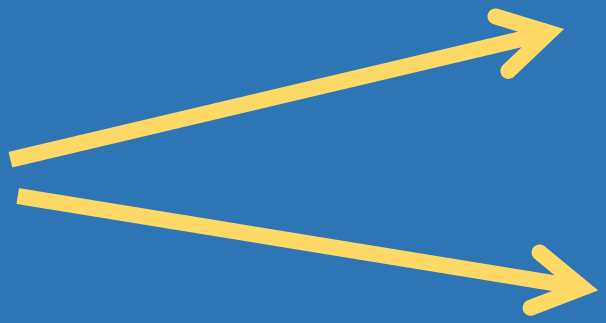
The Earth and its Materials

GGY3020



Structure of the Earth

Plate tectonics

Minerals

Igneous rocks

Sedimentary rocks

Metamorphic rocks

Mineral resources

Energy resources

Dr. Sakuwaha K

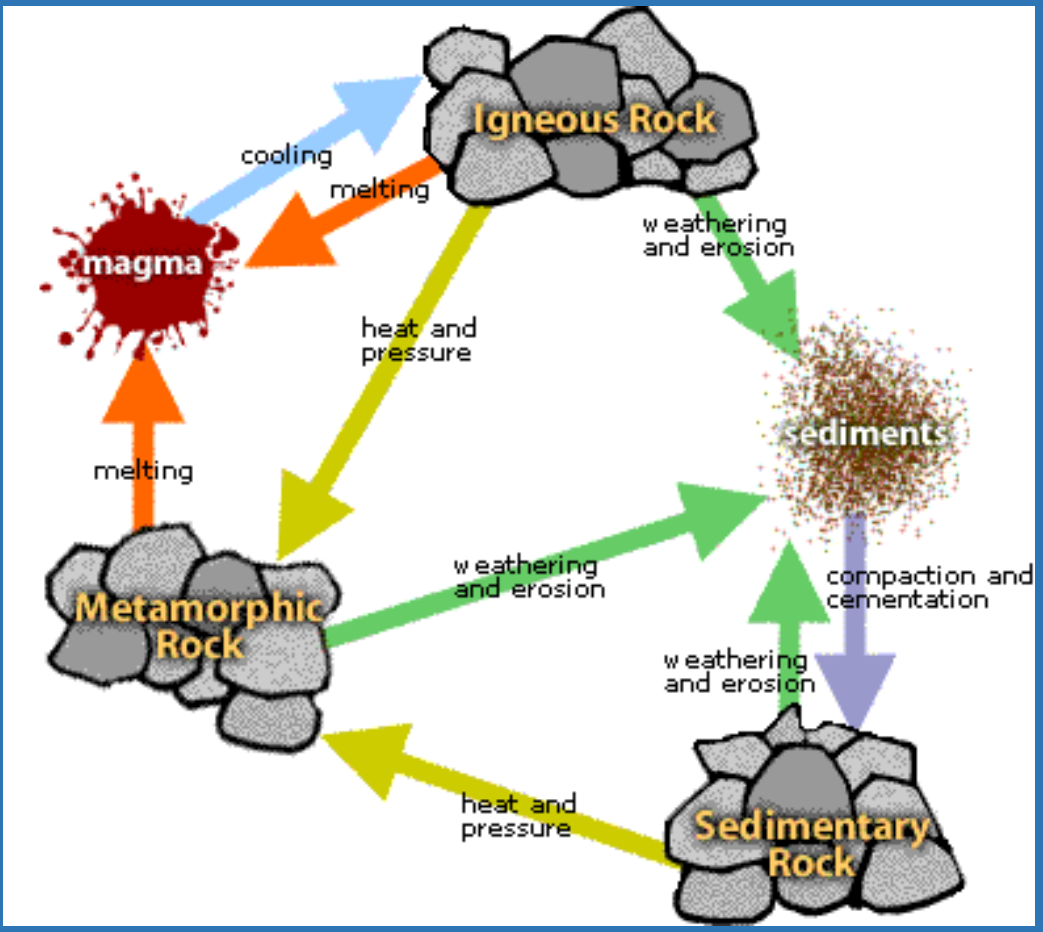
LECTURE 3

Sedimentary rocks

TOPICS TO BE COVERED:

- Classes of sediments and sedimentary rocks
- Sedimentary structures
- Depositional environments

Weathering and erosion of any rock (igneous, metamorphic or sedimentary) forms sediments.



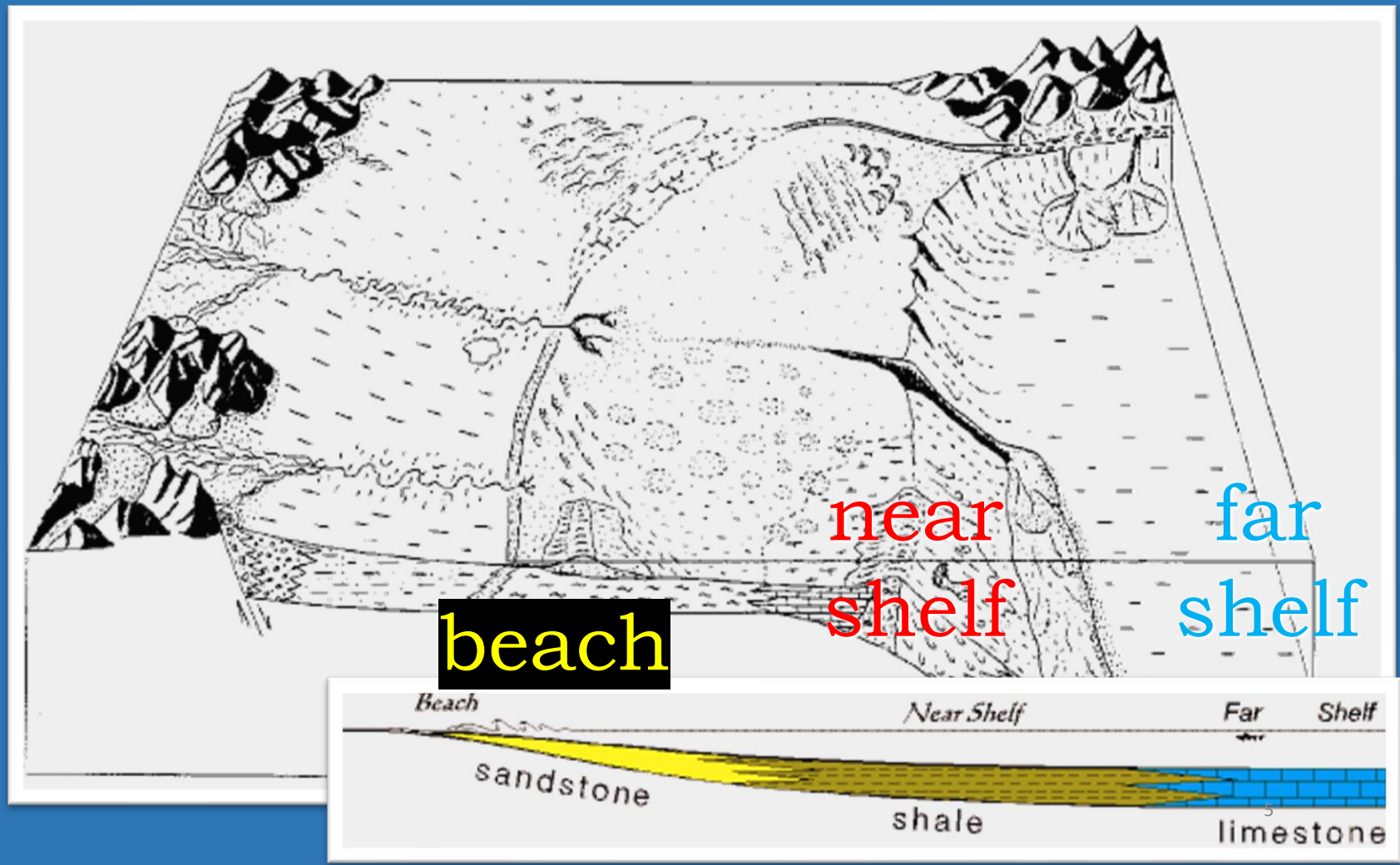
The sediments are transported, deposited, compacted, and lithified to form sedimentary rocks

3. SEDIMENTARY ROCKS

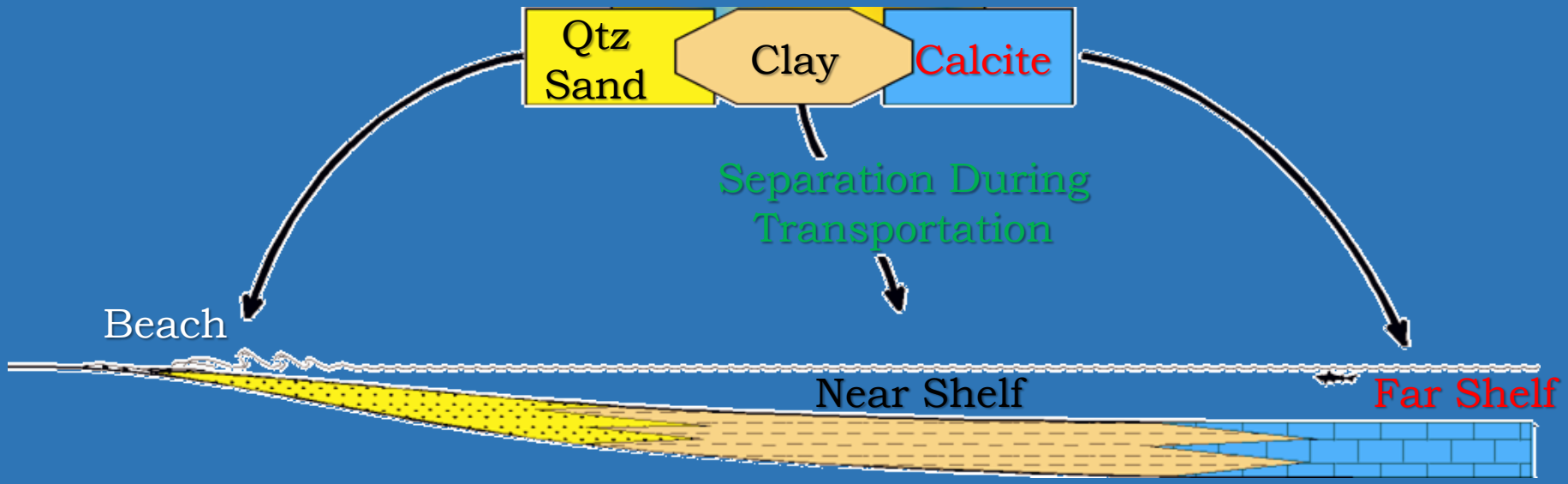
SEDIMENTARY ROCK = formed near the Earth's surface by the cementation of clasts, (fragments) produced by the disruption of pre-existing rocks, or by the accumulation of organic and biologic remains.

Sedimentary rocks comprise the grains and the cements that bind those grains together.

