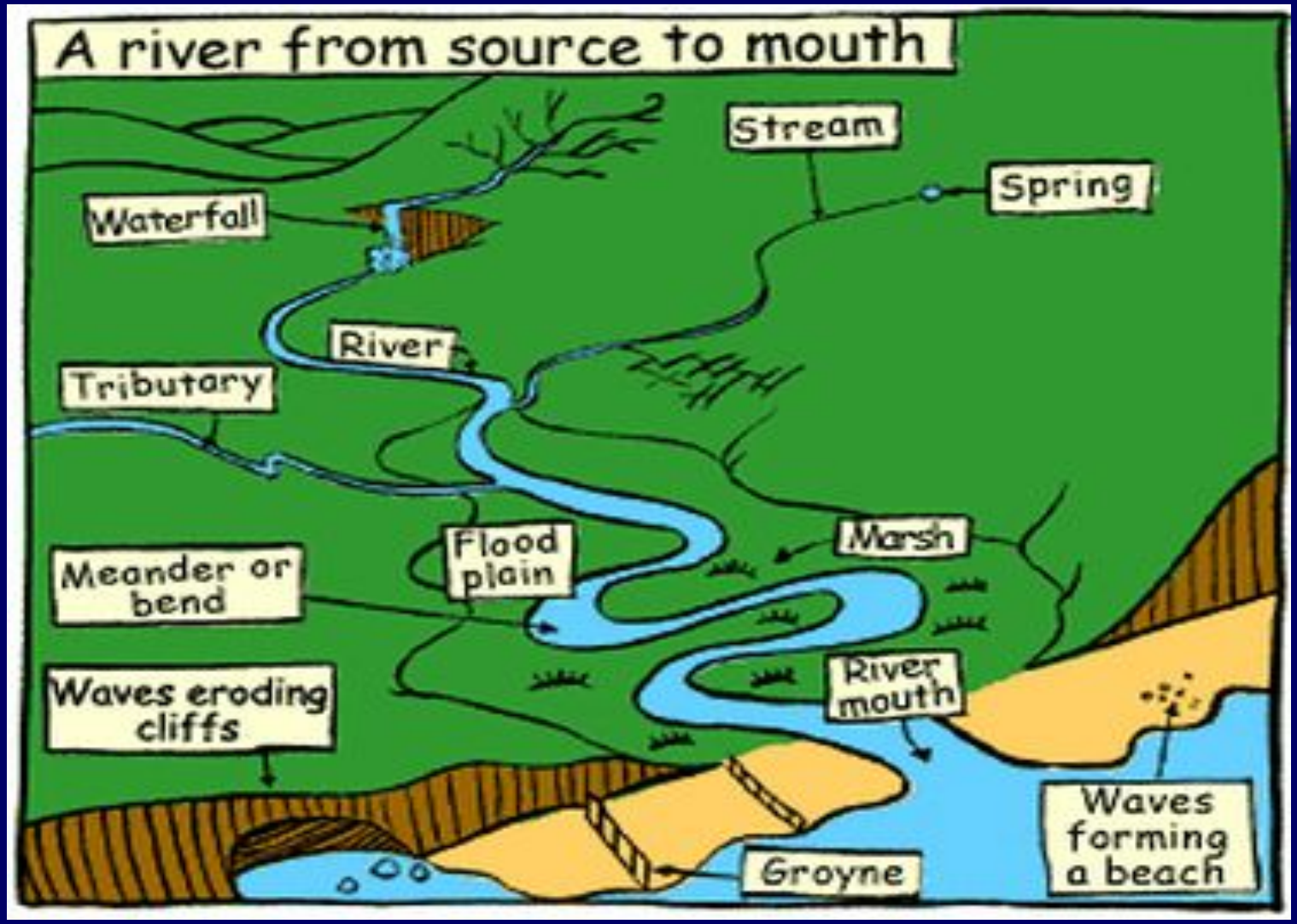
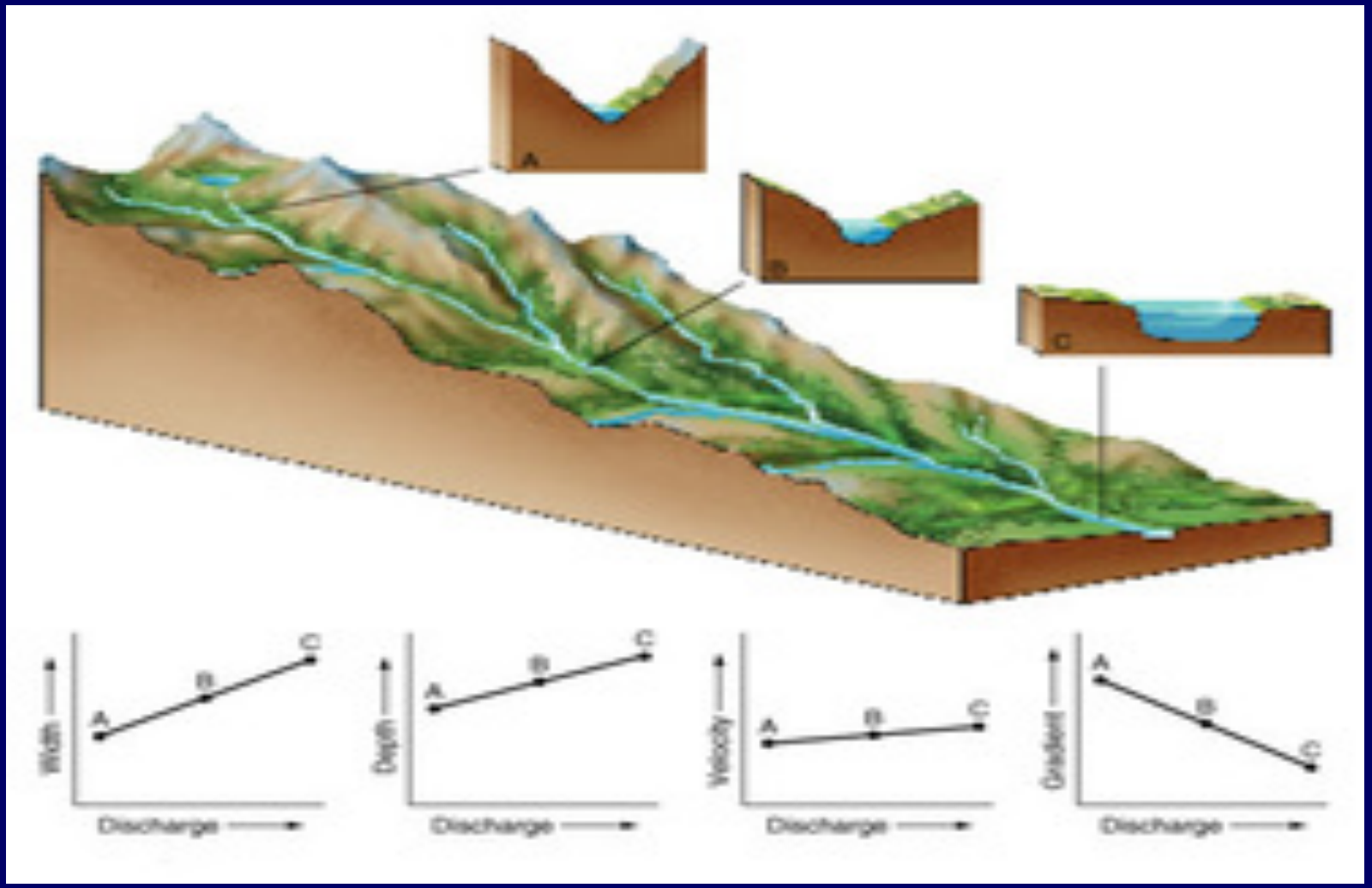
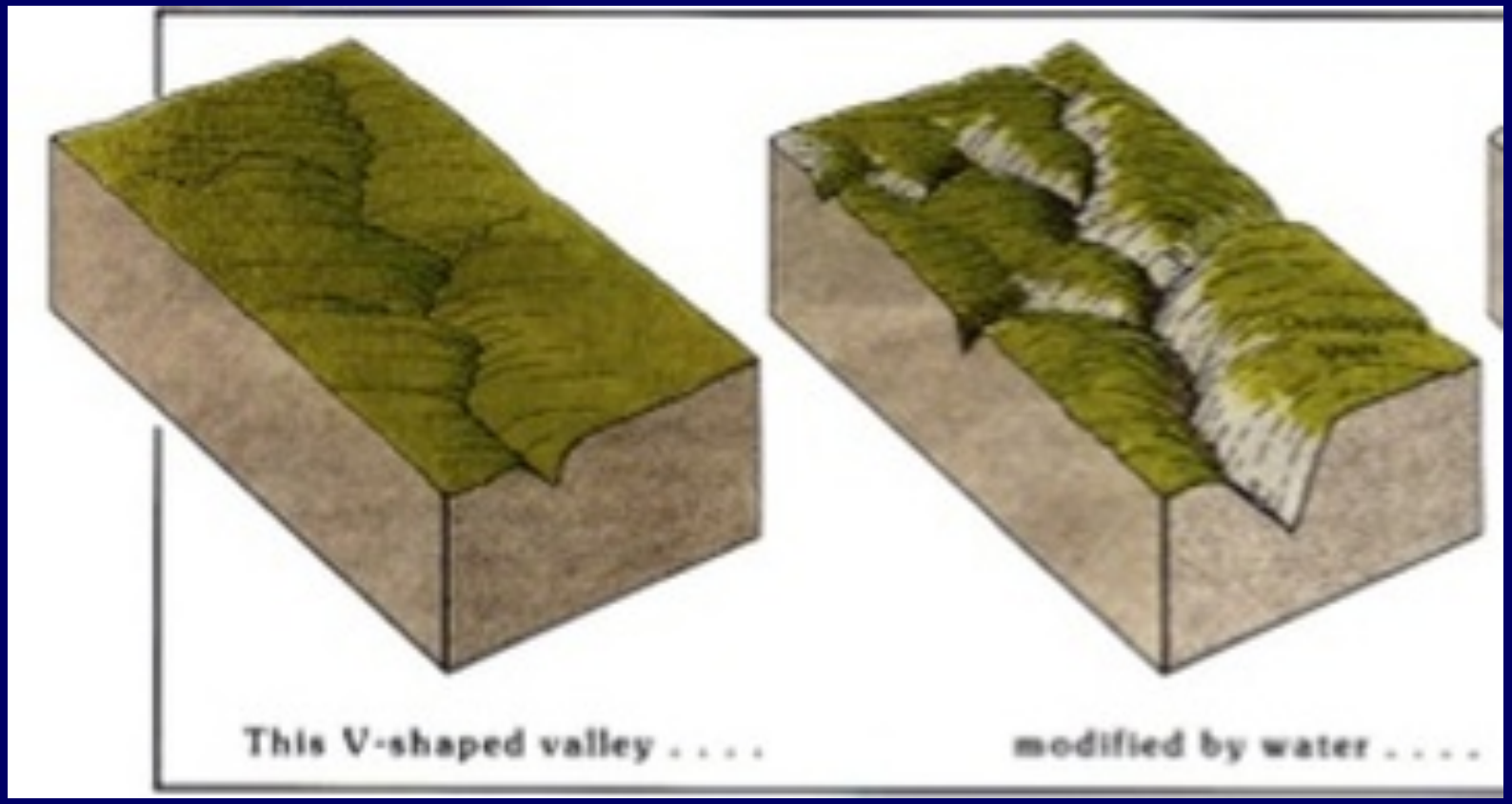
River Land Form



