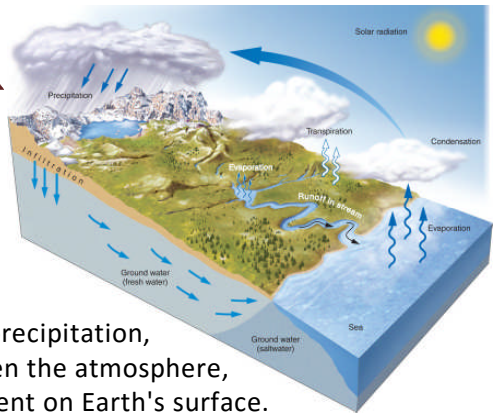
Chapter Outlines

Hydrologic Cycle



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

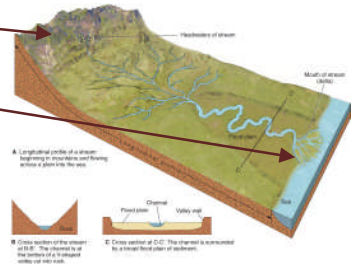
Streams & Floods

The **hydrologic cycle** is the constant circulation of the earth's water through precipitation, evaporation, 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.

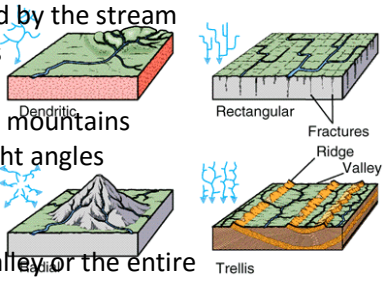
Water travels on Earth's surface as creeks, streams, and rivers. Geologists call all of these "**<u>streams</u>**". It is one way rain returns to the ocean in the hydrologic cycle. Carrying products of weathered rock, streams are the most important agent of land erosion and transportation.

River headwaters

River mouth

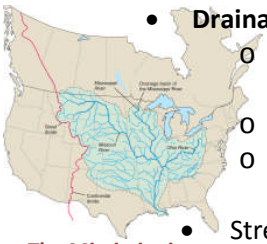


- Running water
  - **Headwaters** - upper part of stream near its source in the mountains
  - **Mouth** - place where a stream enters sea, lake, or larger stream
  - **Channel** - a long, narrow depression eroded by a stream into rock or sediment
  - **Stream banks** - sides of the channel
  - **Streambed** - bottom of the channel
  - **Floodplain** - flat valley floor adjacent to stream composed of sediment deposited by the stream
- Stream drainage patterns – the 'map view' arrangement of a stream and its tributaries
  - **Dendritic** – resembling the branches on a tree
  - **Radial** – streams diverge outward like the spokes of a wheel, such as on conical mountains
  - **Rectangular** – tributaries have frequent 90° bends and join other streams at right angles
  - **Trellis** – parallel streams with short tributaries meeting at right angles



Four drainage patterns

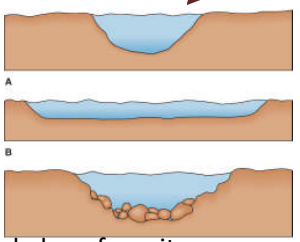
- **Drainage basins**
  - The total area drained by a stream and its tributaries. It could be a small valley or the entire Mississippi drainage basin
  - A '**divide**' is a ridge or high ground that divides one drainage basin from another
  - **Continental Divide** separates the streams that flow into the Pacific from those that flow into the Atlantic and Gulf of Mexico

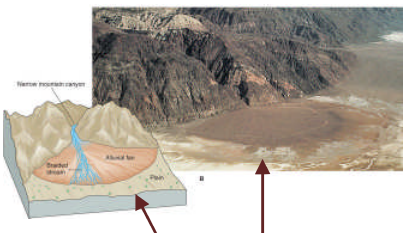


The Mississippi drainage basin, and the continental divide

- Stream weathering, transportation, and deposition
  - **Discharge** – is the volume of water flowing past a point in a given amount of time.
  - **Base level** – the lowest point to which stream erosion is possible, the ocean being the ultimate base level.
  - Stream velocity is controlled by:
    - gradient: vertical fall / horizontal distance
    - channel size & shape: less surface area = higher velocity
    - channel roughness: lots of boulders and debris = lower velocity
  - Higher velocity will carry more sediment and do more eroding
  - Lowering of velocity will cause a stream to deposit its sediment load as:
    - **Bars** – ridges of sediment deposited in middle or along sides. If multiple bars form it may become a **braided stream**
    - **Deltas** – body of sediment deposited at a river's mouth when flow velocity decreases
    - **Alluvial fans** - large, fan- or cone-shaped pile of sediment that forms where stream velocity decreases as it emerges from a narrow mountain canyon onto a flat plain
    - **Natural levees** are slightly raised stream banks with respect to the adjacent floodplain