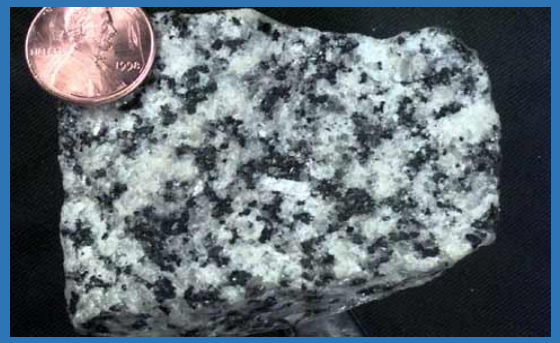
Sediments are generally deposited near the shore (beach), near shelf and far shelf regions



Simple model for the formation of Sedimentary Rocks



Simple model for the formation of Sedimentary Rocks



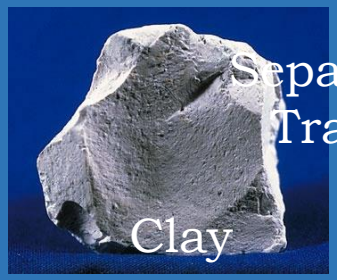
Complete Weathering

Mixed Weathering Products

Qtz Sand

Clay

Calcite



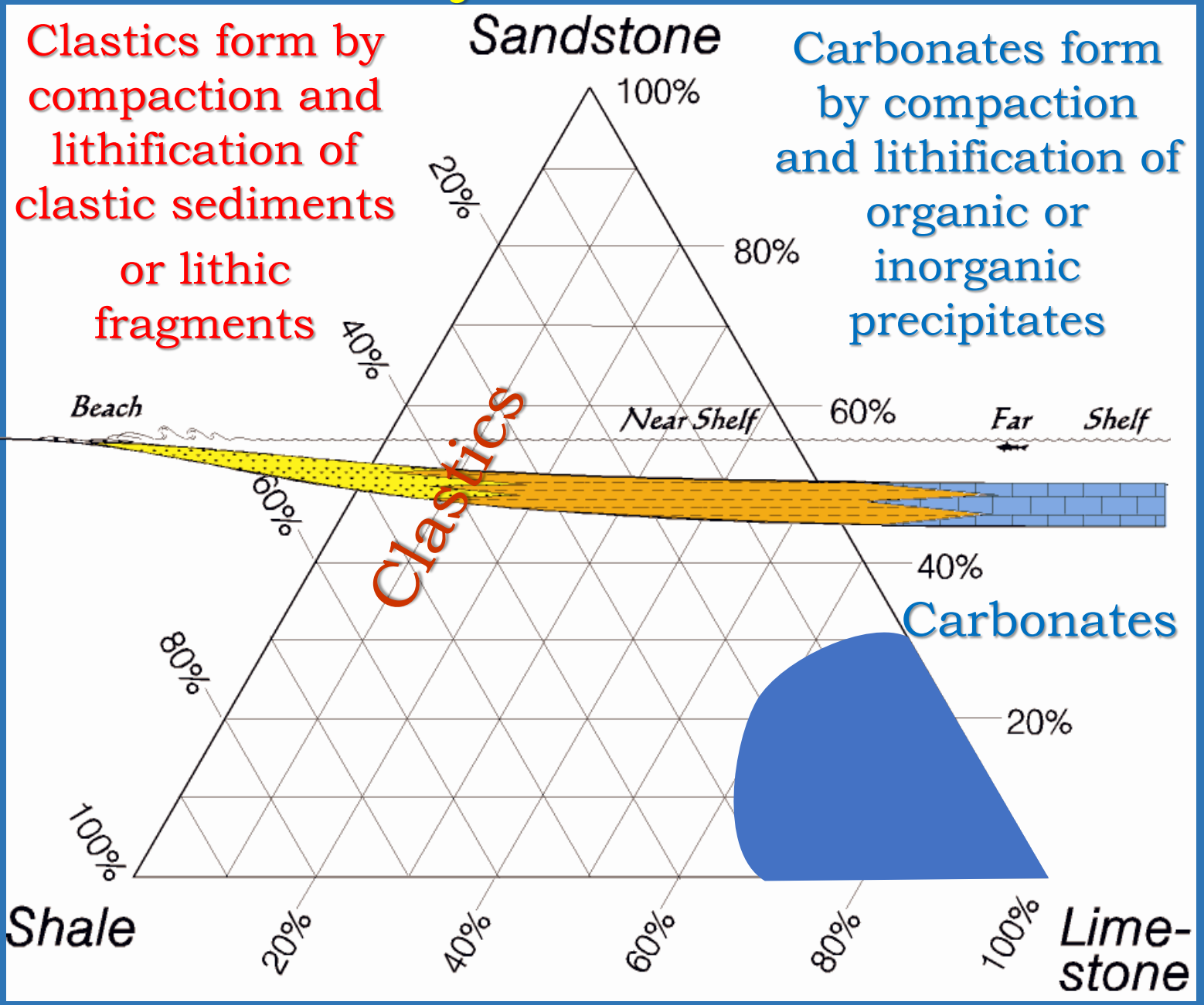
Separation During Transportation

Beach

Near Shelf

Far Shelf

Sedimentary Rock Classification



3. SEDIMENTARY ROCKS

Based on their origins sedimentary rocks are divided in:

1. CLASTIC
2. BIOCHEMICAL
3. ORGANIC
4. CHEMICAL

Sedimentary rocks can be divided on the basis of their composition: e.g. siliceous, carbonatic, etc.

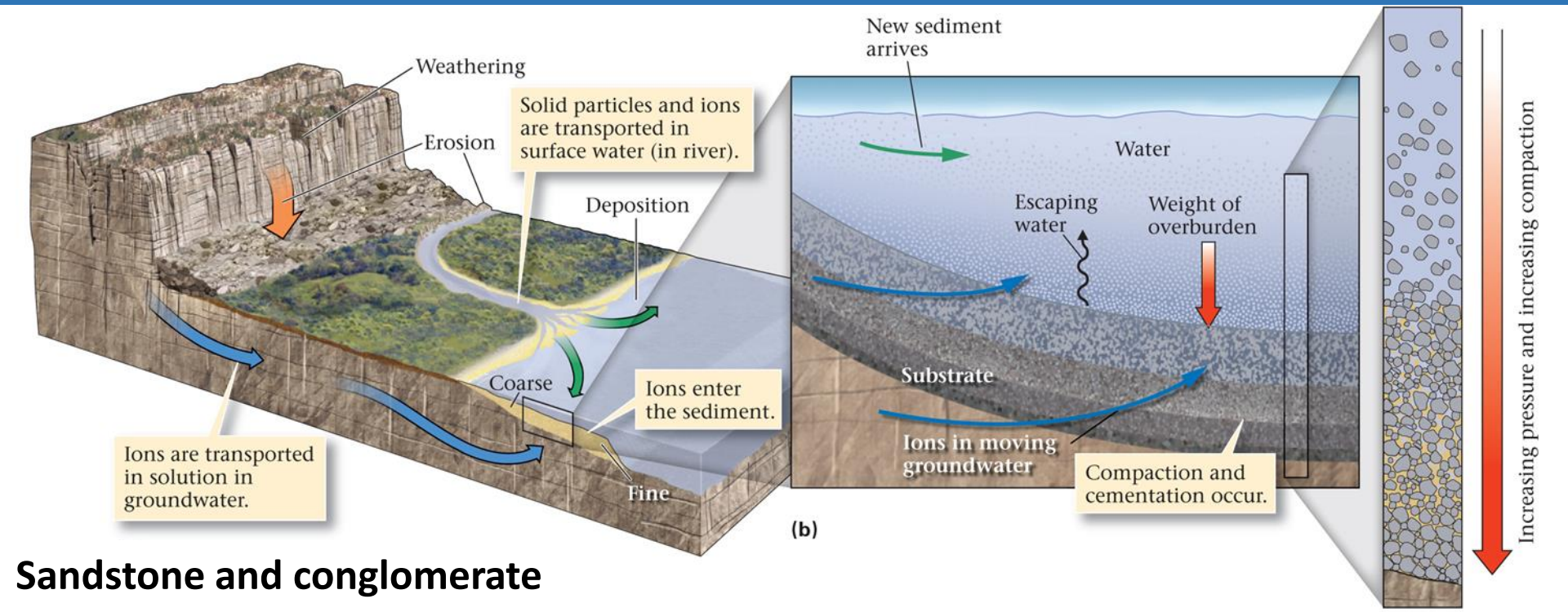
Biochemical: cemented shells of organisms.

Organic: carbon-rich remains from dead organisms

Chemical: minerals that crystallize directly from water.

3. SEDIMENTARY ROCKS

Clastic sedimentary rocks

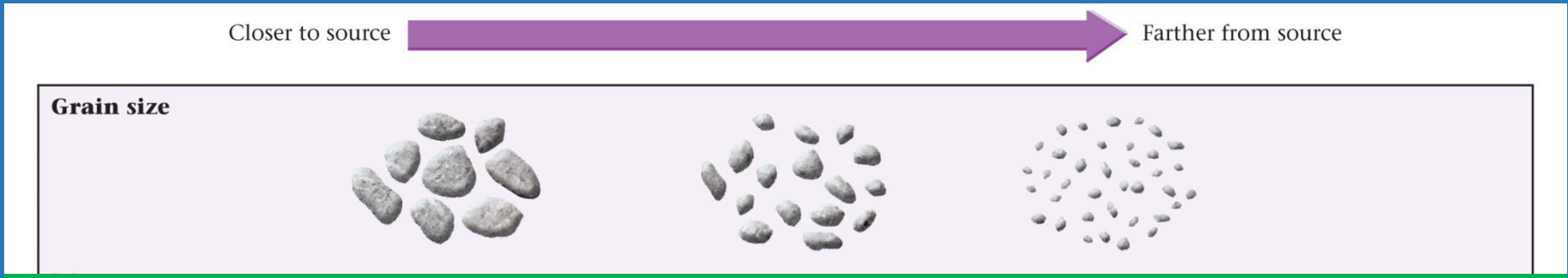


Sandstone and conglomerate

WEATHERING → EROSION → TRANSPORT → DEPOSITION → LITHIFICATION

3. SEDIMENTARY ROCKS

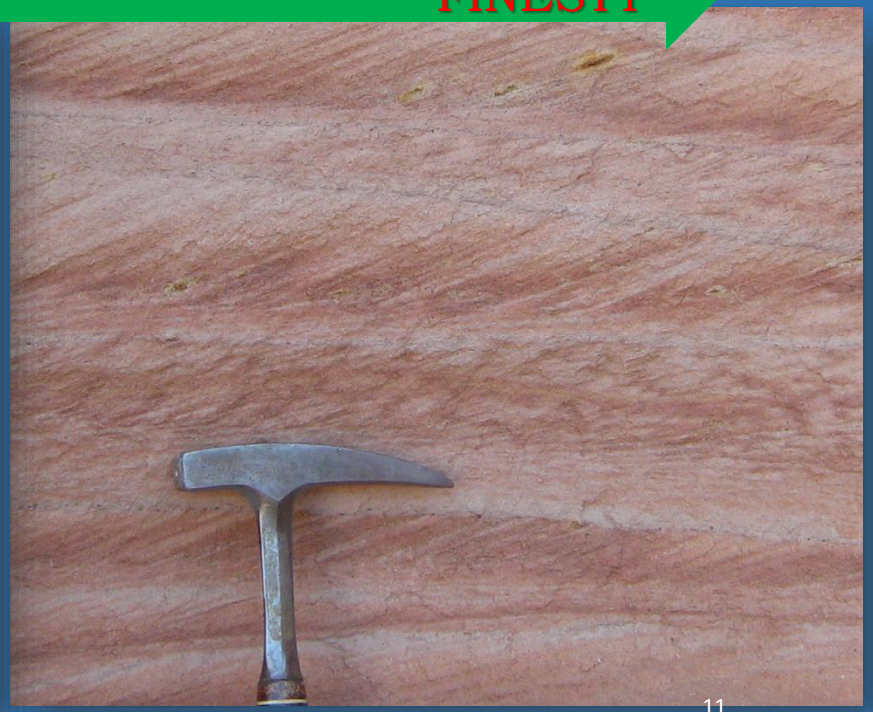
Clastic sedimentary rocks: CLASSIFICATION



