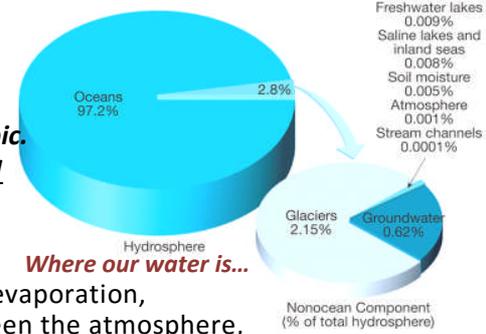


# Chapter Outlines

**NOTE: This is intended to help students 'organize' their understanding of each topic. It is not a comprehensive study guide for quizzes or midterms, i.e. study your text!**



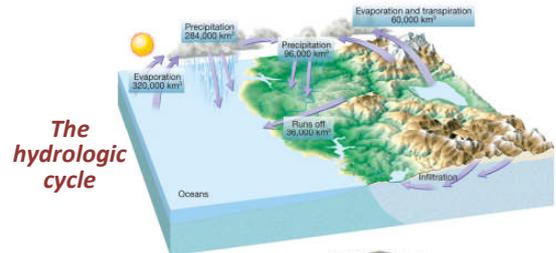
## Running Water and Groundwater

The **hydrologic cycle** is the constant circulation of the earth's water through evaporation, precipitation, and transpiration. It is the continuous exchange of water between the atmosphere, land, and ocean. **Running water** is the most active landscape-transforming agent on Earth's surface. Waterways erode, transport, and deposit rock and sediment to produce landforms such as canyons, valleys, deltas, alluvial fans, and floodplains.

Water travels on Earth's surface as creeks, streams, and rivers. Geologists call all of these "**streams**". It is one way rain returns to the ocean in the hydrologic cycle. Carrying products of weathered rock, streams are the most important agent of land erosion and transportation.

### I. Earth as a system: the hydrologic cycle

- Illustrates the circulation of Earth's water supply
- Processes involved in the cycle include – **evaporation, precipitation, infiltration, runoff, transpiration**
- The cycle is balanced

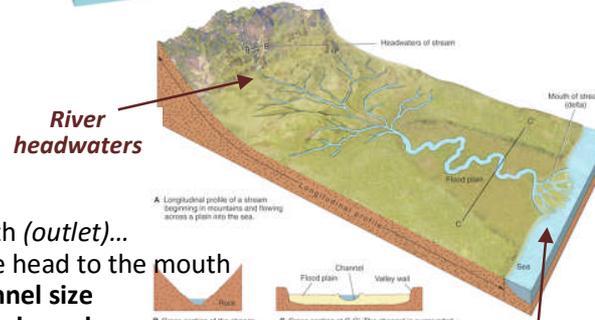


### II. Running water

#### A. Streamflow (geologists call all creeks & rivers "streams")

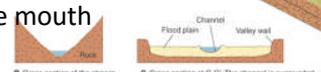
Factors that determine velocity:

- Gradient**, or slope
- Channel characteristics include - **shape, size, roughness**
- Discharge** – the volume of flowing water (water/time)



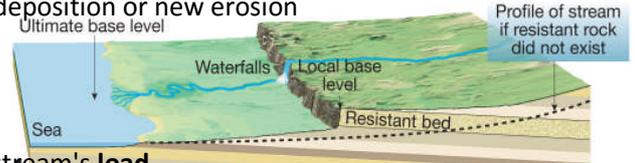
#### B. Upstream–downstream changes

- Profile – cross-sectional view of a stream from head (*source*) to mouth (*outlet*)... Profile is a relatively smooth curve w/decreasing gradient from the head to the mouth
- Factors that increase downstream include - **velocity, discharge, channel size**
- Factors that decrease downstream include - **gradient** or slope, **channel roughness**



#### C. Base level – the lowest point to which a stream can erode

- Two general types of base level include - **ultimate**, and **local (or temporary)**
- Change in base level causes readjustment of the stream—new deposition or new erosion

