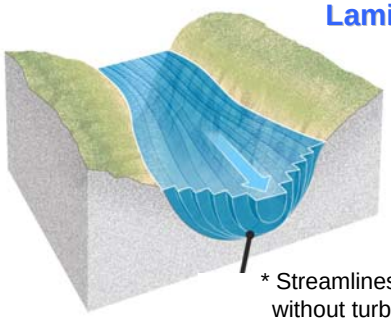
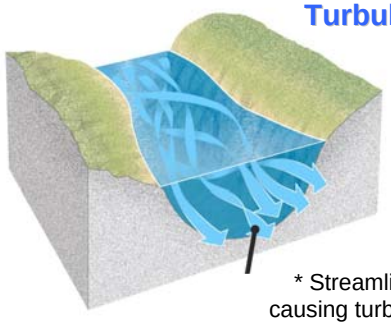
Laminar Flow *



* Streamlines flow parallel without turbulent mixing

Figure 18.13

Turbulent Flow *



* Streamlines cross causing turbulent mixing

Figure 18.13

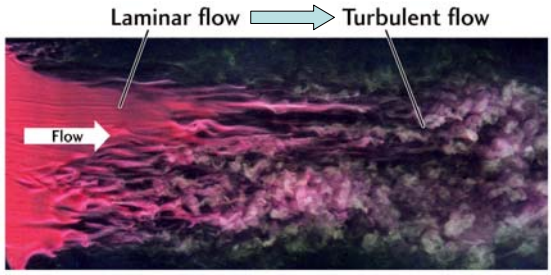


Figure 18.13

Whether Flow is Laminar* or Turbulent Depends On:

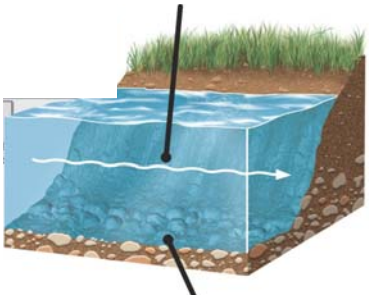
- **flow velocity**
- **geometry** (primarily depth)
- **viscosity**
  (a measure of a fluids resistance to flow)

*** note: laminar flow almost never exists in surface water flows**

Types of Sediment Transport

- **Suspended Load**
  - Fine-grained sediment (typically clay and silt) transported in suspension due to turbulence
- **Bed (or traction) Load**
  - Coarser-grained sediment (typically sand and gravel) transported on the bottom of the stream bed by rolling and sliding
- **Saltation**
  - Sediment (typically sand) transported by intermittent jumps - a transitional state between bedload and suspended load.

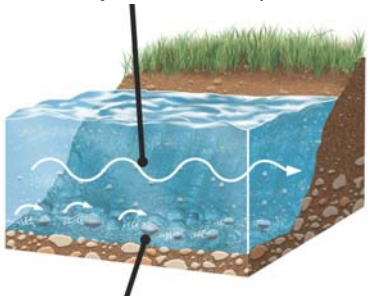
Fine-grained sediment carried in suspension



coarse-grained sediment slides and rolls as bedload.

Figure 18.14

Increased velocity increases suspended load and…



increases bottom shear stress, increased bedload.

Figure 18.14

Saltation (intermittent bouncing)
a transitional state between bedload and suspension

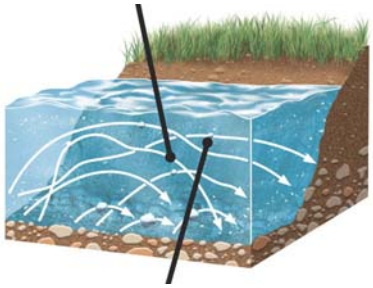


Figure 18.14

Measures of a Streams Ability to Transport Sediment Include:

Competence: A measure of the maximum size particle a stream can transport

Capacity: A measure of the total volume of sediment stream can transport

Clay particles have a high surface to volume ratio, as well as residual charges on their outer layers…

...thus they tend to be cohesive and stick together….

…making clay relatively harder to erode than coarser silt and fine-grained sand!

