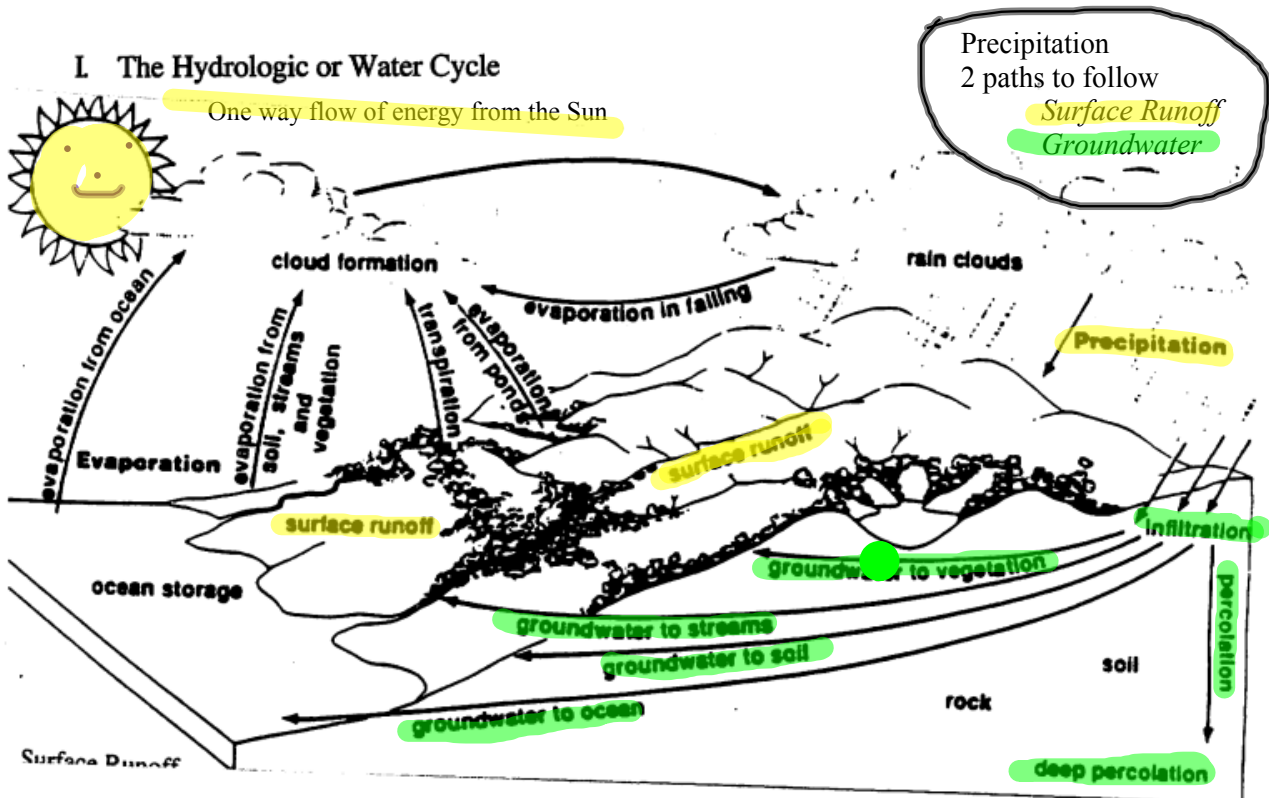


## Chapter 13 and 14 Notes: Surface Water and Groundwater

### I. The Hydrologic or Water Cycle



Water of the Earth = 100%

97% of the world's water salt

3% Freshwater ---> 2% Frozen (polar / glaciers)

1% available freshwater

.97% groundwater .03% surface water

### II. Surface Runoff

A. Surface runoff occurs when water flows across the surface of the ground from high elevations to lower elevations.

1. There are 5 factors that affect the rate of surface runoff as well as the amount of erosion.

a. **Climate**- this is the most important factor in determining surface runoff. The greater the precipitation, the greater the amount of **erosion** by running water.

Removal and movement of sediment

b. **Slope**- the steeper the slope of the land, the faster the surface runoff occurs and the greater the erosion.

c. **Permeability**- the measurement of the flow of water into the ground. If water flows very quickly into the ground, it will not be able to flow across the surface which causes erosion.

Porosity  
Water storage

Coffee filter  
Collendar

d. **Volume**- the greater the amount of liquid flowing across the surface, the greater the amount of erosion.

e. **Velocity**- the faster the flow of water, the greater the rate and amount of erosion.

Competance: the size of particle a stream can move / carry (controlled by Velocity)