Changing River Profiles



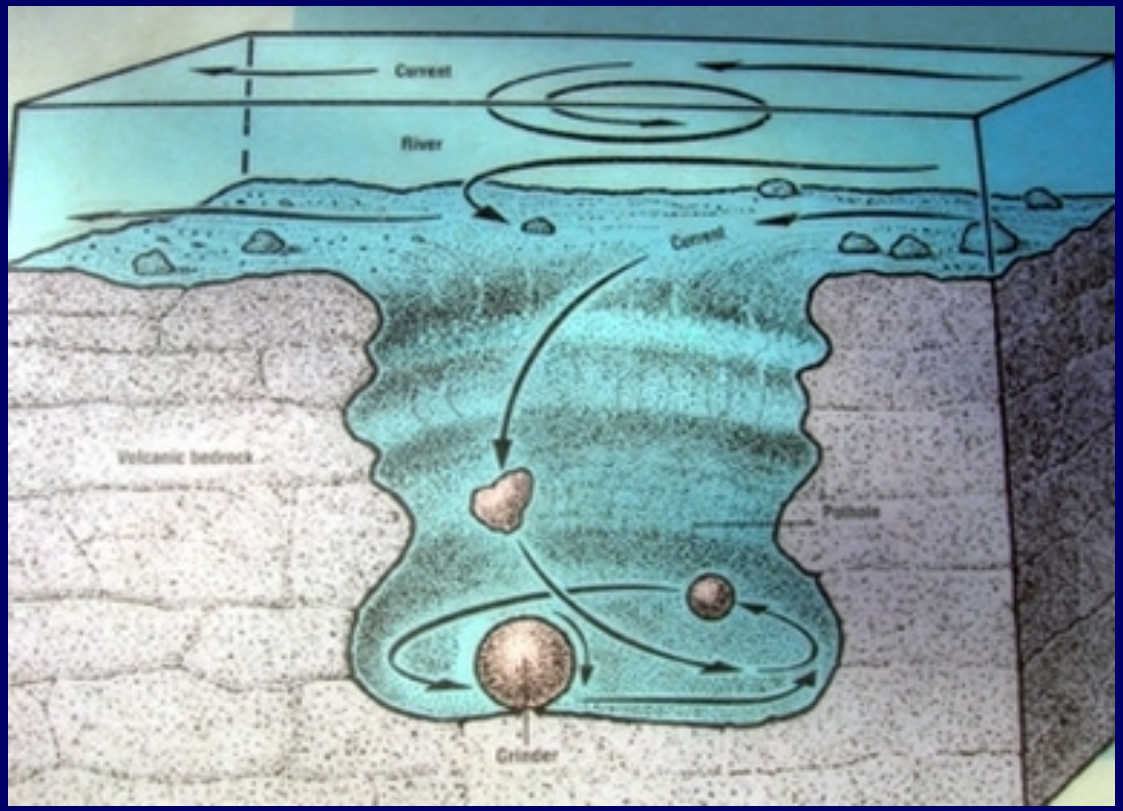
Upper Course Landforms



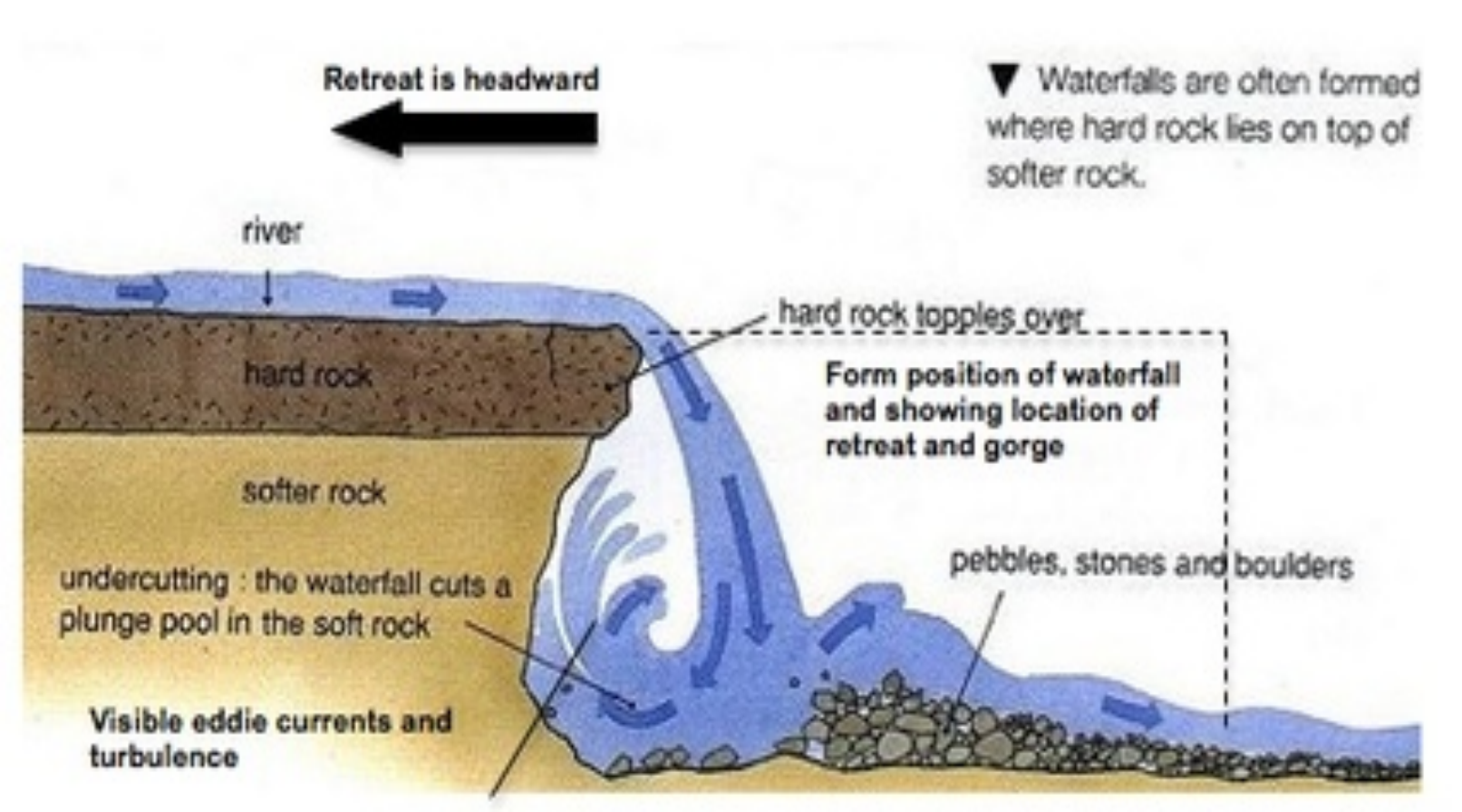
V-shaped Valleys and Interlocking Spurs (projecting ridges that extend alternately from the opposite sides of the wall of a young, V-shaped valley)

Potholes

Potholes form mainly in the upper course of the river, in high altitude where the river channel cuts directly into the bedrock.

