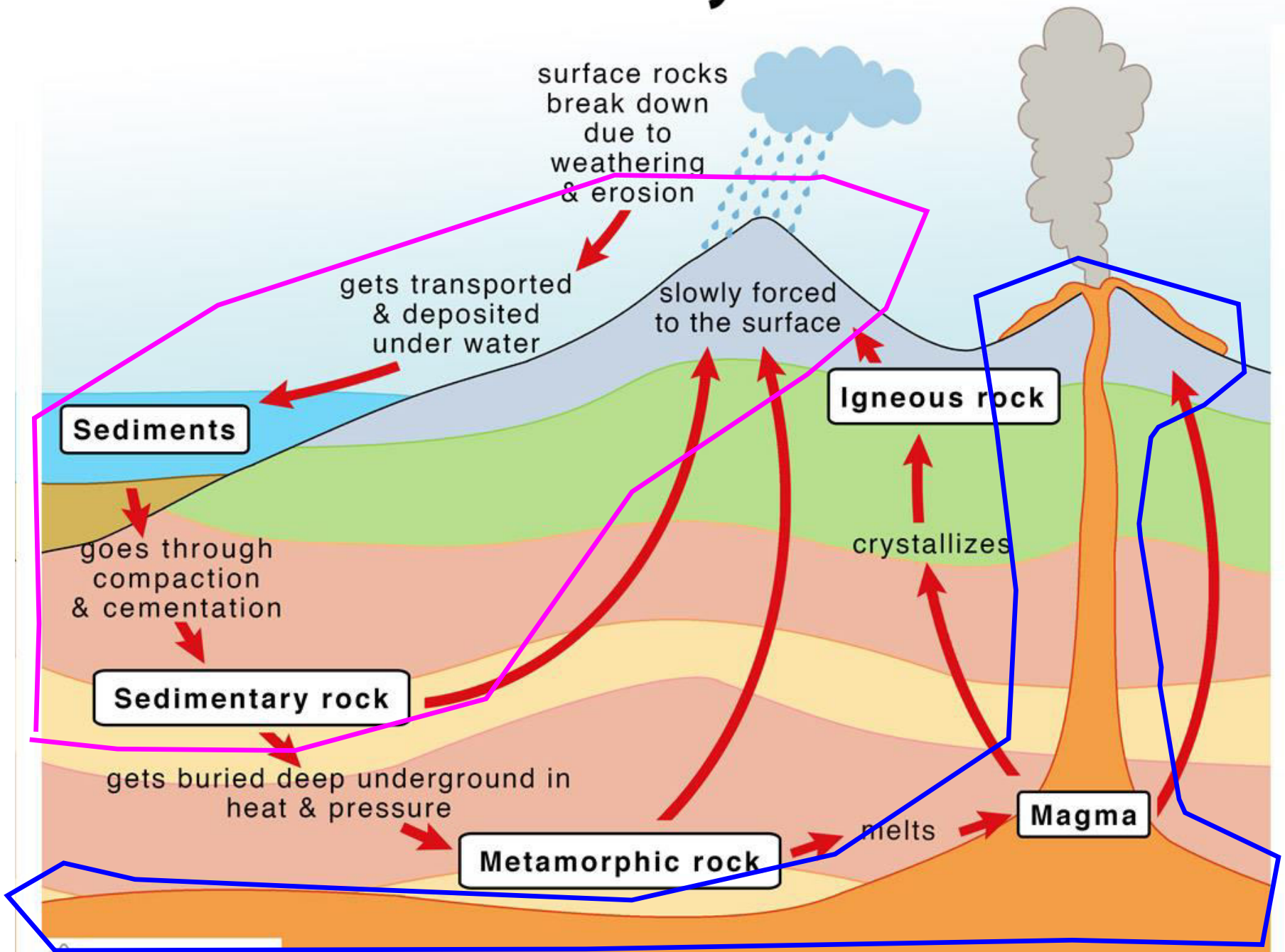
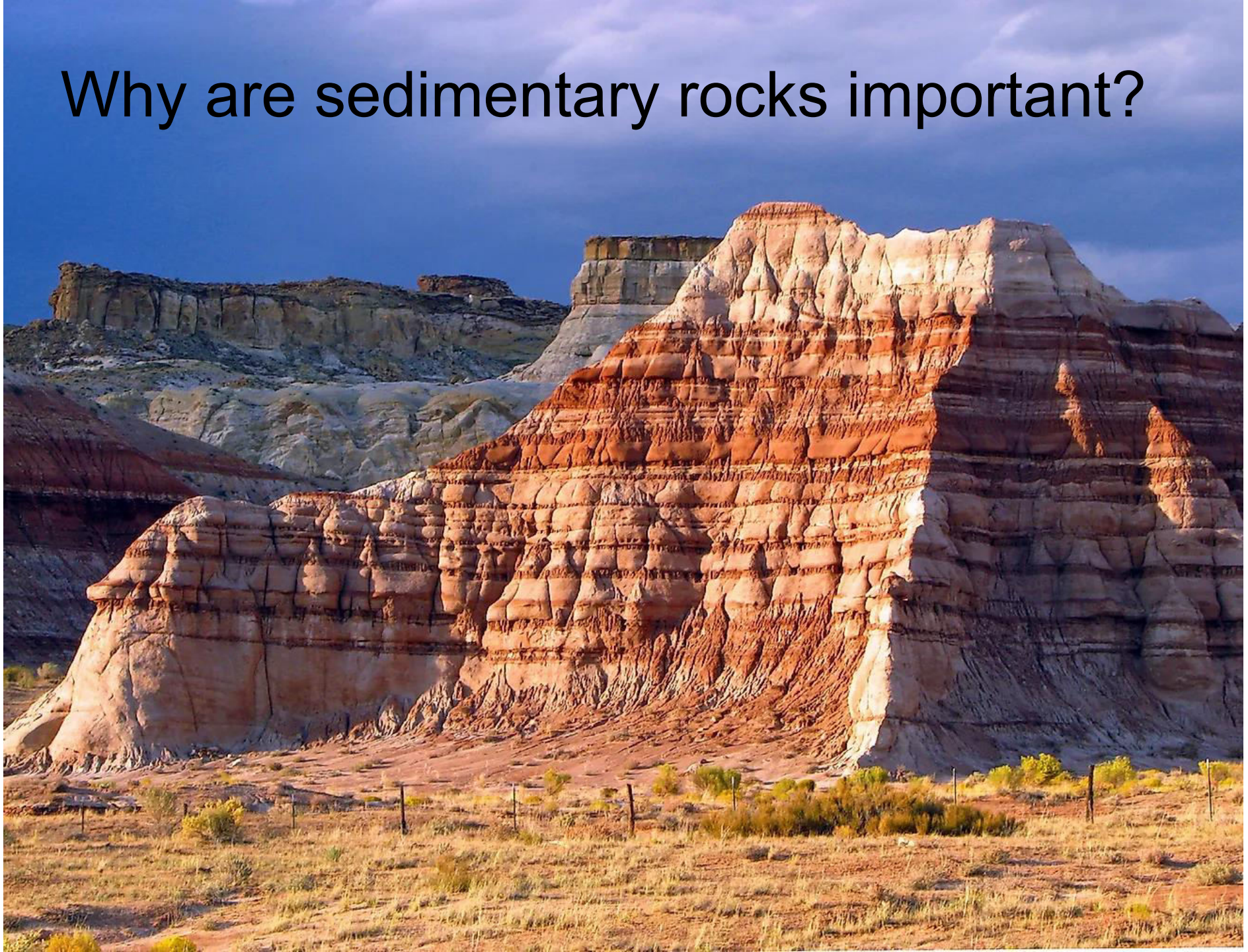
