

# Fluvial Processes



## Part II

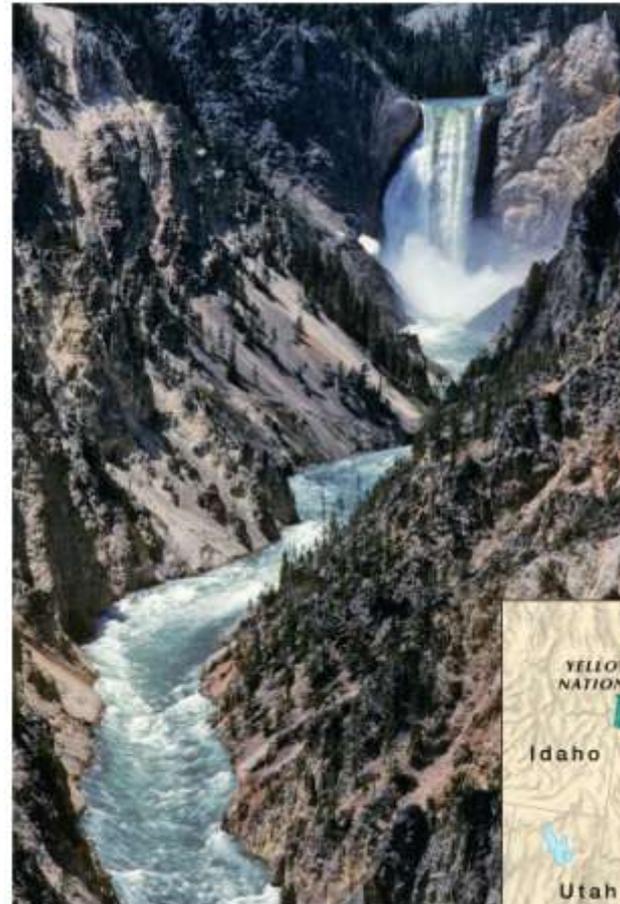
Many a calm river begins as a turbulent waterfall, yet none hurtles and foams all the way to the sea.

—Mikhail Lermontov



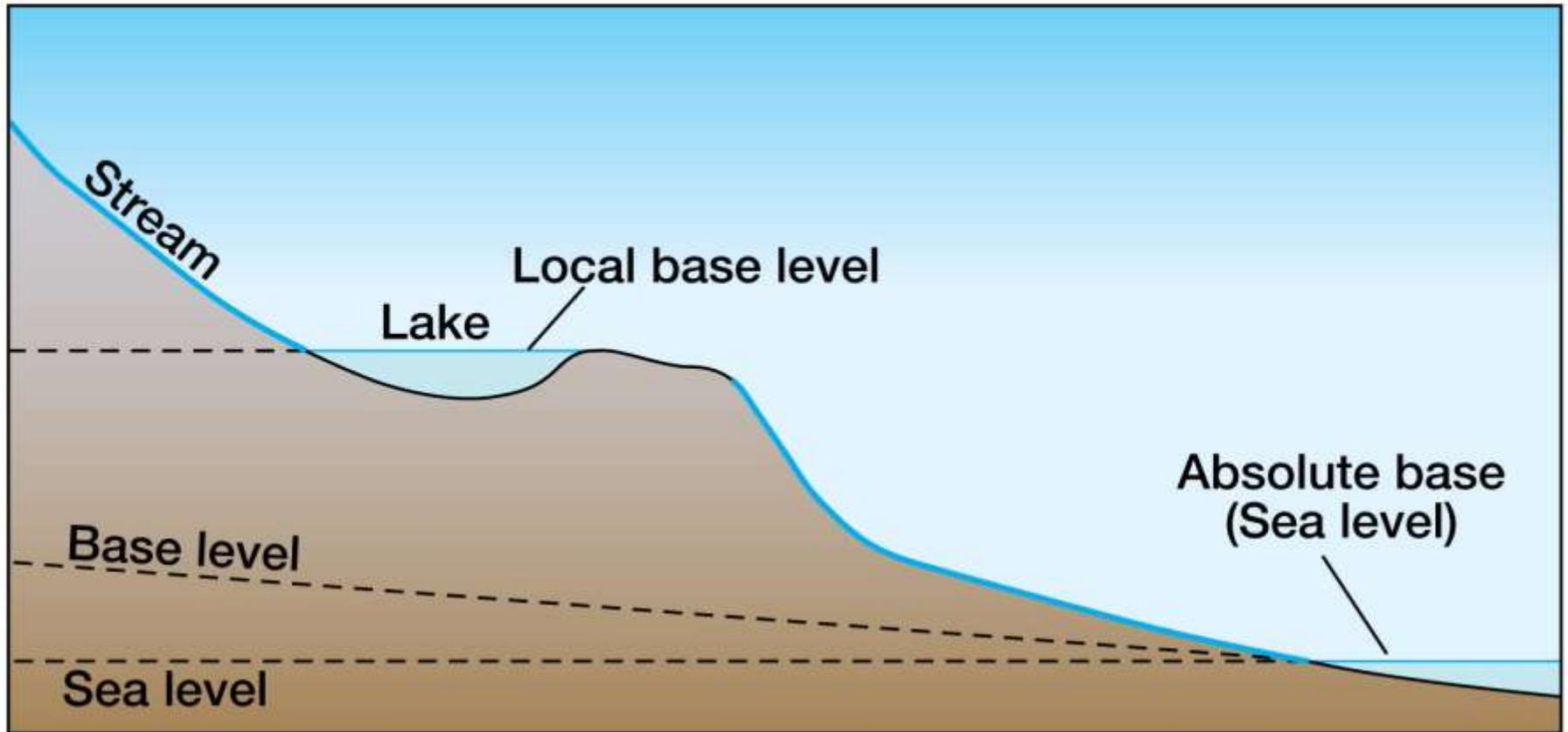
## ❖ The Shaping and Reshaping of Valleys

- Valley Deepening
  - Down cutting and V-shaped Valleys
  - Head (upper end) of a valley