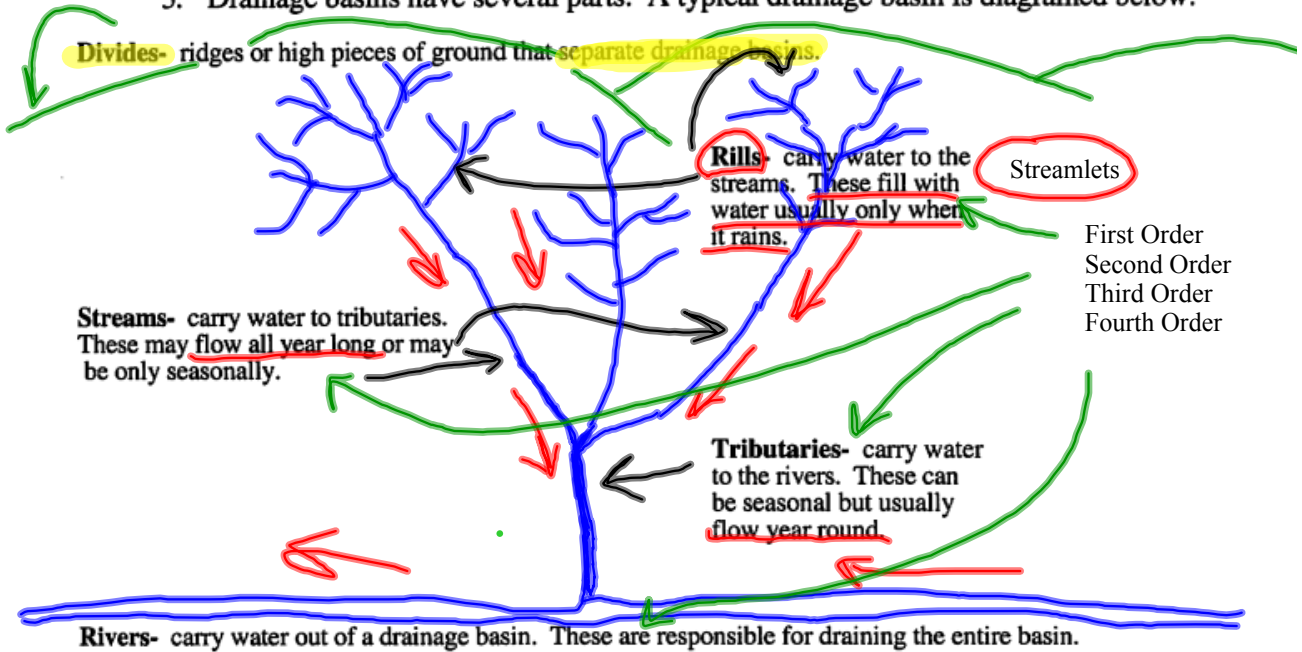
Capacity: the total amount of sediment that a stream can move / carry (controlled by Volume / Discharge)

B. Drainage Basins- when surface runoff flows from high elevations to lower elevations, it forms drainage basins.

1. Drainage basins are defined as a definite system of drainage channels carrying water out of a given area.

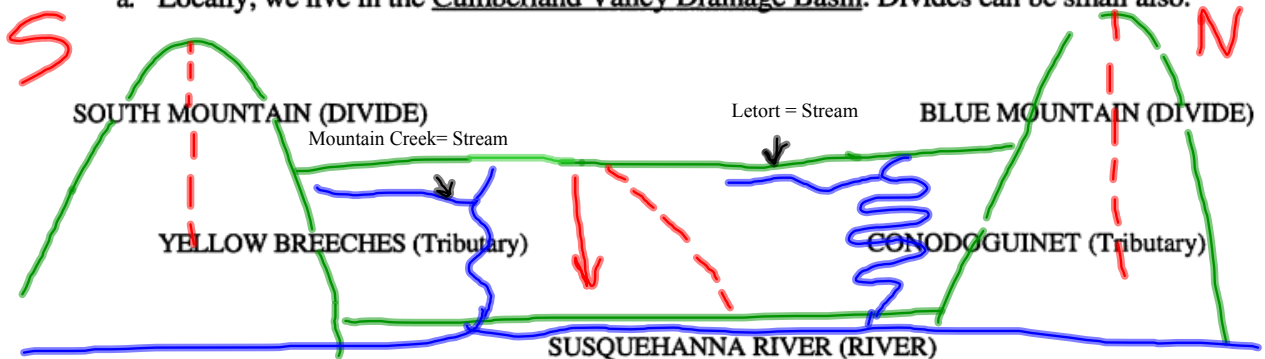
2. Every drainage basin has at least one river system draining it.

3. Drainage basins have several parts. A typical drainage basin is diagramed below.



4. The entire US is often considered to be divided up into three main drainage basins, each containing thousands of smaller drainage basins. The Rocky Mountains act as the main divide for the two main basins. For this reason, the Rockies are sometimes referred to as the continental divide. In the east, the Appalachian Mountains are the divide for this part of the US.

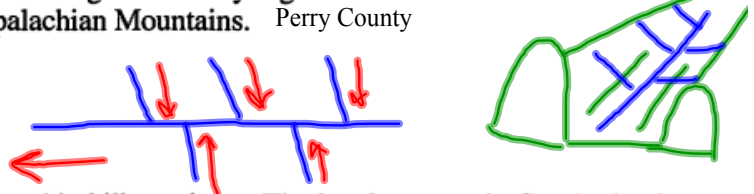
a. Locally, we live in the Cumberland Valley Drainage Basin. Divides can be small also.



5. **Drainage basins are classified according to their shape.** All drainage basins fit into 1 of 3 shapes. The shape of the drainage basin depends on the topography of the land, and the rock type in a given area.

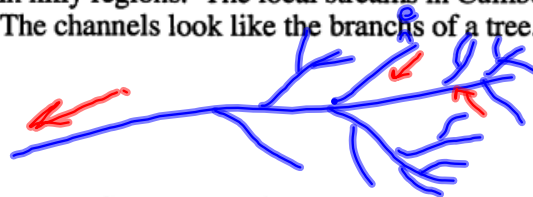
**a. Trellis-** this shape is found in ridge and valley regions such as those found in central Pennsylvania within the Appalachian Mountains. Perry County

Trellis Drainage - Top Down View



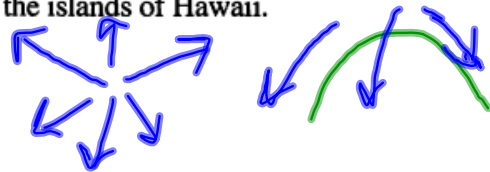
**b. Dendritic-** this shape is found in hilly regions. The local streams in Cumberland Valley form this type of pattern. The channels look like the branches of a tree.

