Essentials of Geology, 11e

Running Water

Chapter 9

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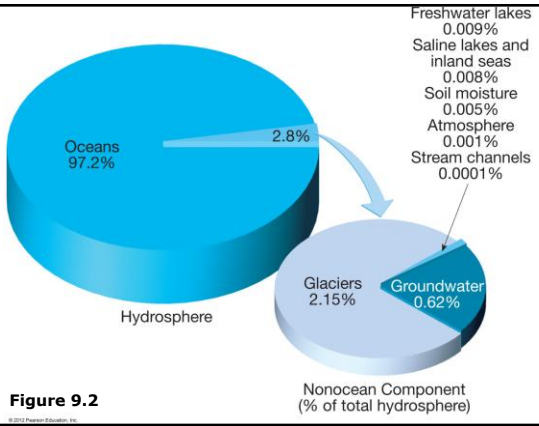


Figure 9.2

Hydrologic Cycle

- **The hydrologic cycle is balanced and driven by the sun**
- **It represents continuous movement –**
  - **– Oceans to atmosphere**
  - **– Atmosphere to land**
  - **– Land to sea**

Hydrologic Cycle

- **The hydrologic cycle is a summary of the circulation of Earth's water supply**
- **Processes involved in the hydrologic cycle**
  - **Precipitation**
  - **Evaporation**
  - **Infiltration**
  - **Runoff**
  - **Transpiration**

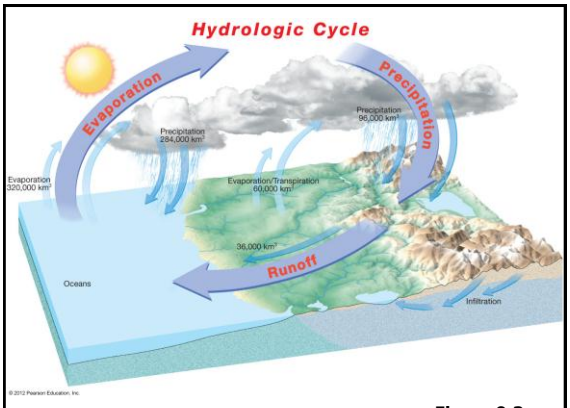


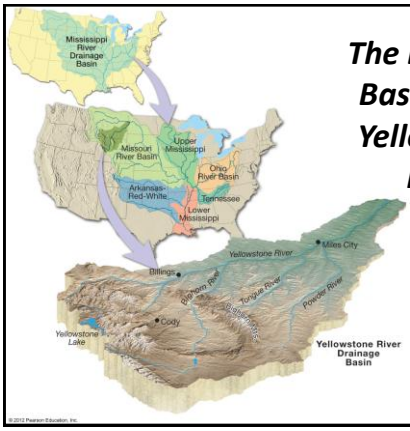
Figure 9.3

Running Water

- **Running water begins as sheet flow**
  - **– Overland flow develops into channels progressively larger called**
    - **Rills -> Gullies -> Streams -> Rivers**
  - **– Infiltration capacity is controlled by**
    - **Intensity and duration of rainfall**
    - **Prior wetted condition of the soil**
    - **Soil texture**
    - **Slope of the land**
    - **Nature of the vegetative cover**

Running Water

- **Drainage networks**
  - **The land area that contributes water to a stream is called the drainage basin**
  - **The drainage pattern consists of the interconnected network of streams in an area**
  - **Stream drainage basins are divided by an imaginary line called a divide.**



The Drainage Basin of the Yellowstone River

Figure 9.5

TABLE 9.1
World's Largest Rivers Ranked by Discharge

			Drainage Area		Average Discharge	
Rank	River	Country	Square kilometers	Square miles	Cubic meters per second	Cubic feet per second
1	Amazon	Brazil	5,778,000	2,231,000	212,400	7,500,000
2	Congo	Rep. of Congo	4,014,500	1,550,000	39,650	1,400,000
3	Yangtze	China	1,942,500	750,000	21,800	770,000
4	Brahmaputra	Bangladesh	935,000	361,000	19,800	700,000
5	Ganges	India	1,059,300	409,000	18,700	660,000
6	Yenisei	Russia	2,590,000	1,000,000	17,400	614,000
7	Mississippi	United States	3,222,000	1,244,000	17,300	611,000
8	Orinoco	Venezuela	880,600	340,000	17,000	600,000
9	Lena	Russia	2,424,000	936,000	15,500	547,000
10	Parana	Argentina	2,305,000	890,000	14,900	526,000

