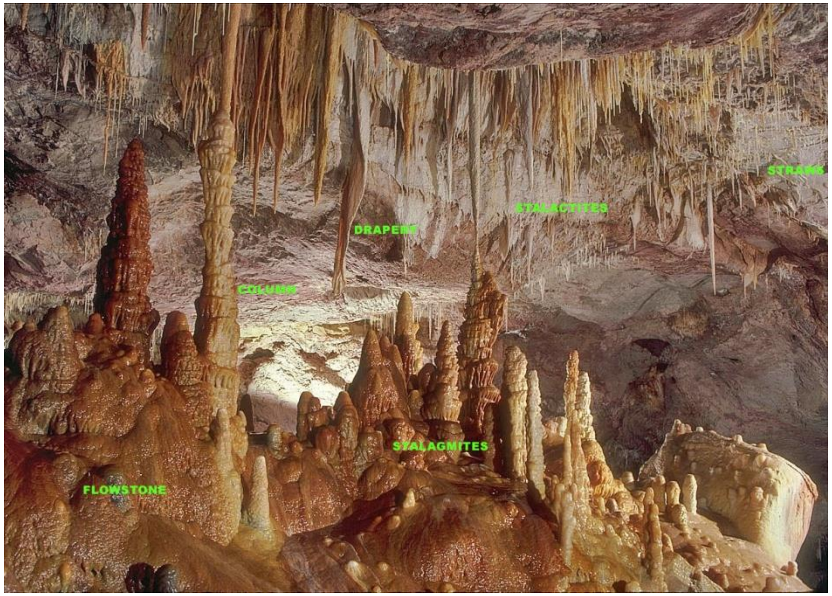
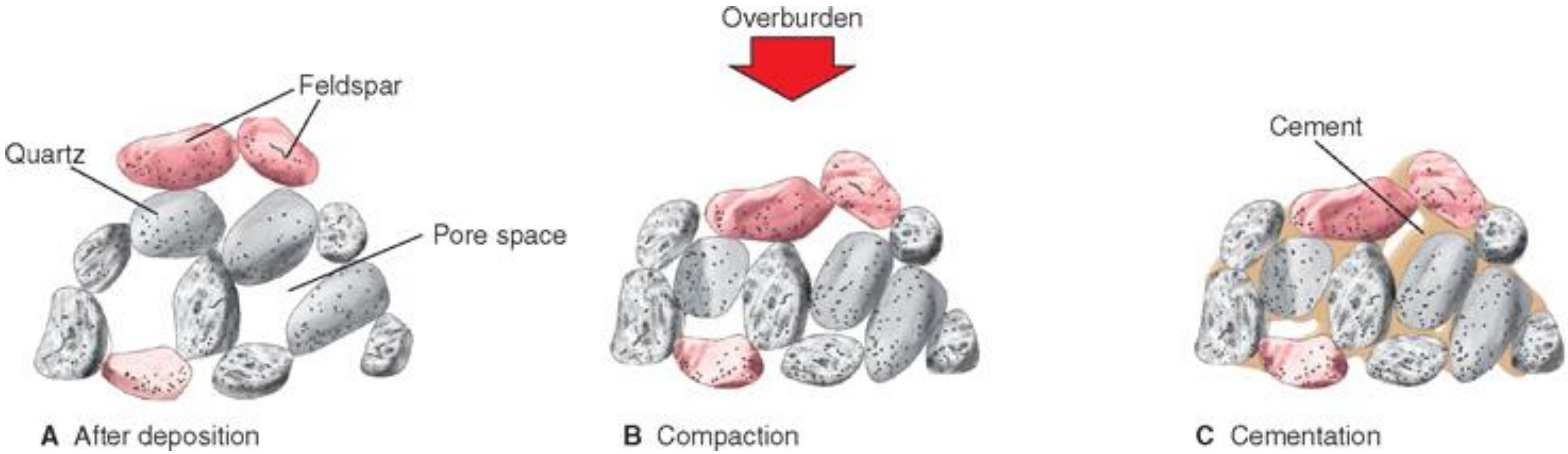
IDC 203: INTRODUCTION TO EARTH SCIENCES



Lithification



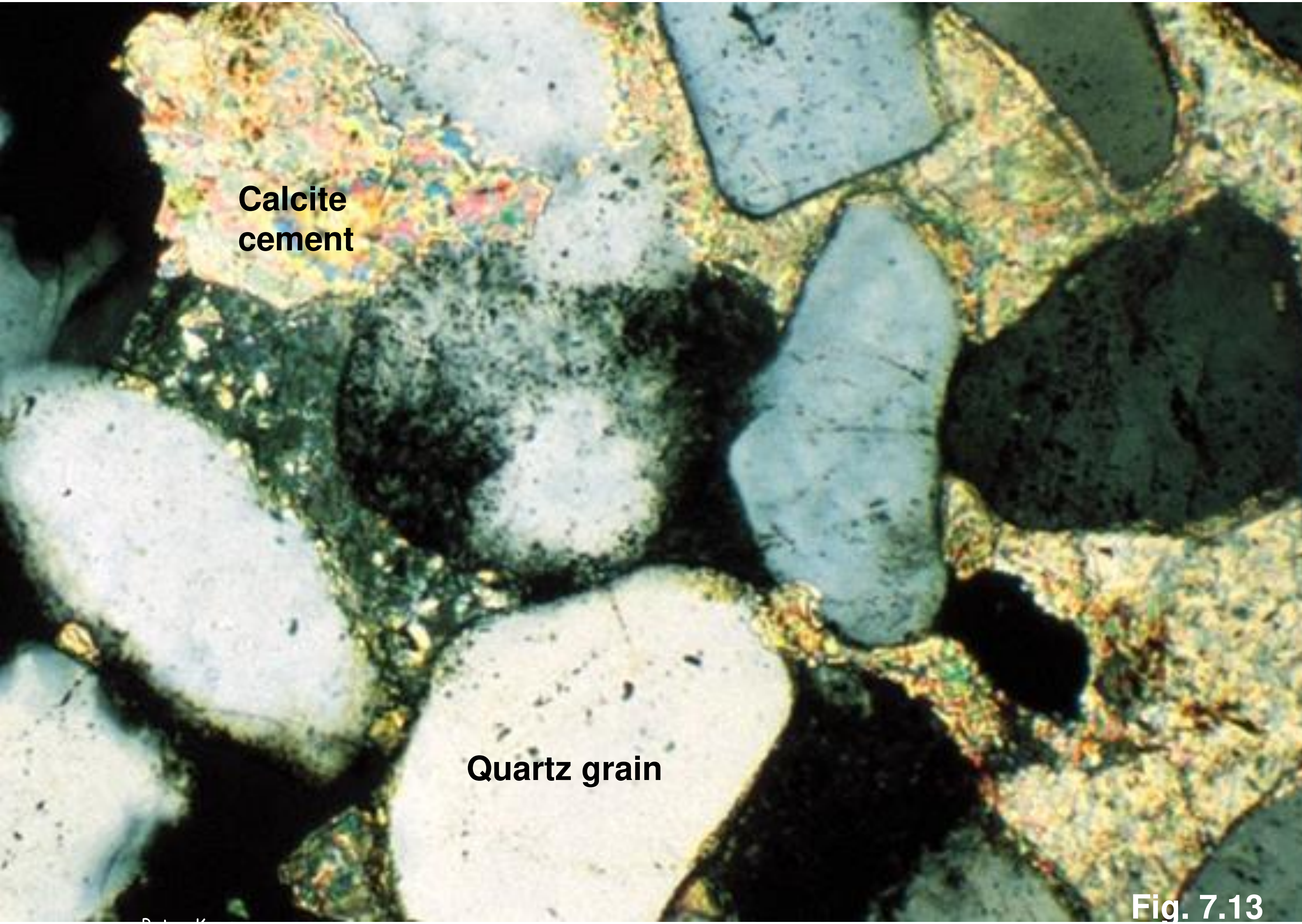


Fig. 7.13

Products of lithification

Mud →	Mudstone and shale
Sand →	Sandstone
Gravel →	Conglomerate
Lime muds, sands, oozes →	Limestone and dolomite

From sediment to sedimentary rock (lithification)

***Compaction*: reduces pore space**

Clays and muds are up to 60% water; 10% water after compaction.

***Cementation*: chemical precipitation of mineral material between grains (SiO_2, $CaCO_3$, Fe_2O_3) binds sediment into hard rock.**

***Recrystallization*: *P* and *T* increase with burial 30°C/km or 1°C/33 m.**

Compaction (Primarily of Muds)

Precipitation of new minerals or additions to existing ones

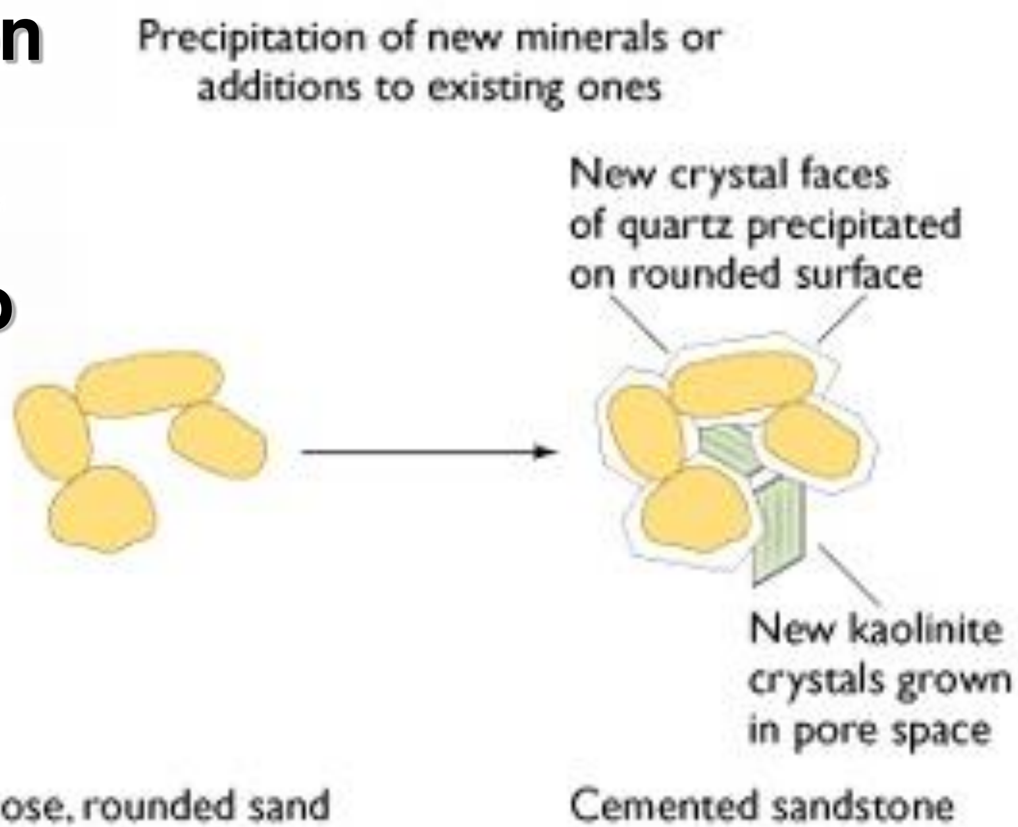


Fig. 7.12

Dissolution of More Soluble Minerals

Recrystallization of Unstable Minerals

Clues to interpreting sedimentary environment

- Sedimentary structures
- Sorting, roundness, sphericity
- Sequence of beds

Environment of deposition

Modern Analogue

- Key to interpreting transport history of sediments and rocks

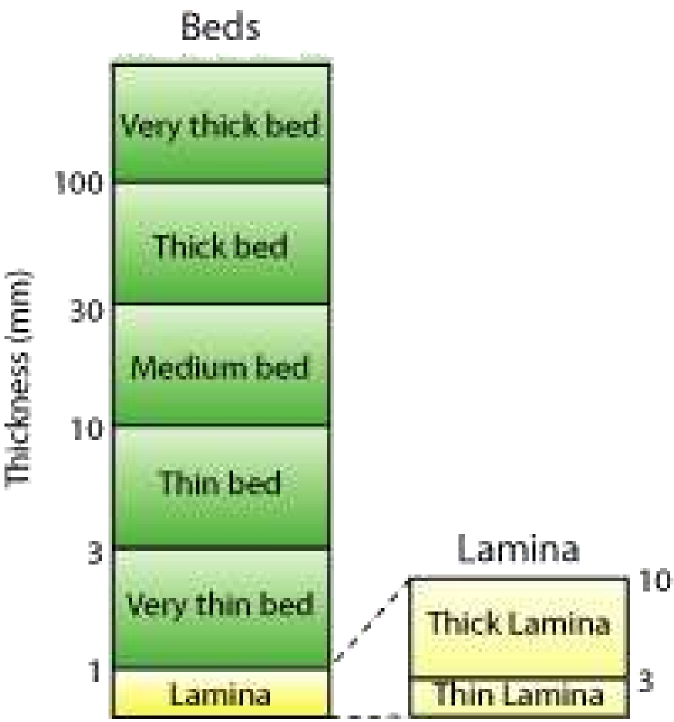
Model

- Based on idea that a "particular set of environmental conditions operating at a particular intensity will produce a sedimentary deposit with a unique set of properties that will identify if as the product of a particular environment"

(Boggs, 2001)

Sedimentary Structures

- *Bedding*
  - Series of visible layers within a rock
  - Most common sedimentary structure



Laminae & Beds (Modified from Boggs 2001)

Sedimentary structures

Stratification = bedding = layering

Produced due to differences in

1. size of particles
2. kinds of particles

Sedimentary structures

Particular structural features can give information about the environment of deposition.

