

# Chapter 3

## Landscapes Fashioned by Water

معالم سطح الارض التي تشكلها  
المياه

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*2017*

# *Earth's external processes*

- **Weathering, mass wasting, and erosion** are all called external processes because they occur at or near Earth's surface.
- Internal processes, such as **mountain building and volcanic activity**, derive their energy from Earth's interior

# ***Mass wasting: The work of gravity***

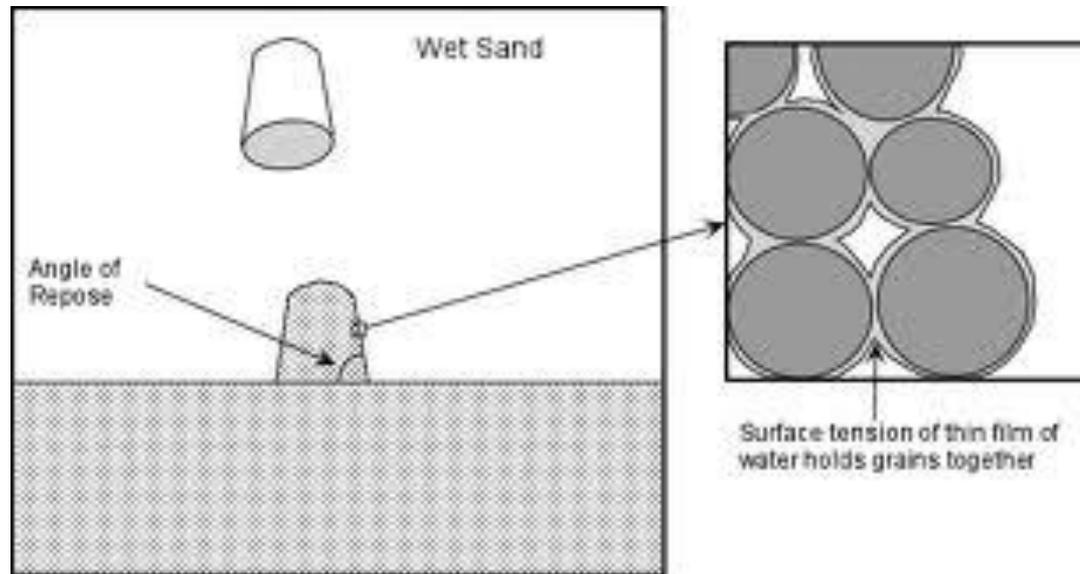
- ***Mass wasting*** : is the downslope movement of rock and soil due to gravity.
- **Controls and triggers محفزات of mass wasting:**
  1. ***Addition of Water*** — reduces the internal resistance of materials and adds weight to a slope
  2. **Oversteepening of slopes**
  3. **Removal of vegetation**
    - **Root systems bind soil and regolith together**
  4. **Earthquakes**
    - **Earthquakes and aftershocks can dislodge large volumes of rock and unconsolidated material.**

# *Mass wasting*

- *Mass wasting*: is the downslope movement of rock and soil due to gravity.
- Mass Wasting and Rock failure **requires steep slopes** and bedrock exposures.
- Common in **mountain belts**.

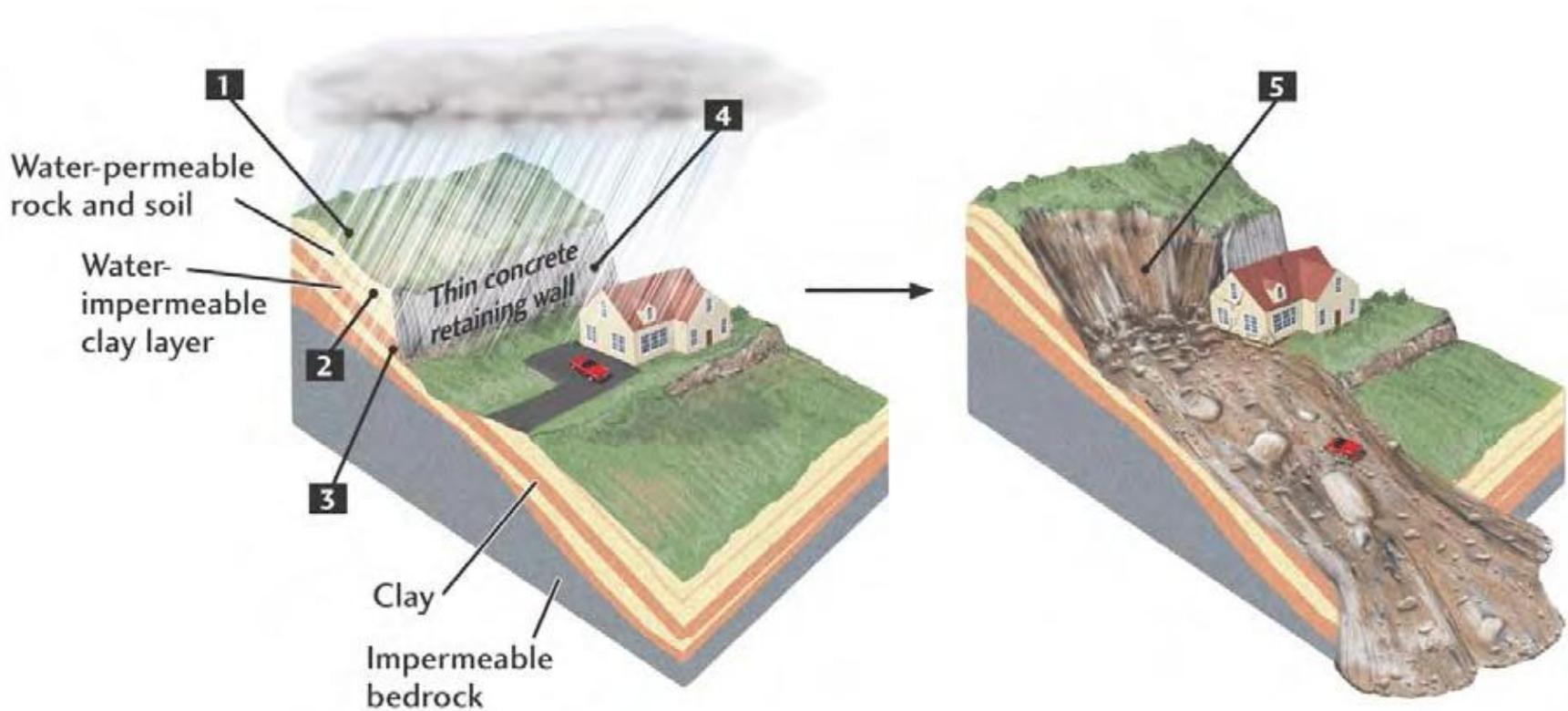
# -What are the Factors that Control **تحفز** and **تتحكم ب** of mass wasting?

1. **Water** — reduces the internal resistance of materials and adds weight to a slope (Clay and Marl).

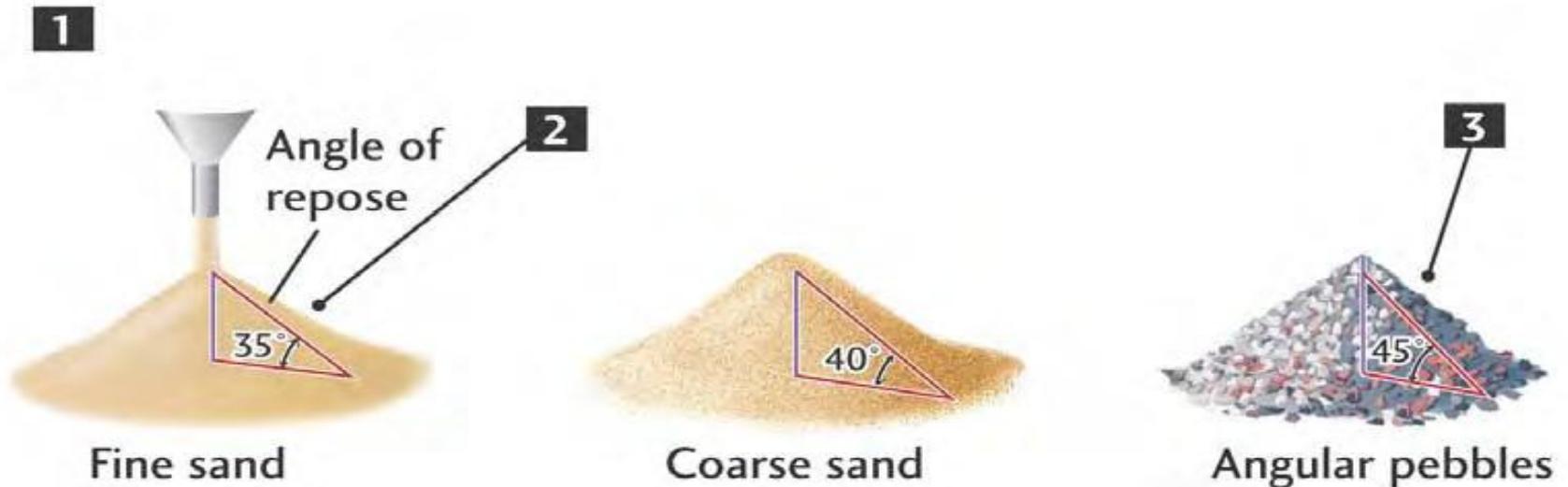


2. **Oversteepening** **زيادة ميل** of slopes **المنحدرات** .

# Steepened Slope - Saturated Material



# Angle of Repose



-The maximum angle at which a pile of unconsolidated particles can rest.

- The angle of repose increases with increasing grain size.

### 3. Removal of vegetation

- Root systems bind **يربط** soil and regolith together.
- Loss of vegetation and root systems increases susceptibility of soils to erosion and mass movement.

### 4. Earthquakes

- Earthquakes and aftershocks can dislodge **تزيل** large volumes of rock and unconsolidated material.



## **Mass Wasting Classified on the basis of:**

- **Type of movement - falling, sliding, or flowing.**
- **Rate of movement - fast or slow.**
- **Type of material - rock, soil, and debris**

# Mass Wasting are of 3 types:

## 1. Falls السقوط الحر

Rock Falls/ debris fall (cliff).