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River Systems

- **3 main zones of process domination and landscape formation**
  - **Zone of erosion**
  - **Zone of sediment transportation**
  - **Zone of sediment deposition**

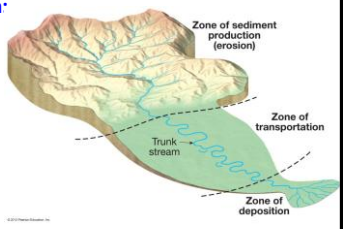


Figure 9.6

Running Water

- **Streamflow**
  - **Water flows under the influence of gravity**
  - **Two types of flow determined primarily by velocity**
    - **Laminar flow – lazy tubing**
    - **Turbulent flow – whitewater rafting**
  - **The ability of a stream to erode and transport materials depends on its velocity.**

Running Water

- **Streamflow**
  - **Factors that determine velocity**
    - **Gradient – the slope (vertical drop over a specified distance)**
    - **Shape, size, and roughness – affect the coefficient of friction**
    - **Discharge - the volume of water moving past a given point in a certain amount of time**

Running Water

- **Changes from upstream to downstream**
  - **Factors that increase downstream**
    - **Velocity**
    - **Discharge**
    - **Channel size**
  - **Factors that decrease downstream**
    - **Gradient**
    - **Channel roughness**

Running Water

- **Changes from upstream to downstream**
  - **Profile**
    - **Cross-sectional view of a stream**
    - **Viewed from the head (headwaters or source) to the mouth of a stream**
    - **Profile is a smooth curve**
    - **Gradient decreases downstream**

Longitudinal Profile of a Stream

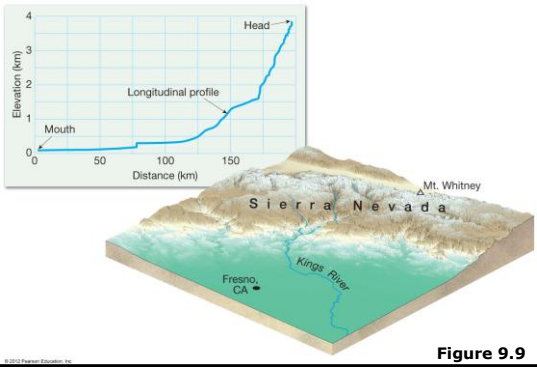
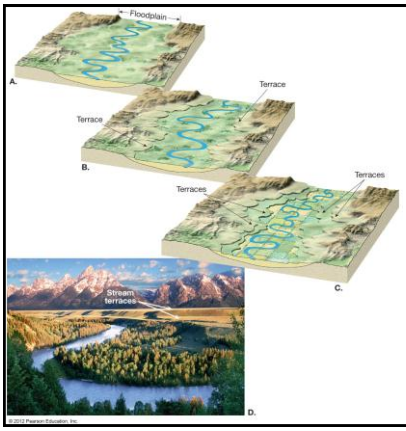


Figure 9.9

Running Water

- **3 main zones of process domination – erosion, transport, & deposition**
- **Stream erosion**
  - **Lifting loosely consolidated particles by**
    - **Abrasion**
    - **Dissolution**
  - **Stronger currents lift particles more effectively**



Erosion- *Stream* ***Terraces***

Figure 9.22

Running Water

- **3 main zones of process domination –**
- **Transport of sediment by streams**
  - **Transported material is called the stream's load**
  - **3 Types of load**
    - **Dissolved load**
    - **Suspended load**
    - **Bed load**

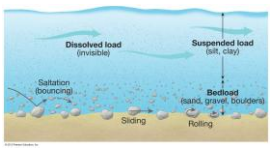


Figure 9.12

Running Water

- 3 main zones of process domination –
- Transport **Capacity**
  - The maximum load a stream can transport
  - Determined by stream **discharge**
- Transport **Competence**
  - Indicates the maximum particle size a stream can transport
  - Determined by stream **velocity**

Running Water

- 3 main zones of process domination –
- **Deposition** of sediment by a stream
  - Caused by a decrease in velocity
    - Competence is reduced
    - Sediment begins to drop out by **sorting**
  - Stream sediments
    - Generally well sorted or graded
    - Stream sediments are known as **alluvium**

