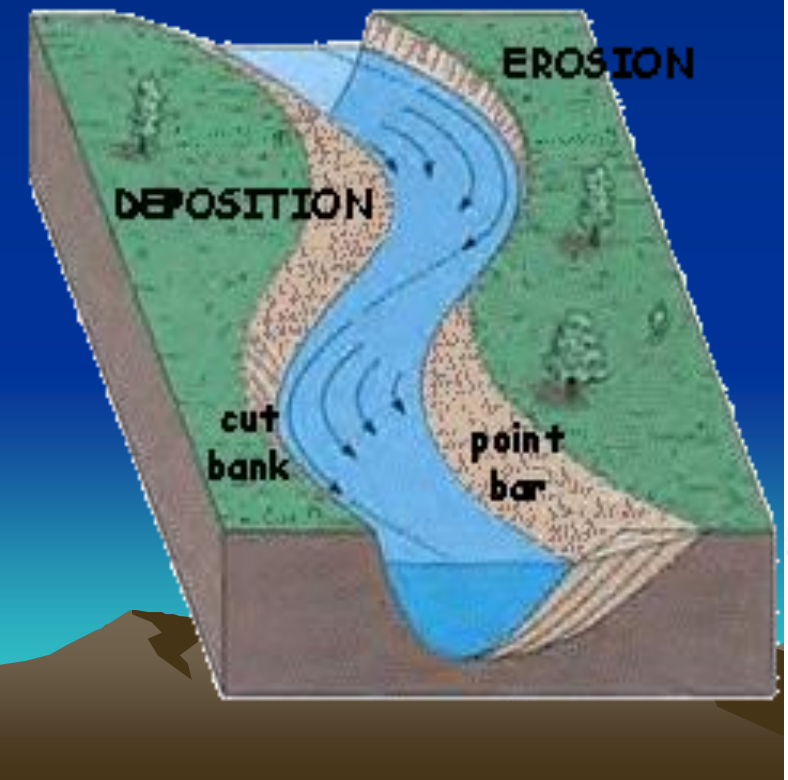


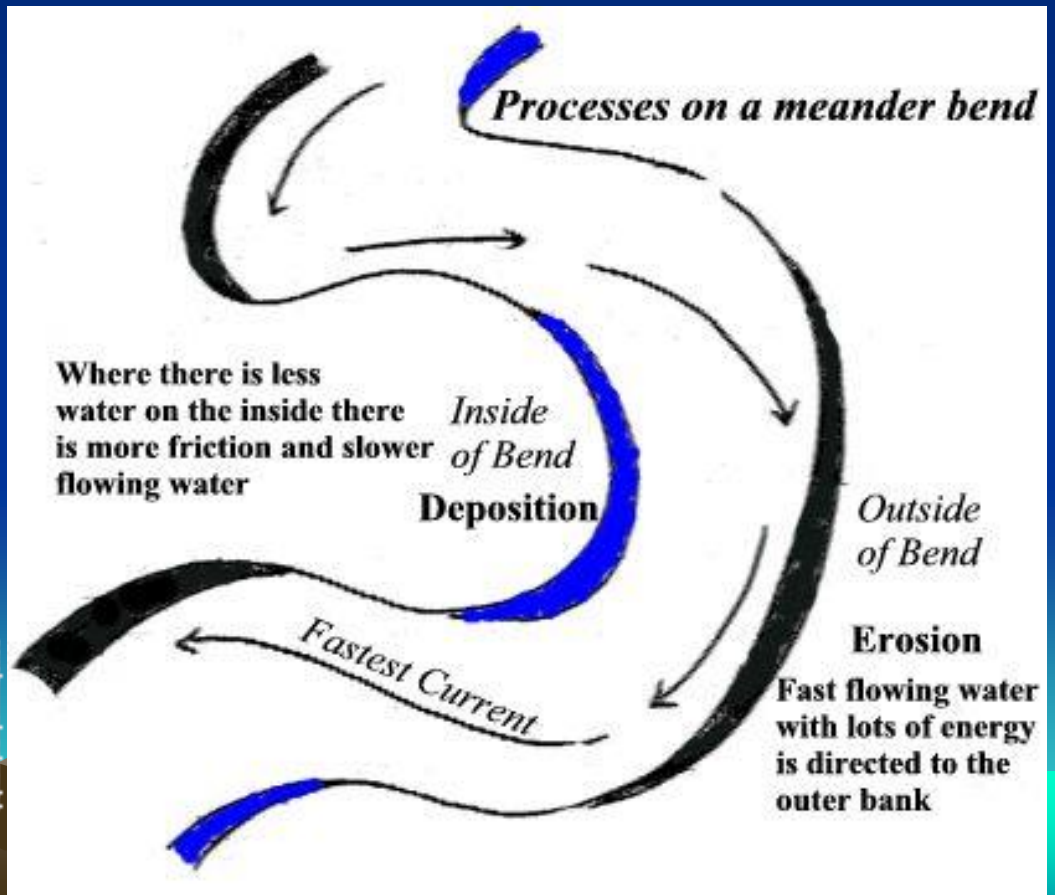
Velocity changes in Meandering Rivers