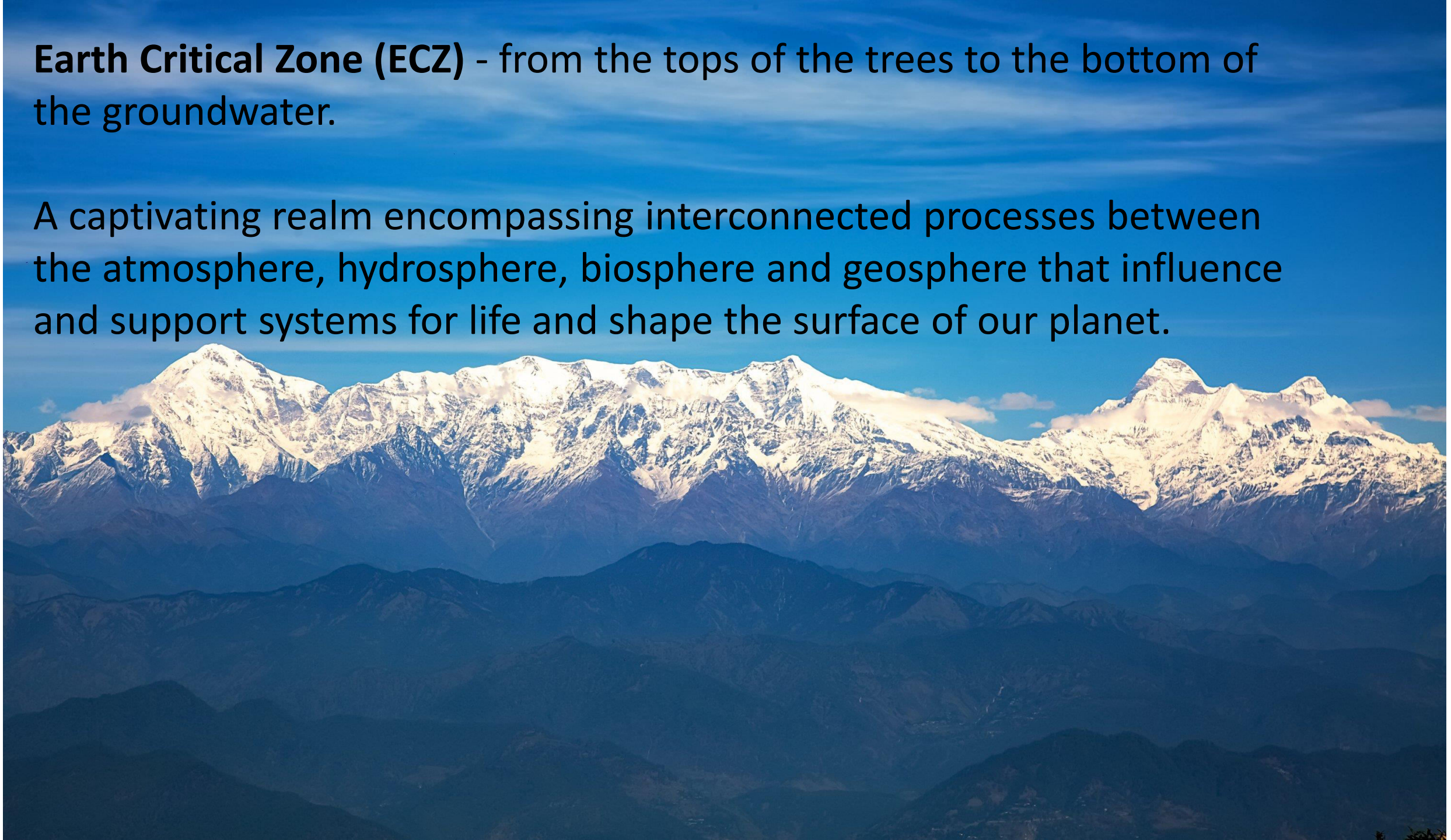
Rock Cycle


