

Sedimentary Unit Notes

Part 2

#5 - Sedimentary Structures:

Sedimentary structures are features in the sediment as it accumulated or after it accumulated.

PRIMARY

SECONDARY

You will be responsible for knowing the **SEDIMENTARY STRUCTURES** shown on Page # 169-170 (Figure 6.12) of your LAB MANUAL
They Include....

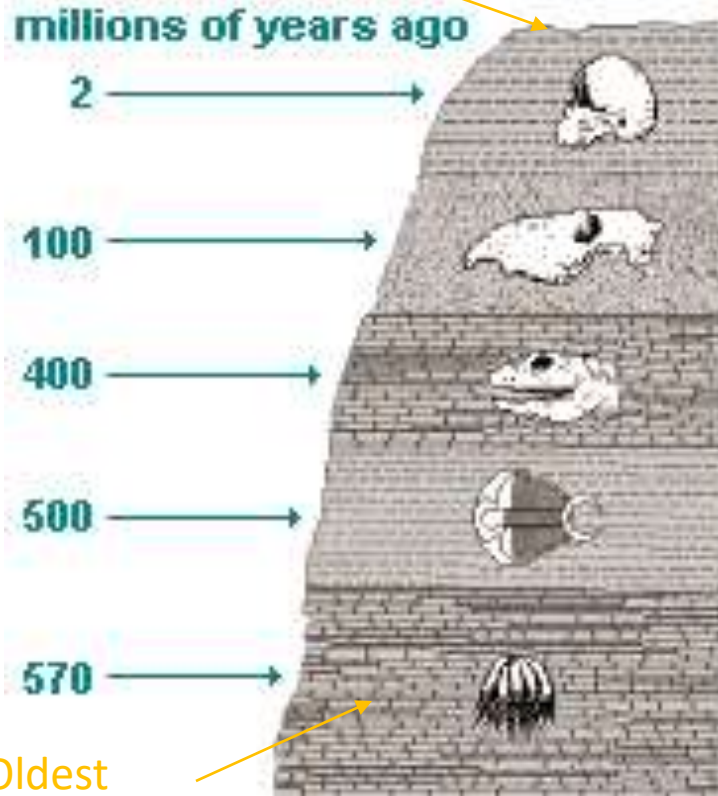
1. Strata/Stratification
2. Bedding/Lamination
3. Varves **PRIMARY**
4. Graded Bedding
5. Cross Bedding
6. Ripple Marks
7. Mud cracks
8. Flutes / Flute Casts **SECONDARY**
9. Raindrop Impressions
10. Various Plant/Animal Structures

Strata / Stratification

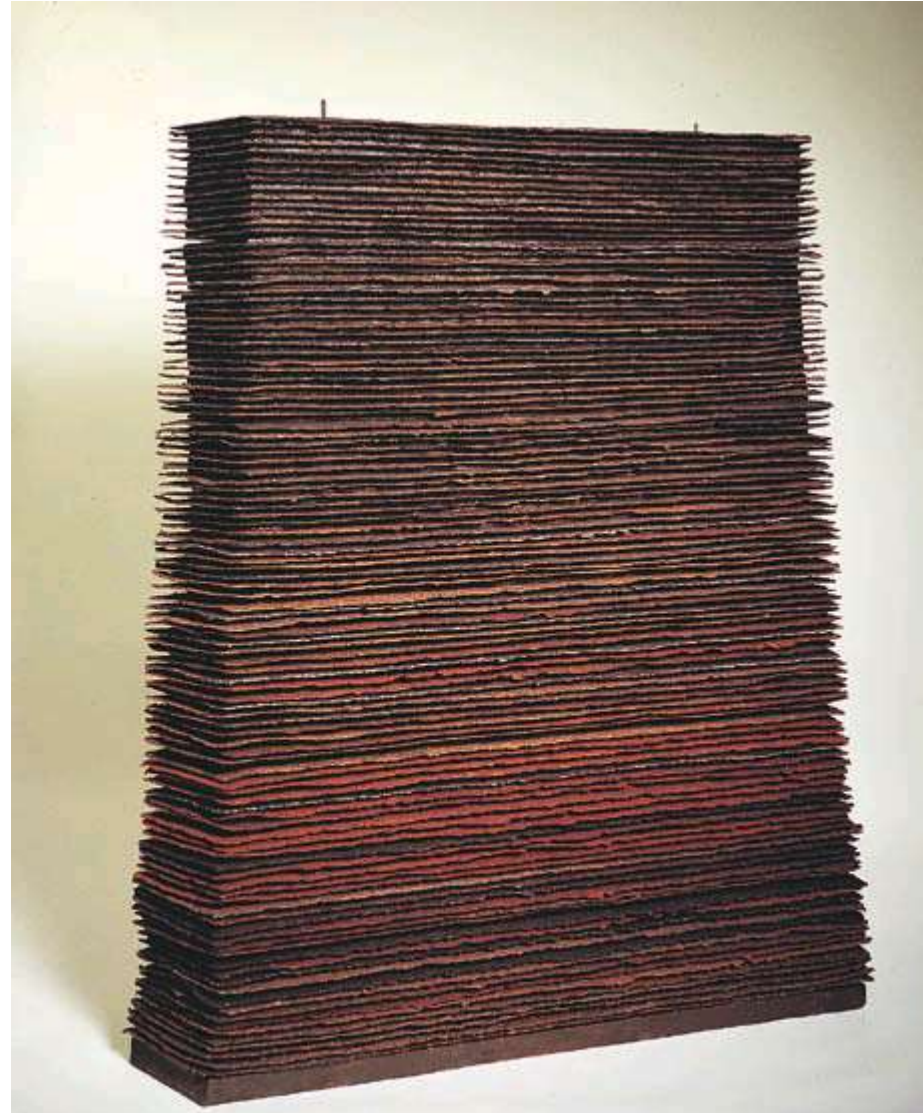
- Strata are essentially individual layers of rock.
- Each strata has individual characteristics which distinguish it from the strata above and below.
- Laid down successively over time...the deeper they are...the older they are...we call this the **“Law of Super Position”**
- Strata are always laid down flat or horizontal...we call this the **“Law of Original Horizontality”**

Getting older as we get deeper!

Youngest



Each Strata is distinct from the ones above and below!

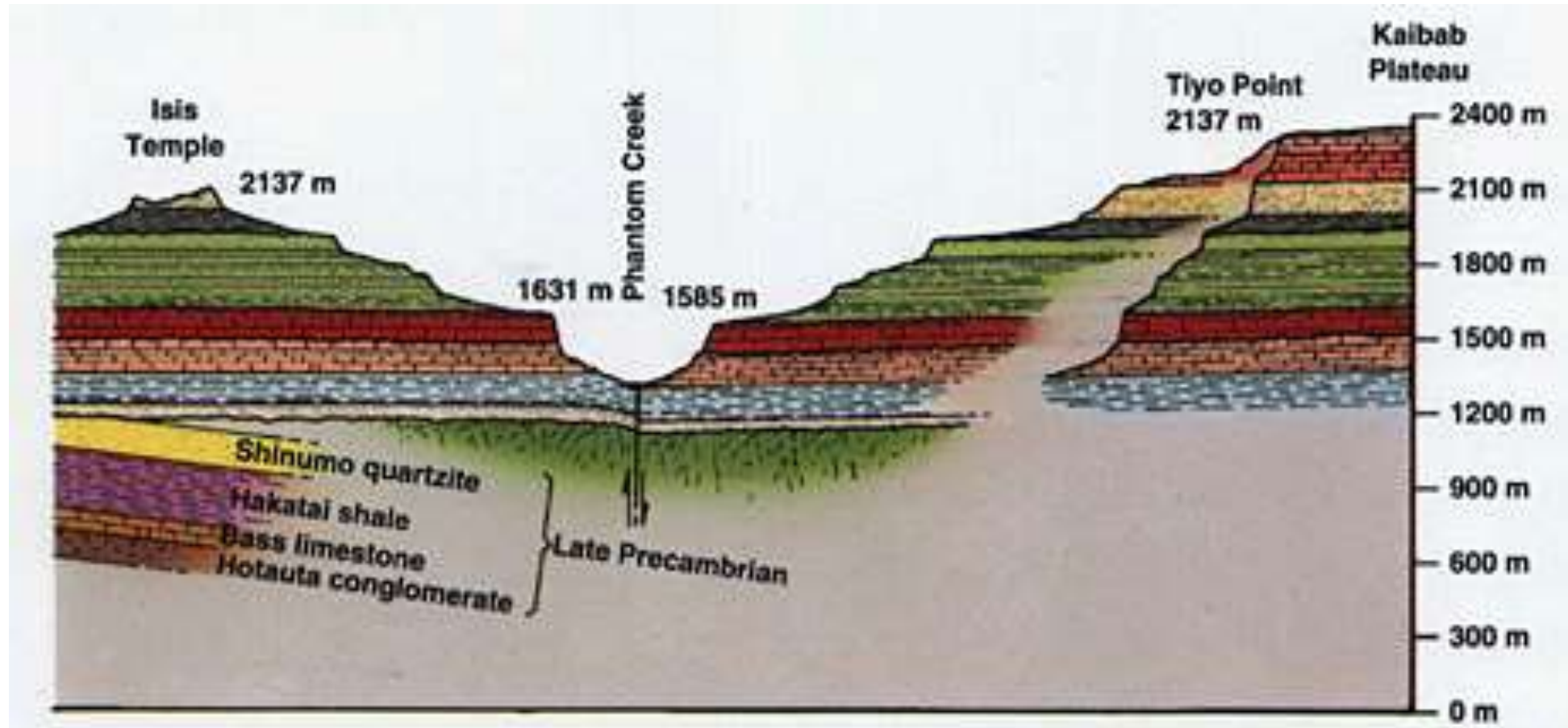


Laid down horizontal at first!

Strata are exposed at “OUTCROPS”

Outcrops form anywhere there is a cut down into the Earth such as:

-River Erosion (*below*), Road Cuts, Glacial Erosion, Etc...

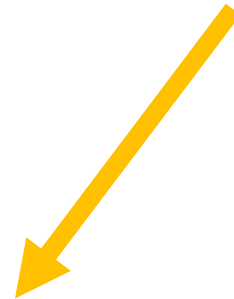




Depositional layering of sedimentary rocks (>1cm)



Bedding / Lamination:



very fine or thin layers or beds of material deposited (<1cm)

one **STRATA** can contain many **laminations**



Bedding plane

Beds



Laminations
<1cm





**Keele
University**

**Geologist's
birthday
cake**



Varves:

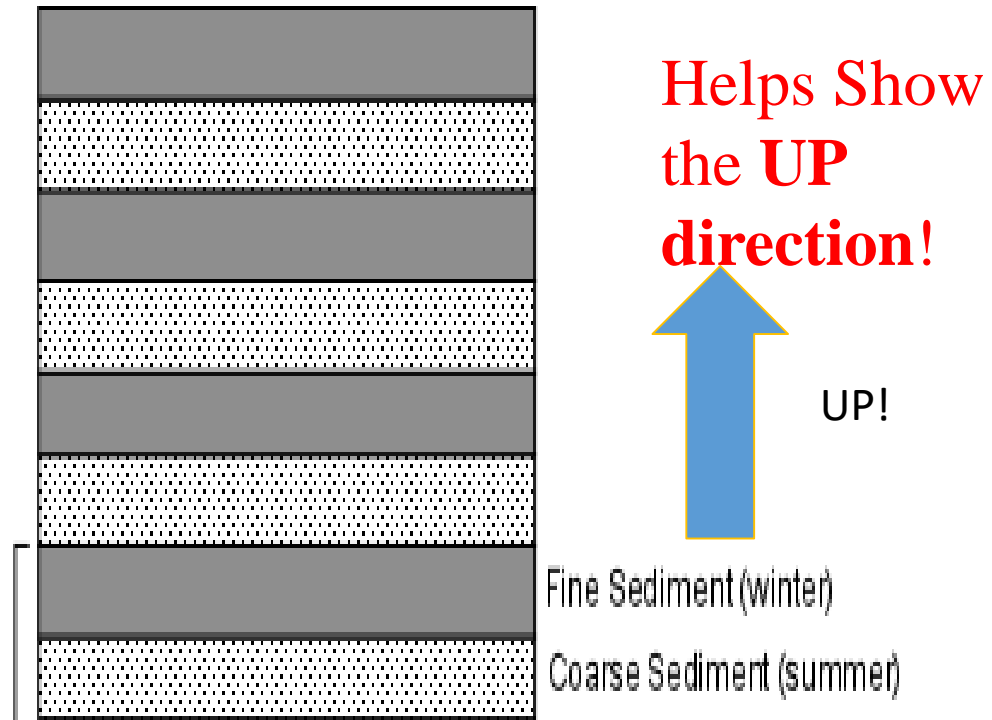
Varves:

Alternating parallel layers having different properties ranging from **coarse** at the bottom to **fine** at the top.

Similar to Graded Bedding BUT Sediments are **MUCH FINER** on the whole!

Also **specifically** caused by **Seasonal Changes** in deposition on **Glacial Lake Bottoms**

One Varve =  **Varve**
One Year's Deposition



One Year!



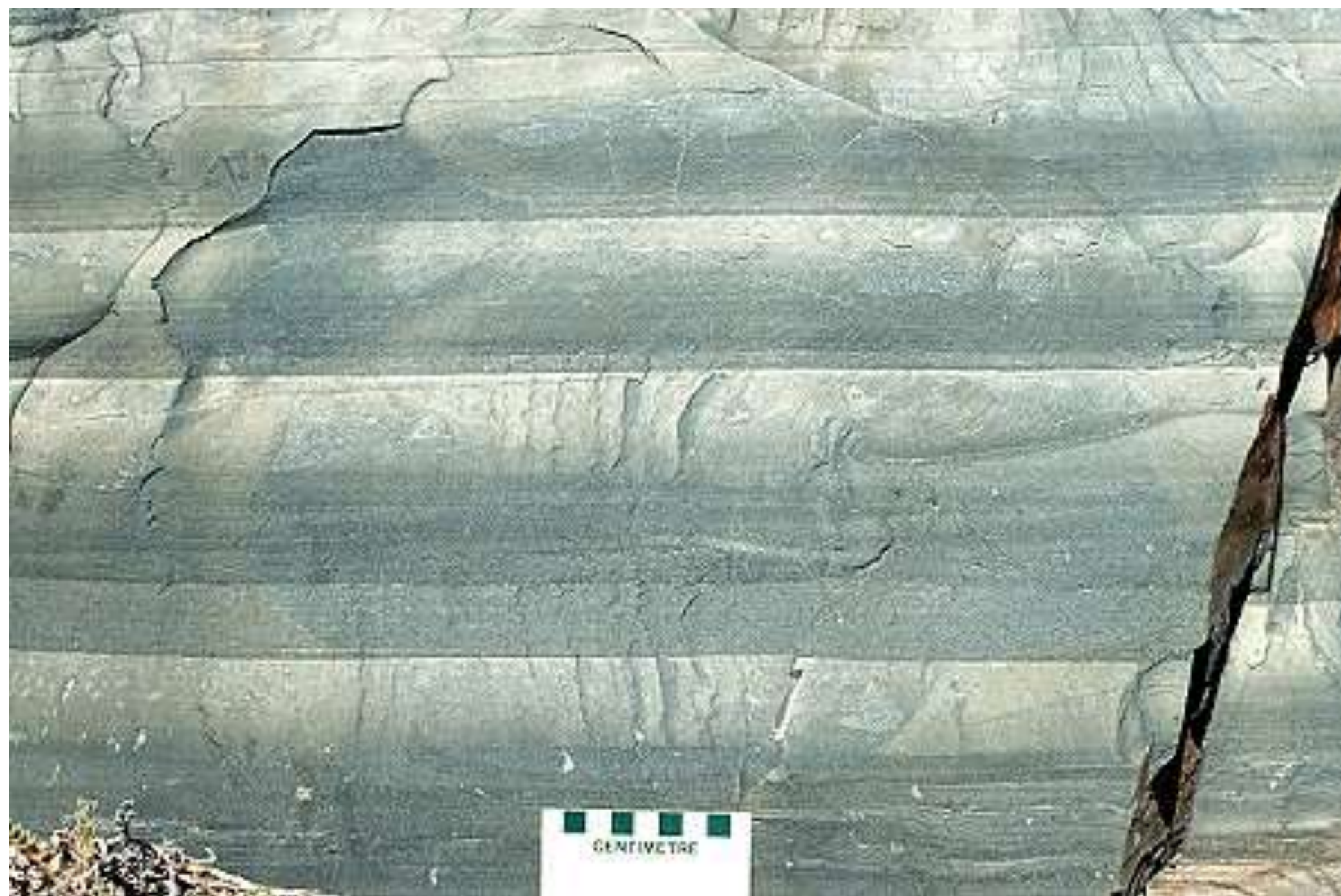
One Year of
Deposition on
Glacial Lake
Bottom





One Hundred
Years of Lake
Bottom
Deposition!

Graded Bedding:



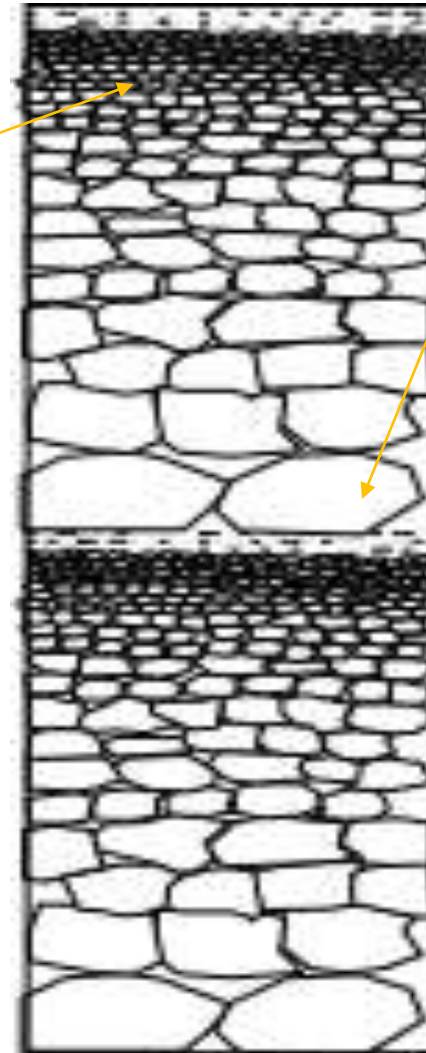
Graded Bedding -

As **current velocity decreases**, first the larger or more dense particles are deposited.

Followed by smaller or less dense particles.

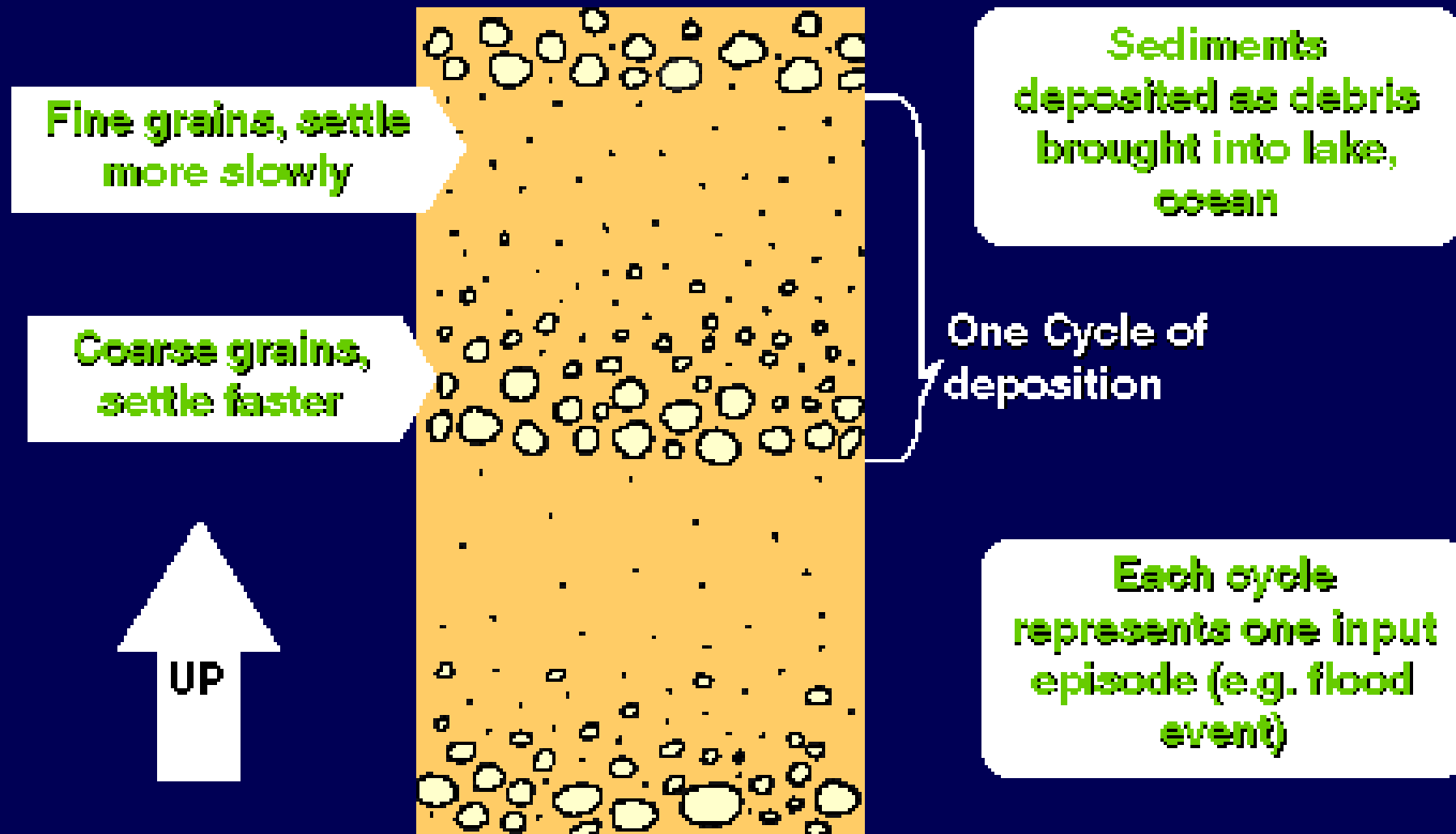
This results in bedding showing a **decrease in grain size from the bottom of the bed to the top of the bed.**

Often these represent one Stream / River Flood Cycle!