Structures also help determine if a bed is right-side-up.

— this is important in deformed rocks

Environment of deposition

Modern Analogue

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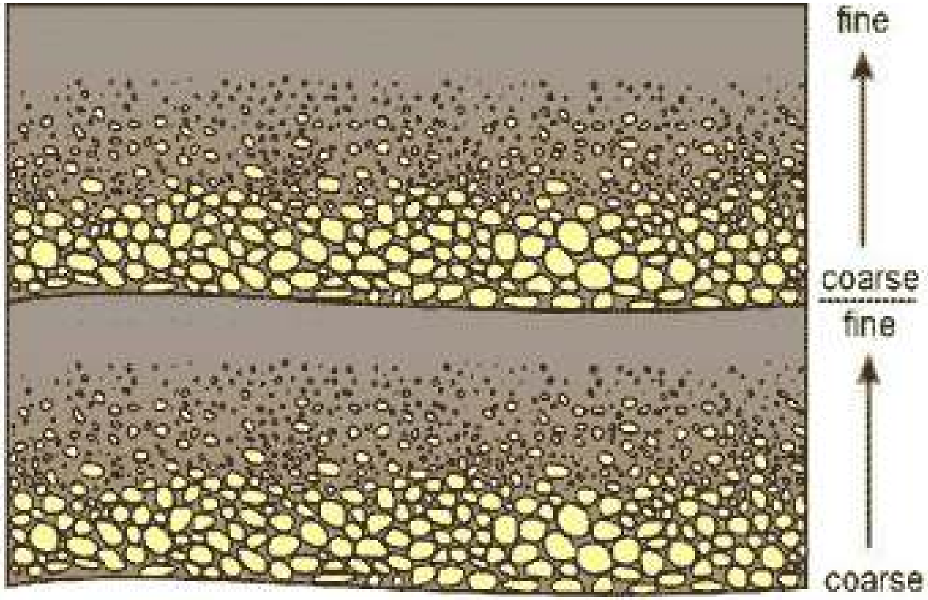
Graded bedding



Scale may be mm to m

Fossils

- Traces of plants or animals preserved in rock

- Hard parts (shells, bones) more easily preserved as fossils

Bioturbation tracks and tunnels

Fossils

Streams: transport to the ocean

Rivers and streams

Stream **: body of water flowing in a channel**

The floor of the channel is called the *bed*.

When rainfall is very heavy or snow melts rapidly, bodies of water overflow their banks and water covers the adjacent land called the *floodplain*.

RIVERS AND STREAMS

Carry away runoff to lakes and seas

Erode land (degradation)

Transport and deposit sedimentary debris

STREAM BEHAVIOR

Mostly determined by velocity and shape of channel.

These factors combine to allow either laminar or turbulent flow.

Turbulent flow is much more erosive.

Stream velocities may vary from 0.25 to 7 m/s.