Running Water

- **Deposition** of sediment by a stream
  - Channel deposits
    - Bars
    - Braided streams
  - Deltas
    - Forms when river empties into a lake or ocean
    - broad arc, divided into smaller distributaries
  - Alluvial fans
    - Develop where a high-gradient stream leaves a narrow valley
    - Slopes outward in a broad arc

Running Water

- **Deposition** of sediment by a stream
  - Floodplain deposits
    - **Natural levees** – landforms deposited parallel to the stream channel by successive floods over many years
    - Back swamps
    - Yazoo tributaries

Delta Formation

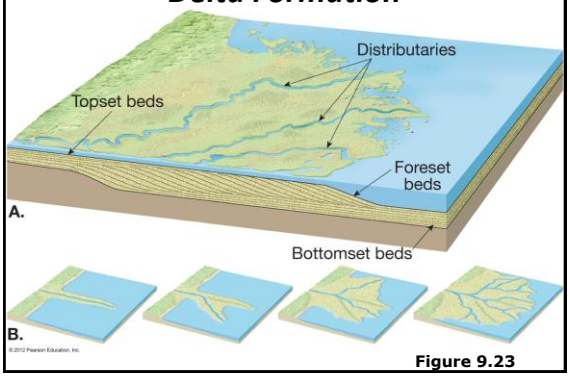


Figure 9.23

Formation of Natural Levees by Repeated Flooding

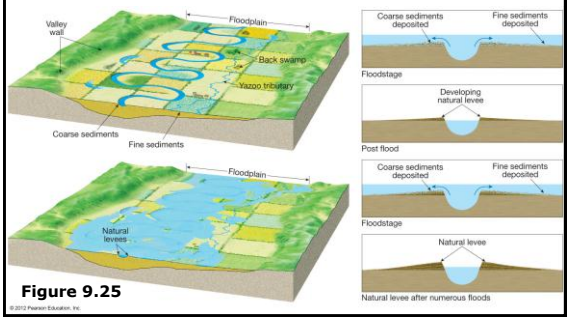


Figure 9.25

Mississippi River Deltas

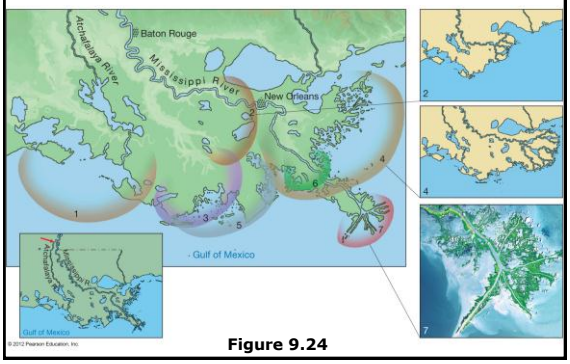


Figure 9.24

Running Water

- **Base level and graded streams**
  - **Base level is the lowest point to which a stream can erode**
    - **Two general types of base level**
      - **Ultimate (sea level)**
      - **Local or temporary**
  - **Changing conditions causes readjustment of stream activities**
    - **Raising base level causes deposition**
    - **Lowering base level causes erosion**

Adjustment of Base Level

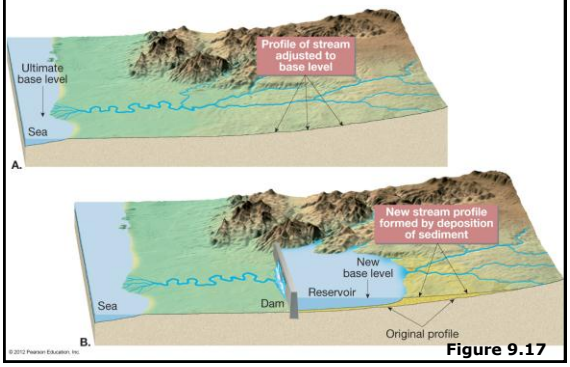


Figure 9.17

Steam Channels

- **Bedrock channel**
- **Alluvial channel (2 common types)**
  - ***Meandering* streams – sweeping bends**
    - **Meanders, cut bank, point bars, cutoff, and oxbow lakes**
    - **More laminar flow, smaller/finer load**
  - ***Braided* streams – interwoven channels**
    - **Channels constantly shifting seasonally**
    - **More turbulent flow, larger/coarser load**