Meandering Stream Table Clip

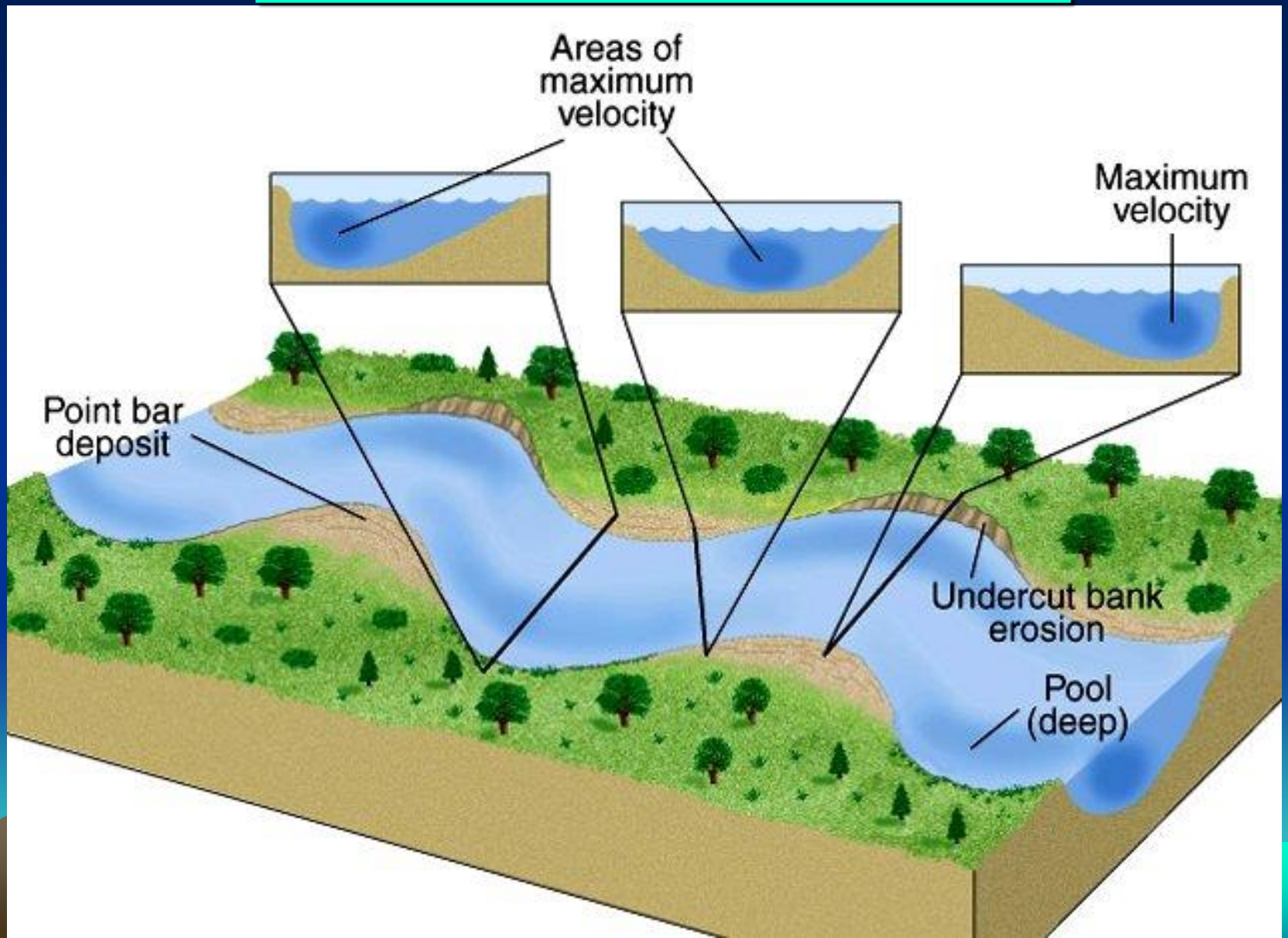
1.)Faster water swings to the outside of the bend causing EROSION