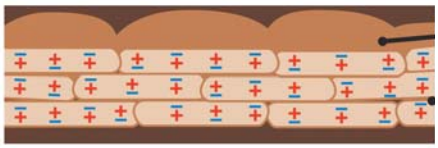
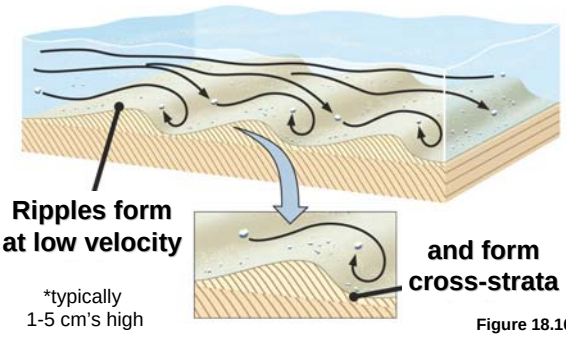


Figure 14.3

Ripples: low velocity bedforms*



Ripples form at low velocity

and form cross-strata

*typically 1-5 cm's high

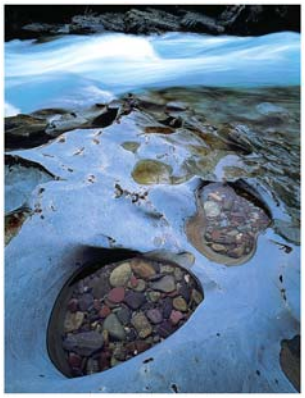
Figure 18.16

Dunes*: higher velocity bedforms

Dunes **may occur with ripples**

*Typically range from 10 cm to 10's of meters high

Figure 18.16



Potholes form by pebbles and gravel grinding inside eddies

Figure 18.11

Waterfall formed by headward erosion

Figure 18.12

The Two Main Types of Channel Patterns on Floodplains are:

- **Meandering Streams**
  - have a single channel with a sinuous pattern
  - are the most common pattern on floodplains
- **Braided Streams**
  - have an interlacing network of channels
  - are relatively uncommon

Meandering River in Alaska

Figure 18.3

Lateral migration of meandering streams…

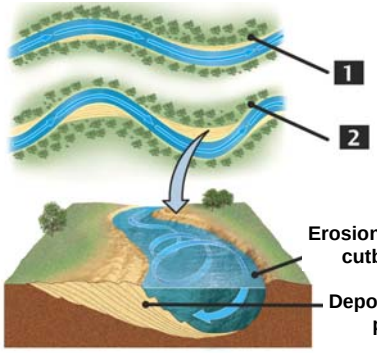


Figure 18.3

Meandering Rivers Gradually Change Their Course by Lateral Migration

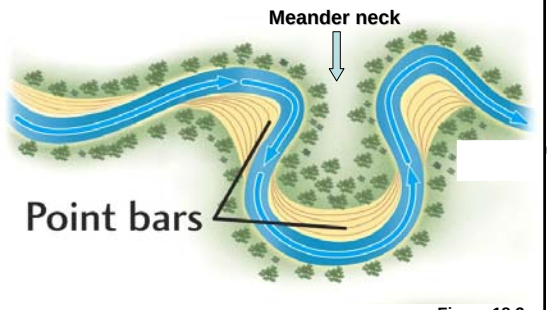


Figure 18.3

Meandering Rivers Abruptly Change Their Course by Meander Cutoffs During Major Flood Events

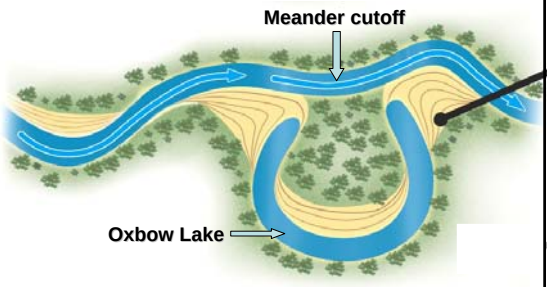


Figure 18.3

Braided River in Alaska

Figure 18.3

Variables that Encourage Channel Braiding Include:

- highly variable water discharge
- large sediment load
- easily eroded bank material

Low Discharge Period
(e.g. summer)