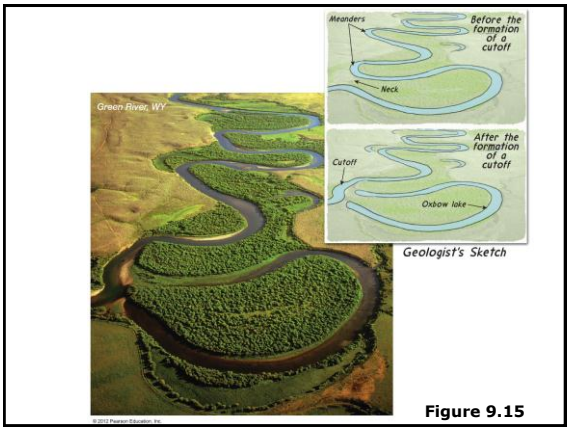


Figure 9.15

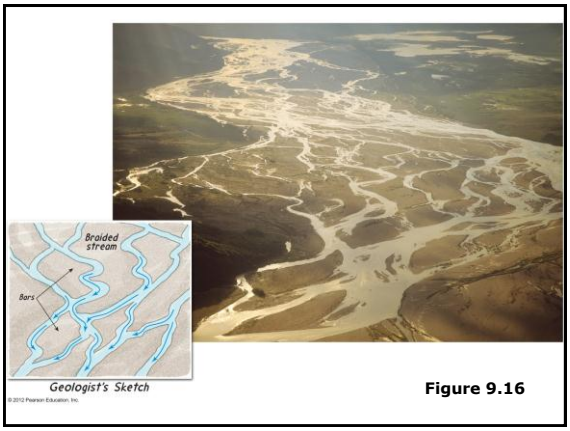


Figure 9.16

Running Water

- **Stream valleys**
  - **The most common landforms on Earth's surface**
  - **Two general types of stream valleys**
    - **Narrow valleys**
      - **V-shaped**
      - **Downcutting toward base level**
      - **Features often include rapids and waterfalls**

Running Water

- **Stream valleys**
  - **Two general types of stream valleys**
    - **Wide valleys**
      - **Stream is near base level**
      - **Downward erosion is less dominant**
      - **Stream energy is directed from side to side forming a floodplain**

Valley Deepening and Widening

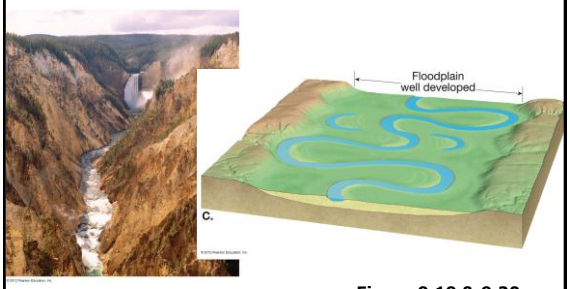


Figure 9.19 & 9.20c

Running Water

- **Stream valleys**
  - **Features of wide valleys often include**
    - **Floodplains**
      - **Erosional floodplains**
      - **Depositional floodplains**
    - **Meanders**
      - **Cut bank and point bar**
      - **Cutoffs and oxbow lakes**

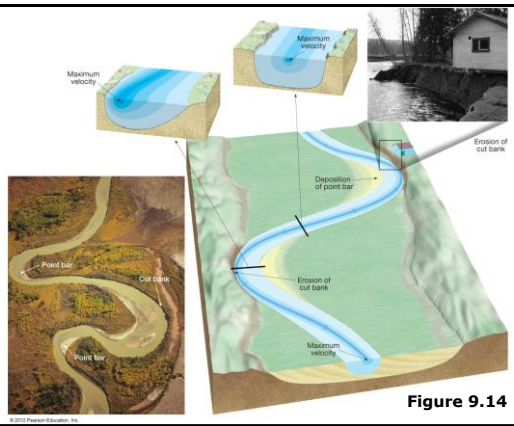


Figure 9.14

Running Water

- **Incised meanders and stream terraces**
  - **Incised meanders**
    - **Meanders in steep, narrow valleys**
    - **Caused by a drop in base level or uplift of the region**
  - **Terraces**
    - **Remnants of a former floodplain**
    - **River has adjusted to a relative drop in base level by downcutting**