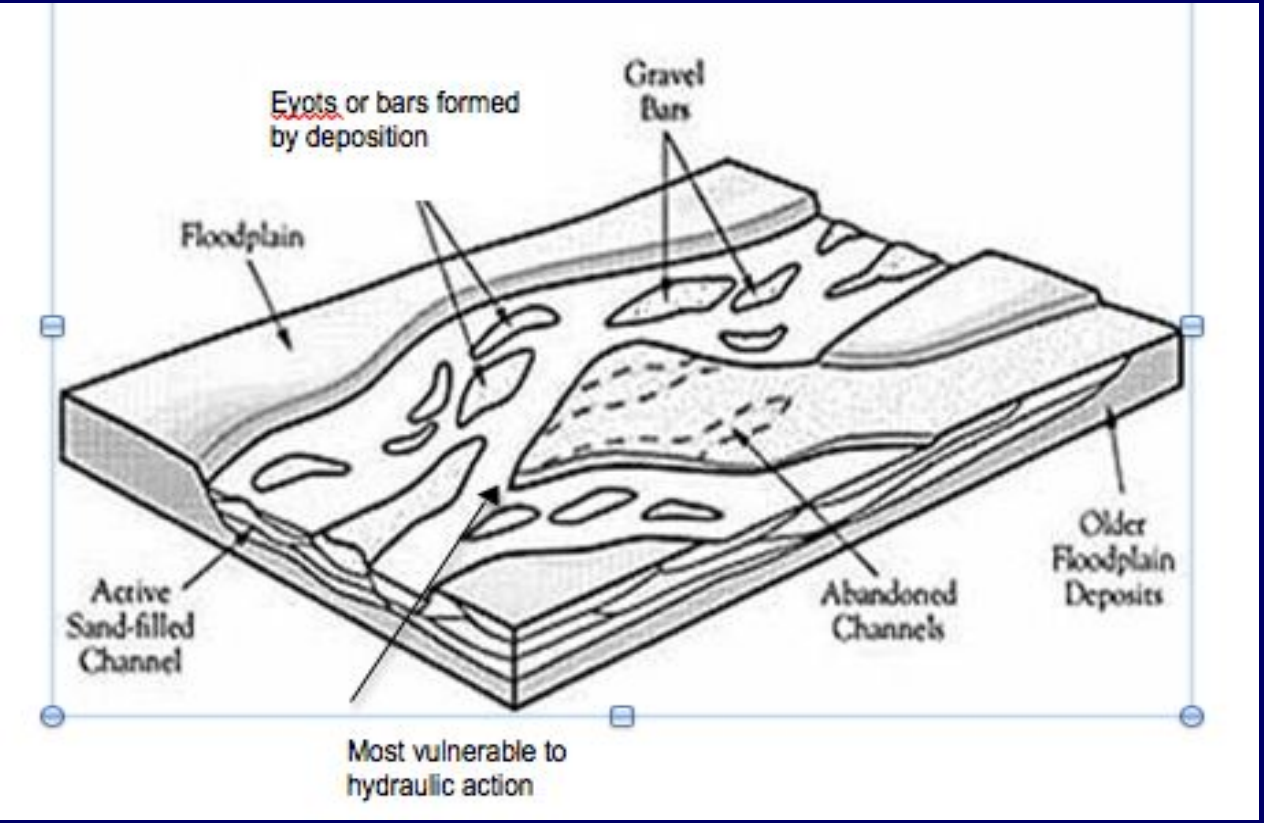


Waterfalls



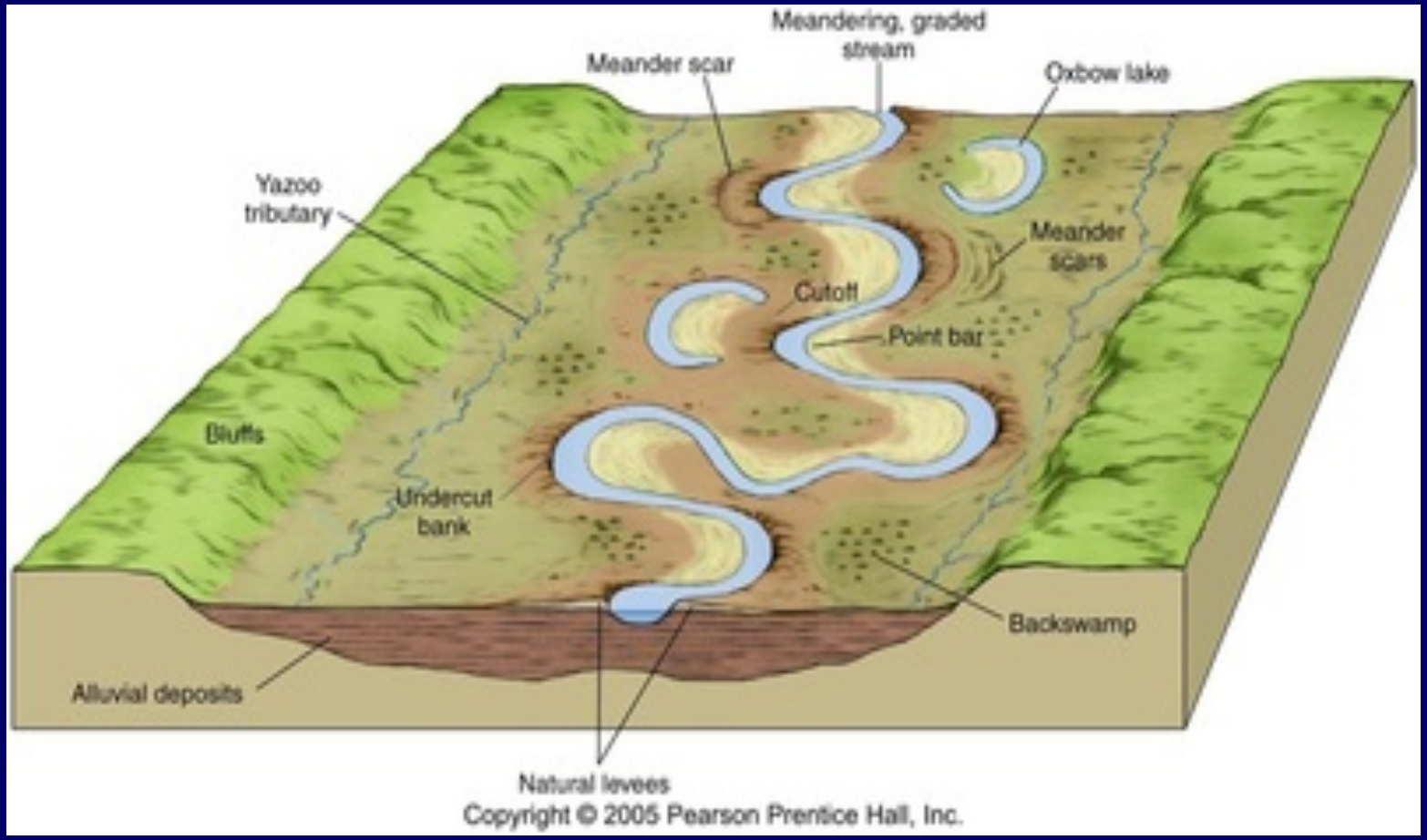
Waterfalls like rapids form mainly in the upper course

Braided Channels

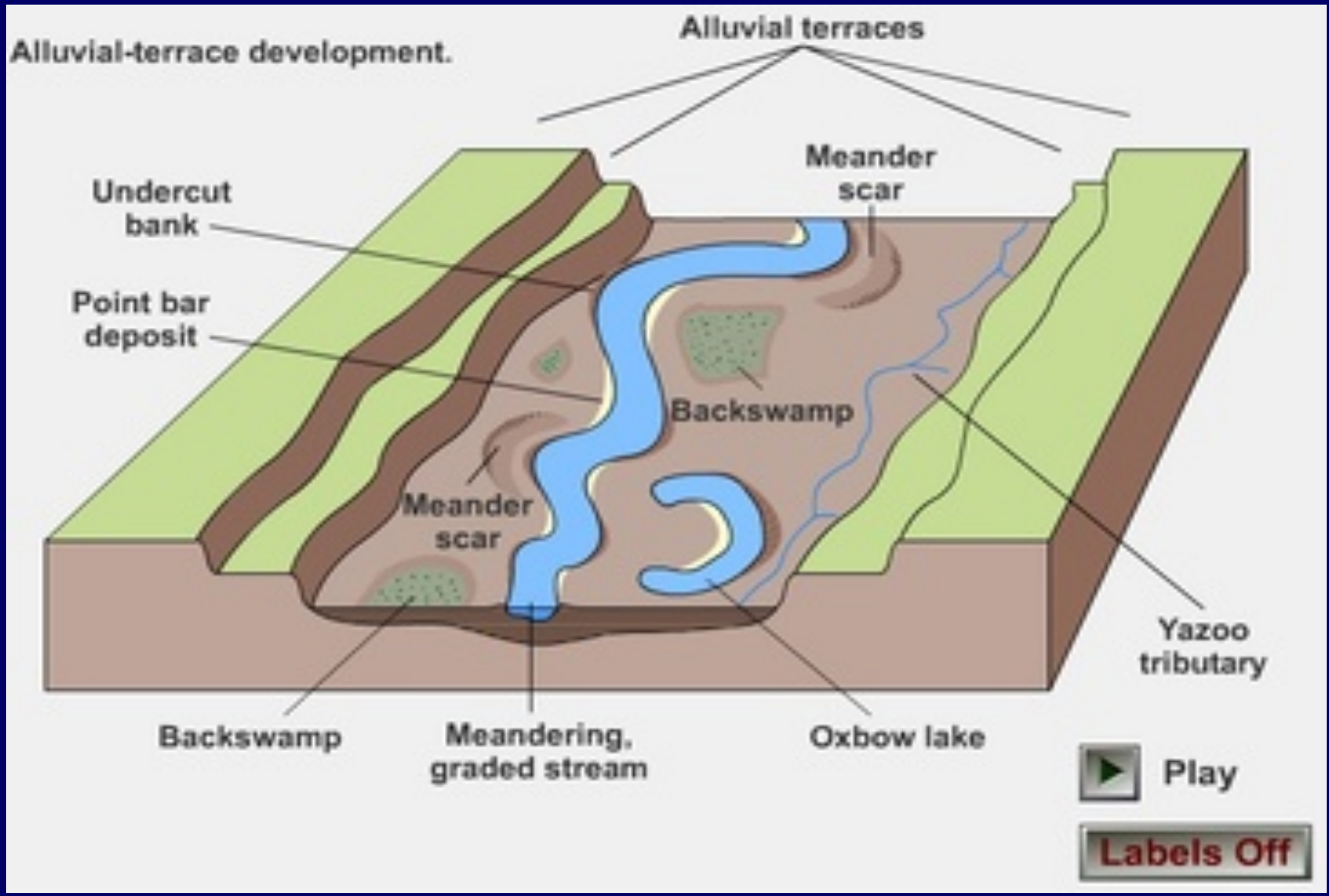


Braided channels can form nearly anywhere along the course of the river but are most commonly found in the upper course