Dendritic Drainage - Top Down View



**c. Radial-** This shape forms when water flows away from a common point in all directions. The channels look like the spokes of a wheel. This type of drainage is found on volcanoes like the one forming the islands of Hawaii.

Radial Drainage - Top Down View



→ Creates sediment

**C. Weathering by Running Water-** weathering by water occurs when sediment is formed by running water.

- 1. Abrasion by Running Water-** A **mechanical** weathering process which occurs when sediment is picked up by the running water and is forced against the sides of the channel or against other rocks breaking off more sediment.
- 2. Hydrolysis by Running Water-** A **chemical** weathering process where water dissolves the minerals out of the rock and wears it away. Water is the universal solvent and is able to dissolve many minerals. In Cumberland Valley, the landscape is greatly affected by hydration. (More on this later)

Transport

**D. Erosion by Running Water-** occurs when running water picks up sediment and transports it from one place to another location. This process is diagramed below.

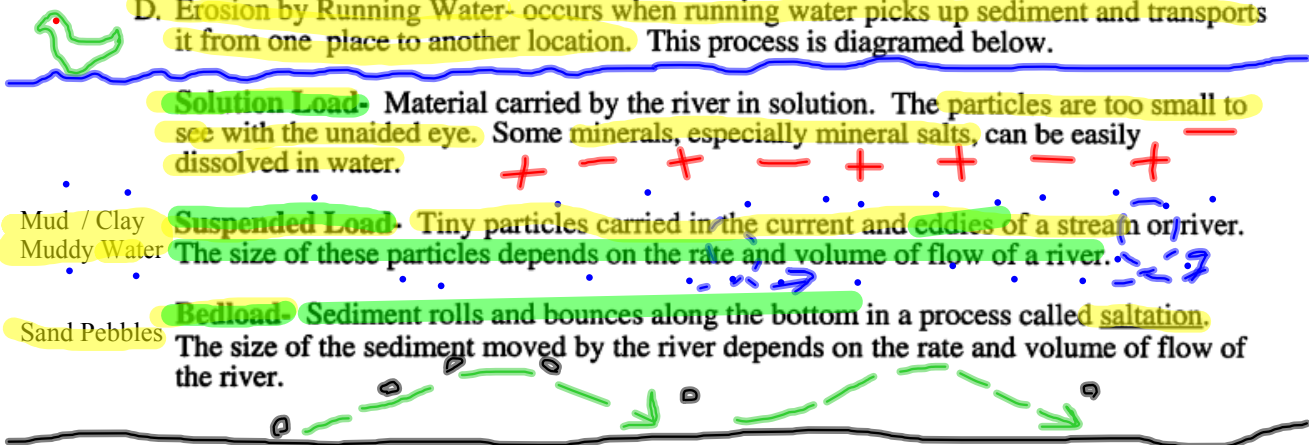
**Solution Load-** Material carried by the river in solution. The particles are too small to see with the unaided eye. Some minerals, especially mineral salts, can be easily dissolved in water.

Mud / Clay  
Muddy Water

**Suspended Load-** Tiny particles carried in the current and eddies of a stream or river. The size of these particles depends on the rate and volume of flow of a river.

Sand Pebbles

**Bedload-** Sediment rolls and bounces along the bottom in a process called saltation. The size of the sediment moved by the river depends on the rate and volume of flow of the river.





E. Deposition by Running Water- deposition by running depends on the stage of river development the volume of water and the rate of flow of the water.

1. Water deposits sediments in the same way that the wind deposits sediments.
2. Water deposited sediments are well sorted. The largest and heaviest sediments are deposited first until finally the smallest clay particles are deposited last.

F. The Aging of Rivers- Rivers go through an aging process made up of different stages.

1. Youth Stage- a young river is marked by the following features. Gradient= feet / mile

Diagram A

a. The slope of the drainage basin is at the steepest point it will ever be.

b. The river channel is V shaped, narrow, deep, and straight.

c. The current flows the fastest rate of any other stage. Waterfalls and rapids are common.

d. Erosion is greater than deposition. This leads to few landforms associated with this stage of river development.



Diagram B

2. Mature Stage- This stage is marked by the appearance of well developed erosional features and the beginning of depositional features. The characteristics of this stage are as follows:

a. The slope of the drainage basin is decreasing due to erosion.

b. The channel is becoming wider and more shallow.

c. The following erosional features are well formed:

2. Undercut Bank- banks that overhang the river channel because the river has eroded out underneath them.

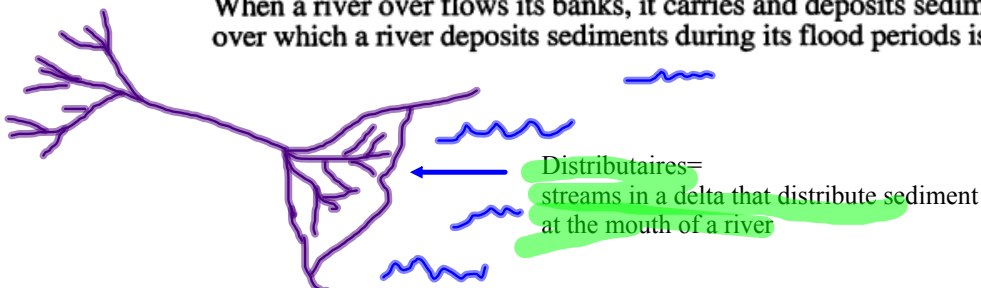
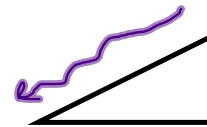
d. The following depositional features are well formed:

1. Delta- sediments that accumulate when a river enters a large body of water

2. Alluvial Fans- sediments that accumulate on dry land in the shape of a fan. Alluvial fans form when a river drains on to dry land or from water washed off a levee.