2.)Slower water stays inside the bend causing DEPOSITION



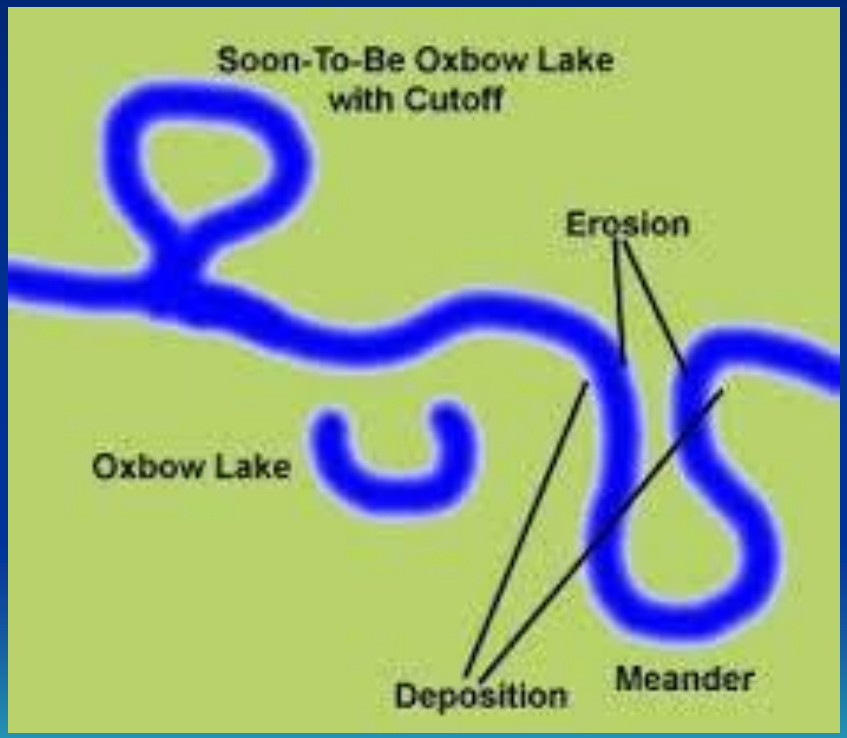


Stream Table Demo



Formation of Oxbow Lakes:

Erosion by the river eventually cuts a new path for water to flow leaving behind an oxbow