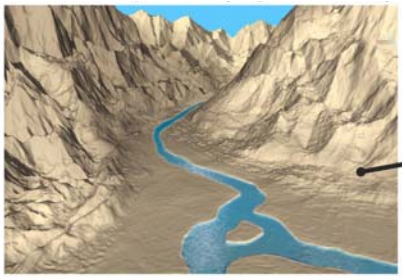


Figure 18.3

High Discharge Period
(e.g. spring snowmelt)

Figure 18.3

River valleys are built by two processes

- **Lateral accretion:** by the lateral migration of bar deposits (mainly sands and gravels).
- **Vertical accretion:** by the deposition of natural levee and flood basin deposits on the ***floodplain*** during periods of overbank (flood) flow (mainly silts and clays).

Building a Floodplain, One Flood at a Time

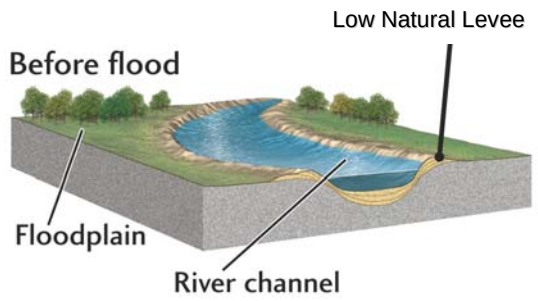


Figure 18.4

Building a Floodplain, One Flood at a Time

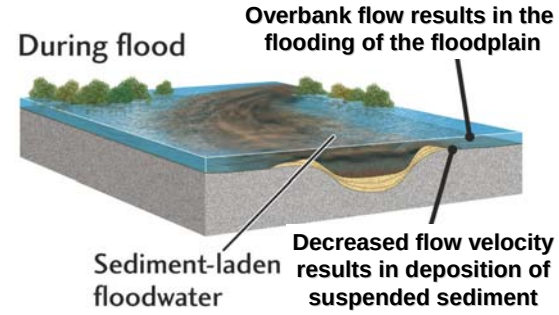


Figure 18.4

Building a Floodplain, One Flood at a Time

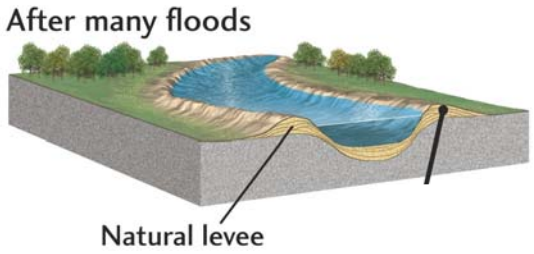


Figure 18.4

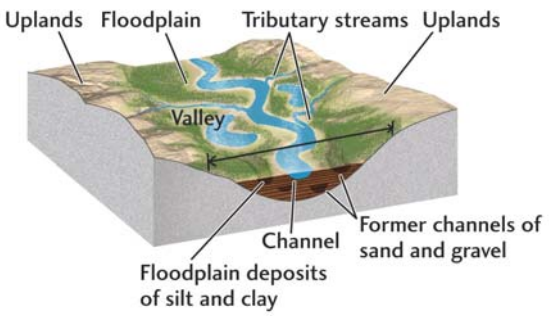
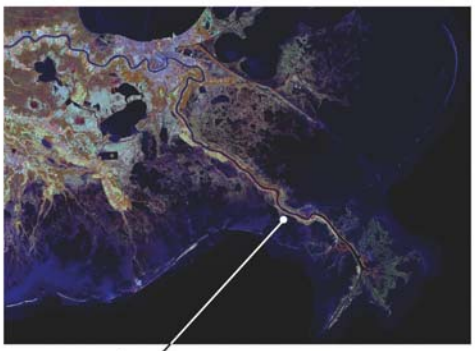