BOULDER – COBBLE – PEBBLE – SAND – SILT - CLAY

COARSEST

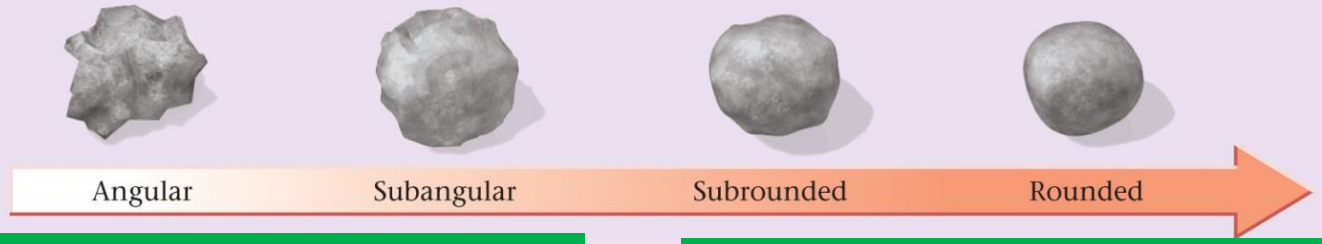
FINESTT



3. SEDIMENTARY ROCKS

Clastic sedimentary rocks: CLASSIFICATION

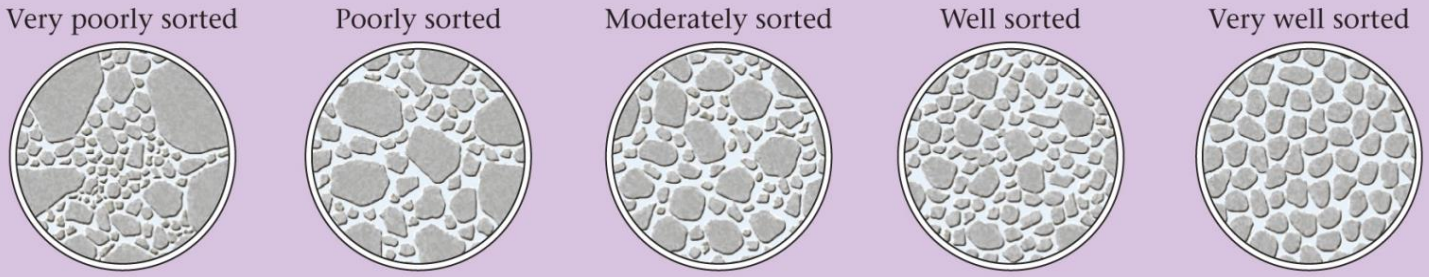
Angularity



Fresh detritus is usually angular and poorly sorted

Grain roundness, sphericity and sorting increase with transport.

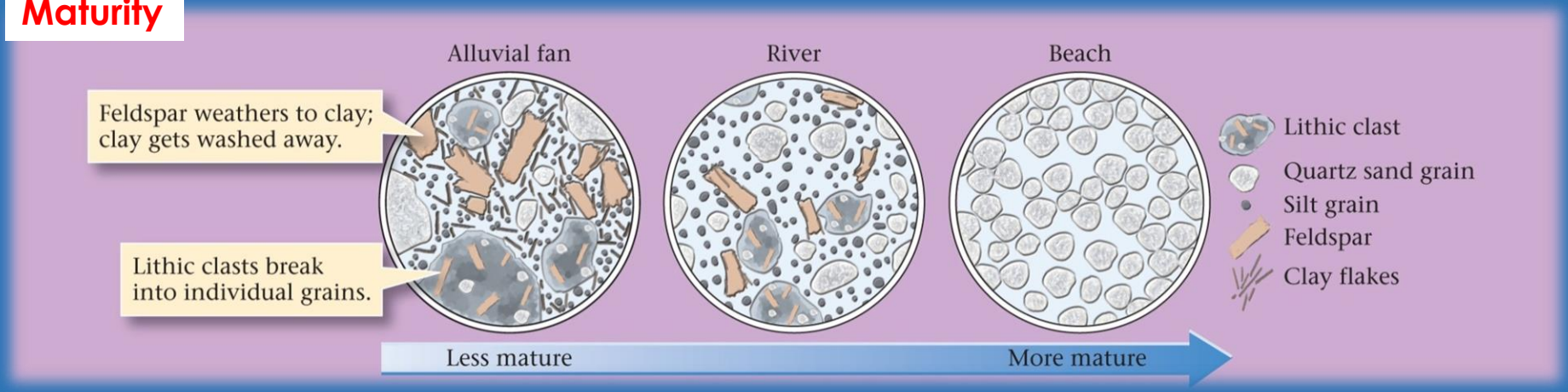
Sorting



3. SEDIMENTARY ROCKS

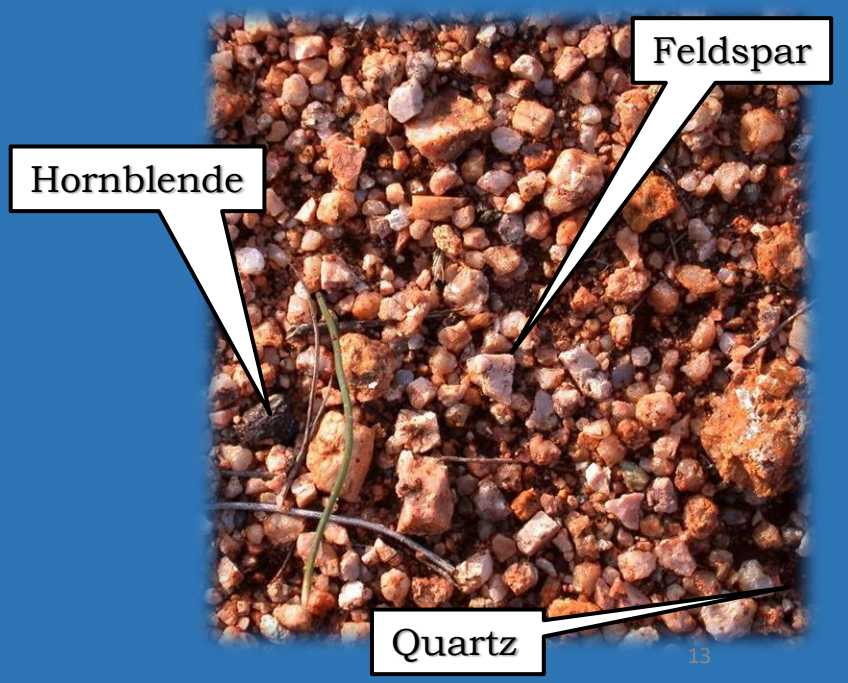
Clastic sedimentary rocks: CLASSIFICATION

Maturity



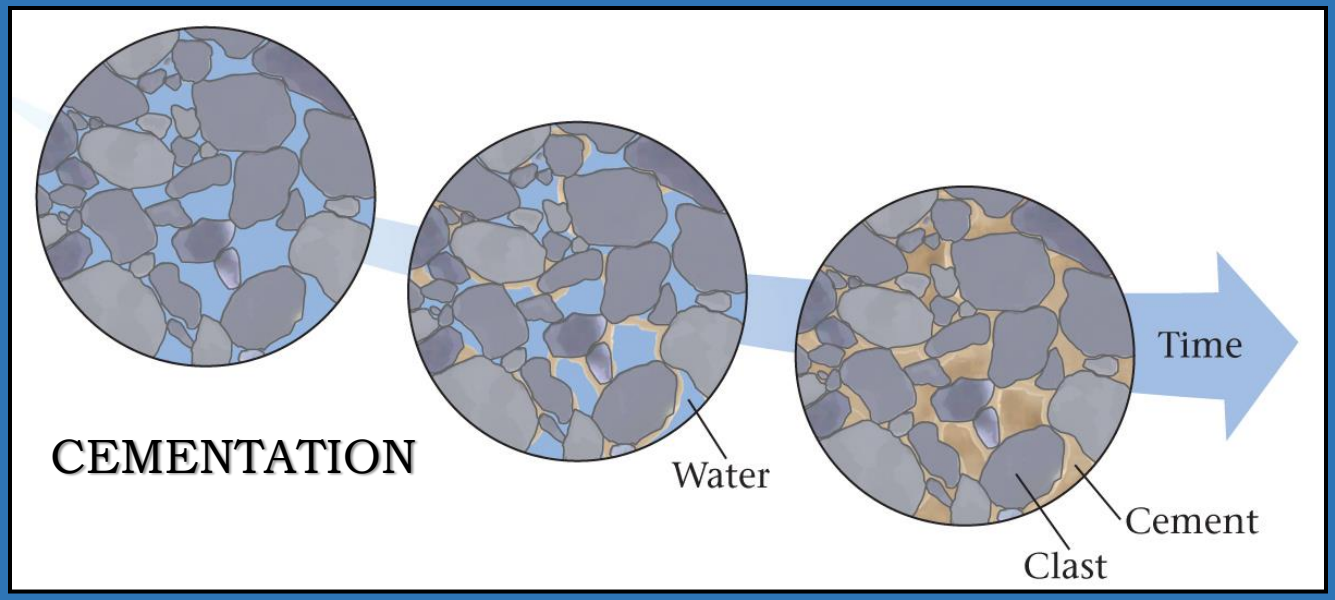
These rock and mineral fragments are derived from chemical and physical weathering of a Precambrian granite retaining similar composition.

These sediments are poorly sorted and less mature



3. SEDIMENTARY ROCKS

Clastic sedimentary rocks: CLASSIFICATION



CEMENTING MATERIALS

- Quartz
- Calcite
- Aragonite
- Dolomite
- Ankerite
- Hematite

3. SEDIMENTARY ROCKS

Clastic sedimentary rocks: CLASSIFICATION

Clast Size*	Clast Character	Rock Name (Alternate Name)
Coarse to very coarse	Rounded pebbles and cobbles Angular clasts Large clasts in muddy matrix	Conglomerate Breccia Diamictite
Medium to coarse	Sand-sized grains • quartz grains only • quartz and feldspar sand • sand-sized rock fragments • sand and rock fragments in a clay-rich matrix	Sandstone • quartz sandstone (quartz arenite) • arkose • lithic sandstone • wacke (informally called graywacke)
Fine	Silt-sized clasts	Siltstone
Very fine	Clay and/or very fine silt	Shale (if it breaks into platy sheets) Mudstone (if it doesn't break into platy sheets)

A conglomerate is a sedimentary rock consisting of rounded fragments of individual clasts within a finer-grained matrix that have become cemented together.

Deposited farther from the source than breccia.

(a) Conglomerate

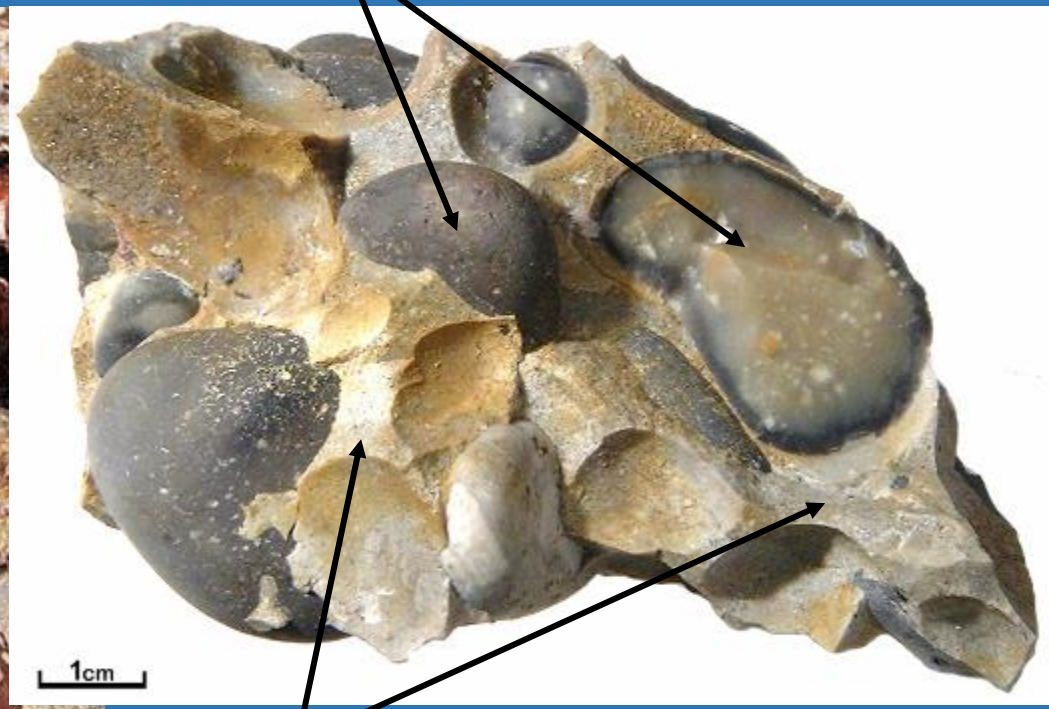
3. SEDIMENTARY ROCKS

Clastic sedimentary rocks: CLASSIFICATION

BRECCIA: coarse, angular rock fragments. Angularity indicates the absence of rounding by transport, hence, deposited relatively close to clast source.