surface rocks break down due to weathering & erosion
gets transported & deposited under water
slowly forced to the surface
Igneous rock
Sediments
goes through compaction & cementation
crystallizes
Sedimentary rock
gets buried deep underground in heat & pressure
Metamorphic rock
melts
Magma

Why are sedimentary rocks important?





Earth Critical Zone (ECZ) - from the tops of the trees to the bottom of the groundwater.

A captivating realm encompassing interconnected processes between the atmosphere, hydrosphere, biosphere and geosphere that influence and support systems for life and shape the surface of our planet.

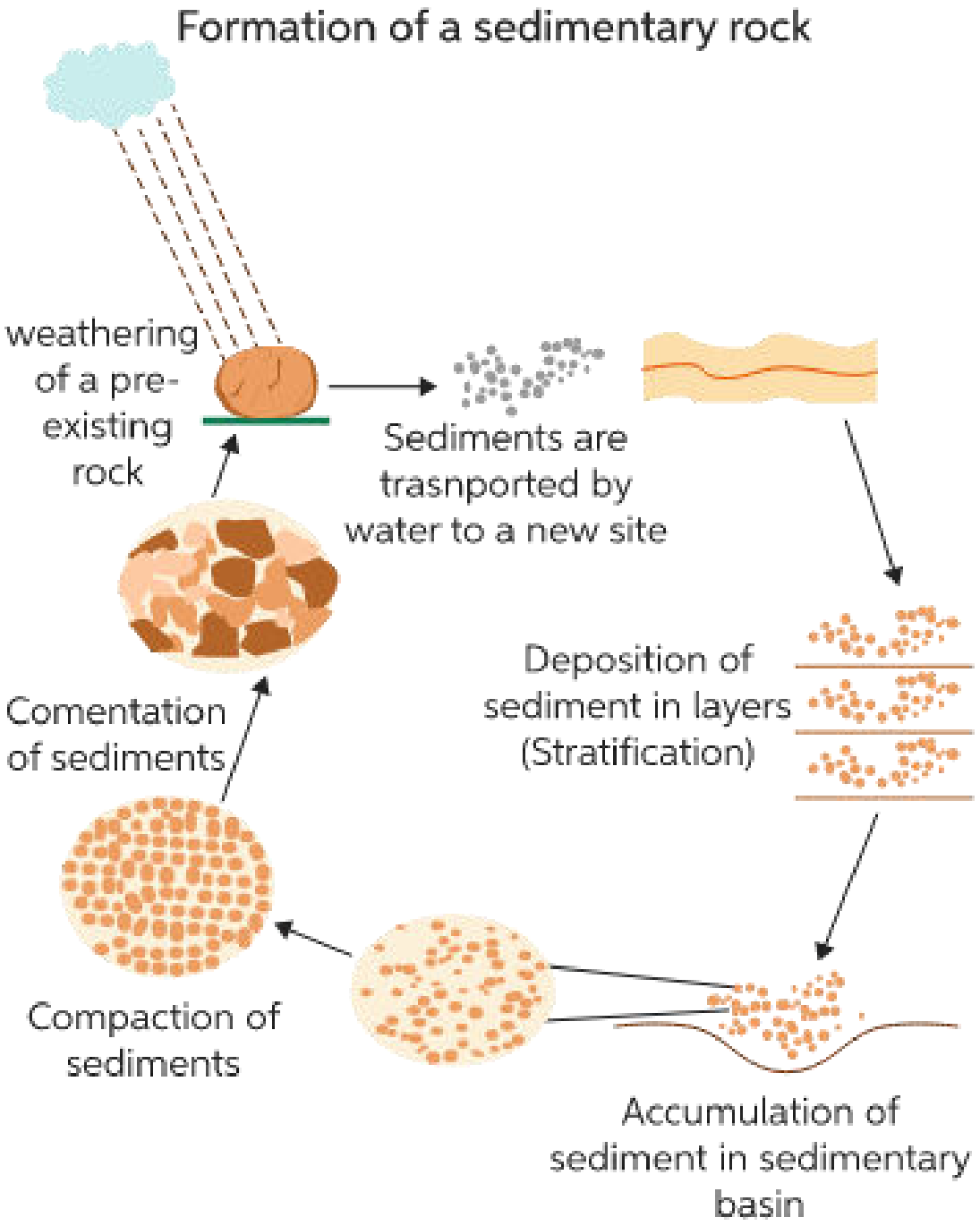
The Bengal Fan is the largest submarine fan on Earth.