Desert = drainage does not make it to the sea  
Basin and Range - Interior drainage

3. Flood Plain- every river floods as a regular part of its life cycle. (100 year) When a river over flows its banks, it carries and deposits sediments. The area over which a river deposits sediments during its flood periods is its floodplain.



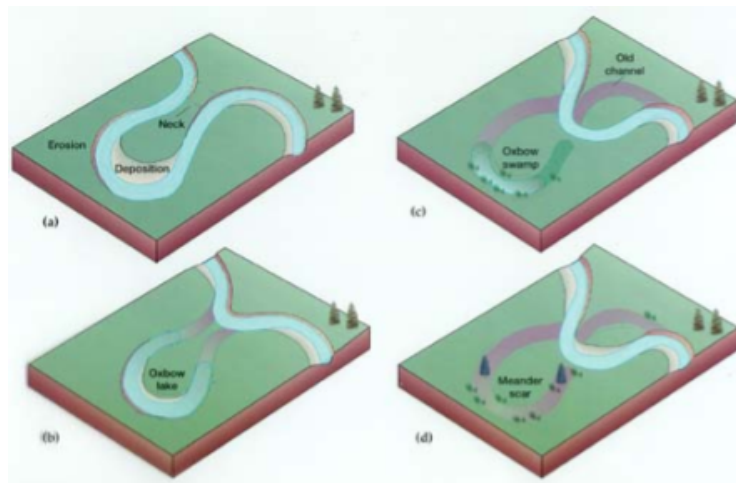
Undercut Bank



Alluvial Fan

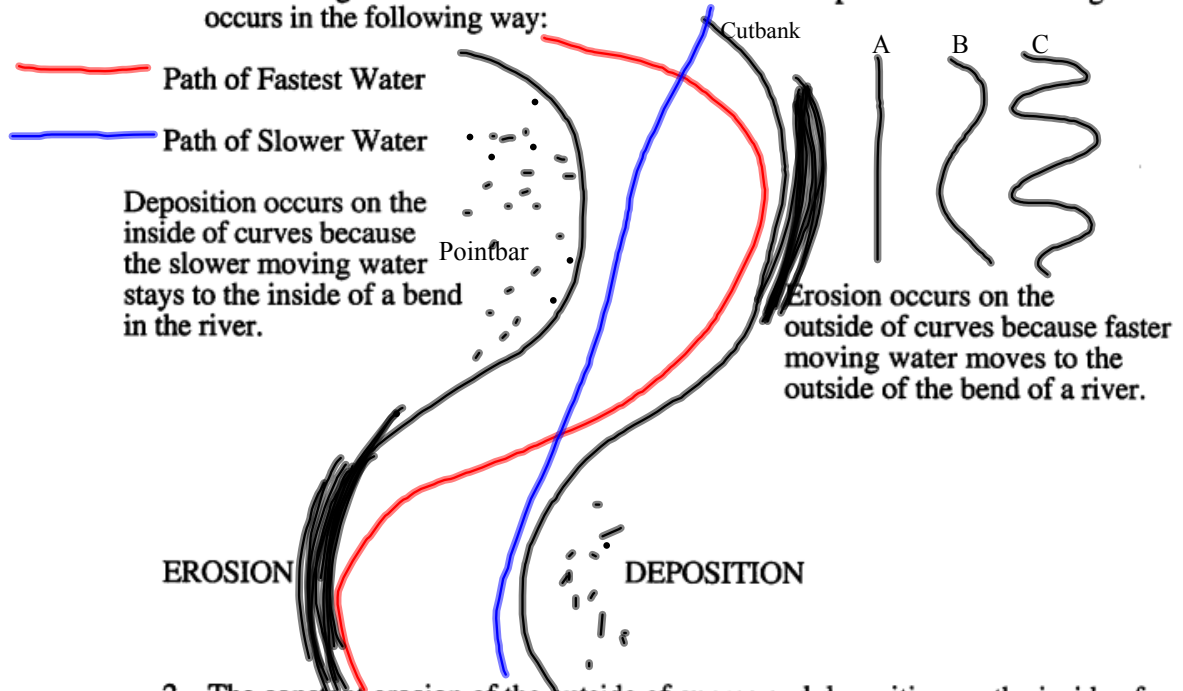


Delta

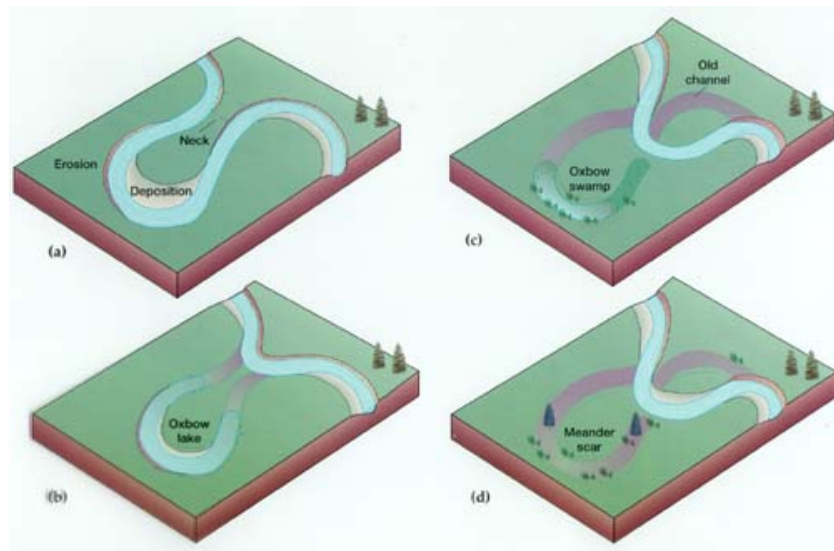


e. Meandering begins to occur.