LAMINAR FLOW

Smooth sheet-like flow at a low velocity

Usually confined to edges and top of stream

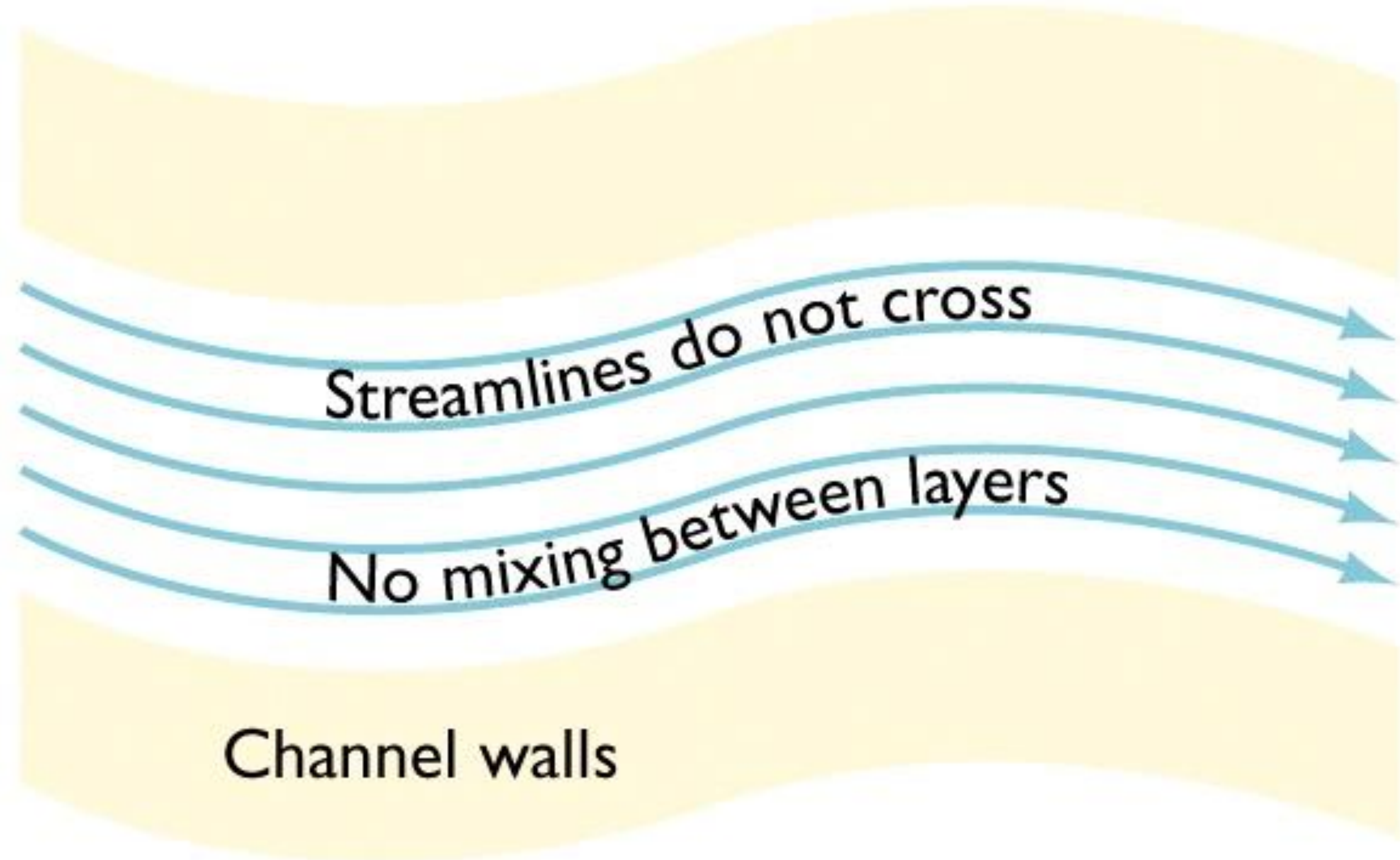
TURBULENT FLOW

Irregular swirling flow

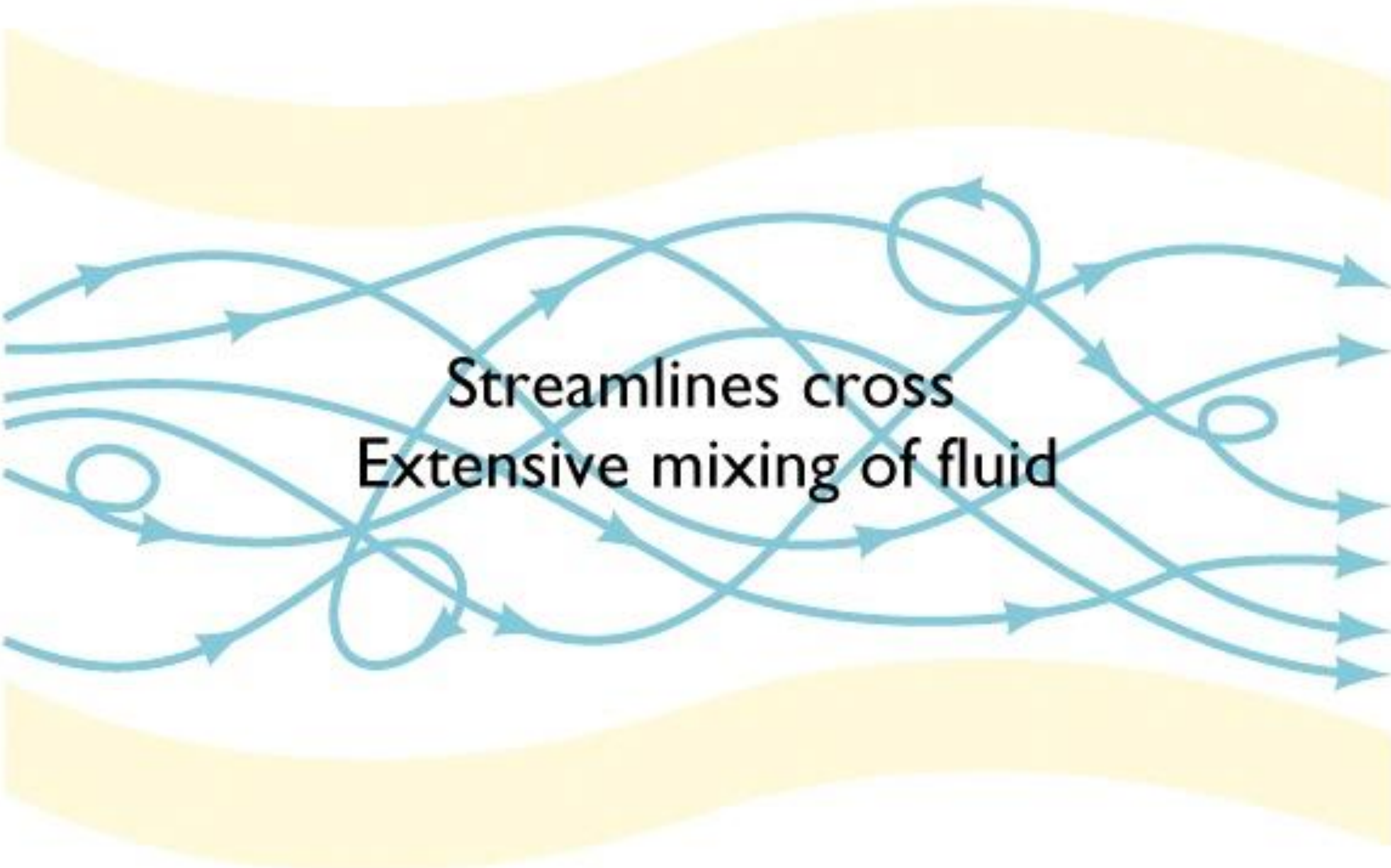
Occurs at most rates of stream flow

Keeps particles in suspension

LAMINAR FLOW

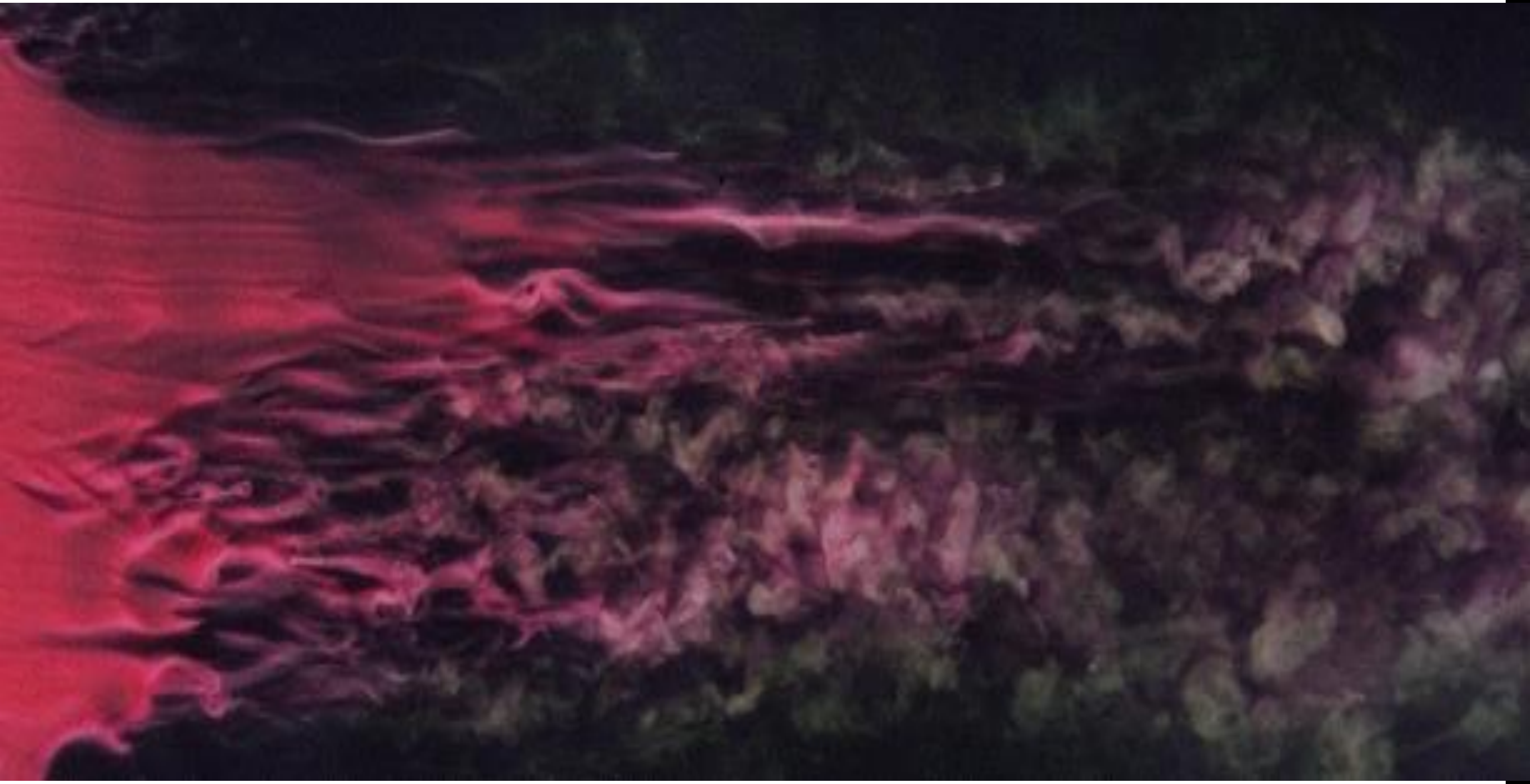


TURBULENT FLOW



LAMINAR TO TURBULENT TRANSITION

Laminar flow **Turbulent flow**



ONERA

Fig. 13.1c

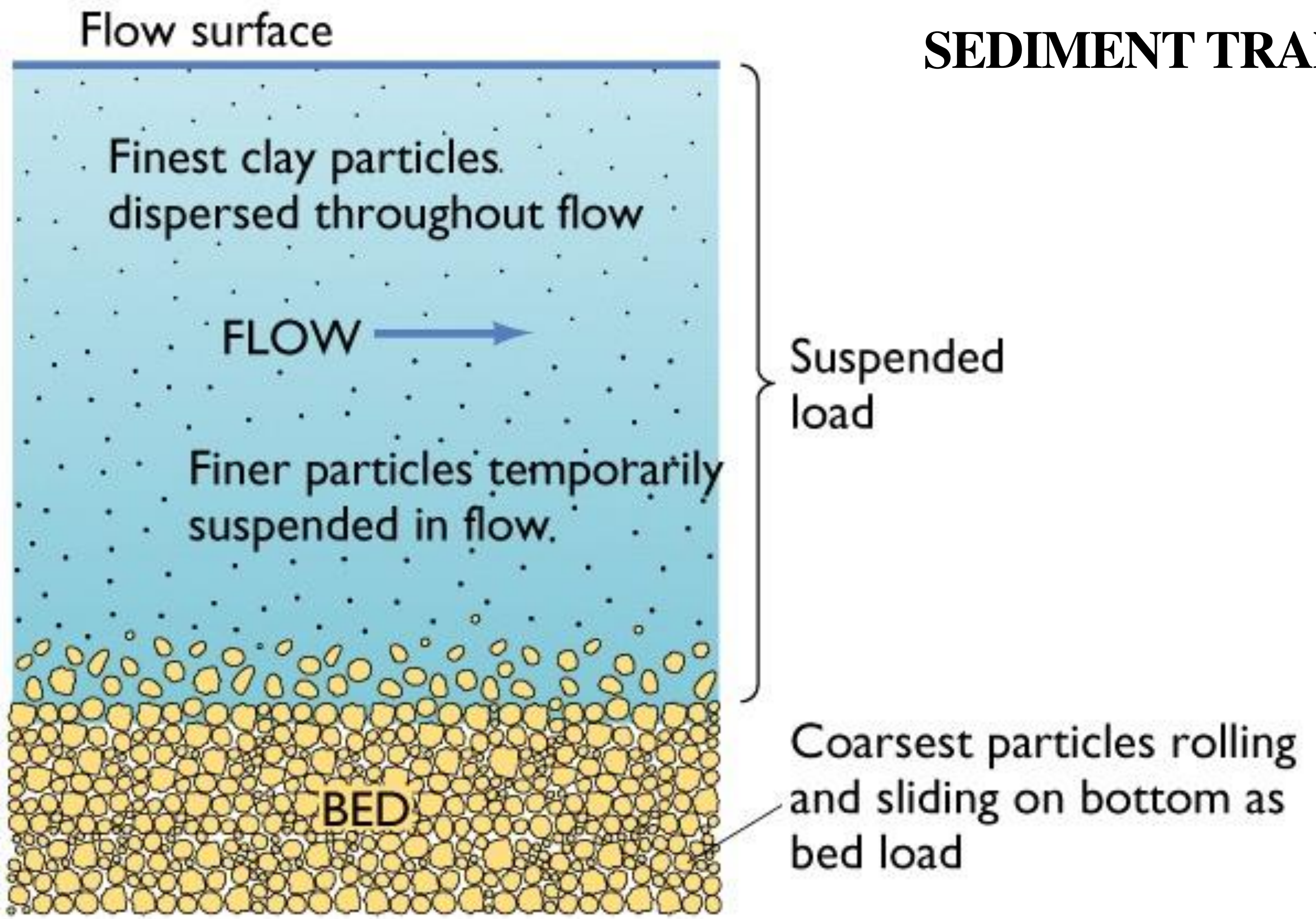
STREAMS MOVE MATERIAL IN THREE FORMS

Dissolved load

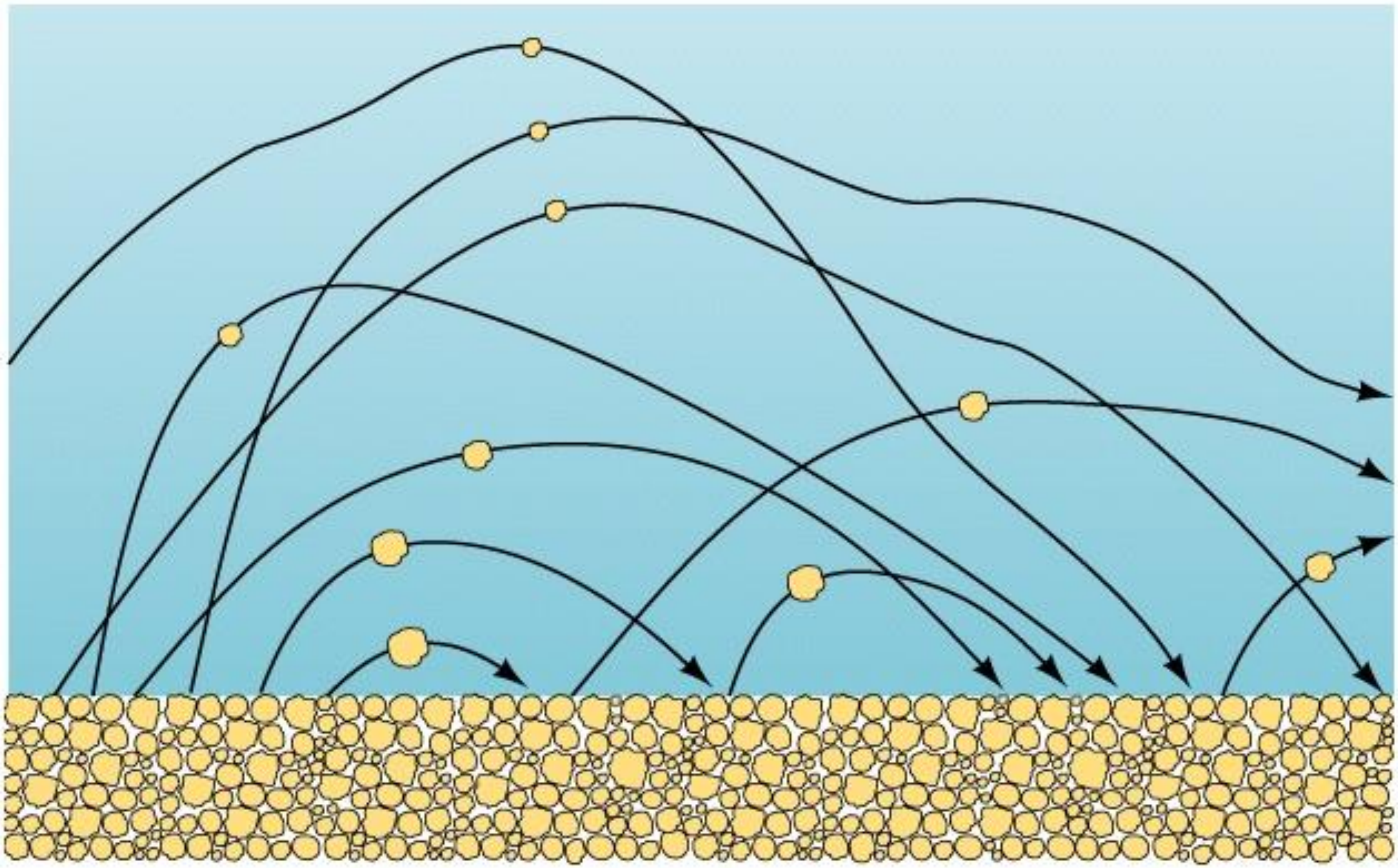
Suspended load

Bed load (traction and saltation)