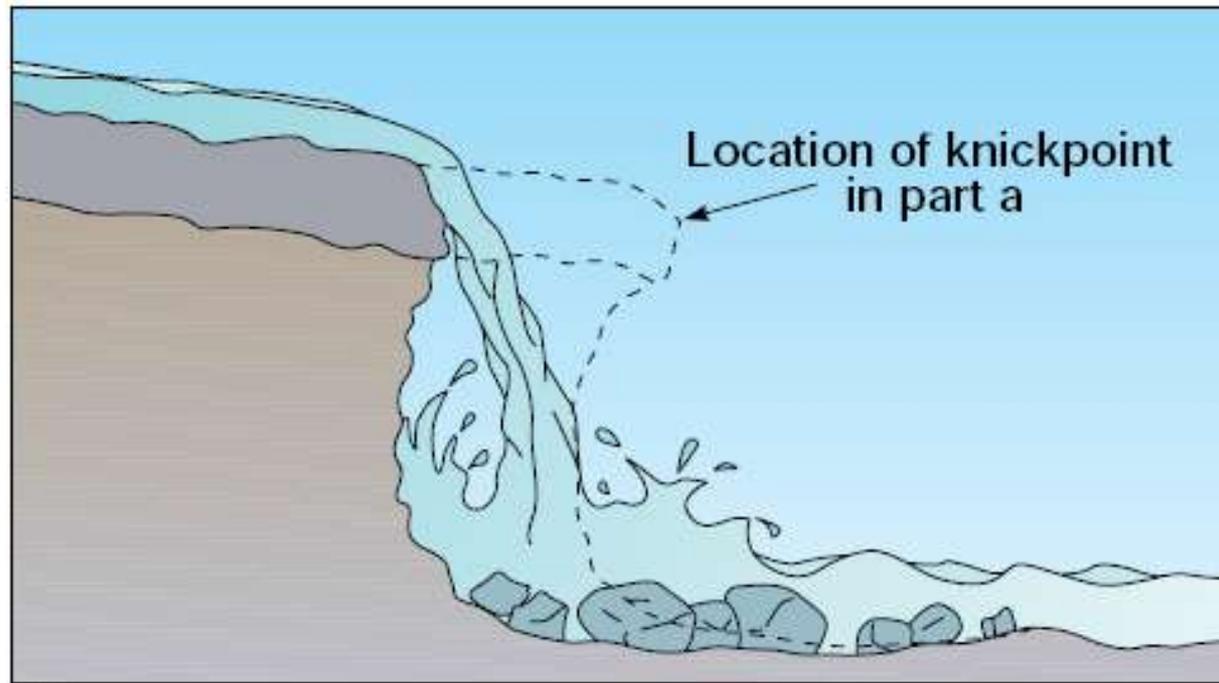


- Base level
  - Sea level, base level, and local base level

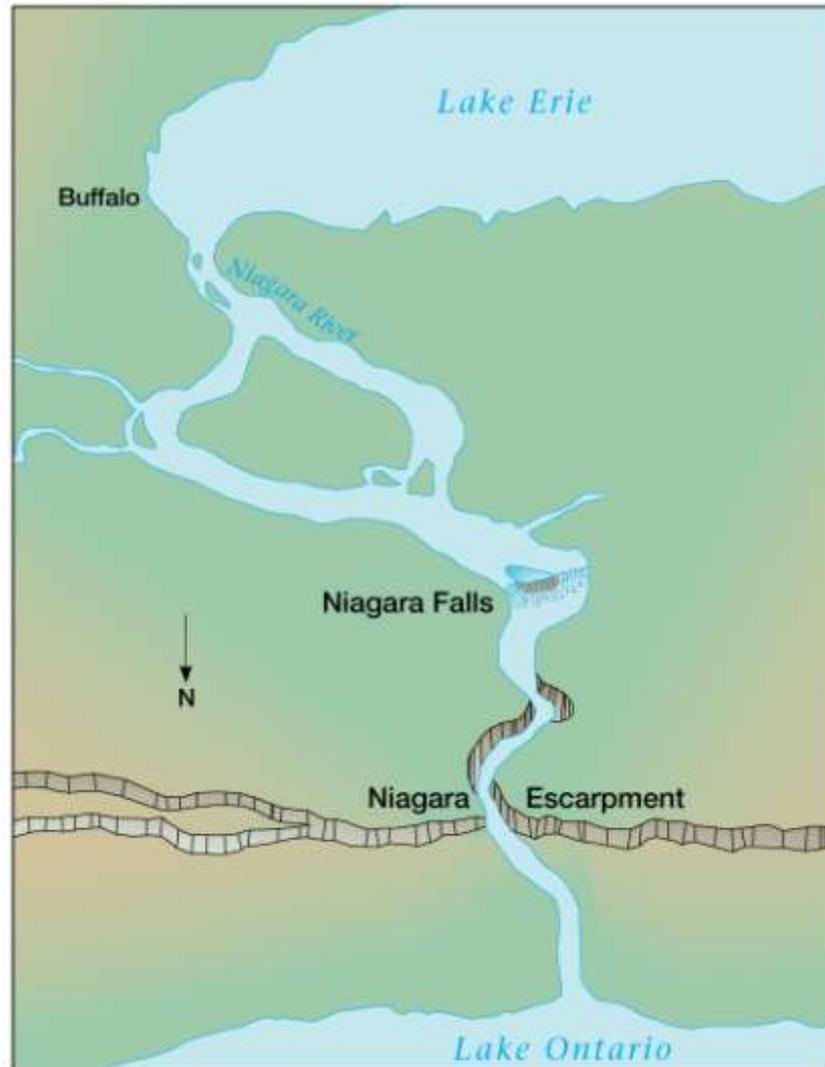




– Knickpoint Migration



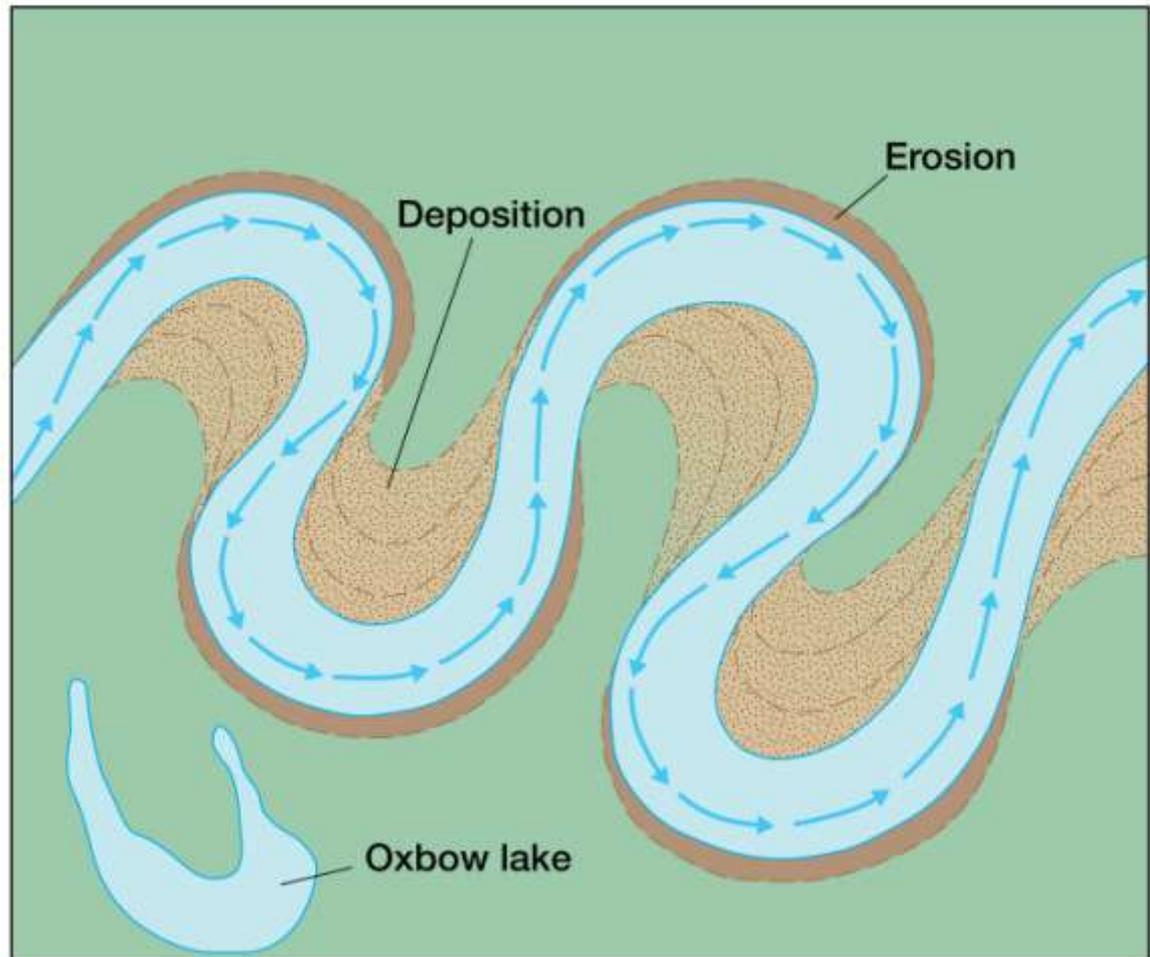
(d)