Channel shape effects flow velocity

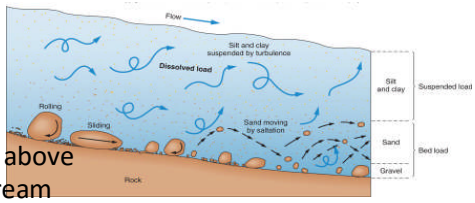




An alluvial fan

Example of a young stream valley

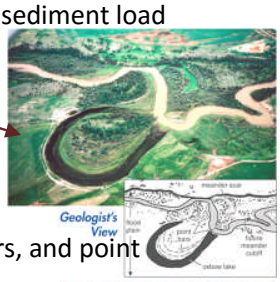
Methods of stream sediment transport



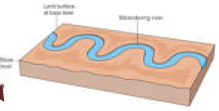
- Sediment in a stream moves by:
  - **Traction load** - rolling or sliding on the stream bottom
  - **Saltation** – individual particles 'bouncing' on the stream bed
  - **Suspended load** – individual particles light enough to be held above the stream bed in the water flow by the turbulence of the stream
  - **Dissolved load -** ions produced by chemical weathering of soluble minerals upstream
- Streams cut their own valleys, deepening and widening them over time and carrying away the sediment by:
  - ***hydraulic action*** - ability to pick up and move rock and sediment
  - ***solution*** - dissolving of rocks
  - ***abrasion*** - grinding away of stream channel by the friction and impact of the sediment load

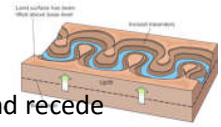
- River valley forms and processes
  - **Young valley** – recent uplift
    - Downcutting, with V-shaped valleys, until they reach base level
    - followed by **lateral erosion**
  - **Mature valley** – uplift has ended and/or base level has been reached
    - Valley floor widens and a flood plain develops
    - **Meanders** develop – stream velocity is highest at the outside of the meanders, and point bars form at the inside of meanders
    - Natural levees form; Yazoo tributaries form occasionally
    - Oxbow lakes form when meanders are 'cut off'.
    - Lowering of base level or renewed uplift can result in formation of **stream terraces** above the flood plain *(downcutting into the former flood plain)*
  - **Incised meander** – may occur as a result of renewed uplift
  - **Stream lengthening** –by headward erosion and/or delta building
  - **Graded stream** – when a stream has achieved balance between available sediment load and transport capacity, i.e. it has an even gradient without waterfalls, etc.

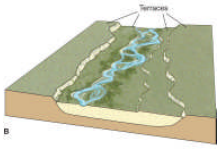
Mature stream valley, oxbow lake, meanders



Incised meanders

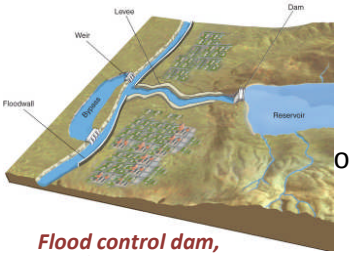






Formation of stream terraces

- Flood hazards
  - **Floods** – involve increased discharge and velocity, when water levels rise and overtop a stream's banks – all streams flood at some time!
    - Large amounts of sediment *(flood plain deposits)* are left behind as flood waters slow and recede
    - **Flash floods** – occur mostly in desert areas
      - local, sudden floods of large volume and short duration
      - typically triggered by heavy thunderstorms
    - Urban flooding – one result of land paved with streets & parking lots
    - Flood protection is designed based on the relative likelihood of flooding
      - **100 year flood** is a level a stream can be expected to reach once every 100 years (1% chance any given year)
      - Stream stages
        - **Normal stage** – below the tops of levees
        - **Bankfull stage** – at the levee's top
        - **Flood stage** – flood waters flow over the top of the levees.
    - Controlling flooding
      - **Dams** - to hold back flood water by storing flood water in a reservoir
      - **Bypasses** – bypass storm water into a manmade channel around a high flood risk area
      - **Artificial levees** – increase stream channel capacity by raising the banks
      - Wise land use planning - avoiding building on flood plains!
  - Sacramento *(see accompanying Sacramento flood related summary)*
    - Flooded nearly annually until late 1800's
    - During the 1860's the downtown portion of Sacramento was raised by hauling in soil.
    - An extensive levee system has been built in the Sacramento and surrounding area
    - A river flood bypass system was installed through the lower Sacramento valley in 20's & 30's
    - Folsom dam completed in 1955



Flood control dam, artificial levee, & bypass

✓ Do you know your local risk of flooding? (cityofsacramento.org/Utilities/Education/Flood-Ready/Maps)