

# GEOMORPHOLOGY



**2013 : GEOM 201**

## **LECTURE 5 A**

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# • Course Outline



- Introduction & Overview **L1**
- Structure of the Earth **L2 & L3**
- Systems in Geomorphology **L4**
- **Fluvial Geomorphology L5- L7**
- Landforms **L8**
- Aeolian Geomorphology
- Coastal Geomorphology
- Glacial Geomorphology
- History & Development of Geomorphology
- Applied Geomorphology

# Systems approach in Geomorphology (1)



## Some definitions :

- Definition of **morphology** (*noun*)

the study of the forms of things, in particular:

- *Biology* the branch of biology that deals with the form of living organisms, and with relationships between their structures.

- *Linguistics* the study of the forms of words.

[\[http://oxforddictionaries.com/definition/english/morphology\]](http://oxforddictionaries.com/definition/english/morphology)

- Definition of **geomorphology** (*noun*)

the study of the physical features of the surface of the earth and their relation to its geological structures.

[\[http://oxforddictionaries.com/definition/english/geomorphology?q=geomorphology\]](http://oxforddictionaries.com/definition/english/geomorphology?q=geomorphology)

# Gravitational flow of Water as landform-creating cascade system

## Gravitational water flow sub-systems (land):

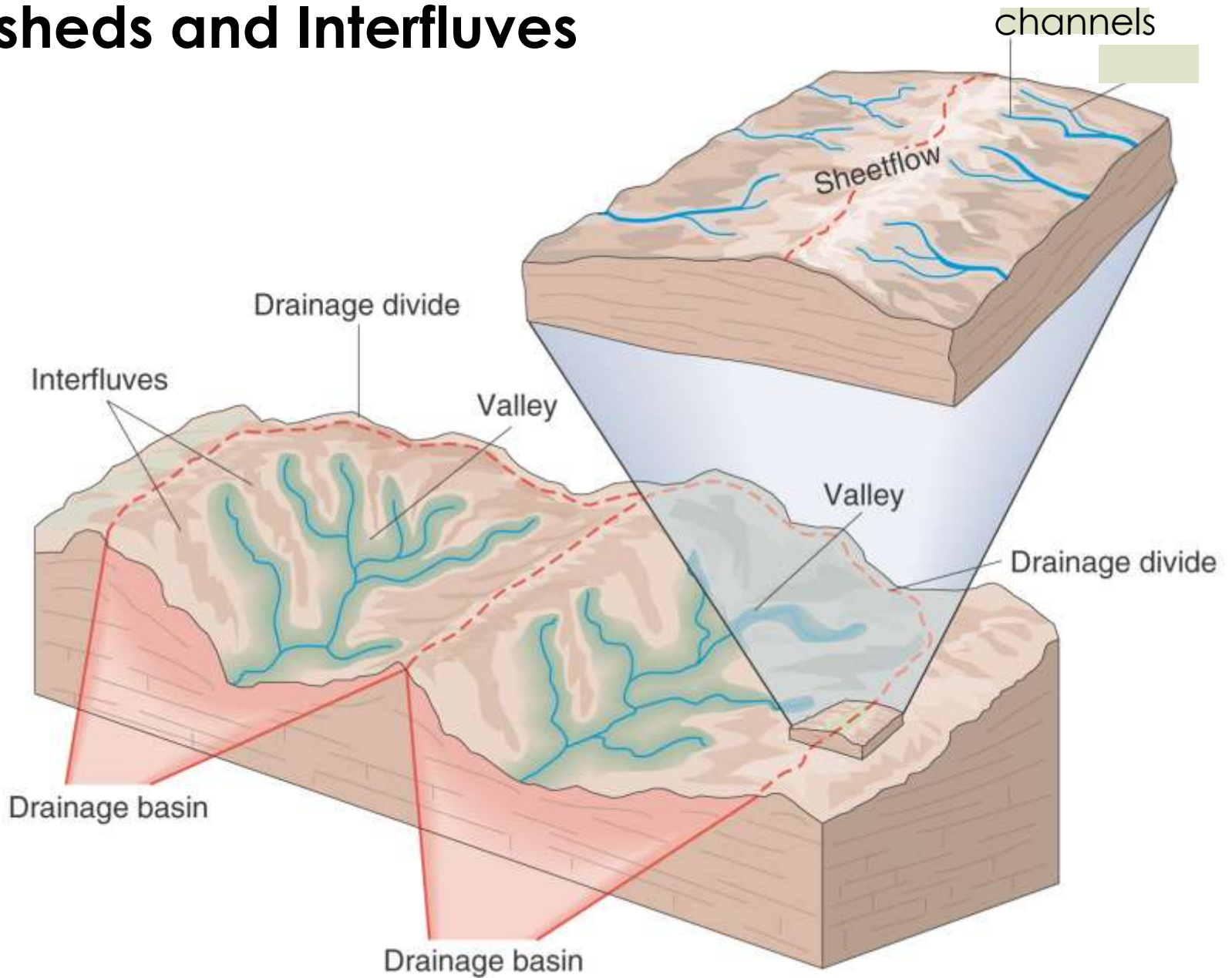
- **Groundwater**: water seeping through soil layer and stored in rock layers
- **Soil water**: water seeping through the pedosphere and held in temporary storage
- **Land surface water cascade system**:
  - This is the **main surface system** contributing to **landform formation**.
  - Surface water **cascades from one morphological subsystem** of the land surface system **to another**.
  - **In each morphological subsystem, flow is regulated** by variables (morph) like **elevation, slope, rock structure, etc.**
  - The **gravity flow of water on the land surface** system forms a **hierarchical cascade system**, linking the many morphological subsystems.

# Gravitational flow of Water as landform-creating cascade system

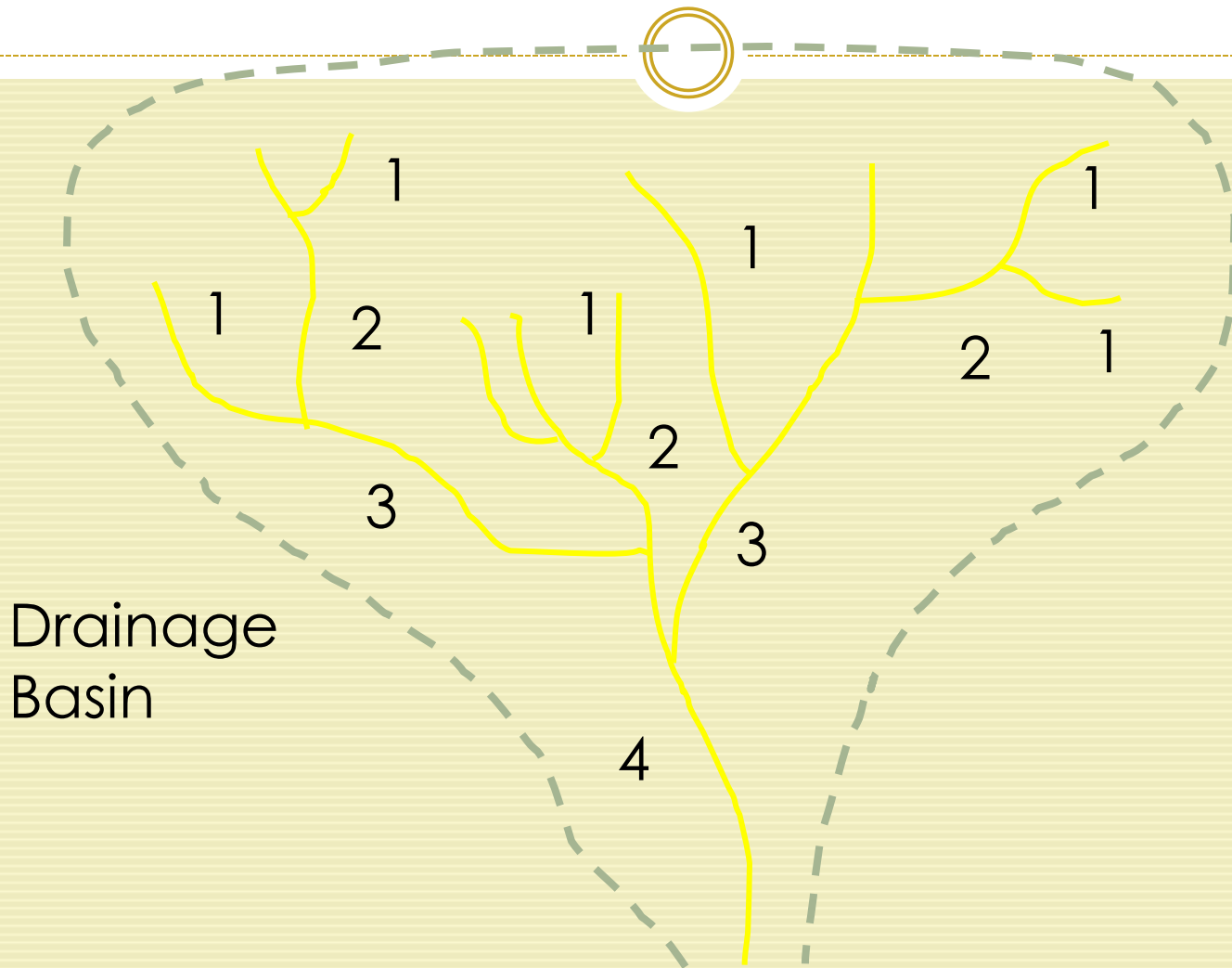
## Gravitational water flow sub-systems (land):