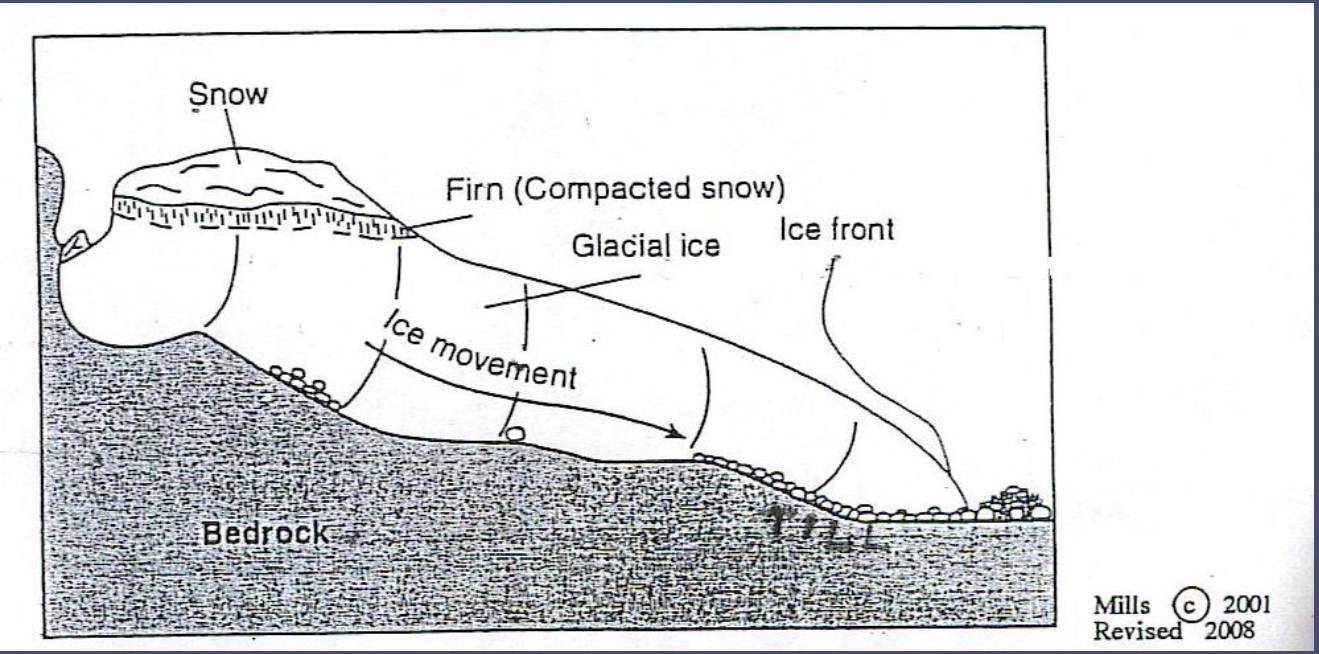
Erosion by Ice: Glaciers

- a. A glacier is a large mass of slowly moving ice that forms from the compaction of snow over time under the pressure of its own weight.

  Where? occur in the polar regions and at high altitudes

Profile of a valley glacier

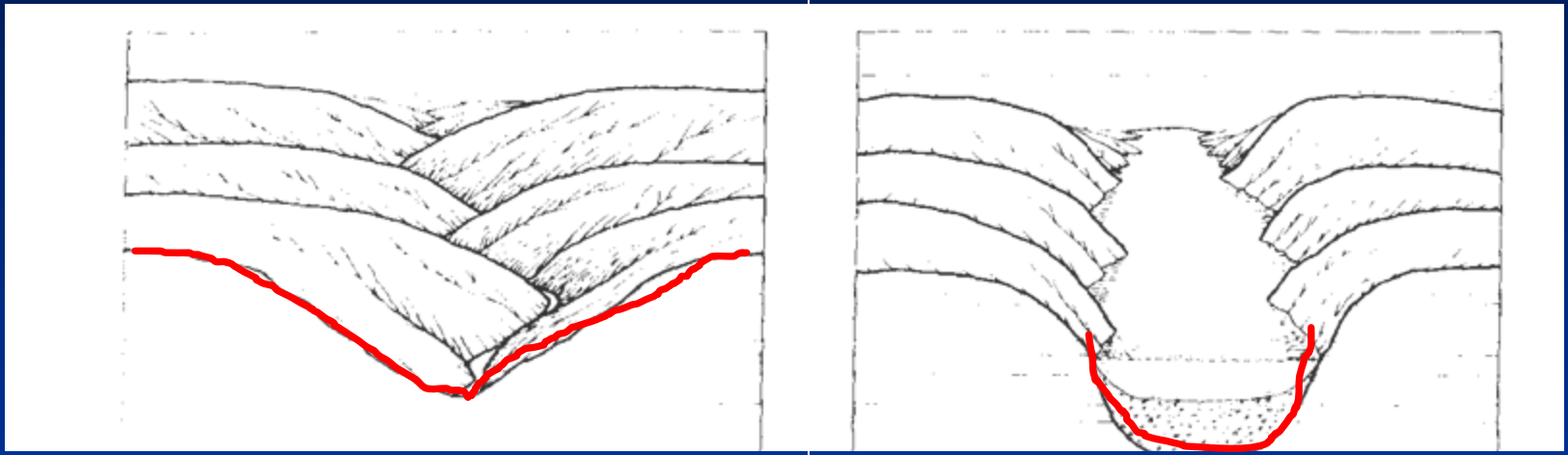
- B. When glaciers form in a mountain valley, they move downward under the force of gravity, and fastest in the middle, just like a young stream. As the glacier moves, it plucks up sediments (Till) as it scrapes the land beneath



- A MORAINE is rock and sediment debris pushed along the edges of a glacier.