Conglomerate (rounded clasts)
Breccia (angular clasts)

Matrix = all the fine grained "stuff" between the larger grains



3. SEDIMENTARY ROCKS

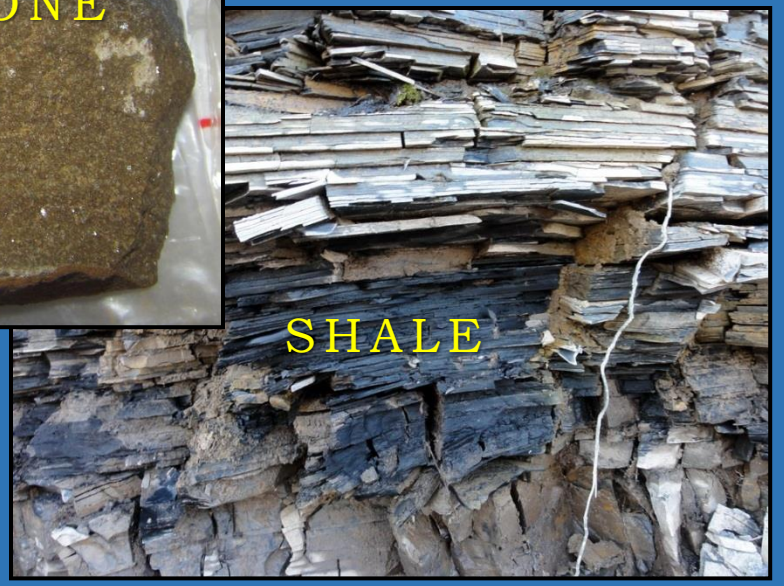
Clastic sedimentary rocks: CLASSIFICATION

SANDSTONE: clastic rock made of sand-sized particles. Quartz is, by far, the most common mineral in sandstones.

Sand: coarse, medium, and fine.

3. SEDIMENTARY ROCKS

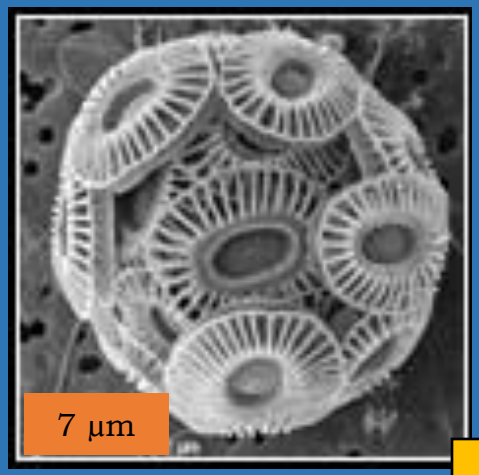
Clastic sedimentary rocks: CLASSIFICATION



3. SEDIMENTARY ROCKS

Biochemical sedimentary rocks

Nannoplankton



Corals & Shells

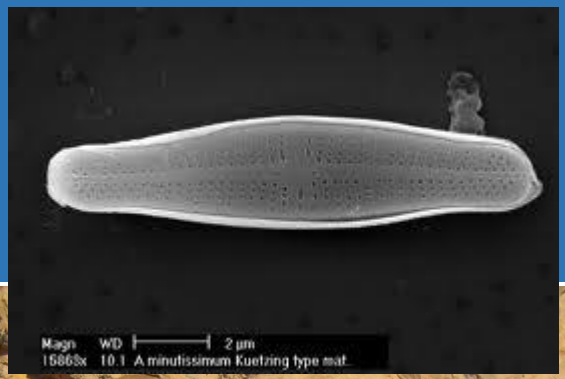
The $CaCO_3$ in limestone comes from shells from a diversity of organisms (plankton, corals, clams, snails, etc.).

Biochemical limestone forms in a unique depositional environment such as warm, tropical, shallow, clear, O_2-rich, marine water.

These rocks may preserve the original shape of the organisms which contributed to the rock formation.

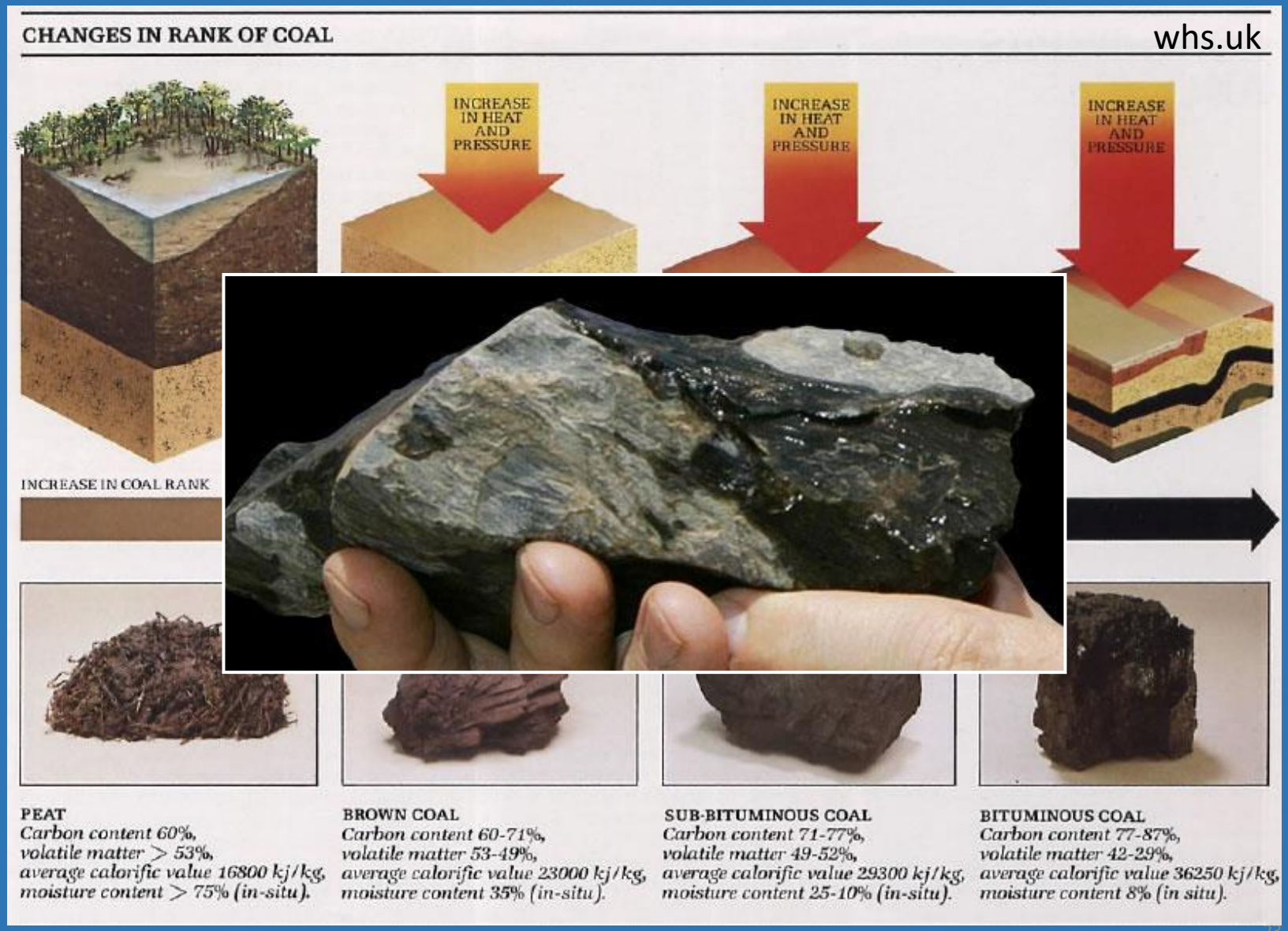
3. SEDIMENTARY ROCKS

Biochemical sedimentary rocks



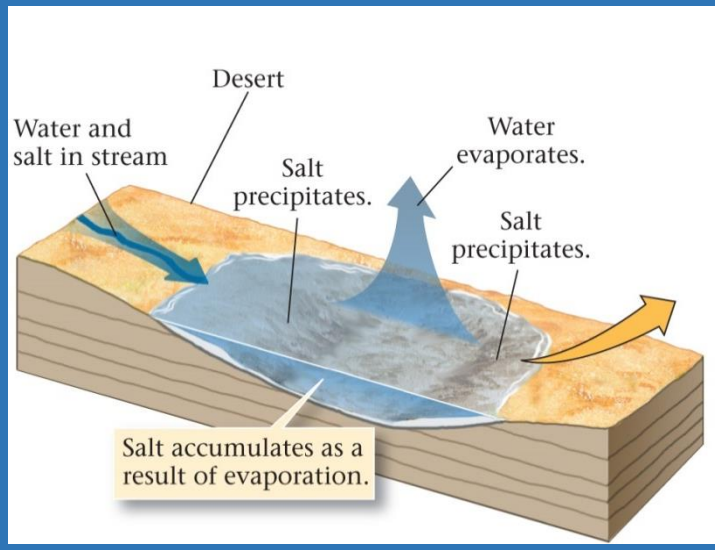
3. SEDIMENTARY ROCKS

Organic sedimentary rocks



3. SEDIMENTARY ROCKS

Chemical sedimentary rocks



EVAPORITES

Chemical sedimentary rocks are comprised of minerals precipitated from water solution.

They have a crystalline (interlocking) texture developed from initial crystal growth from solution (which may be recrystallized during burial).