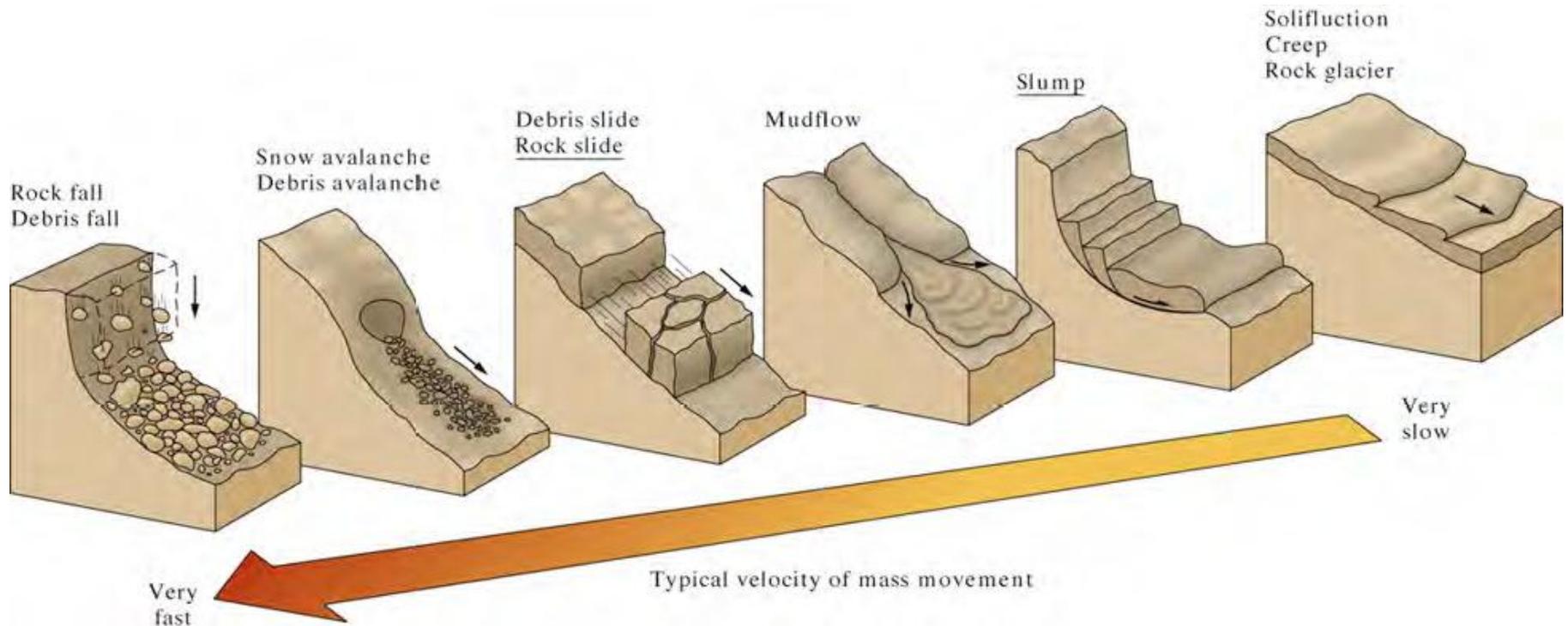
## 2. Slides الإنزلاق على المنحدرات

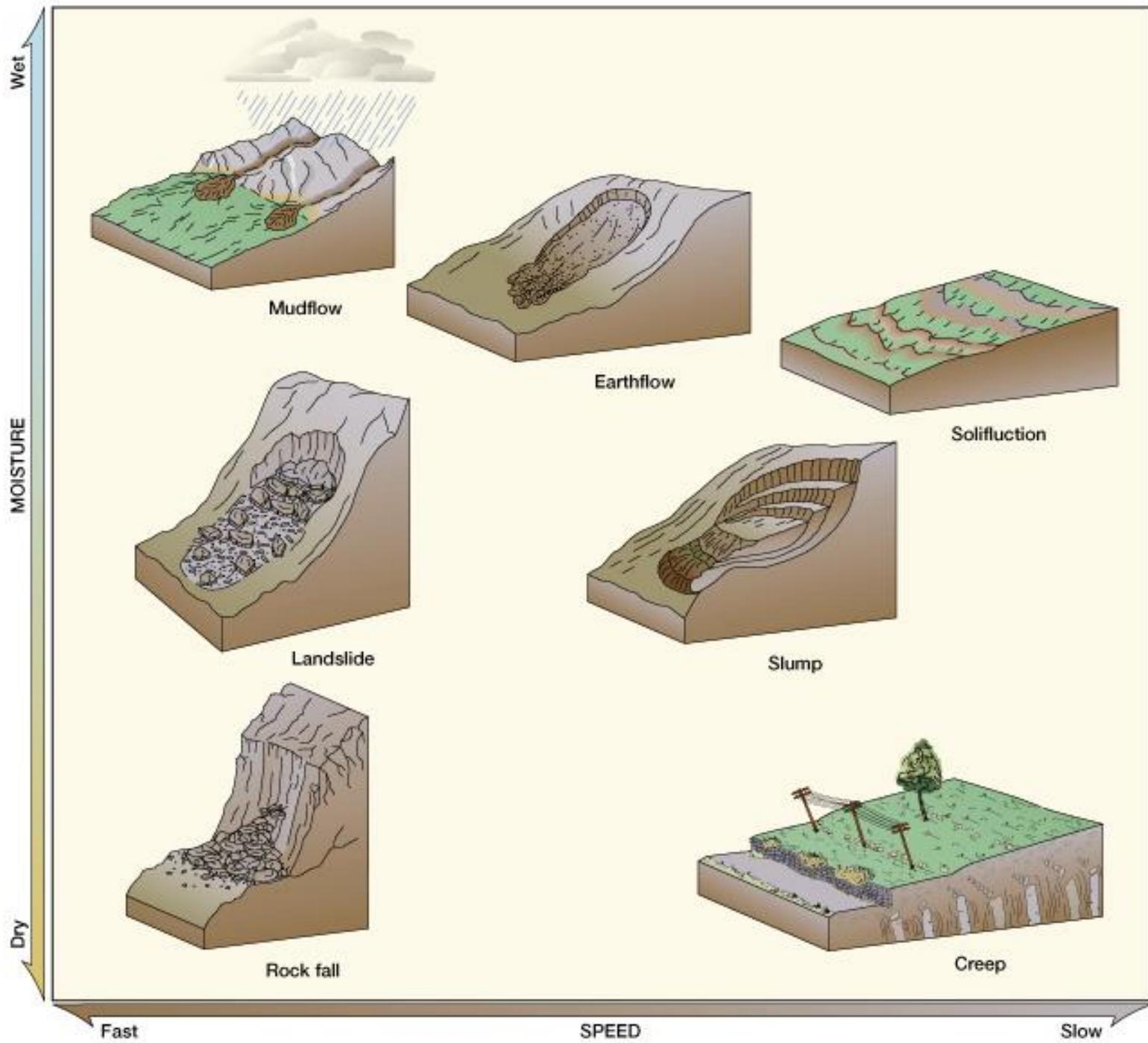
Landslides or rock slide/ (Slumps when slope is curve)

## 3. Flow التدفق

Creep/Debris flow / Earth flow/Mud Flows (It needs water or air).

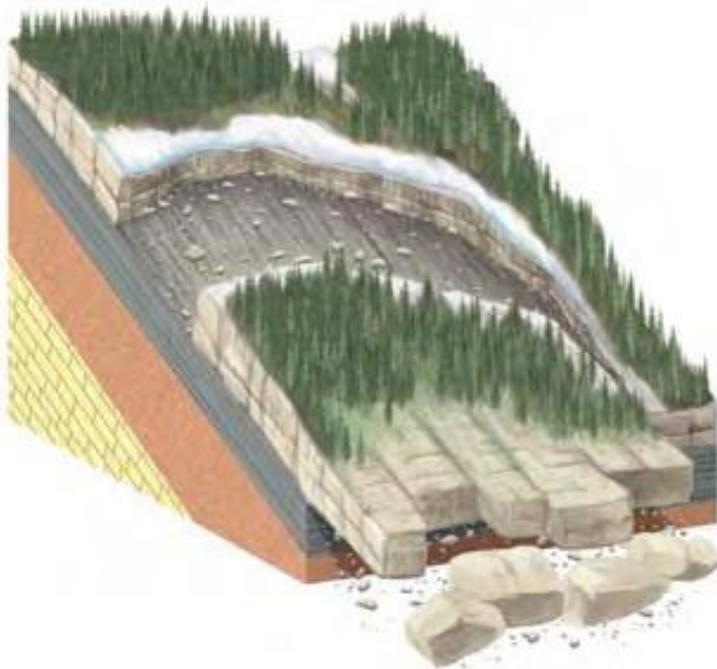
# Classification of Mass Wasting based on Velocity





# Rock Slides

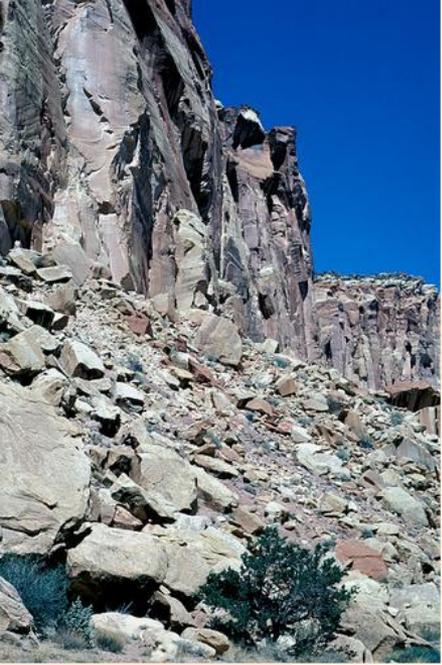
- The rapid movement of large blocks of detached bedrock
- sliding more or less as a unit.