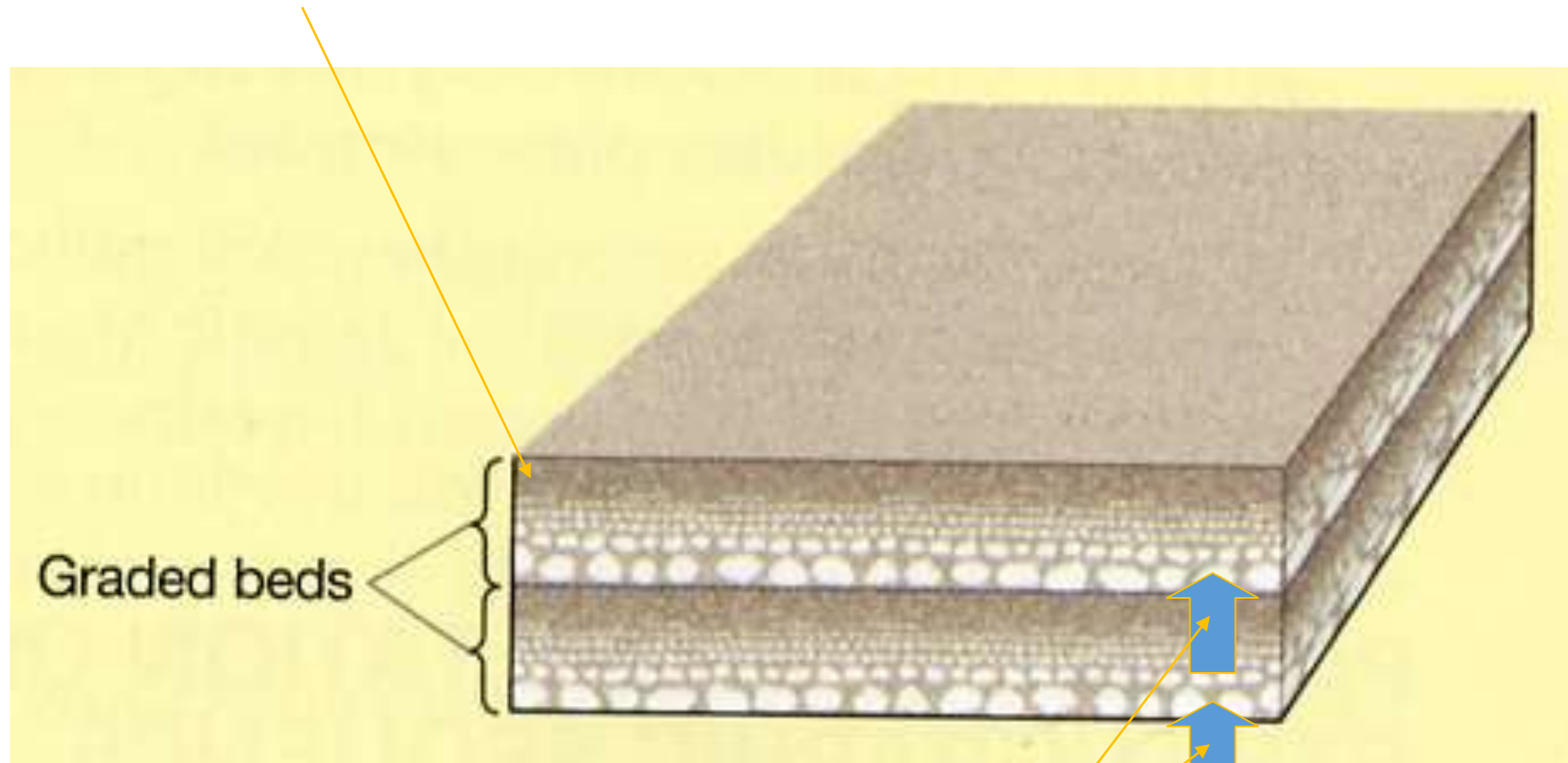


Sketches — Graded Bedding

MG f 2.31



The lighter particle settle out as the flood event loses energy....



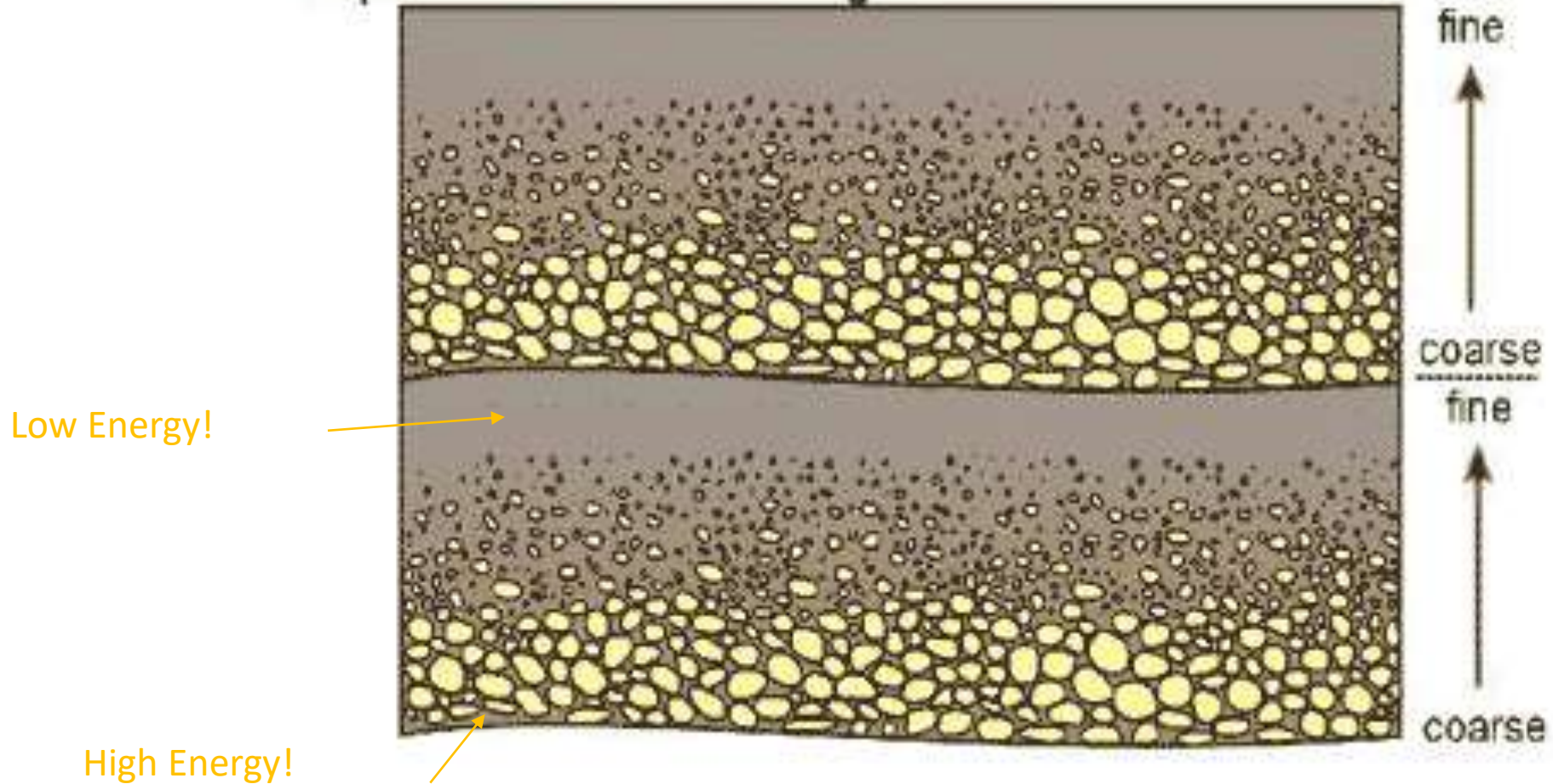
Helps Show the UP direction!

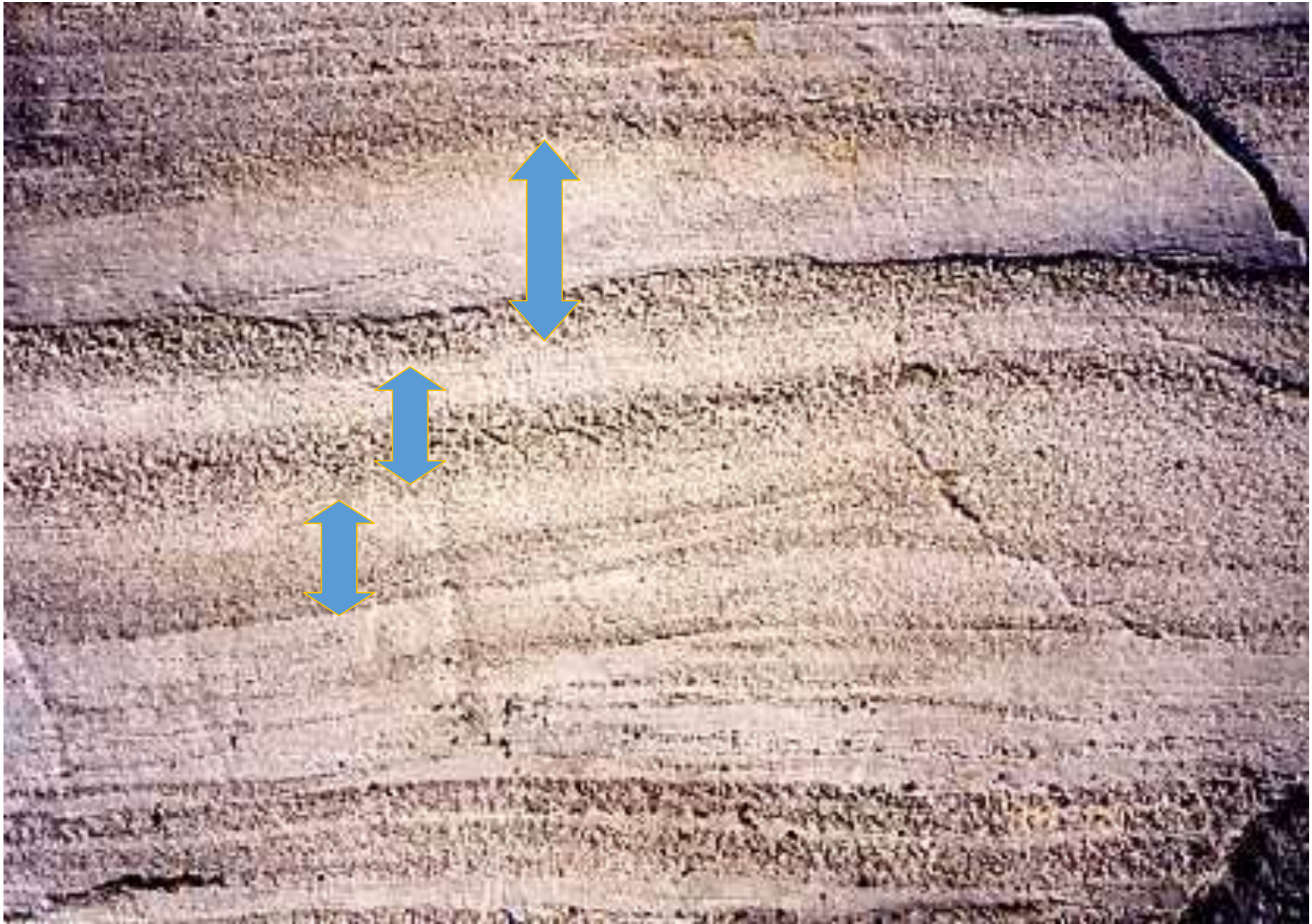
Graded Bedding:



Graded bedding

Decreasing grain size upward through the bed indicating deposition from a *waning* current:







Cross Bedding:

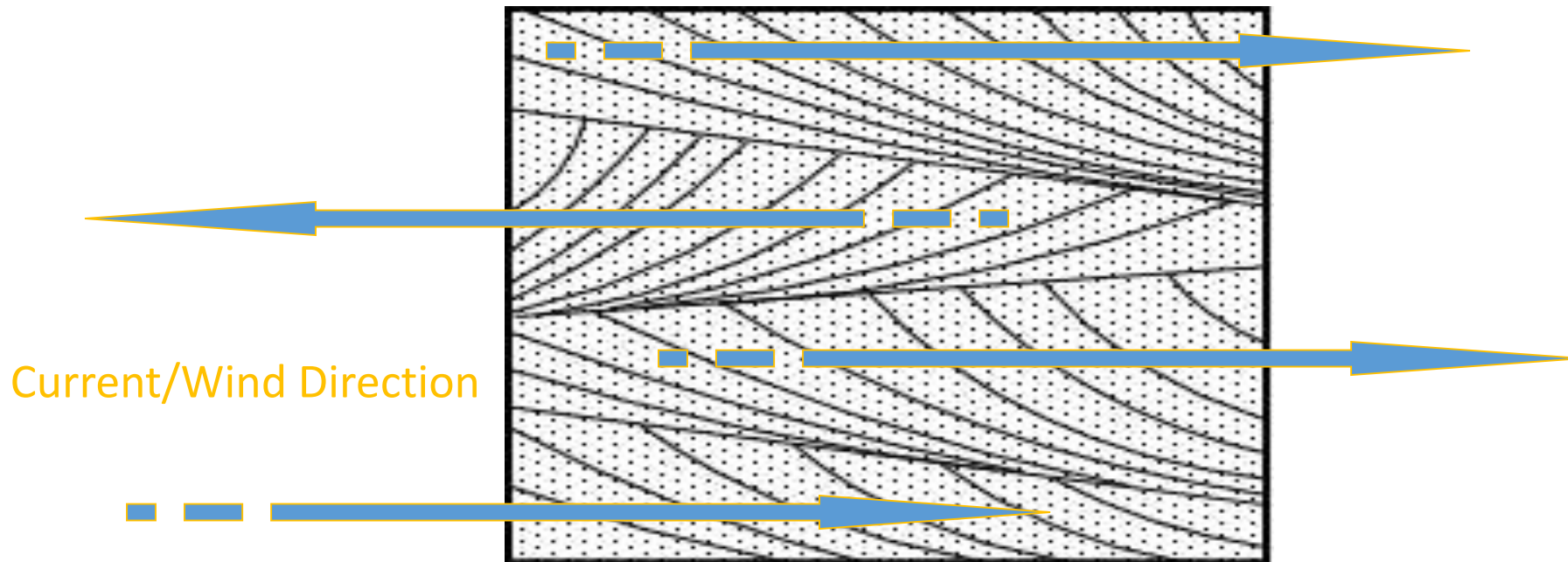
Cross Bedding -

Sets of beds that are **inclined relative to one another**.

The beds are **inclined in the direction that the wind or water was moving at the time of deposition**.

Boundaries between sets of cross beds usually represent an erosional surface.

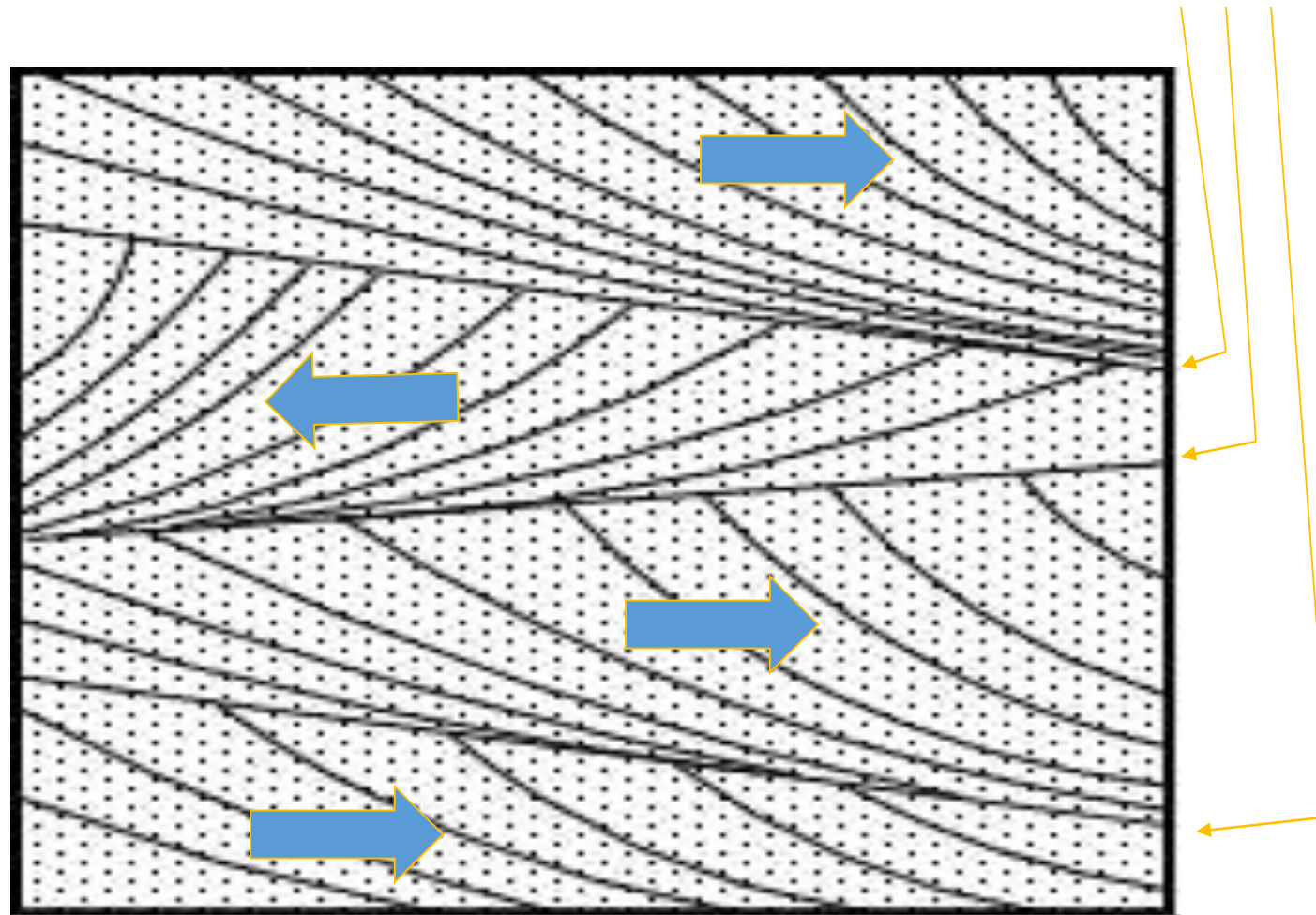
Very common in **beach deposits**, **sand dunes**, and **river** deposited sediment.

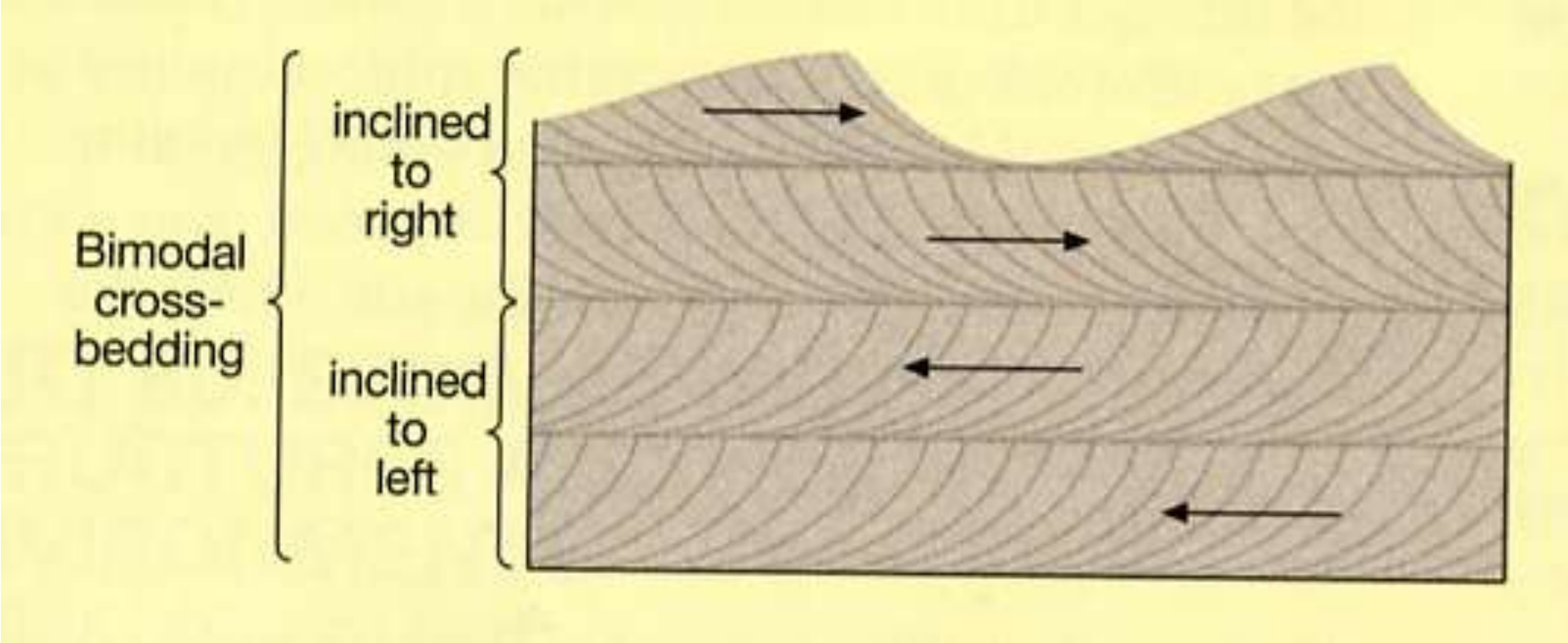


Bimodal Cross-Bedding:

Current changes direction over time!

Intermittent periods of erosion show as small “**Unconformities**”





Bimodal Cross-Bedding:

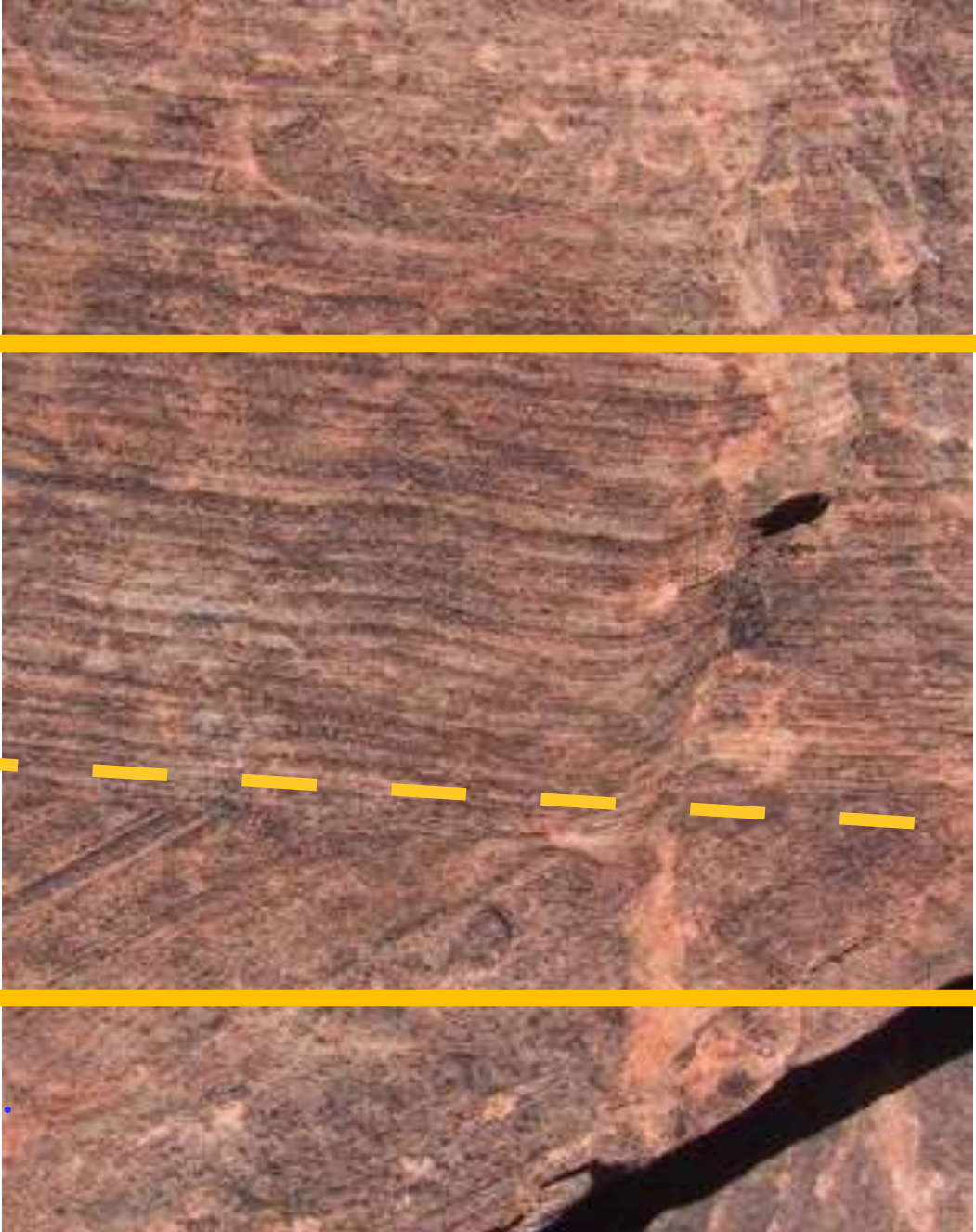
Current Direction **Late...**



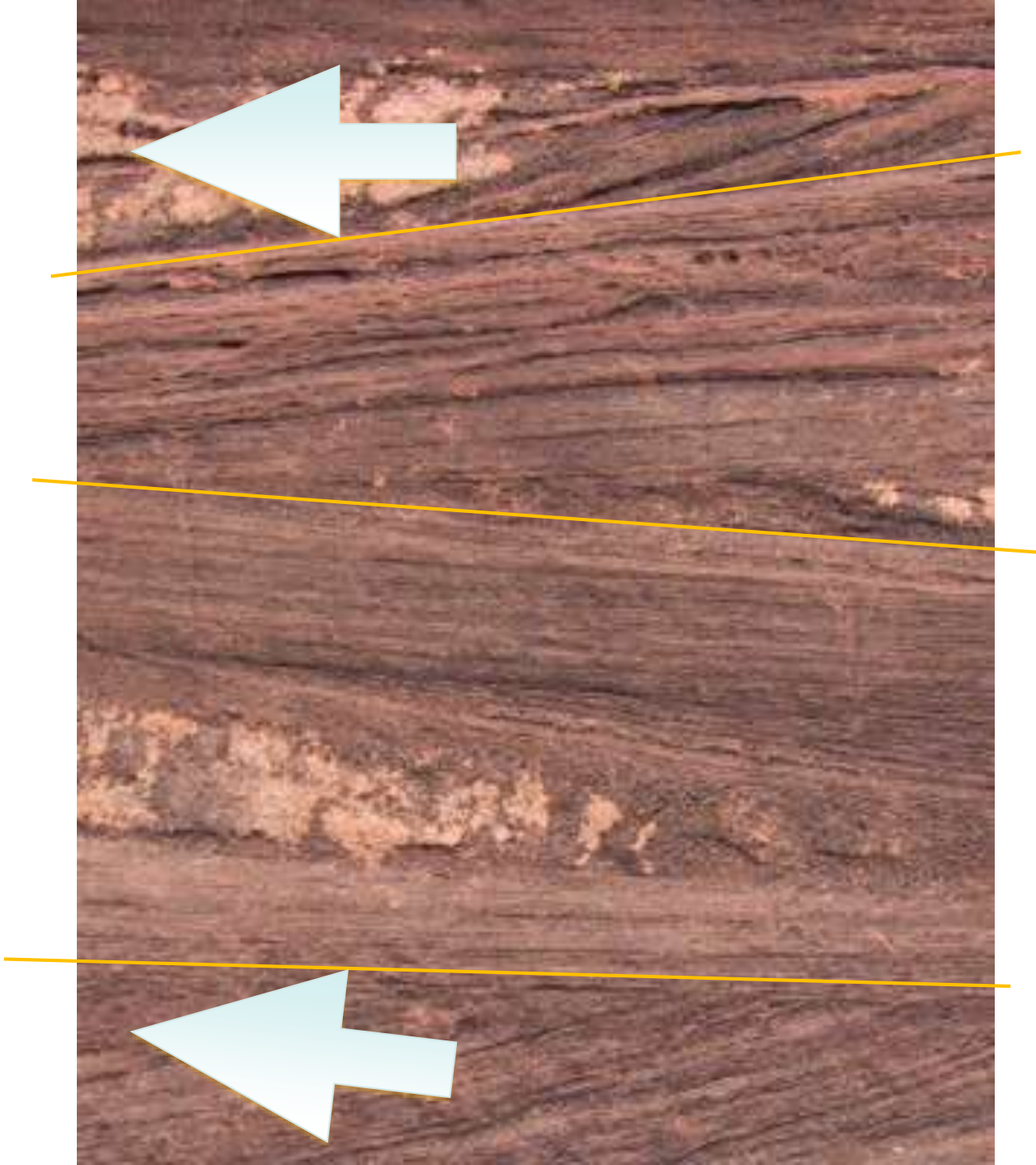
Erosion Surface!