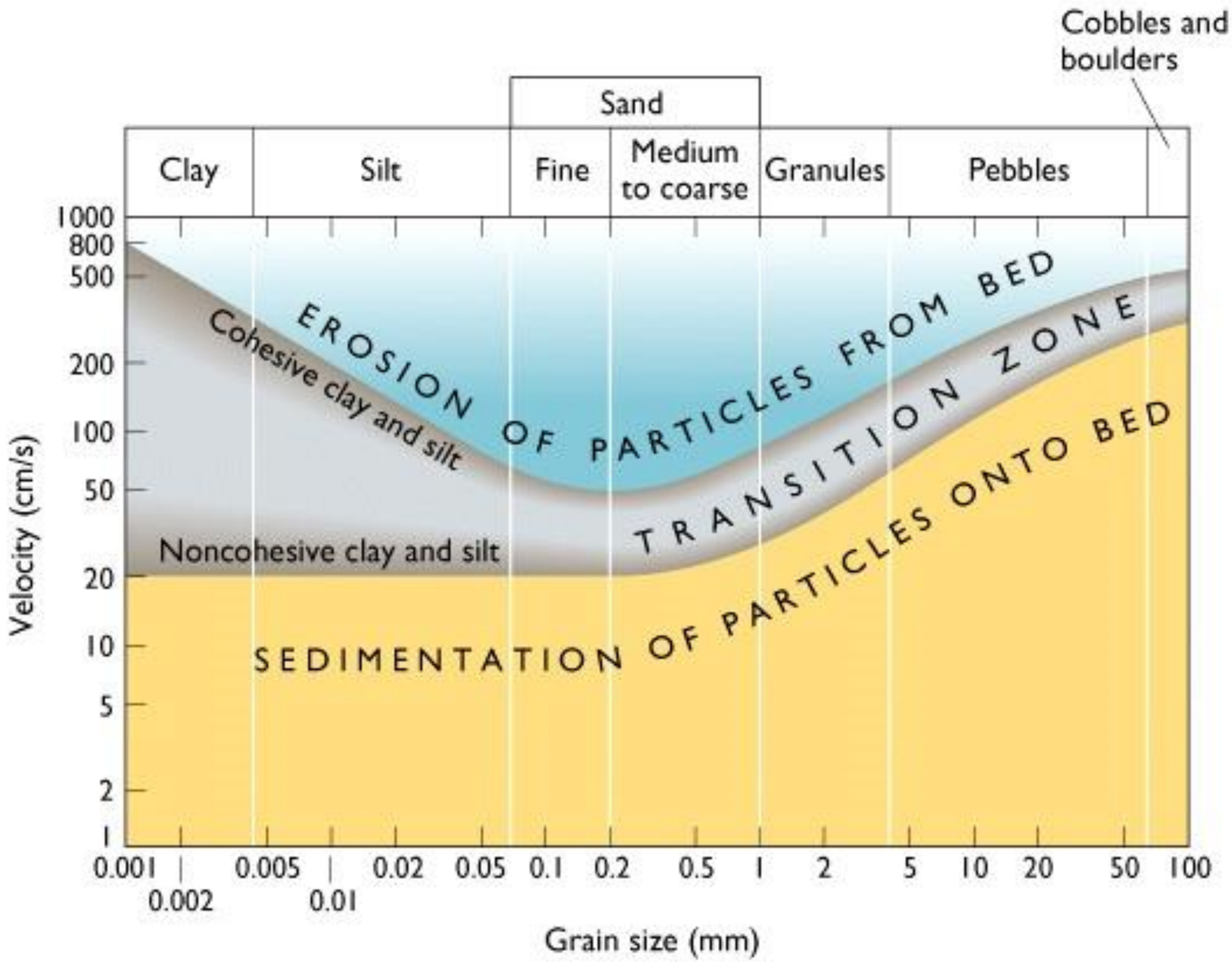
SEDIMENT TRANSPORT



SALTATION



GRAIN SIZE AND FLOW VELOCITY

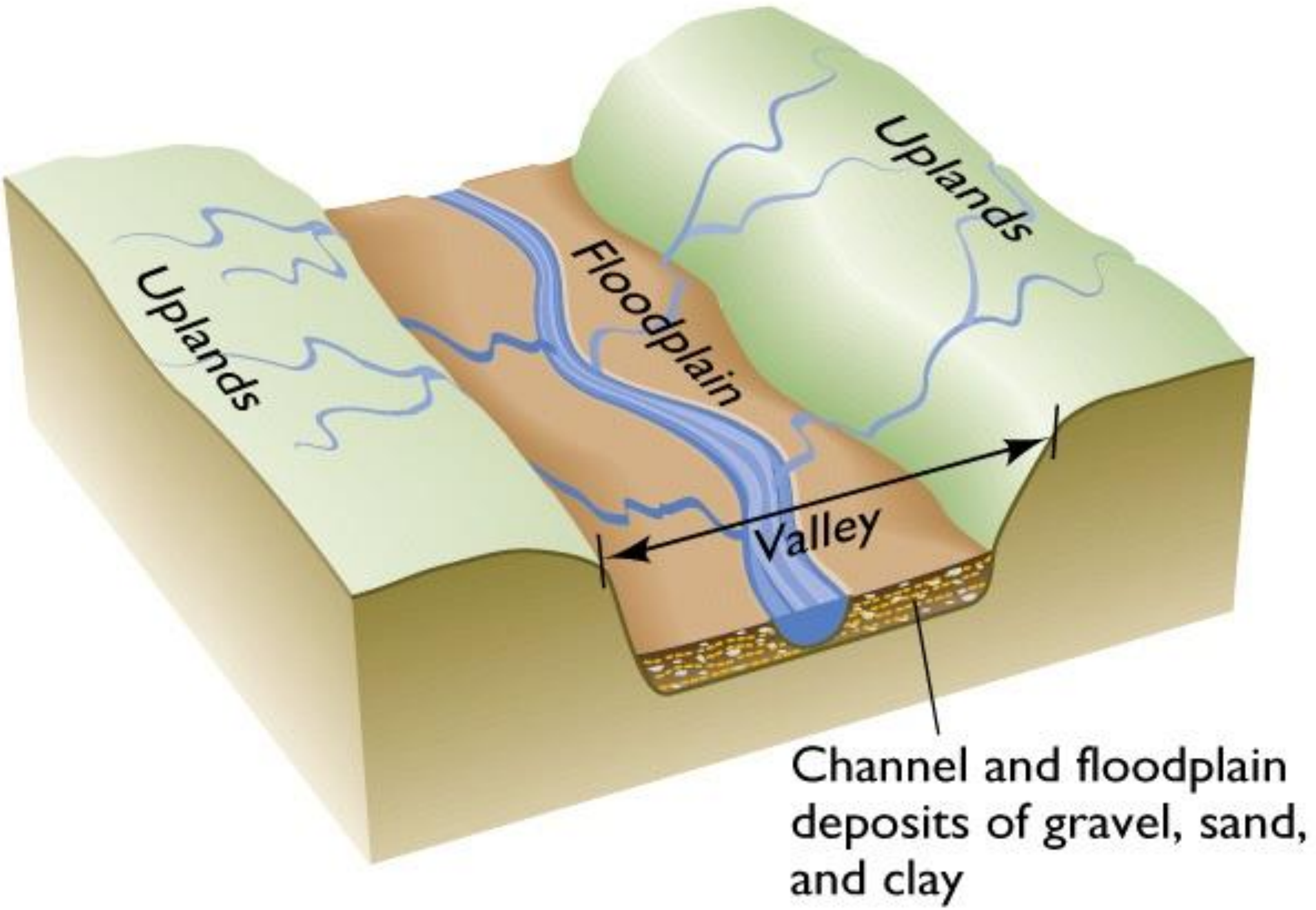


STREAM TERMS

competence: **measure of the largest particles a stream can transport** ***proportional to*** v^2

capacity: **maximum quantity of sediment carried by stream** ***proportional to Q and v***

PARTS OF A RIVER SYSTEM



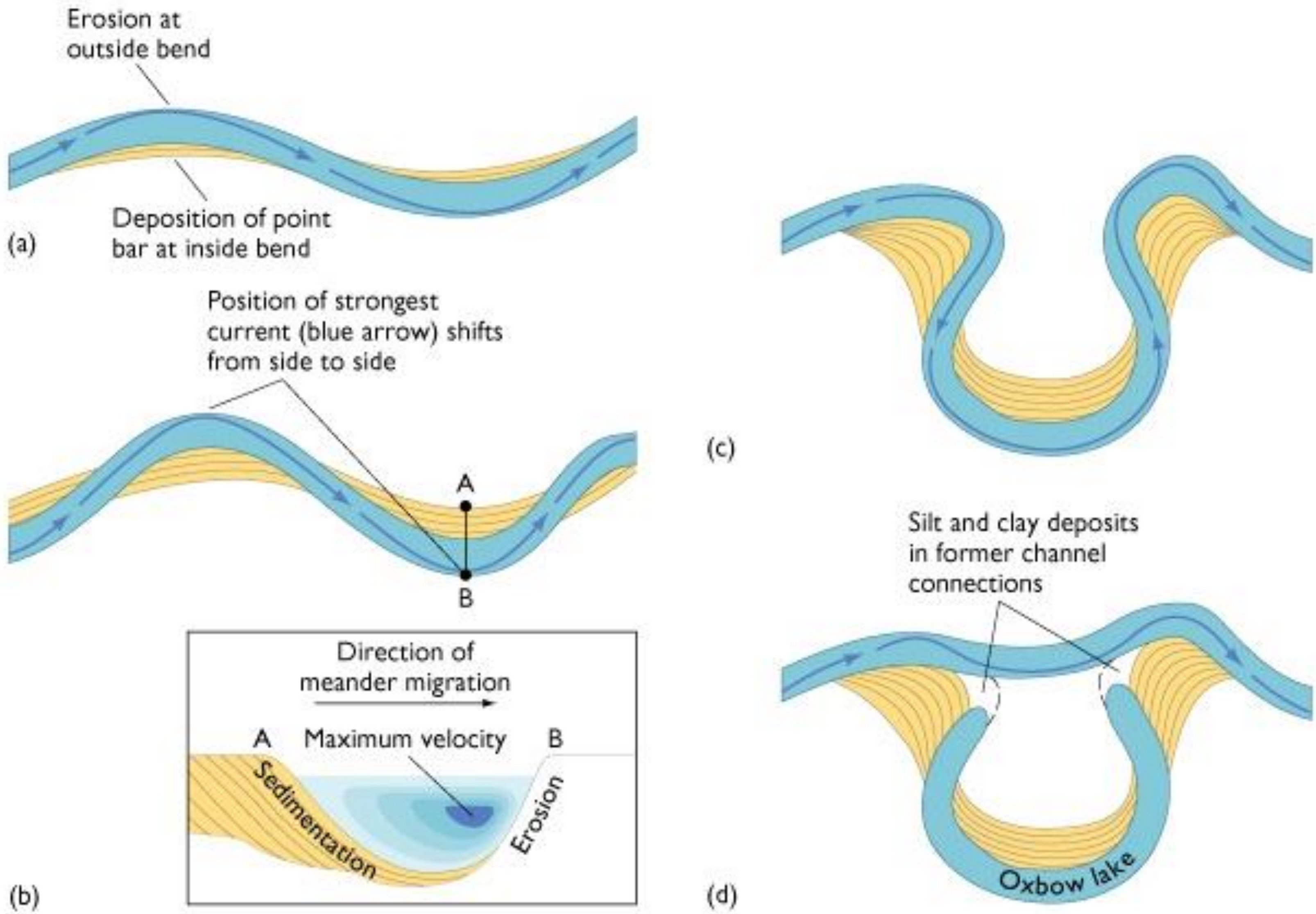
TWO IMPORTANT STREAM TYPES

1. **Meandering Streams**

A meander, in general, is a bend in a sinuous watercourse or river.

A meander forms when moving water in a stream erodes the outer banks and widens its valley, and the inner part of the river has less energy and deposits silt

MEANDERING RIVER OVER TIME



INCISED MEANDERS, UTAH

Tom Bean

MEANDERING RIVER

TWO IMPORTANT STREAM TYPES

2. Braided Streams

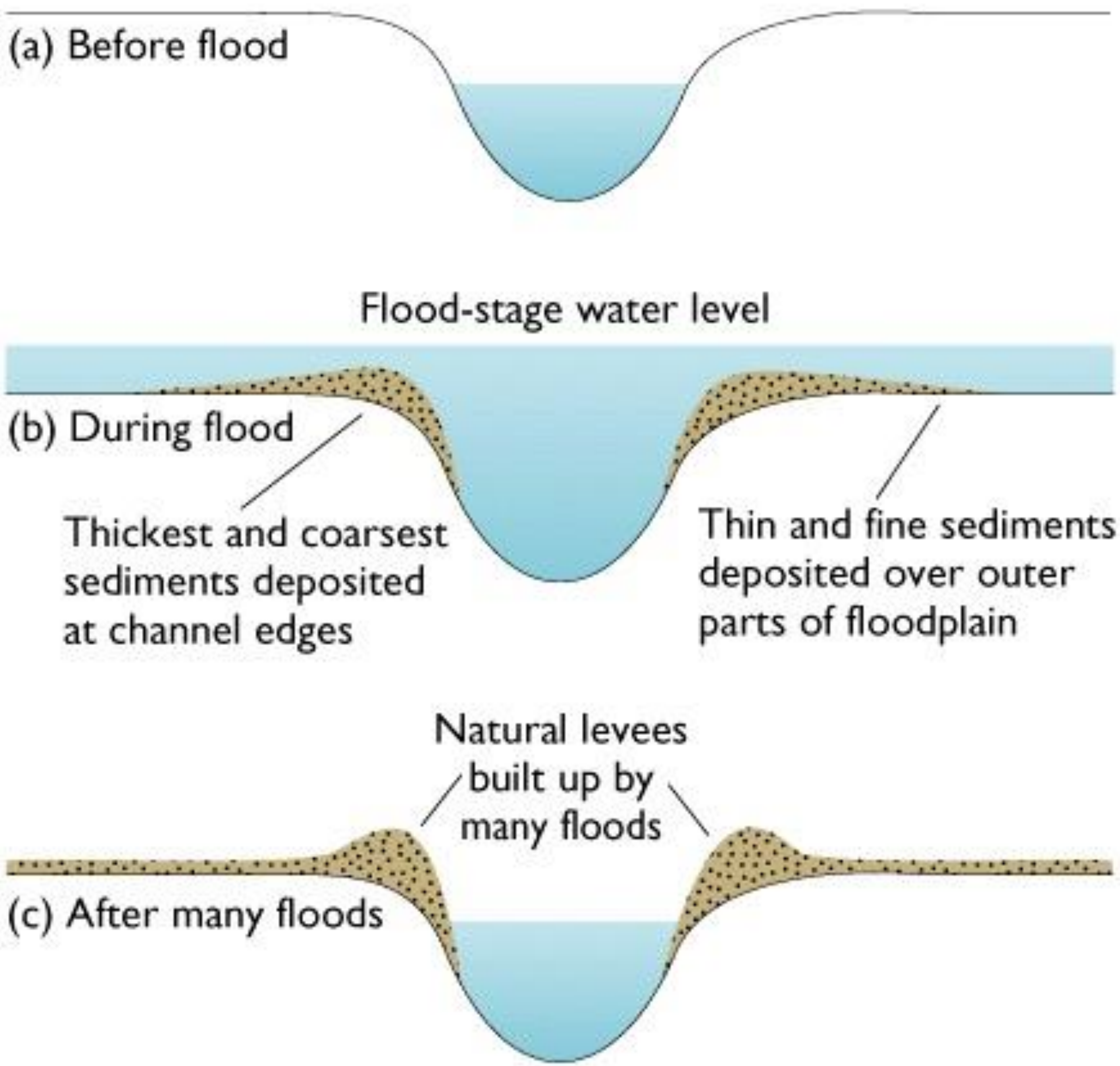
Sediment supply greater than amount stream can support.