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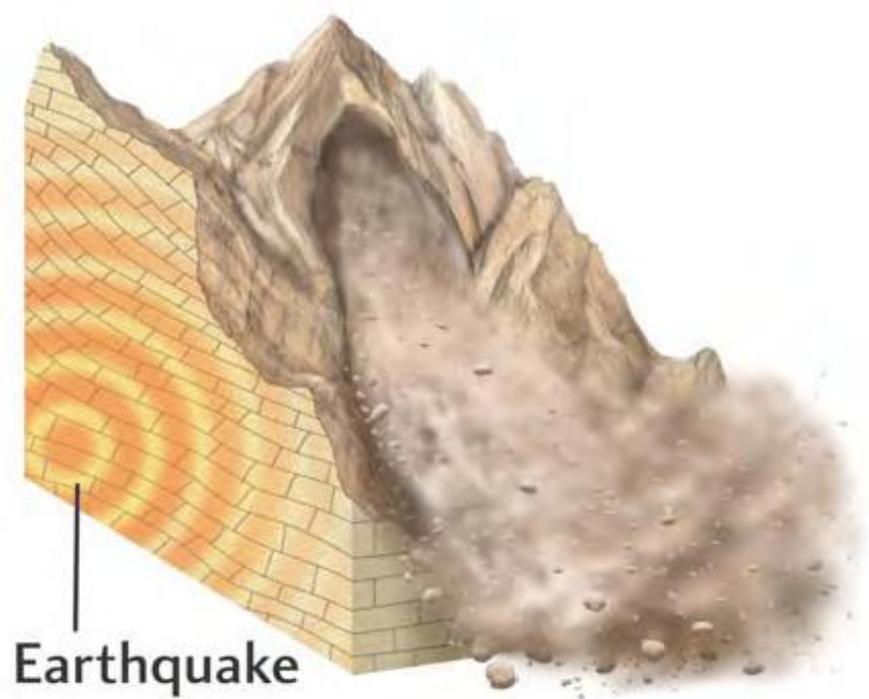


# Falls



**Talus Deposits**

# Rock Avalanches



**slump**



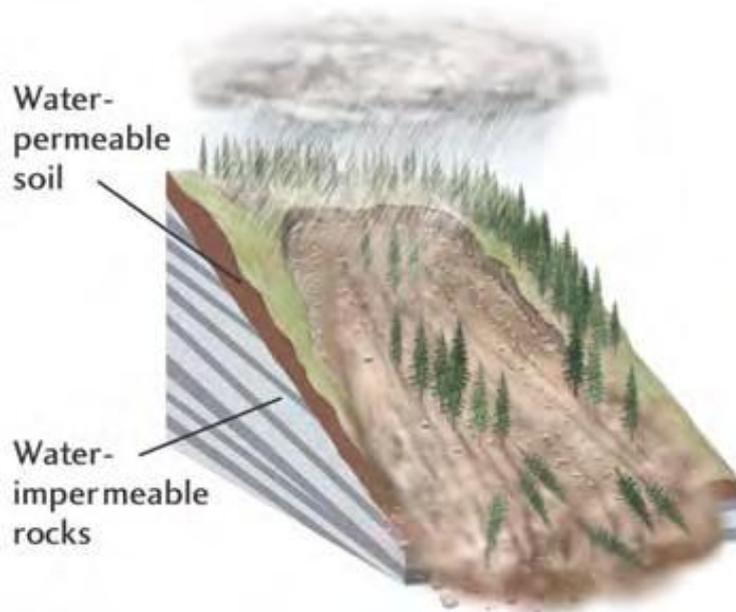
# Creep



# Earth Flows

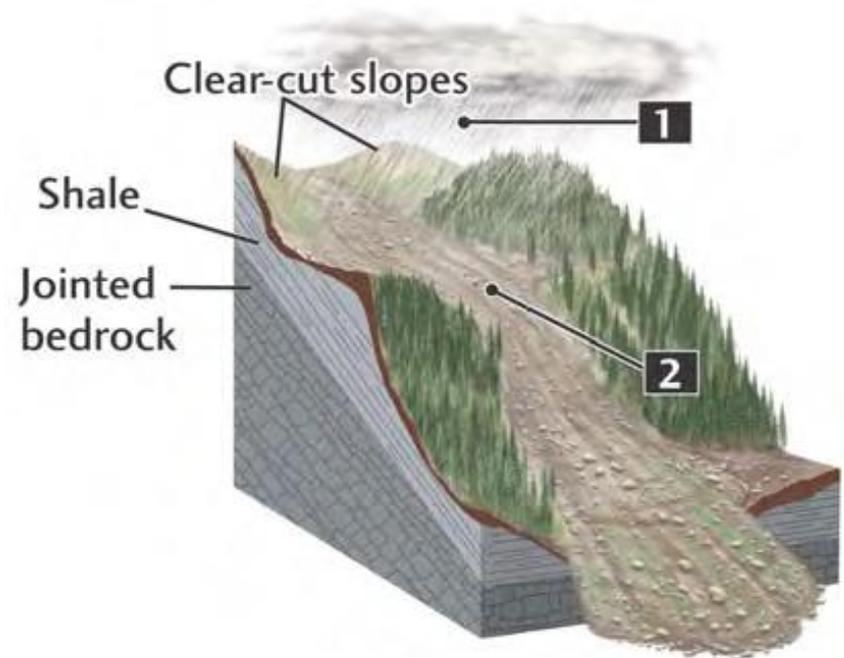
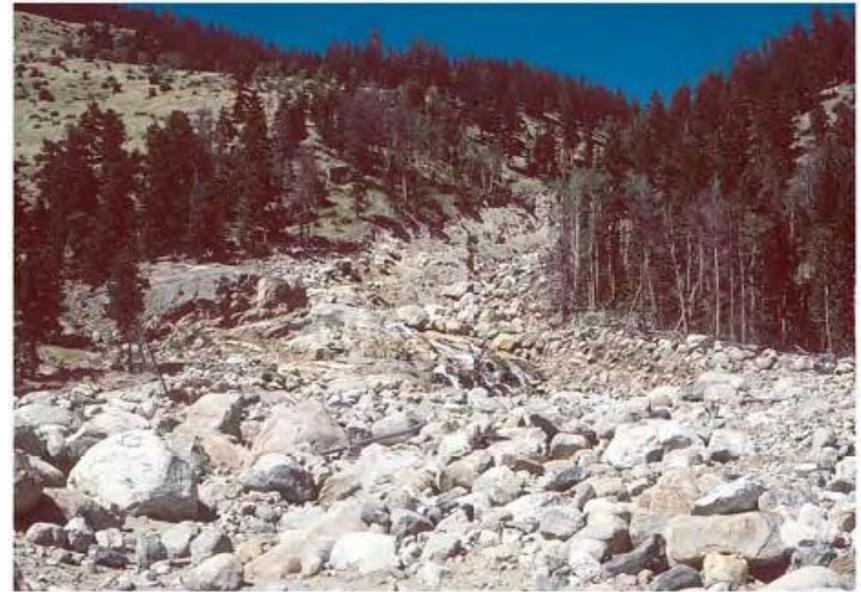
Take unconsolidated soil and sediment on moderate slope

- Add lots of water
  - Shake or Stir A fluid movement of relatively fine-grained material, e.g. soils, weathered shale, and clay.



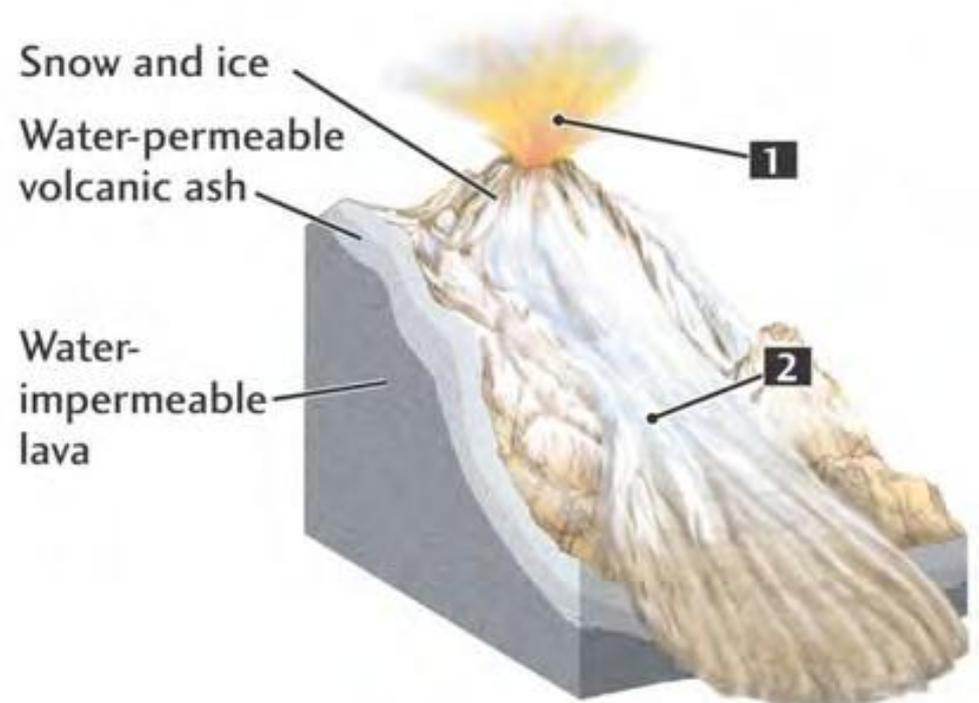
## Debris Flows

- Take unconsolidated soil and sediment on moderate slope
- Add lots of water - Shake or Stir
- A fluid mass movement of rock fragments supported by a muddy matrix. May move at speeds of up to 100 km/hr!