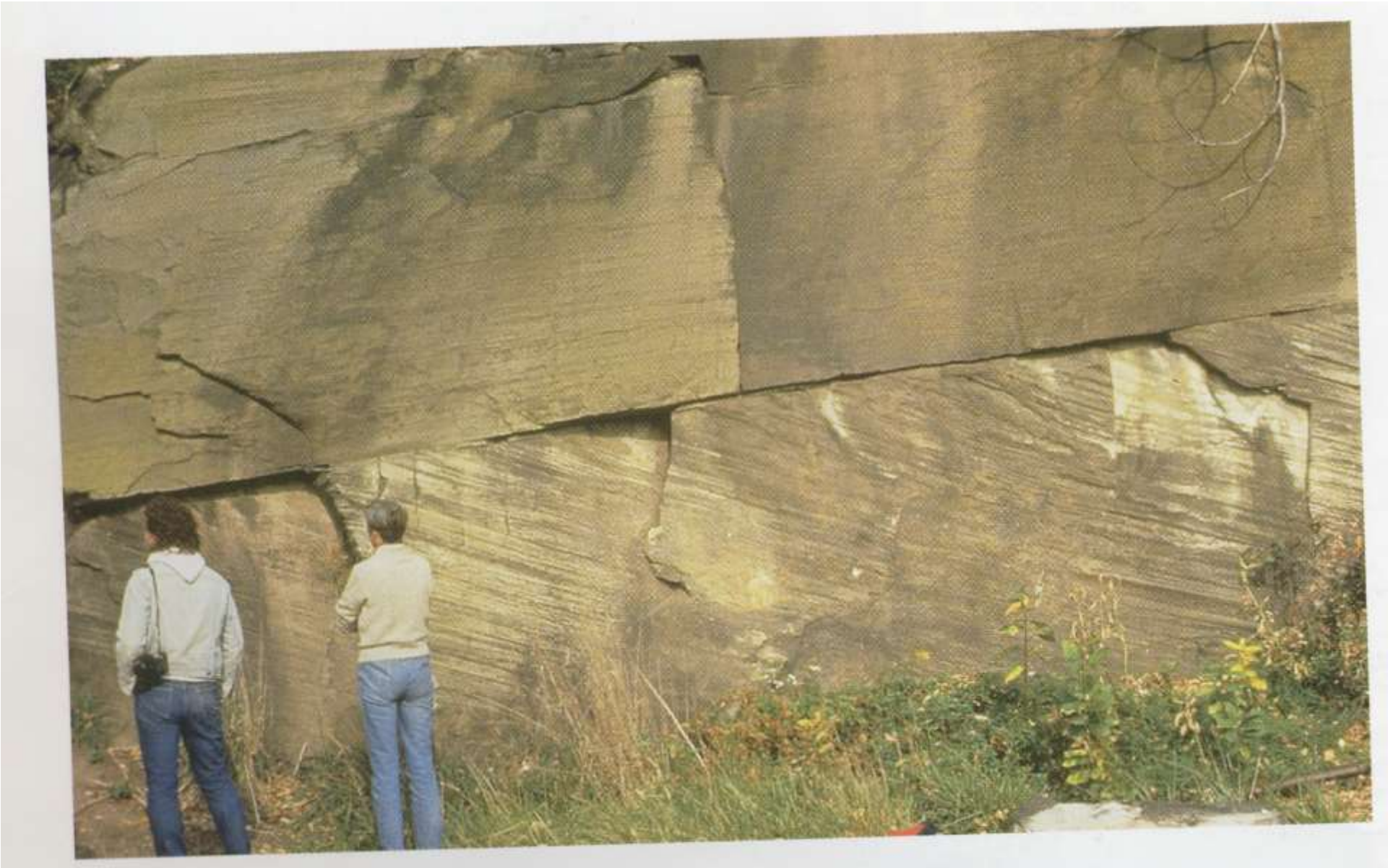
Current Direction **Early...**



Can you identify
erosion surfaces &
current directions?



Large Scale Bimodal CrossBedding is usually indicative of a *desert "Sand Dune" environment*...where wind direction constantly changes!







Large Scale Cross Bedding From Ancient Sand Dunes...



Example Of *Single Mode* Cross-Bedding:



Small Scale Cross Bedding usually indicates a **river / lake / ocean-shore** environment!

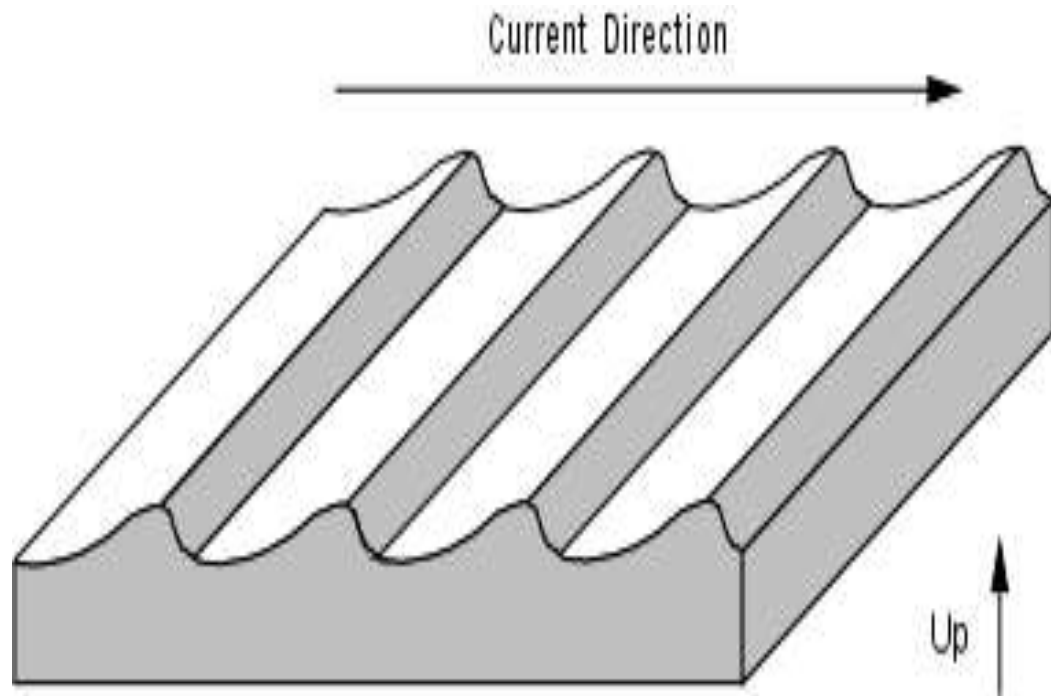
Ripple Marks:

Ripple Marks -

Characteristic of **shallow water deposition**.

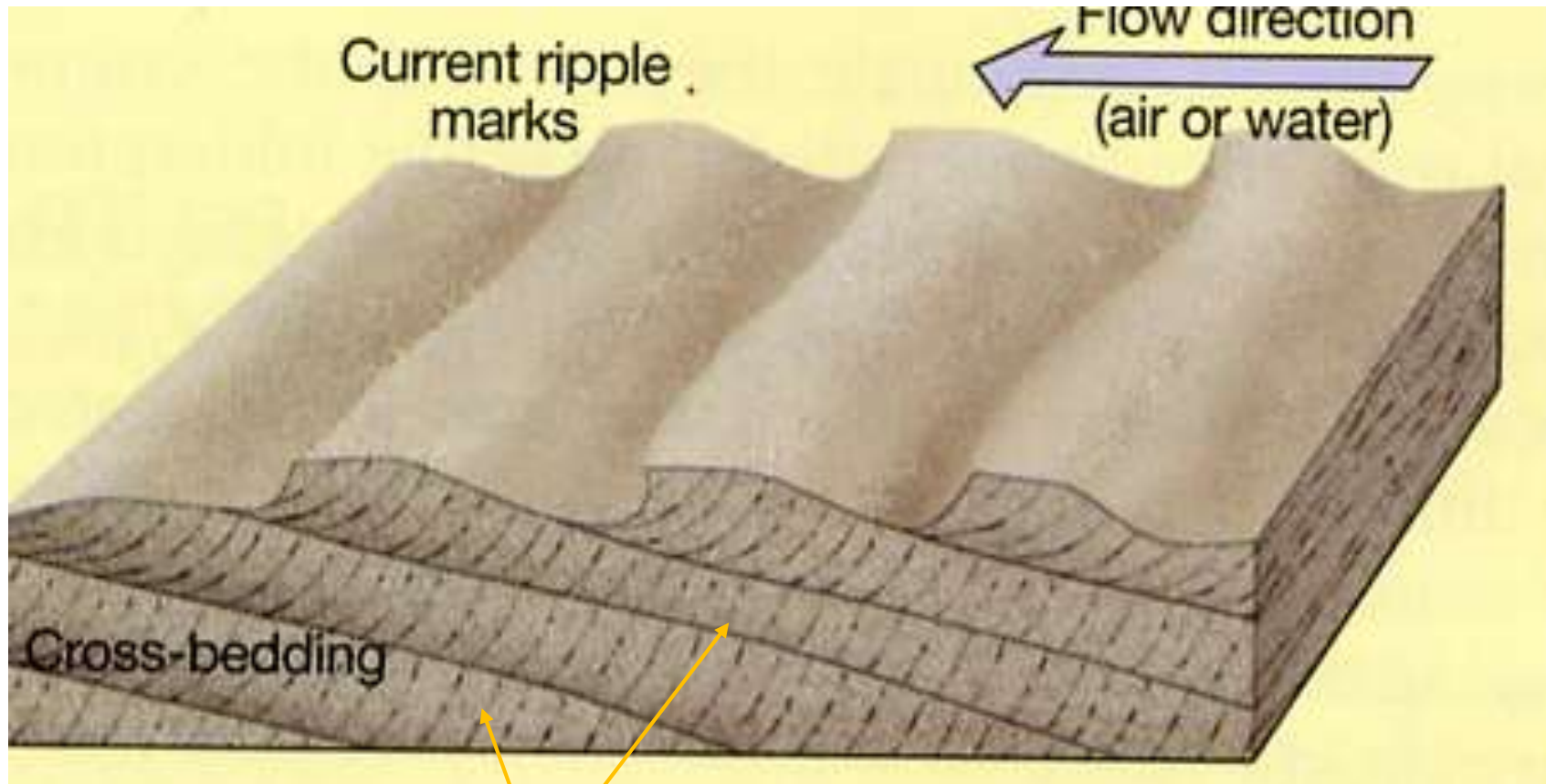
Caused by **waves** or **winds**.

These are **current / asymmetrical ripple marks** =
current always in one direction.



Common in bodies of water with a **steady current** such as a river or stream!

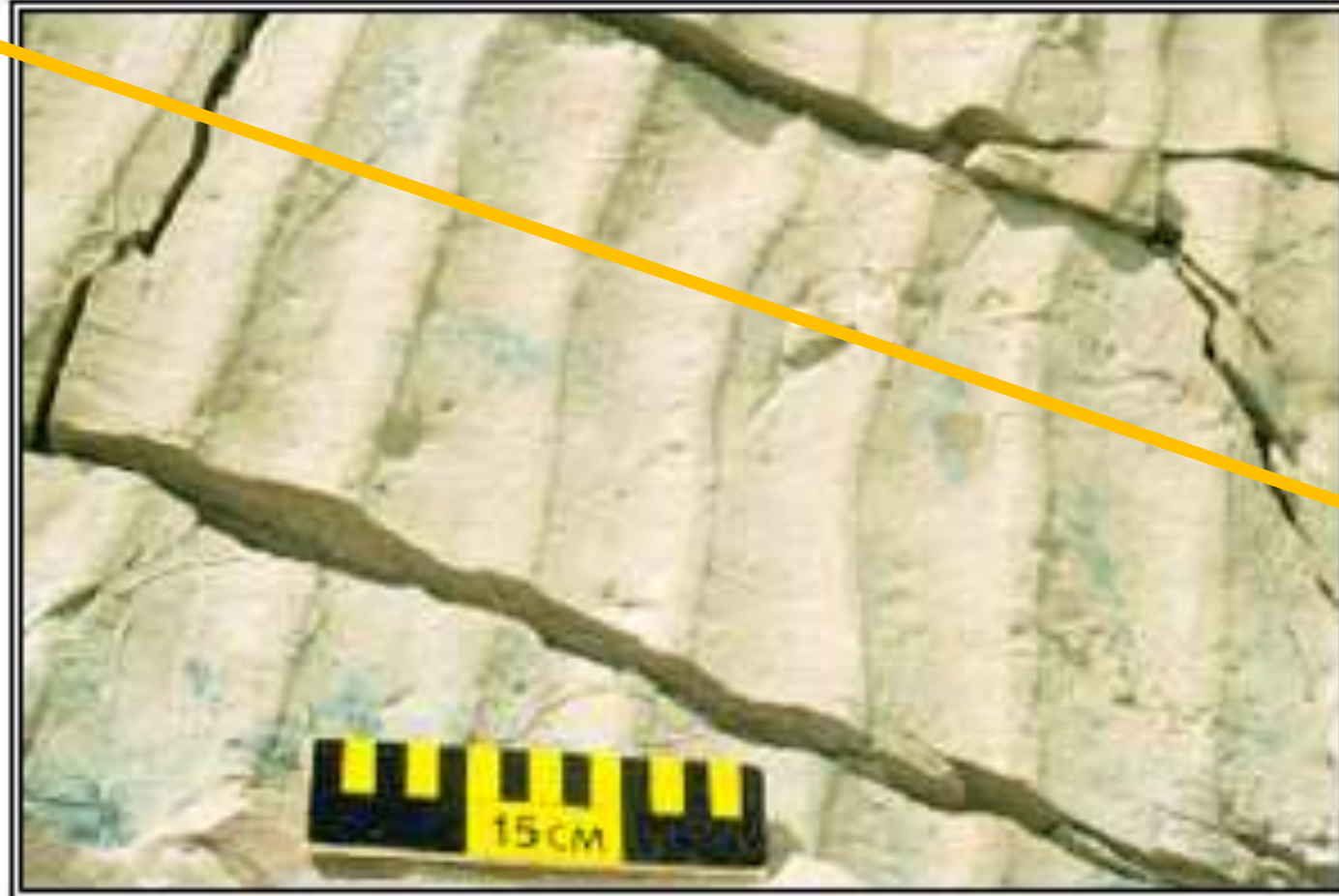
How might oscillation/symmetrical ripple marks look?



This type of **small scale cross bedding** is commonly associated with ripple marks...gives us insight into the environment in which the rock preserving these structures was formed!

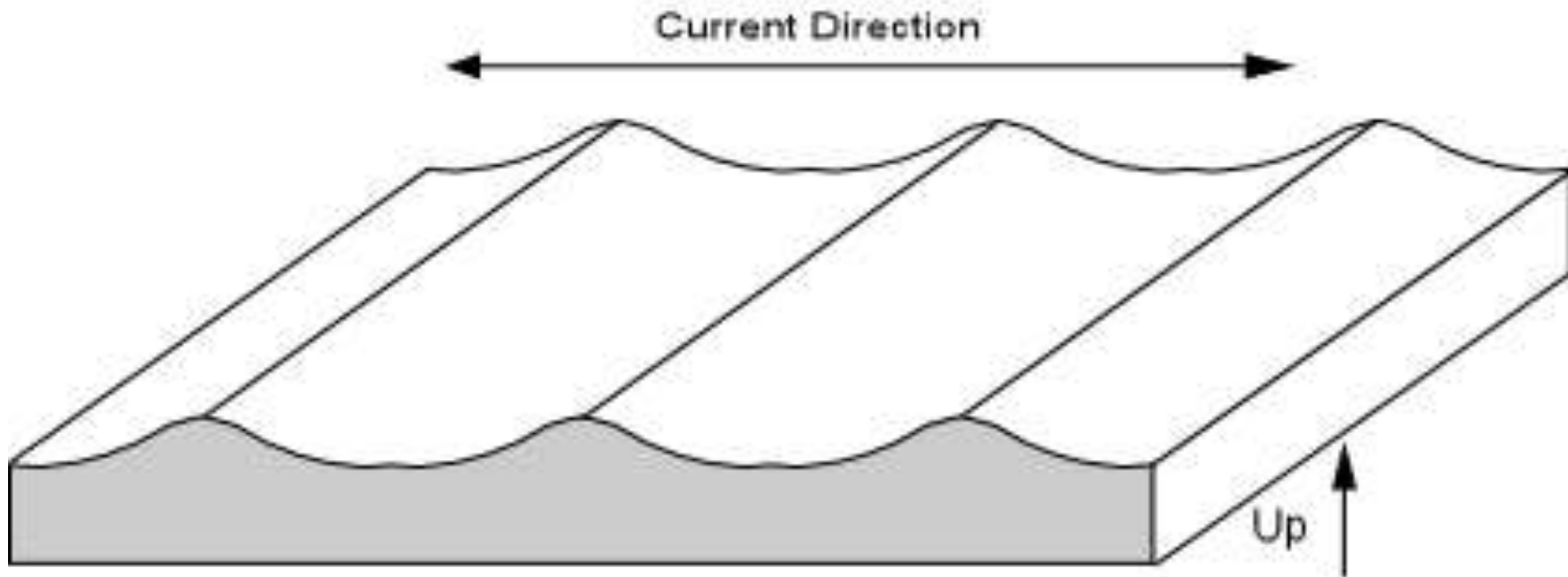
Current (asymmetrical) Ripple Marks:

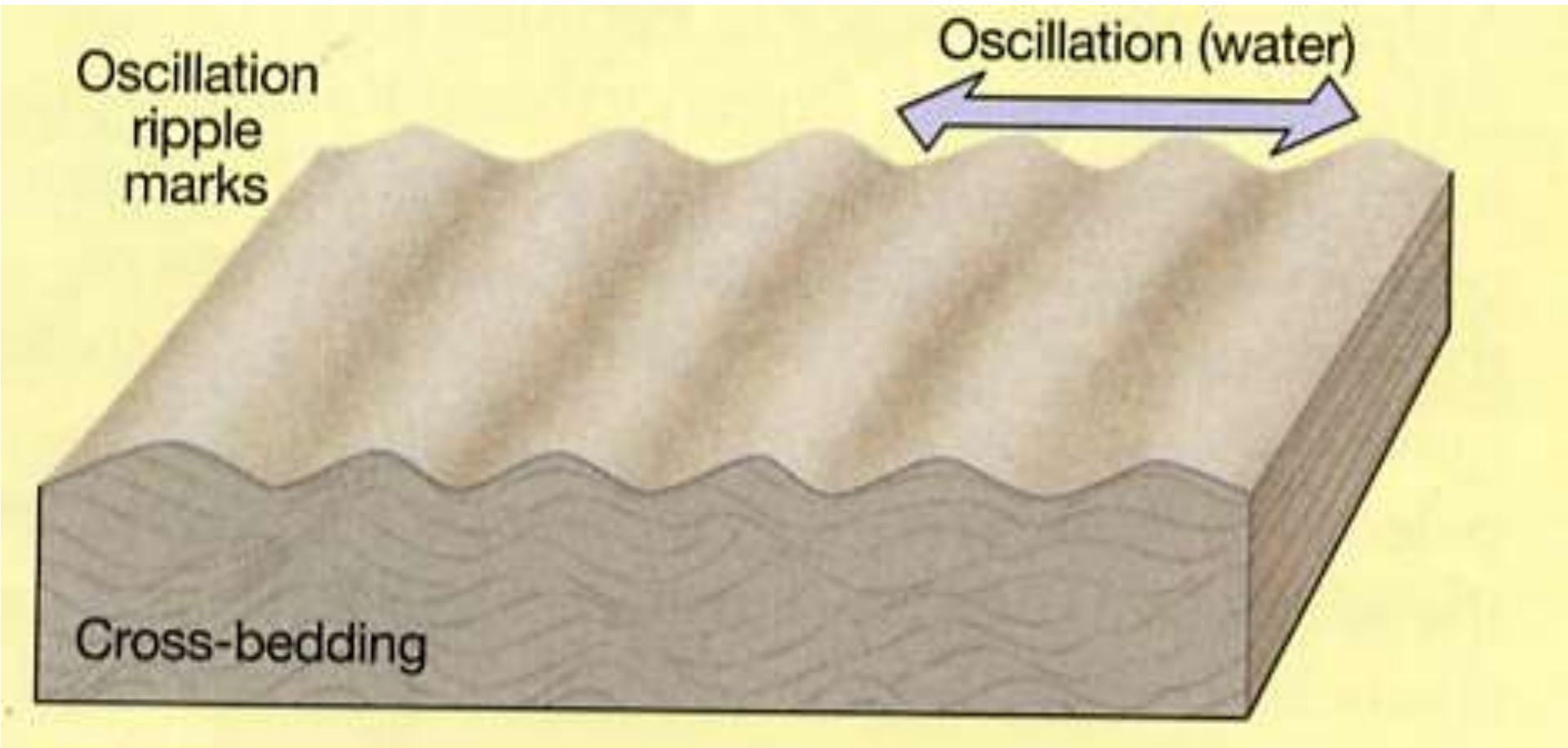
Current



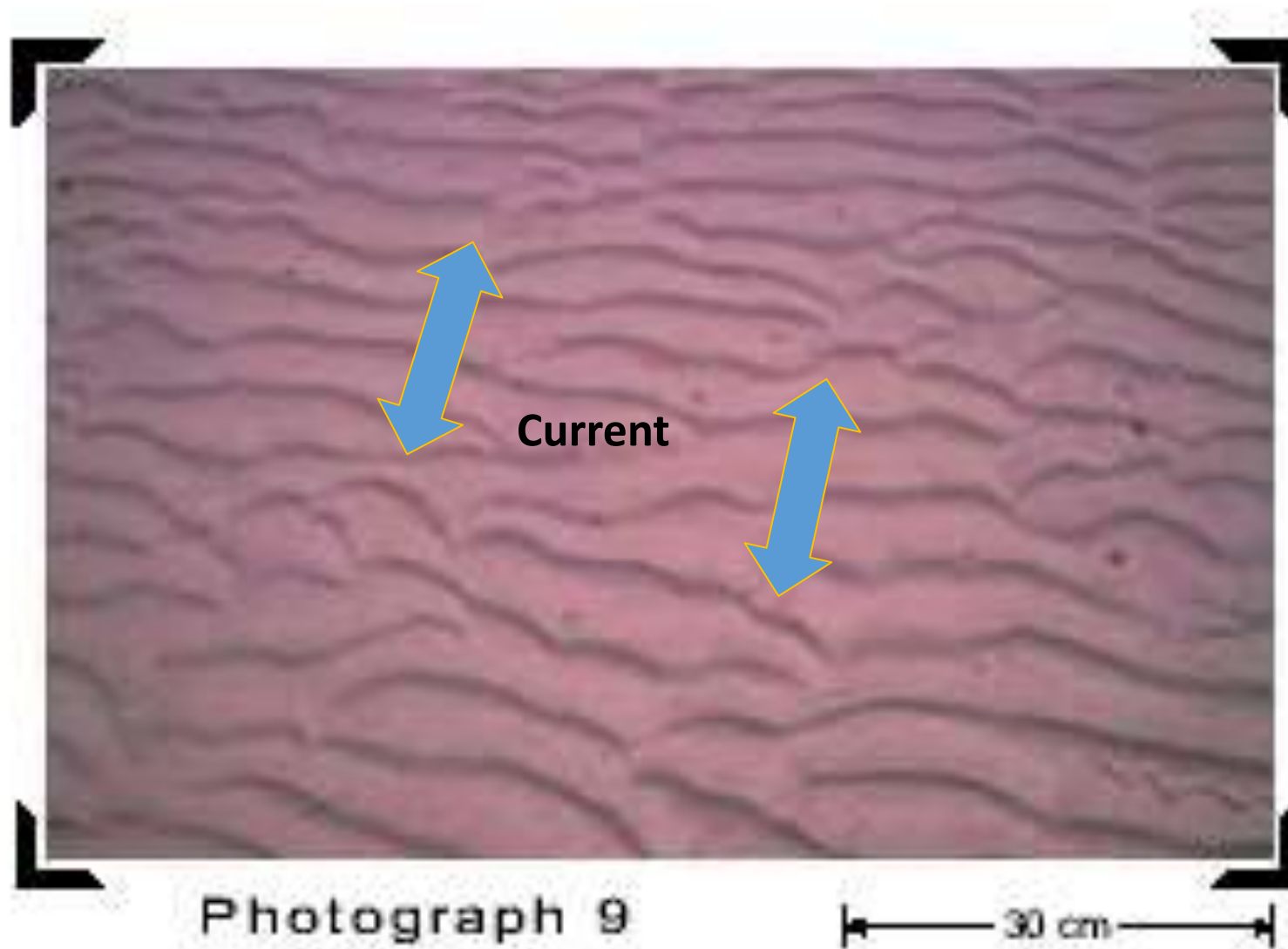
These are **oscillation / symmetrical** ripple marks =
current changes direction.

These form in any body of water where **gentle waves or weak currents move back and forth** such as at the sea or lake shore





Oscillation (Symmetrical) Ripple Marks:



**Can you guess what the following examples are
& describe the current?**





***These Sediments
at Wreck Beach
near UBC show ripple marks forming!***



Mud Cracks:

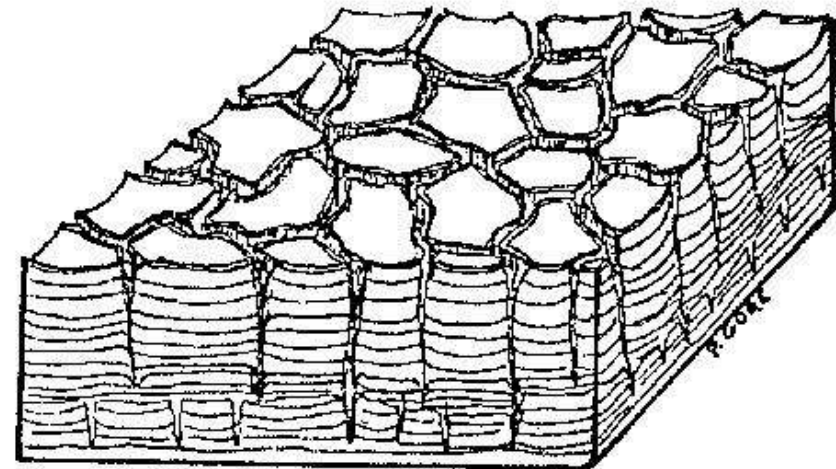
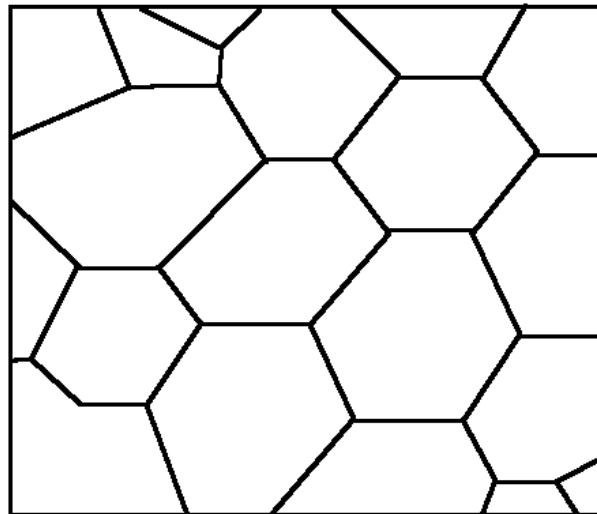
Mudcracks -

Result from the **drying out & cracking of wet sediment.**

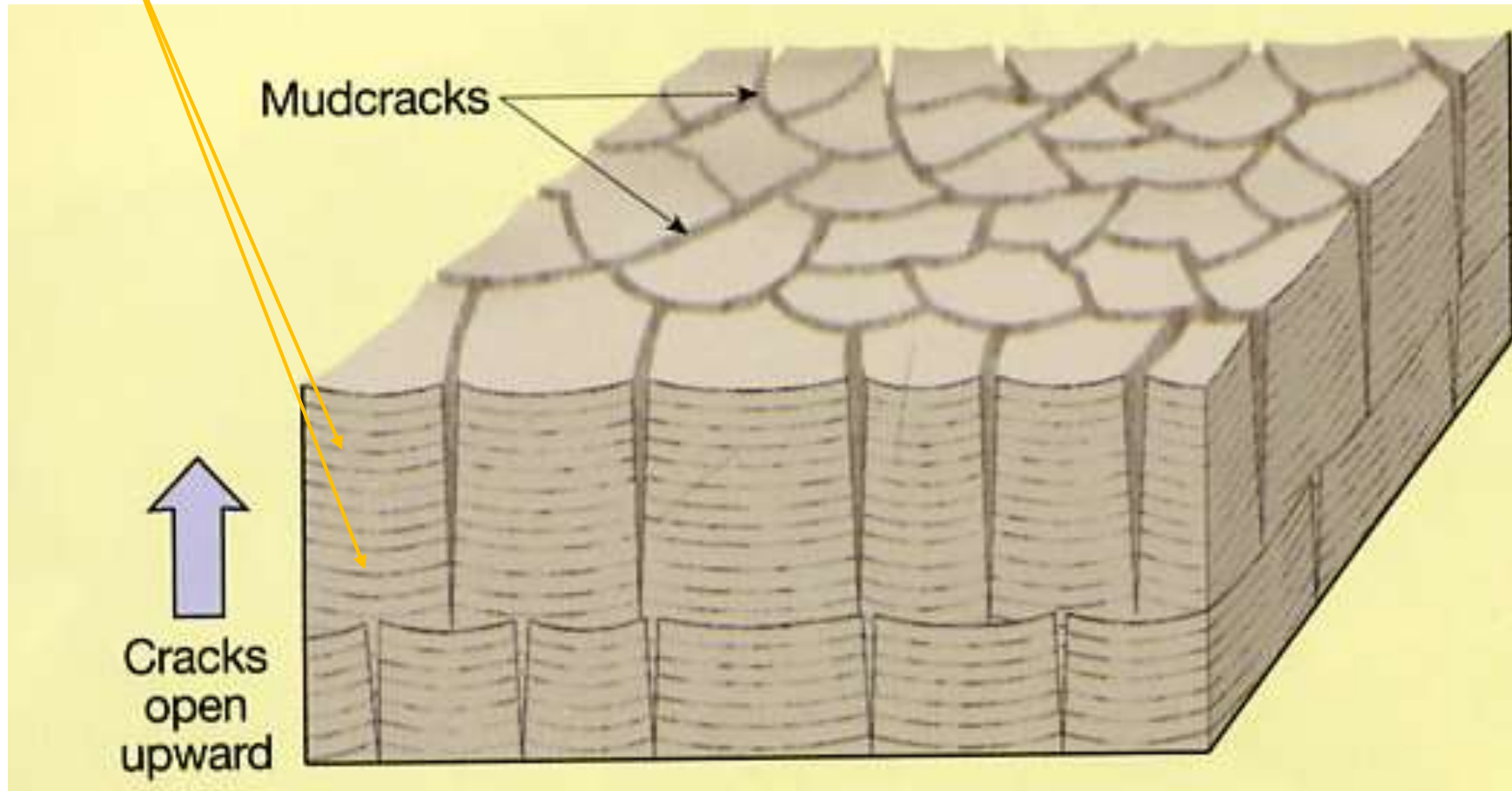
-Occur only in **FINE grained** sediments such as **SILTS** or **CLAYS** (i.e. Mudstones)

-Mud Cracks **CANNOT** form in Sand or Gravel sized sediments!!

-The cracks form due to **shrinkage of the sediment** as it dries.



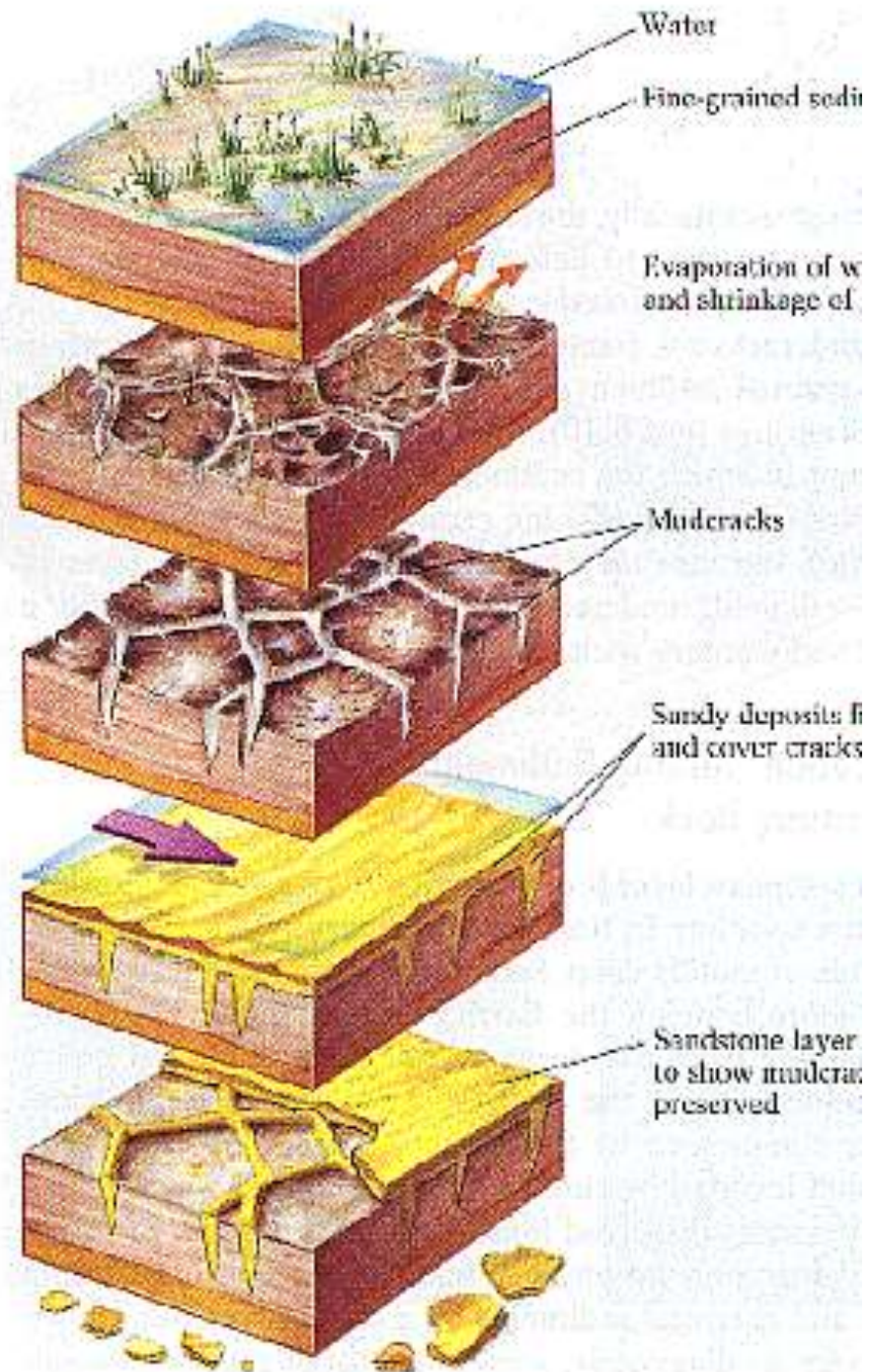
**Fine Grained Sediments -
In fine strata or layers or laminations**



Helps show the **UP** direction!

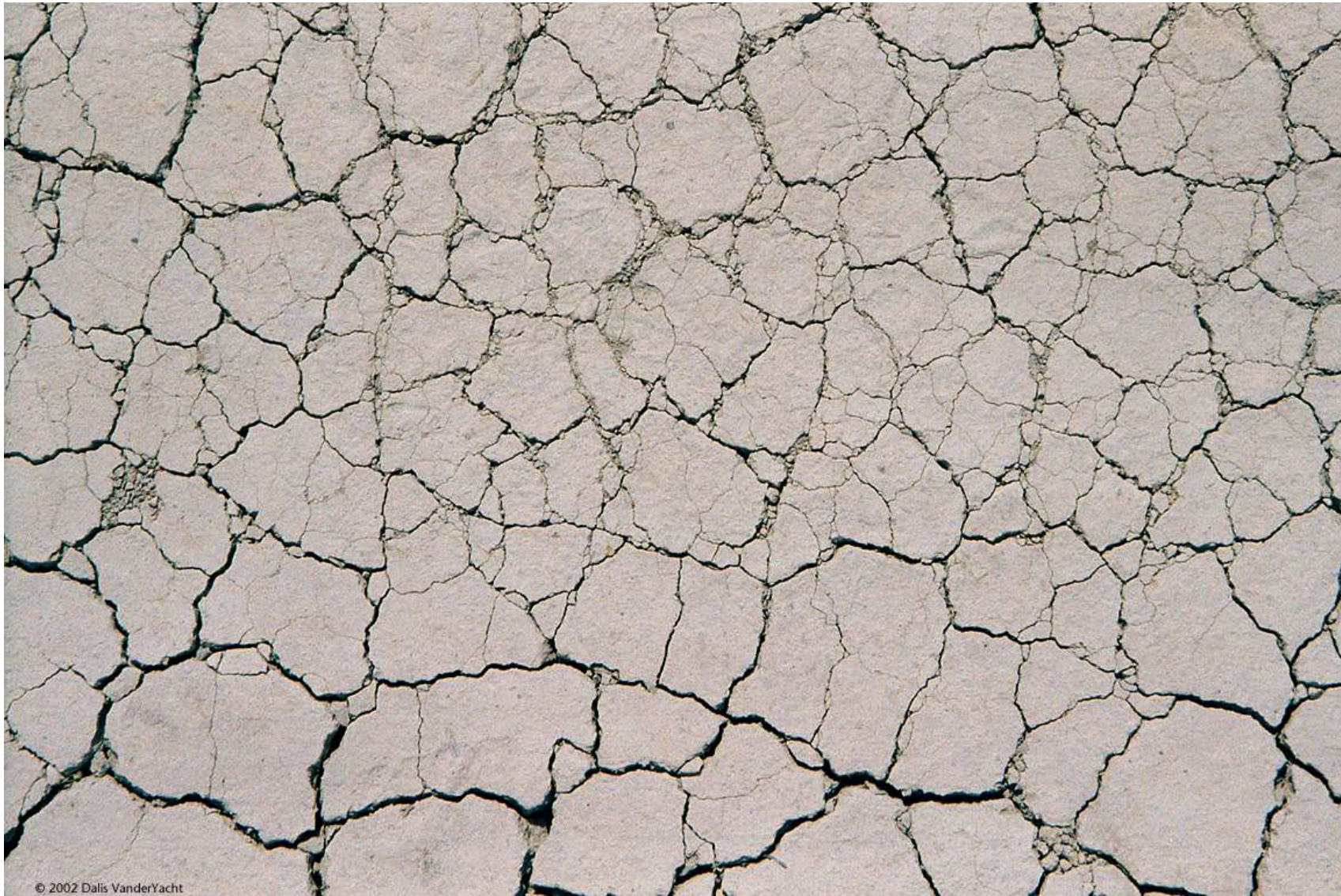


Figure 6-10 The origin of mudcracks. The presence of these mudcracks in oxidized red shale in Glacier National Park, Montana, suggests that a body of water once evaporated to dryness within terrain that is today part of the Montana Rockies.

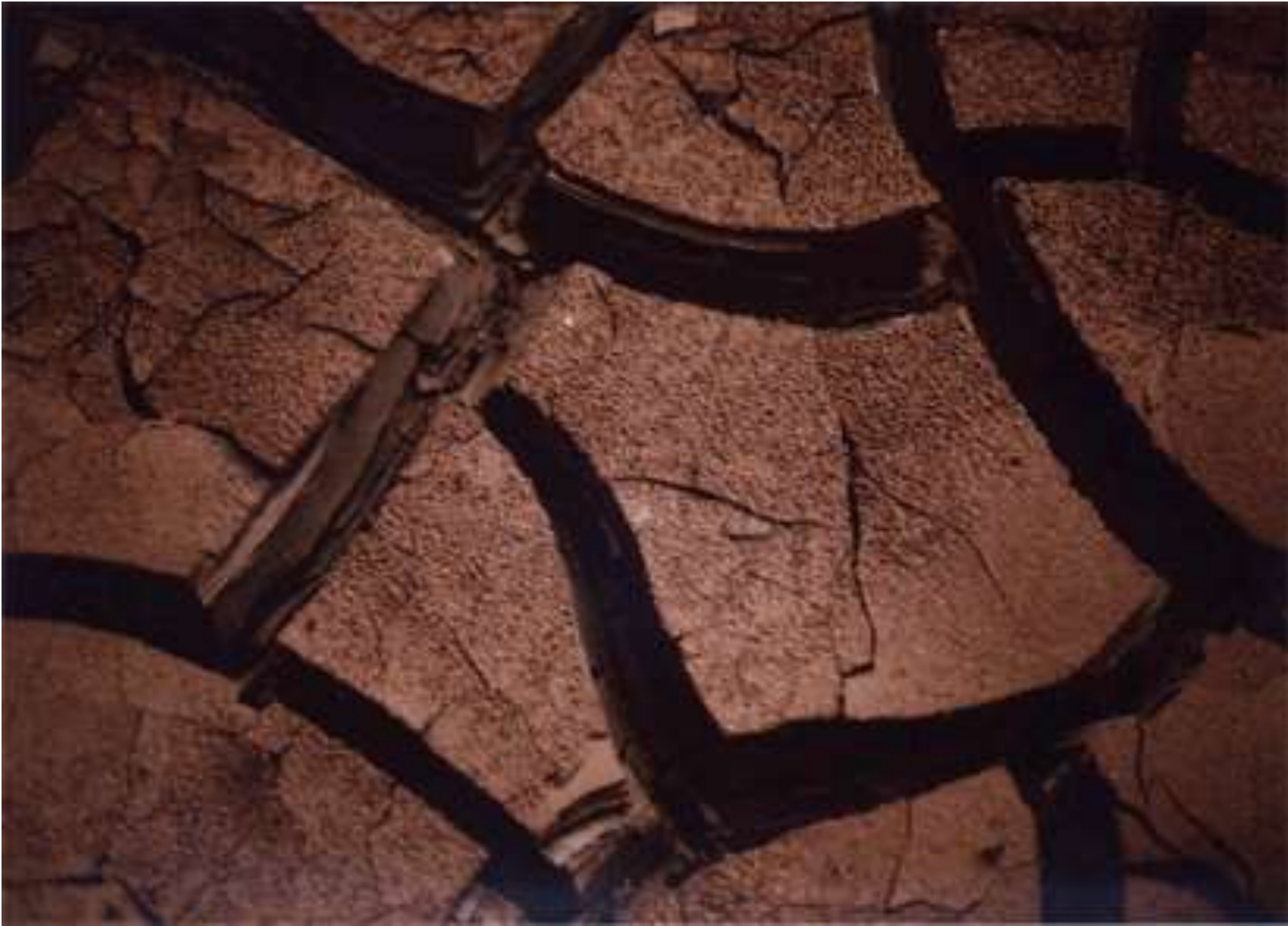




Mud Cracks forming



Mud Cracks



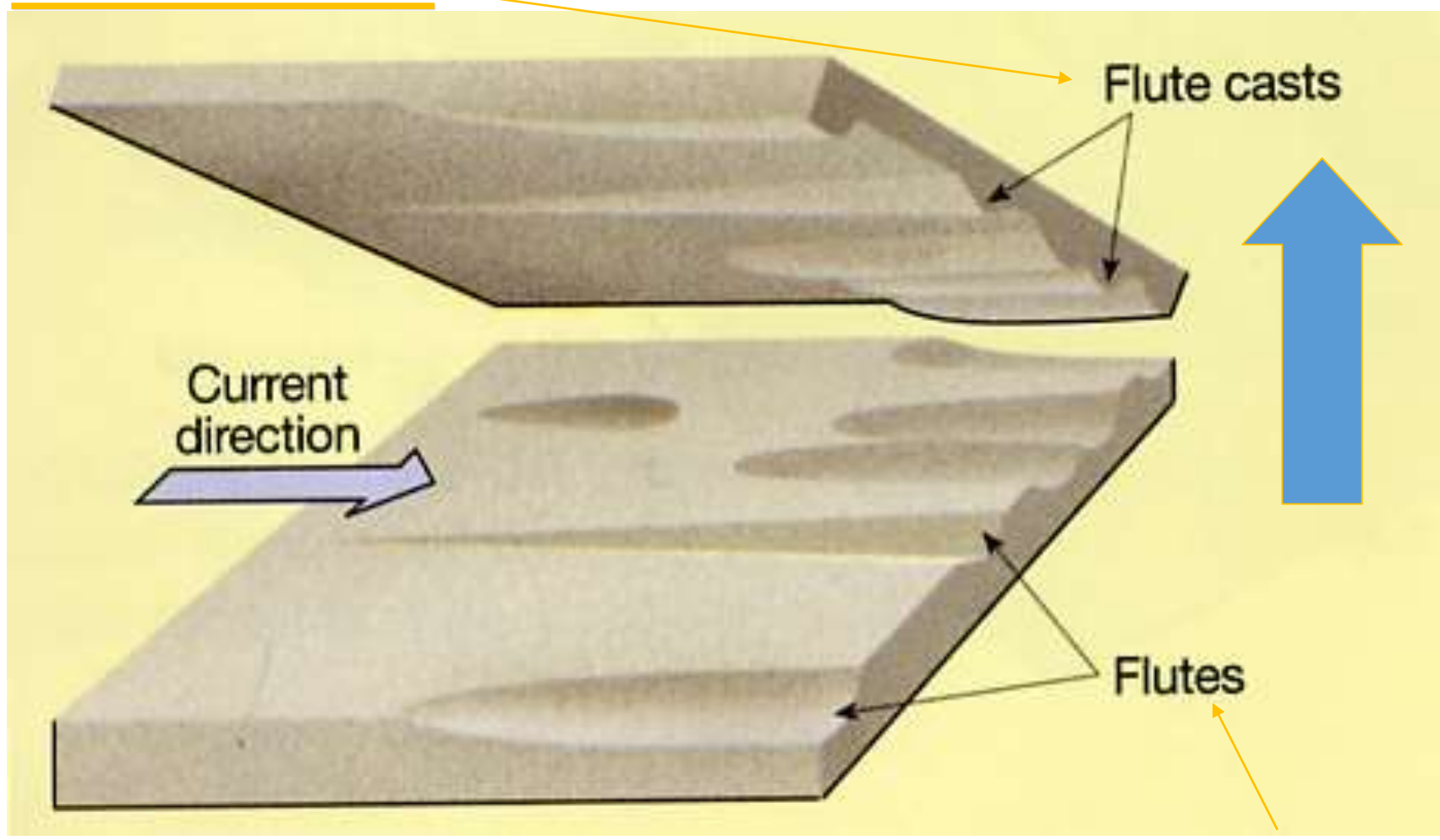
Mud Cracks



Mud Cracks

Flutes / Flute Casts

If the layer above fills the flute & preserves it the result
= **FLUTE CAST** Flute Casts occur at the **bottom** of a layer.