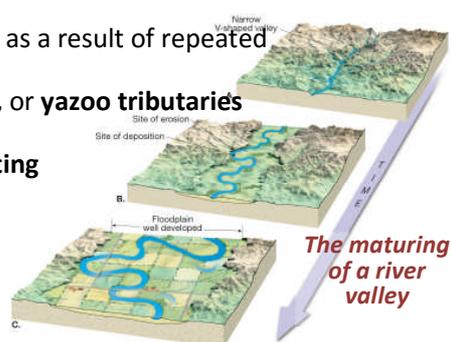


#### D. The work of streams

- Erosion – of the stream bed
- Transportation - transported material is called the **stream's load**  
Types of stream load include - **dissolved load, suspended load, bed load**  
Determinants of load:

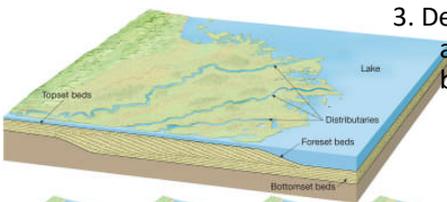
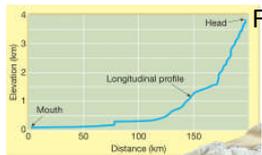
- Maximum particle size is determined mostly by stream velocity
- Capacity - maximum load is related to discharge, and velocity
- Deposition – a decrease in velocity causes sediment to begin to drop out
  - Stream sediments (*deposits*) – called alluvium, and are commonly well sorted
  - Features produced by stream deposition

- Deltas** – exist where streams flow into oceans or lakes... distributaries often form in the stream channel
- Natural levees** - form parallel to the stream channel as a result of repeated flooding... area behind the levees may contain – **backswamps, or yazoo tributaries**

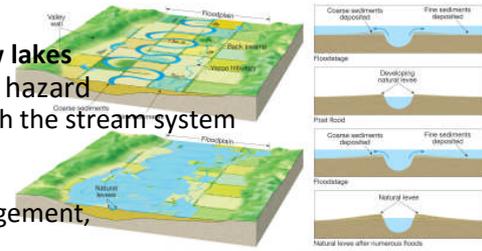


#### E. Stream valleys

- Valley sides are shaped by – **weathering, overland flow, mass wasting**
- Characteristics of narrow valleys
  - V-shaped, and downcutting toward base level
  - Features often include – rapids, and waterfalls



3. Characteristics of wide valleys
  - a. Stream is near base level, and downward erosion is less dominant with stream's energy directed from side to side
  - b. **Floodplain** – with features such as **meanders, cutoffs, oxbow lakes**



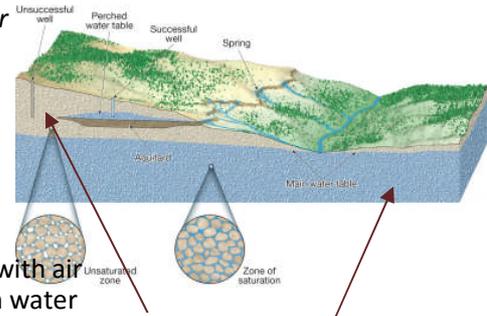
**Floodplain, and formation of natural levees**

- F. Floods and flood control - floods are the most common geologic hazard
  1. Causes of floods include – weather, and human interference with the stream system
  2. Flood control - engineering efforts include:
    - artificial levees, dams, channelization**
  3. And...nonstructural approaches through sound floodplain management, i.e. **work with nature when possible!**

- G. **Drainage basins and patterns**
  1. The area from which a stream receives runoff is its drainage basin
  2. A **divide** separates drainage basins
  3. Types of drainage patterns include – **dendritic, radial, rectangular, trellis**

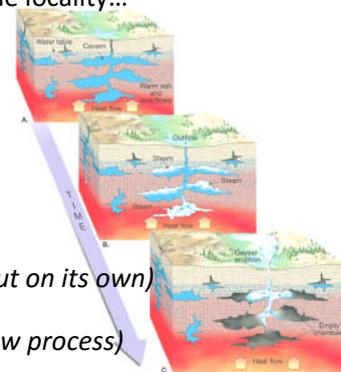
### III. Water beneath Earth's surface (*groundwater – is the largest freshwater reservoir for humans*)