Niagara Falls (Knickpoint) Retreat

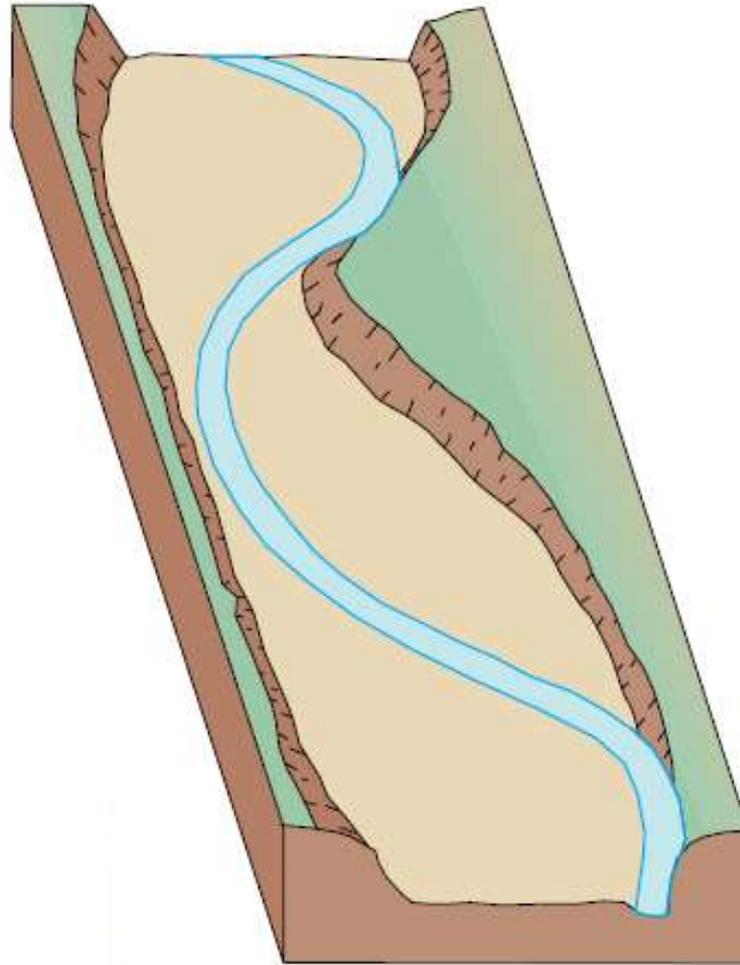


- Valley Widening
  - Lateral erosion by a meandering stream



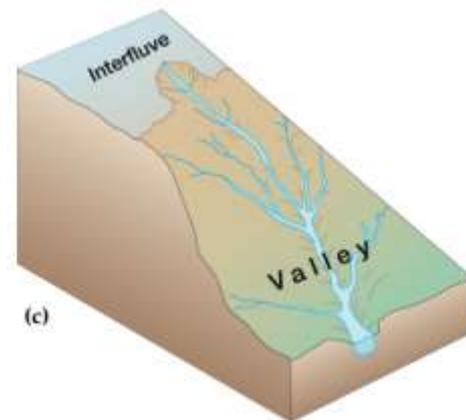
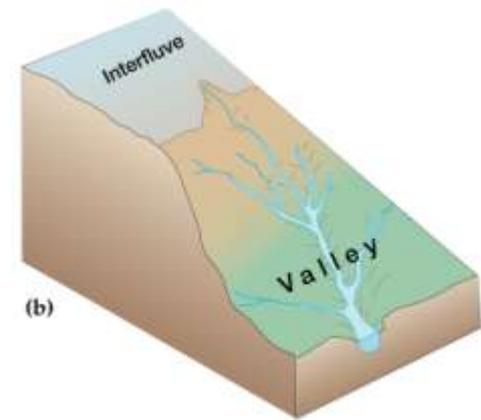
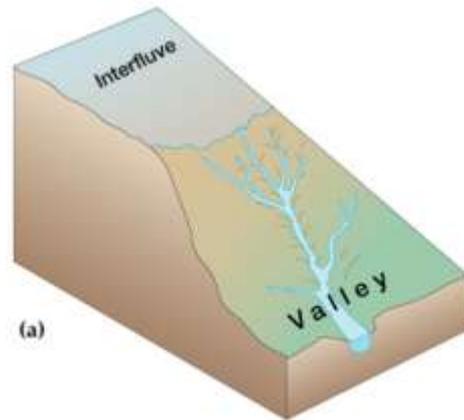


(c)