3. SEDIMENTARY ROCKS

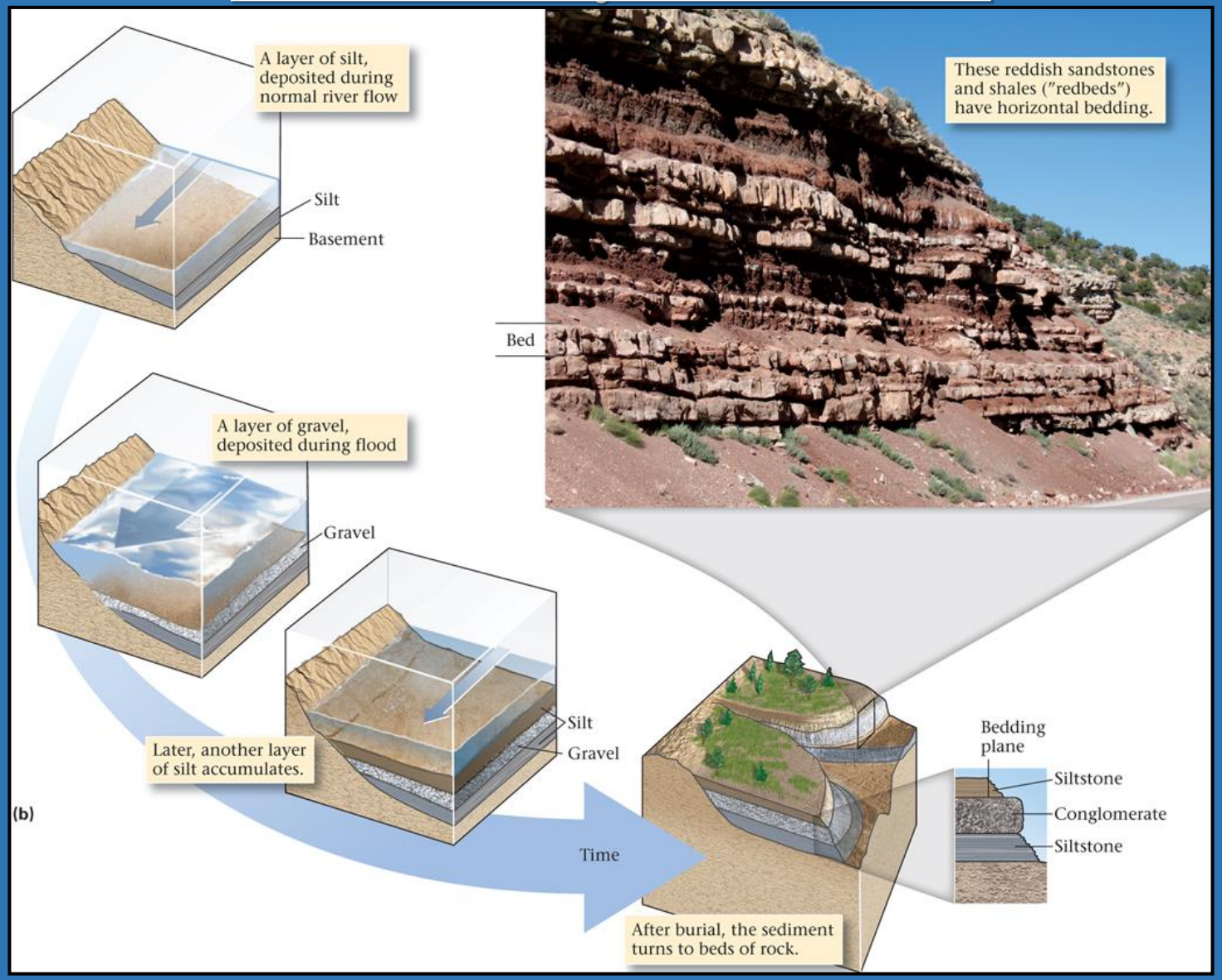
Chemical sedimentary rocks

TRAVERTINE: calcium carbonate ($CaCO_3$) precipitated from ground water where it reaches the surface.

Dissolved calcium (Ca^{2+}) reacts with bicarbonate (HCO_{3-}). When CO_2 is expelled into the air, it causes $CaCO_3$ to precipitate. This process occurs in thermal (hot) springs and in caves.

3. SEDIMENTARY ROCKS

Sedimentary structures



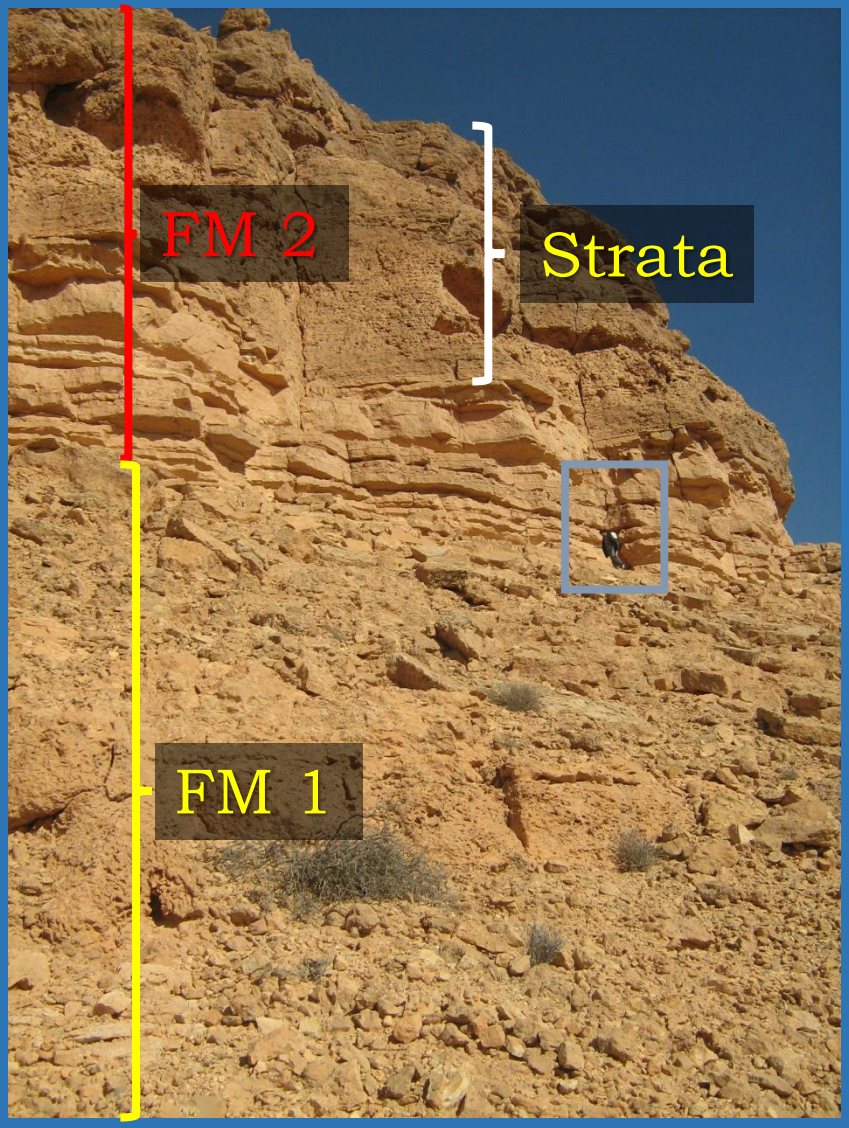
3. SEDIMENTARY ROCKS

Sedimentary structures

Distinct rock units that are so unique that they can be recognized (and mapped) over large regions, are termed **formations (FM)**. Formations are named for places where they are best exposed. Geologic maps display the distribution of formations.