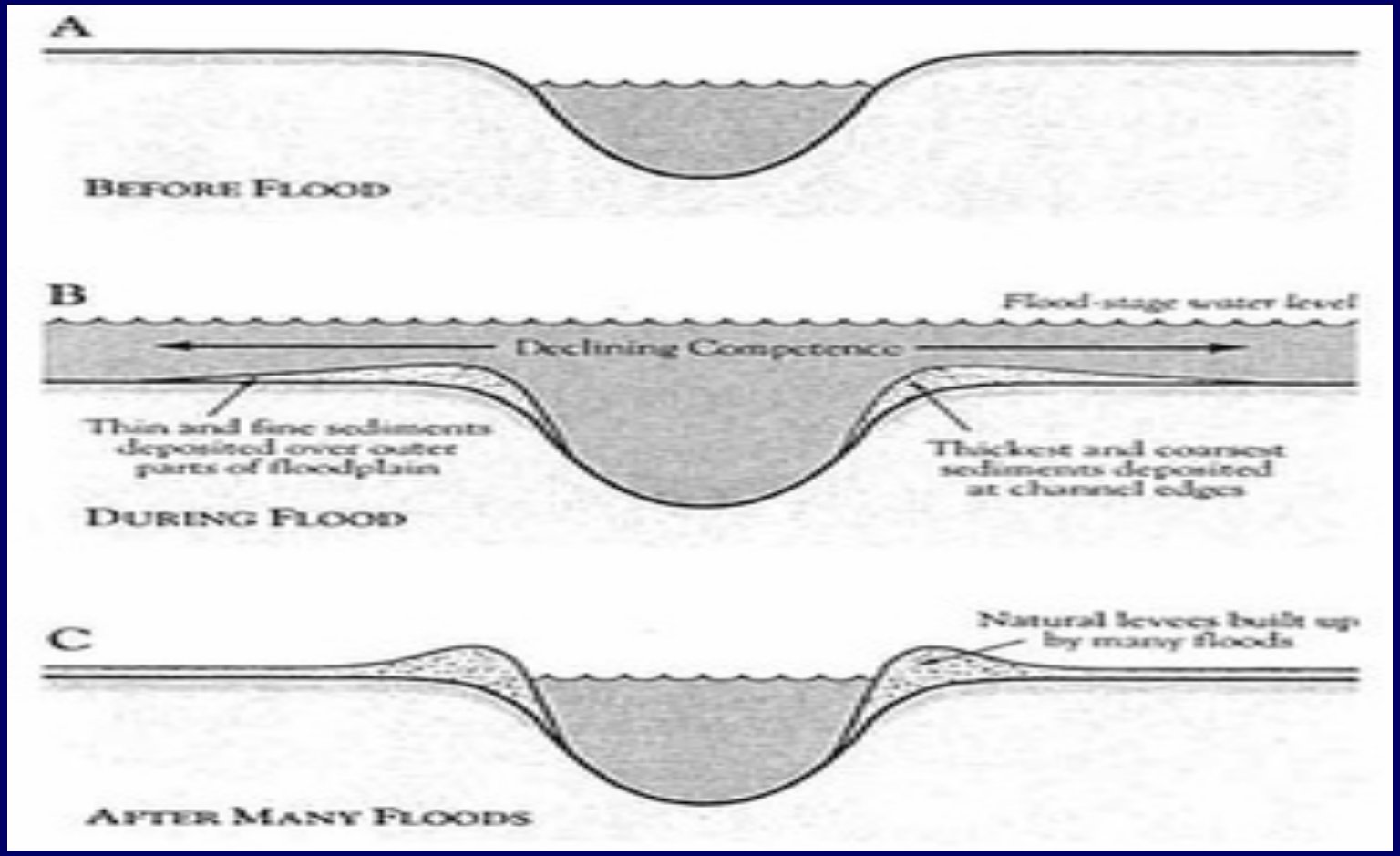
Middle Course Landforms



Waterfalls


Alluvial-terrace development.
Alluvial terraces
Undercut bank
Meander scar
Point bar deposit
Backswamp
Meander scar
Yazoo tributary
Backswamp
Meandering, graded stream
Oxbow lake
Play
Labels Off

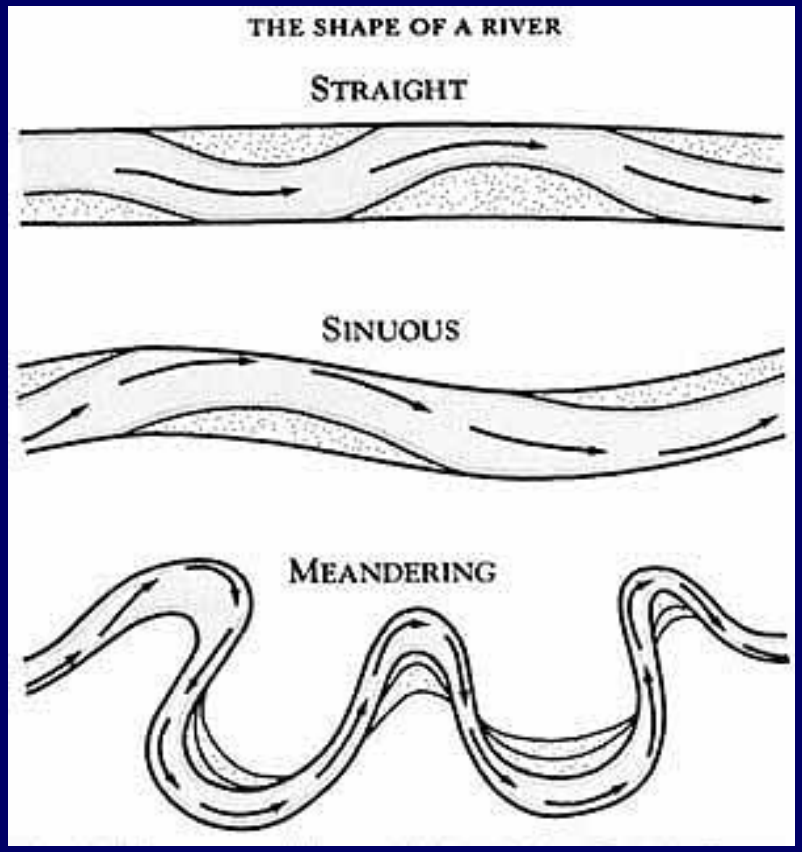
Levées

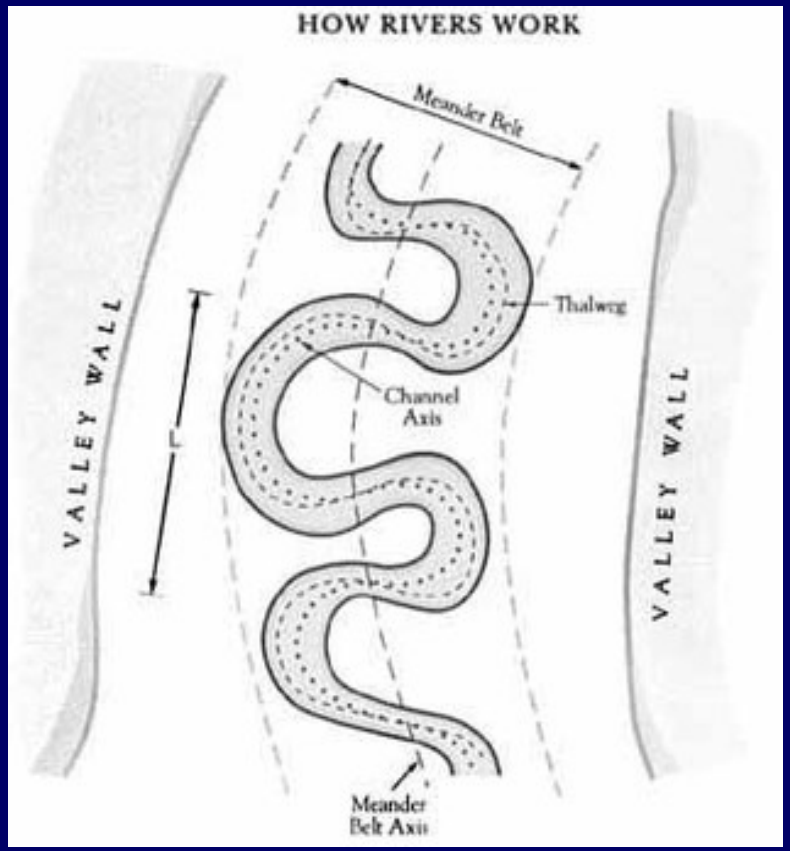


Natural levées form as the river floods its banks and inundates the floodplain.

Meanders

Meanders are sweeping loops or bends in the middle and lower course of the river caused by rivers developing increased sinuosity downstream.





Lower Course Forms



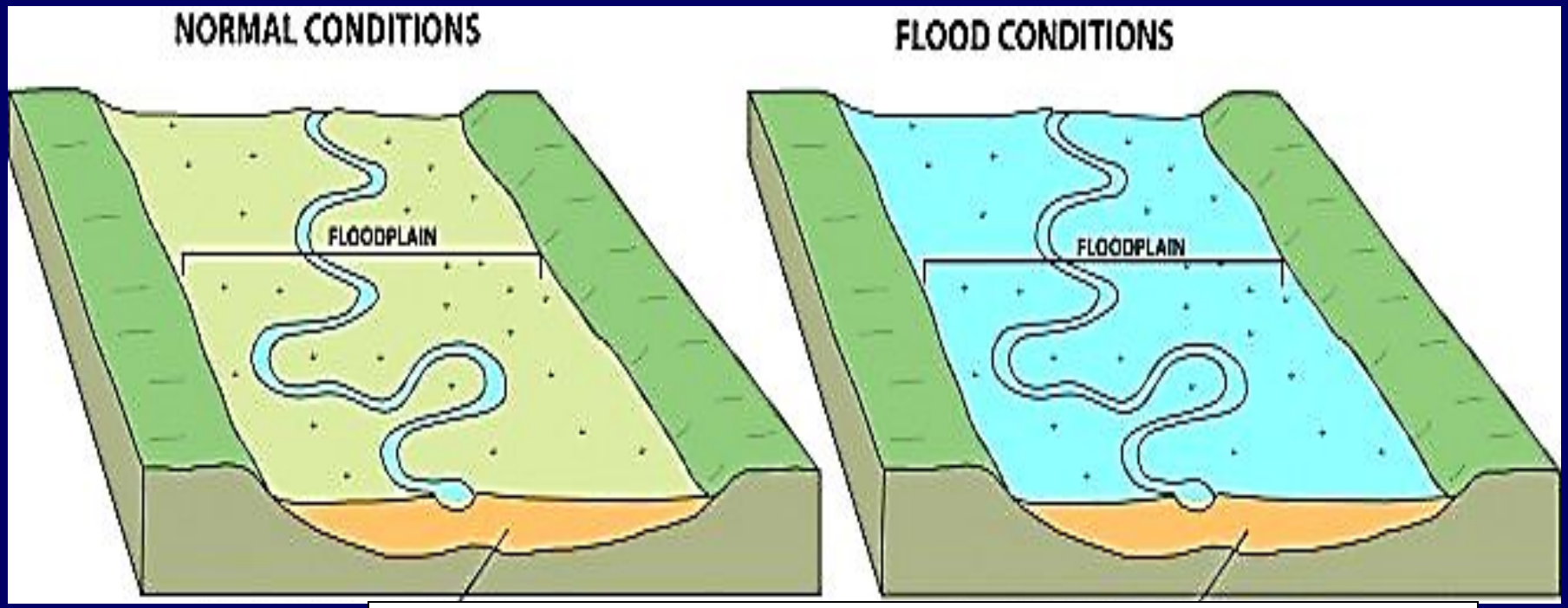


River deltas form at the mouth of the river

Flood Plain

Flood Plain

A flood plain is a flat or nearly flat area of land adjacent to a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge.