- Valley Lengthening  
– Headward erosion

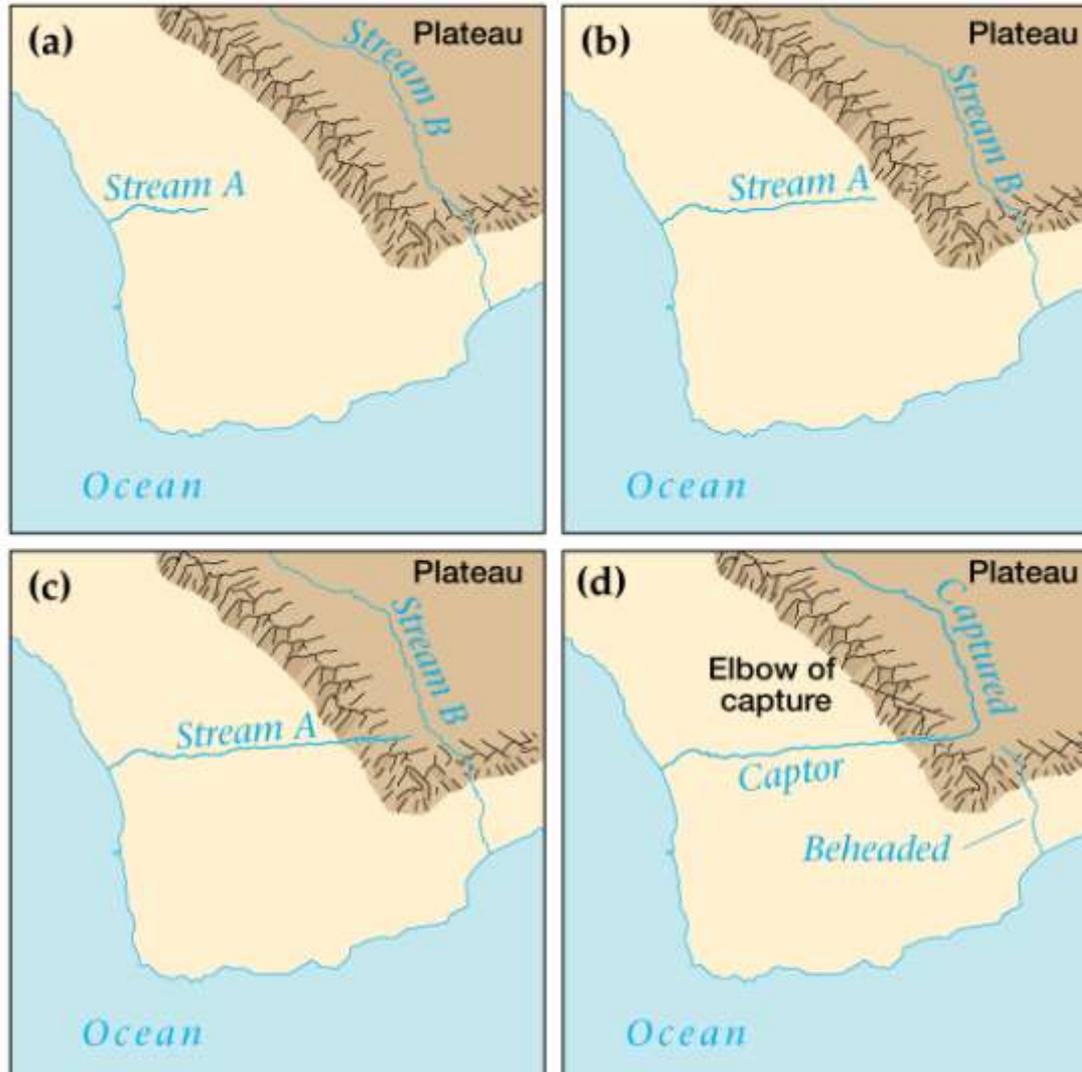




Headward (gully) erosion into a Wisconsin field



## – Stream Capture





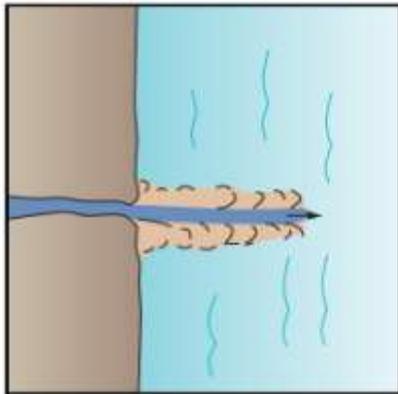
(c)

Stream capture by the Niger River, western Africa.

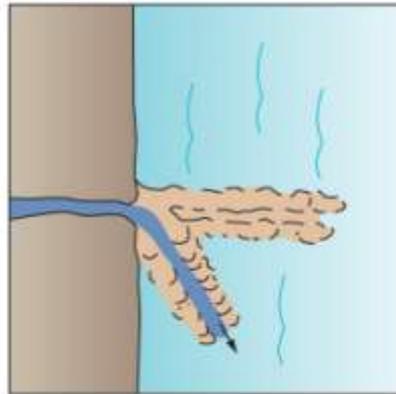


## – Delta Formation

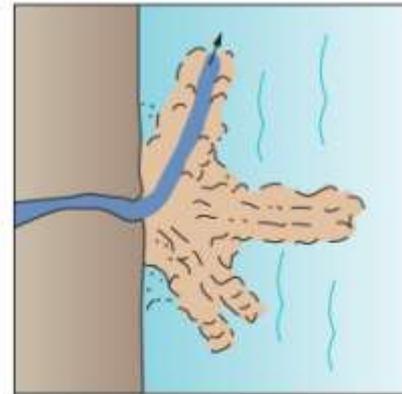
- River mouth deposits



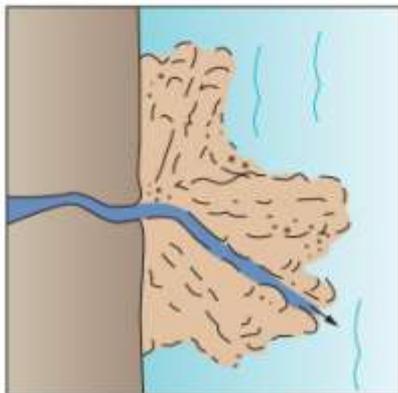
(a)



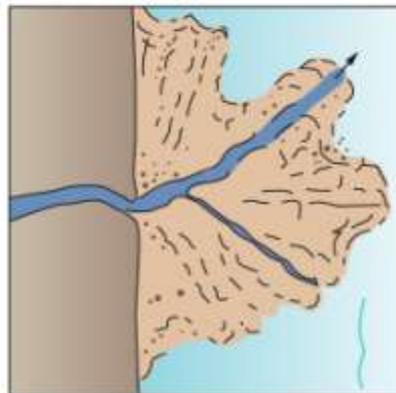
(b)



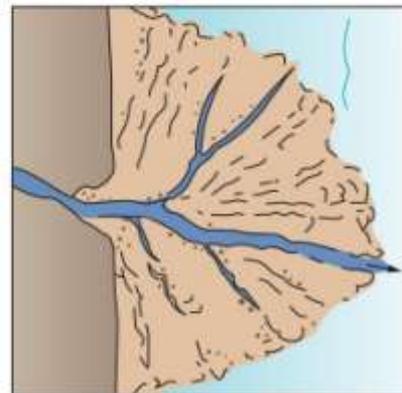
(c)



(d)



(e)



(f)