1. Meandering is the movement of a river channel across its floodplain. Meandering is the result of a both of erosion and deposition. Meandering occurs in the following way:



2. The constant erosion of the outside of curves and deposition on the inside of curves causes a river to meander across its floodplain.
- f. The following features are formed by both erosion and deposition during the mature stage.
1. **Levees**- a mound of material on each side of a floodplain or along the river channel. The mounds can be due to the river cutting into its own floodplain. Excess sediments are also deposited on the side of the channel during flooding periods.
  2. **Meanders**- bends or curves in the river channel as explain earlier.
  3. **Abandoned meanders or meander scars**- meanders where the water has since dried up in them after the river changed its course and abandoned the old channel.
  4. **Oxbow Lake**- abandoned meanders which remain full of water.
  5. **Islands**- a body of land that is surrounded on all sides by water. These can be the result of either erosion or deposition.



Rejuvenation Stage = Diagram  
last page of notes



3. The Old Age Stage- this stage of river development has developed the following characteristics:
  - a. The drainage basin has been eroded nearly to sea level.
  - b. The channel is very wide, very shallow, and the current is slow.
  - c. Deposition is greater than erosion.
  - d. Deltas and other depositional features are well developed.
4. Death- when a river erodes its drainage basin to sea level it stops flowing and dies.

## Chapter 14

### II. Groundwater Runoff

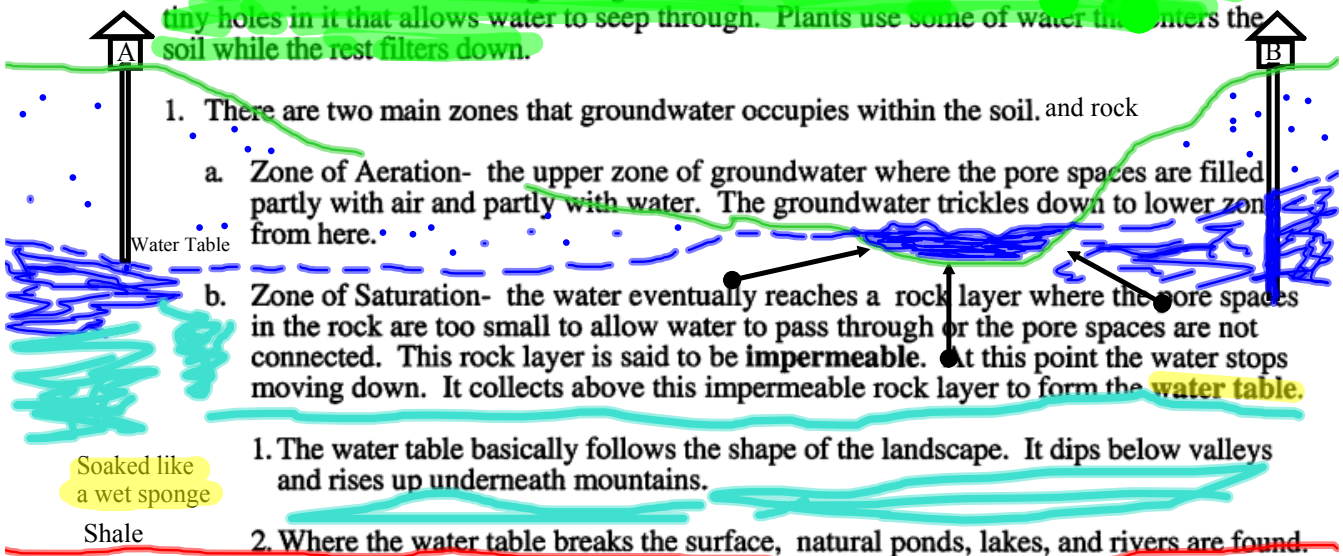
A. Groundwater is water in the ground near the surface. Groundwater can change the landscape as it moves through the ground.

B. As groundwater seeps through the limestone in Cumberland Valley, it dissolves calcium carbonate,  $\text{CaCO}_2$  of the rock making it hard. It contains many minerals in it. Soft water, such as rain, contains few or no dissolved minerals.

Porosity = storage

Permeability = water transfer

C. Groundwater can travel through the ground because much of the bedrock is porous- has tiny holes in it that allows water to seep through. Plants use some of water that enters the soil while the rest filters down.