Earth history: Sedimentary rocks are archives of

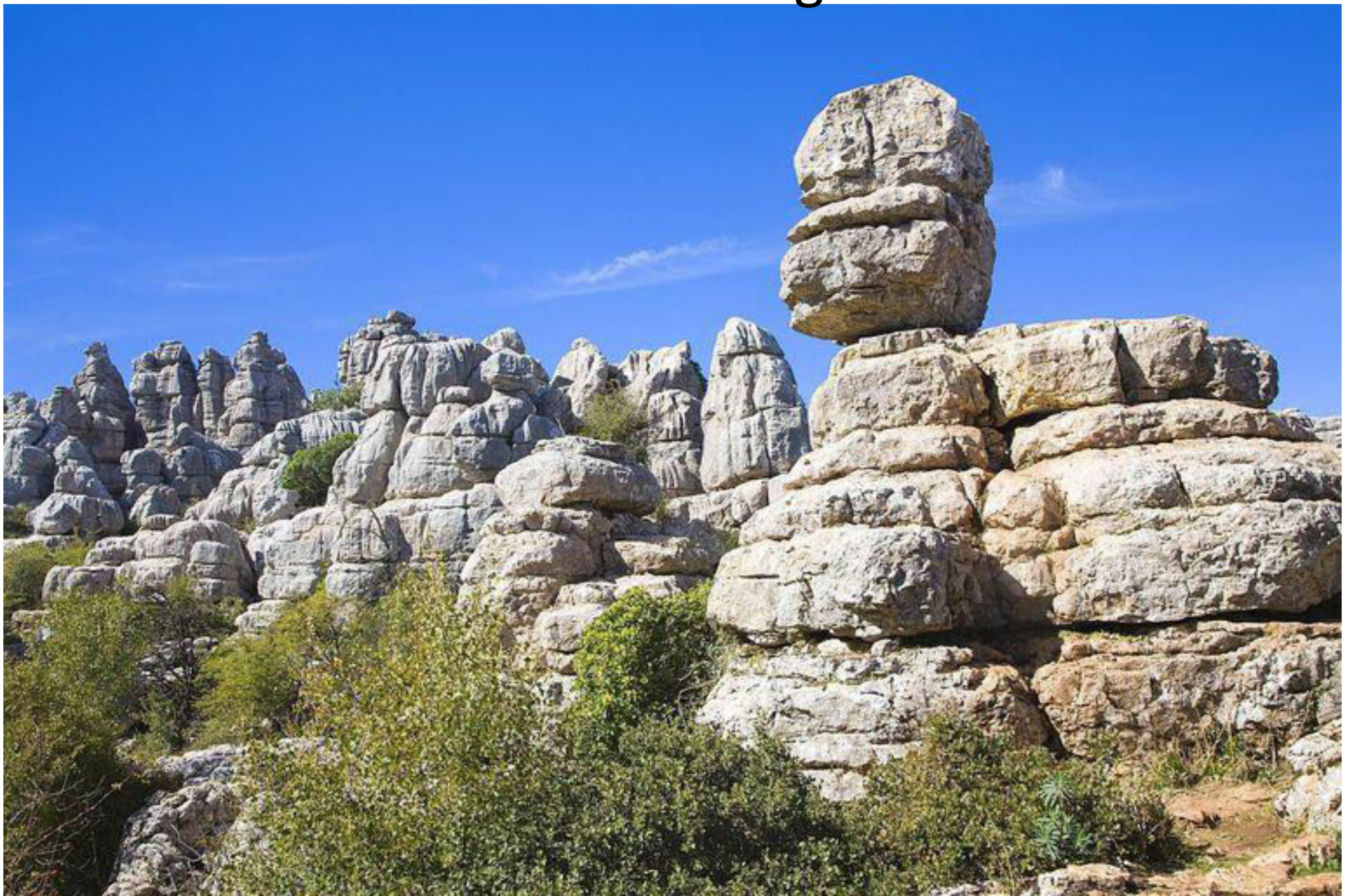
- Past tectonics
- Past depositional environments
- Evolution of organisms
- Climate change
- Atmosphere and ocean evolution
- Earth’s landscape evolution

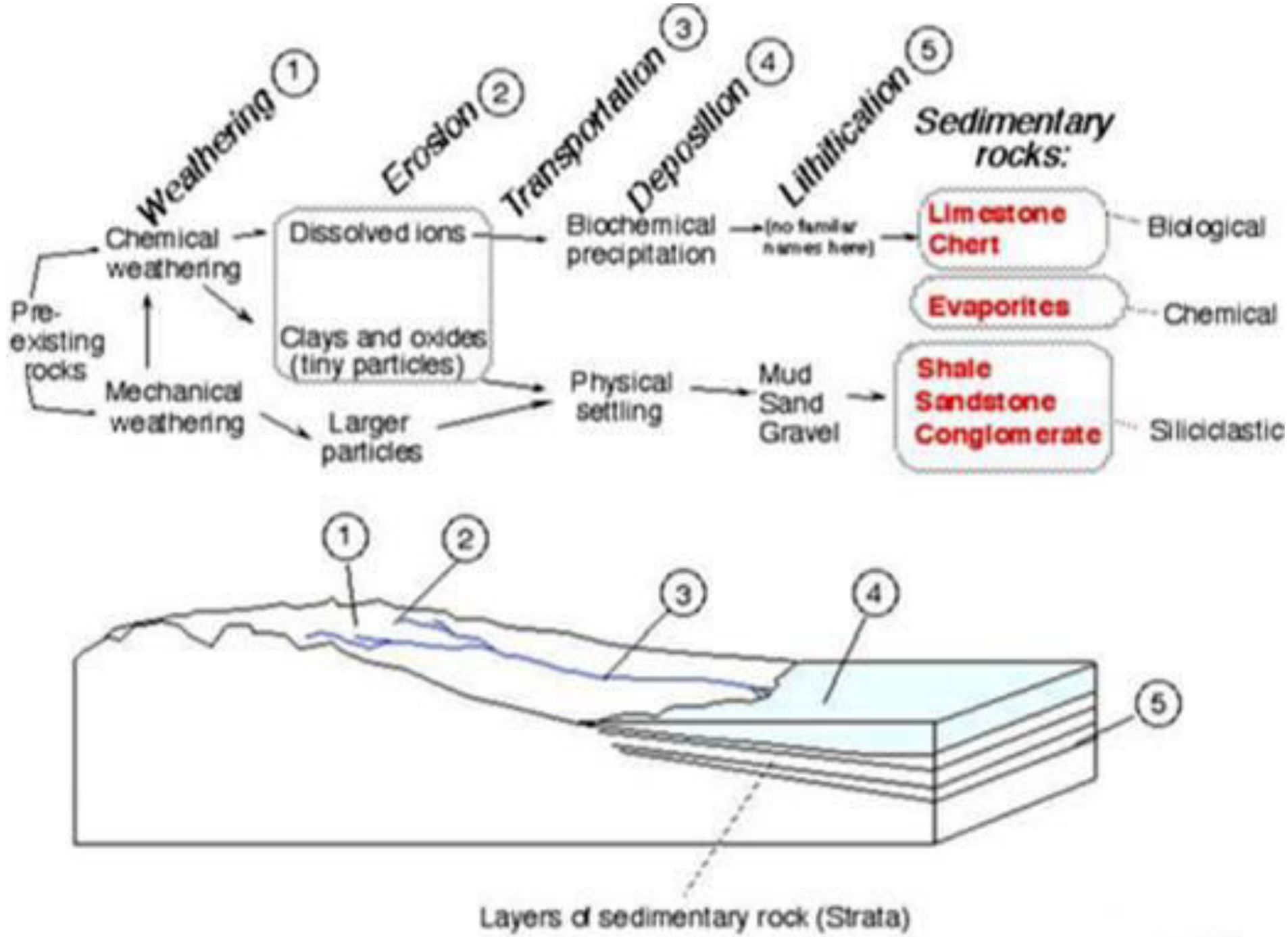
Economic resources:

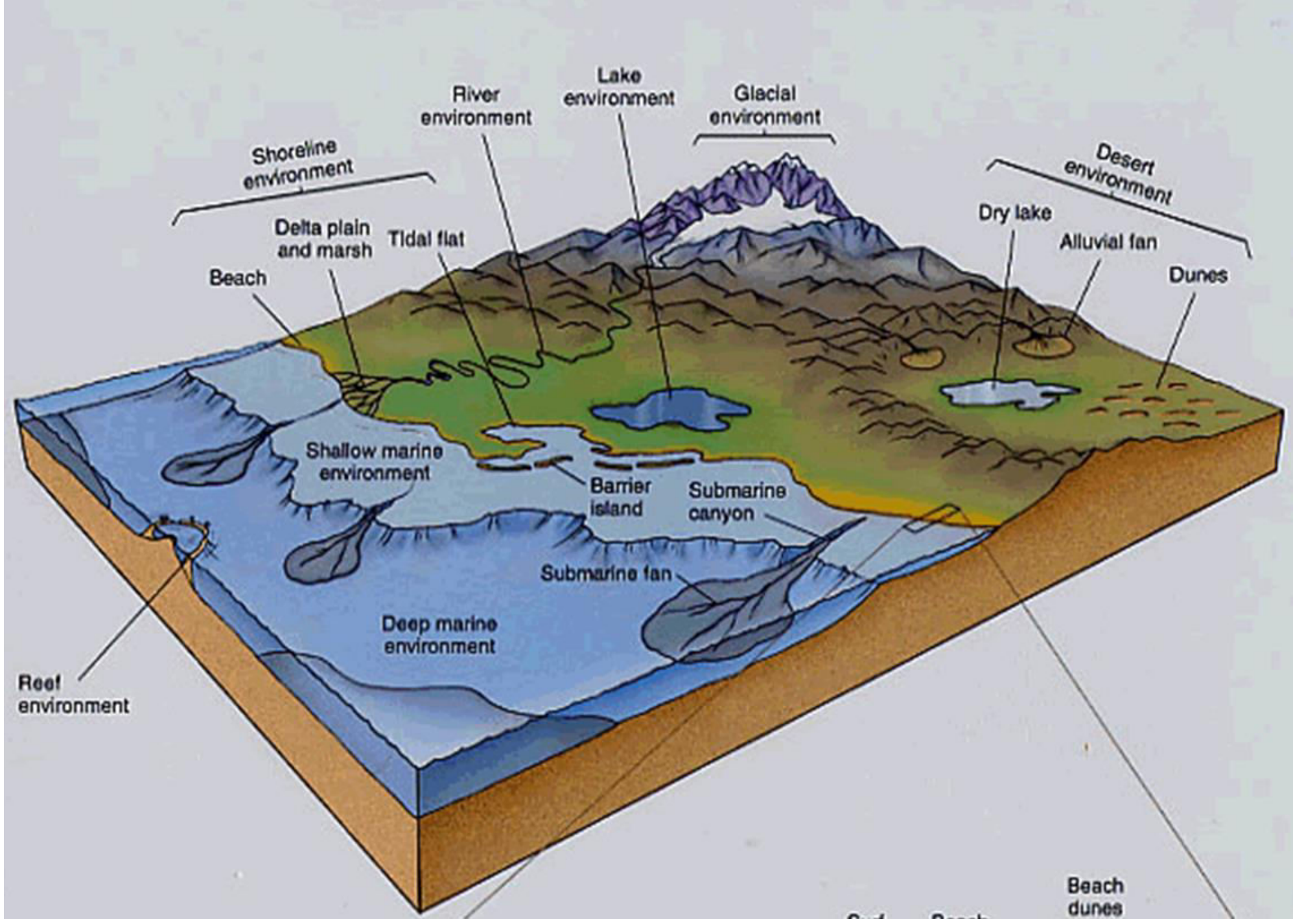
- Petroleum (gas and oil)
- Coal
- Metalliferous deposits (Fe, Mn, Au, U, Pb, Zn)
- Nonmetallic deposits (diamond, salt, phosphorus, sulfur, limestone, + many others)


Formation of a sedimentary rock
weathering of a pre-existing rock
Sediments are trasnported by water to a new site
Deposition of sediment in layers (Stratification)
Accumulation of sediment in sedimentary basin
Compaction of sediments
Comentation of sediments

Weathering




Weathering 1
Erosion 2
Transportation 3
Deposition 4
Lithification 5
Sedimentary rocks:
Pre-existing rocks
Chemical weathering
Mechanical weathering
Dissolved ions
Clays and oxides (tiny particles)
Larger particles
Biochemical precipitation
(no familiar names here)
Physical settling
Mud
Sand
Gravel
Limestone
Chert
Biological
Evaporites
Chemical
Shale
Sandstone
Conglomerate
Siliciclastic
1
2
3
4
5
Layers of sedimentary rock (Strata)


River environment
Lake environment
Glacial environment
Shoreline environment
Desert environment
Dry lake
Alluvial fan
Dunes
Delta plain and marsh
Tidal flat
Beach
Shallow marine environment
Barrier island
Submarine canyon
Submarine fan
Deep marine environment
Reef environment
Beach dunes