Figure 18.1



Natural Levee Along the Mississippi River Figure 18.4

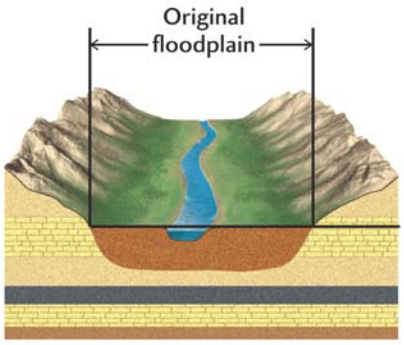


Figure 18.26

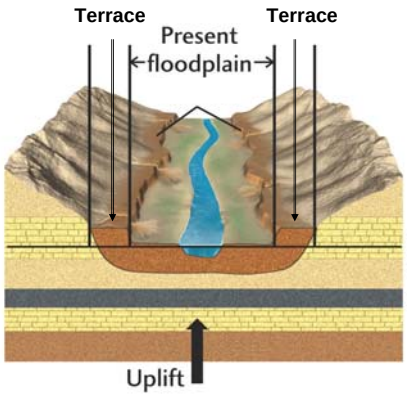


Figure 18.26

Uplift can also result in the entrenchment of meandering streams, forming "incised meanders"

Figure 18.2

Discharge = water cross section (width x depth) x velocity (distance/time)

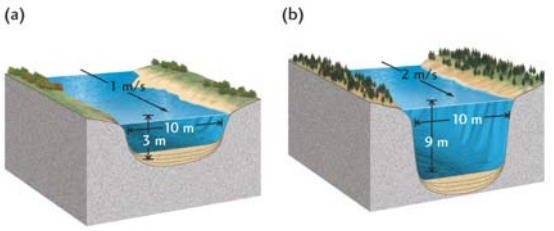


Figure 18.20

Life on the Floodplain!

Box 18.1

Recurrence Interval

Annual recurrence interval (R I) is average number of years between events of similar or greater magnitude.

100 year flood is one which occurs, **on the average**, once every 100 years.

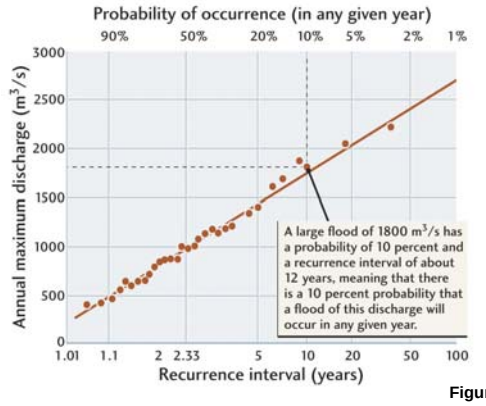


Figure 18.21

The dynamic equilibrium of a stream system is controlled by:

- **Topography** (including slope)
- **Climate**
- **Streamflow**
- **Resistance** of underlying bedrock

Base level

The elevation at which a stream ends by entering a large standing body of water, such as a lake or ocean