At any one moment the active channels may account for only a small proportion of the area of the channel system, but essentially all is used over one season.

Common in glacial, deserts, and mountain regions.

BRAIDED RIVER

FORMATION OF NATURAL LEVEES

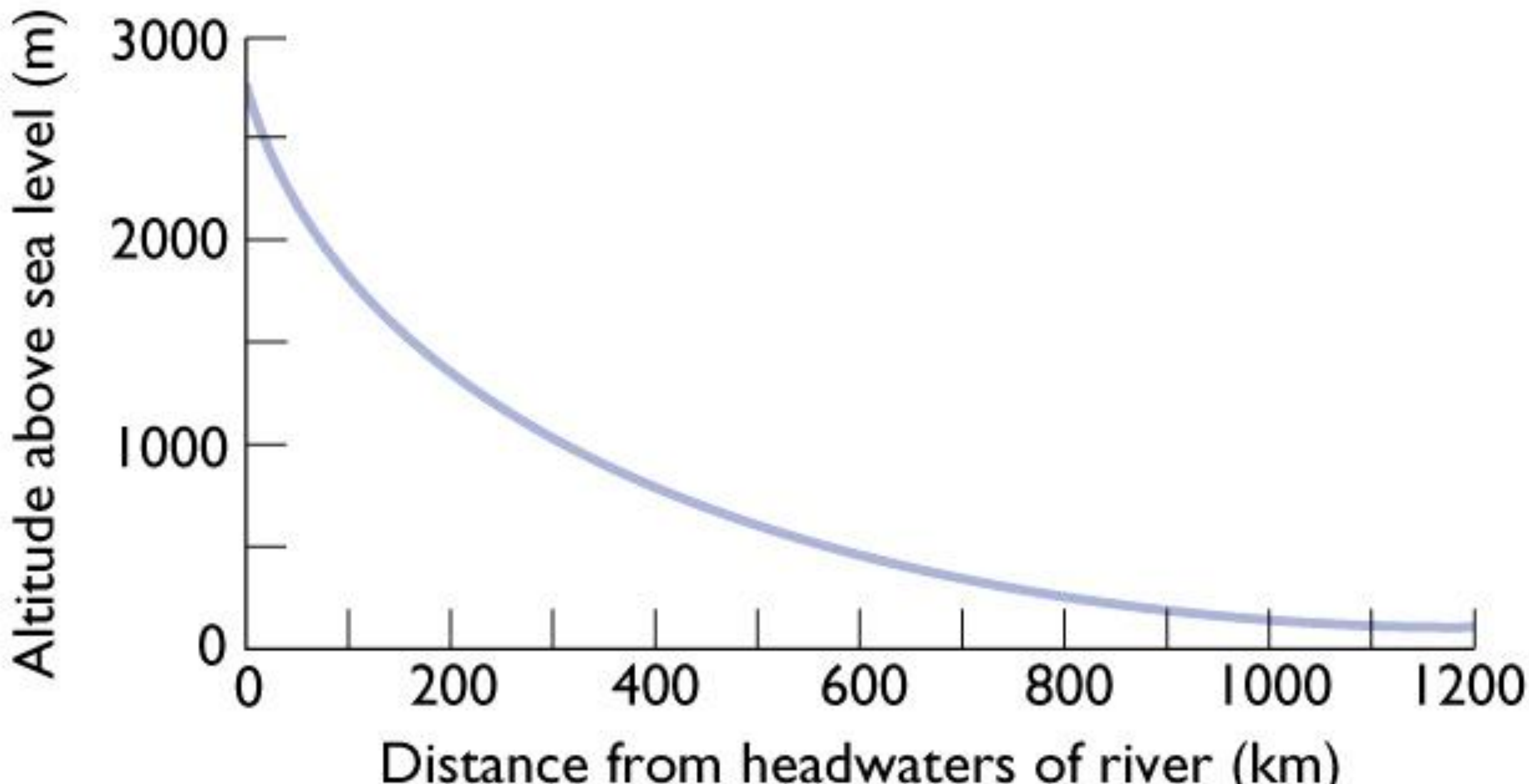


FLOODING

Water in the stream is greater than the volume of the channel.

Interval between floods depends on the climate of the region and the size of the channel

LONGITUDINAL STREAM PROFILE OF THE PLATT AND SOUTH PLATT RIVERS



GRADED STREAM

Stream in which neither erosion nor deposition is occurring, due to an equilibrium of slope, velocity, and discharge.

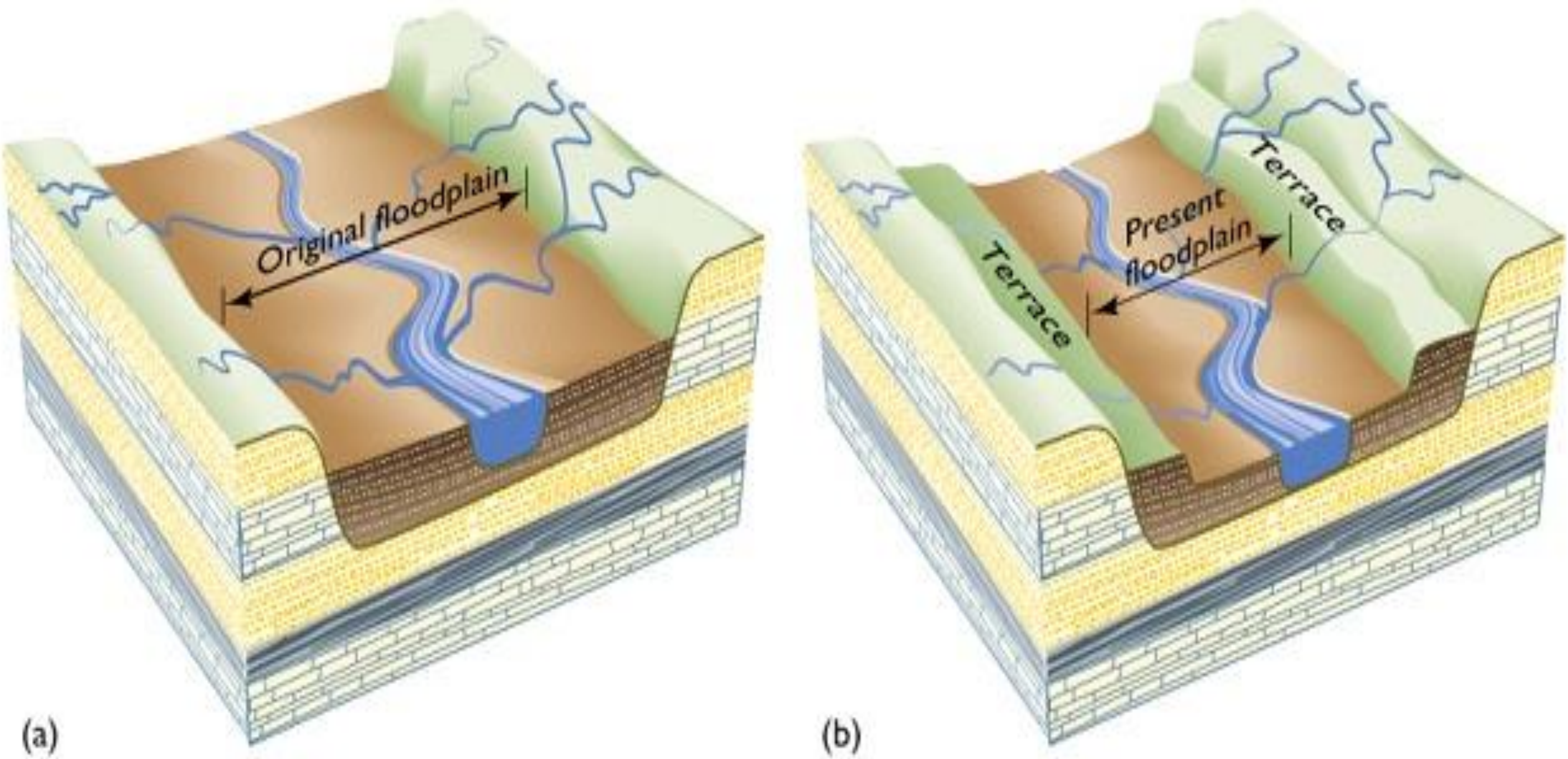
GEOLOGIC EVIDENCE OF CHANGES IN STREAM EQUILIBRIUM

Alluvial fans

Terraces: erosional remnants of former floodplains

Alluvial fans

FORMATION OF RIVER TERRACES



LIFE HISTORY OF A STREAM

Youthful Stream

Steep gradients

V-shaped cross sections

Rough sediments flowing rapidly down stream.

Due to greater water velocity larger sediment can be moved.

LIFE HISTORY OF A STREAM

Sediments cut through bedrock as they are moved along

Common to find rapids and waterfalls due to differences in resistance of the bedrock to weathering.

MATURE STREAMS

Potential energy for cutting and removing rock becomes less.

The average gradient is decreased.

Velocity near the bed becomes less.

The size of sediment that can be moved decreases.

Bed becomes covered with loose material, thus protecting it from further erosion.

OLD STREAMS

Gradient becomes extremely small and only the finest of sediments can be moved.

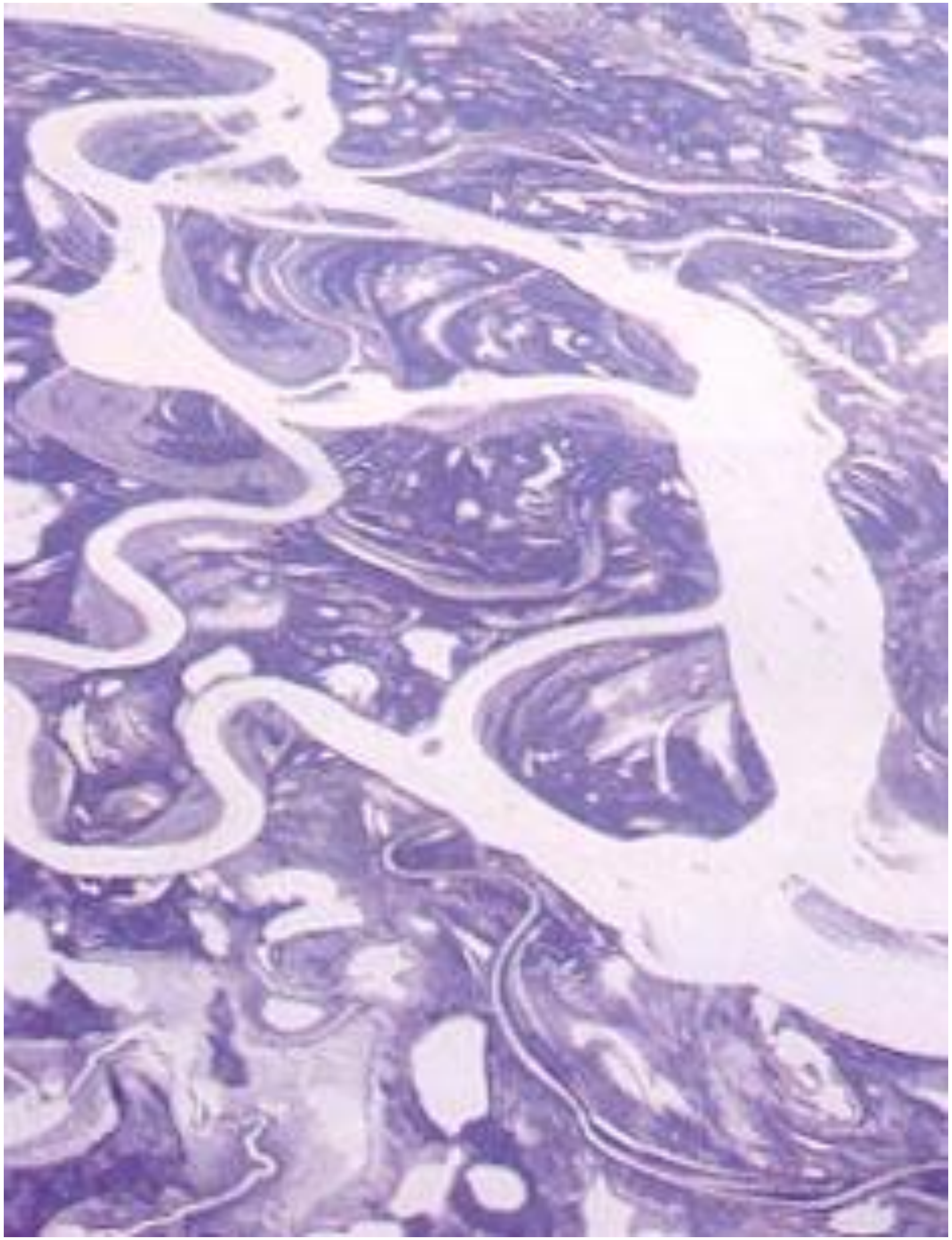
During times of peak flow the banks will overflow and flood the nearby portions of its valley.