Helps
Show the
UP
direction!

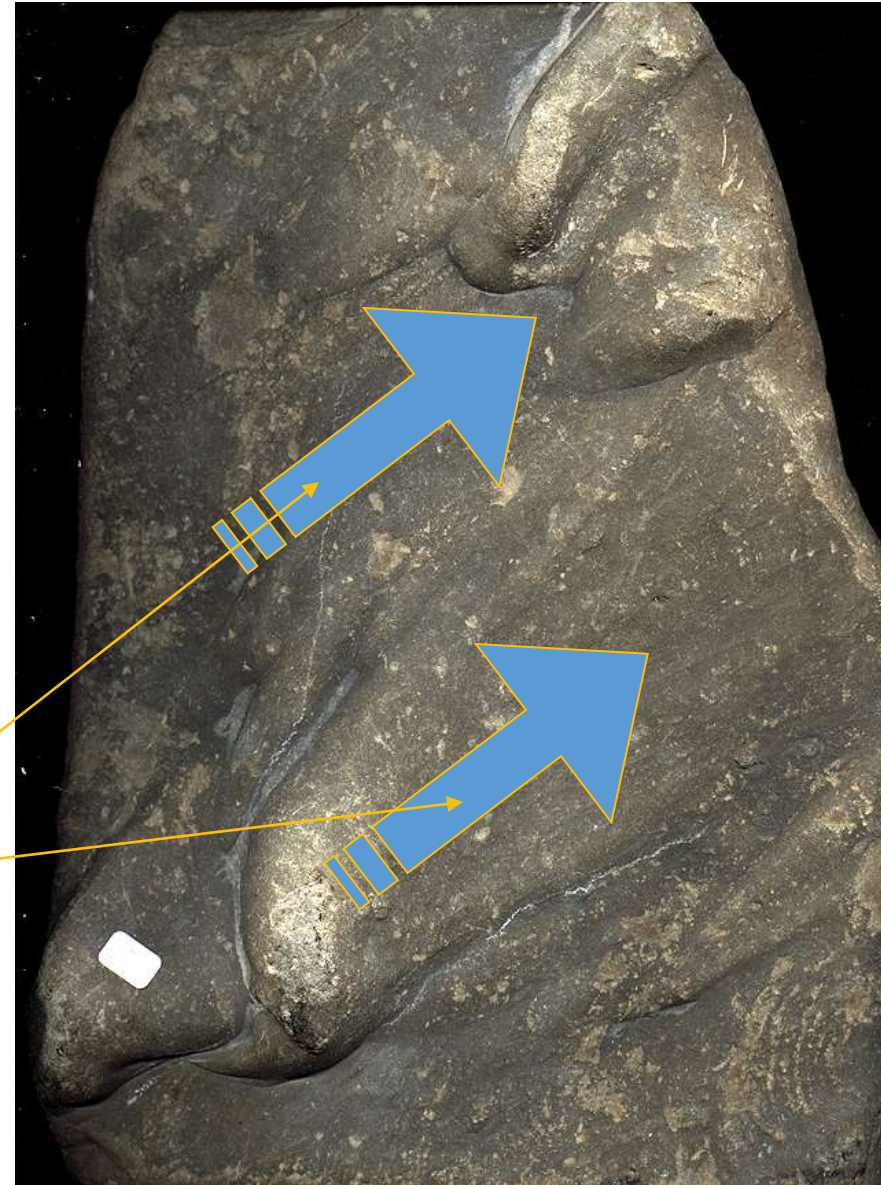
Grooves or Gouges that are scoured out by current
= **FLUTE!** Flutes occur at the **top** of a layer.

These are Flute Casts!

NOTE:

We are looking at the
BOTTOM of this structure

Current Direction!



Such a geologist!



1. What is the current direction?

2. Is this the bottom or top?

Bottom!



Current direction?

Current direction?



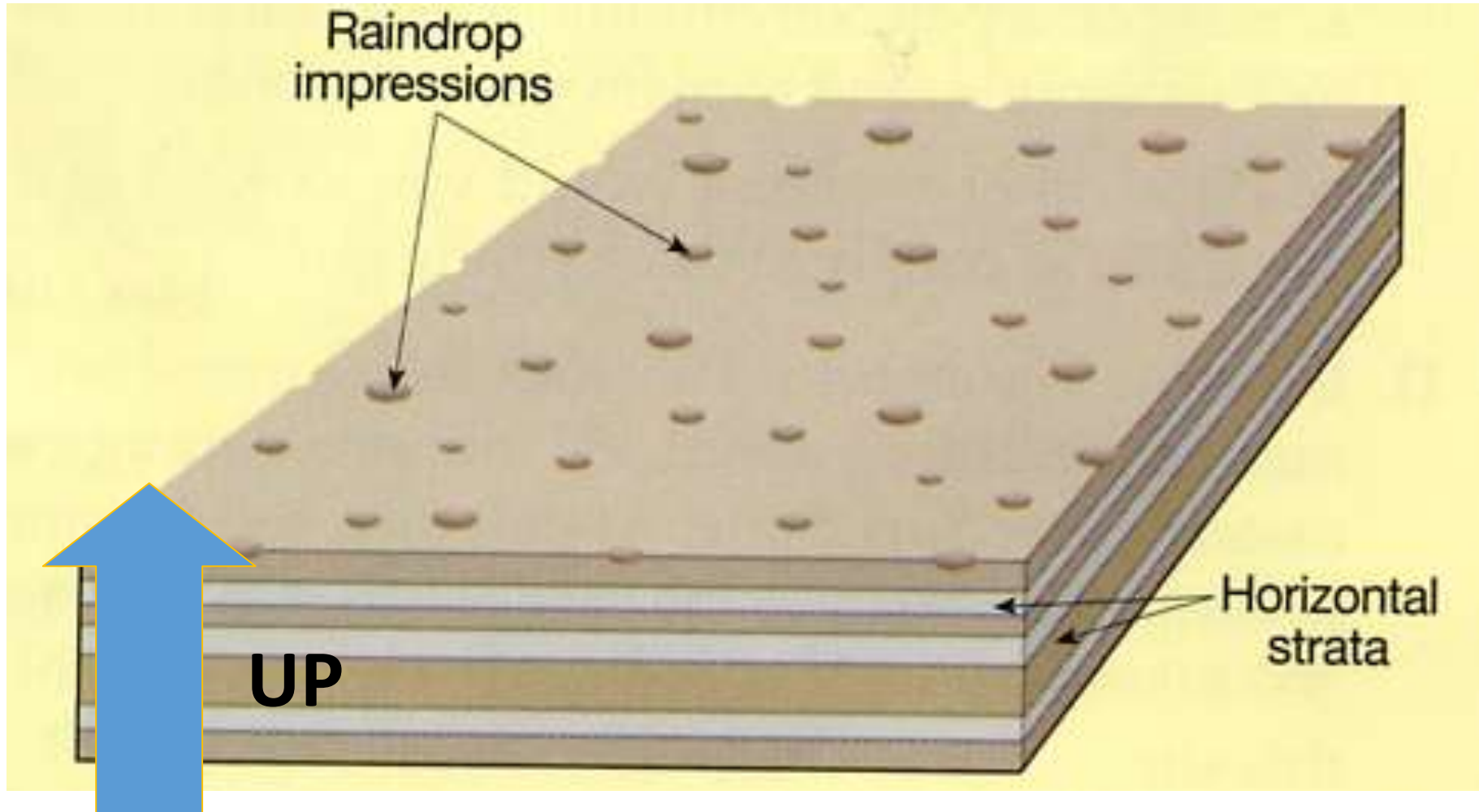
Rain Drop Impressions:

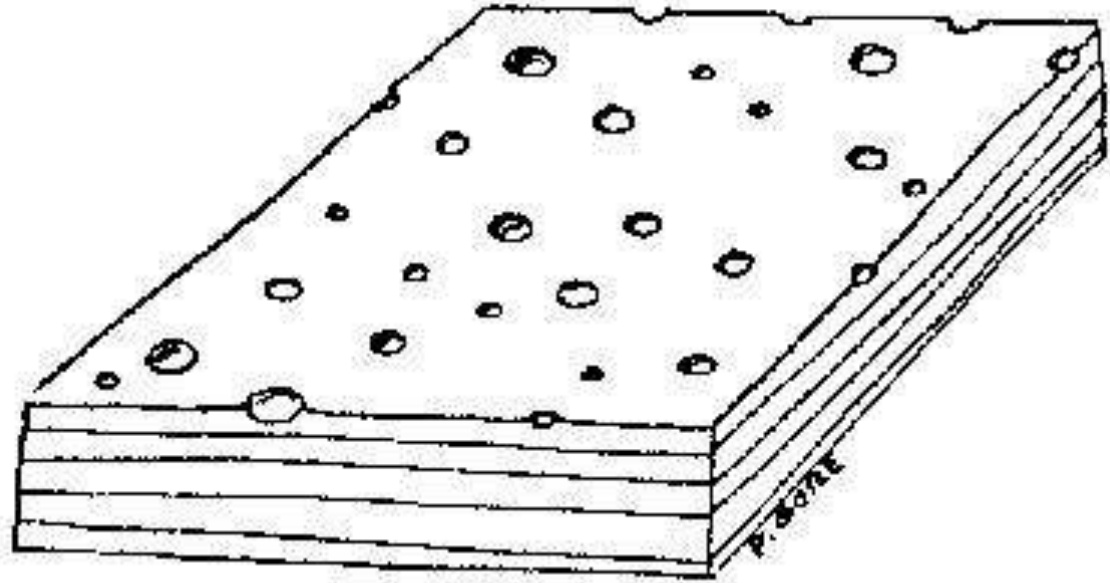
Raindrop Marks -

Pits (or tiny craters) created by **falling rain**.

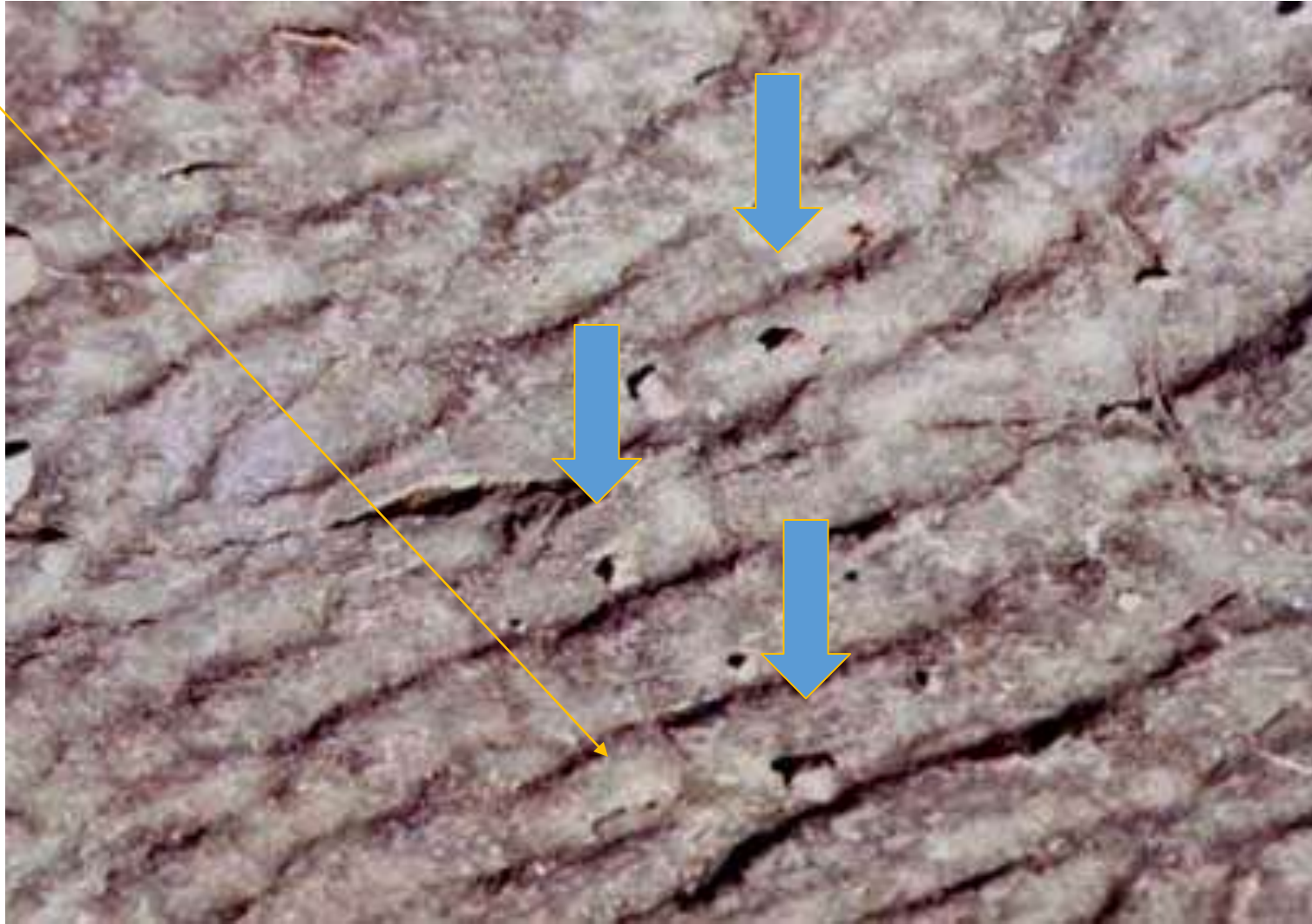
If present, this suggests that the **sediment was exposed** to the surface of the Earth.

Helps Show the **UP** direction!





Notice also present = Ripple Marks
= Gives clues as to the environment
this rock was formed in



Various Plant / Animal Marks:

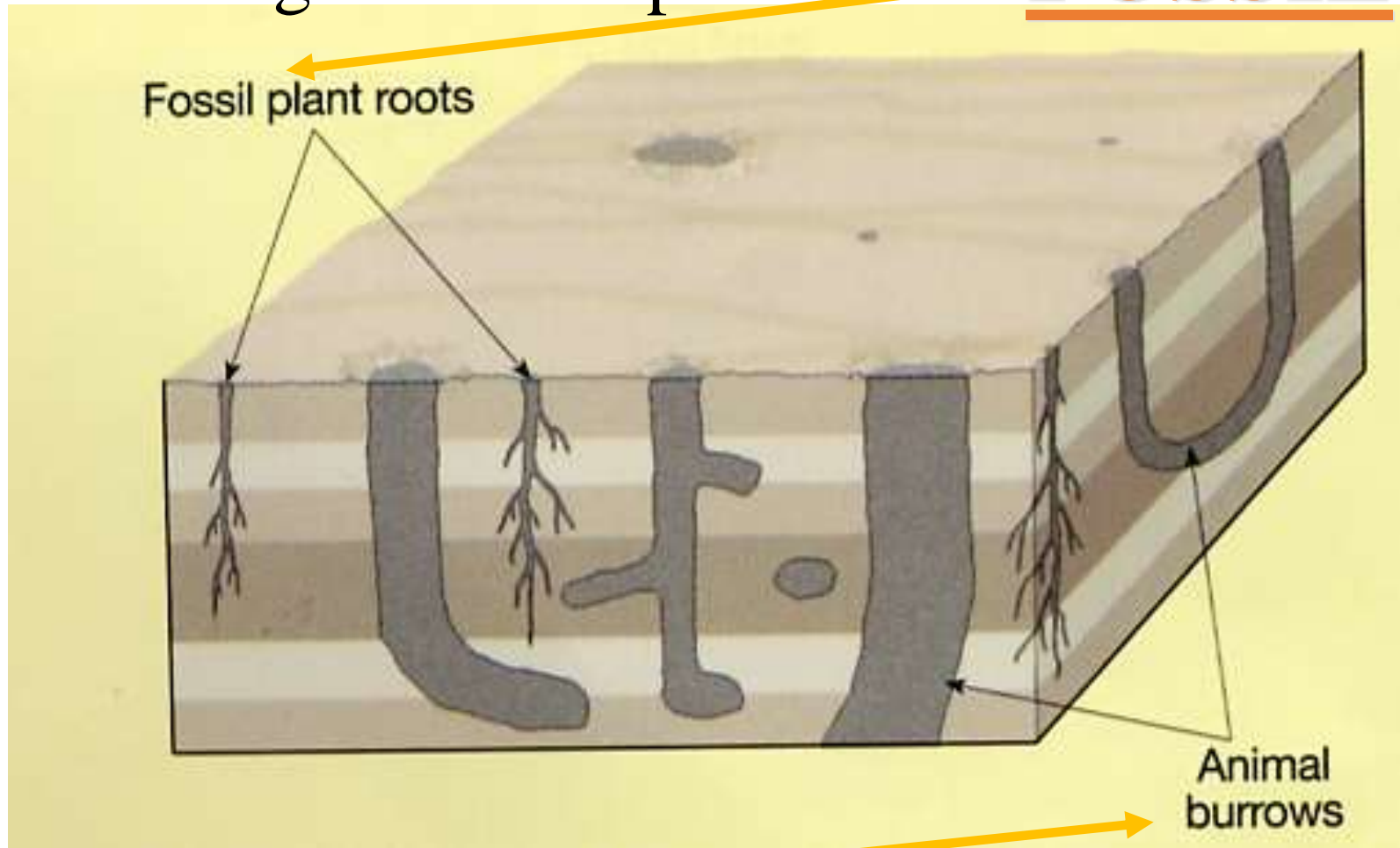
Fossils -

Remains of once living organisms.

Probably the **most important** indicator of the environment of deposition:

- Different species usually inhabit **specific** environments.
- Because life has **evolved** - fossils give clues to relative age of the sediment.
- Can also be important indicators of **past climates**

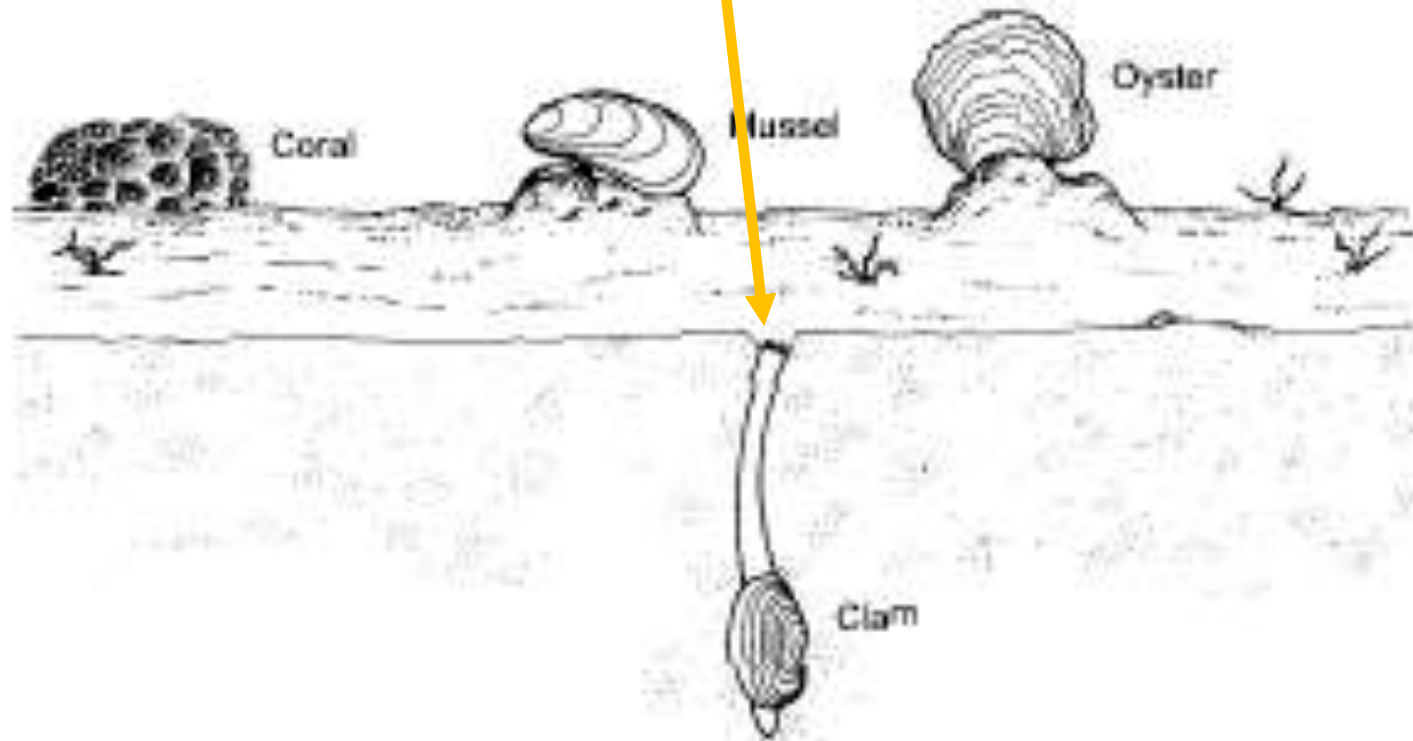
If actual organism is represented = **FOSSIL**



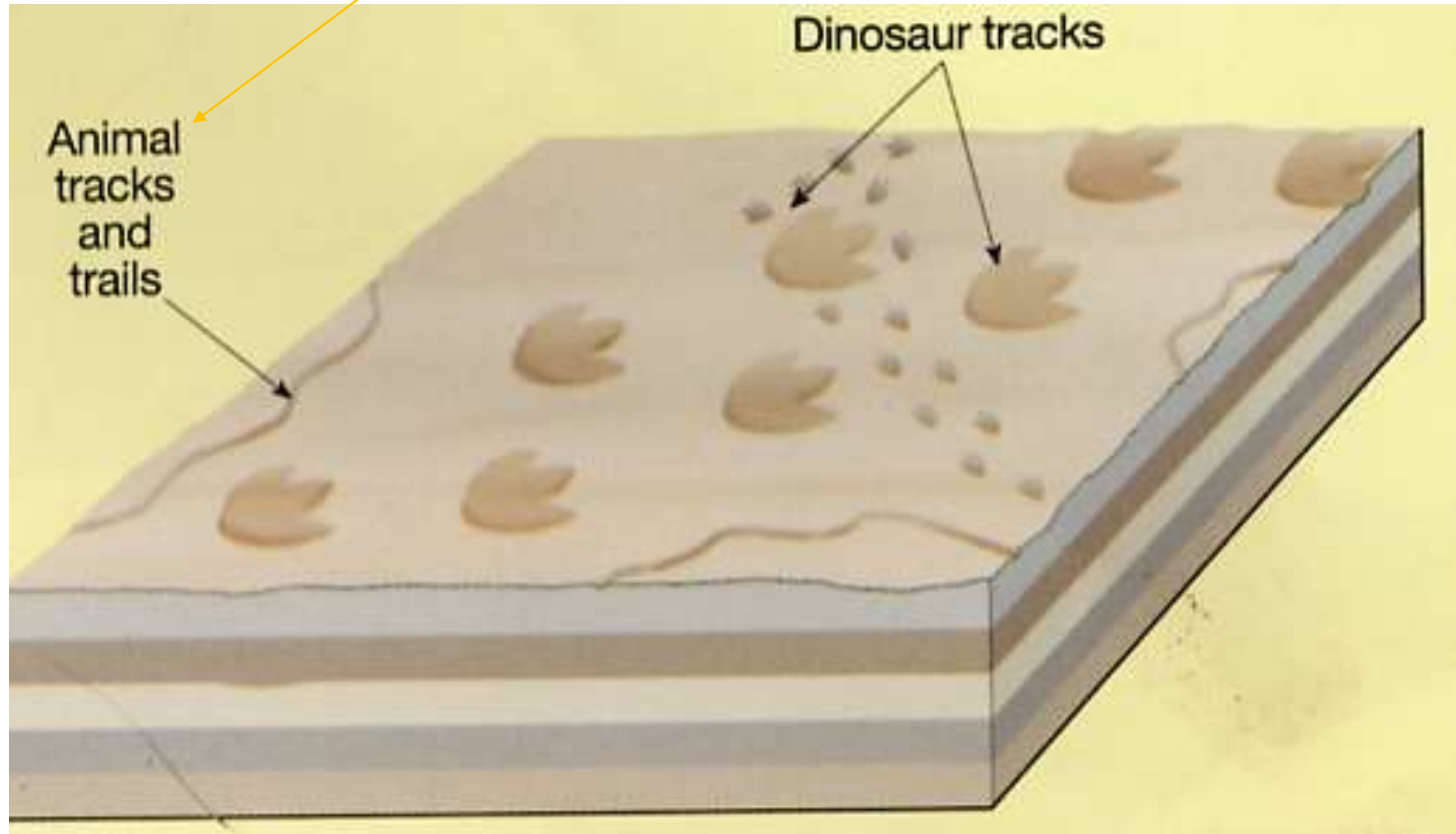
If only EVIDENCE of the organism existence is represented =

TRACE FOSSIL

If this clam's burrow gets preserved
it will be a “Trace Fossil”



Trace Fossils






Worm burrows

Worm burrows





Fossil worm holes

Cross bedding



Track marks .. Trilobite?