- **Organised in drainage systems of given hierarchy**  
(1<sup>st</sup> order stream has small catchments; 2<sup>nd</sup> order bigger, etc)
- **Watersheds** are the **boundaries between such drainage systems.**
- **A drainage system** is a clearly definable **subsystem of the land surface system, drained according to a particular pattern by a specific linked network of streams.**
- Each drainage system is an **open process-response system**

# Watersheds and Interfluves



# Stream Order



# RIVERS AND ASSOCIATED LANDFORMS



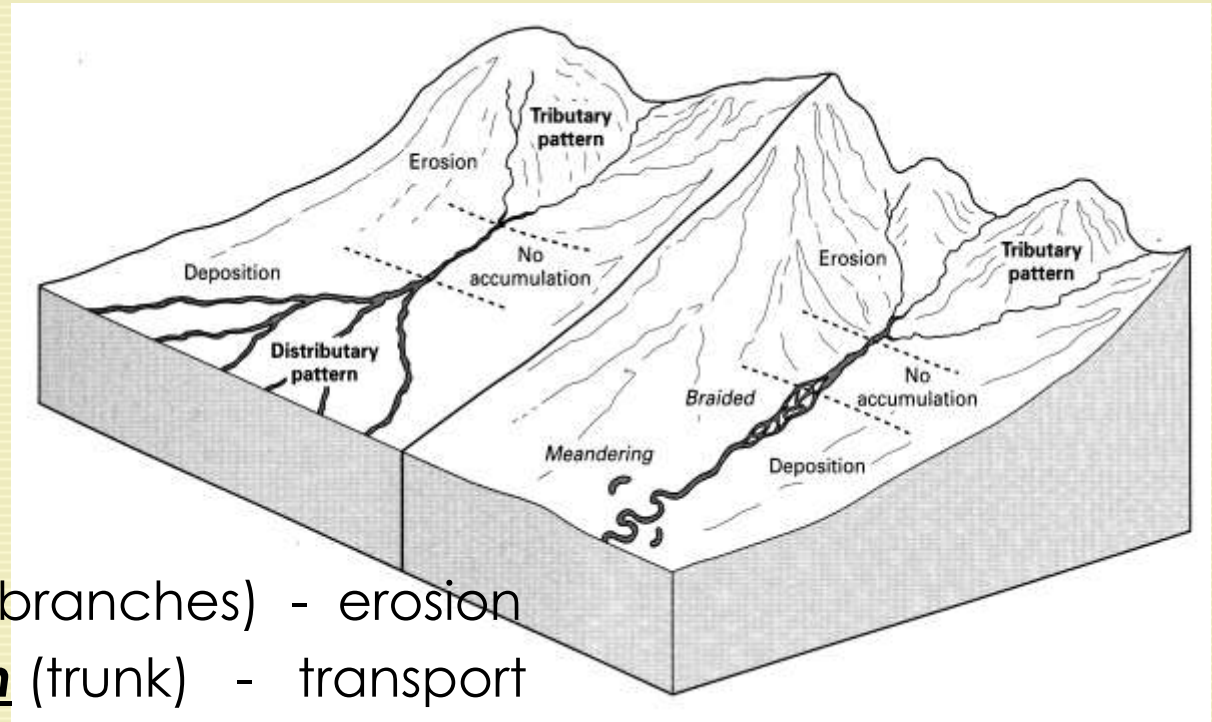
## River

- Running water is the most important agent of erosion on the continents and the stream valleys are the most common landforms.
- Rivers flowing to the oceans drain about 68 % of the Earth's land surface. The remainder of the land either is covered by ice or drains to closed basins.
- River gradually mould the land by eroding away the material in some place and depositing it in another



# RIVERS AND ASSOCIATED LANDFORMS

- A river system can be divided into three subsystems:



- **collecting system** (branches) - erosion
- **transporting system** (trunk) - transport
- **dispersing system** (roots) - deposition