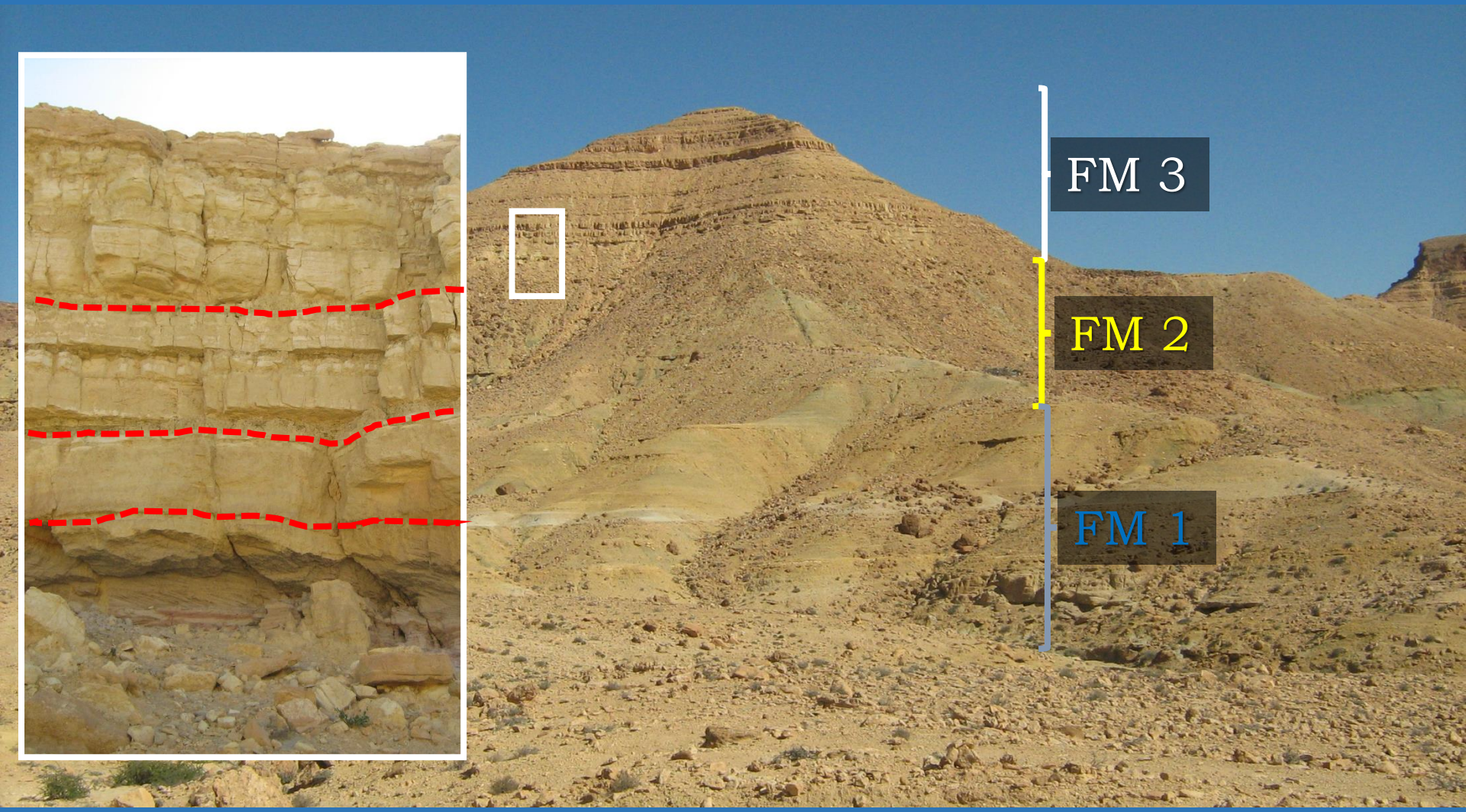
3. SEDIMENTARY ROCKS

Sedimentary structures



3. SEDIMENTARY ROCKS

Sedimentary structures



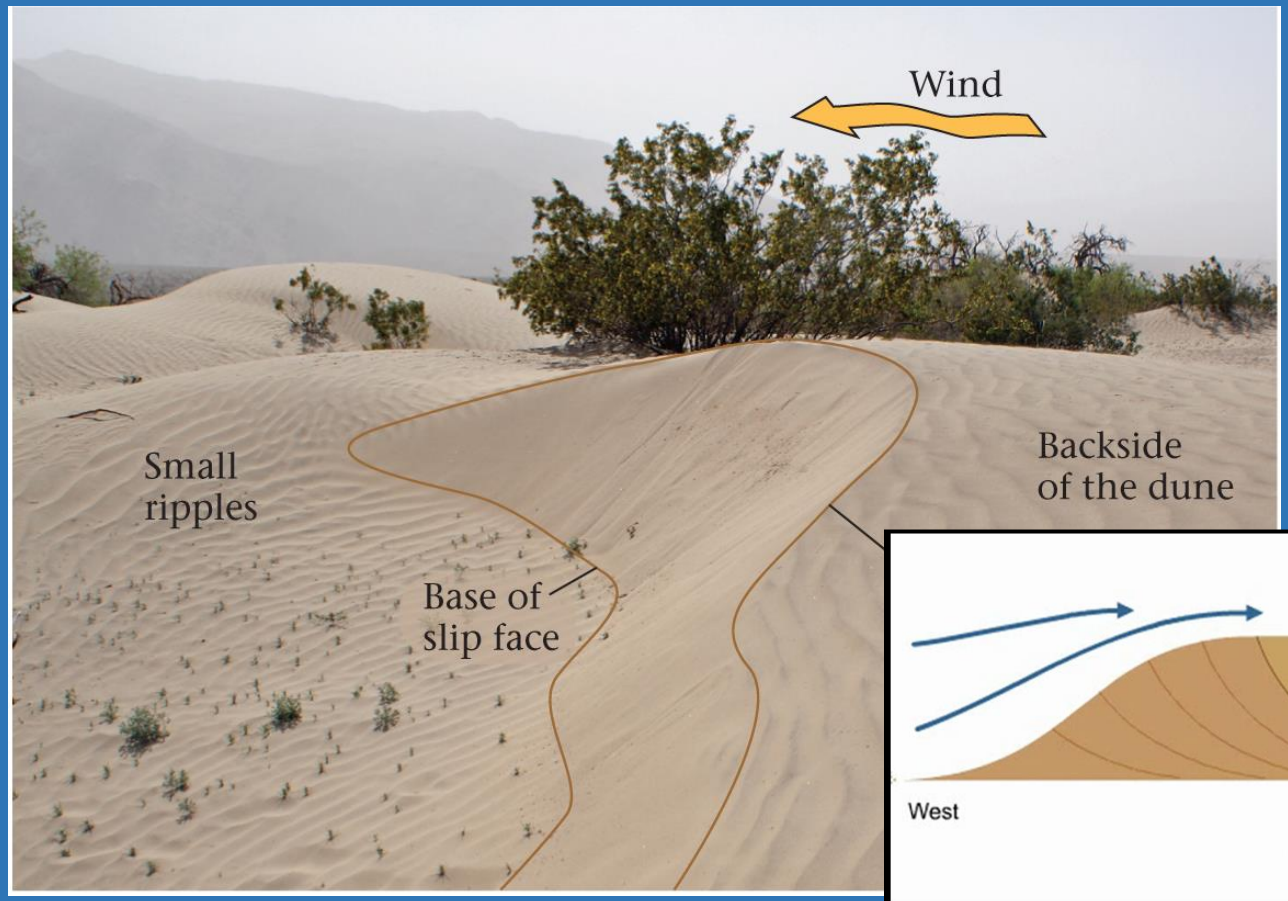
3. SEDIMENTARY ROCKS

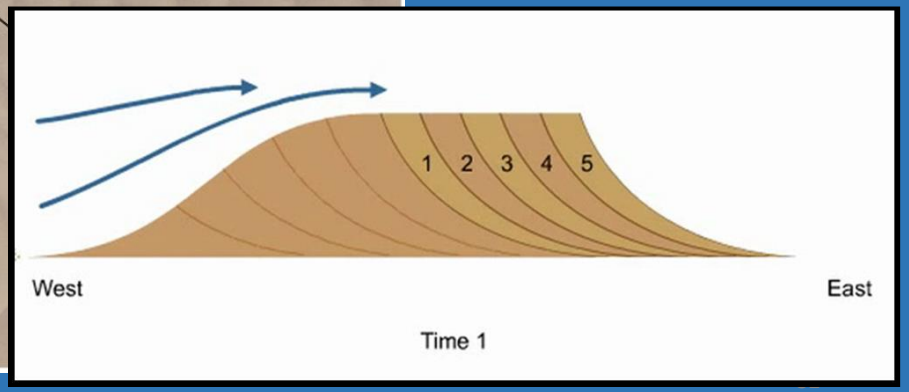
Sedimentary structures

3. SEDIMENTARY ROCKS

Sedimentary structures

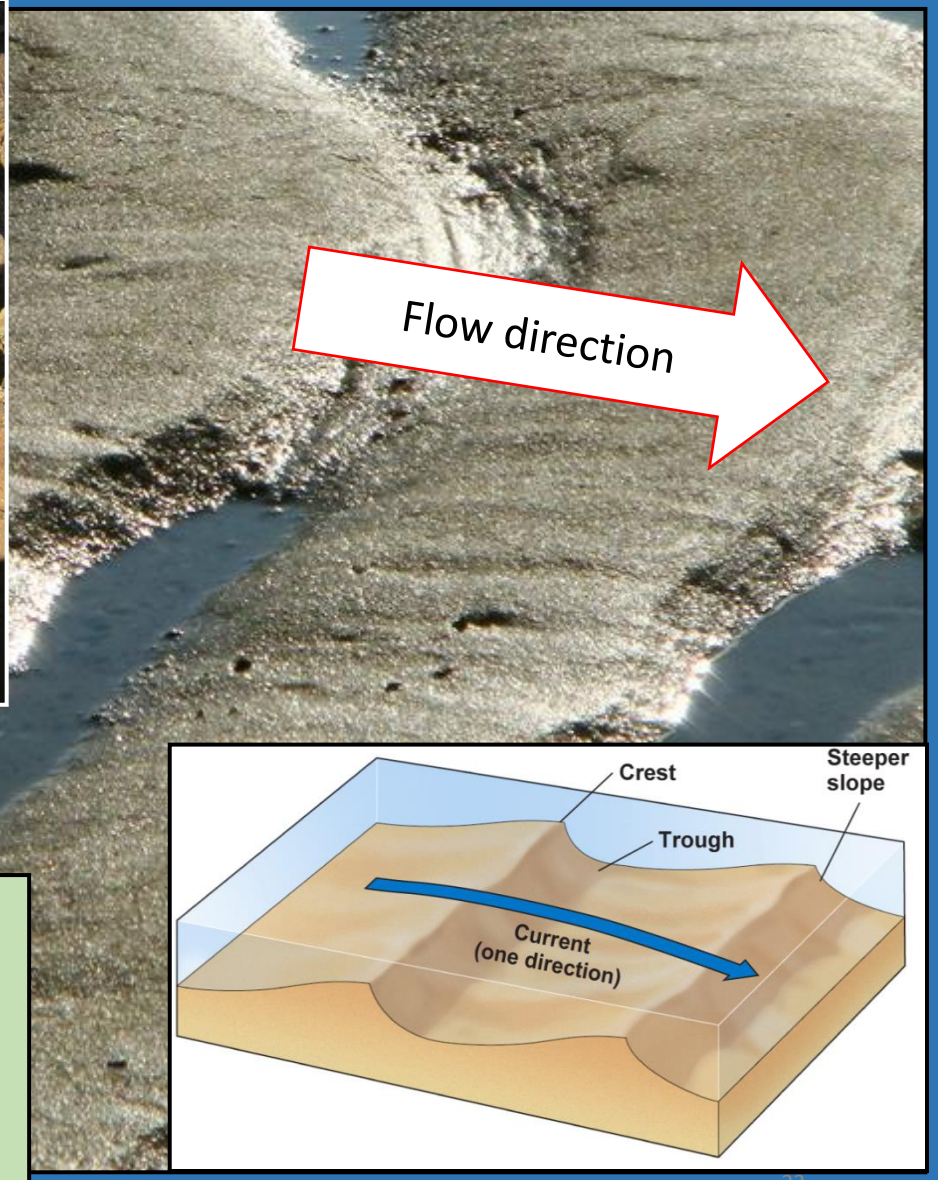
Water flowing over loose sediment creates **bedforms**, which directly reflect flow velocity and grain size. Bedforms in ancient sediments are useful indicators of **environmental conditions**.





3. SEDIMENTARY ROCKS

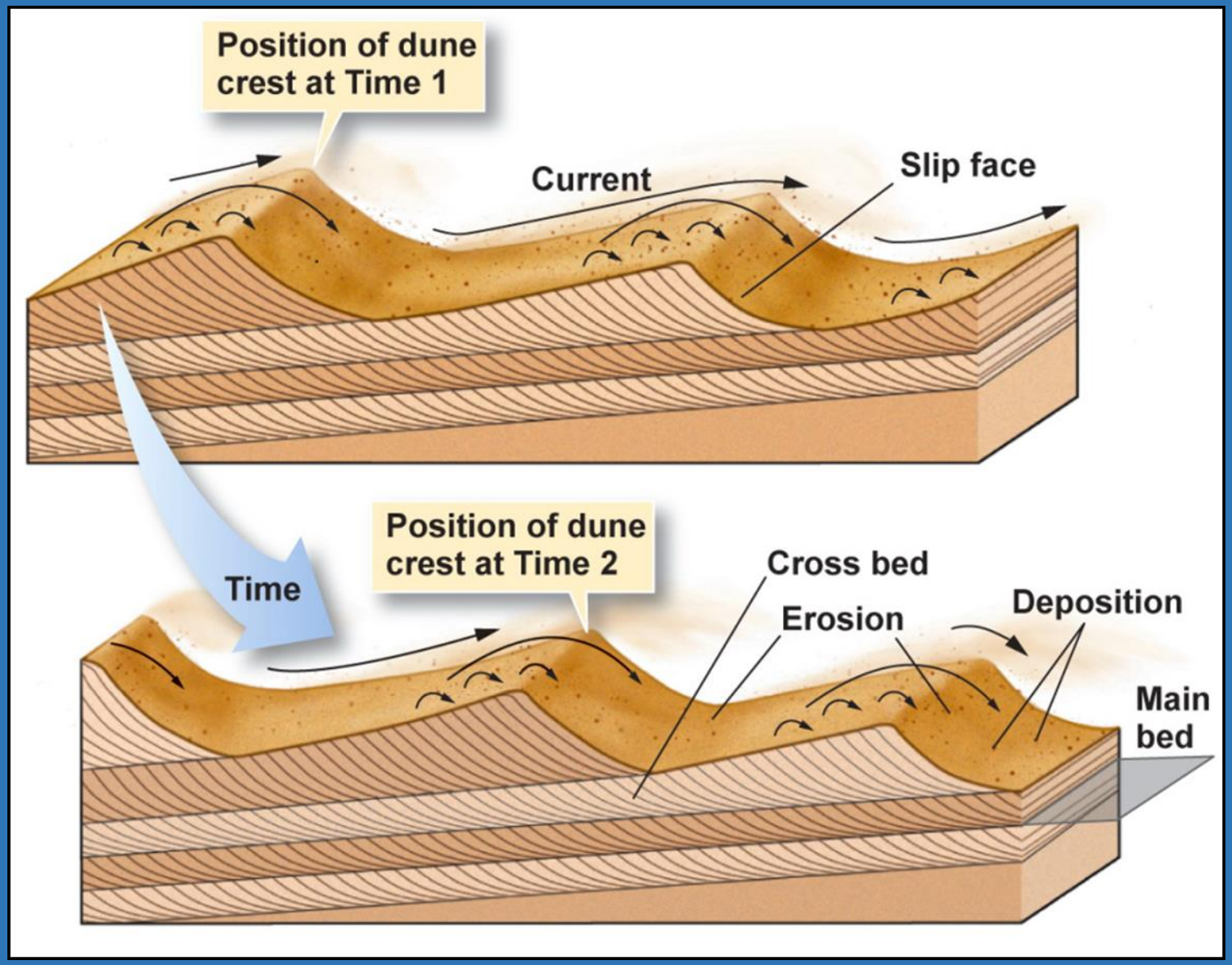
Sedimentary structures



Asymmetric ripples develop as the result of current flow in one direction. In cross section, the ripples have a short, steeper slope in the down-current direction and a longer less-steep ramp on the up-current side.