Dinosaur footprint





Dinosaur trackways

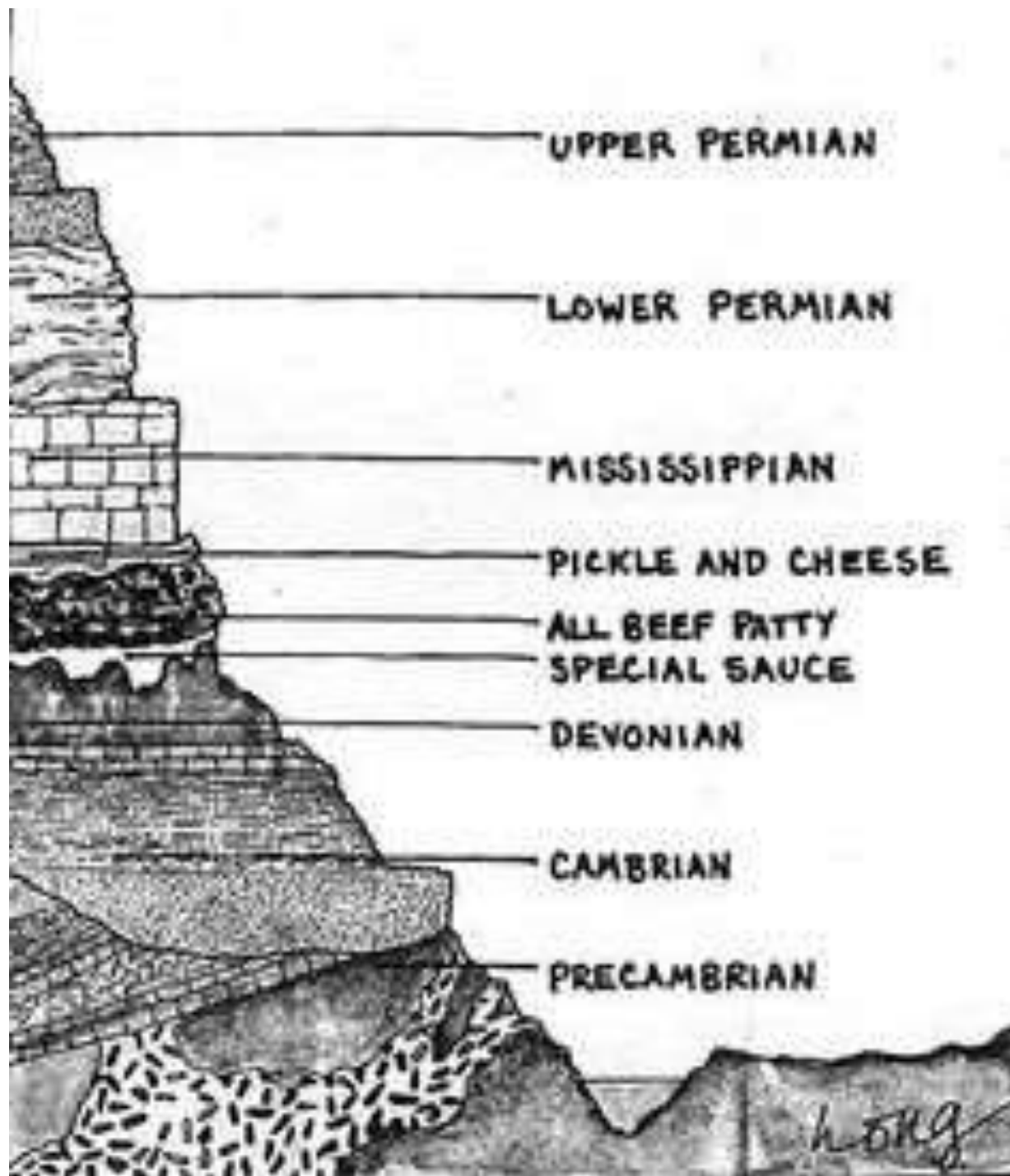
Can you guess what happened?



Check these out!!!

**5000 dinosaur footprints
from the Late Cretaceous
in Bolivia**





Homework:
Complete Awesome
Sedimentary Structures
Review sheet

#6 - Sedimentary Environments

&

**Factors Influencing Sedimentary
Character:**

There are MANY different sedimentary environments

BUT basically THREE General Types:

1- Continental

2- Coastal

3- Marine

These can be broken down into either...

a. Clastic / Detrital

or

b. Chemical / Biological

Clastic / Detrital



Inorganic
Chemical

Chemical sediment
(organic)

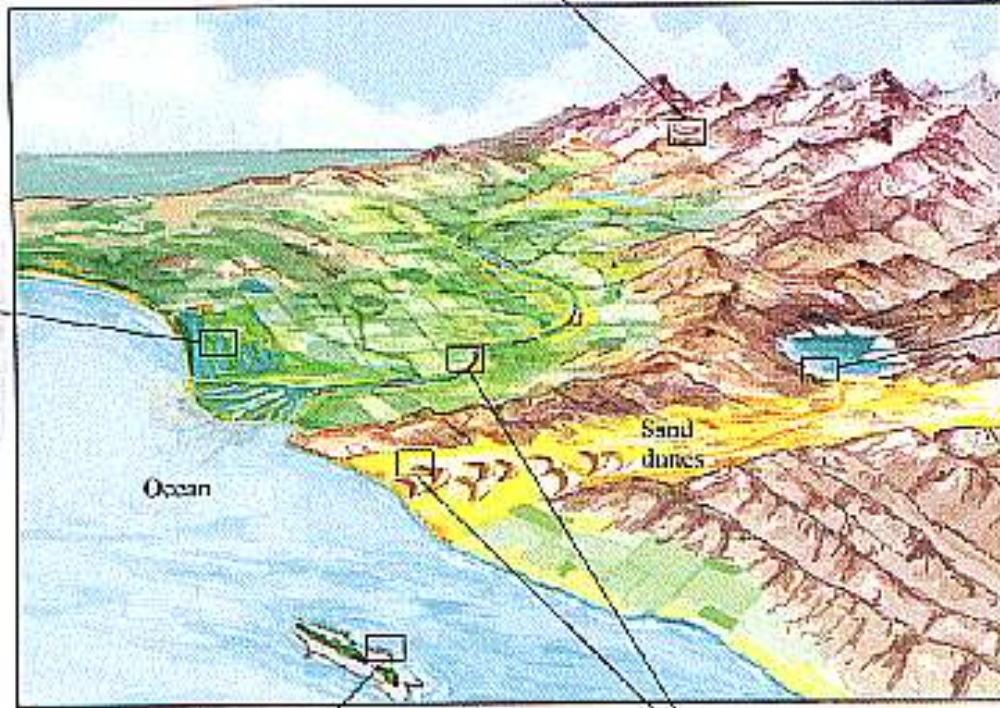


Organic
Chemical

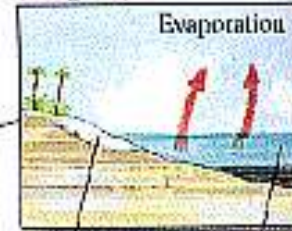
Microscopic marine organisms



Coral reef



Chemical sediment
(inorganic)



Detrital sediment

Clastic /
Detrital

Some Basic Examples of Sedimentary Environments!

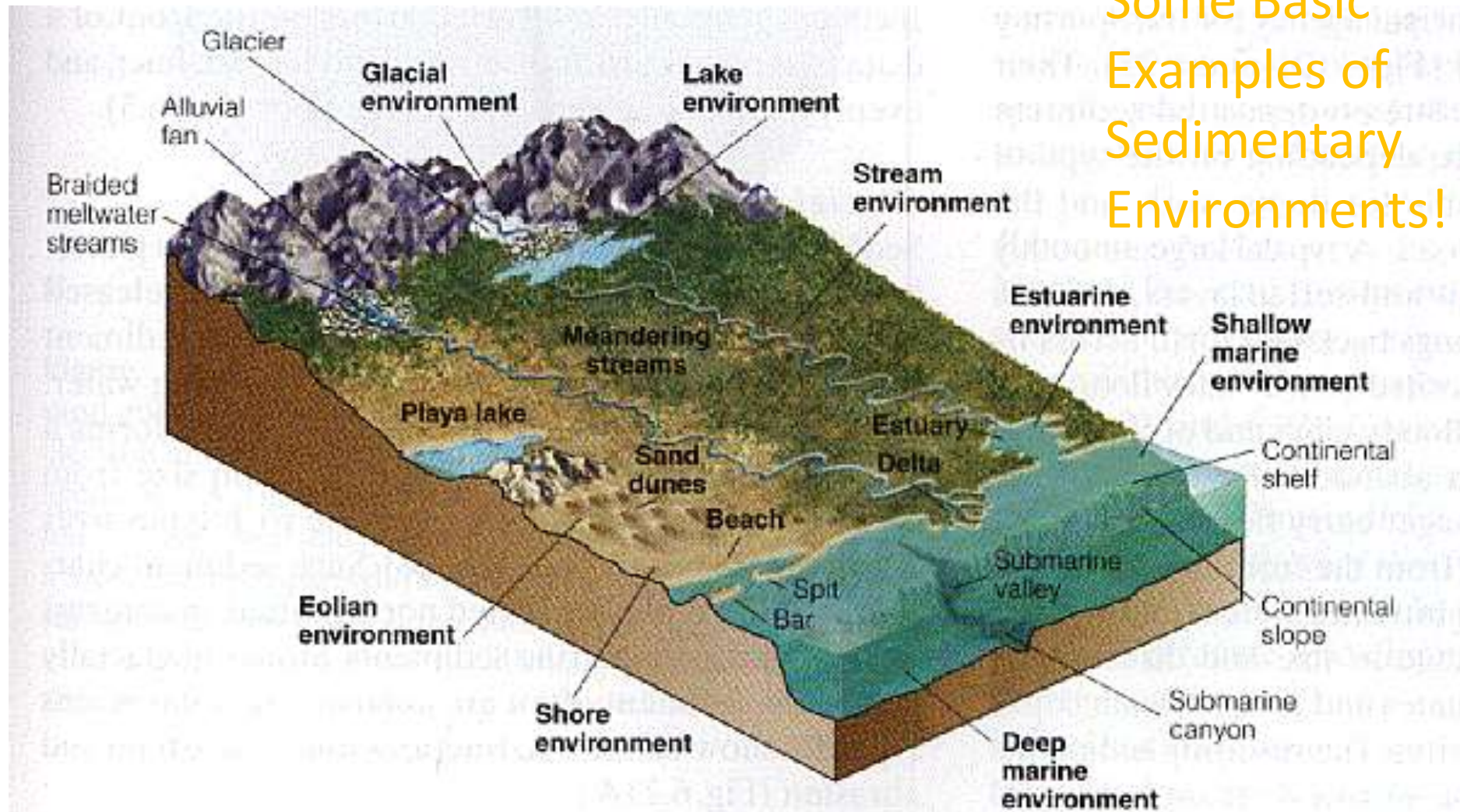


Figure 6.21 Depositional Environments Various depositional environments are seen while traveling from the crest of a mountain range across the edge of a continent to the adjacent margin of a nearby ocean basin.

General Sedimentary Environments:

- **Continental**



- **Coastal**



- **Marine**



Continental:

- **Rivers - *Fluvial***
- **Lakes - *Lacustrine***
- **Swamp - *Paludal***
- **Talus / Scree Slopes**
- **Glaciers**
- **Alluvial Fans**
- **Deserts**

Note!!

- These Next lists are GENERAL EXAMPLES Only!
- **Sedimentary Environments are complex.**
- There are a wide ranges of possibilities for any given environment.
- The net results are from an complex interaction of MANY FACTORS!
- Factors include: ***Composition of source material, Distance from source, Topography, Energy of Transport Medium, Nature of Depositional Environment, Etc...***

Rivers (*Fluvial*):

- **Energy** - Ranges from: HIGH (Flood or large rivers) to LOW (Non-Flood Season or Small streams).
- **Grain Size** - Get smaller as you travel away from source
- **Rounding** - Increases as you travel away from source or energy increases.
- **Sorting** - Increases downstream
- **Rock Types** - CLASTIC - Conglomerate, Breccia, Sandstone, Mudstones.
- **Sedimentary Structures** - Ripple Marks(Asymmetrical), Graded-Bedding, Laminations, Stratification, Mud-Cracks (on shores), Flutes, Rain imprints, Cross-Bedding, Plant/Animal Structures.

This is an example of a High Energy Fluvial Environment!

How can you tell?



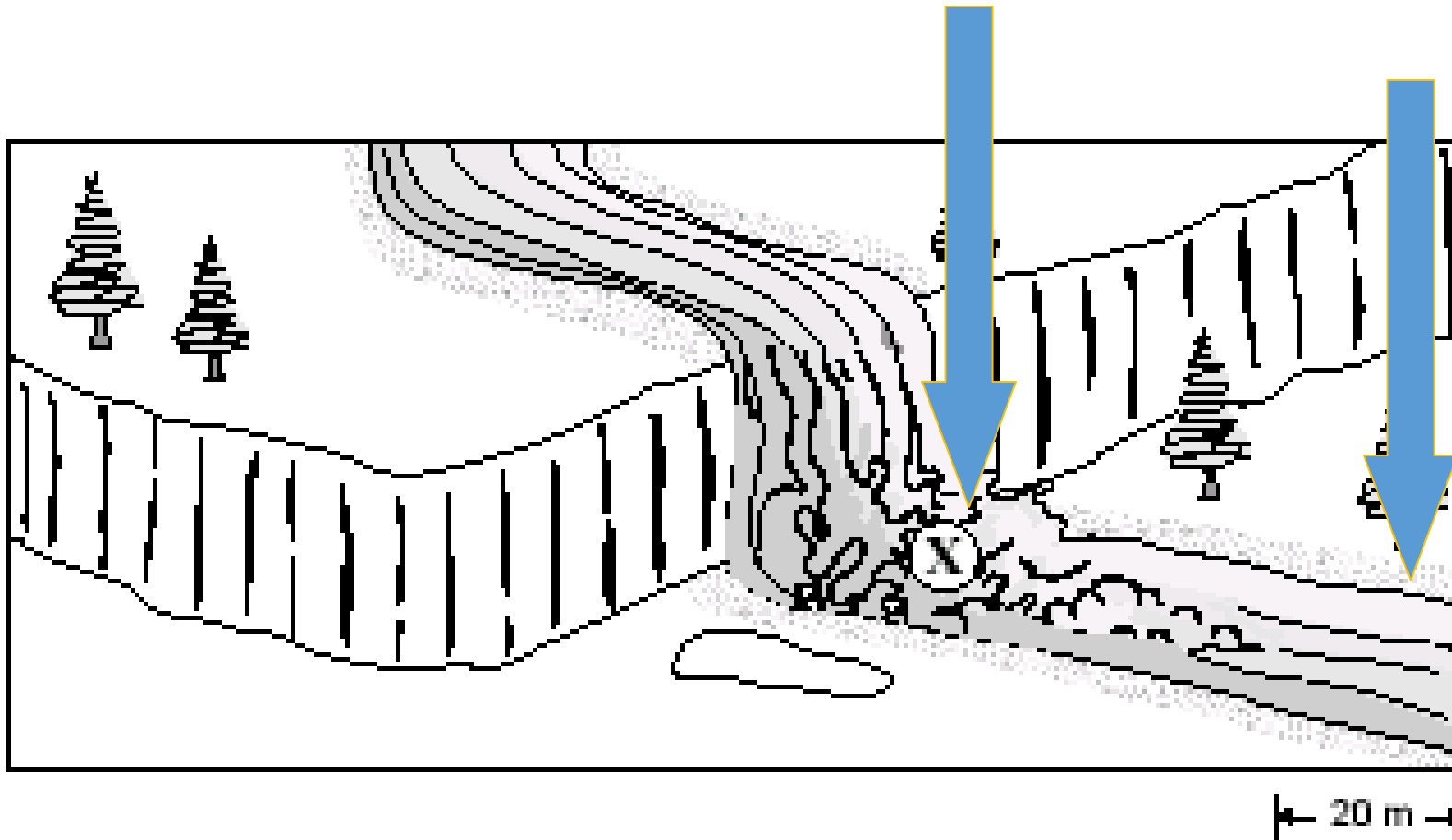
What comments can you make about this photo?



**This is a medium energy
river system...distant from source!**



What type of grains would you expect here & Why?



Look how **smooth** Shannon Creek has made the walls of Shannon Falls!



What can you say about grain type and location in the river?

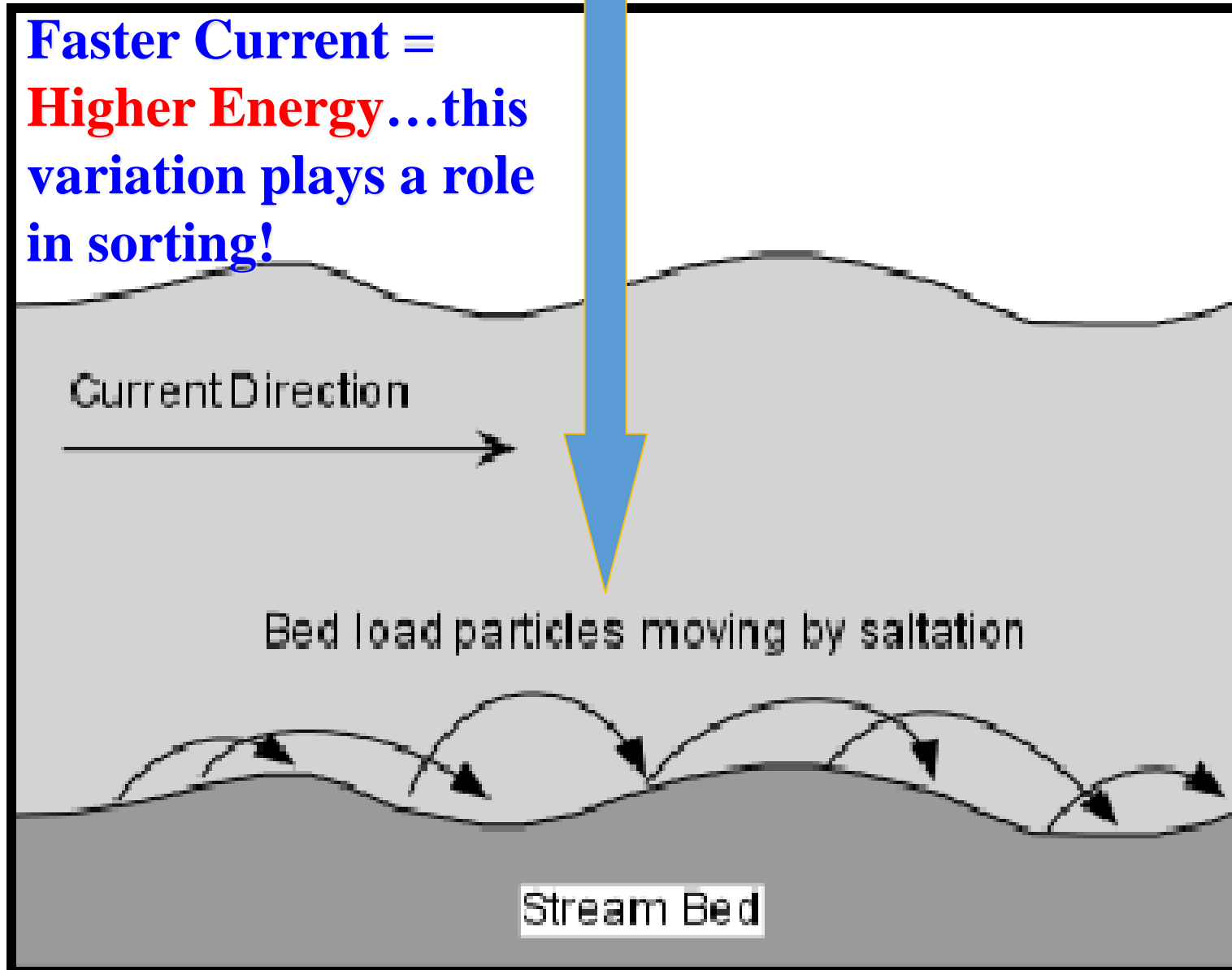


Try to identify layers with high Energy!



This constant banging & crashing creates “Rounding”

Faster Current =
Higher Energy...this
variation plays a role
in sorting!



Lakes (*Lacustrine*):

- **Energy** - Generally LOW
- **Grain Size** - Clay/Silt on bottom, Sand/Gravel on shores.
- **Rounding** - usually more round than rivers, esp.. lake bottom sediments
- **Sorting** - Intermediate on shores to excellent on bottom.
- **Rock Types** - CLASTIC - Various Mudstones, Limestone,
CHEMICAL - Evaporites (Halite, Gypsum)
- **Sedimentary Structures** -Ripple Marks (Symmetrical), Cross-Bedding,
Graded-Bedding, Laminations, Stratification,
Mud-Cracks, Varves, Rain imprints,
Plant/Animal Structures.