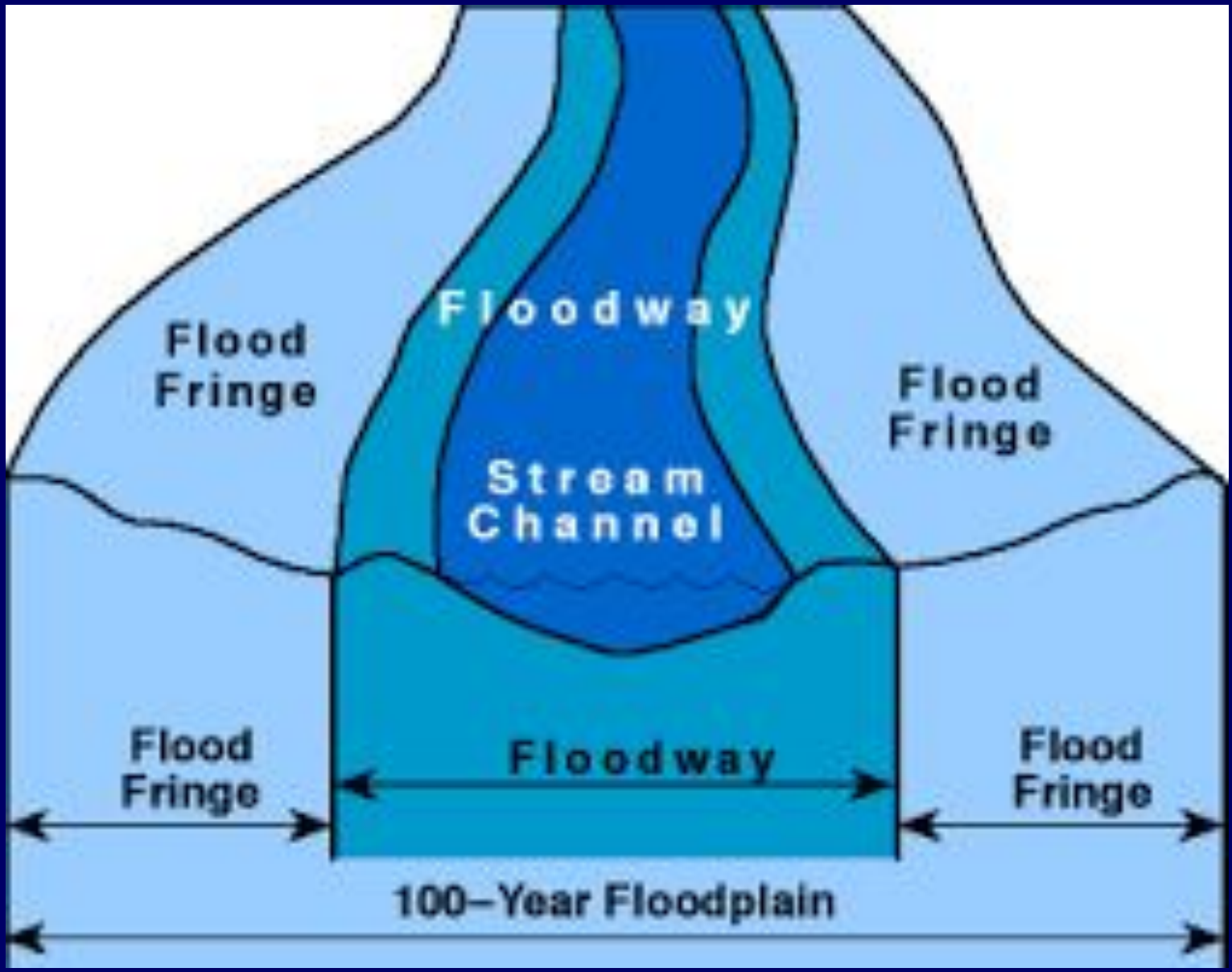
Older River Channel and Flood Plain Sediment

Flood Plain

It includes:

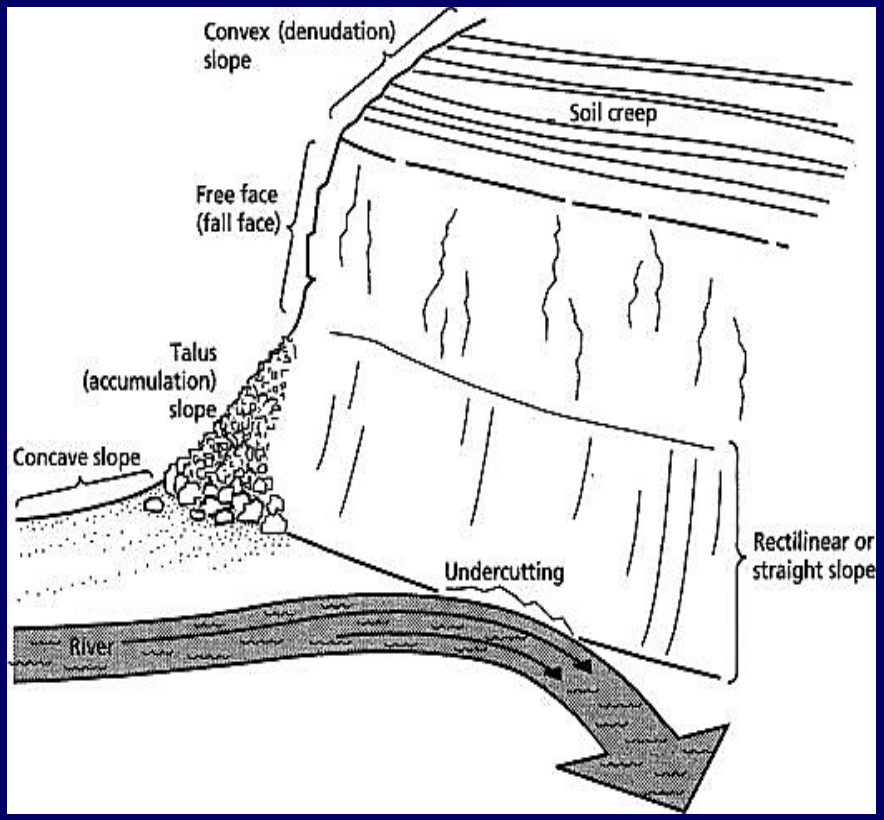
- **Floodway**, which consists of the **stream channel** and **adjacent areas** that actively carry flood flows downstream.
- **Flood fringe**, which are **areas inundated** by the flood, but which do not experience a strong current.
- In other words, a floodplain is an area near a river or a stream which floods when the water level reaches flood stage.

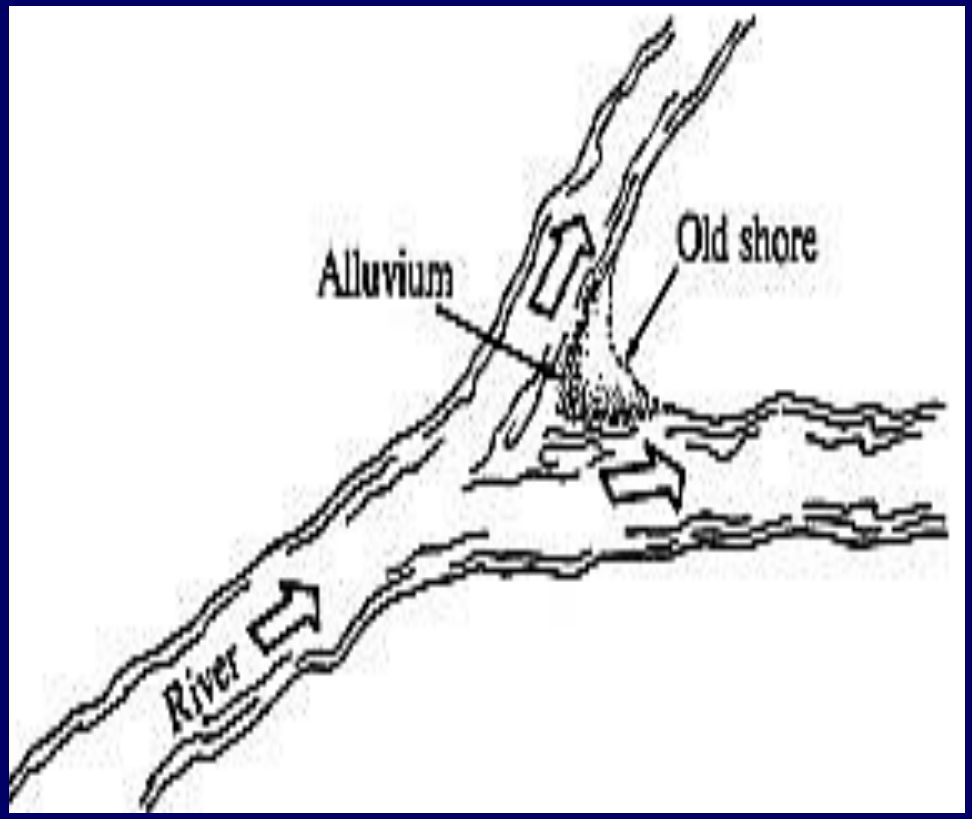
Flood Plain


Flood
Fringe
Floodway
Flood
Fringe
Stream
Channel
Flood
Fringe
Floodway
Flood
Fringe
100–Year Floodplain

Flood Plain Formation

- Flood plains are made by a **meander eroding sideways** as they travel downstream. When a river breaks its banks and floods, it leaves behind **layers of alluvium (silt).** These gradually build up to create the floor of the flood plain.