- **Mud Flows**

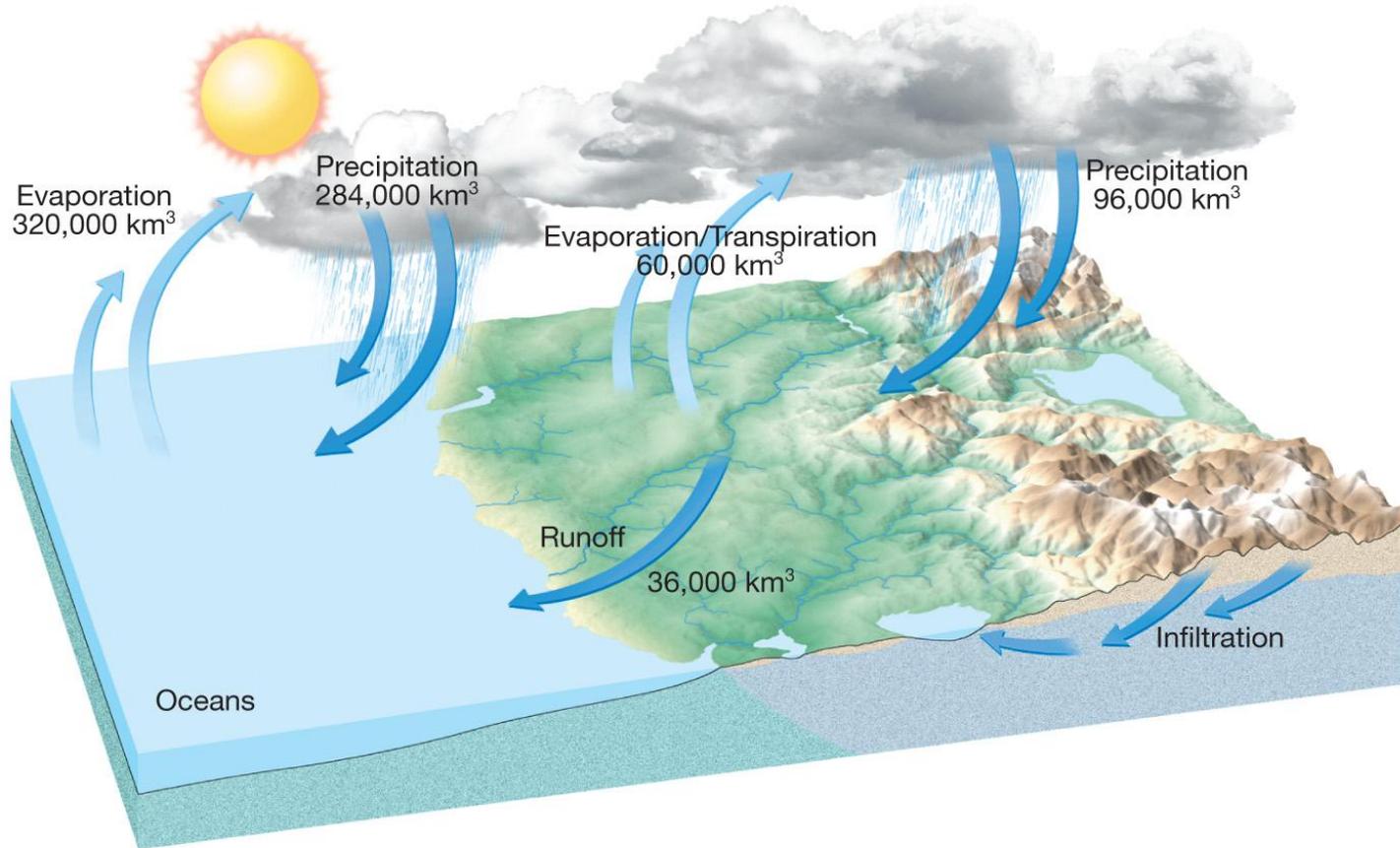
- Take unconsolidated soil and sediment on moderate slope
- Add lots of water - Shake or Stir
- A flowing mass of material (mostly finer than sand, along with some rock debris) containing a large amount of water. It may travel large distances and high speeds, and carry particles as large as a house!



# *Water cycle*

- The *hydrologic cycle* is a summary of the circulation of Earth's water supply
- Processes in the water cycle
  - Precipitation الهطل
  - Evaporation التبخر
  - Infiltration الارتشاح
  - Runoff الجريان
  - Transpiration النتح

# *The hydrologic cycle*



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# *Running water*

- **Stream flow** الجريان النهري
- **Velocity** determines the ability of a stream to erode, transport and deposit materials.
- **Factors that determine stream velocity:**
  1. **Channel gradient**, or slope الميل
  2. **Channel characteristics** including: shape, size, and roughness الخشونة او الوعورة
  3. **Discharge:** The volume of water moving past a given point in a certain amount of time.

# *The work of streams*

- **Stream erosion** التعرية النهرية
  - **Lifting** رفع loosely consolidated particles by
    - *Abrasion* الحت
    - *Dissolution* الإذابة
  - **Stronger currents lift particles more effectively**

- **Transport of sediment by streams**
  - Transported material is called the stream's *load*
  - Types of load
    1. *Dissolved load*
    2. *Suspended load*
    3. *Bed load*
  - *Ability to transport is described using two criteria:*
    1. *Capacity*: the maximum load a stream can transport
    2. *Competence*: Indicates the maximum particle size a stream can transport and determined by the stream's velocity.

- **Deposition of sediment by a stream**
  - **Caused by a decrease in velocity**
    - **Competence is reduced**
    - **Sediment begins to drop out**
  - **Stream sediments**
    - **Generally well sorted**
    - **Stream sediments are known as *alluvium***

# Depositional Landforms

- **Deposition of sediment by a stream**

1. **Delta:** Body of sediment where a stream enters a lake or the ocean

- Results from a sudden decrease in velocity.

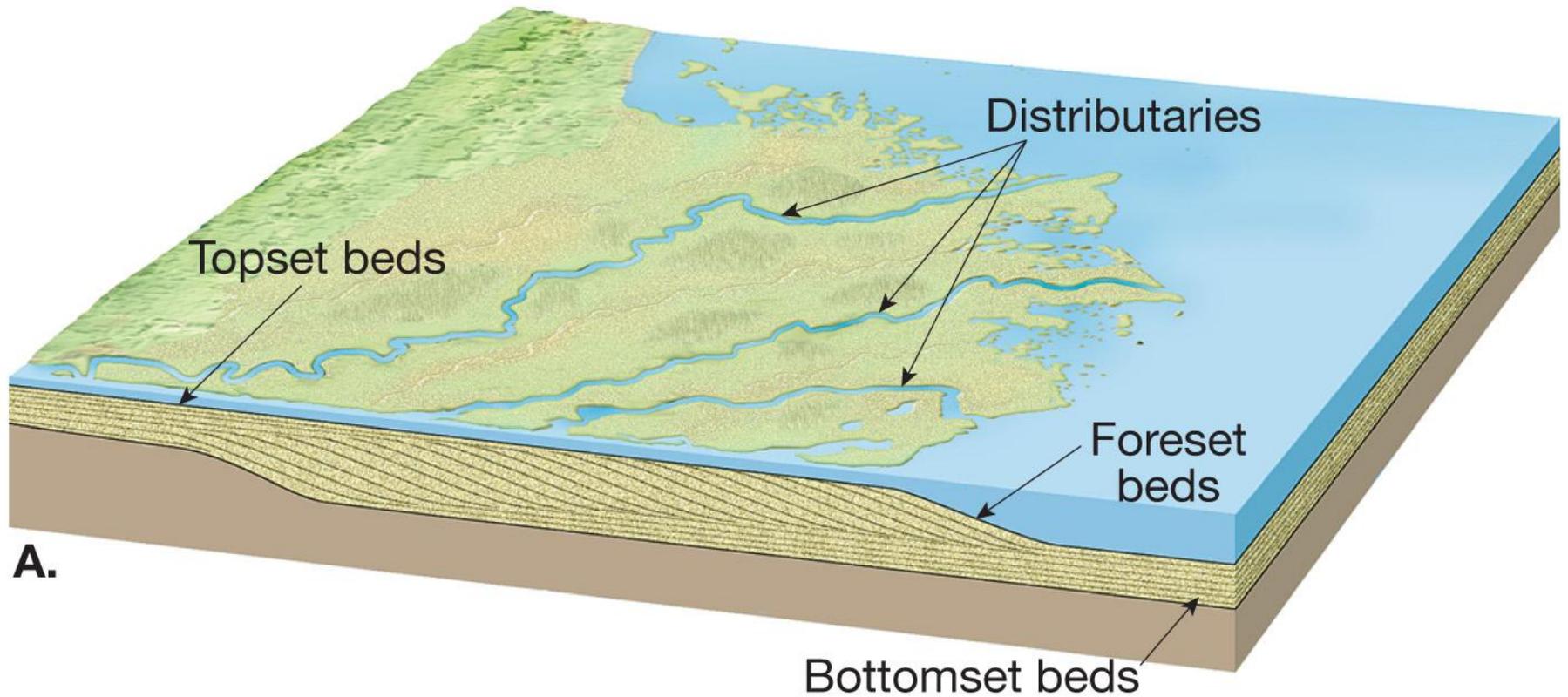
2. **Natural levees** المصاطب او الحواجز الطبيعية

Form parallel to the stream channel by successive floods over many years.