Swamp (*Paludal*):

- **Energy** - Low
- **Grain Size** - Varies with location but usually small.
- **Rounding** - Varies with location but usually well rounded.
- **Sorting** - Well to intermediate sorting.
- **Rock Types** - CLASTIC - Mudstones, Sandstone.
BIOLOGICAL - Peat, Coal
- **Associated Sedimentary Structures** - Will Vary Widely with Nature of Swamp but may include:

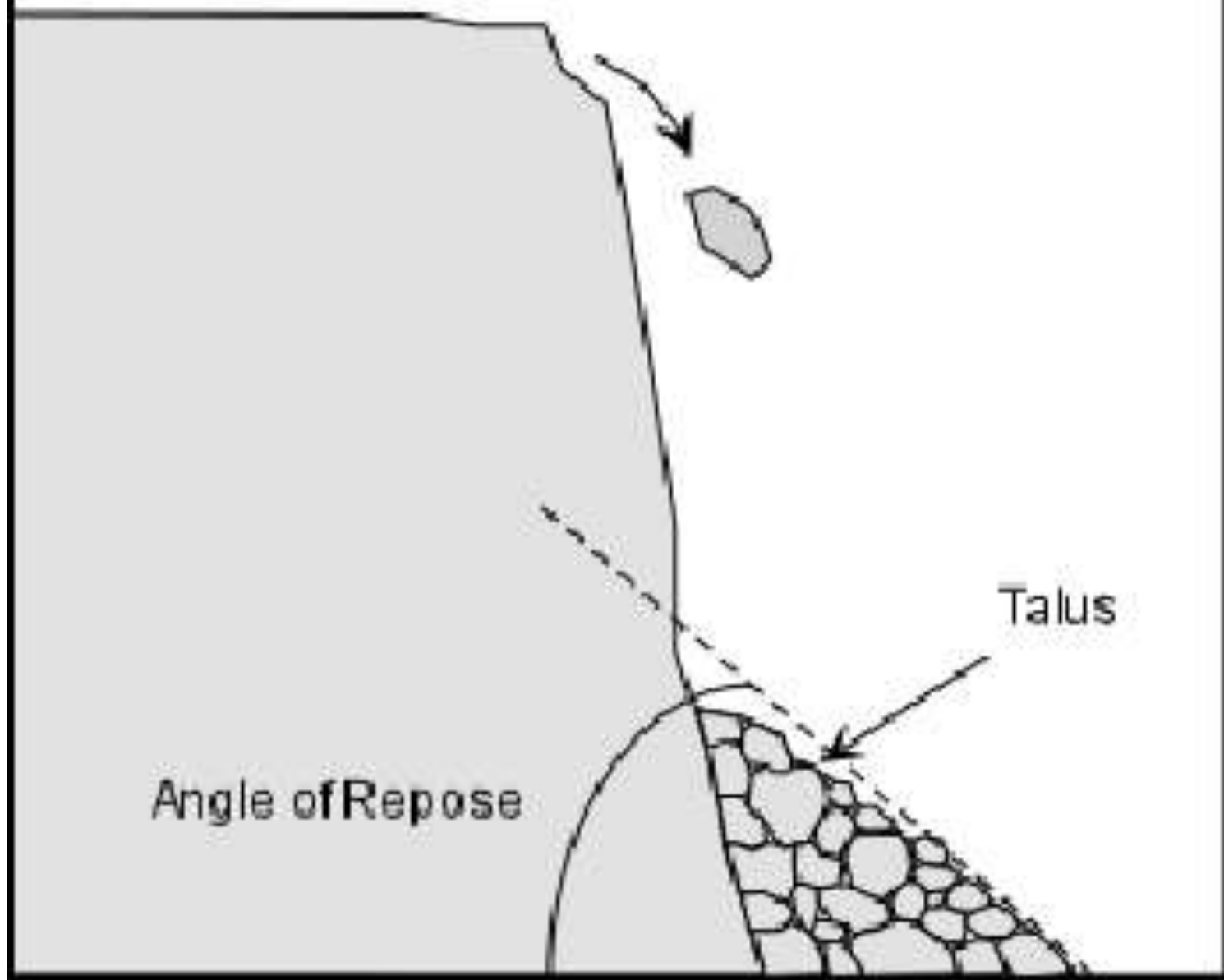
Ripple Marks, Cross-Bedding, Graded-Bedding,
Laminations, Stratification, Mud-Cracks, Flutes, Rain imprints,
Plant/Animal Structures



Talus / Scree Slopes:

- **Energy** - Low at times of rest, High at times of Rock Fall/Slide.
- **Grain Size** - LARGE.
- **Rounding** - POOR
- **Sorting** - POOR.
- **Rock Types** - Broken chunks of Pre-Existing Rocks Only!!
- **Associated Sedimentary Structures** -None!

Rock and Debris Falls





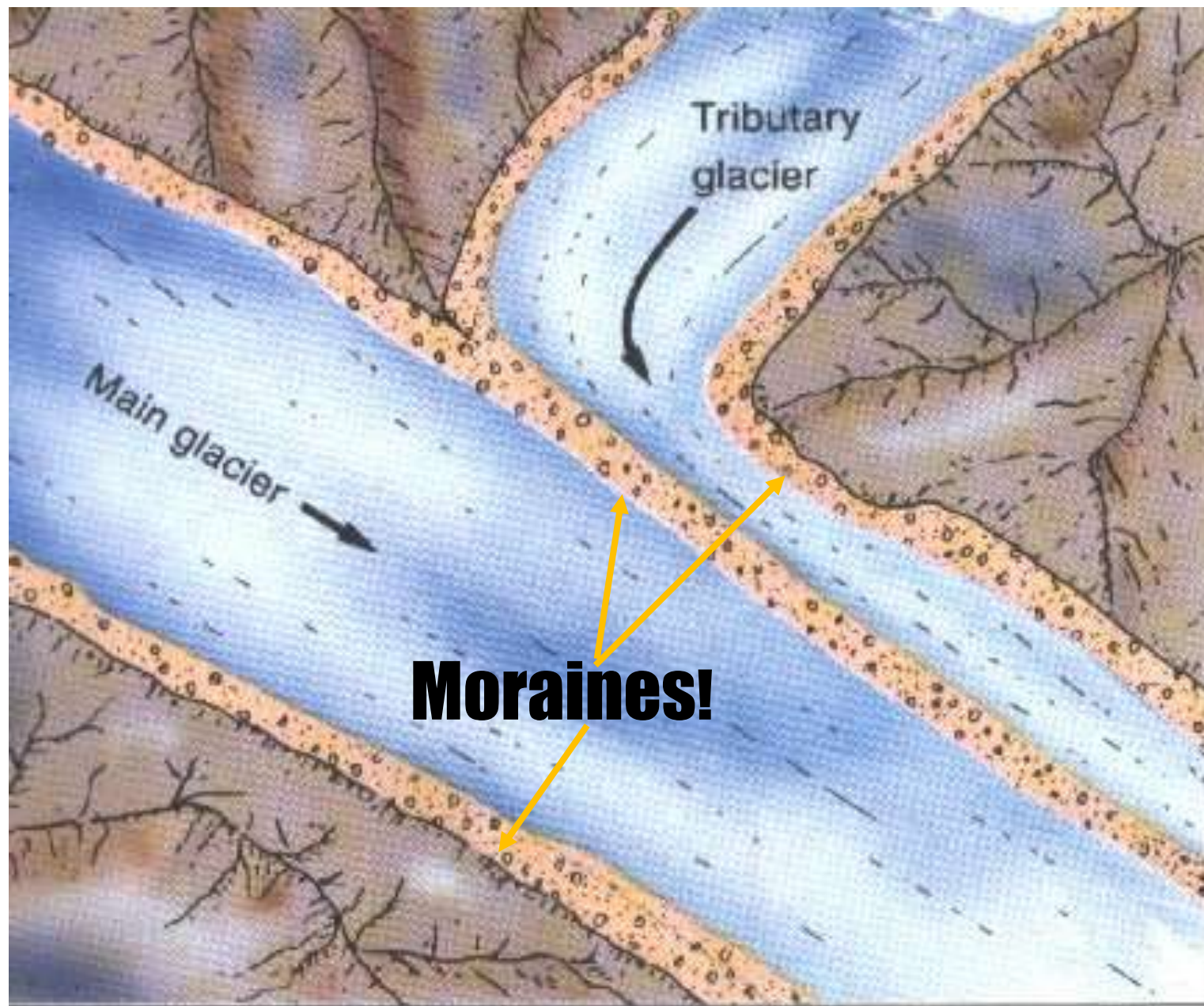
**We call this the
angle of
repose...why do
you think it is
significant?**

Note the angle again!



Glaciers (*Glacial*):

- **Energy** - Low & Slow!
- **Grain Size** - Wide Range from “Rock Flour” to Boulders = TILL!
- **Rounding** - POOR
- **Sorting** - POOR
- **Rock Types** - TILL Only!
- **Sedimentary Structures** - Usually associated with GLACIAL WATER BODIES...
 - Moraines = various sized & shaped piles of TILL!
 - Glacial Lakes = structures associated with normal lakes + VARVES!
 - Glacial Rivers & Streams = structures associated with normal Streams / Rivers!



Moraines!

*composed of:
poorly sorted, poorly rounded TILL!*

Note the massive erosive power of a glacier!



Look at the
size of the
moraines!

Some typical Glacial Water Courses!

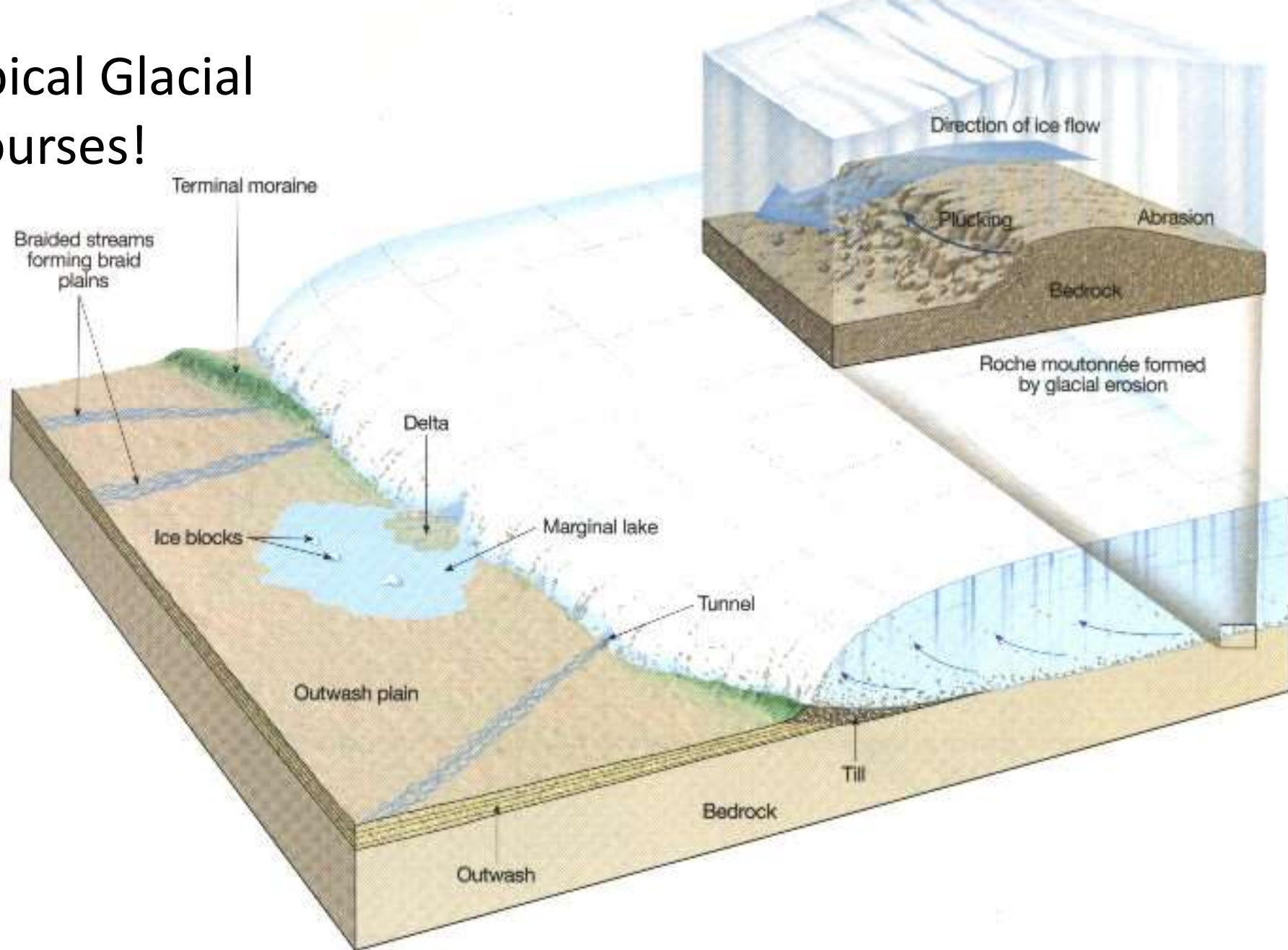
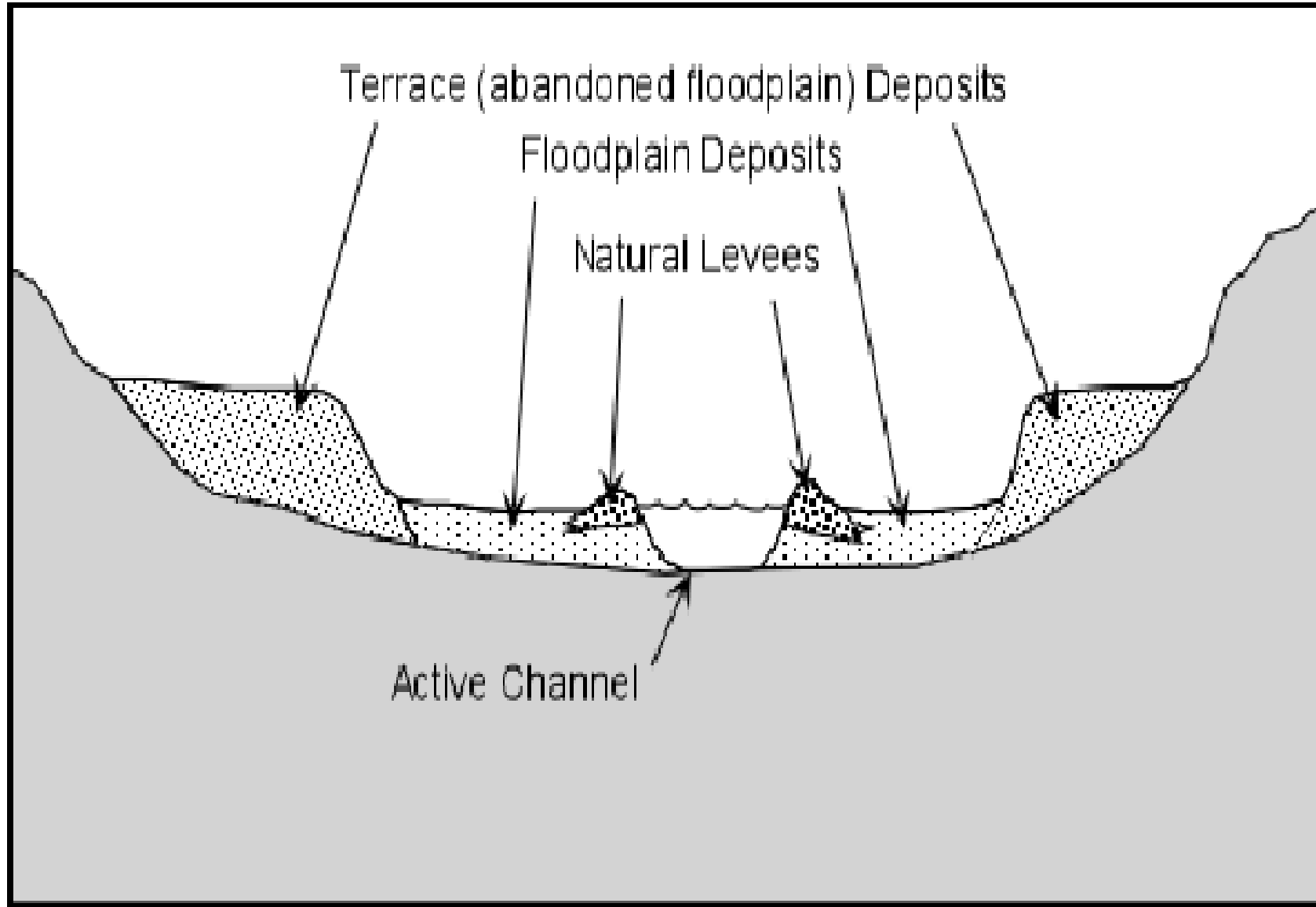
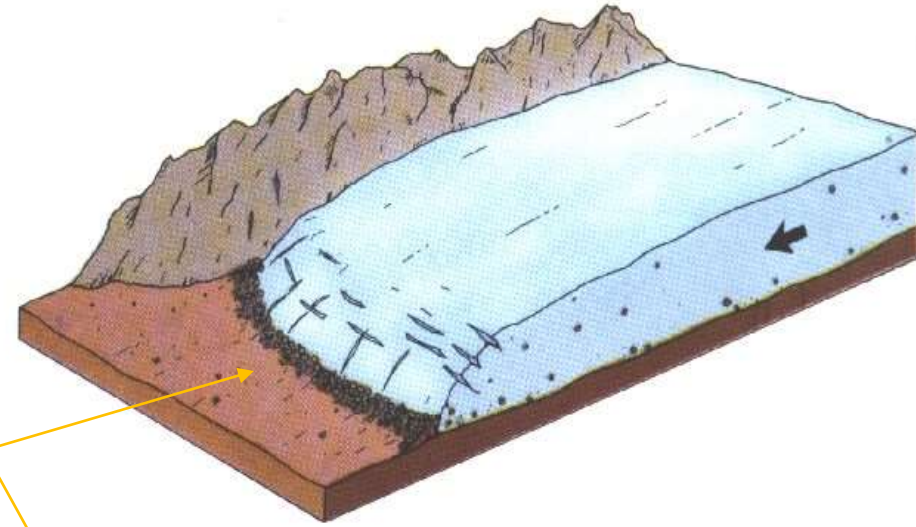


FIGURE 13.6 Continental glaciation produces these characteristic landforms at the beginning of ice wastage (decrease in glacier size due to severe ablation).

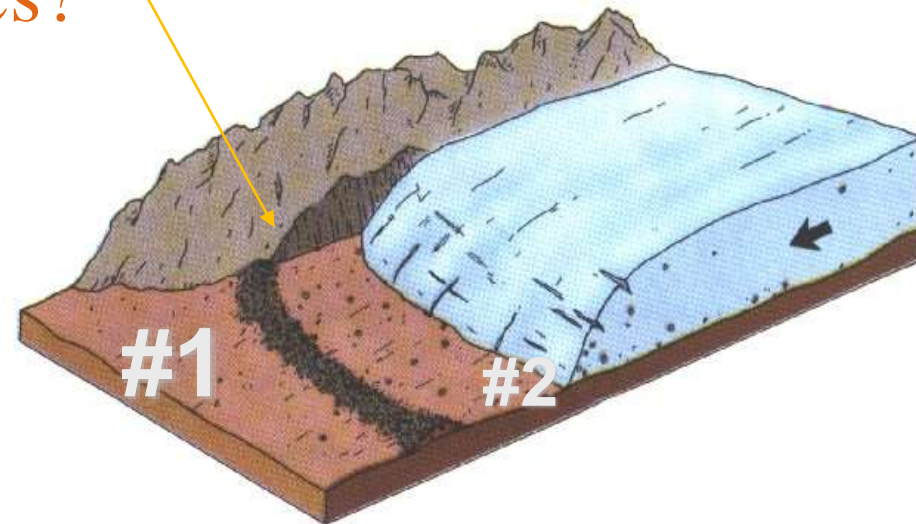
Discuss how **Rounding & Sorting** might vary at different locations on this diagram!





What is this called?
What is it made of?
What are its characteristics?

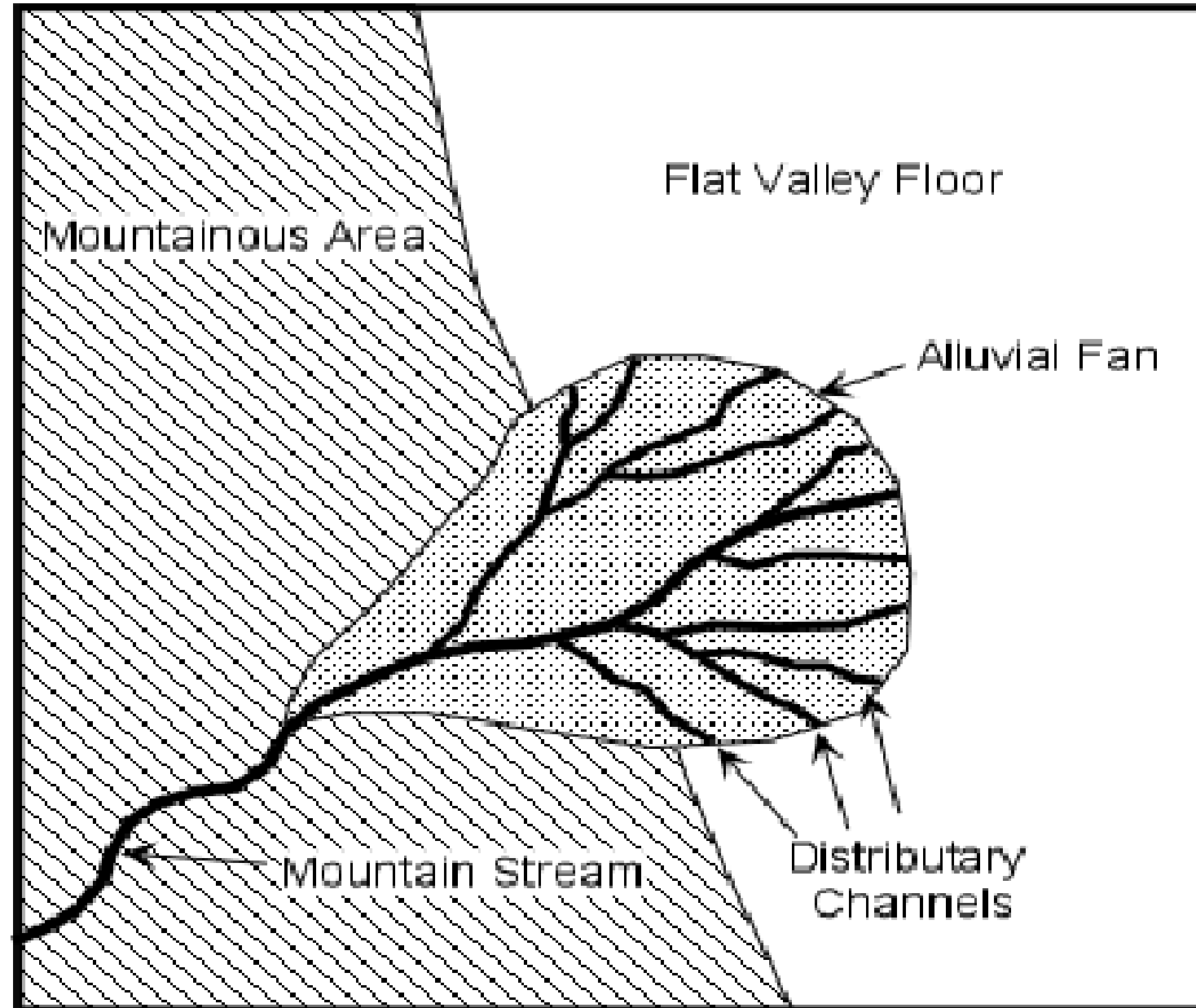
Discuss Possible differences
between location #1 & #2!