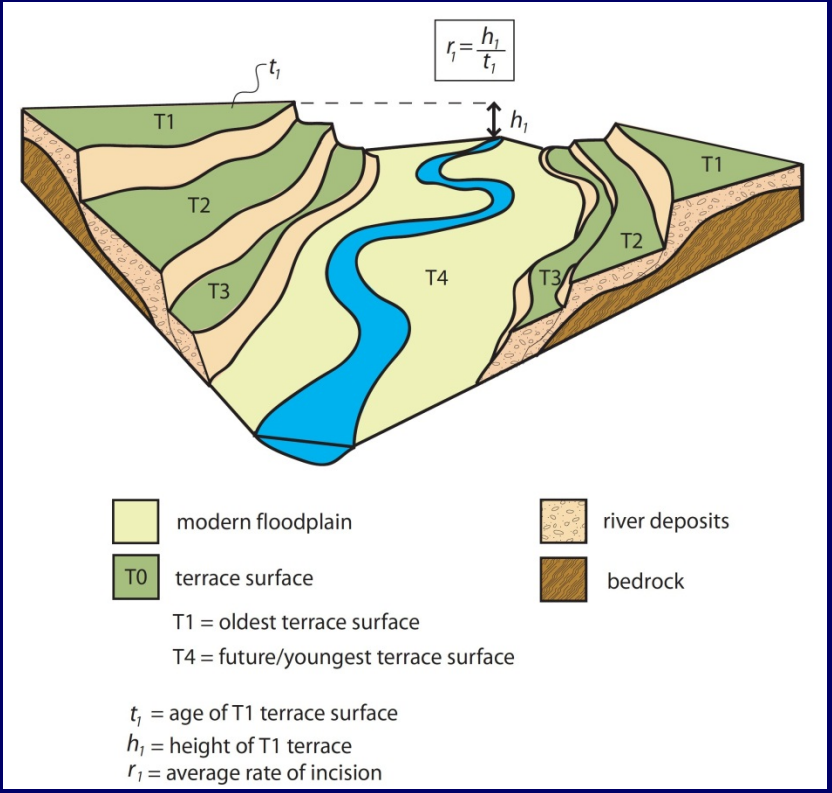




Flood Plain Formation

- **Floodplains generally contain unconsolidated sediments. These are accumulations of sand, gravel, loam, silt, and/or clay.**

- Geologically ancient floodplains are often represented in the landscape by **fluvial terraces**.
- These are old floodplains that remain relatively high above the present floodplain and indicate former courses of a stream.



Flood Plain Formation

Sections of the floodplain show a great variety of material of varying coarseness, the stream bed having been scoured at one place and filled at another by currents and floods of varying swiftness, so that sometimes the deposits are of coarse gravel, sometimes of fine sand or of fine silt.



Layers with different textures **along a stream bank soil profile** that represent flooding events of different magnitude.

Flood Plain Formation

- The floodplain during its formation is marked by meandering or anastomotic (interconnected) streams, ox-bow lakes and bayous (slow-moving or stagnant stream), marshes or stagnant pools, and is occasionally completely covered with water.
- When the drainage system has ceased to act or is entirely diverted for any reason, the floodplain may become a level area of great fertility.
- The floodplain has a gentle slope down-stream, and often, for a distance, from the side towards the centre.

Flood Plain Formation

- The floodplain is the natural place for a river to dissipate its energy.
- Meanders form over the floodplain to slow down the flow of water and when the channel is at capacity the water spills over the floodplain where it is temporarily stored.
- In terms of flood management the upper part of the floodplain is crucial as this is where the flood water control starts.
- Artificial canalization of the river here will have a major impact on wider flooding.

Alluvial Plain

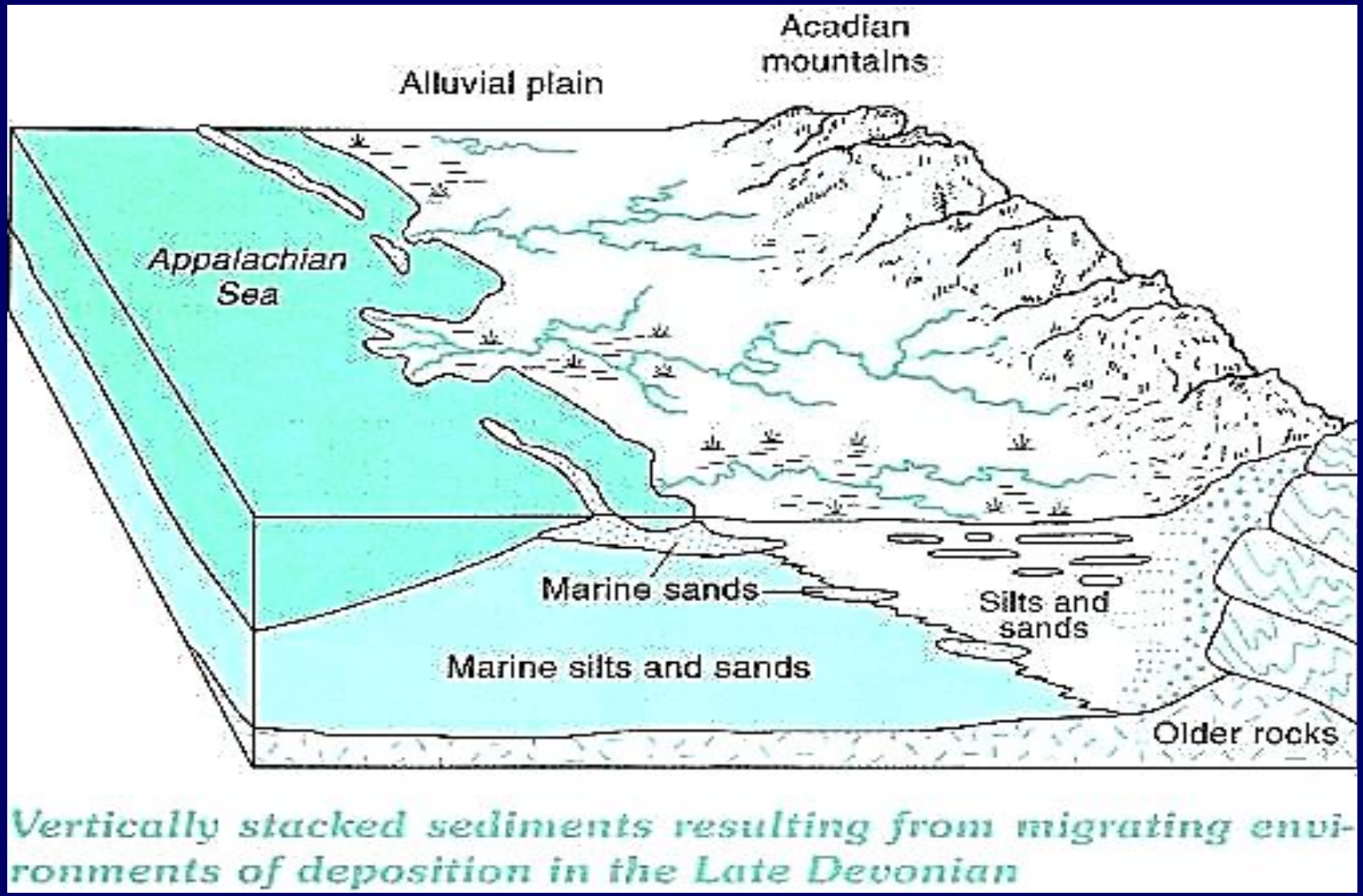
- An alluvial plain is a largely flat landform created by the deposition of sediment over a long period of time by one or more rivers coming from highland regions.

- A floodplain is part of the process, being the smaller area over which the rivers flood at a particular period of time, whereas the alluvial plain is the larger area representing the region over which the floodplains have shifted over geological time.

Alluvial Plain Formation

- As the **highlands** erode due to **weathering and water flow**, the sediment from the hills is transported to the **lower plain.**
- As the sediments are deposited during flood conditions in the floodplain of a creek, the **elevation of the floodplain will be raised.**
- As this reduces the **channel floodwater capacity**, the creek will, over time, **seek new, lower paths**, forming a **meander** (a curving sinuous path).

Alluvial Plain Formation



Vertically stacked sediments resulting from migrating environments of deposition in the Late Devonian

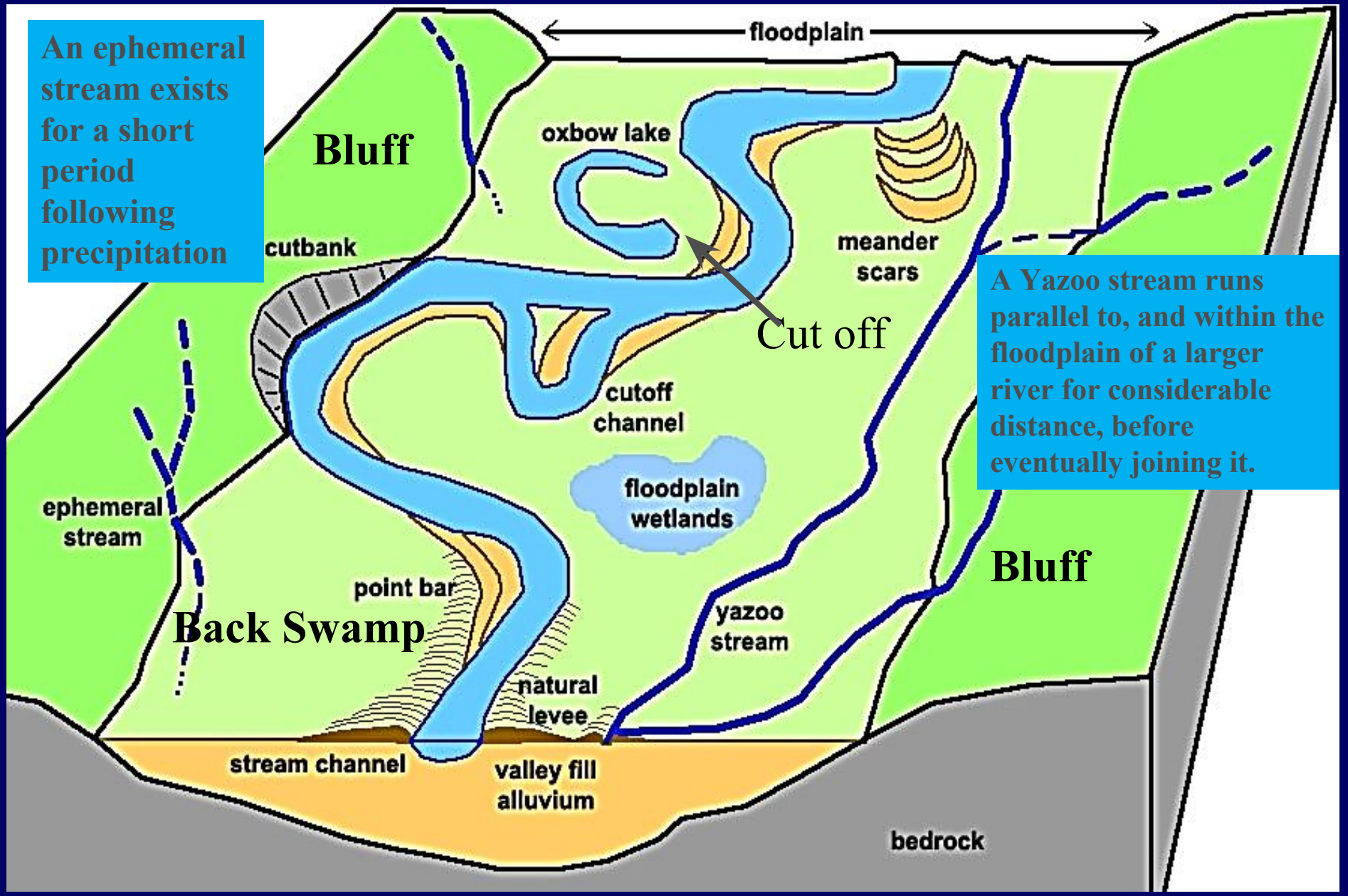
a mountain system in eastern North America that stretches from Quebec and Maine in the north to Georgia and Alabama in the south.