## Largest Deltas

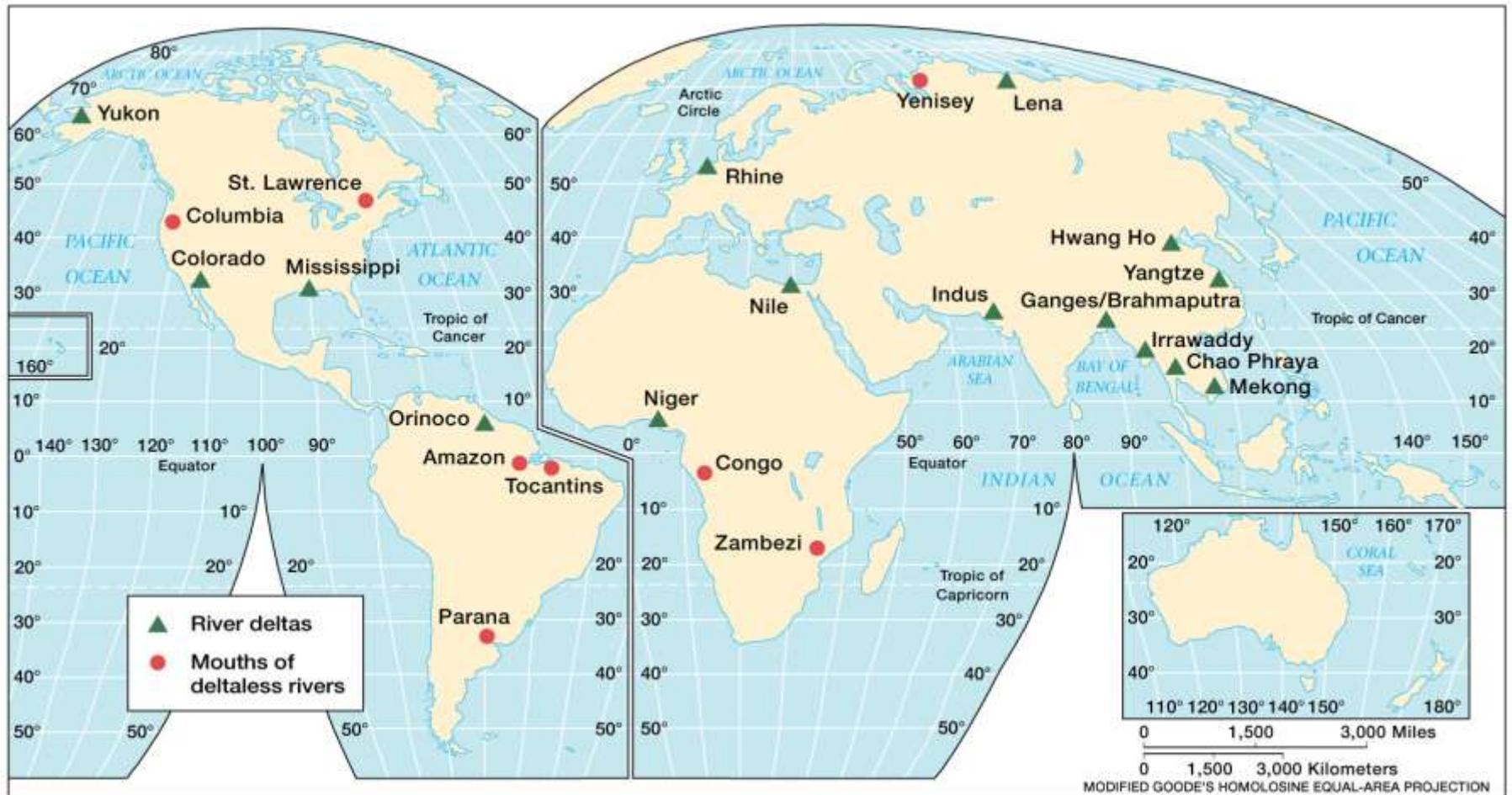
Rank	River (Country)	Area (km <sup>2</sup> × 1000)
1	Indus (Pakistan)	163.0
2	Nile (Egypt)	160.0
3	Hwang Ho (China)	127.0
4	Yangtze (China)	124.0
5	Ganges/Brahmaputra (Bangladesh)	91.0
6	Orinoco (Venezuela)	57.0
7	Yukon (Alaska)	54.0
8	Mekong (Vietnam)	52.0
9	Irrawaddy (Myanmar)	31.0
10	Lena (Russia)	28.5
11	Mississippi (United States)	28.0
12	Chao Phraya (Thailand)	24.6
13	Rhine (Netherlands)	22.0
14	Colorado (Mexico)	19.8
15	Niger (Nigeria)	19.4



## Largest Delta-less Rivers

Rank*	River (Country)
1	Amazon (Brazil)
2	Congo (Democratic Republic of Congo)
6	Yenisey (Russia)
10	Paraná (Argentina)
11	St. Lawrence (Canada)
15	Tocantins (Brazil)
20	Columbia (United States)
21	Zambezi (Mozambique)

\*In terms of average discharge.



Locations of the world's largest deltas and of the mouths of world's largest delta-less rivers.