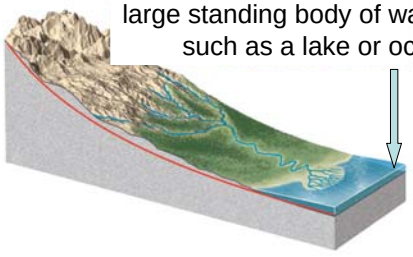


Fig. 18.22

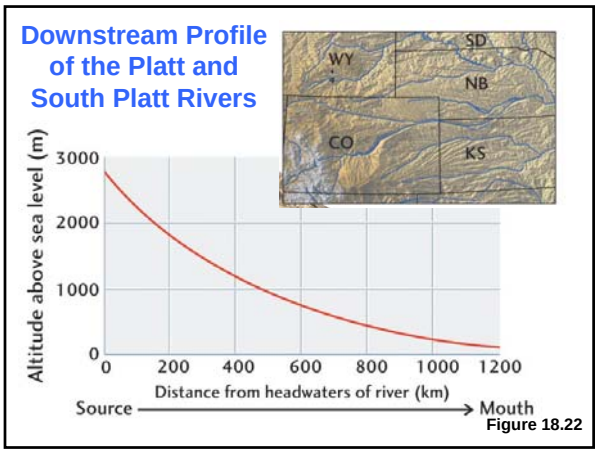


Figure 18.22

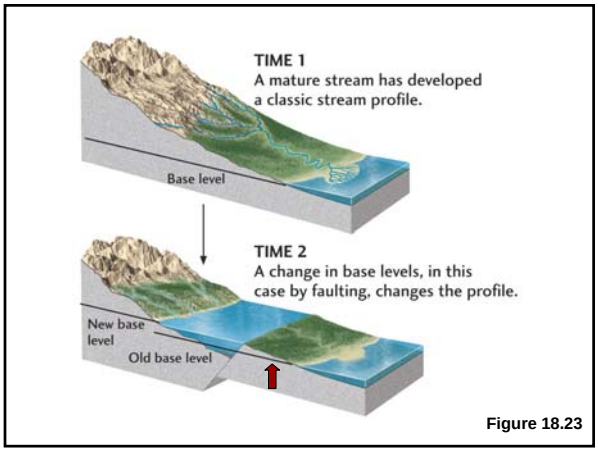


Figure 18.23

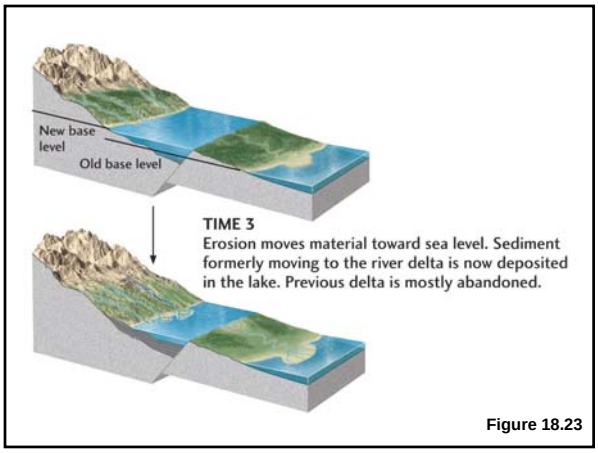


Figure 18.23

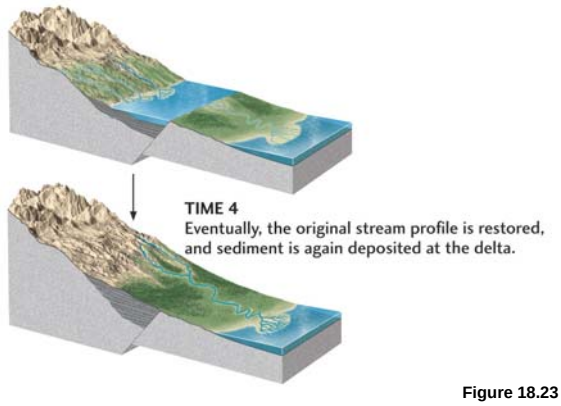


Figure 18.23

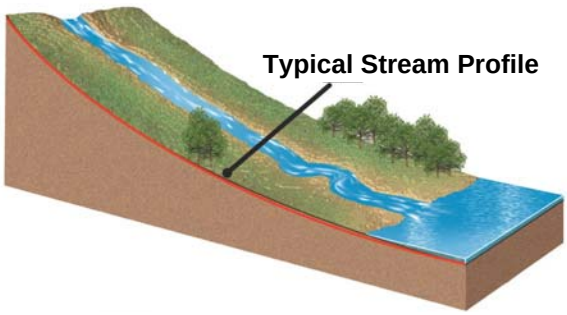


Figure 18.24

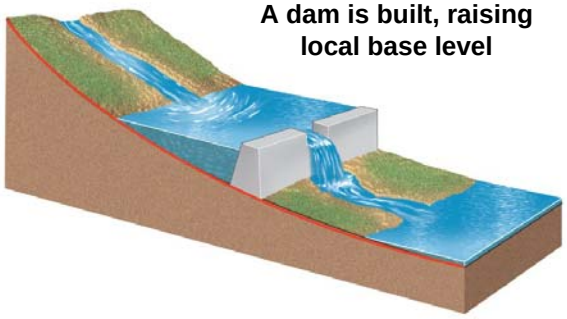


Figure 18.24

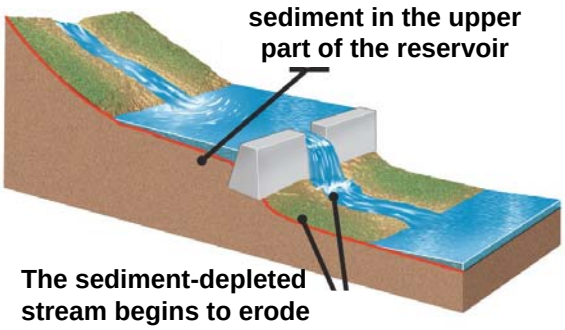


Figure 18.24

Alluvial Fans:

accumulations of sediment formed where streams widen and slow down suddenly at the base of a mountain