3. SEDIMENTARY ROCKS

Sedimentary structures



3. SEDIMENTARY ROCKS

Sedimentary structures

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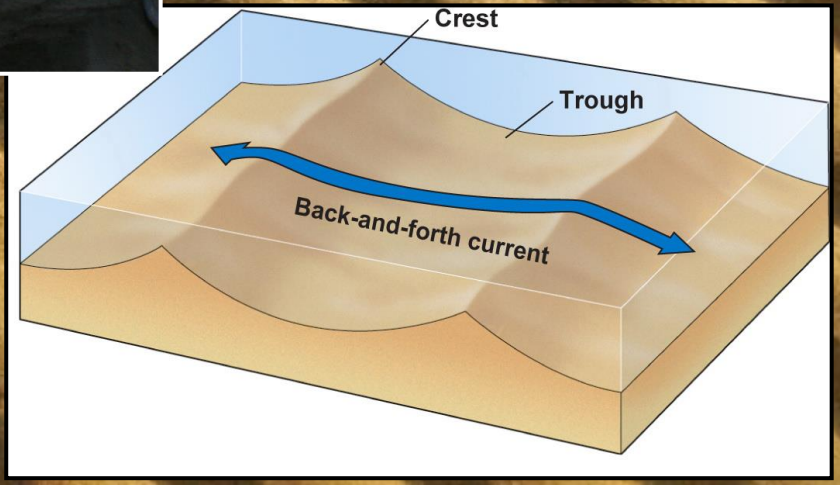
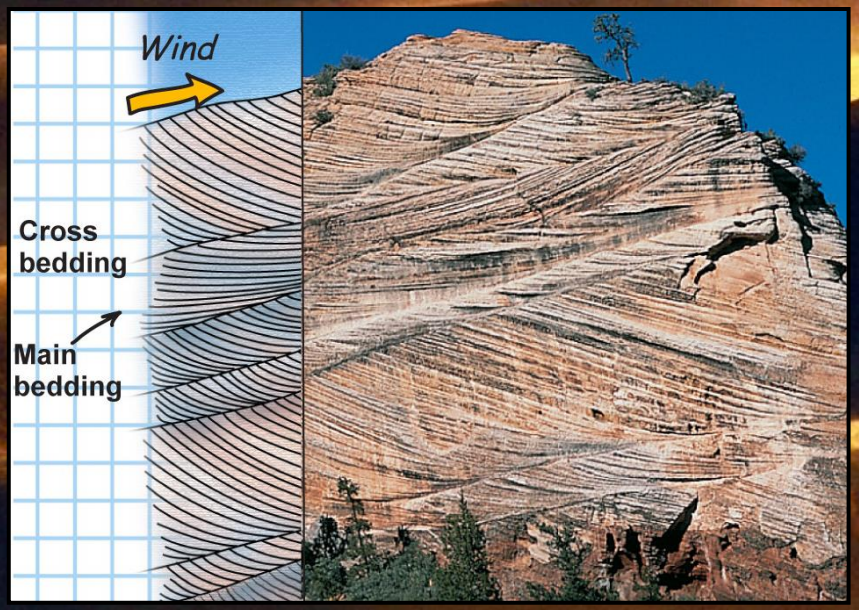
Sedimentary structures



Symmetric ripples have sharp ridges and concave-up troughs. They form in response to the back-and-forth swash of water waves oscillating in very shallow water near shore environments.

3. SEDIMENTARY ROCKS

Sedimentary structures



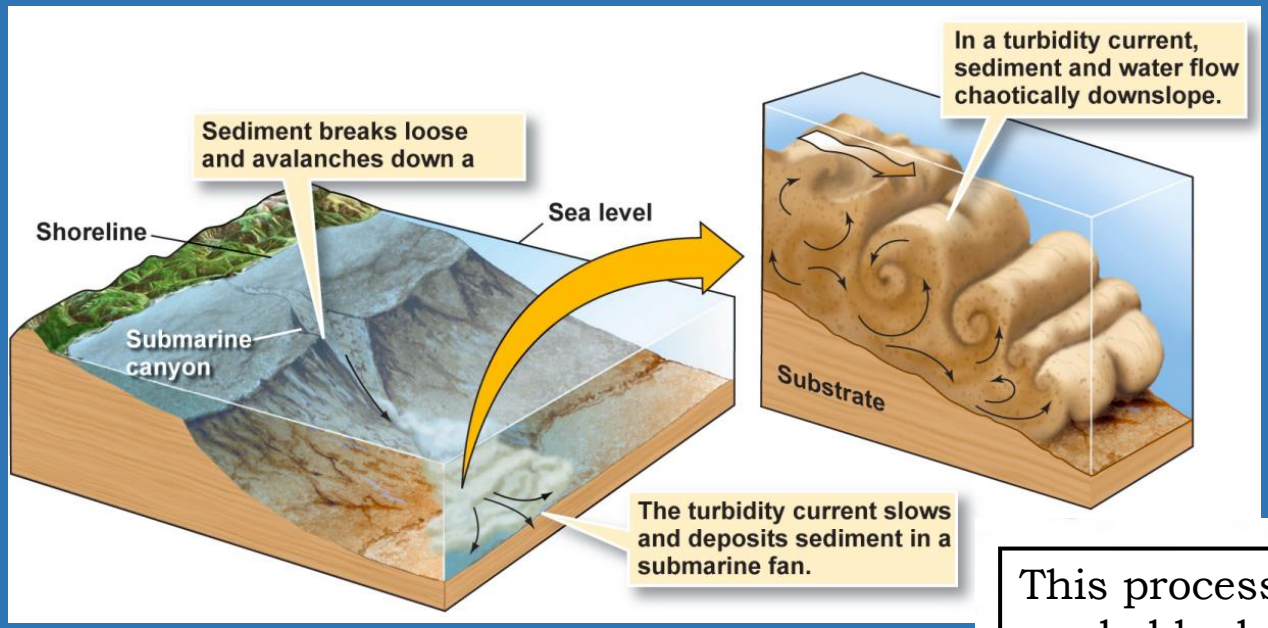
Dunes are similar to ripples except they are much larger (tens of cm to hundreds of m). They occur in streams and in desert or beach regions from water- or wind-transported sand.

3. SEDIMENTARY ROCKS

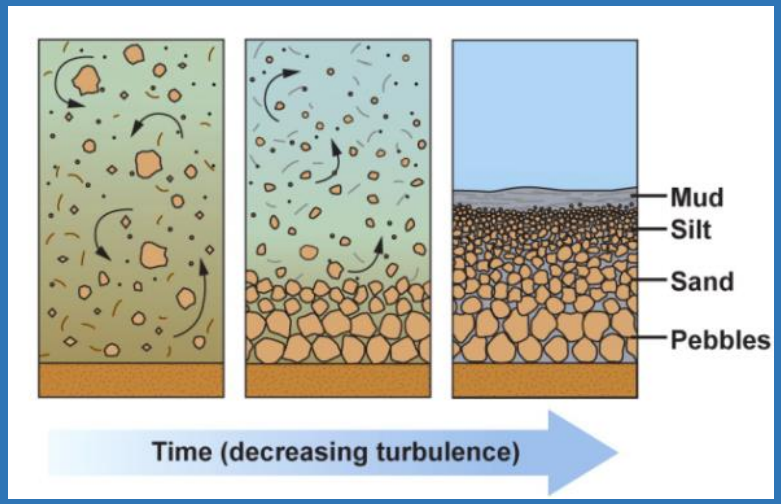
Sedimentary structures

3. SEDIMENTARY ROCKS

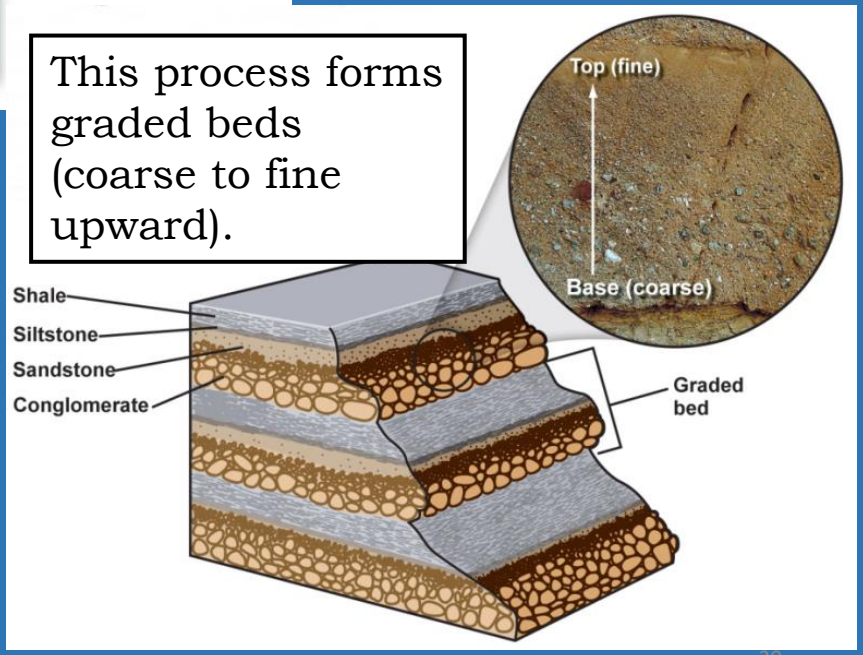
Sedimentary structures



Turbidity currents are formed in deep basins that receive periodic pulses of turbid water. Such pulses might result from an earthquake shock loosening sediment on a slope.



This process forms graded beds (coarse to fine upward).



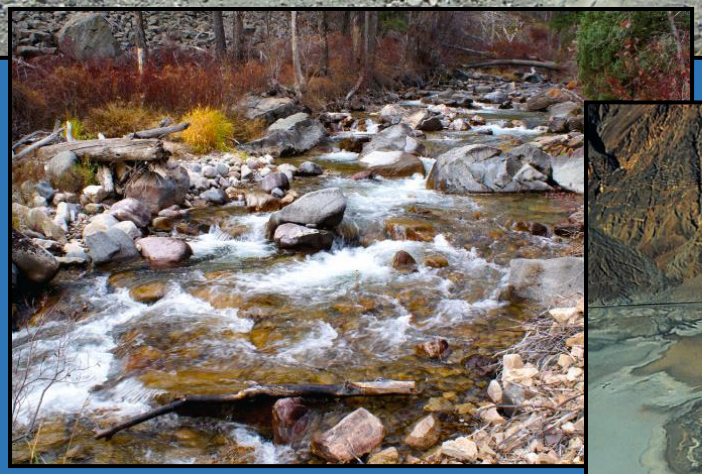
3. SEDIMENTARY ROCKS

Sedimentary structures

3. SEDIMENTARY ROCKS

Depositional environments: TERRESTRIAL

In glacial environments, sediments are created, transported, and deposited by the actions of **moving glacial ice**. Ice carries and dumps every grain size.
A common feature of this environment is **glacial till**, a poorly sorted mixture of all grain sizes, gravel, sand, silt, and clay.



Alluvial fans are cone-shaped wedges of sediments that pile up where a rapid drop in stream velocity occurs at a mountain front.

3. SEDIMENTARY ROCKS

Depositional environments: TERRESTRIAL

3. SEDIMENTARY ROCKS

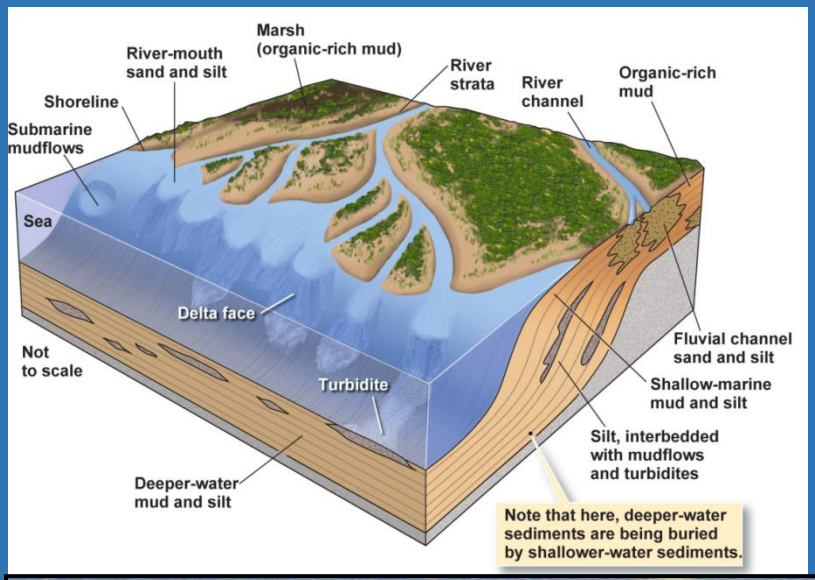
Depositional environments: TERRESTRIAL

Fine sand, silt, and clay are deposited on nearby **flood plains**.