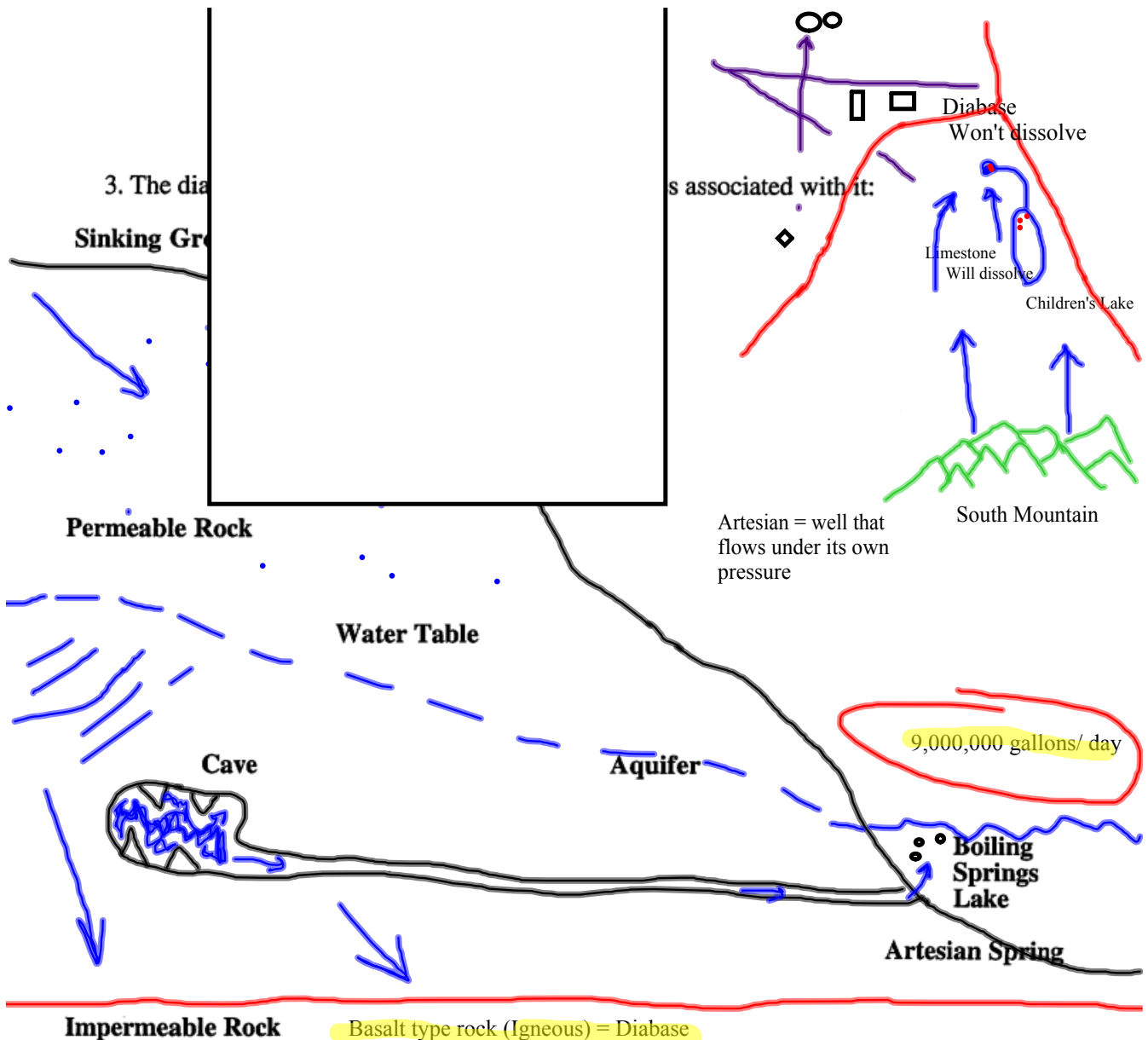


2. Water will sink into the ground until it reaches an impermeable layer of rock such as shale. When it reaches the impermeable layer the water may flow along it until it finds its way back to the surface forming a spring much like the Boiling Springs. The water may also find another permeable layer and sink deeper.

Aquifer = underground source of water  
allows the passage of water

Aquiclude = stops the flow water



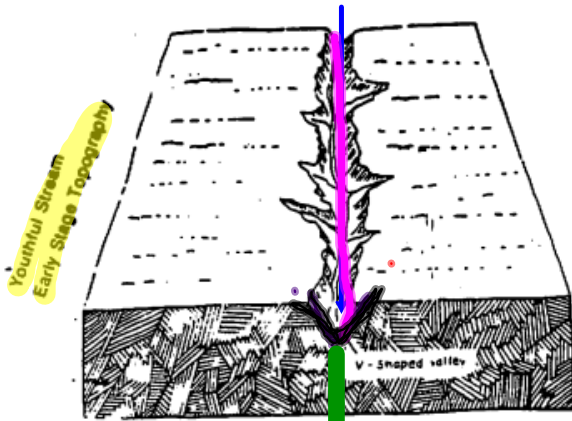


**Impermeable Rock** Basalt type rock (Igneous) = Diabase

- Groundwater - The movement of water through the ground as part of the hydrologic cycle.
- Aquifer - a region of permeable material that is water soaked.
- Impermeable Rock - Does not allow water to flow through it.
- Water Table - The upper most level of water in an aquifer.
- Spring - a natural flow of water from the ground.
- Artesian Spring - A spring fed by ground water, with the water flows freely without pumping.
- Cave - an opening beneath the surface of the earth formed by groundwater erosion. Caves often form in limestone because it is water soluble.

Youthful Stage

Diagram A



PRINCIPAL CHARACTERISTICS OF THE STAGES OF STREAM DEVELOPMENT:

**Youthful stage**

high stream gradient (generally greater than 10 ft/mi)

narrow, V-shaped stream valley

little or no floodplain developed

few, if any, meanders

vertical erosion dominant

**Mature stage**

moderate gradient (generally less than 10 ft/mi, possibly as low as 1 or 2 ft/mi)

wide, flat-bottomed stream valley with well defined valley walls

floodplain well developed

meanders common; individual meander loops may occupy the full width of the stream valley

transportation and lateral erosion dominant

very low gradient (generally less than 2 ft/mi, often less than 1 ft/mi)

extremely wide valley, perhaps with indistinct valley walls  
extensive floodplain, with features such as natural levees  
extreme meandering; a distinct meander belt may be developed