When the flow subsides a layer of silt and clay is left behind on the valley surface, this is the flood plain.

WATER VELOCITY IN A MEANDER

Water velocity is greatest along the outside curve of a meander. Here erosion is dominant.

Water velocity is slowest along the inside of a meander. Here deposition is dominant.



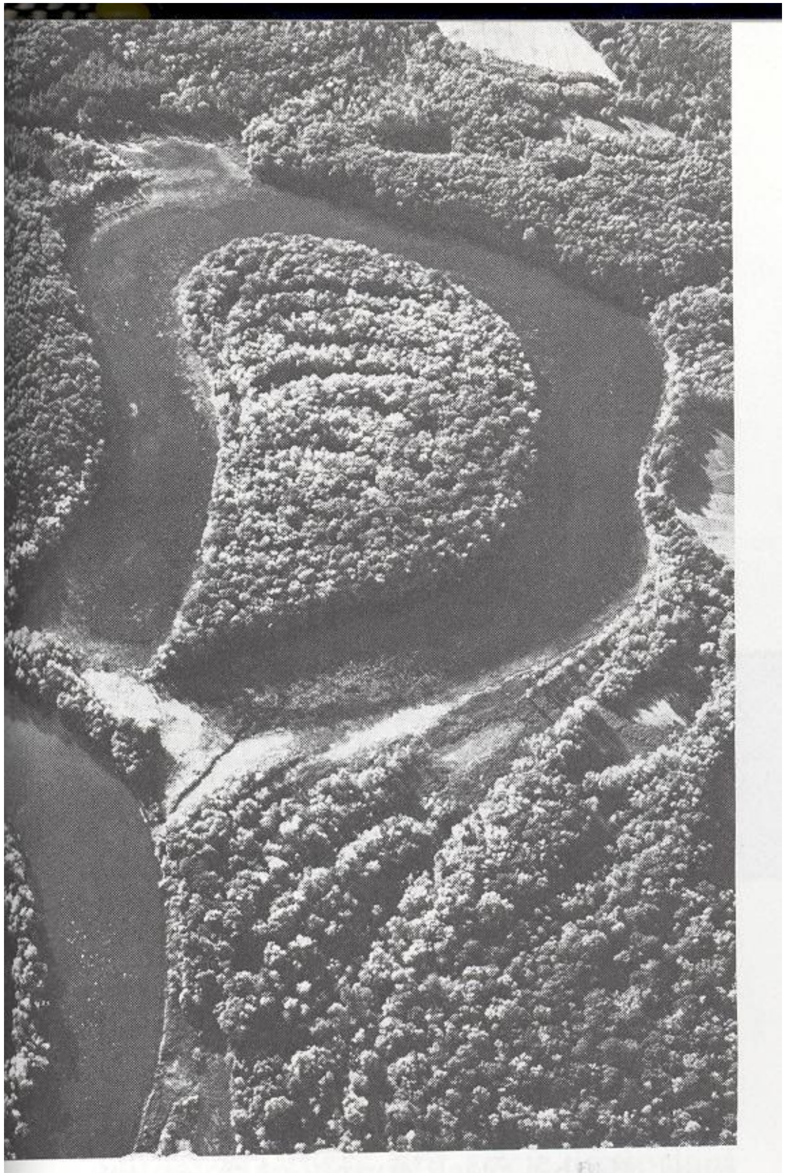
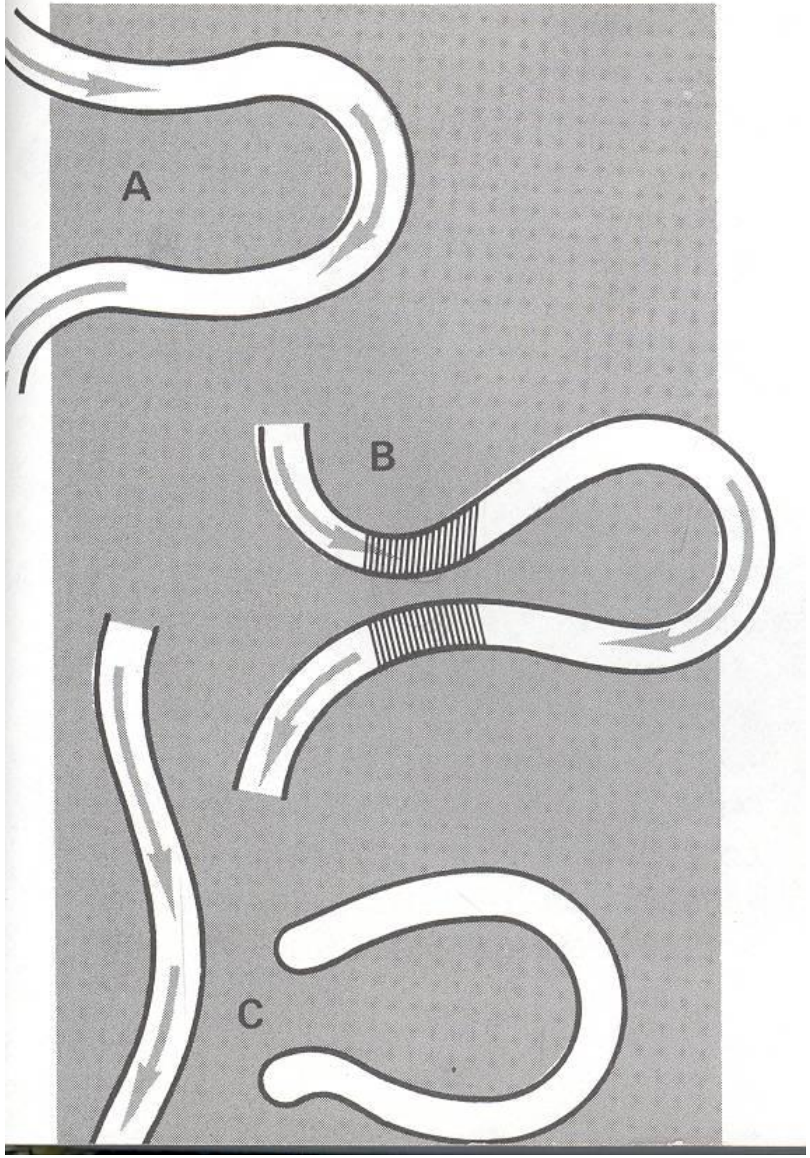
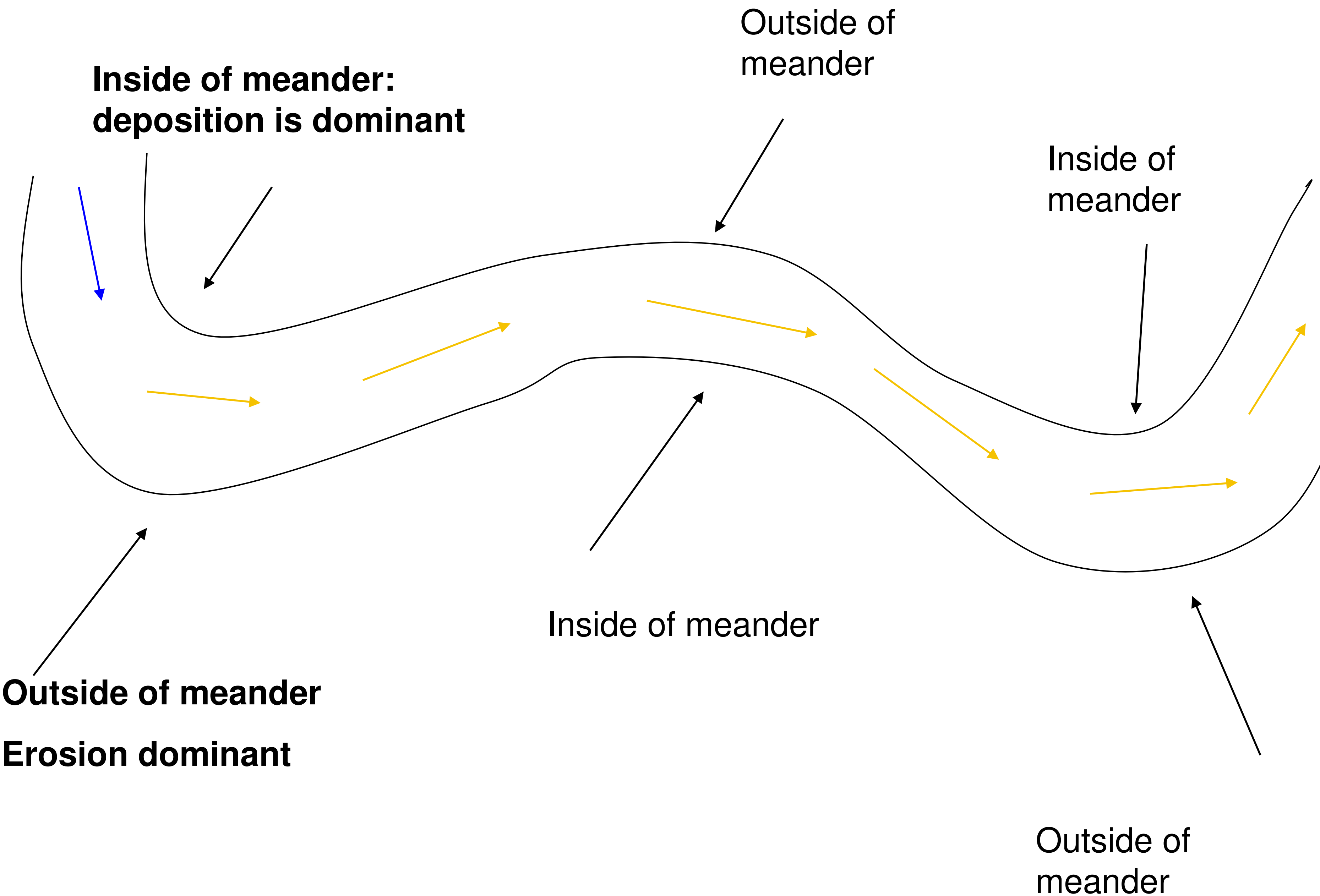


Figure 15-14. Stream in old age.

Figure 15-15. Formation of oxbow lakes.




Outside of meander
Inside of meander: deposition is dominant
Inside of meander
Inside of meander
Outside of meander
Erosion dominant
Outside of meander

LOCATIONS OF STAGES

It is unlikely that any stream is at the same stage of development throughout it entire length.

Most streams tend to have the characteristics of youth near their source and of old age near their mouths and to be in the mature stage somewhere in-between..

WIND EROSION

Wind erodes dry land much more effectively than it does moist land.

As the wind erodes land it carries rock particles along with it, mostly sand, silt, and clay.

Sand material is moved along by a number of jumps and bounces, much how a pebble is moved along the bottom of a stream bed.

WIND EROSION

The grains do not rise higher than about 1meter, and they move in the same direction the wind is blowing.