Types of Sedimentary Rocks

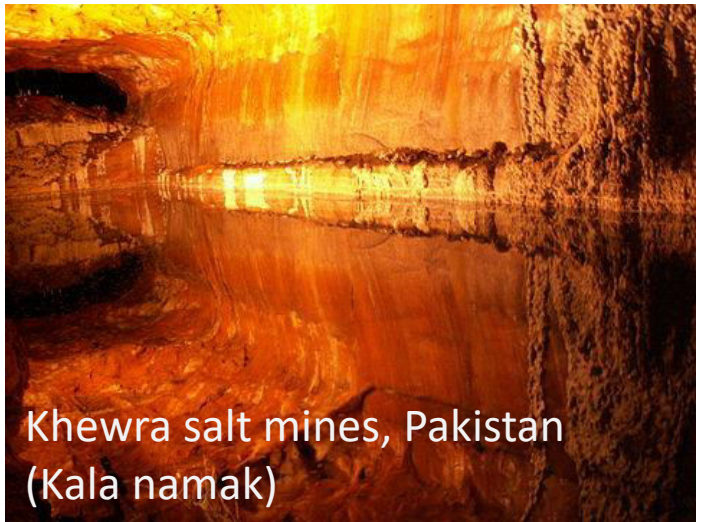
1) **Clastic (detrital) rocks**: composed of fragments formed by weathering & erosion of preexisting rocks and mechanically transported by water, wind, ice.


Sandstone

2) Biogenic (biochemical) rocks: composed of materials formed by the activity of living organisms e.g. limestones made up of the skeletal fragments from marine organisms.


Coral reef

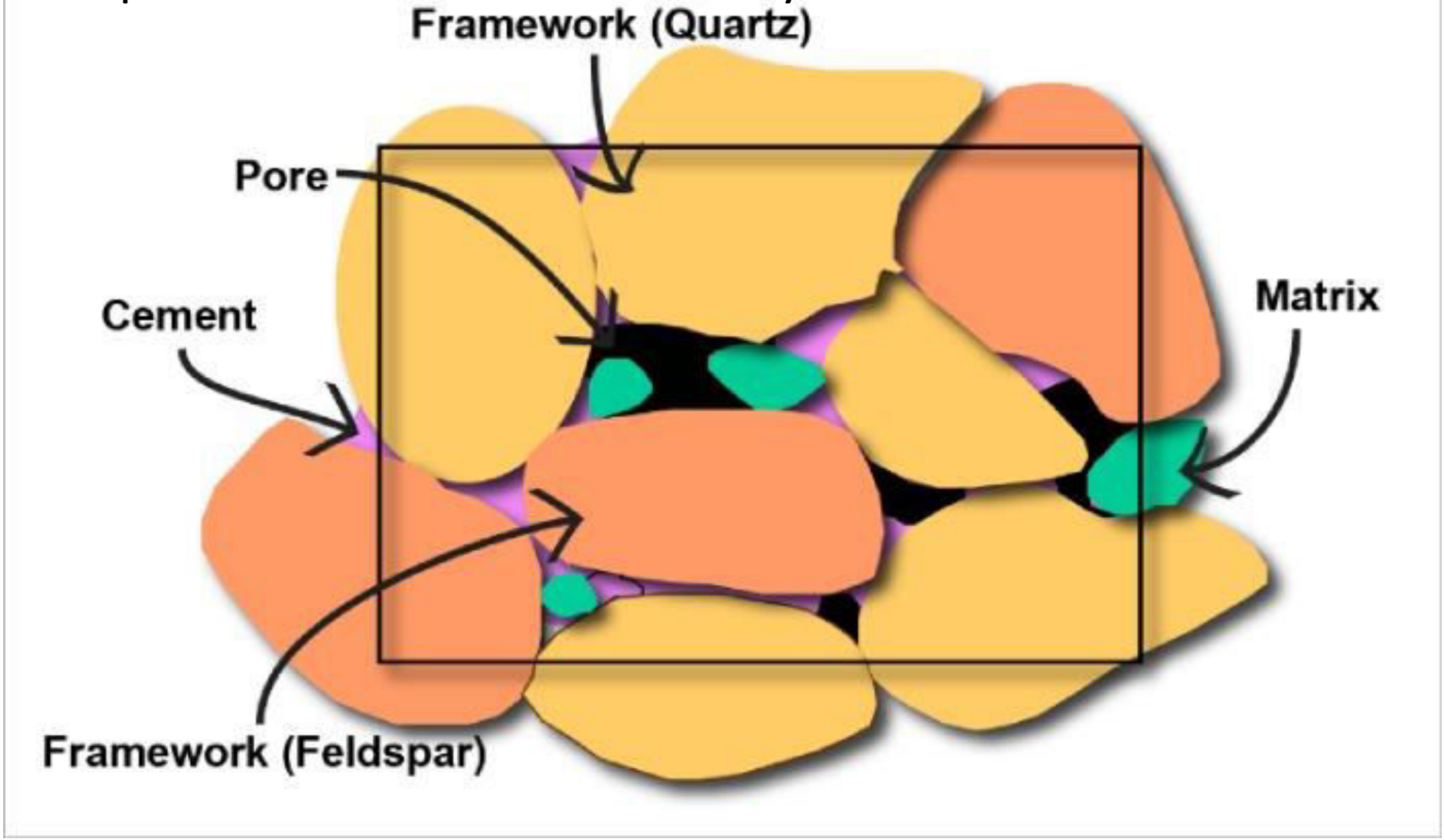
3) Chemically precipitated (chemical) rocks: form by direct precipitation of dissolved ions from water (halite, gypsum, and some limestones, etc.)