Figure 18.25

Drainage Basin

- An area of land that funnels all water that fall on it into a network of streams
- The boundaries of the drainage area are called **divides**

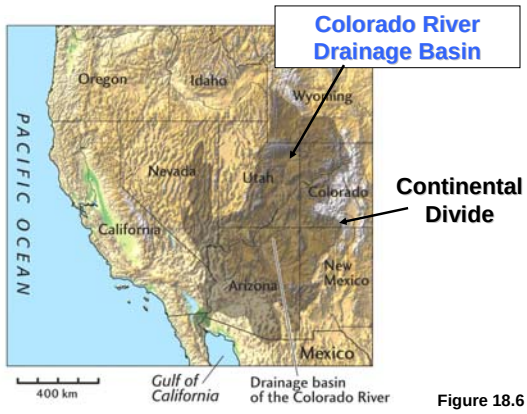


Figure 18.6

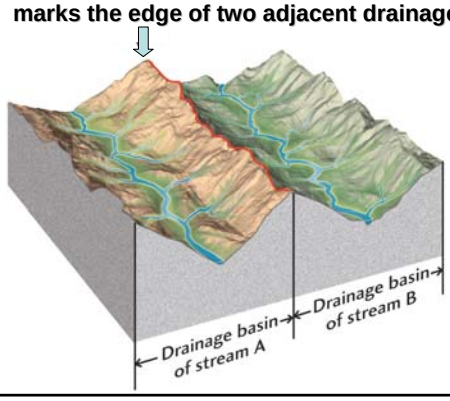


Figure 18.5

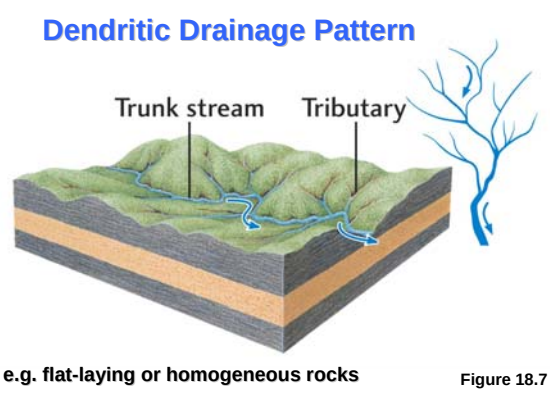
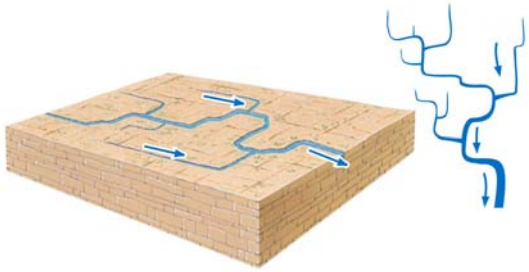