3. **Floodplain** السهل الفيضي **deposits:**

- Back swamps
- Yazoo tributaries

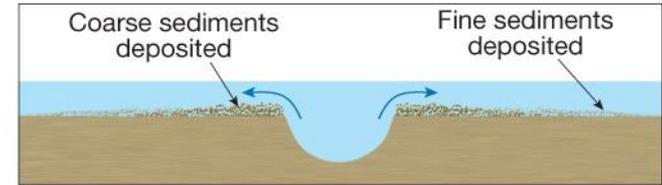
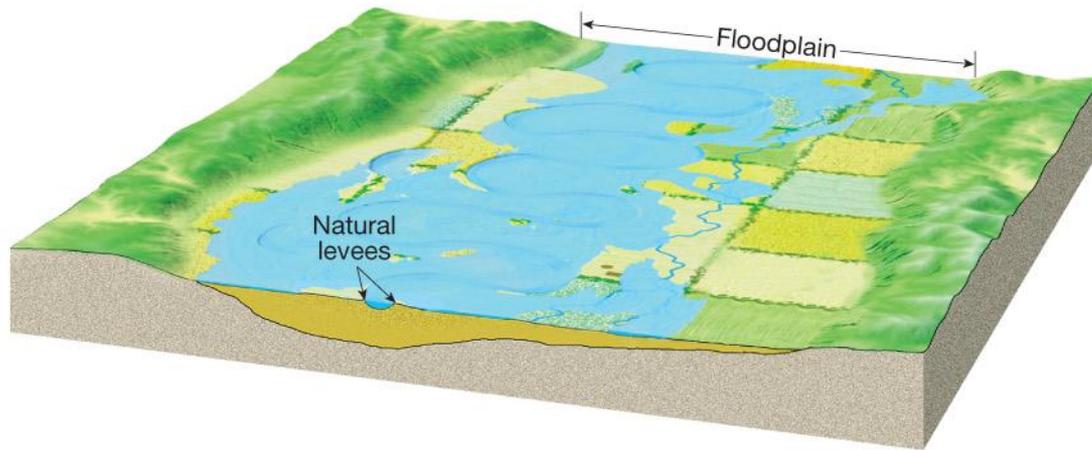
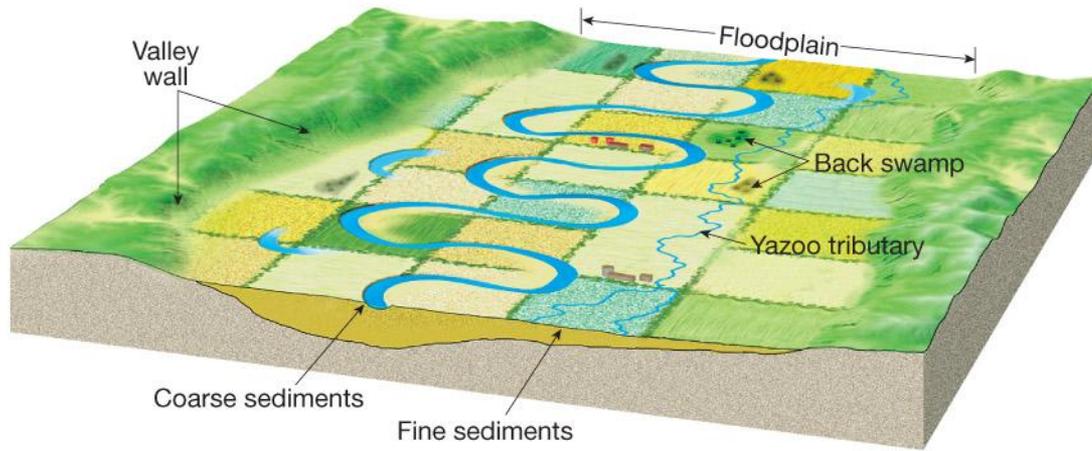
# *Structure of a simple delta*



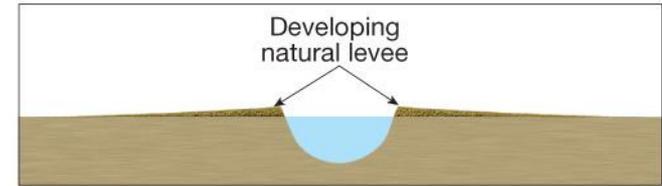
# ***Floods and flood control***

- **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**
    - **Causes include heavy rains, rapid snow melt, dam failure, topography, and surface conditions.**

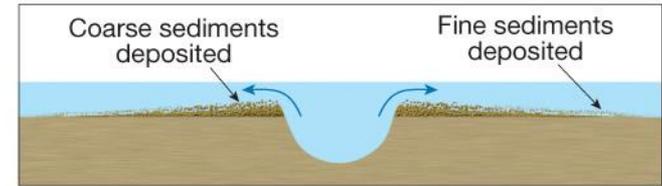
# ***Flood and Natural levees***



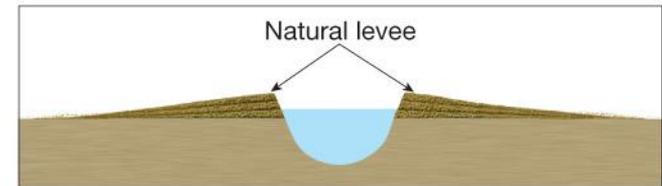
Floodstage



Post flood



Floodstage



Natural levee after numerous floods

# *Stream valleys*

- The most common landforms on Earth's surface
- Two general types of stream valleys:
  1. Narrow valleys
    - *V-shaped*
    - Duncutting toward base level
    - Features often include rapids منحدرات and waterfalls شلالات
  2. Wide valleys
    - Stream is near base level
    - Downward erosion is less dominant
    - Stream energy is directed from side to side forming a *floodplain*

# ***V-shaped valley of the Yellowstone River***

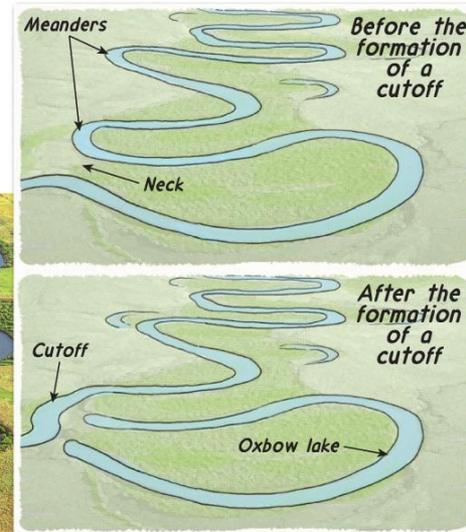
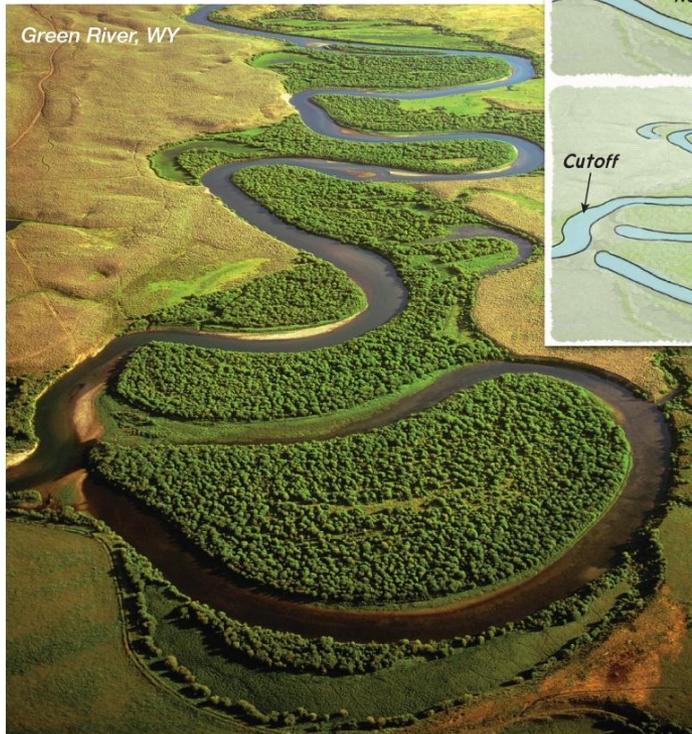


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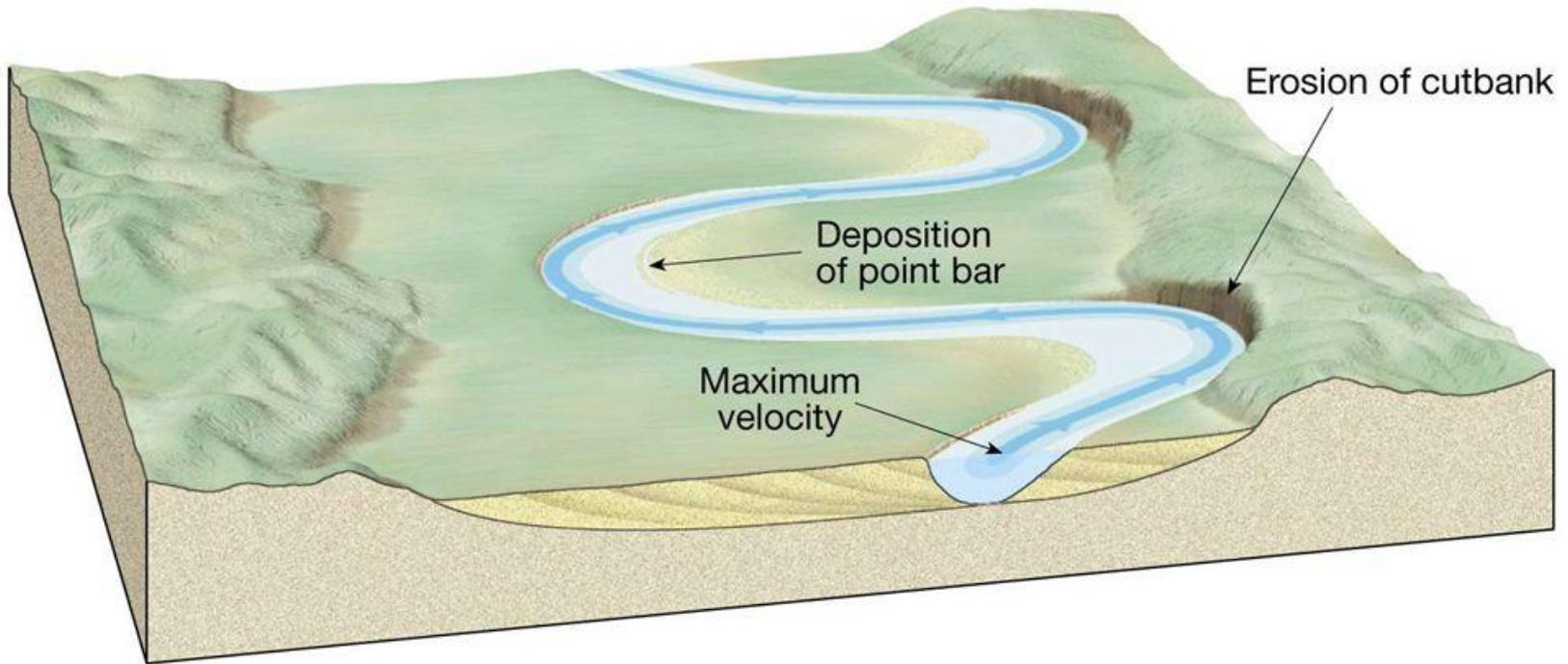
- **Features of wide valleys often include**
  - ***Floodplains***
    - **Depositional floodplains**
      - ***Meanders***
      - **Cut banks and *point bars***
      - **Cutoffs and *oxbow lakes***