# RIVERS AND ASSOCIATED LANDFORMS

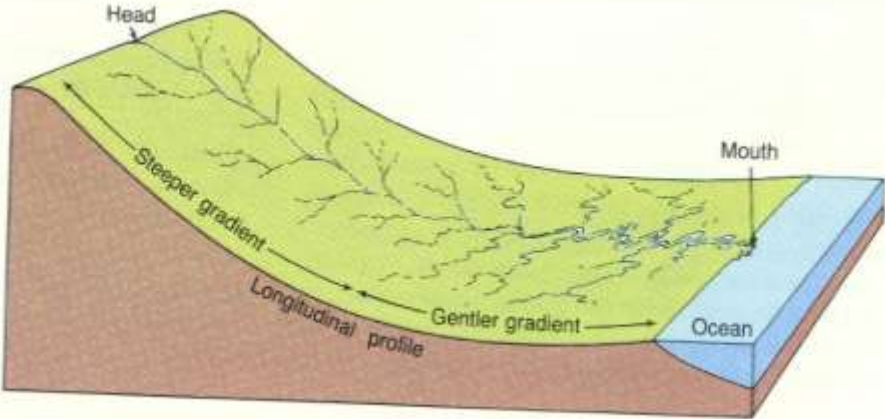
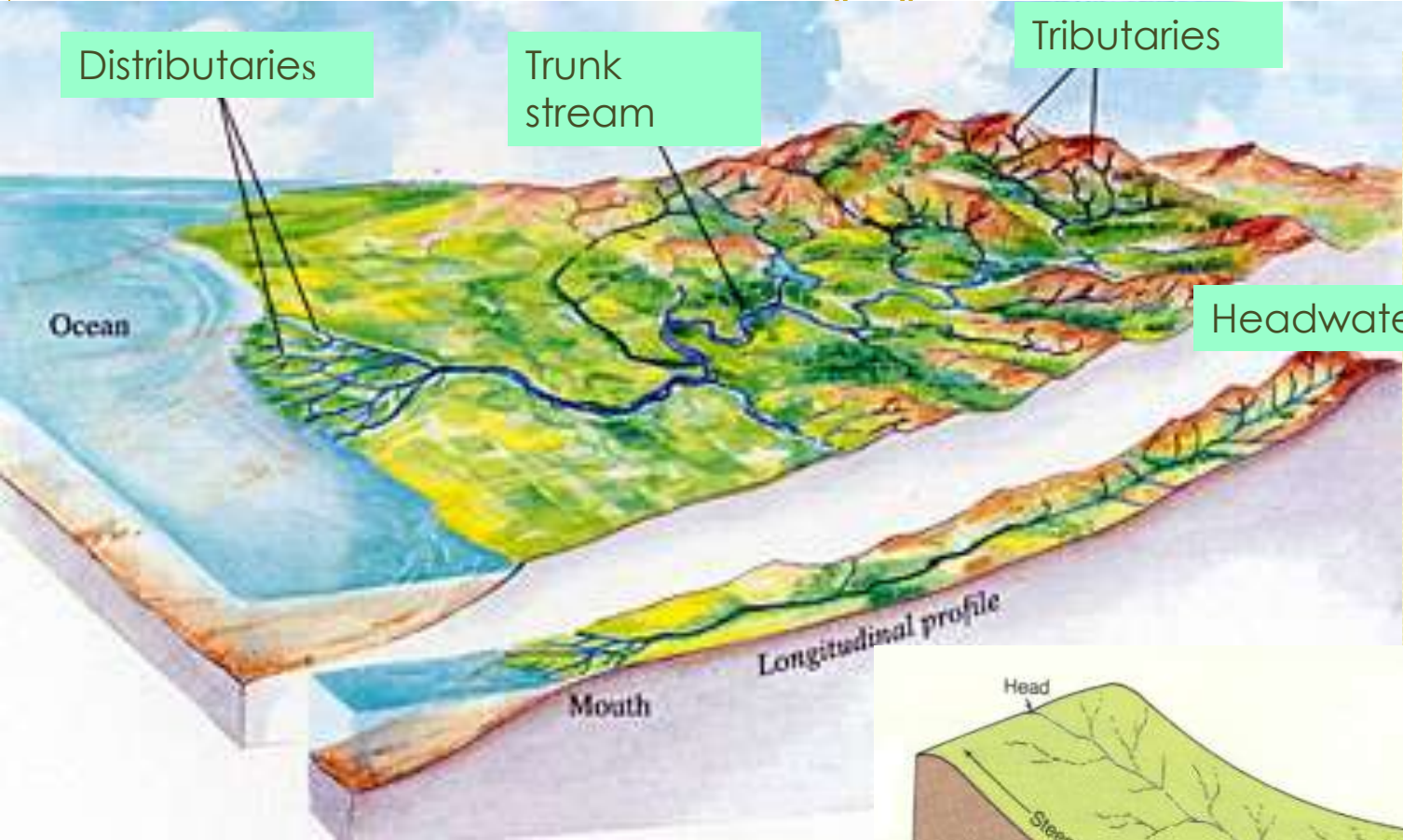
- A river system consists of a main channel (trunk stream) and all of the tributaries that flow into it or joining the trunk stream.
- **A RIVER SYSTEM CAN BE DIVIDED INTO THREE SUBSYSTEMS:**
- **collecting system** (branches) -- consisting of a network of tributaries in the headwater region, collects and funnels water and sediment to the main stream. Predominance of erosional processes.
- **transporting system** (trunk) -- the main trunk stream, which functions as a channelway through which water and sediment move from the collecting area toward the ocean. (Erosion and deposition also occur in a river's transporting system)
- **dispersing system** (roots) -- consists of a network of distributaries at the mouth of a river (delta), where sediment and water are dispersed into an ocean, a lake, or a dry basin. Depositional processes dominant.

# Parts of a River



- **tributary** : a stream flowing into or joining a larger stream; any smaller streams that feed larger streams within a drainage basin.
- **distributary** : numerous stream branches into which a river divides where it reaches its delta
- **upstream** : moves toward headwater (up the regional slope of erosion)
- **downstream** : moves toward mouth of river (delta)
- **Delta** : a large, roughly triangular body of sediment deposited at the mouth of a river
- **Meander** : a broad, looping bend in a river
- **Braided** : river is divided into multiple channels by alluvial islands. Braided rivers tend to have steeper gradients