Moraine's can be seen by "dirty" streaks in the glacier

C. Glacial Erosion: Stream Valleys vs. Glacial Valleys



V-shaped valley

eroded by a _____stream_____

U-shaped valley

eroded by a _____glacier_____

U-Shaped Valley
BANFF National Park, Canada

Other Erosional Features of Glaciers

Striations - parallel lines in the bedrock caused by rock fragments scratching a rocks surface

Finger Lakes – long thin lakes created by the deepening of pre-existing river valleys in western NY

Erosion and Deposition by Ocean Currents and Waves

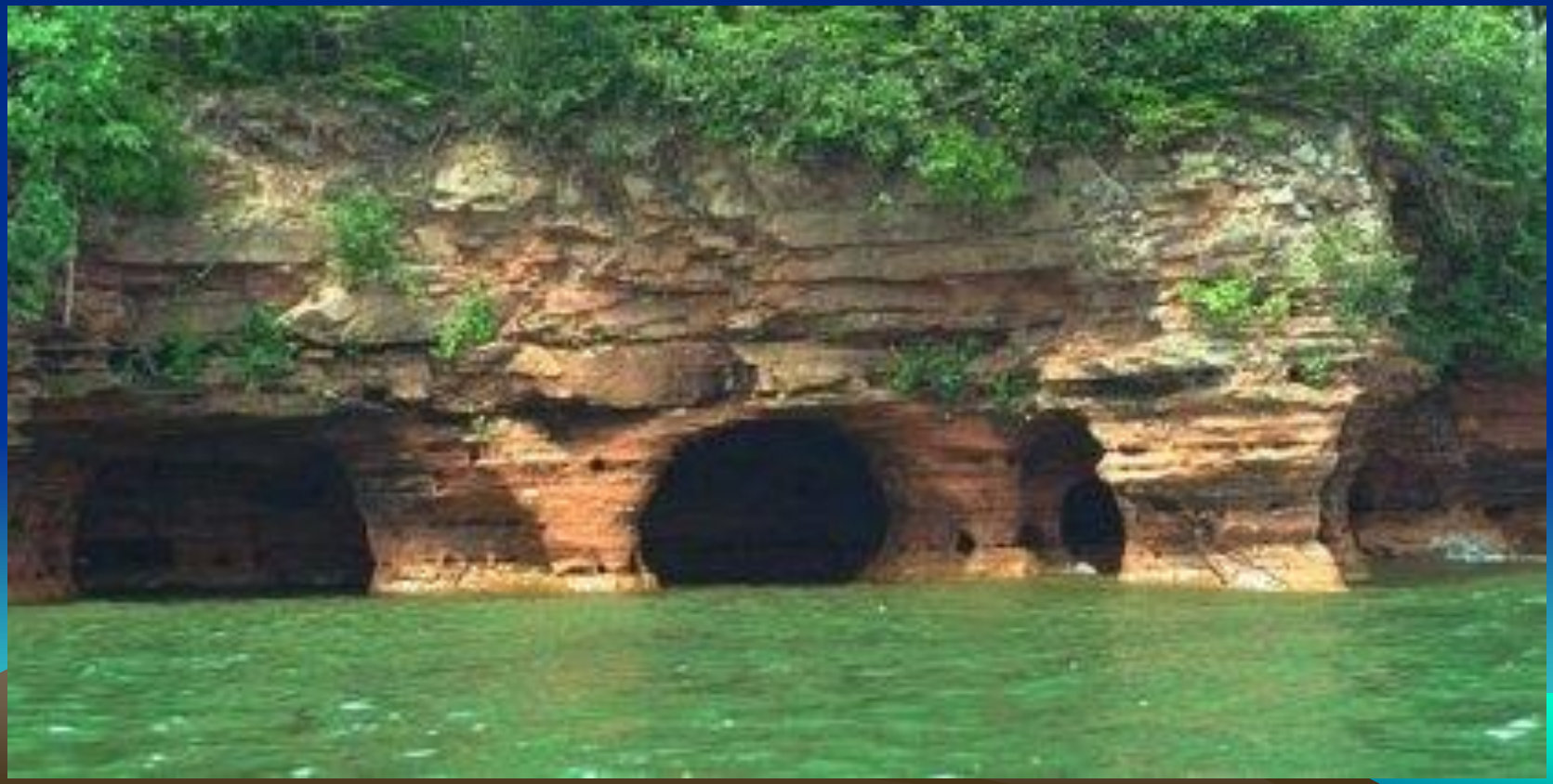
- *Surface* ocean currents and waves are generated mostly by **wind.**