# ***Oxbow lakes and meanders in a wide stream valley***



*Geologist's Sketch*

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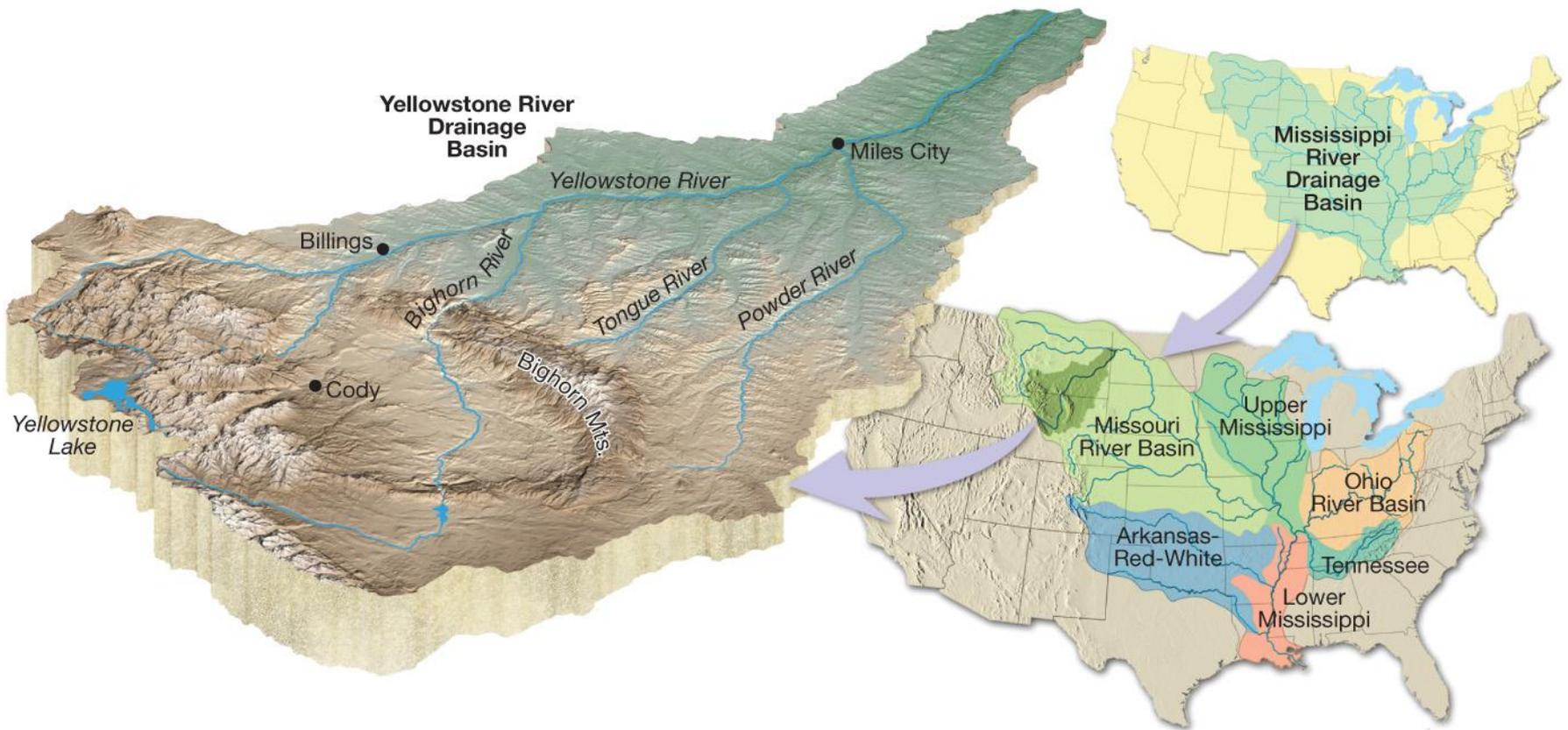
- **Point bars** are deposited on the inside banks and bends along the channel, due to lower velocities and increased flow friction. These features typify the coarse fraction of the river's bedload, commonly, gravel and sand.

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# ***Drainage basins* الأحواض النهرية** ***and*** ***Drainage patterns* الأنماط**

- **Drainage networks** الشبكات النهرية
  - Land area that contributes **تزوّد** water to the stream is the ***drainage basin***
  - Imaginary line separating one basin from another is called a ***divide***

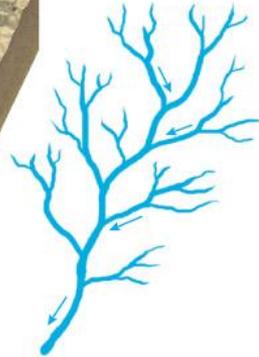
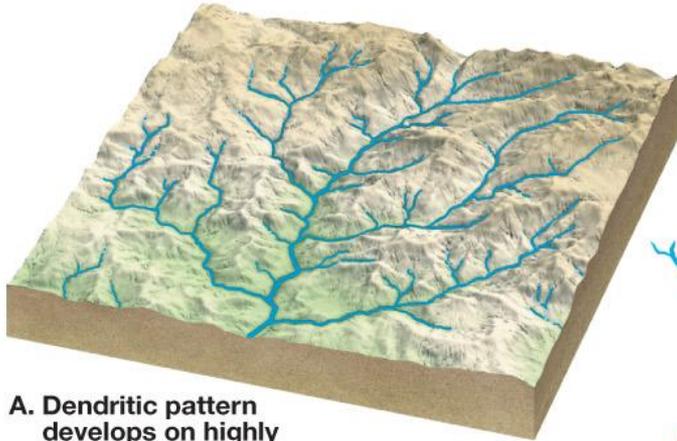
# *Drainage basin of the Mississippi River*



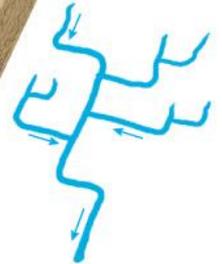
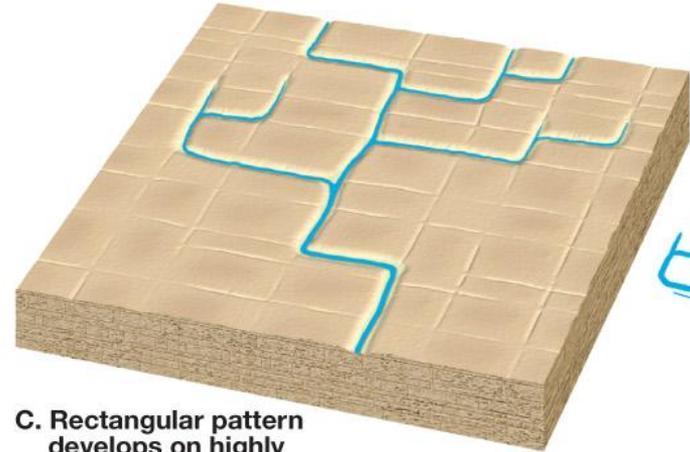
# *Drainage basins and patterns*

- **Drainage pattern**
  - **Pattern of the interconnected network of streams in an area**
  - **Common drainage patterns:**
    - *Dendritic*
    - *Radial*
    - *Rectangular*
    - *Trellis*

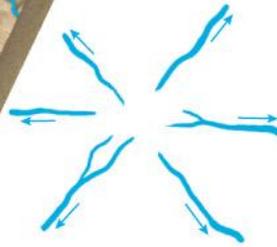
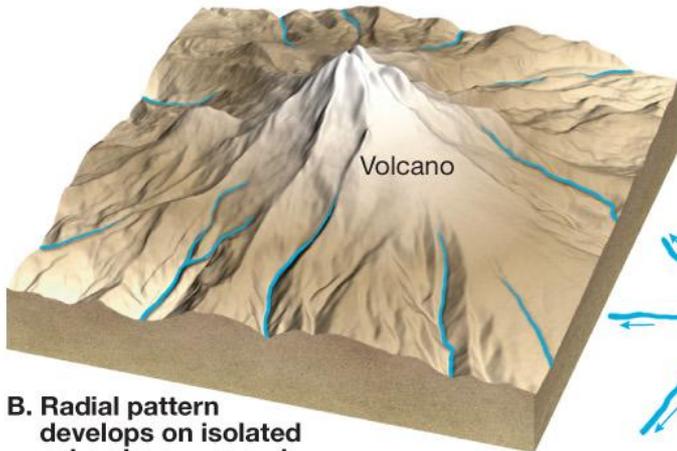
# *Drainage patterns*



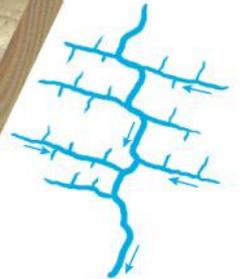
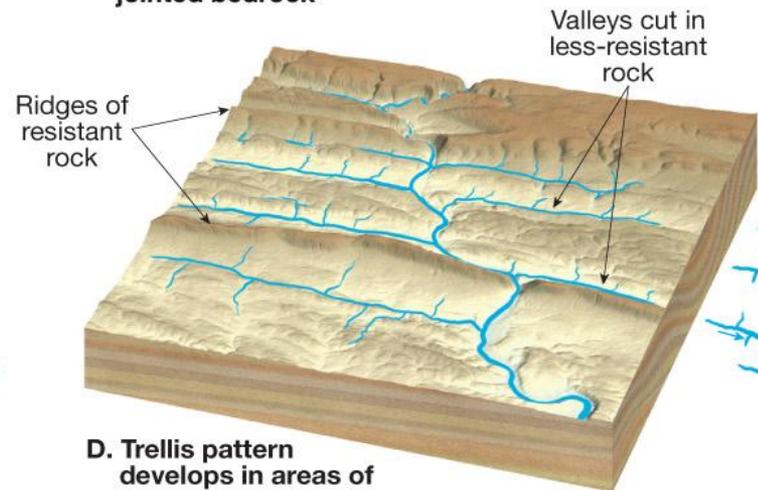
**A. Dendritic pattern develops on highly uniform bedrock**