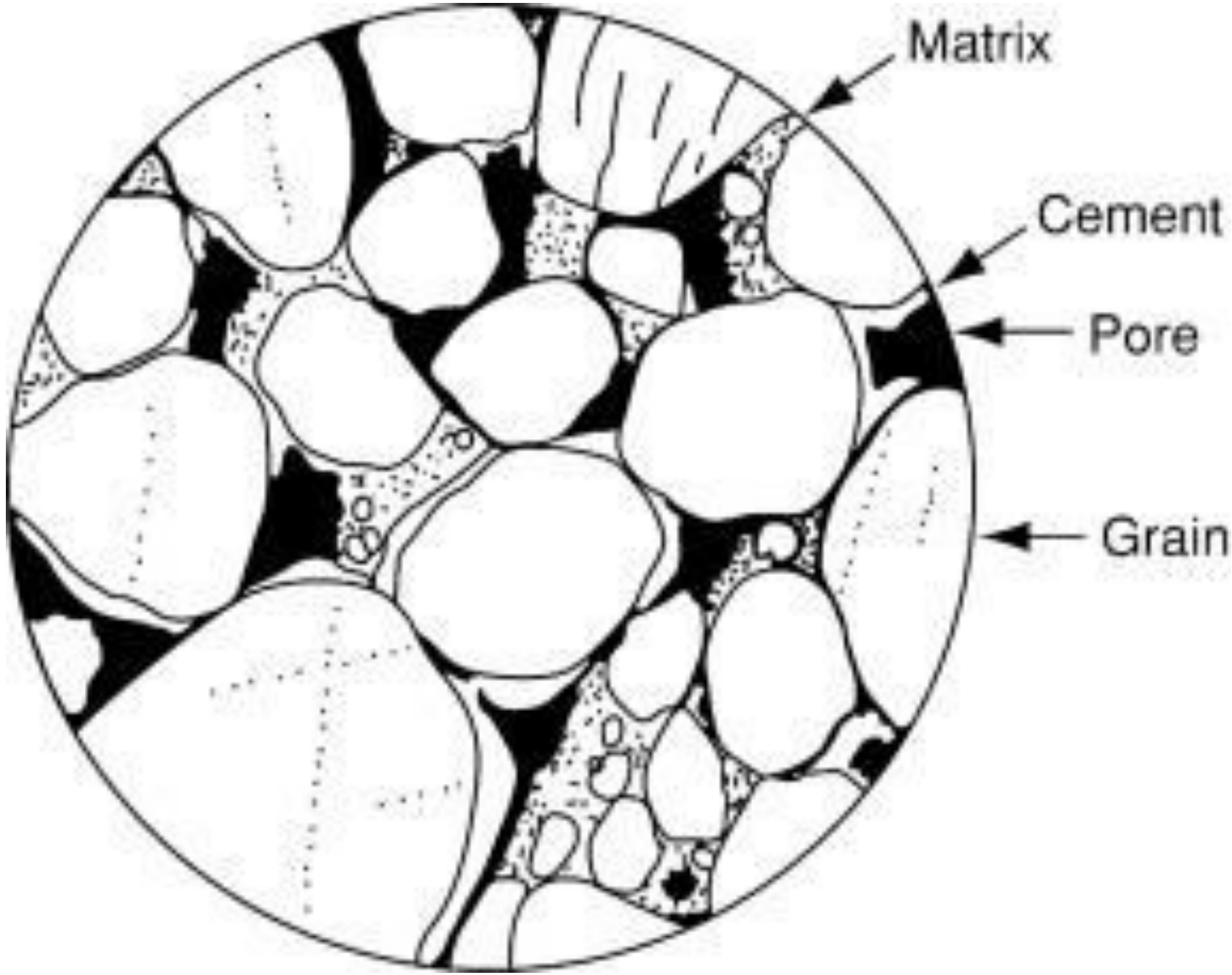

Khewra salt mines, Pakistan (Kala namak)

Characteristics of sedimentary rocks

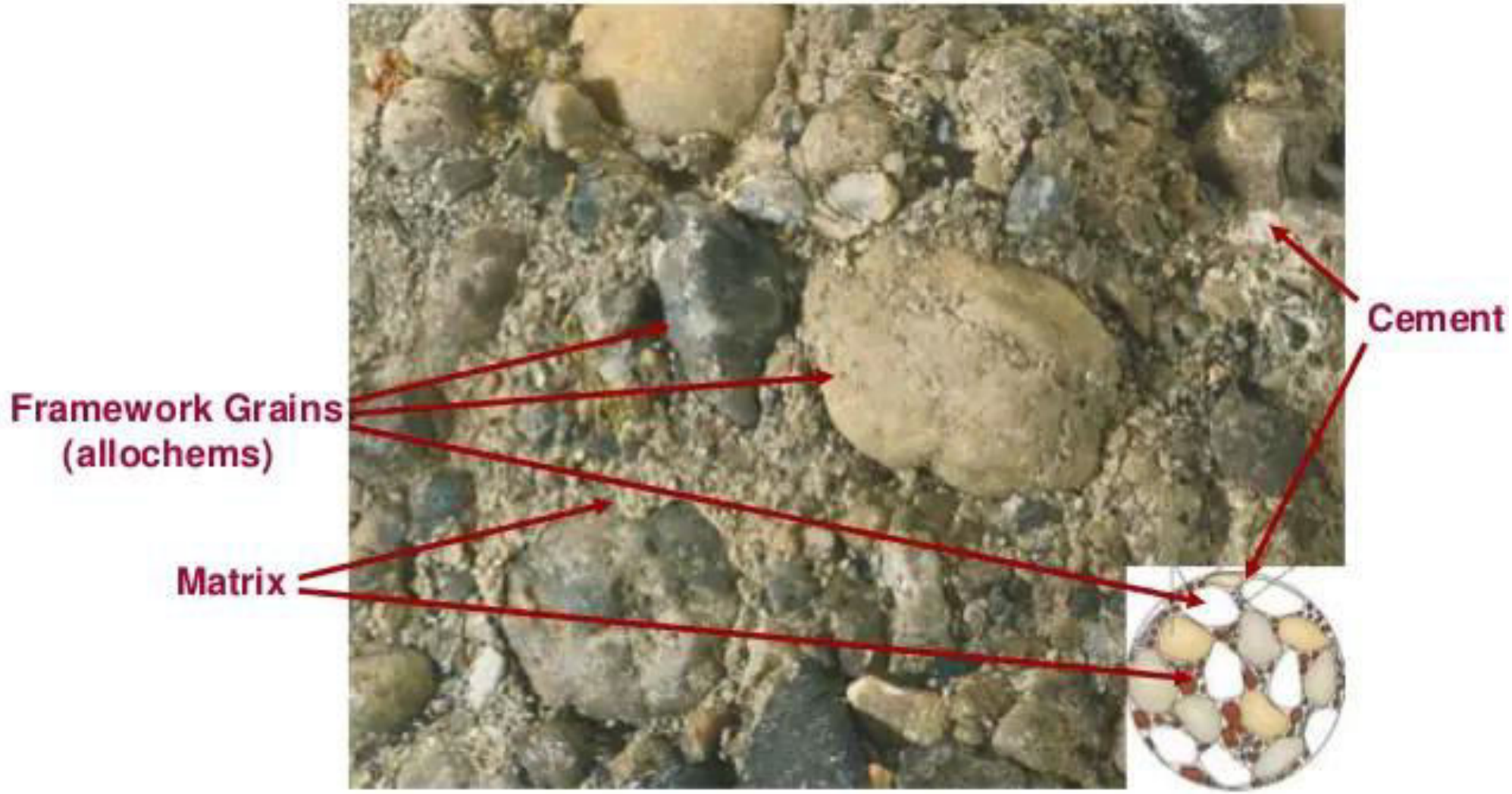
- Usually layered.
- May contain fossils.
- Clastic sedimentary rocks have fragmental texture (contain fragments of preexisting rocks).
- Have characteristic structures.