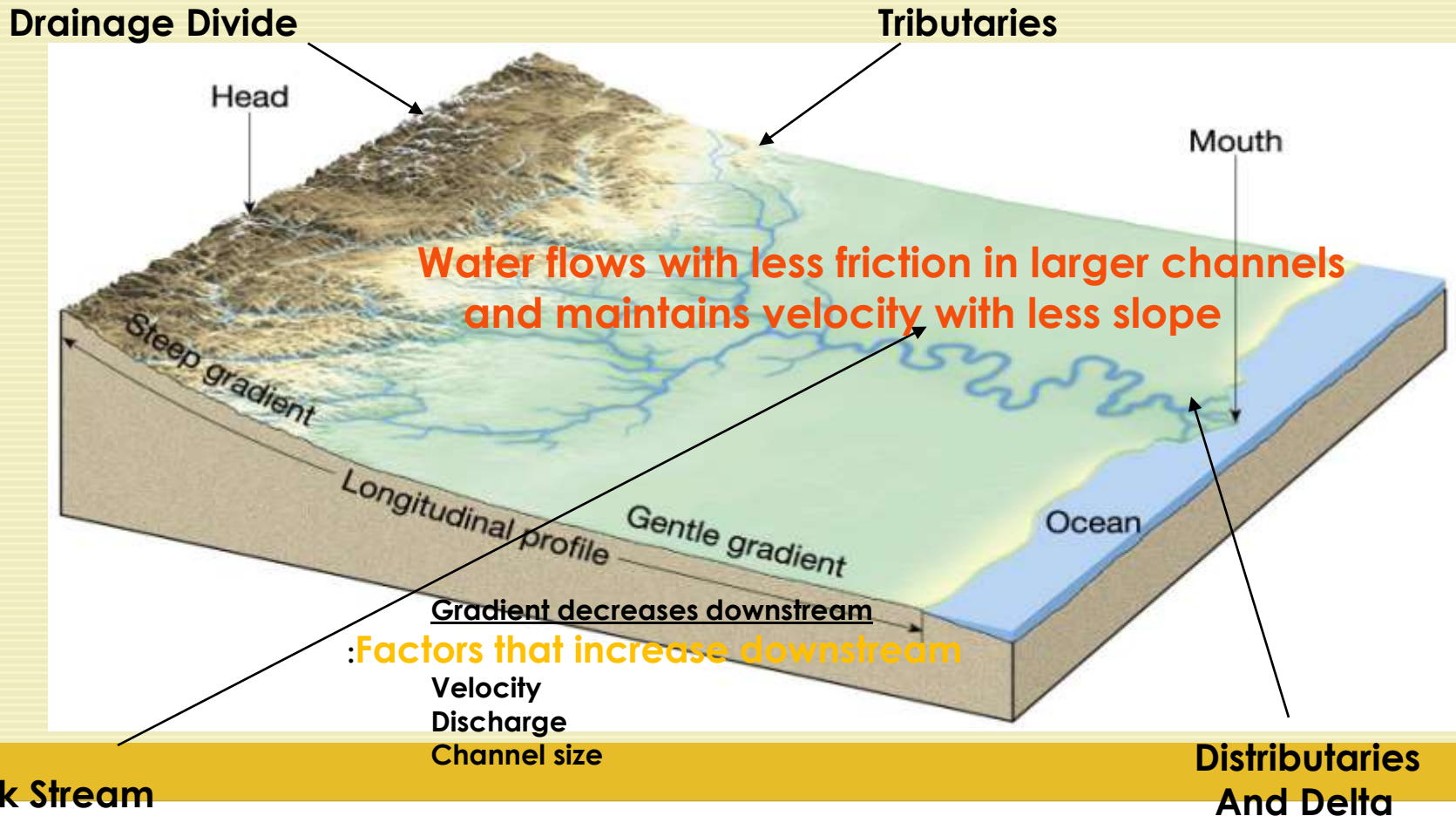
# Longitudinal profile



# Longitudinal Profile



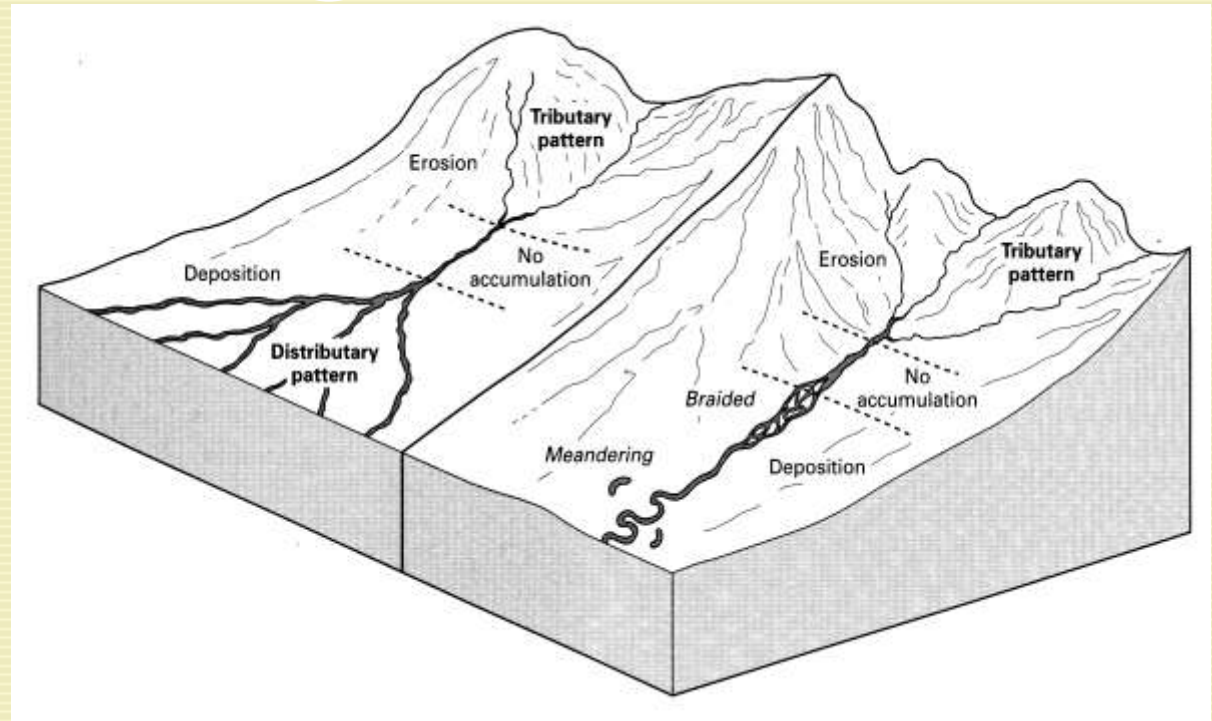
*"As mean discharge of a river increases downstream, channel width, channel depth, and mean current velocity all increase."*



# River definitions



- Braided stream
- Meandering stream
- Longitudinal profile
- Delta
- Accumulation
- Deposition
- Base level
- Knickpoint
- Waterfall
- Rapids
- Runs
- Rills
- Backwaters
- Drainage pattern
- Stream order

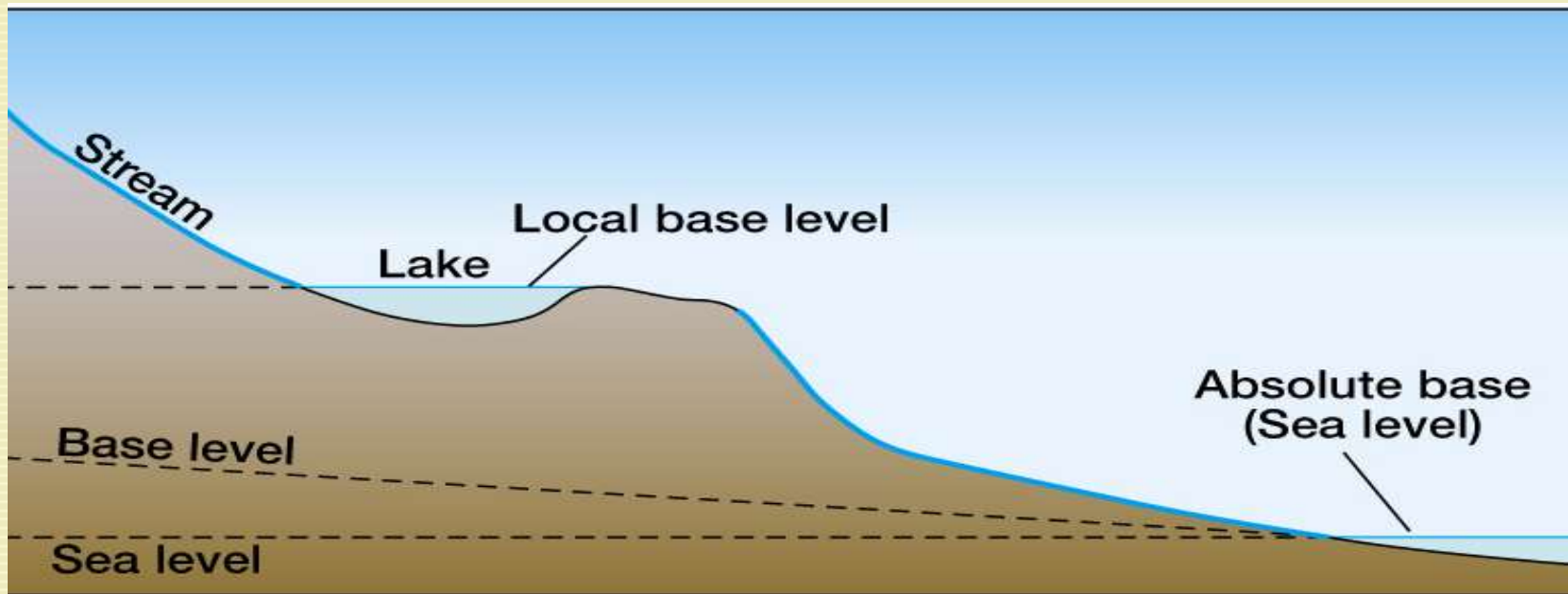


# Base Level: Local vs Absolute



Definition: **Base Level :**

*The level below which a river or stream cannot incise.*



The limiting level below which a stream cannot erode the land is called the **base level** of the stream.