**C. Rectangular pattern develops on highly jointed bedrock**



**B. Radial pattern develops on isolated volcanic cones or domes**

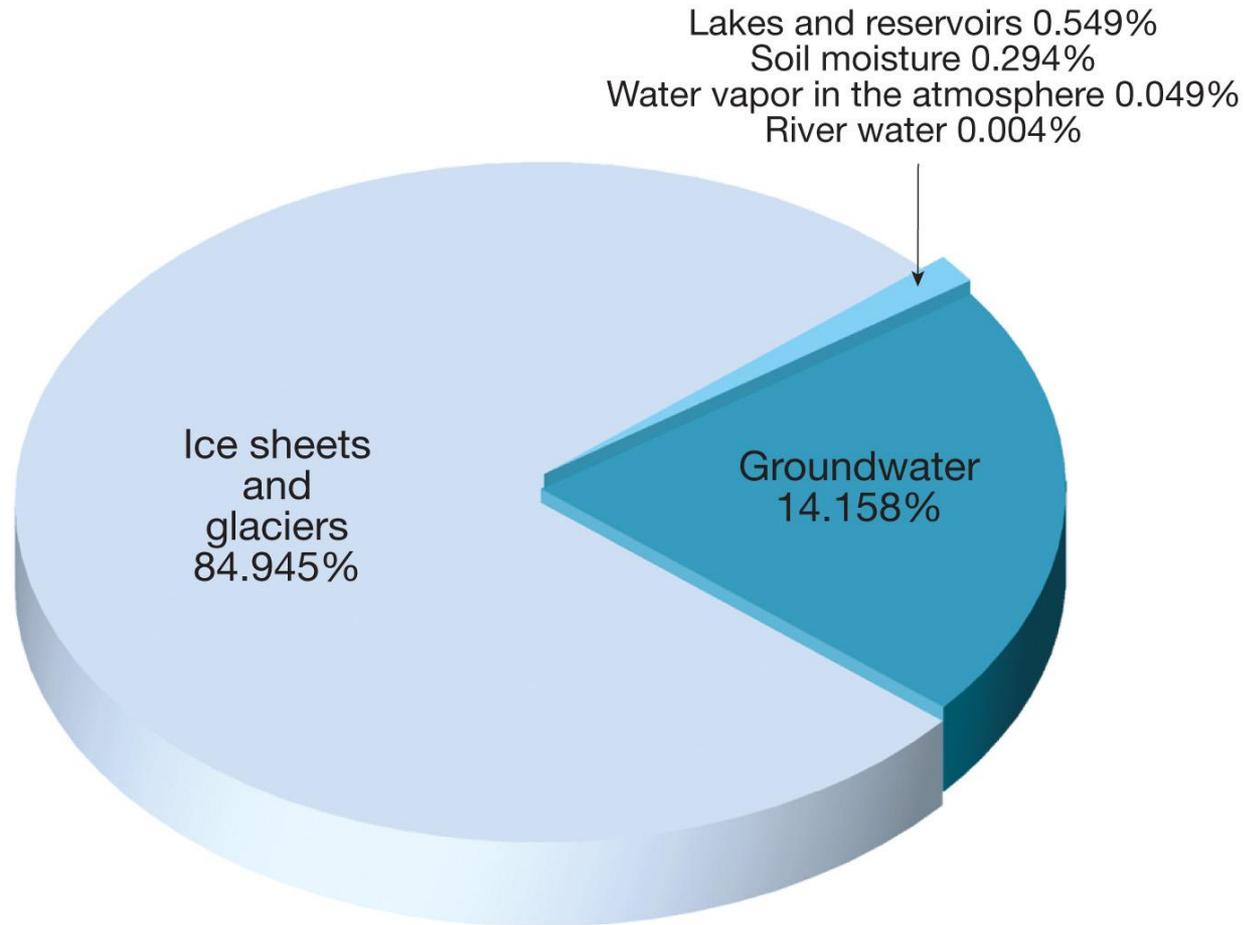


**D. Trellis pattern develops in areas of alternating weak and resistant bedrock**

# Water beneath the surface

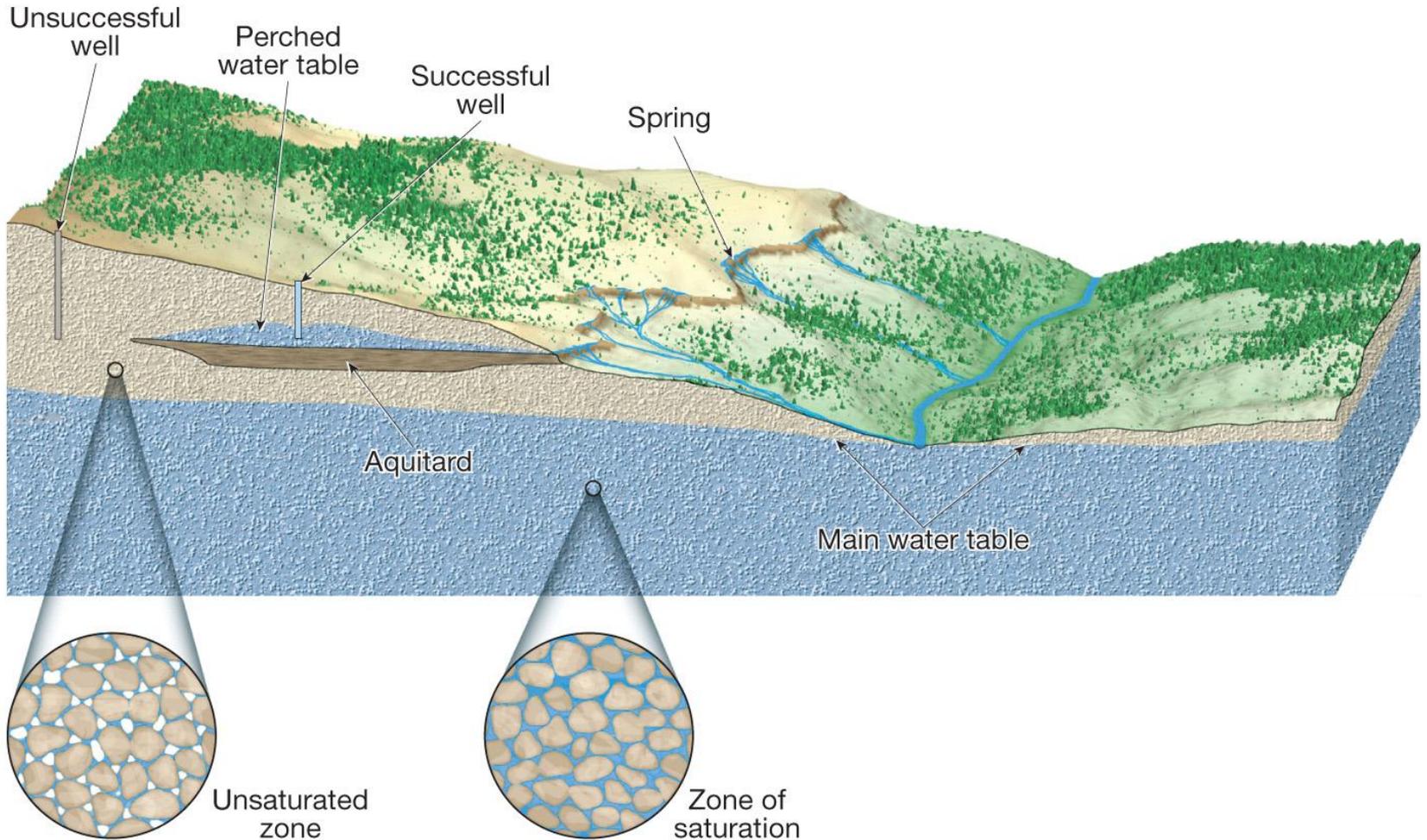
- **Largest freshwater reservoir for humans**
- **Geological roles**
  - **As an erosional agent, dissolving by groundwater produces**
    - **Sinkholes**
    - **Caverns**

# ***Distribution of fresh water in the hydrosphere***



- **Distribution and movement of groundwater**
  - **Distribution of groundwater from top to bottom:**
    - **Belt of soil moisture**
    - **Zone of aeration**
      - **Unsaturated zone**
      - **Pore spaces in the material are filled mainly with air**
    - **Zone of saturation**
      - **All pore spaces in the material are filled with water**
      - **Water within the pores is groundwater**
    - **Water table** : **The upper limit of the zone of saturation**

# *Features associated with subsurface water*



- **Movement of groundwater**
  - **Porosity**
    - Percentage of pore spaces
    - Determines how much groundwater can be stored
  - **Permeability**
    - Ability to transmit water through connected pores
    - **Aquitard** — An impermeable layer of material
    - **Aquifer** — A permeable layer of material ( has porosity and permeability).

- **Springs**

- **Hot springs**

- Water is 6 – 9 °C warmer than the mean air temperature of the locality
    - Heated by cooling of igneous rock

- **Geysers**

- Intermittent hot springs
    - Water turns to steam and erupts

- **Wells**

- Pumping can cause a drawdown (lowering) of the water table
  - Pumping can form a *cone of depression* in the water table.