Alluvial Plain Formation

- **The leftover higher locations, typically natural levees at the margins of the flood channel, will themselves be eroded by lateral *stream erosion* and from *local rainfall* and possibly *wind transport* if the climate is arid (dry and barren) and does not support soil-holding grasses.**

- **These processes, over geologic time, will form the plain, a region with *little relief* (local changes in elevation), yet with a *constant but small slope*.**

Landforms of Alluvial River Flood Plains



Alluvial Fan

- **An alluvial fan is a fan or cone-shaped deposit of sediment overlapped and built up by streams.**
- **If a fan is built up by debris flows it is properly called a debris cone or colluvial fan.**

These flows come from a **single point source** at the **apex** of the fan, and over time move to occupy many positions on the fan surface.



Alluvial Fan

- **Fans are typically found where a canyon draining from mountainous terrain emerges out onto a flatter plain.**
- **A convergence of *neighboring alluvial fans* into a *single apron of deposits* against a slope is called a bajada (pronounce: bahada), or compound alluvial fan.**





Alluvial Fan Formation

As stream's gradient decreases, it drops coarse grained material. This reduces the capacity of the channel and forces it to change direction and gradually build up a conical fan shape.

The system of sediment introduced at the apex of the fan will tend to a state which minimizes the sum of the transport energy involved in moving the sediment and the gravitational potential of material in the fan.

There will be iso-transport energy lines forming *concentric arcs* about the discharge point at the apex of the fan. Thus the material will tend to be deposited equally about these lines, forming the characteristic fan shape.

Alluvial Fan Formation

In Arid Climates

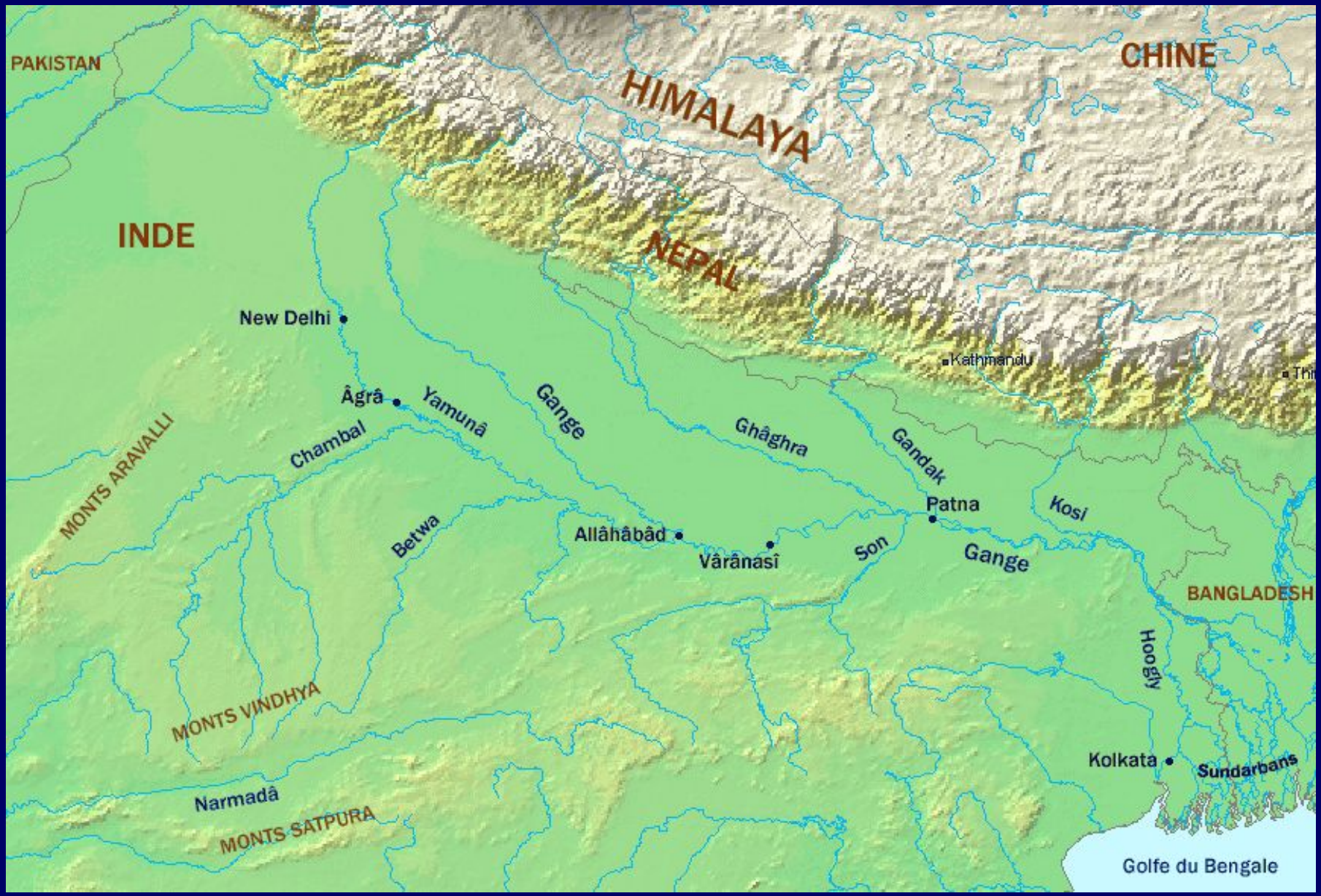
- **Alluvial fans are often found in desert areas subject to periodic flash floods** (a sudden local flood, typically due to heavy rain) **from nearby thunderstorms in local hills.**
- **The typical watercourse has a large, funnel-shaped basin at the top, leading to a narrow defile, which opens out into an alluvial fan at the bottom.**

Alluvial Fan Formation

In Humid Climates

- In Nepal the Koshi River has built a megafan covering some 15,000 km^2 below its exit from Himalayan foothills onto the nearly level plains where the river traverses into India before joining the Ganges.

Alluvial Fan Formation



Alluvial Fan Formation

In Humid Climates

- Along the upper Koshi tributaries, tectonic forces *elevate the Himalayas* several mm annually.

- Uplift is approximately in equilibrium with erosion, so the river annually carries some 1 billion cu m (3.5 billion cft) of sediment as it exits the mountains.

- Deposition of this magnitude over millions of years is more than sufficient to account for the megafan.

Alluvial Fan -Flood Hazards

- Alluvial fans are subject to flooding and can be even more dangerous than the upstream canyons that feed them.
- In the case of the Koshi River, the huge sediment load and megafan's slightly convex sloping surface conspire against engineering efforts to contain peak flows inside manmade embankments.

- In August 2008In August 2008 high monsoonIn August 2008 high monsoon flows breached the embankment, diverting most of the river into an unprotected ancient channel and across surrounding lands with high population density.