# ❖ Floodplains

Animations



1. Meandering Streams
2. Floods and Natural Levee Development

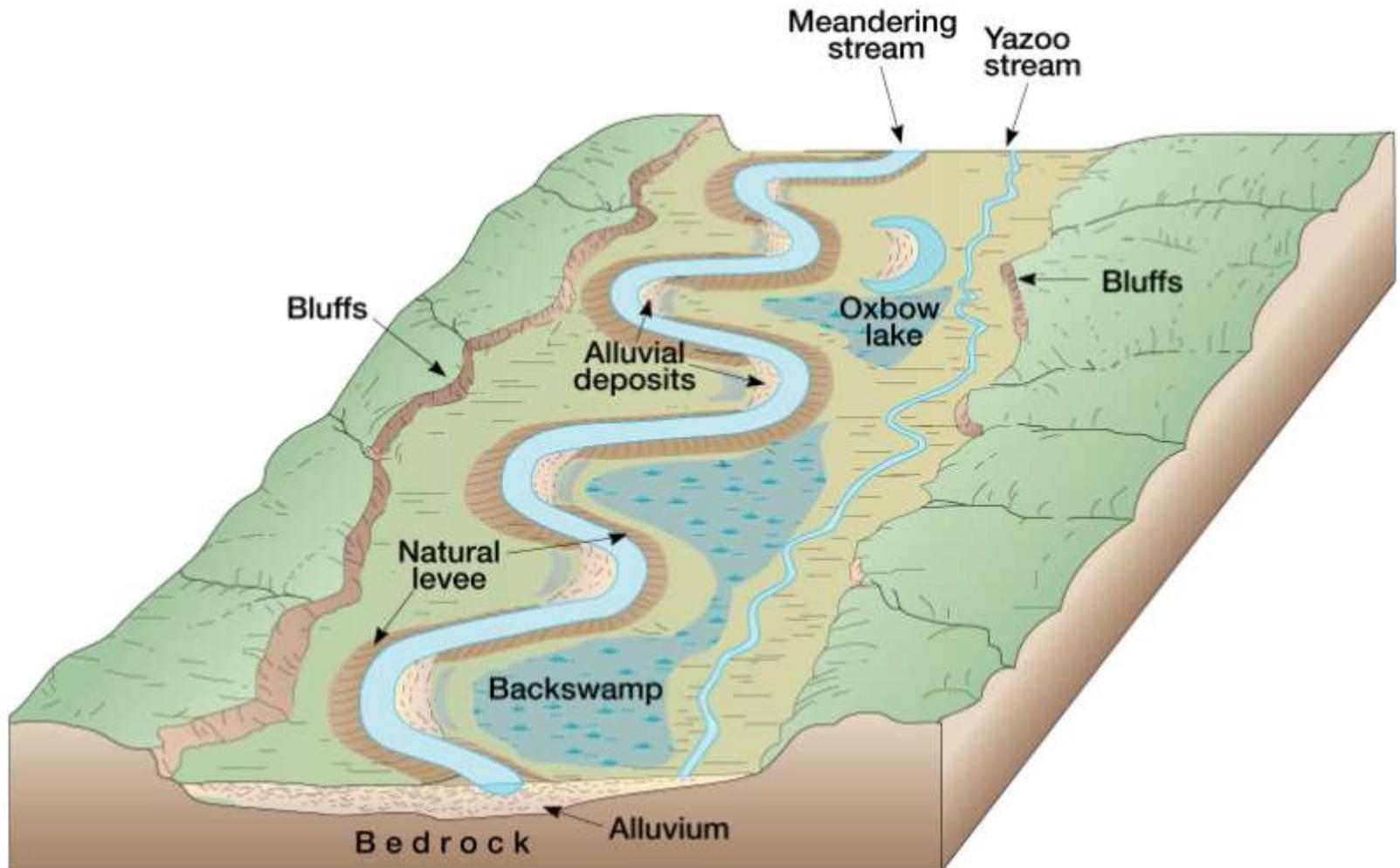
- Floodplain Landforms

- Floodplain – low-lying, flat alluvial valley floor





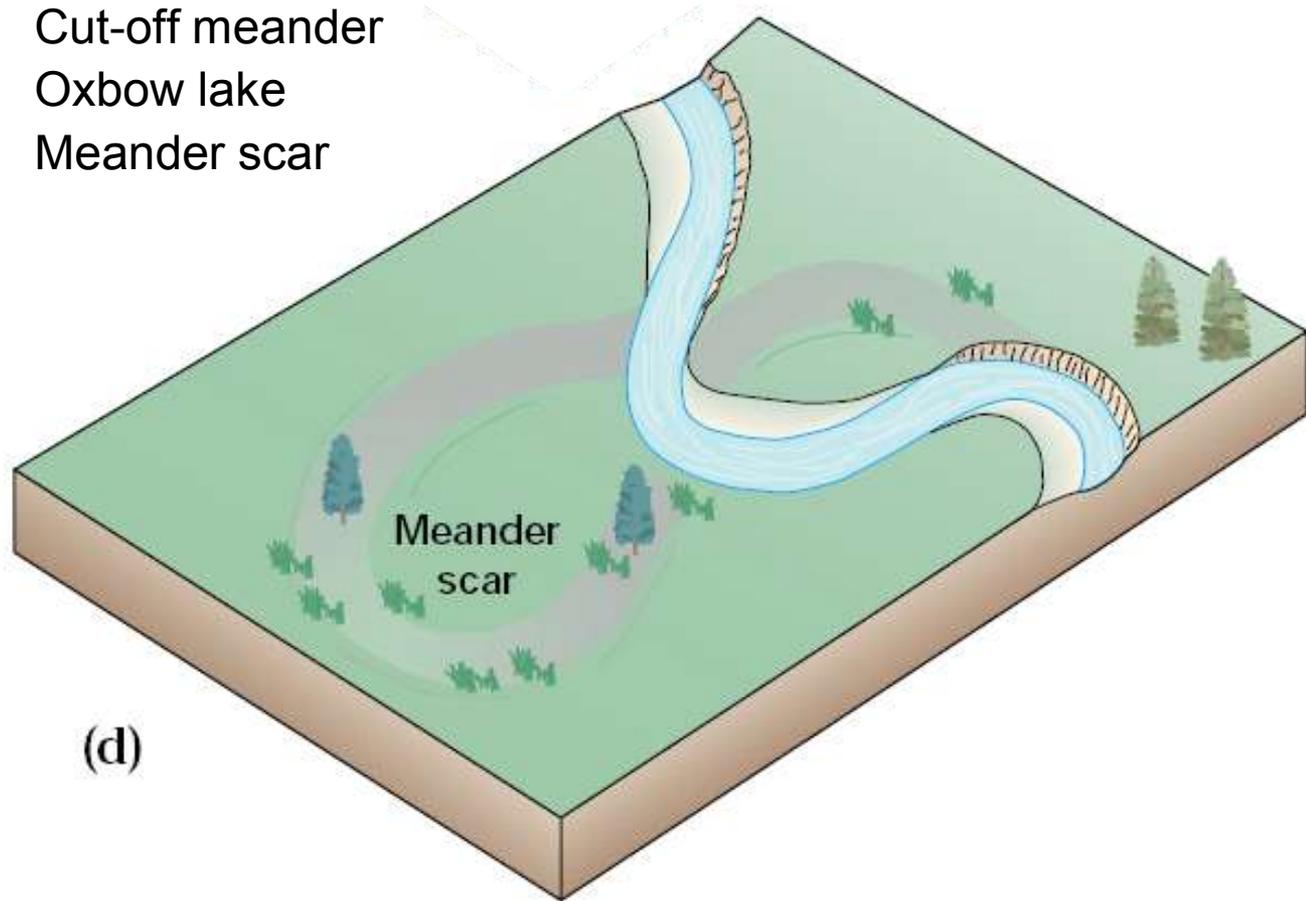
## – Landforms





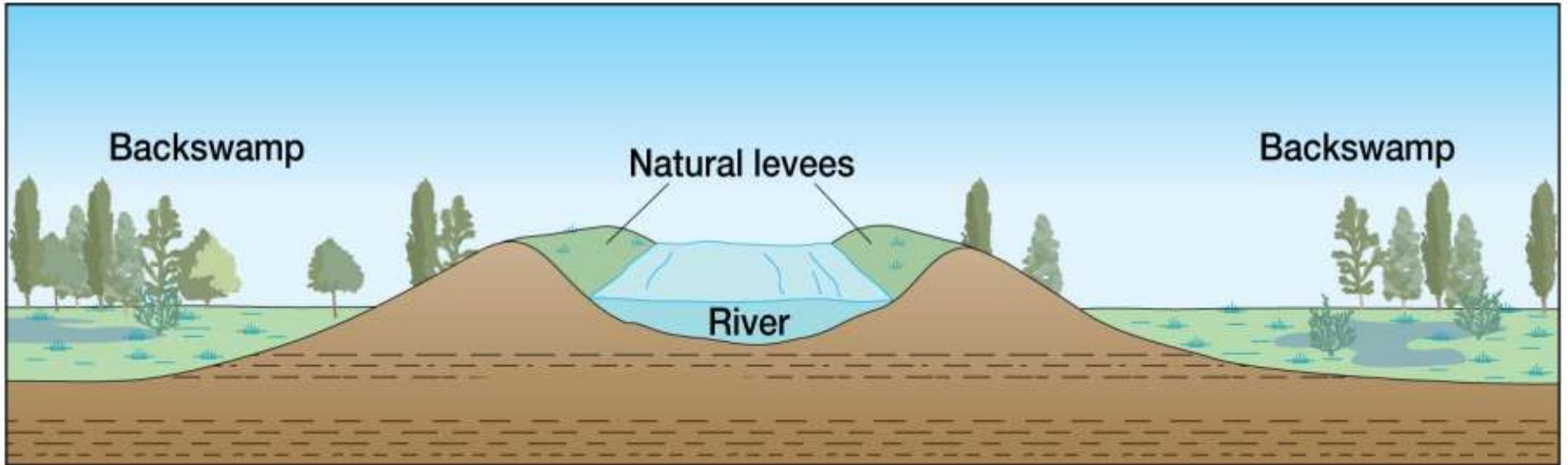
– Landform formation

- Cut-off meander
- Oxbow lake
- Meander scar





- Natural levee

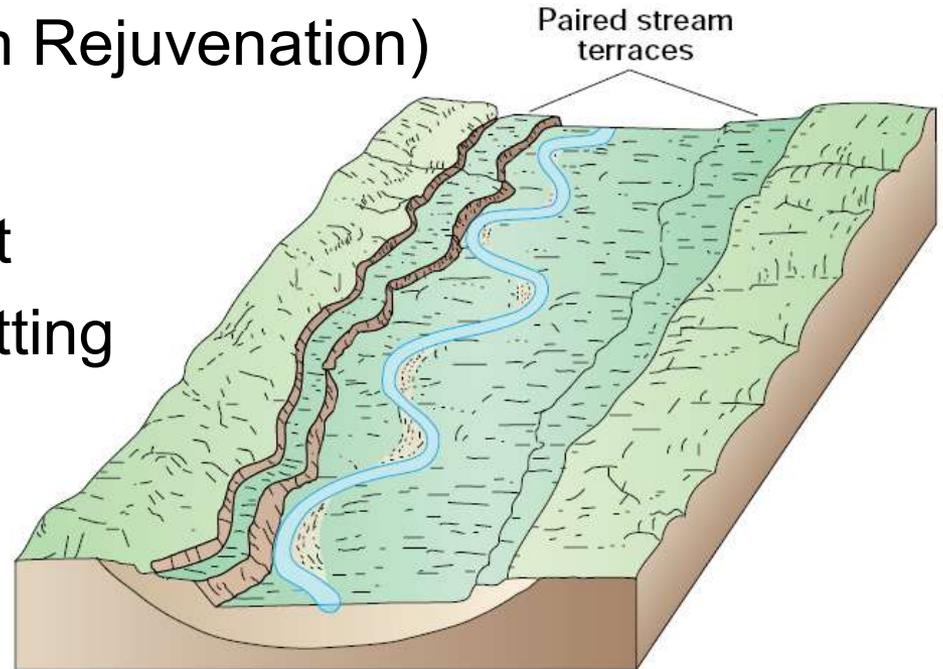




# ❖ Stream Rejuvenation

Animation  (Stream Rejuvenation)