Figure 18.7

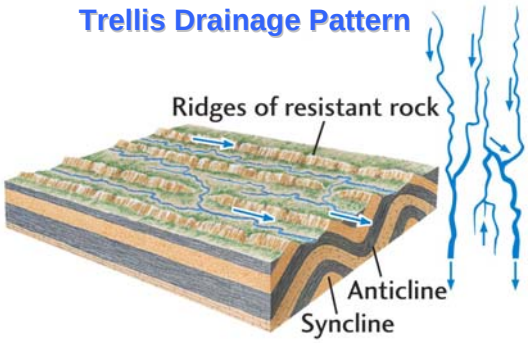
Rectangular Drainage Pattern



e.g. jointed or faulted rocks

Figure 18.7

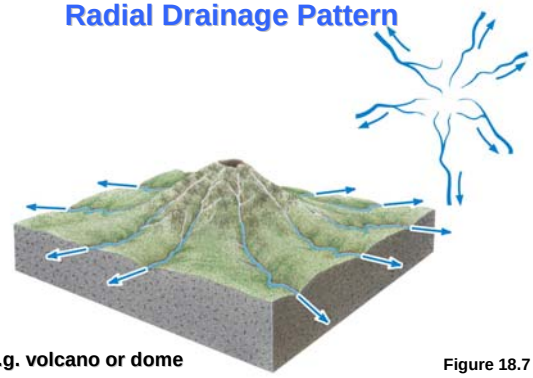
Trellis Drainage Pattern



e.g. folded layered rocks

Figure 18.7

Radial Drainage Pattern



e.g. volcano or dome

Figure 18.7

Delta formed at the mouth of a large river

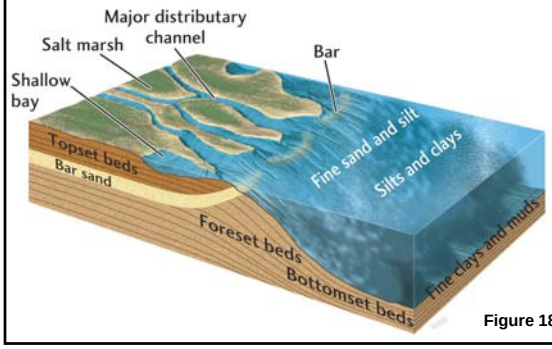


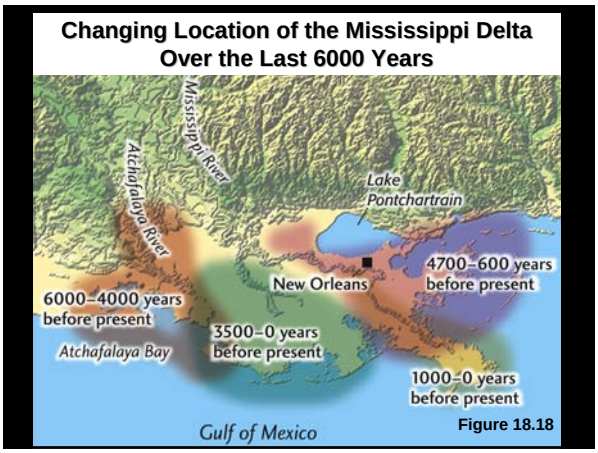
Figure 18.17

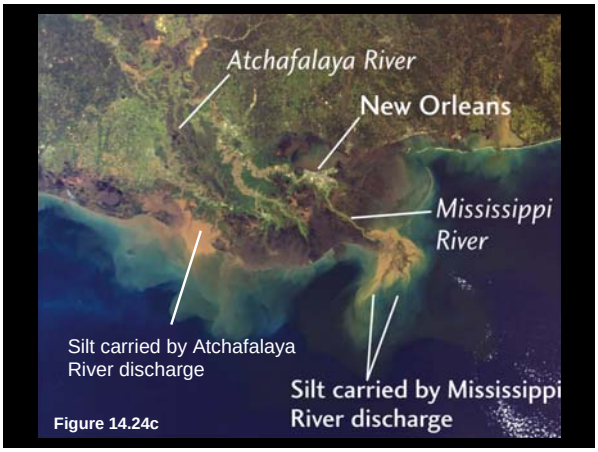
Some Sediment Hugs the Bottom

Figure 18.17

Other Sediment Settles from Suspension

Figure 18.17


Changing Location of the Mississippi Delta
Over the Last 6000 Years
Mississippi River
Atchafalaya River
Lake
Pontchartrain
New Orleans
4700–600 years
before present
6000–4000 years
before present
3500–0 years
before present
Atchafalaya Bay
1000–0 years
before present
Gulf of Mexico
Figure 18.18


Atchafalaya River
New Orleans
Mississippi
River
Silt carried by Atchafalaya
River discharge
Silt carried by Mississippi
River discharge
Figure 14.24c


Atchafalaya River
Mississippi River
Atchafalaya River
delta
Gulf of Mexico
Figure 18.18