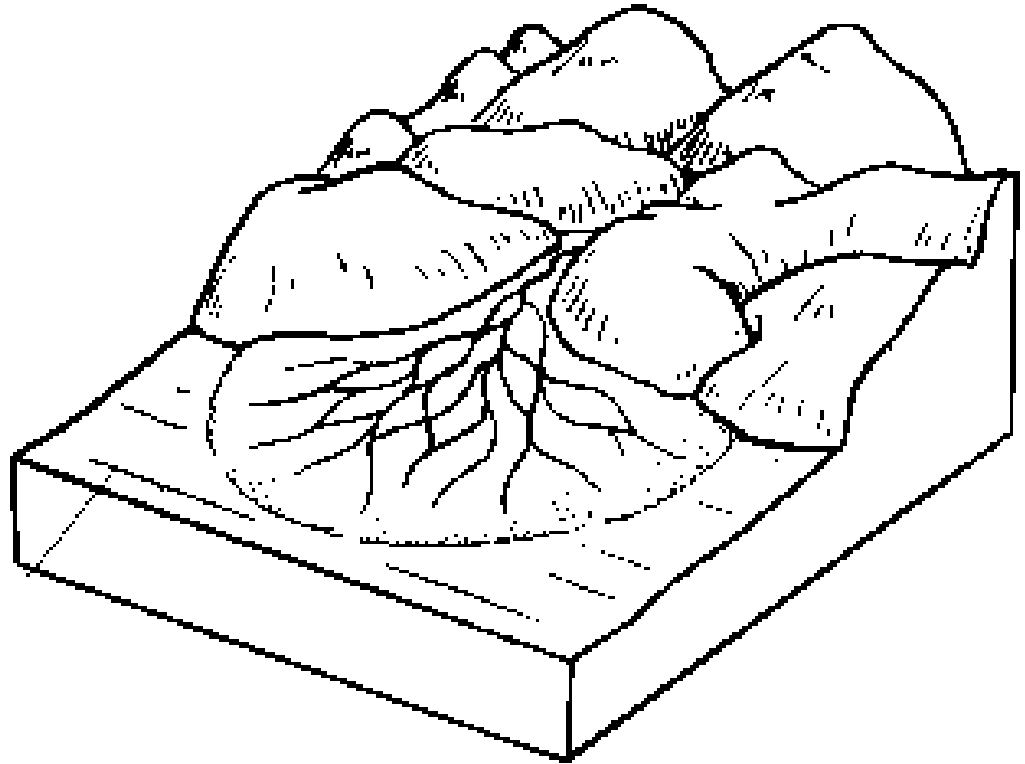
Alluvial Fans:

- **Energy** - Varies from Low when inactive to High when active.
- **Grain Size** - Ranges from Clay To Gravel.
- **Rounding** - Poor
- **Sorting** - Poor
- **Rock Types** - CLASTIC - Conglomerate, Breccia, Sandstone, Mudstones.
- **Sedimentary Structures** - Cross-Bedding, Graded-Bedding, Stratification, Plant/Animal Structures

Alluvial Fan Seen From Above!



An alluvial fan:



Deserts:

- **Energy** - Depends mostly on wind speed...Varies from Low to High.
- **Grain Size** - Sand
- **Rounding** - Excellent
- **Sorting** - Excellent
- **Rock Types** - CLASTIC - Sandstone & occasional Mudstones.
- CHEMICAL - Evaporates like Halite & Gypsum.
- **Sedimentary Structures** - Cross-Bedding, Stratification,
Plant/Animal Structures,
occasional Mud cracks & Rain prints



Coastal:

- **Beaches**
- **Deltas**
- **Estuaries**
- **Lagoons**

Beaches:

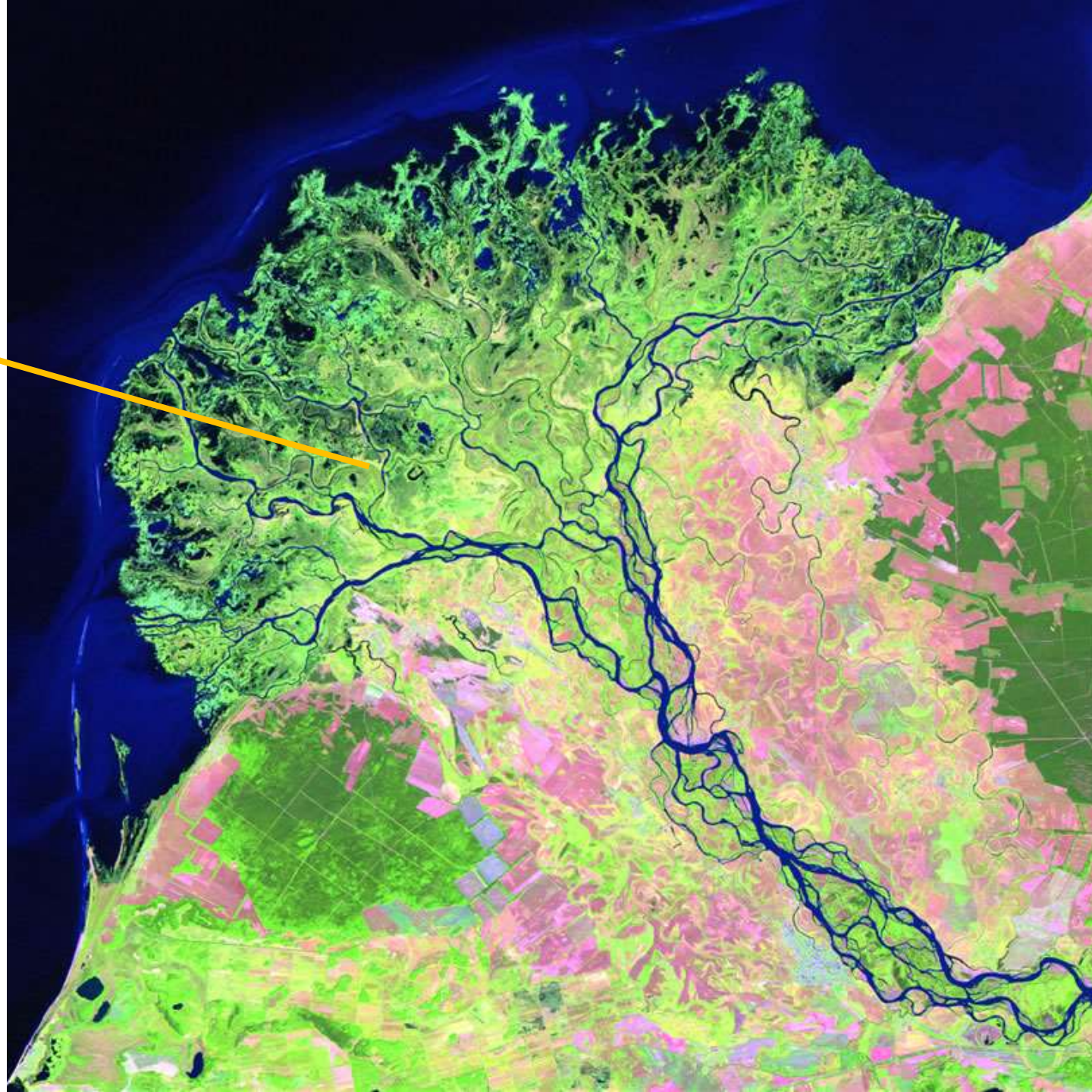
- **Energy** - Moderate to High.
- **Grain Size** - Sand.
- **Rounding** - Good to Excellent.
- **Sorting** - Good to Excellent.
- **Rock Types** - CLASTIC - Sandstone & occasional Mudstones
- **Sedimentary Structures** - Ripple Marks (symmetrical),
Cross-Bedding, Stratification,
Plant/Animal Structures, occasional Rainprints



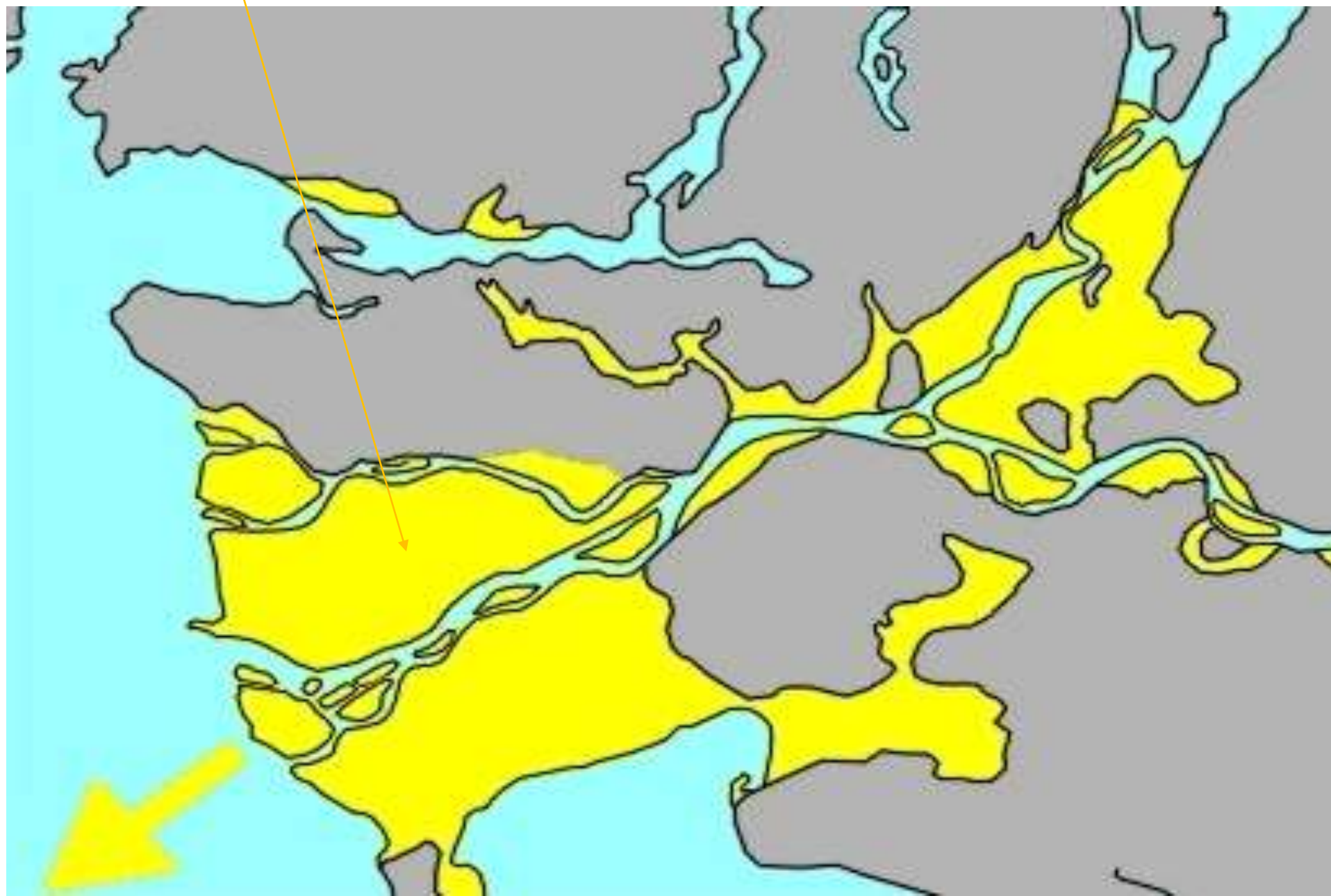
Deltas (*Deltaic*):

- **Energy** - Varies over course of year from high to low depending on river flood cycles!
- **Grain Size** - Clay to Sand & occasional Gravel.
- **Rounding** - Varies with flood cycles but tend to be rounded.
- **Sorting** - Generally poor.
- **Rock Types** - CLASTIC - Sandstone, Mudstone, Some Conglomerate & Breccia.
- **Sedimentary Structures** - Some Ripple Marks (both types depending on location), Cross-Bedding, Graded-Bedding, Stratification, Flutes, Plant/Animal Structures, occasional Rainprints

Delta



Yellow area represents Fraser River Delta Deposits!



Estuaries:

- **Energy** - Low
 - **Grain Size** - Clay to Sand
 - **Rounding** - Usually far from source so usually Good to Excellent.
 - **Sorting** - Usually far from source so usually Good to Excellent.
- Rock Types** - CLASTIC - Mudstones, Sandstone.
- **Sedimentary Structures** - Rainprints, Laminations, Stratification, Mud-Cracks, Plant/Animal Structures

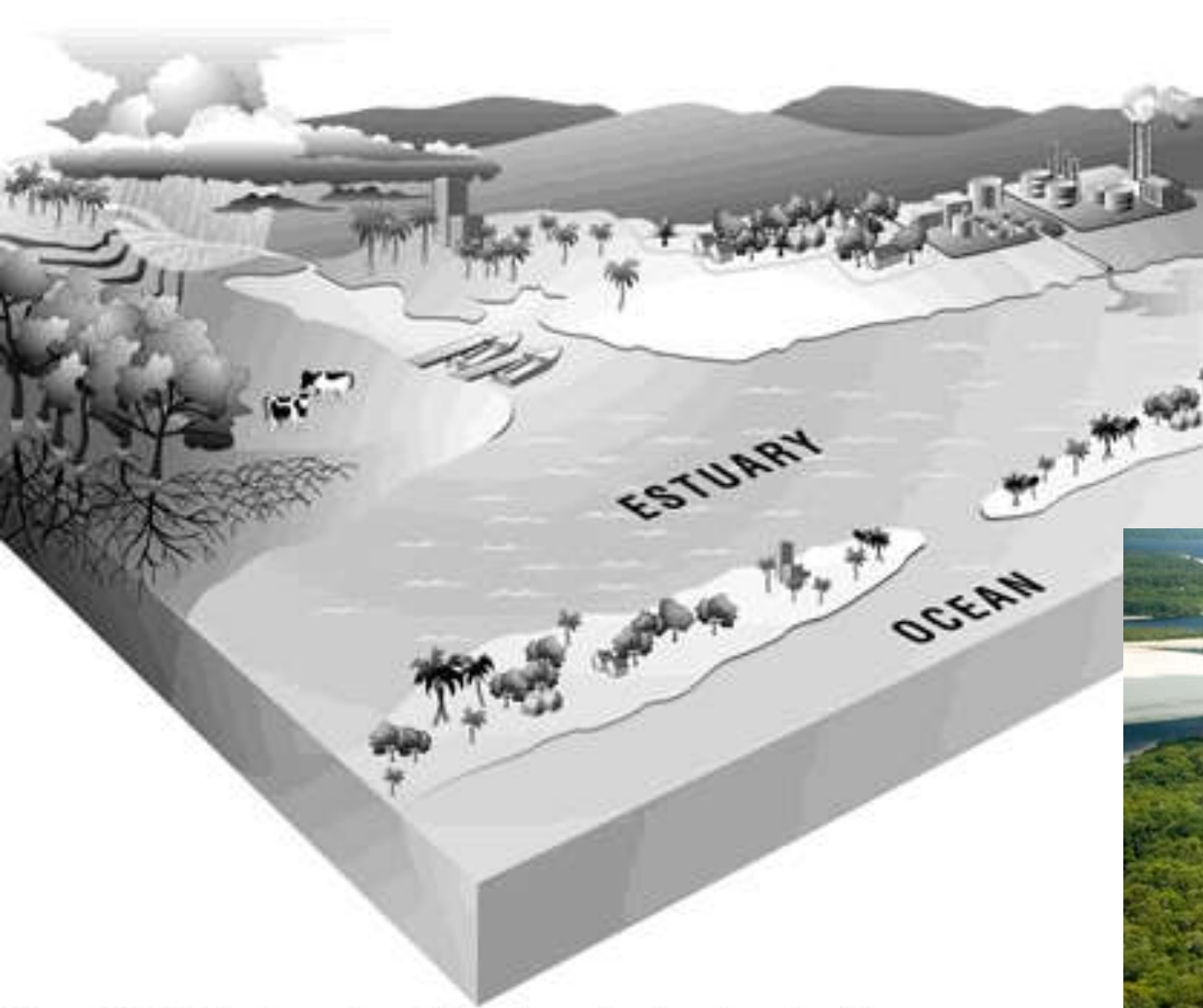


Figure 2-2. Estuaries are transitional zones between land and the ocean
(redrawn from EPA Web site: <http://www.epa.gov/owow/oceans/factsheets/fact5.htm>)

E S T U A R I E S



WHERE RIVERS MEET THE SEA

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Lagoons:

- **Energy** - Low
- **Grain Size** - Clay & Silt
- **Rounding** - Good
- **Sorting** - Moderate...close to source
- **Rock Types** - CLASTIC - Mudstone
 - CHEMICAL - Evaporates like Gypsum & Halite.
 - BIOLOGICAL - Limestone from coral reefs.
- **Sedimentary Structures** - Ripple Marks (Symmetrical),
Cross-Bedding, Laminations, Stratification

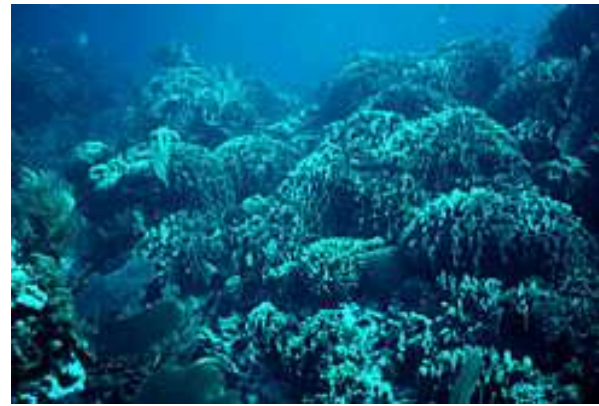


Marine:

- **Reefs**
- **Continental Shelf**
- **Continental Slope & Rise**
- **Abyssal Plain**

Reefs:

- **Energy** - LOW
- **Grain Size** - Usually **Chemical precipitation** of Carbonate (Calcareous) therefore grain size not really applicable!
- **Rounding** - Not Applicable.
- **Sorting** - Not Applicable.
- **Rock Types** - CHEMICAL - Limestone from sea creature's shells.
- BIOLOGICAL - Limestone from coral reefs.
- **Sedimentary Structures** - Lots of Fossil Sea Shells / Creatures!

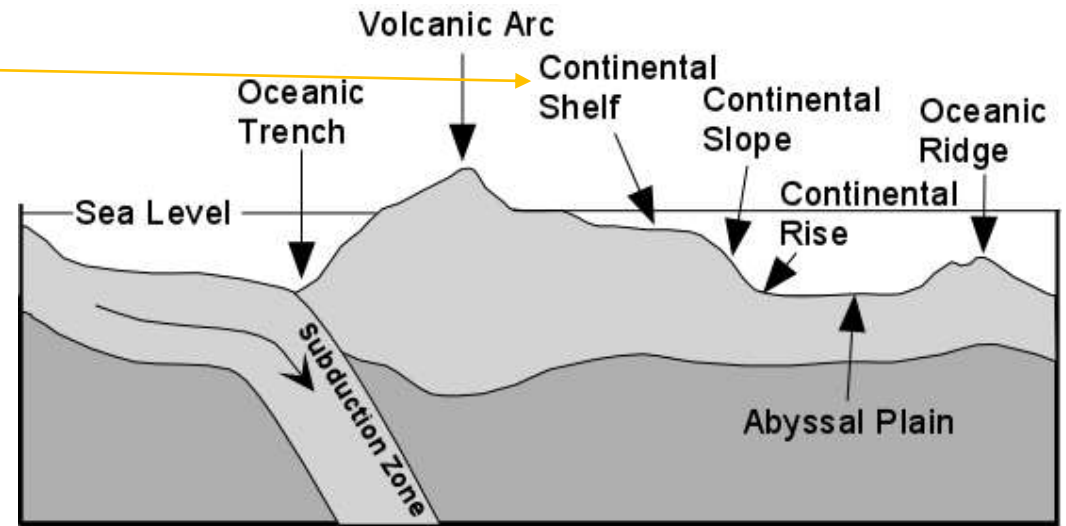


Mike White - Florida Keys NMS



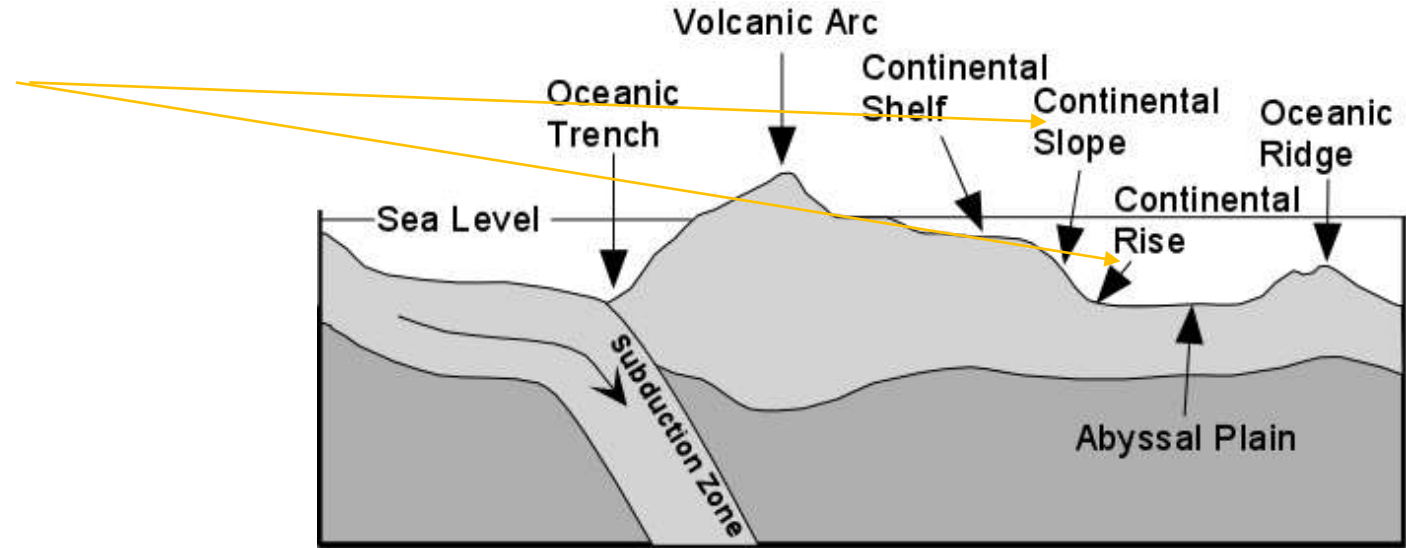


Continental Shelf:



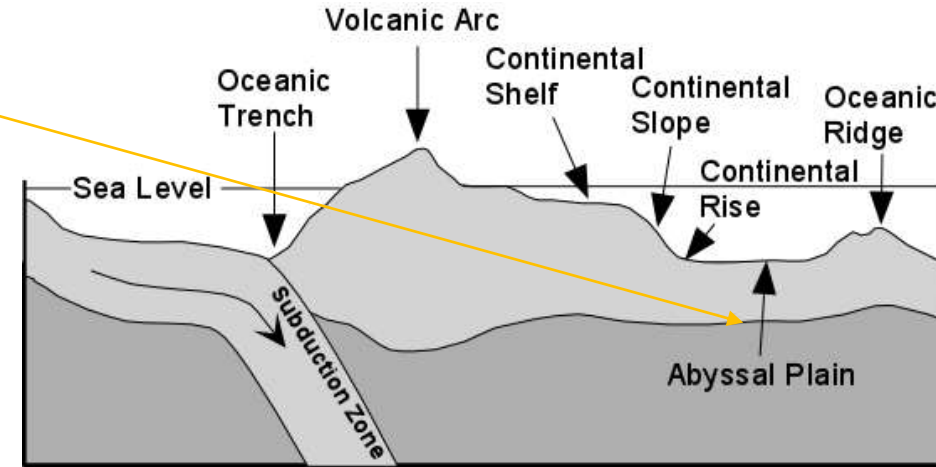
- **Energy** - Low to Moderate during flood season...lots of river outflow!
- **Grain Size** - Clay to Sand
- **Rounding** - Moderate to Excellent.
- **Sorting** - Intermediate to Excellent.
- **Rock Types** - CLASTIC - Mudstone & Sandstone.
 - CHEMICAL - Limestone from sea creature's shells.
 - BIOLOGICAL - Limestone from coral reefs.
- **Sedimentary Structures** - Cross-Bedding, Laminations,
Plant/Animal Structures - lots of fossils!

Continental Rise & Slope:



- **Energy** - Low to High during underwater landslides down the rise!
- **Grain Size** - Clay to Sand.
- **Rounding** - Poor (after Slides) to Excellent.
- **Sorting** - Poor (after Slides) to Excellent.
- **Rock Types** - CLASTIC - Mainly Mudstone.
 - CHEMICAL - Limestone from sea creature's shells.
 - BIOLOGICAL - Limestone from coral reefs.
- **Sedimentary Structures** - Laminations, Graded-Bedding & Cross-Bedding, Flutes/Flute casts, Plant/Animal Structures - lots of fossils!

Abyssal Plain:



- **Energy** - LOWEST of the LOW!
- **Grain Size** - Silt, Clay, Mud = Small!
- **Rounding** - Excellent!
- **Sorting** - Excellent!
- **Rock Types** - CLASTIC - Mudstone.
 - CHEMICAL - Limestone from sea creature's shells.
- **Sedimentary Structures** - Fossils of marine Micro-Organisms!