Dust particles (silt and clay) can be carried along great distances and at greater heights than sand particles

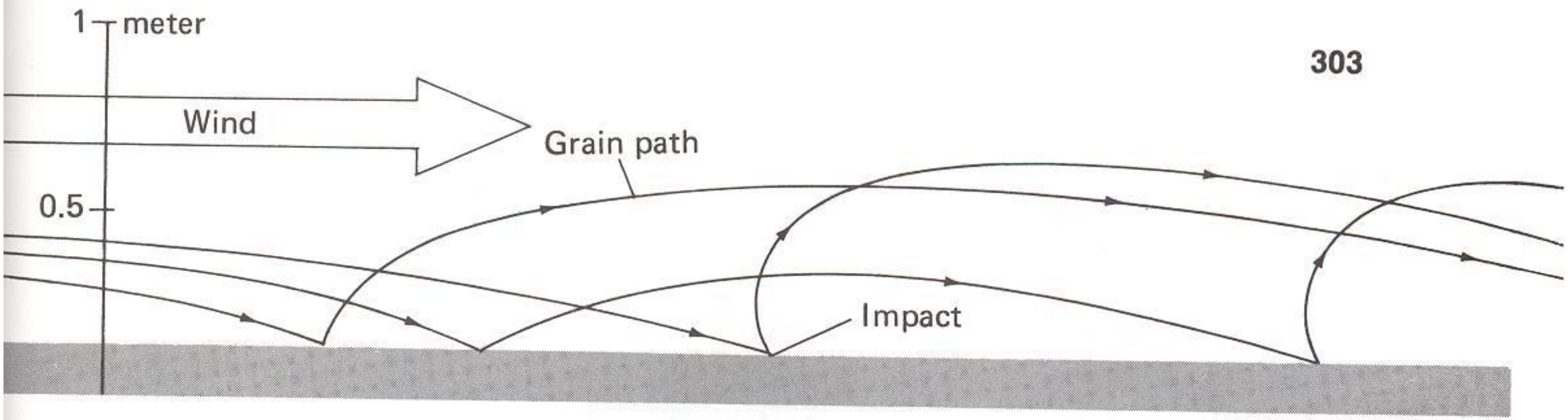
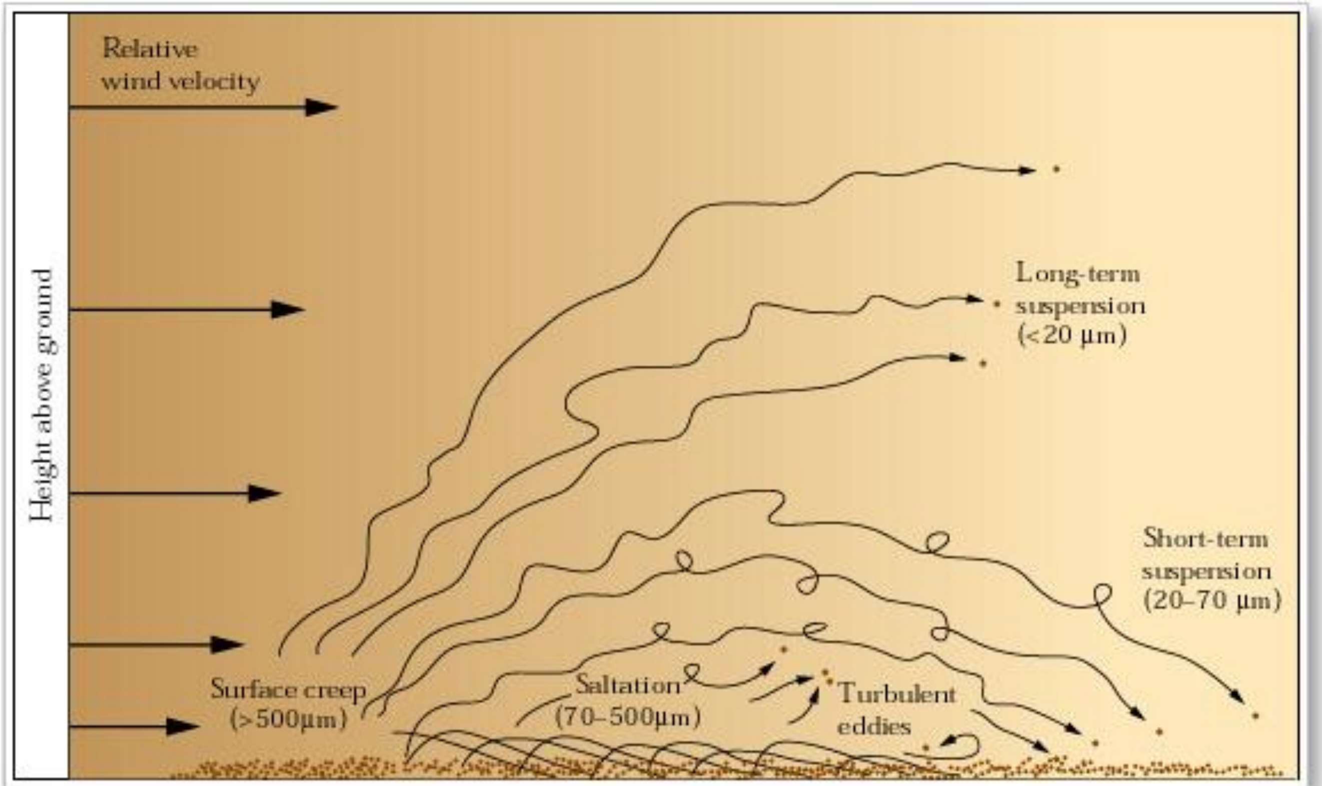


Figure 15-19. Wind erosion. Sand grains carried by the wind generally bounce along the ground. From hitting against other grains, the grains become rounded and their surface frosted.

Wind Transport



Moderate winds move the largest sand grains by surface creep. Slightly smaller sand grains move forward by saltation (bouncing). Finer particles are carried aloft where faster wind transports them downwind before they slowly settle to the ground. The very finest dust particles reach greater heights and are swept along in suspension as long as the wind keeps blowing.

EFFECTS OF WIND EROSION

Abrasion : weathering of rock particles by the impact of other rock particles.

In areas where there are strong, steady winds, large amounts of loose sand, and relatively soft rocks, abrasion causes a great amount of erosion.

EFFECTS OF WIND EROSION

Pebbles and small stones exposed to wind abrasion show surfaces that are flattened and polished on two or three sides.

Rocks smoothed this way are called ventifacts.

EROSIONAL LANDFORMS

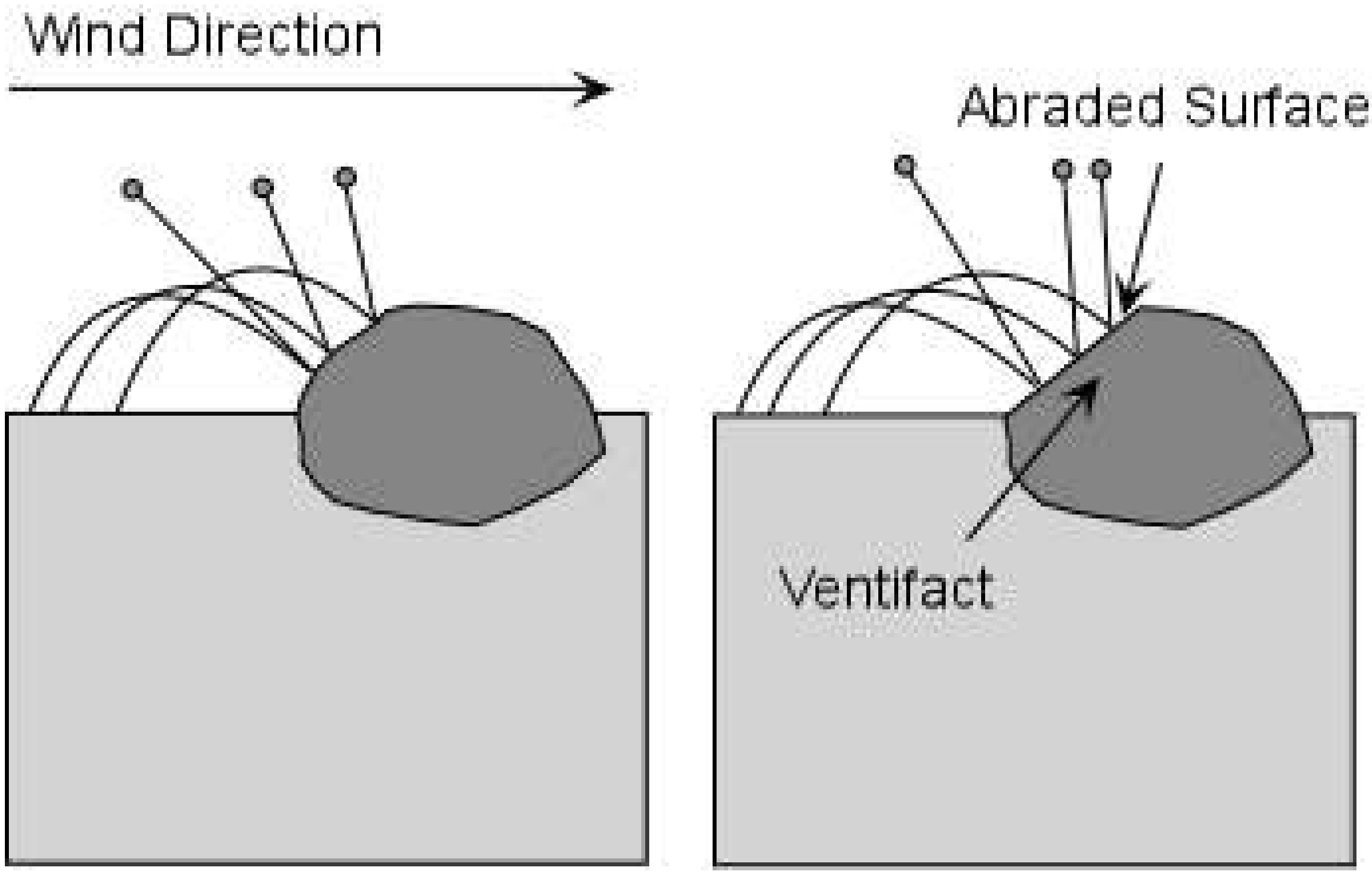
VENTIFACT

Created by wind erosion

Wind carries fine particles that work like a sand blaster (i.e. sand, silt, clay, and ice particles)

The windward face of the rock is flattened and smoothed

Usually pebble to cobble sized


Wind Direction
Abraded Surface
Ventifact

VENTIFACT

DREIKANTER

A type of ventifact that has three ridges

Multiple faces have been formed by either a changing prevailing wind or movement of the actual rock being weathered

DESERT PAVEMENT

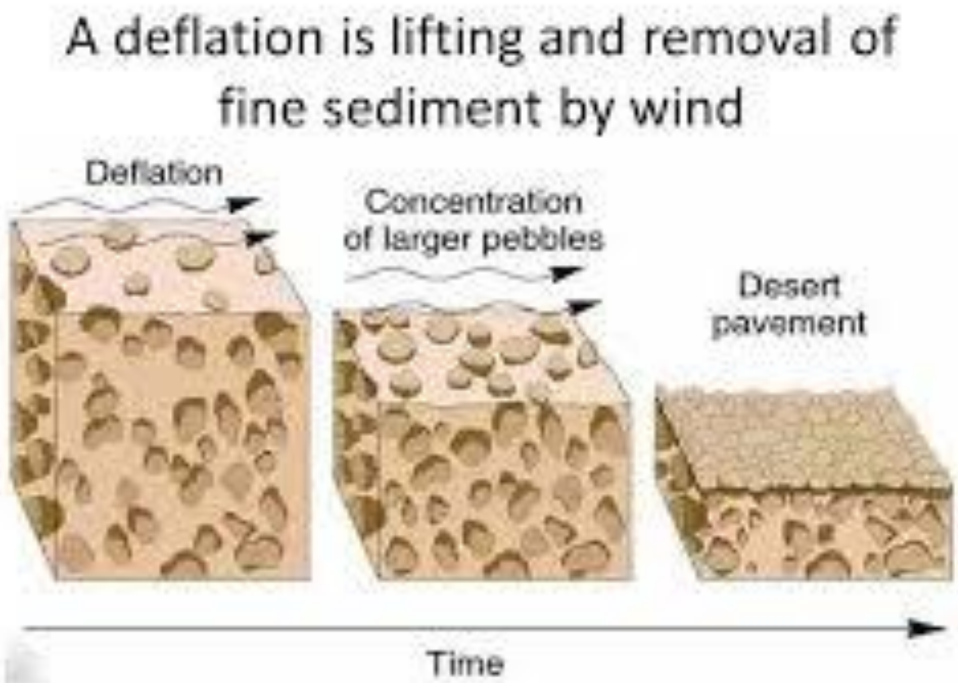
Formed in arid environments when wind carries finer, more lightweight particles such as sand away