- Tectonic Uplift
  - Increased gradient
  - Dramatic down cutting
- Landforms
  - Stream Terraces



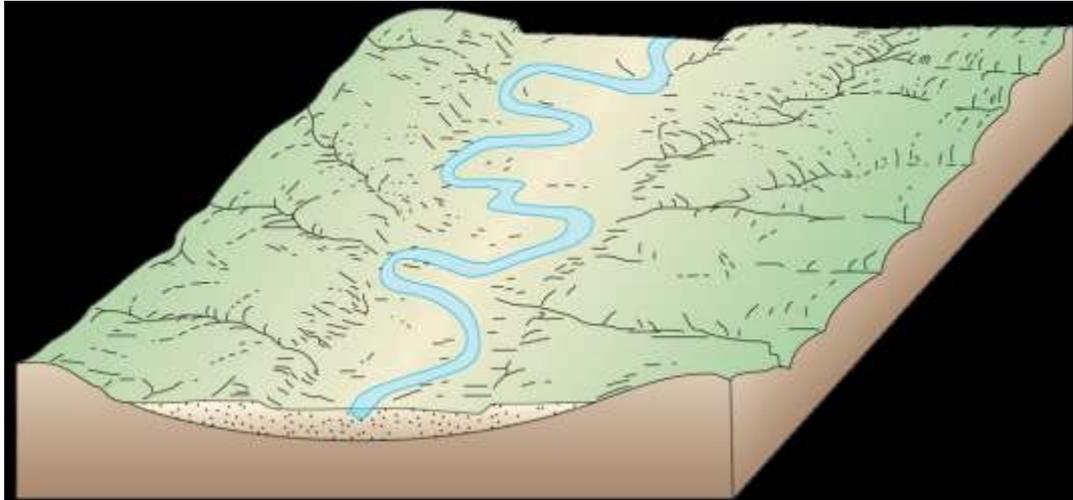
(c) After uplift



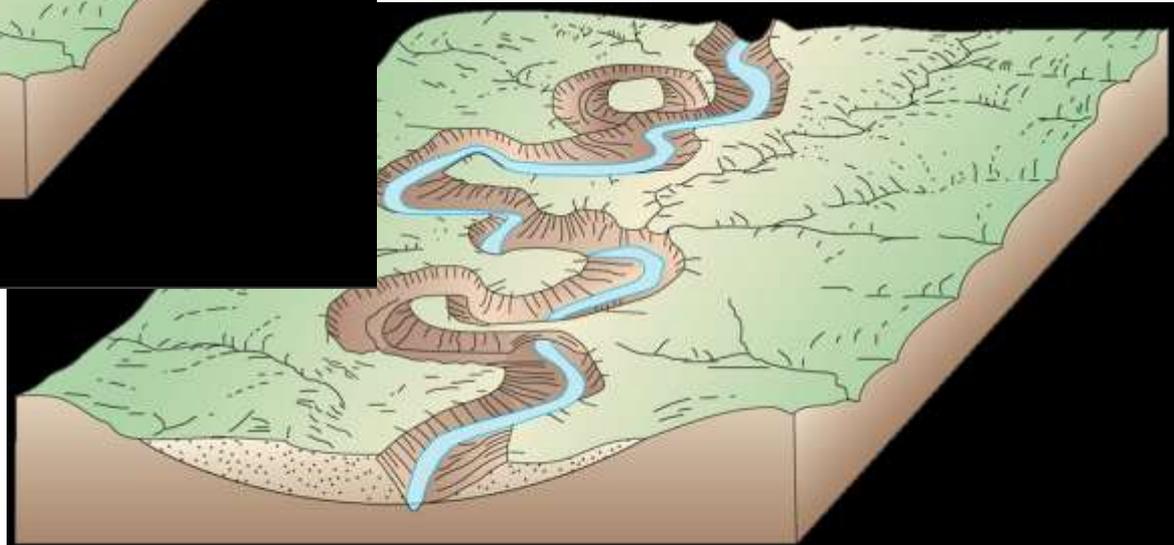
## – Entrenched Meanders



(a)