***The ultimate (or absolute) base level for most streams is global sea level.***

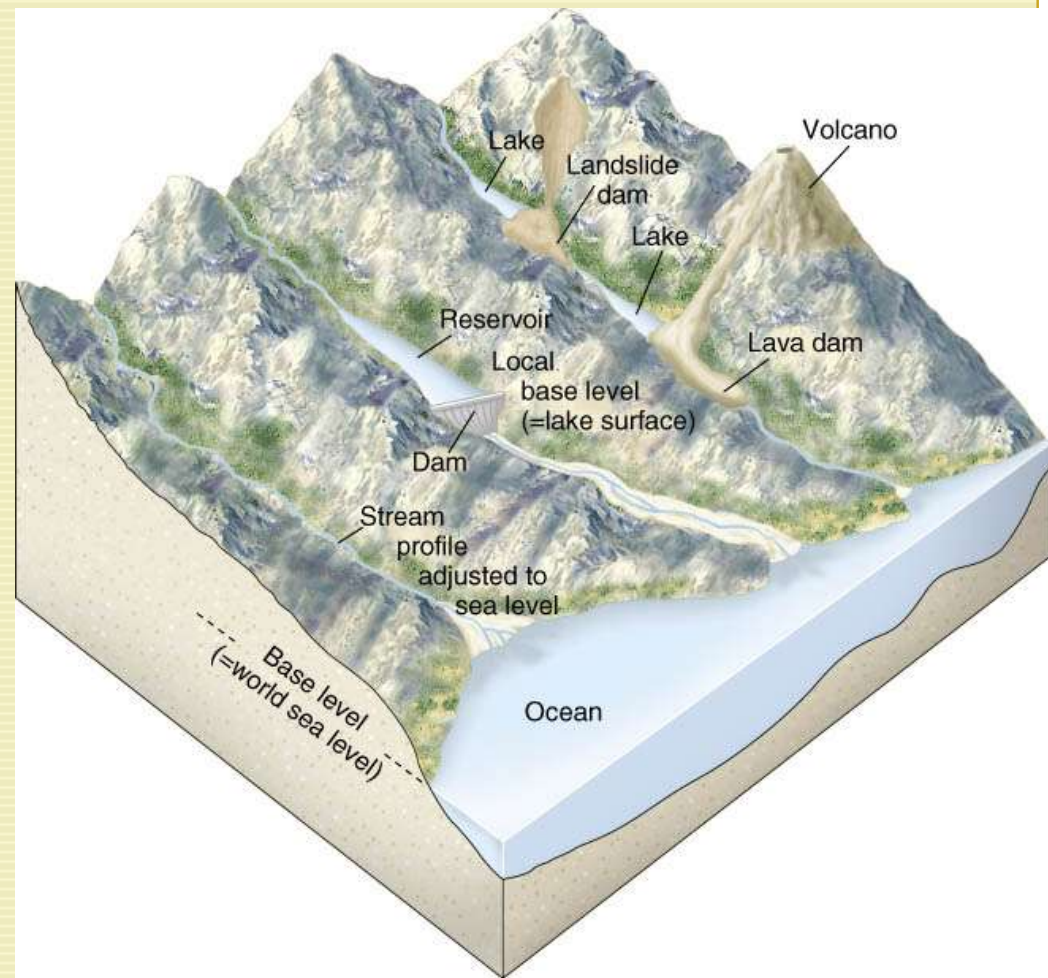
# Base Level



Exceptions are streams that drain into closed interior basins having no outlet to the sea.

Where the floor of a tectonically formed basin lies below sea level (for example, Death Valley, California), the base level coincides with the basin floor.

When a stream flows into a lake, the surface of the lake acts as a local base level.



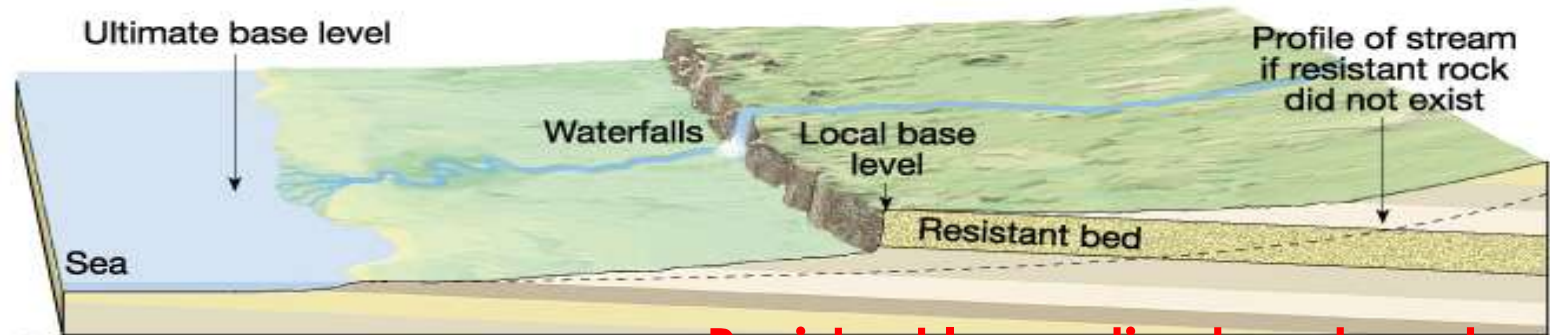


# Ultimate Base Level Control



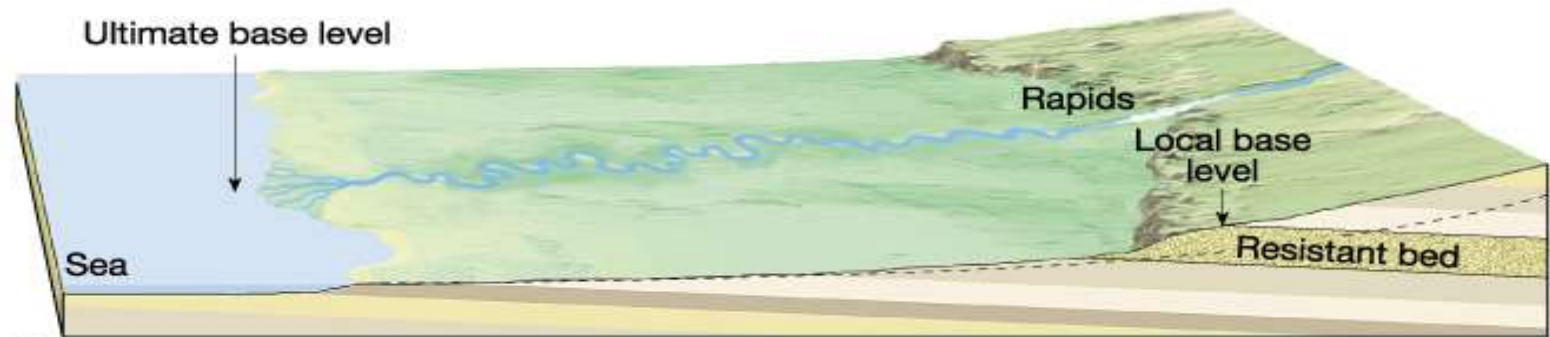
- At **sea level**, no further conversion of potential energy to stream work is possible.
- Sea level **lowered at least 100 m** during peaks of **glaciation**. Headwaters were higher, stream water had more potential energy, faster streams cut deep canyons
- **All rivers now enter the sea via estuaries (drowned lower valleys) or deltas (sediment filling lower valleys).**

# Local change in base level affects river profiles: knickpoints

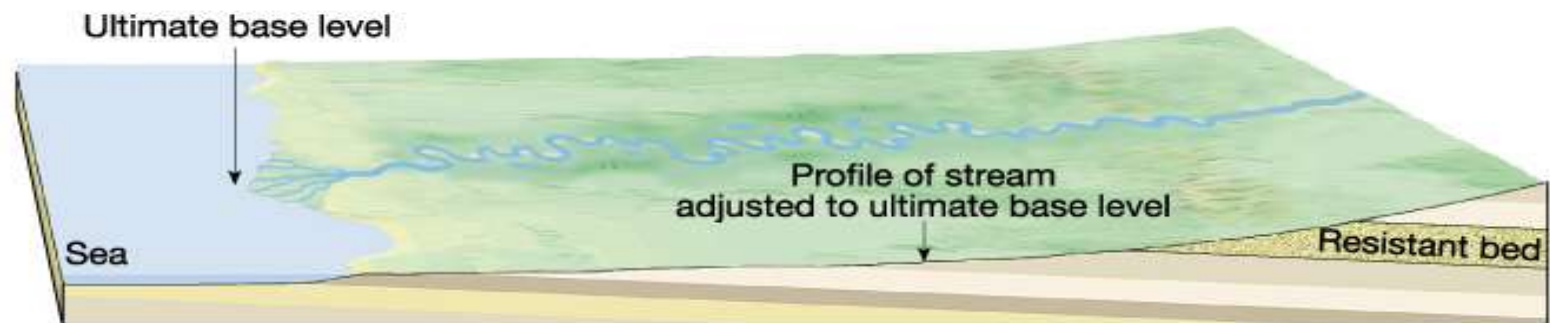


A.