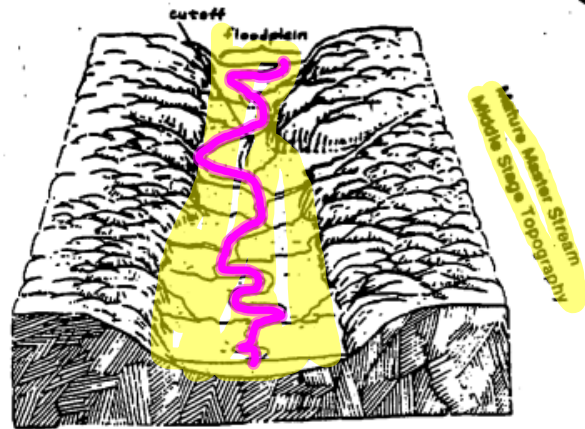
deposition dominant

**Rejuvenated stage**

Tectonic uplift of a region or a lowering of base level may cause the stream gradient to be steepened and an old age or mature stream may be thus rejuvenated. The characteristic feature to look for is the presence of entrenched meanders which show that the stream once achieved a low gradient, but that the gradient has since been steepened, reinitiating downcutting. Increased rainfall due to climatic change may also initiate rejuvenation.

Mature Stage

Diagram B



PRINCIPAL CHARACTERISTICS OF THE STAGES OF TOPOGRAPHIC EVOLUTION:

**Early stage**

regional dissection very incomplete, with broad uplands unaffected by erosion

poorly developed drainage system

few streams, mostly in the youthful stage, separated by broad, uneroded interstream divides

local relief due to erosion is generally low

**Middle stage**

regional dissection advanced, few areas unaffected by erosion

well developed drainage system, with maximum number of tributaries

many streams, mostly in the youthful stage, separated by narrow, rounded interstream divides

master streams mature or old age

local relief due to erosion is at its maximum development

**Late stage**

master stream drainage dominates the region, with the master streams in the old age stage

fewer streams than in middle stage due to the merger of stream valleys as interstream divides are completely destroyed by erosion

remaining interstream divides are broad and low

local relief due to erosion is once again low, except where monadnocks (erosional remnants) remain

Old Age Stream  
Late Stage Topography

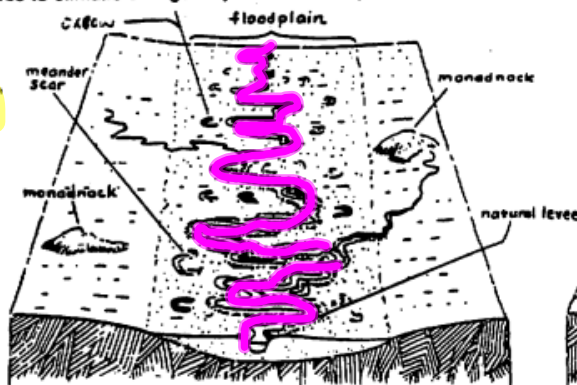


Diagram C

Old Age

Rejuvenation Stage

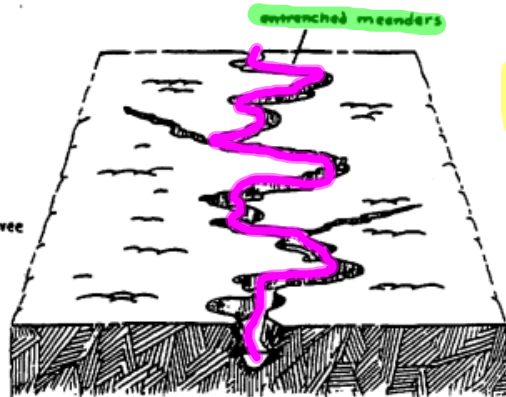
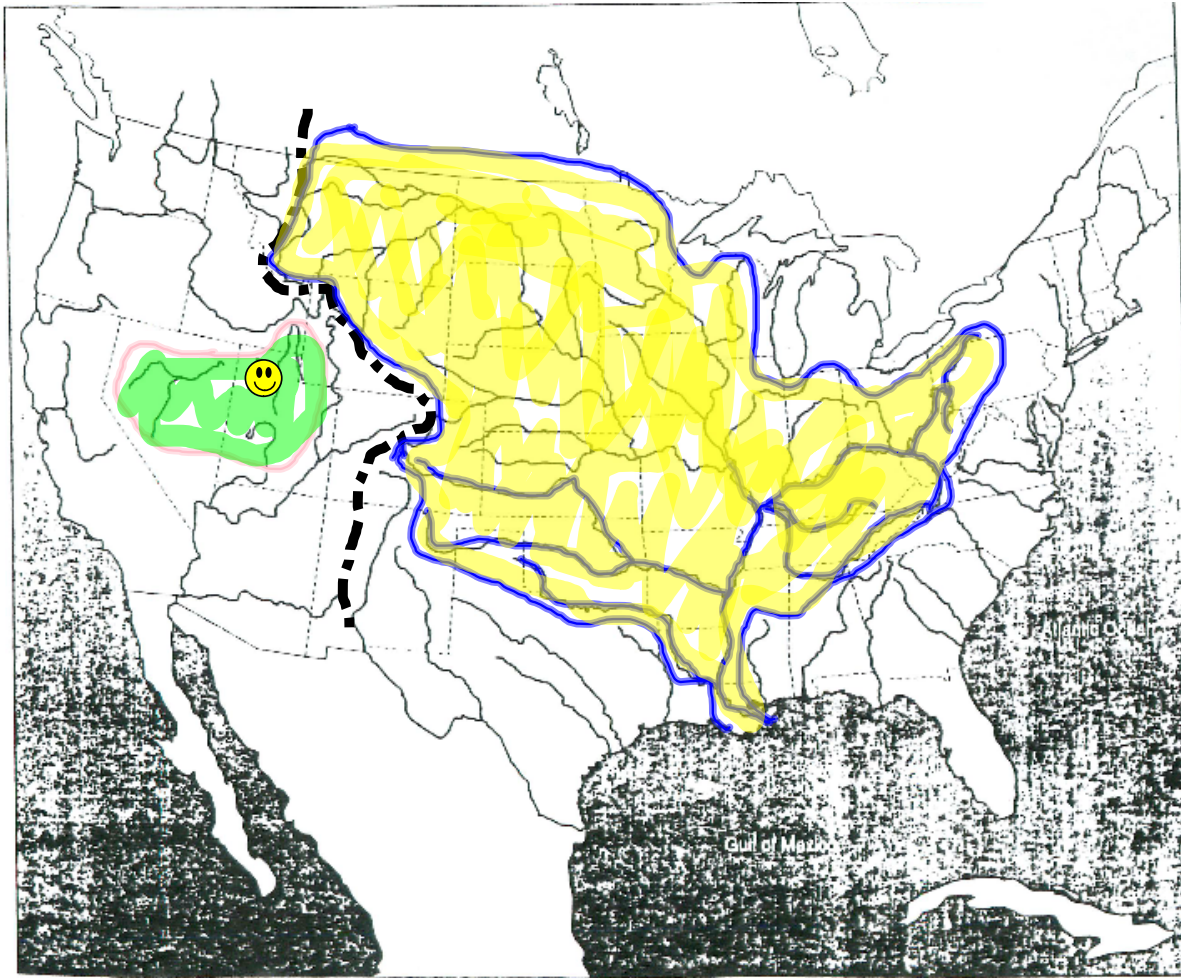