(b) Floodplain meanders



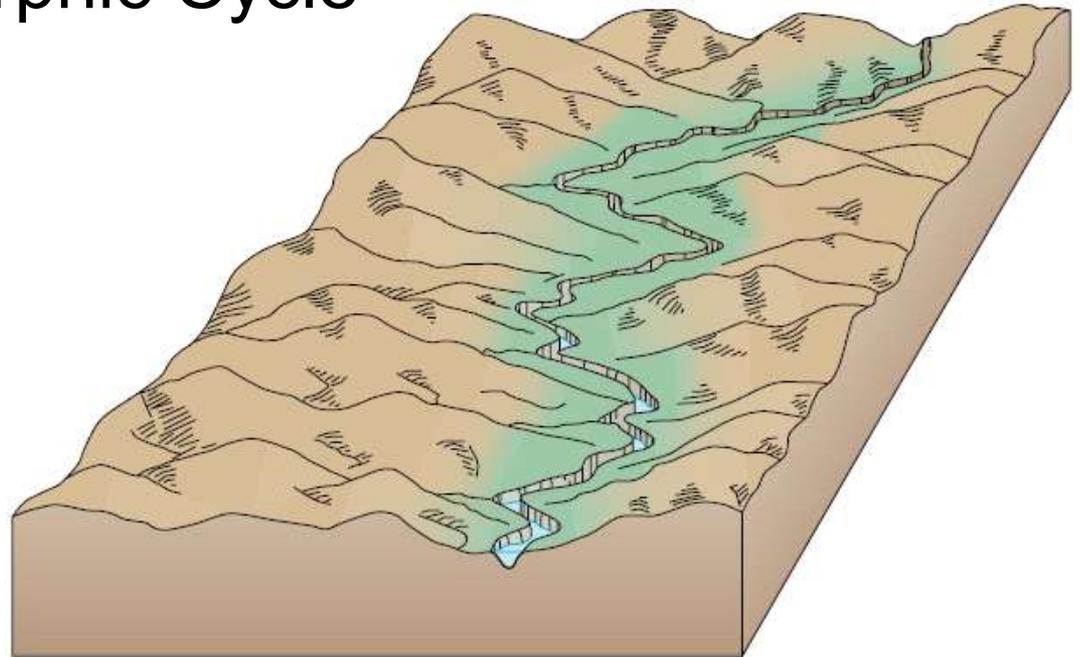
(c) Entrenched meanders



# ❖ Theories of Landform Development

- Davis' Geomorphic Cycle

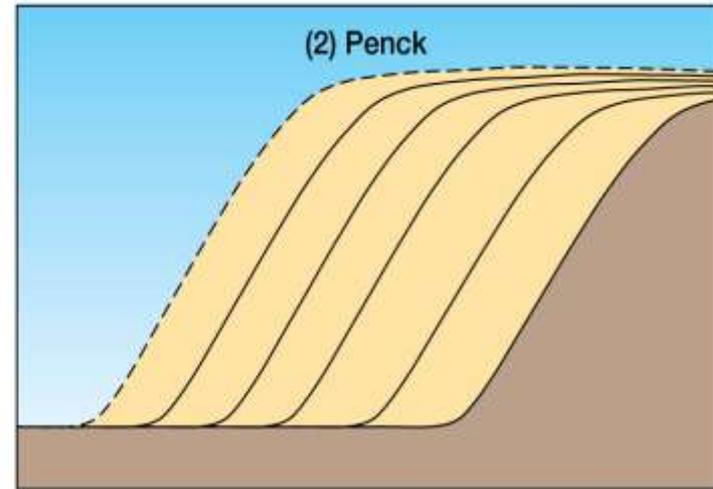
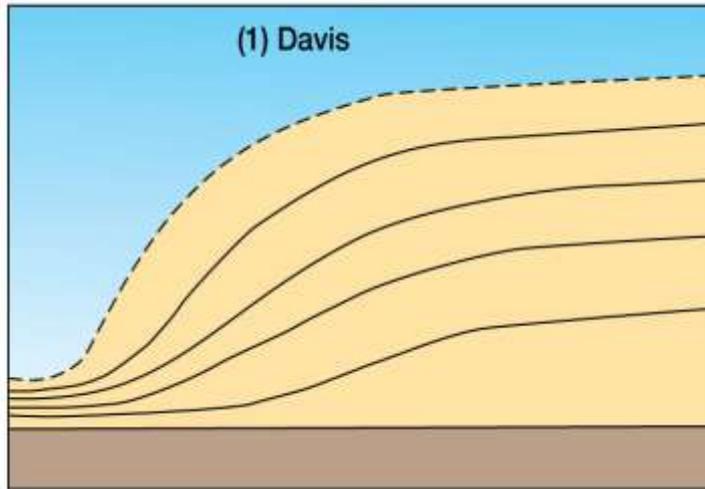
- Model
- Assumptions
- Stages
- Youth
- Maturity
- Old Age
- Rejuvenation



(d) Rejuvenation



- Criticisms of Davis' Geomorphic Cycle
  - No evidence of large peneplains
  - Ignored erosion during initial uplift
  - No clear evidence of sequential stages
- Penck's Theory of Crustal Change and Slope Development
  - Slopes form dependent on rate of tectonic uplift.
    - Davis's cycle – slopes always convex
  - Slopes maintain their angles during uplift – wear back, 'parallel retreat.'
    - Davis' cycle – slope angles decrease or wear down

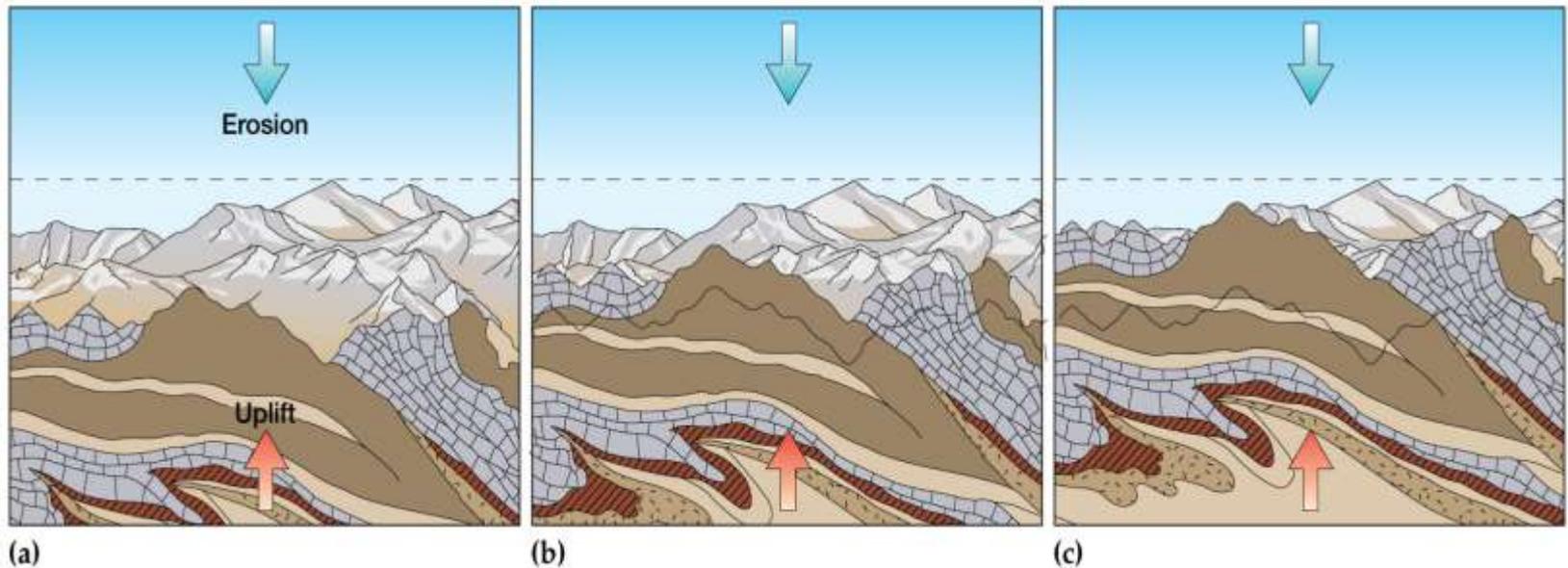


- **Equilibrium Theory**

- Slope form depends on balance between rate of tectonic uplift and energy of the erosion agent.



- The landscape (general pattern of slopes) is an expression of dynamic equilibrium between uplift and erosion.



Swiss Alps. Erosion reduces the land at the same rate tectonic uplift raises the land. Thus, the elevation of the land remains the same. The general topography remains approximately the same also.



## ❖ Summary

- Land surfaces consist of valleys and interfluves. Stream flow erodes valleys and overland flow erodes interfluves.
- Stream channels change rapidly due to scouring and filling, so their channels are seldom straight.
- The principal channel patterns are sinuous, meandering and braided.



- Stream systems form conspicuous drainage patterns in the landscape. They are usually a response to geologic structure. The five common drainage patterns are dendritic, trellis, radial, centripetal and annular.
- Stream systems develop into drainage basins, which consist of interfluvial areas and sub-basins and their tributary streams.
- The branching components of a stream and its tributaries can be classified into a series of stream orders.



- The location and pattern of a stream is often influenced by the underlying geologic structure.
- Over time, a stream deepens, widens and lengthens its valley. The stream deepens its valley by downward erosion, widens it by lateral erosion and lengthens it by headward erosion.
- Stream deposition takes place wherever a stream's speed is inadequate to transport its load.



- The most prominent depositional landscape is the floodplain, which has meandering stream channels and related landforms, such as cut-off meanders, oxbow lakes and meander scars.
- Three theories of terrain evolution are the geomorphic cycle, theory of crustal change and slope development, and equilibrium theory.