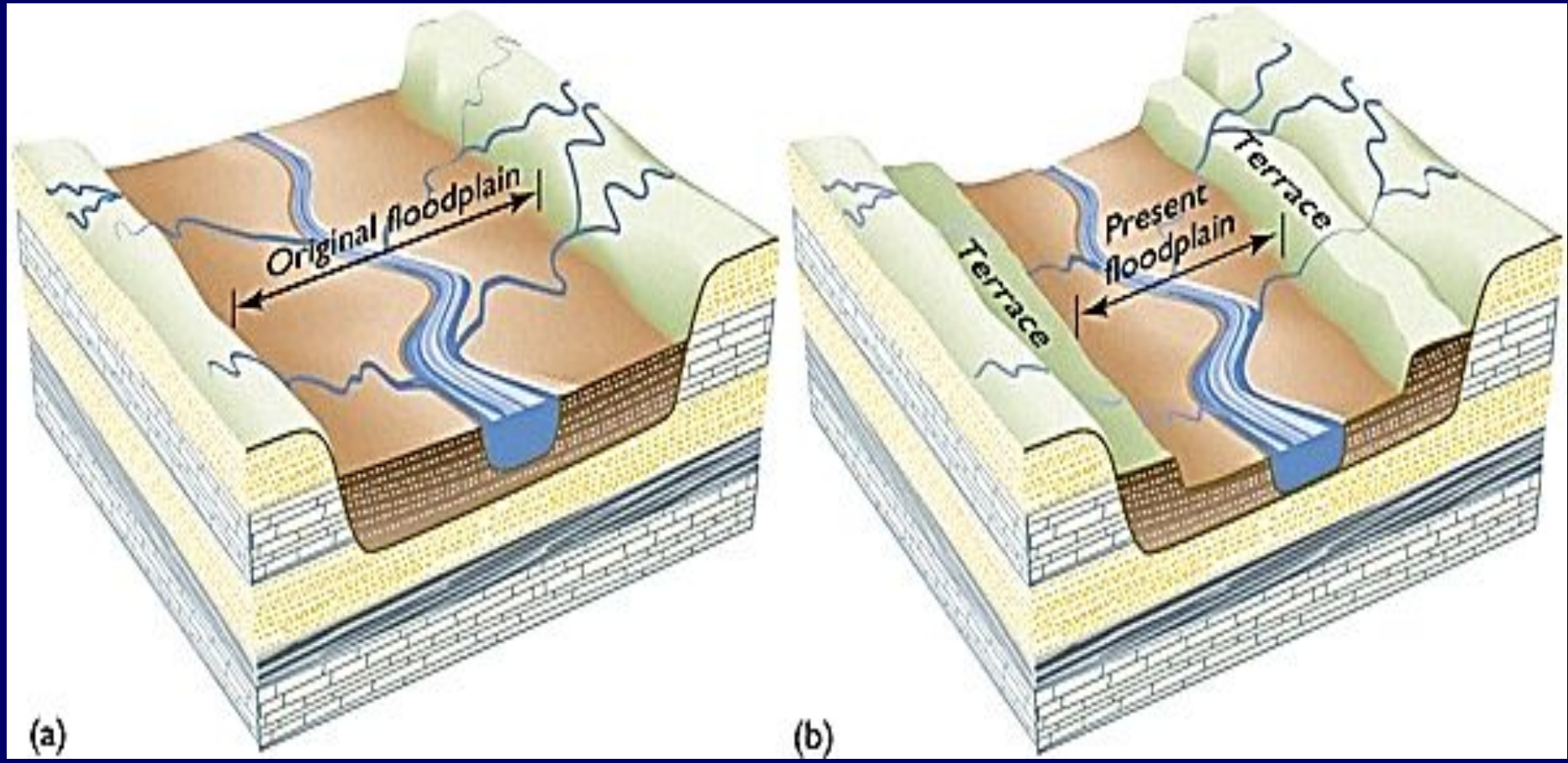
Alluvial Terrace

- A terraced (stepped) embankment of loose material adjacent to the sides of a river valley.

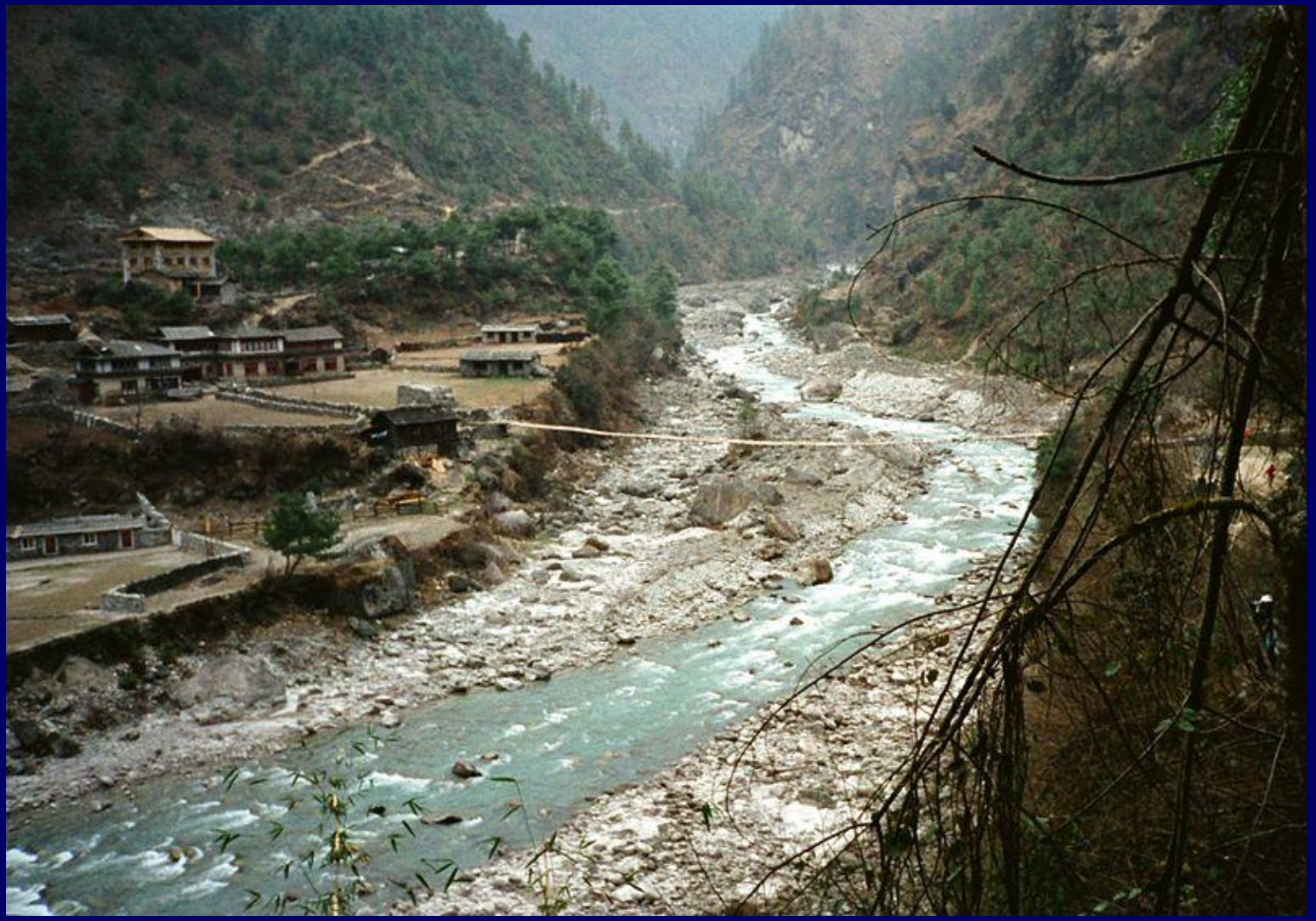
- Also known as built terrace; drift terrace; fill terrace; stream-built terrace; wave-built platform; wave-built terrace.



Alluvial Terrace



Koshi River



Dudh Koshi, one of the seven Himalayan tributaries of Koshi river

Koshi River



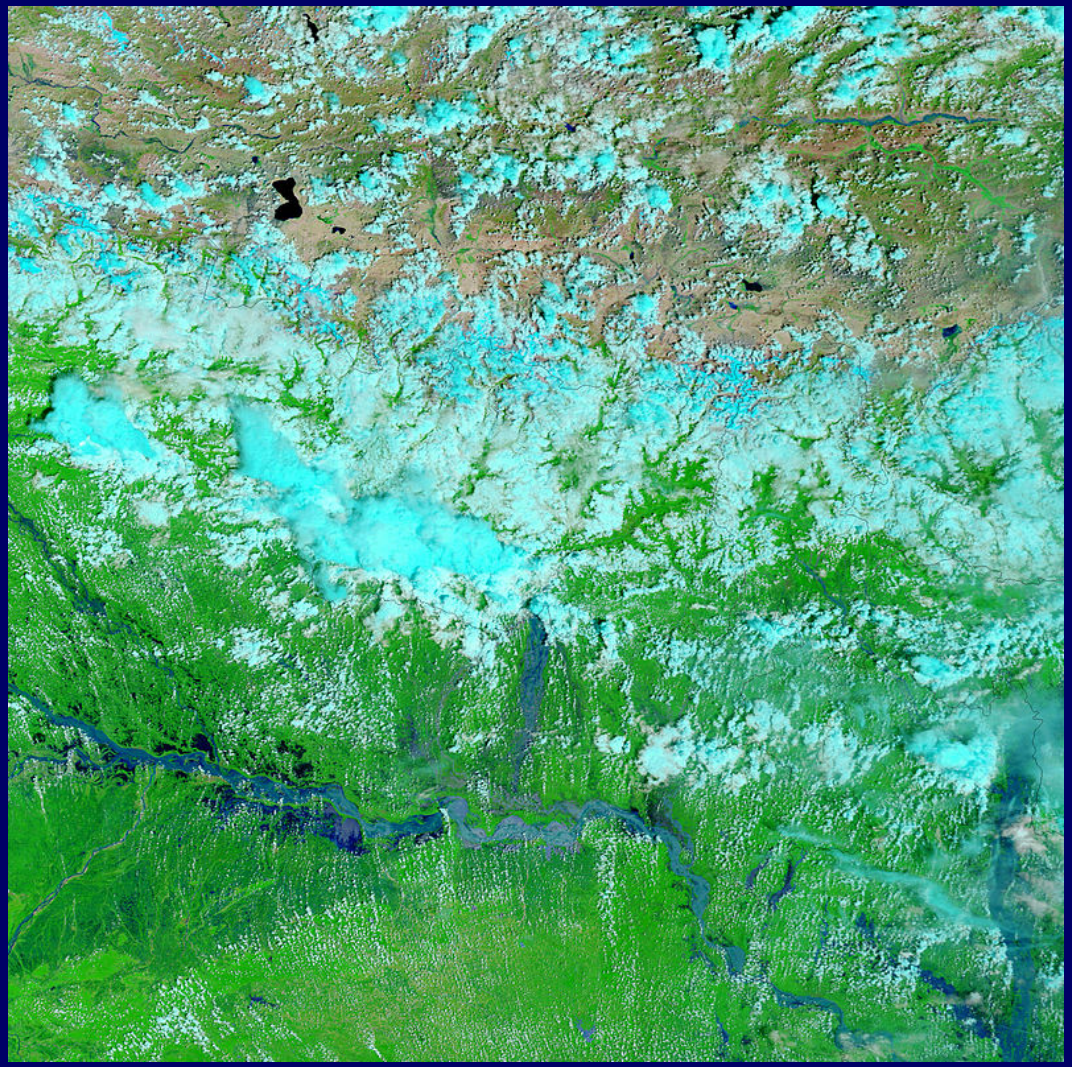
Koshi Barrage

Koshi River



Silt deposition near Kosi embankment at Navbhata, Saharsa, Bihar, India

Koshi River



Koshi flooded in August 2008. Courtesy: NASA Satellites

Koshi River



Flooded north Bihar, India