**Resistant layer dips headward**



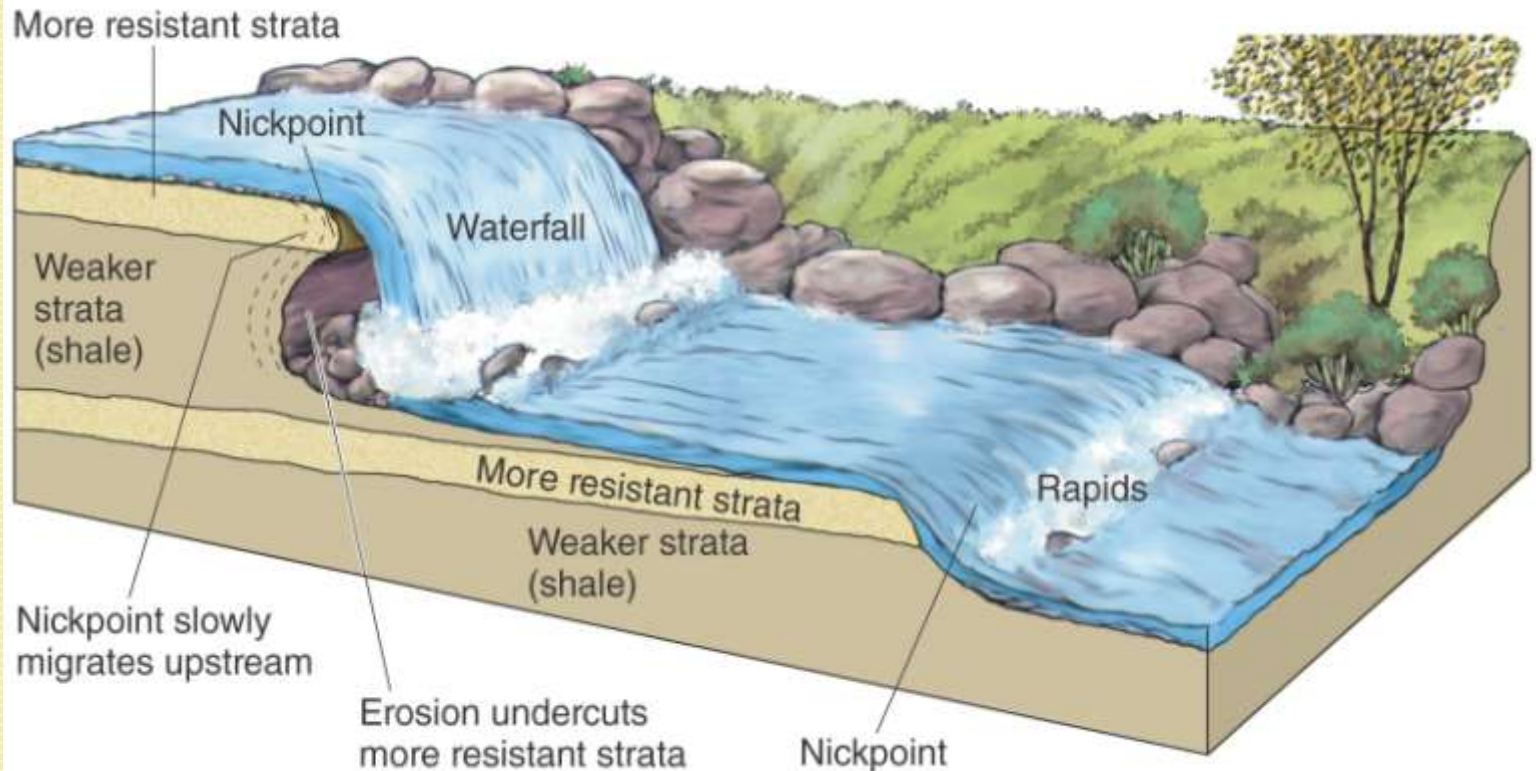
B.



C.

# Knickpoint

A location in a river where there is a sharp change in channel slope, such as at a waterfall or lake, resulting from differential erosion above and below the **knickpoint**.



# Waterfalls

Occur where barriers to down-cutting exist.  
Usually only last as long as the barrier exists.

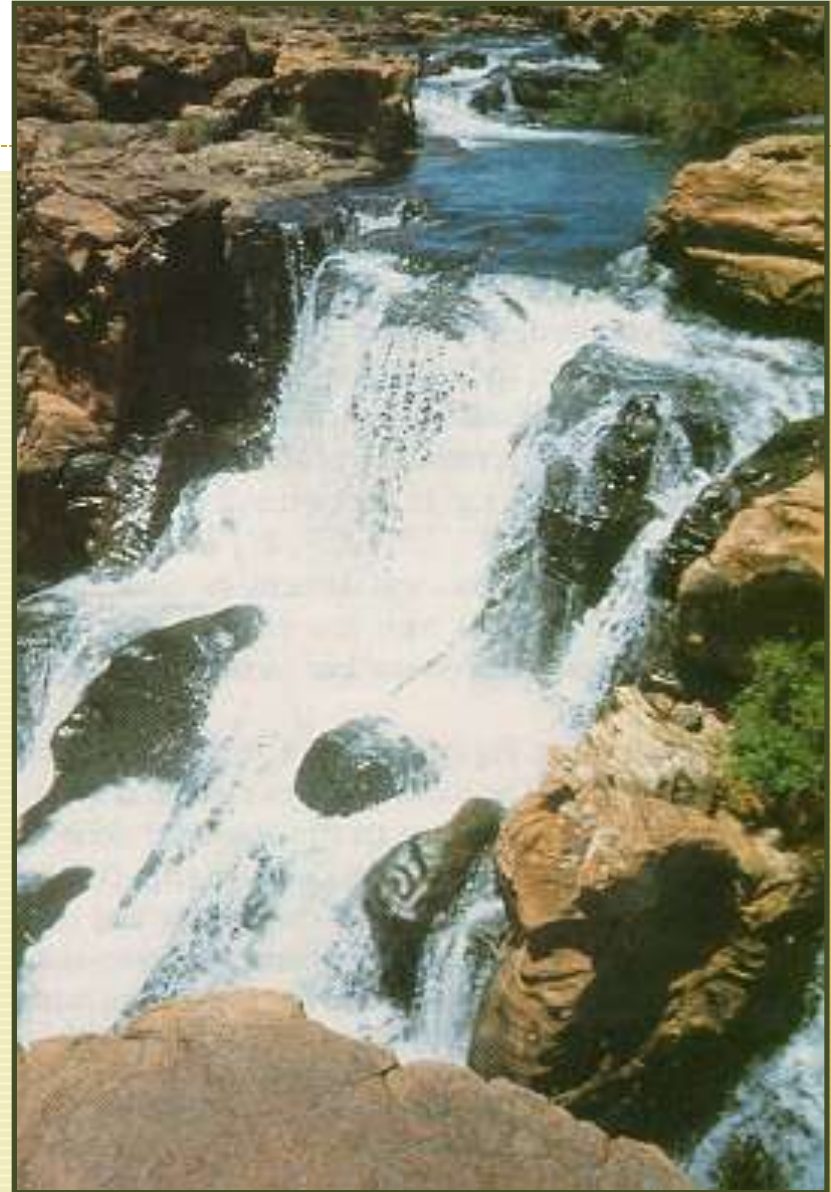


NIAGARA FALLS

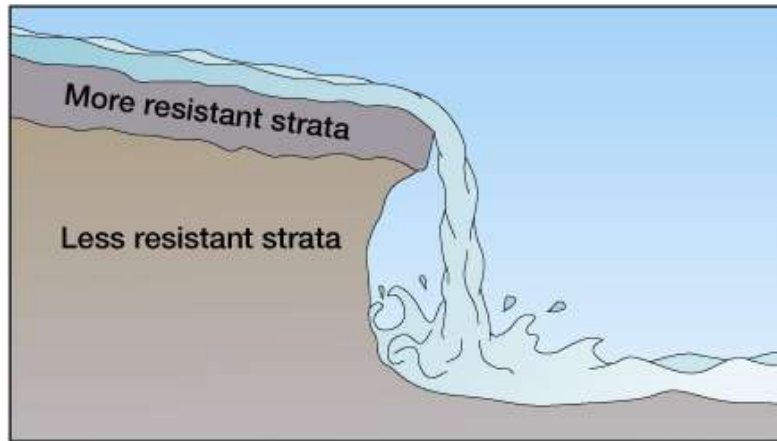
# Knickpoints

Knickpoints are often associated with **lithological contrasts** such as from layers of hard and soft rock.