- Wave action
  - **Circular** motion within a wave results in the movement of sediments

Erosion by Wave Action

As waves crash into the shoreline, they erode the bedrock forming cave like structures as well as cliffs

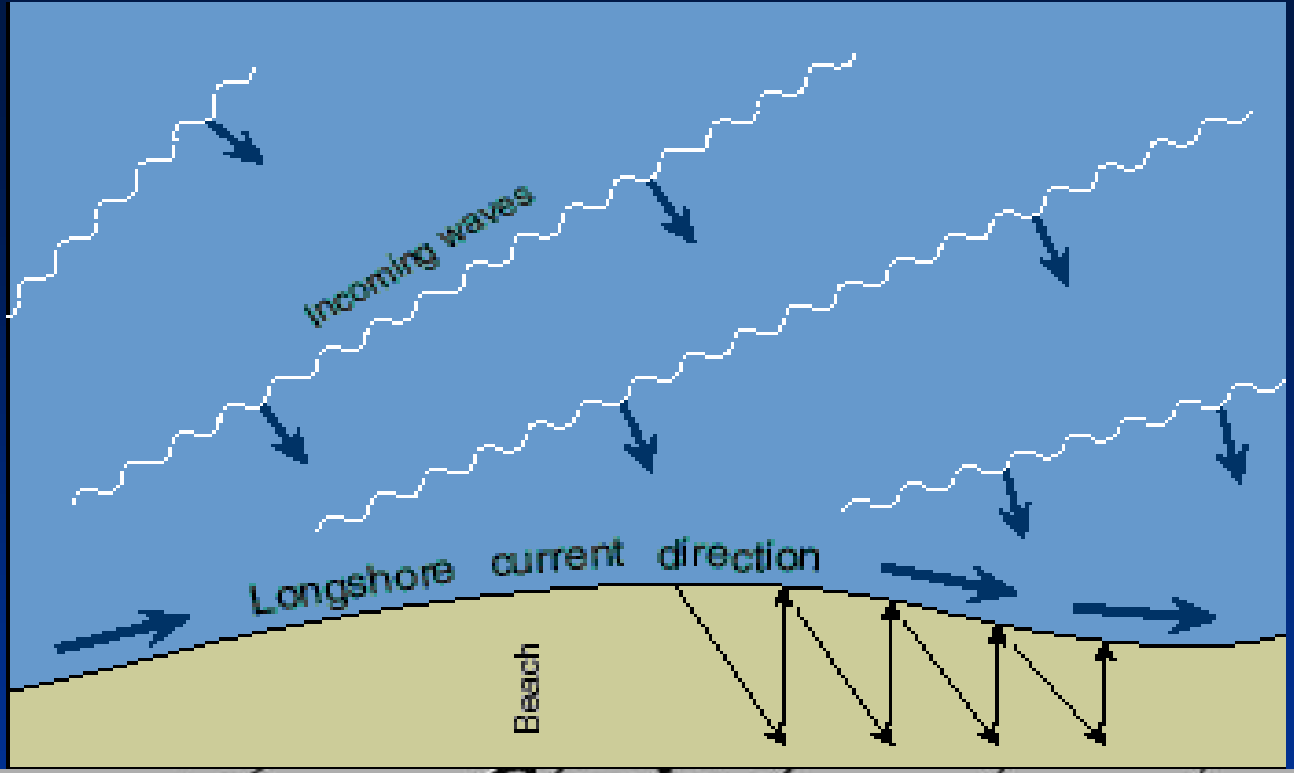
animation

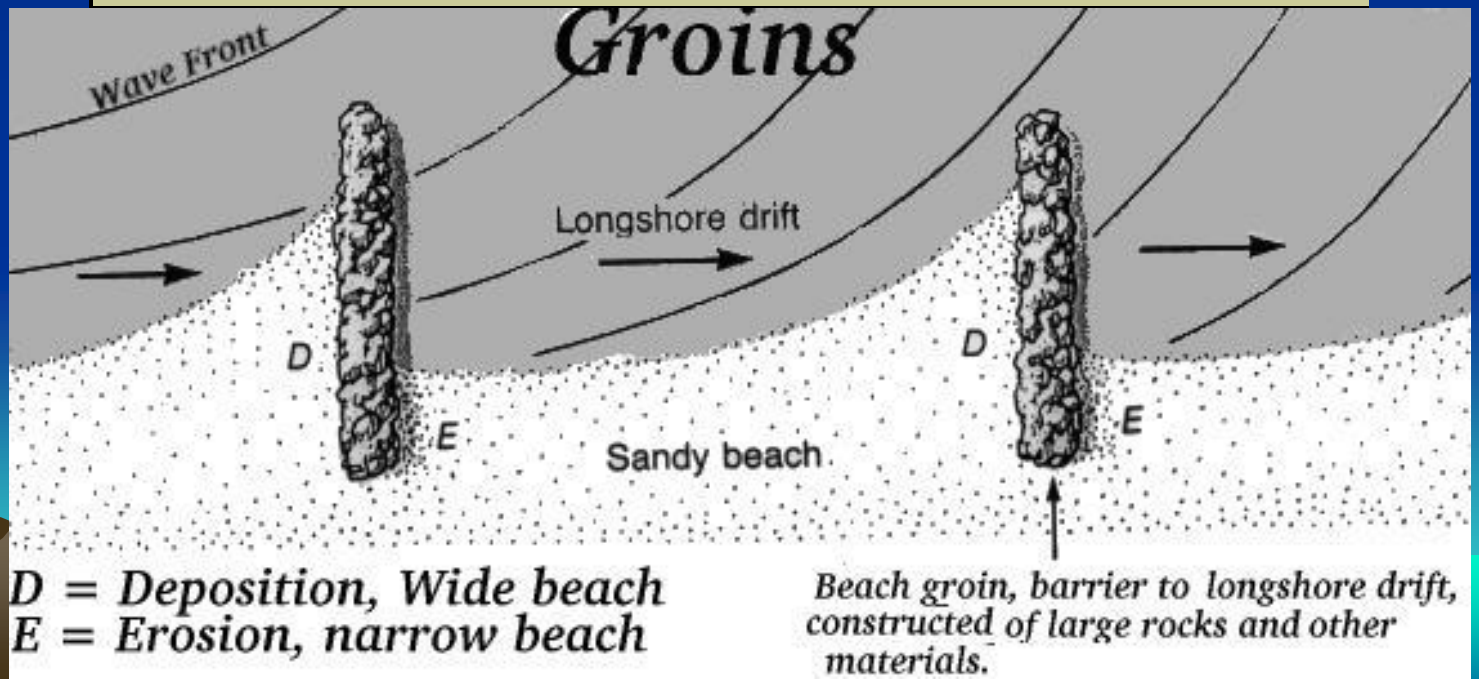


Sand is constantly eroding along a shoreline

- We build jetty's/groins to limit beach erosion over time

As waves crash into the shore at an angle, they carry sediment back out to the sea and transport it parallel to the shoreline. This is known as LONGSHORE DRIFT


Incoming waves
Longshore current direction
Beach


Groins
Wave Front
Longshore drift
D
E
D
E
Sandy beach
D = Deposition, Wide beach
E = Erosion, narrow beach
Beach groin, barrier to longshore drift, constructed of large rocks and other materials.

Erosion Summary

- Due to processes of erosion, most sediments in NYS are not residual
  - This means they DIFFER in composition from the underlying bedrock (non residual)
  - Gravity, Wind, Water, Ice and Ocean Waves are responsible for transporting sediments.
  - Any sediment carried by water will be rounded due to abrasion, but sediments transported by gravity and ice will be angular