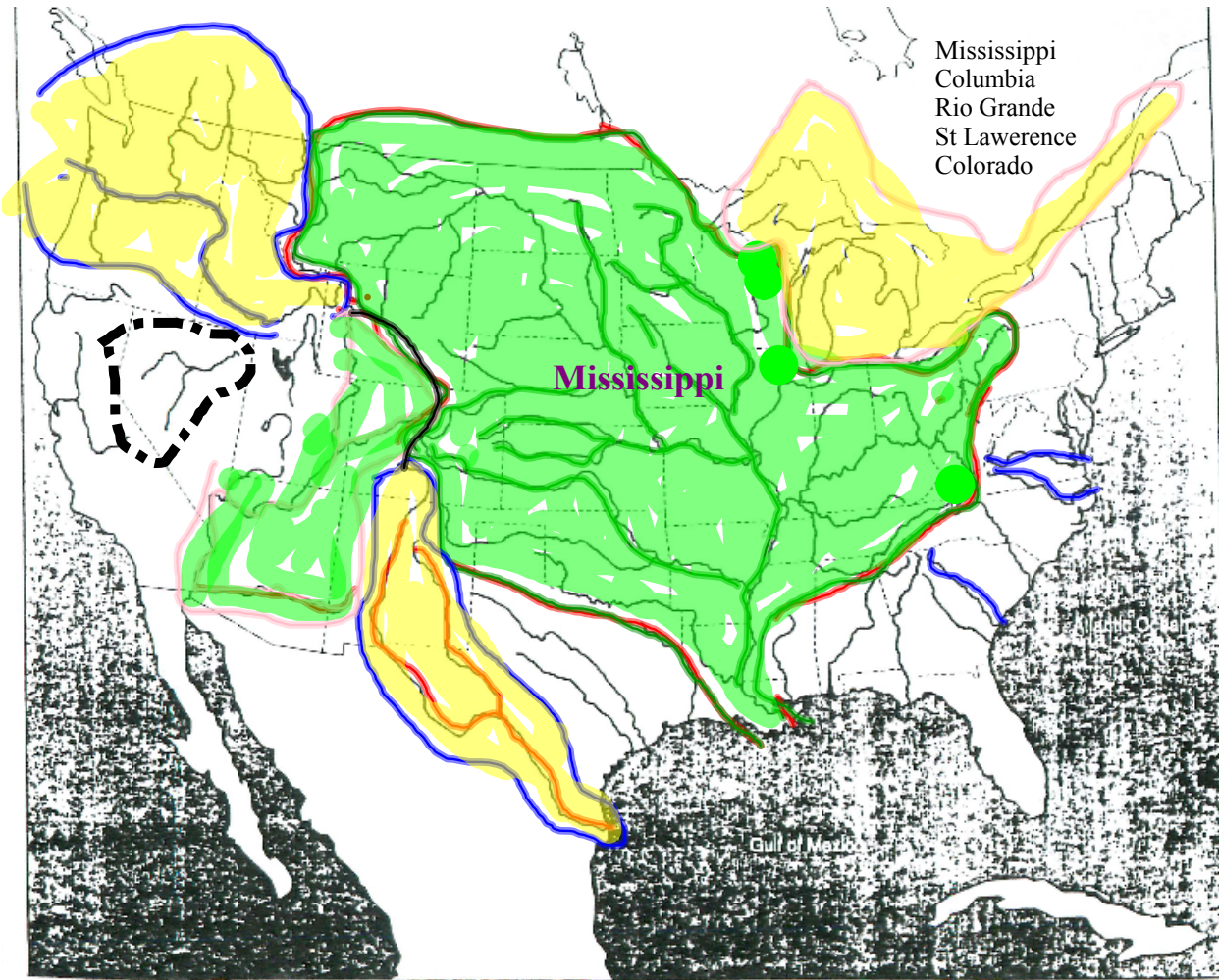
Diagram D Land uplifted

Rejuvenated Stage





10.19 Major rivers of the United States



10.19 Major rivers of the United States