- A. Geological roles
  1. An erosional agent—dissolution by groundwater produces: caverns and sinkholes
  2. An equalizer of streamflow – stream water is either gained or lost through the stream bed to groundwater
- B. Distribution and movement of groundwater
  1. Distribution of groundwater
    - a. Unsaturated zone - pore spaces in the material are filled mainly with air
    - b. Zone of saturation - all pore spaces in the material are filled with water
    - c. **Water table**—the upper limit of the zone of saturation
  2. Movement of groundwater is dependent on:
    - a. **Porosity** - percentage of pore space in the ground... determines how much groundwater can be stored (**but not how well it can flow!**)
    - b. **Permeability** – the ground's ability to transmit water through connected pore spaces
      - i. **Aquitard**—an impermeable layer of material
      - ii. **Aquifer**—a permeable layer of material that contains useful amounts of groundwater



**Unsaturated zone & saturated zone**

- C. Features associated with groundwater
  1. **Springs**
    - a. Hot springs - water is 6–9°C warmer than the mean air temperature of the locality... heated by igneous rock
    - b. Geysers – groundwater turns to steam and erupts, then repeats
    - c. Freshwater spring - where groundwater runs out onto Earth's surface
  2. **Wells** – a hole drilled down into an aquifer in order to pump groundwater
    - a. Pumping can cause a drawdown (*lowering*) of the water table
    - b. Pumping can form a localized '**cone of depression**' in the water table
  3. **Artesian wells**
    - a. Water in the well rises higher than the initial groundwater level
    - b. Types of artesian wells include – non-flowing and flowing (*water flows out on its own*)

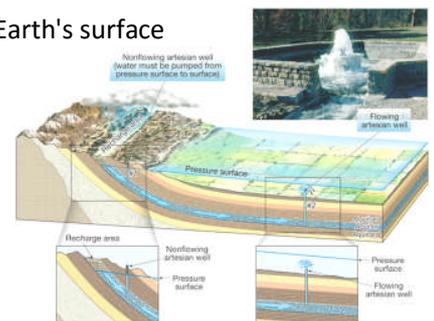


**Typical geyser process**

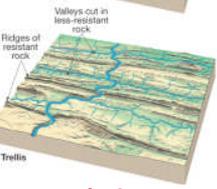
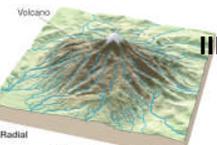
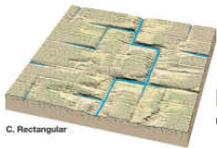
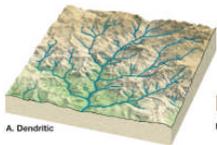
- D. Environmental problems associated with groundwater
  1. Treating it as a renewable resource (*recharge of an aquifer is often a very slow process*)
  2. Land subsidence caused by its withdrawal
  3. Contamination – either by contaminants from the surface, or by saltwater intrusion

- E. Geologic work of groundwater
  1. Groundwater is often mildly acidic, containing weak carbonic acid... this dissolves the calcite in limestone
  2. Caverns - formed by dissolution of rock (*often limestone*) beneath Earth's surface
    - a. Formed originally in the zone of saturation
    - b. Features commonly found within caverns include – **stalactites (ceiling), and stalagmites (floor)**
  3. **Karst topography**
    - a. Formed by dissolution of rock at, or near, Earth's surface
    - b. Common features include:

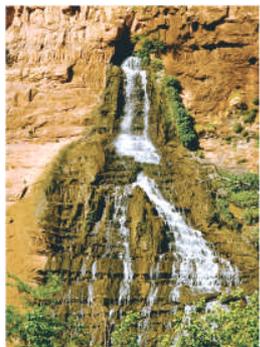
**Sinkholes (collapsed caverns), surface depressions (dissolved bedrock), caves and caverns**



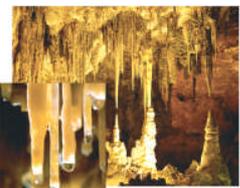
**Confined aquifer with flowing artesian well**  
Print Date: August 16, 2016



**Four drainage patterns**



**A spring, groundwater flowing out of the ground**



**Limestone cavern**