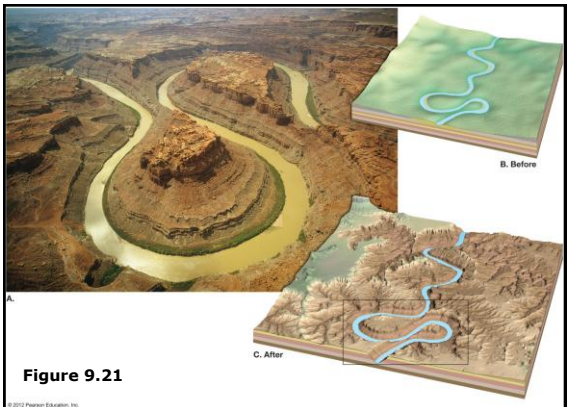


Figure 9.21

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Running Water

- Drainage patterns are formed by the network of streams in a given area
- Common drainage patterns
  - Dendritic
  - Radial
  - Rectangular
  - Trellis

Drainage Patterns

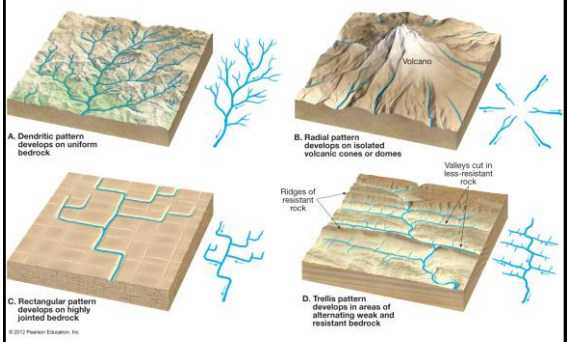

Figure 9.26

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Running Water

- Incised meanders and stream terraces
  - Incised meanders
    - Meanders in steep, narrow valleys
    - Caused by a drop in base level or uplift of the region
  - Terraces
    - Remnants of a former floodplain
    - River has adjusted to a relative drop in base level by downcutting

Floods and Flood Control

- **Floods** and flood control
  - Floods are the most common and most destructive geologic hazard
  - Causes of flooding
    - Result from naturally occurring and human-induced factors

Floods and Flood Control

- **Floods** and flood control
  - Types of floods
    - Regional floods
    - Flash floods
    - Ice-jam floods
    - Dam failure

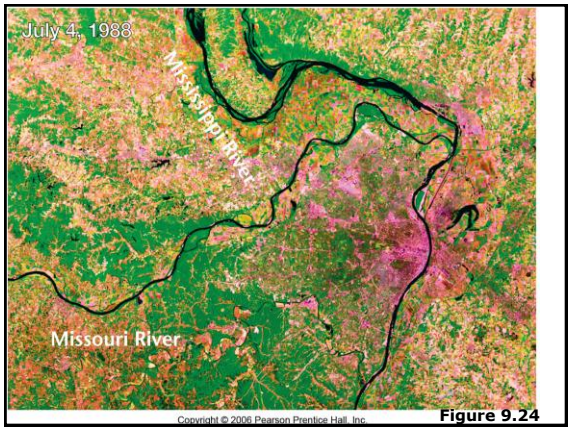

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Figure 9.24

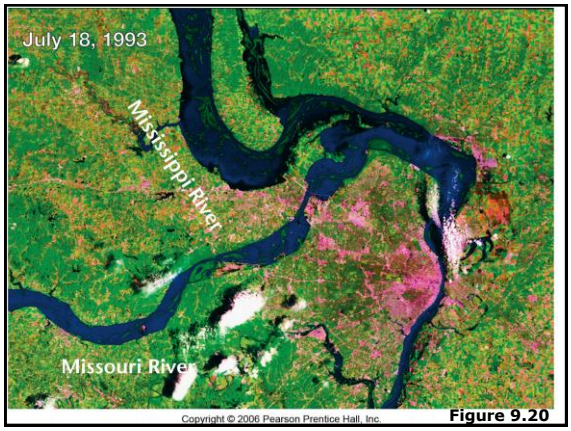

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Figure 9.20

Floods and Flood Control

- **Floods and flood control**
  - **Flood control**
    - **Engineering efforts**
      - **Artificial levees**
      - **Flood-control Dams**
      - **Channelization**
    - **Adopt a nonstructural approach through sound floodplain management**

End of Chapter 9