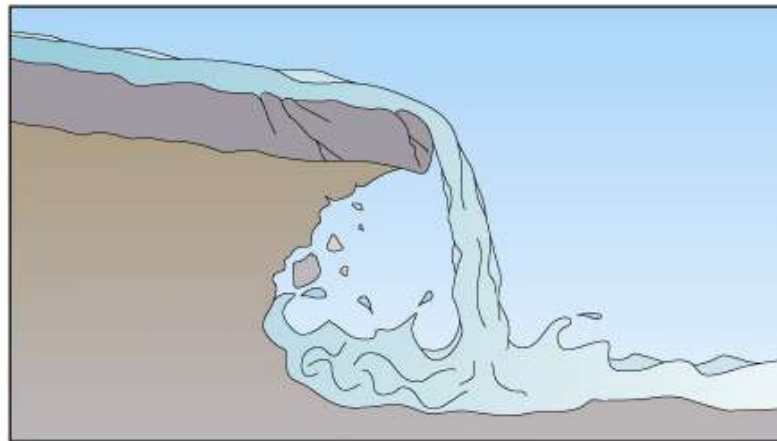
**Waterfalls often occur where barriers to down-cutting exist.** Usually only last as long as the barrier exists.



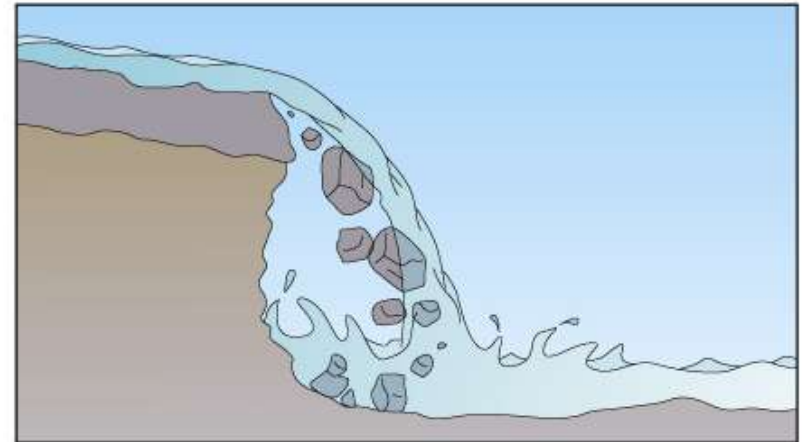
# Knickpoint Migration



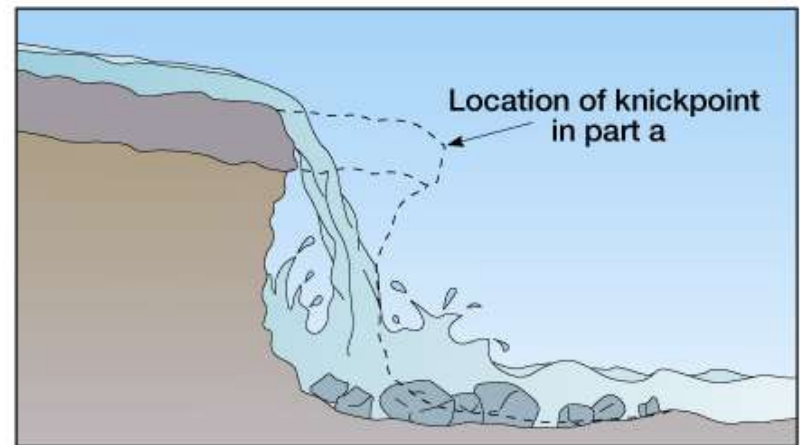
(a)



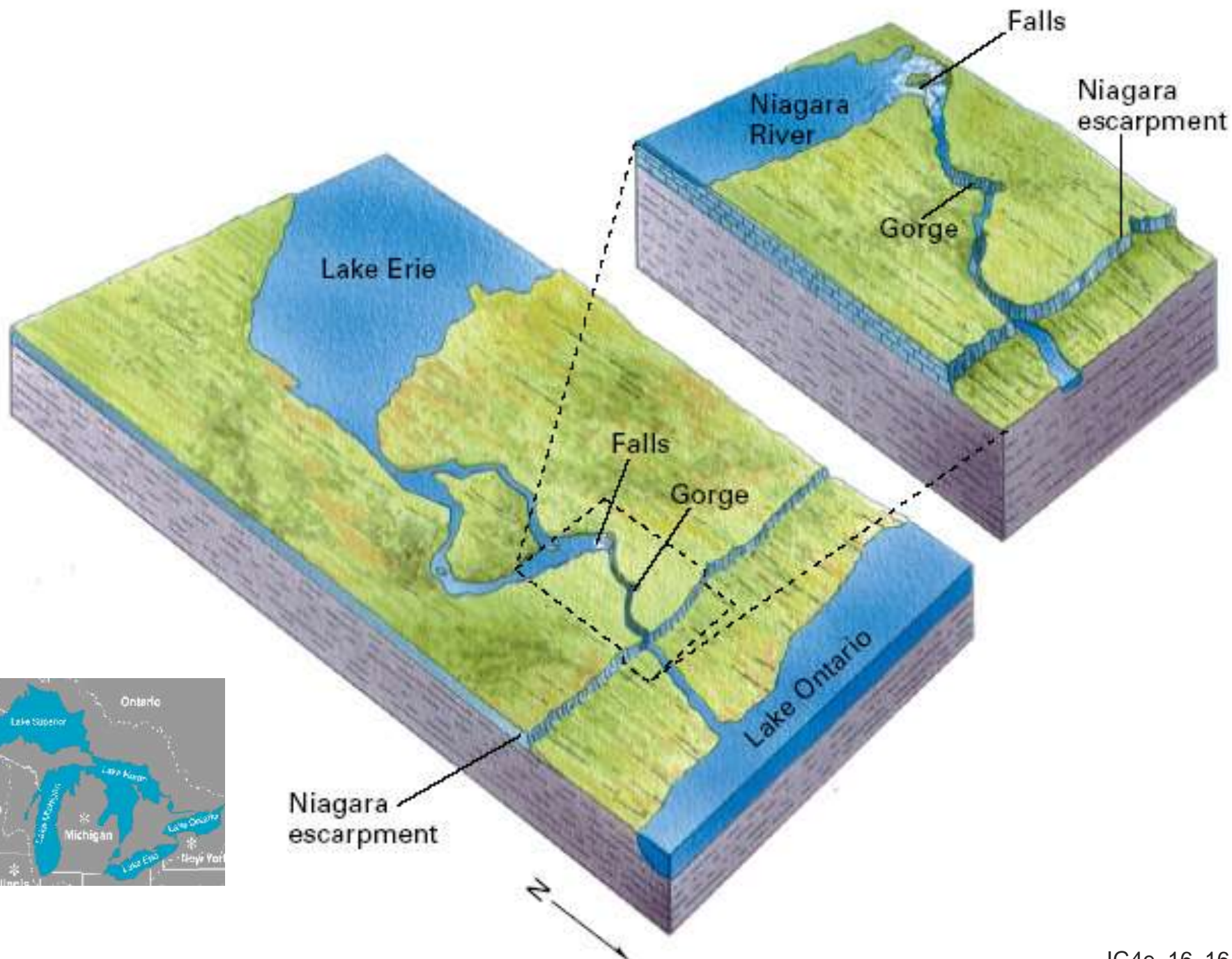
(b)



(c)