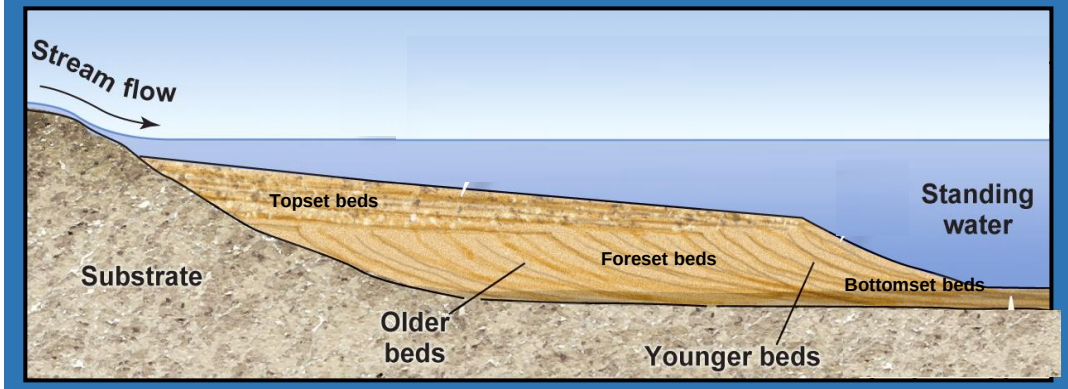
River environments preserve evidence of channelized sediment transport. Sand and gravel fill concave-up channels that often scour into previously deposited floodplain fines.

3. SEDIMENTARY ROCKS

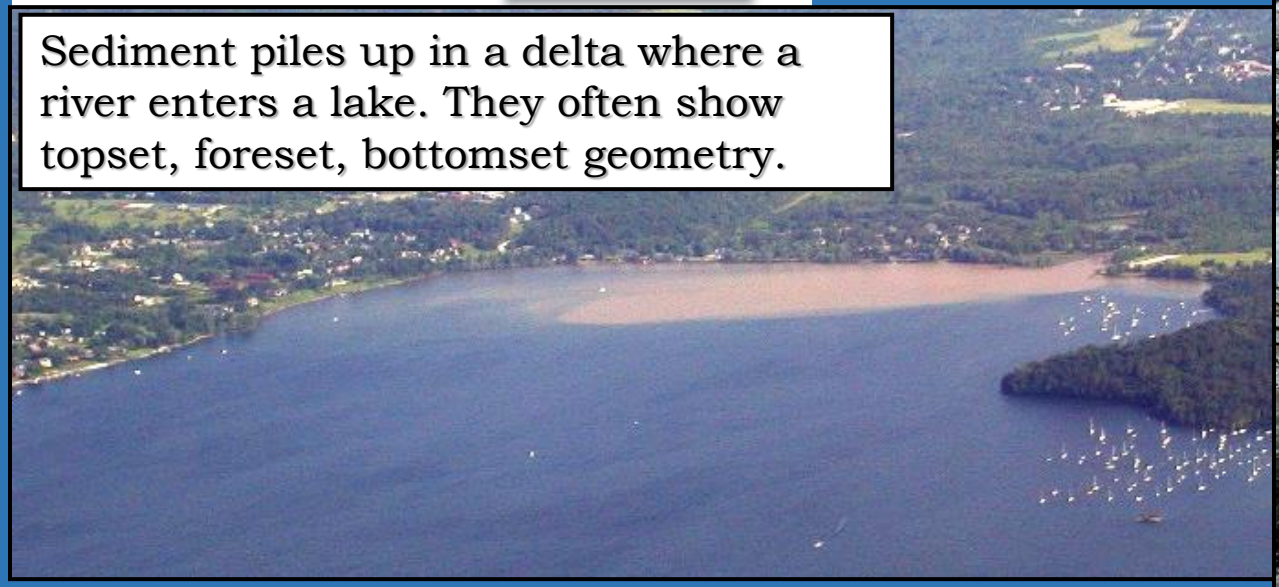
Depositional environments: TERRESTRIAL

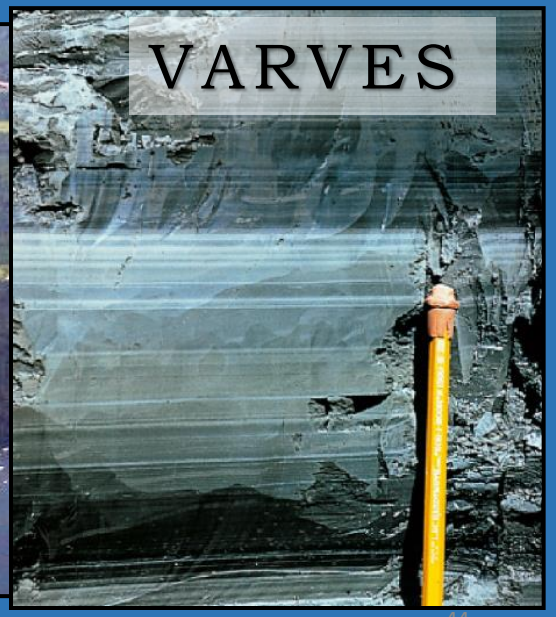


DELTA and ESTUARIES: both terrestrial (LAKE) and marine.



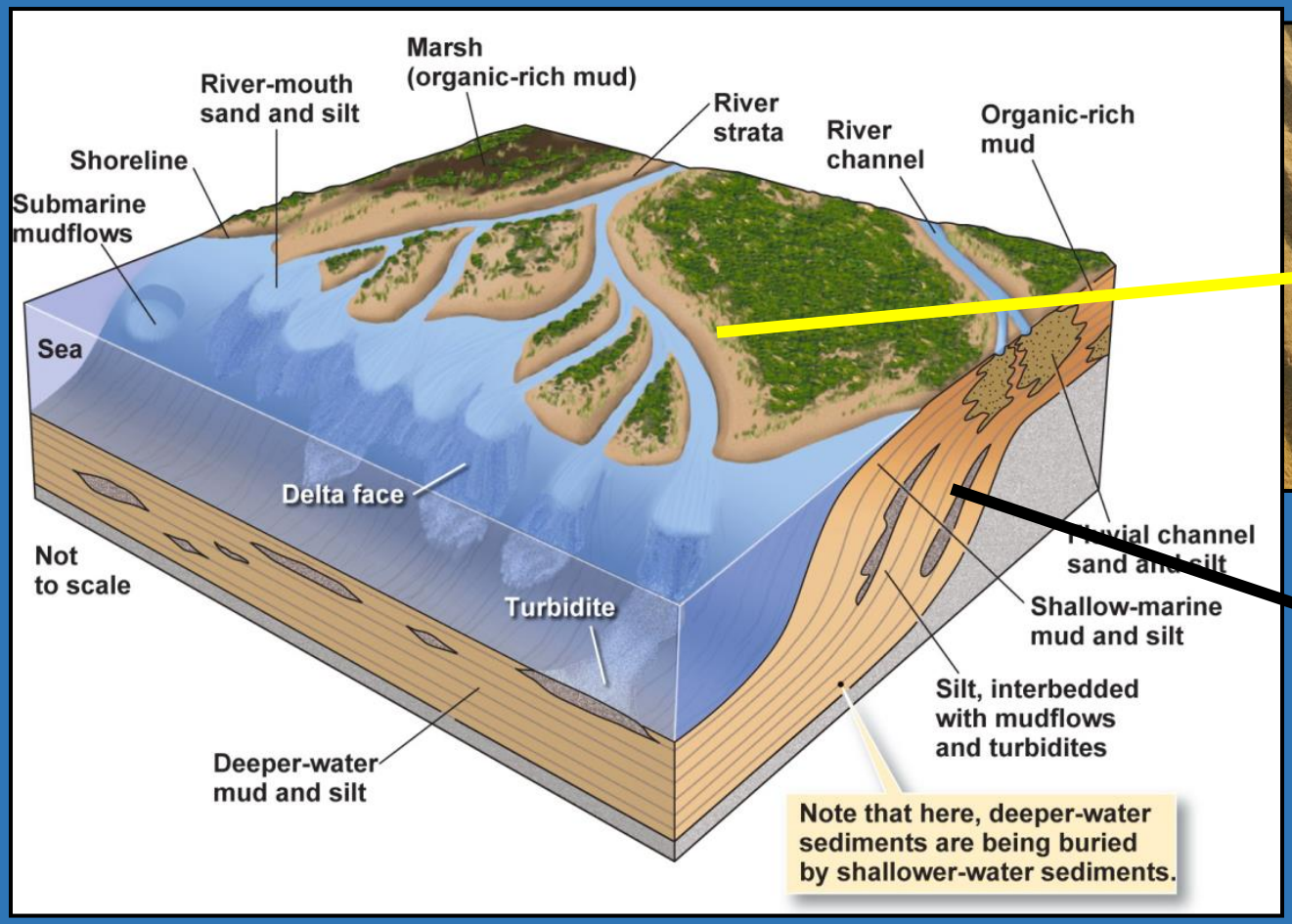
Sediment piles up in a delta where a river enters a lake. They often show topset, foreset, bottomset geometry.





3. SEDIMENTARY ROCKS

Depositional environments: TERRESTRIAL

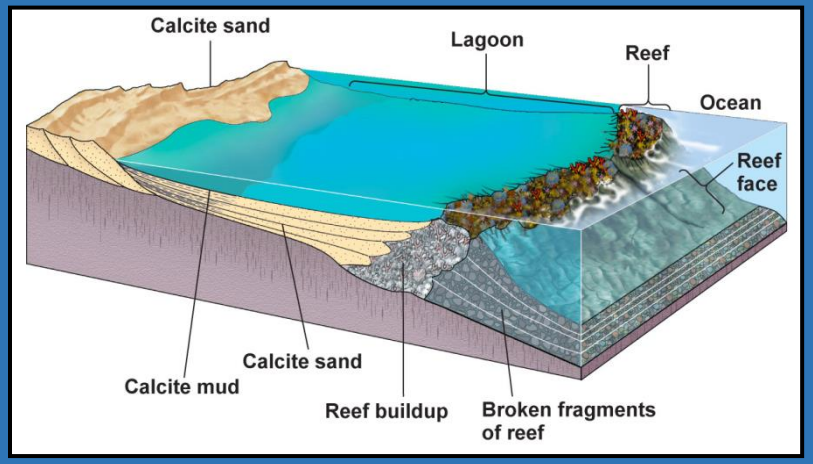


GAS & OIL

In a marine delta environment, sediment accumulates where river velocity drops upon entering the sea. Deltas grow over time, building out into the basin.

3. SEDIMENTARY ROCKS

Depositional environments: TERRESTRIAL



SHALLOW MARINE DEPOSITS:
e.g. REEF CARBONATES

DEEP-MARINE DEPOSITS:
e.g. TURBIDITES

CHAPTER 7 of the TEXTBOOK:
Pages of Earth's Past: Sedimentary Rocks
pp. 202 - 232