Large particles are left behind and protect from further erosion

DEFLATION

Low spots carved out by wind erosion

High elevations are left due to vegetative stabilization

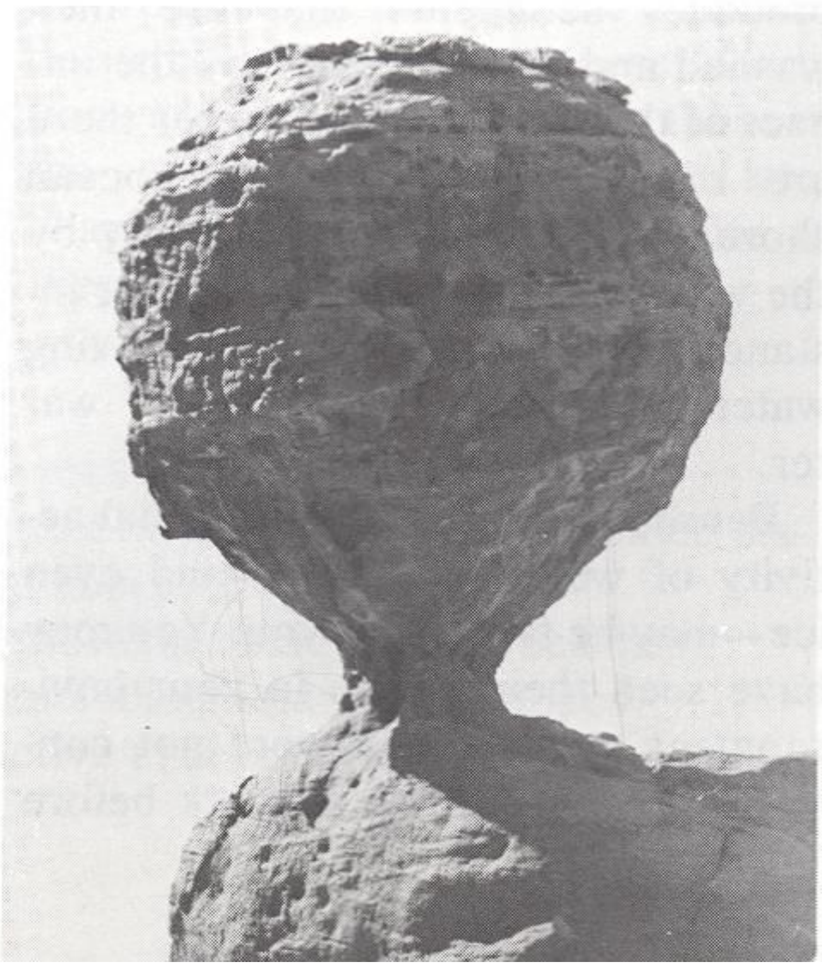


PEDESTAL ROCK

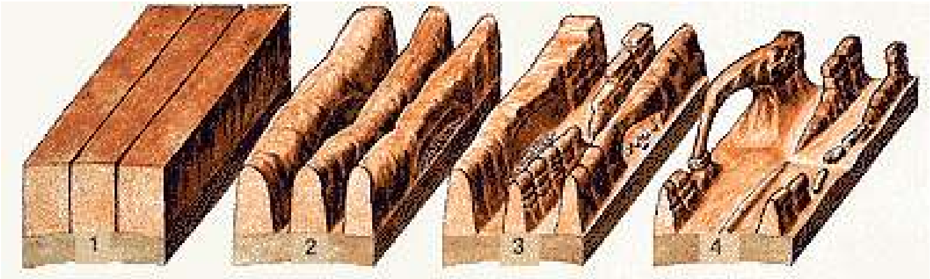
Base of a rock is weathered and eroded more quickly due to sand blasting

Sand grains can only be picked up a couple of feet

Figure 15-20. Erosion of a rock by wind. Because the particles transported by the wind remain close to the ground, the base of the rock undergoes the greatest amount of erosion.



Desert Arch



- Typically formed by wind
- Narrow ridges are formed and the softer substrata is weathered first, forming a bridge/arch overhead

DEPOSITIONAL LANDFORMS

LOESS

Yellowish, fine grained silt and clay sized particles

Carried and deposited by wind

LOESS

Criteria for Loess formation:

- dust source (Periglacial and non-glacial deposits)

-adequate wind energy to transport the dust,

-a suitable accumulation area

-sufficient amount of time

LOESS

甘肃靖远山川景观

SAND DUNES

Piles of sand

Deposited by wind

Leeward side (slipface) has a steeper slope

Windward side is more gradual

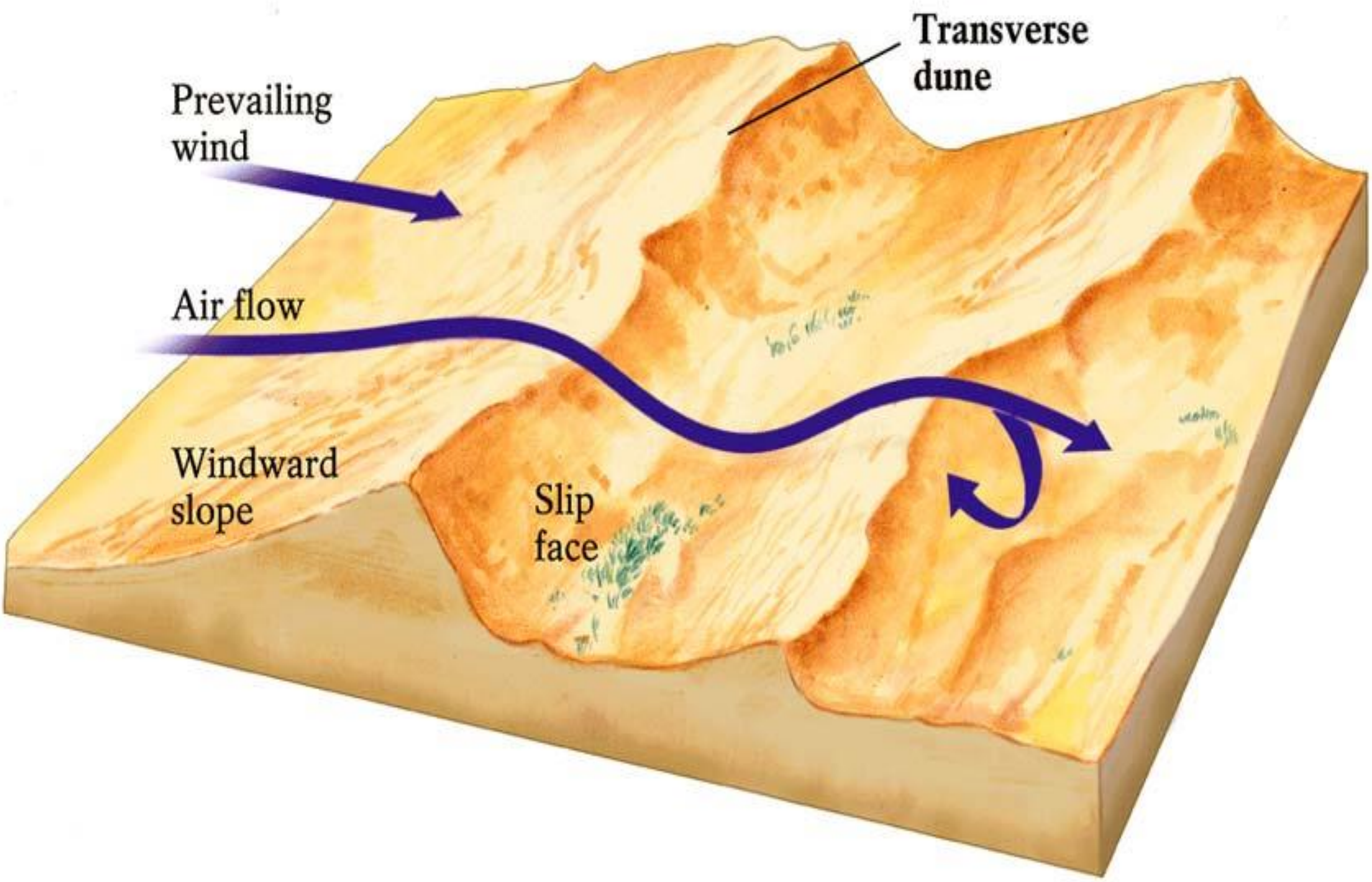

leeward
windward
leeward

DEPOSITION AND DUNE TYPES

Dune Types

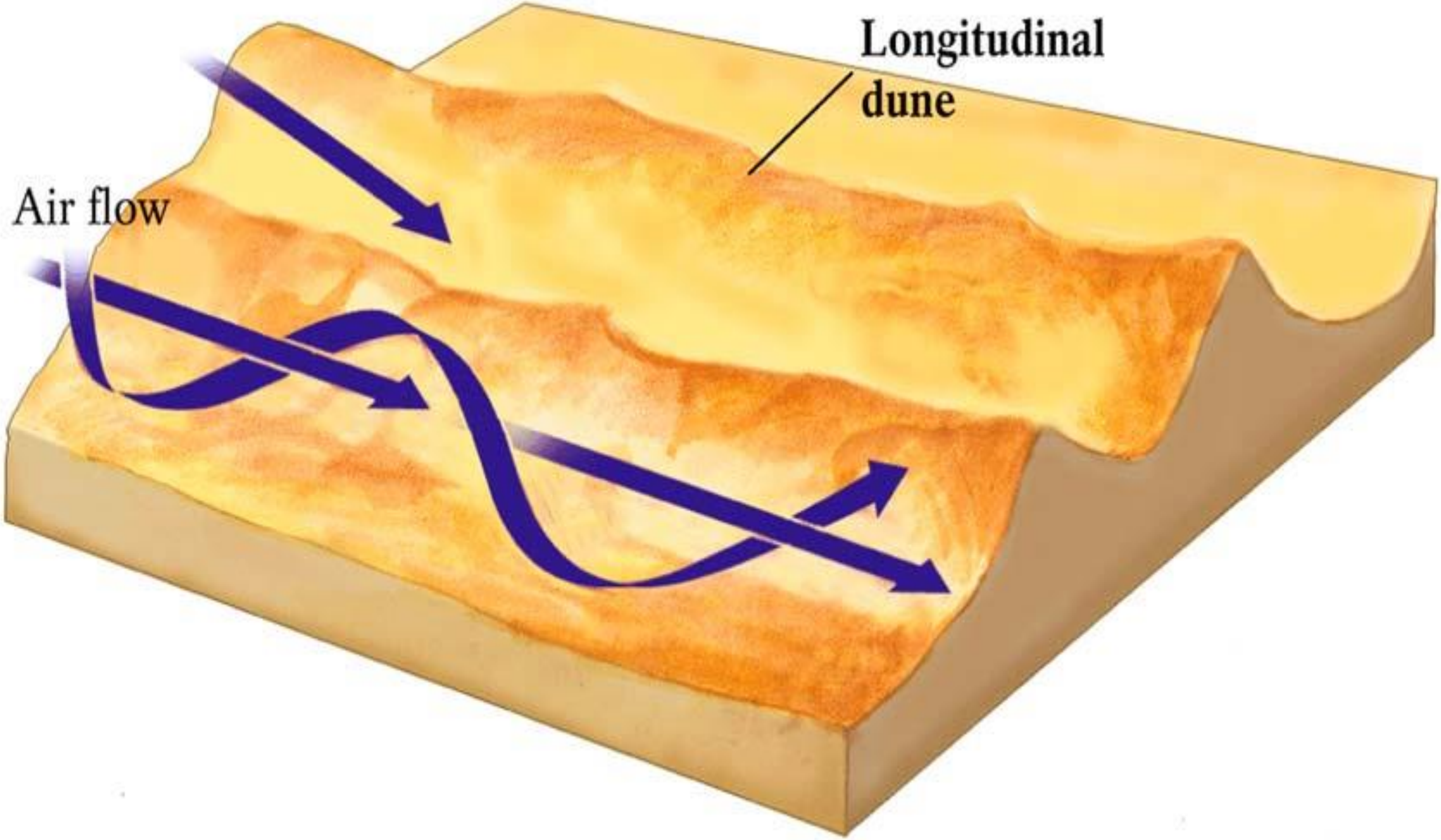
- Transverse- ridges that are perpendicular to prevailing wind direction
- Longitudinal- ridges that are parallel to prevailing wind direction
-

TRANSVERSE DUNES



TRANSVERSE DUNES

LONGITUDINAL DUNES



LONGITUDINAL DUNES