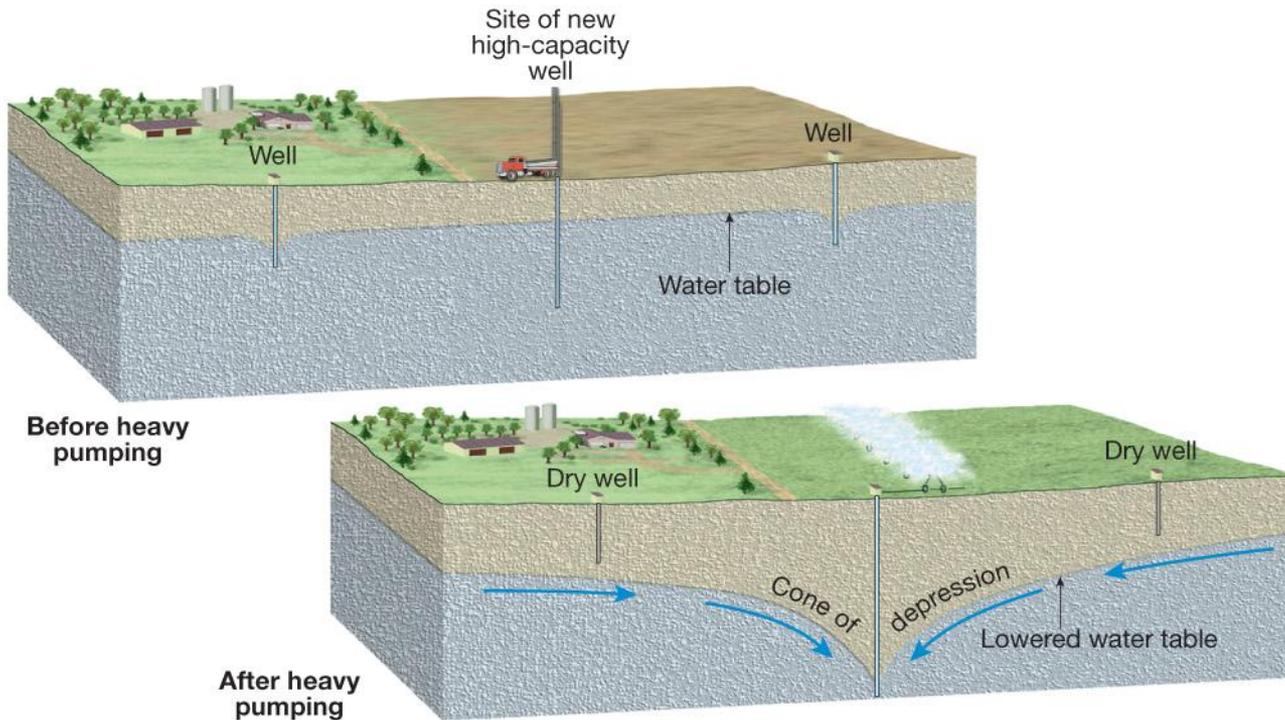
# *Wintertime eruption of Old Faithful*



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# *Formation of a cone of depression*

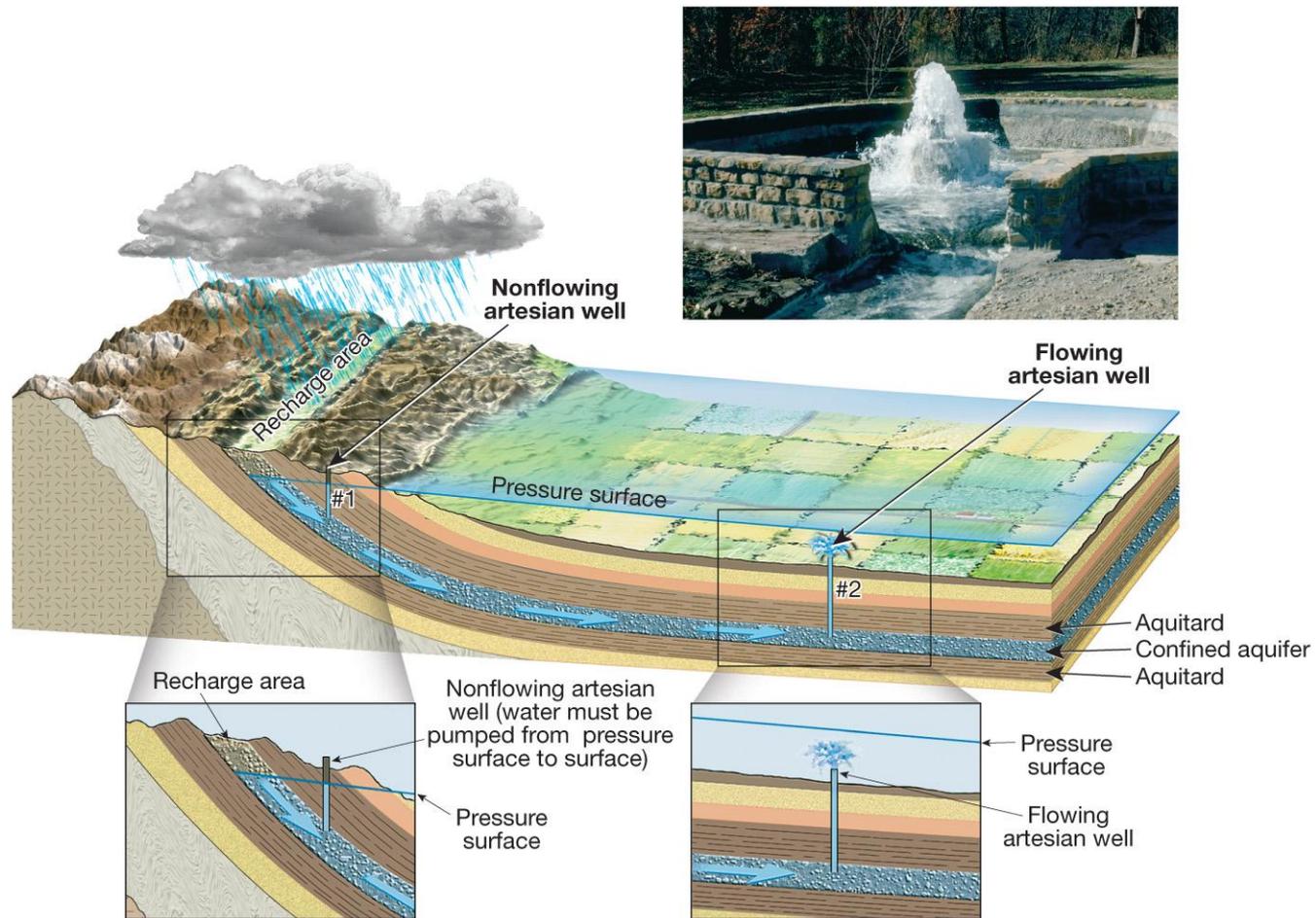


Well drilling rig

- **Artesian wells**

- **Water in the well rises higher than the initial groundwater level**
- **Artesian wells act as “natural pipelines” moving water from remote areas of recharge great distances to the points of discharge**

# *An artesian well resulting from an inclined aquifer*



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- **Environmental problems associated with groundwater**
  - **Treating it as a nonrenewable resource**
  - **Land subsidence caused by its withdrawal.**
  - **Contamination**

- **Geologic work of groundwater**
  - **Groundwater is often mildly acidic**
    - **Contains weak carbonic acid**
    - **Dissolves calcite in limestone and form**
  - **Caverns**
    - **Formed by dissolving rock beneath Earth's surface**
    - **Formed in the zone of saturation**

# Features found with caverns

- Form in the zone of aeration
- Composed of dripstone
- Common features include *stalactites* (hanging from the ceiling) and *stalagmites* (growing upward from the floor)

# ***Stalactites and stalagmites in Carlsbad Caverns National Park***



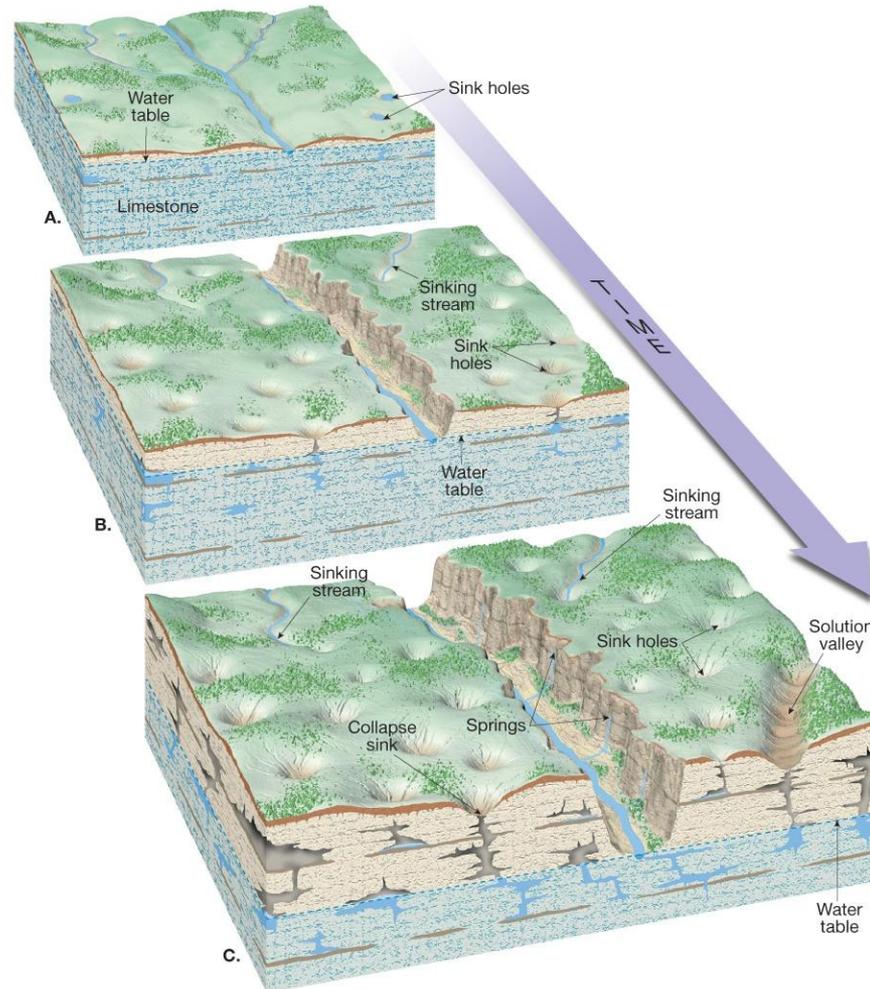
**B.**

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- **Karst topography**
  - **Formed by dissolving rock at, or near, Earth's surface**
  - **Common features**
    - **Sinkholes** – surface depressions
    - **Sinkholes form by dissolving bedrock and cave collapse**
    - **Caves and caverns**
  - **Area lacks good surface drainage**

# *Features of karst topography*



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# ***End of Chapter 3***