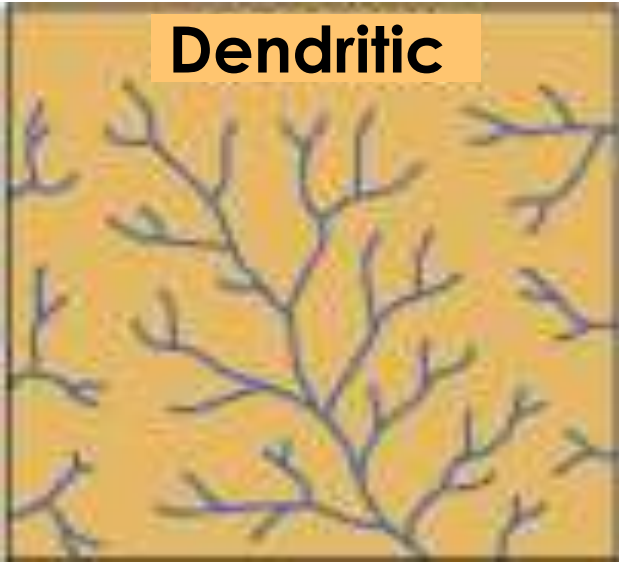


(d)



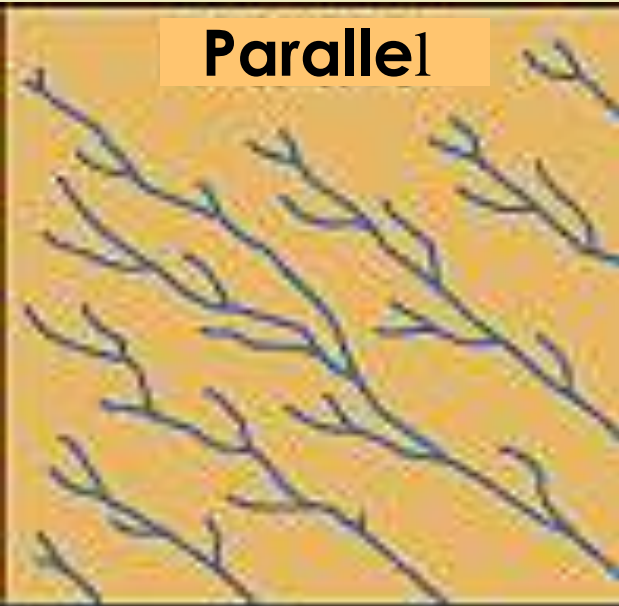
# Drainage Pattern

## Dendritic



- Irregular branching pattern (tree like) in many direction.
- It is common in massive rocks and in flat lying strata
- Due to strong resistance of rocks headward development of valley is negligible.

## Parallel

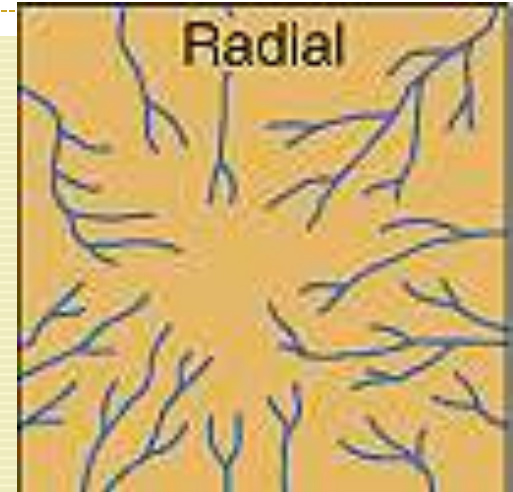


- Parallel or sub-parallel drainage formed on sloping surface.
- Common in terrain with homogeneous rocks.
- Development of parallel rills, gullies or narrow channels are commonly seen on gently sloping surface

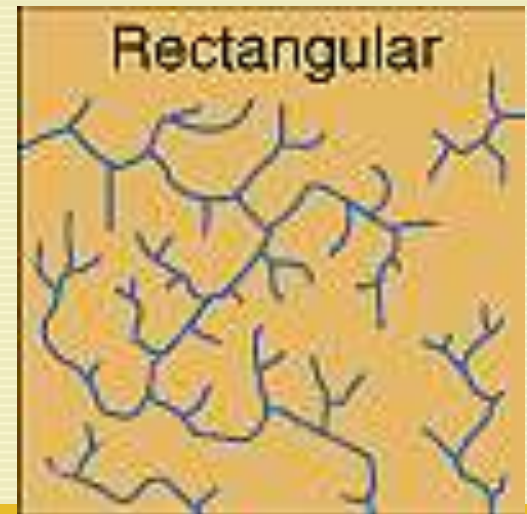


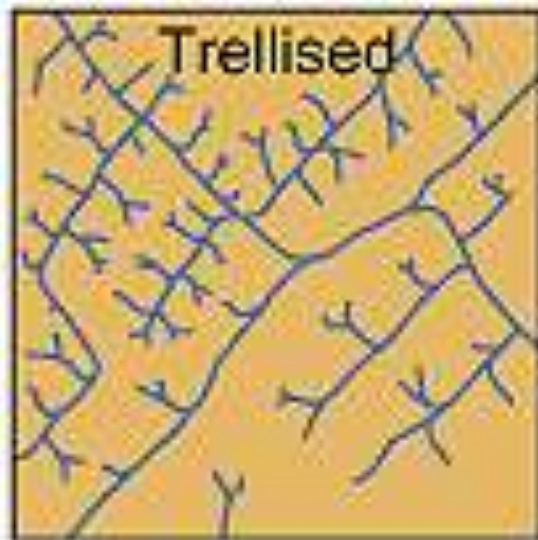


- Streams radiates out from the center of the topographic high
- common in Volcanic terrain

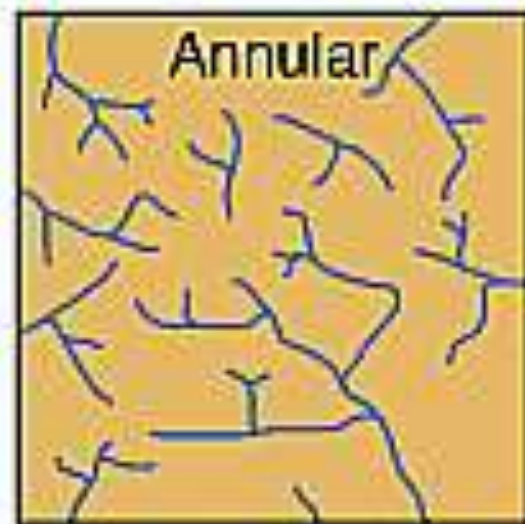


- Channels marked by right-angle bends
- Commonly due to presence of joints and fractures in the massive rocks or foliation in metamorphic rocks

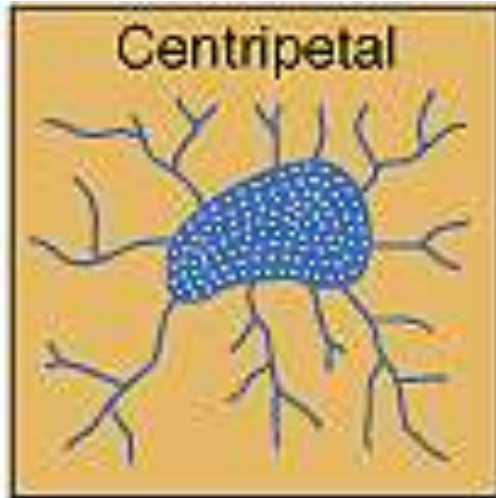




*Rectangular arrangement of channels in which principal tributary streams are parallel and very long, like vines trained on a trellis. This pattern is common in areas where the outcropping edges of folded sedimentary rocks, both weak and resistant, form long, nearly parallel belts.*



*Streams follow nearly circular or concentric paths along belts of weak rock that ring a dissected dome or basin where erosion has exposed successive belts of rock of varying degrees of erodibility.*



*Streams converge toward a central depression, such as a volcanic crater or caldera, a structural basin, a breached dome, or a basin created by dissolution of carbonate rock.*

# Strahler Stream order



- A method of classifying or ordering the hierarchy of natural channels.
- Stream order correlates well with drainage area, but is also regionally controlled by topography & geology.
- Stream order helps to conceptually organize the streams in a watershed / catchment
- As streams increase in order, they also increase in length, exponentially.
- World-wide, about 70-75% of stream kilometres occur as headwater (first order) streams.