Components of clastic sedimentary rocks

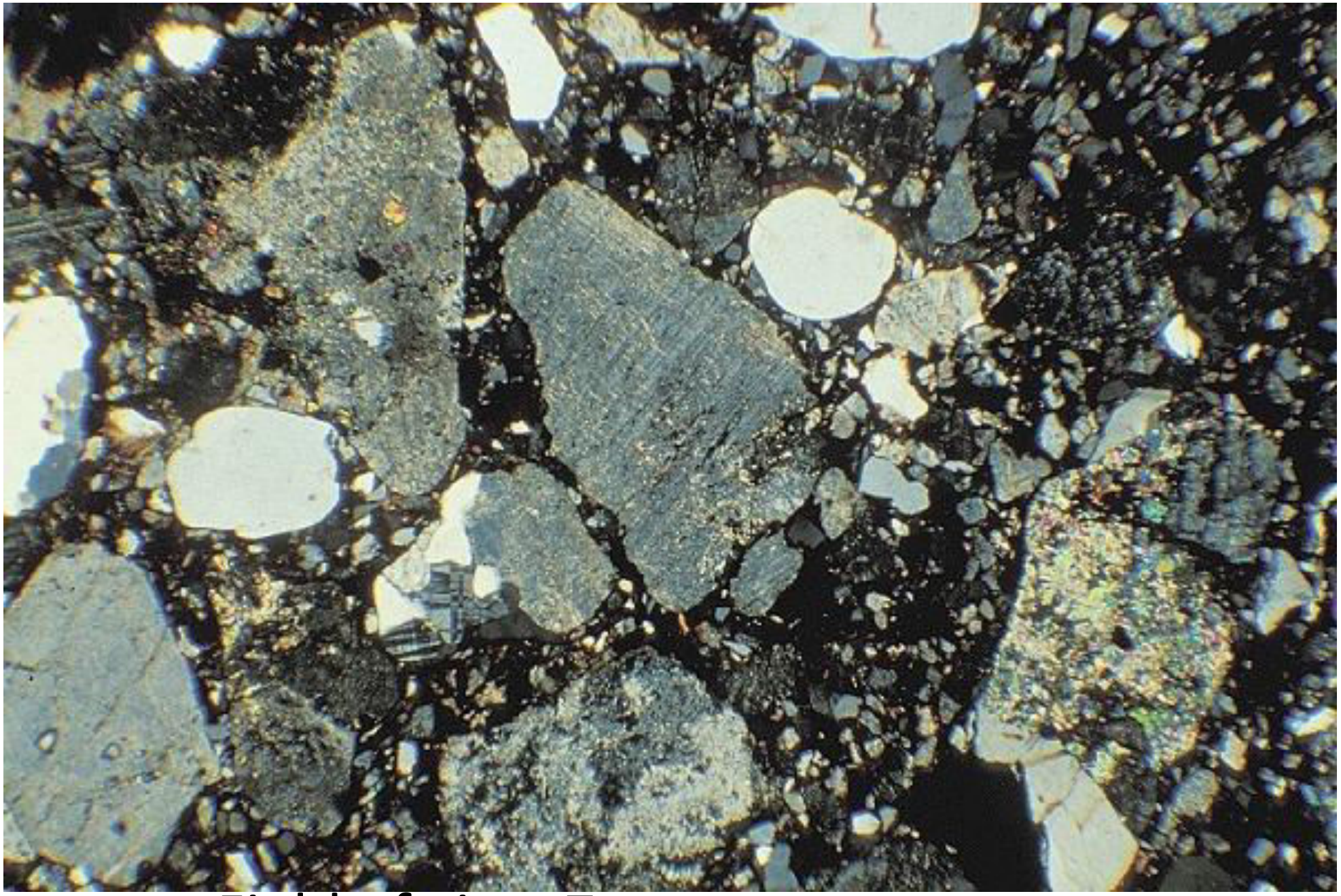



Matrix
Cement
Pore
Grain

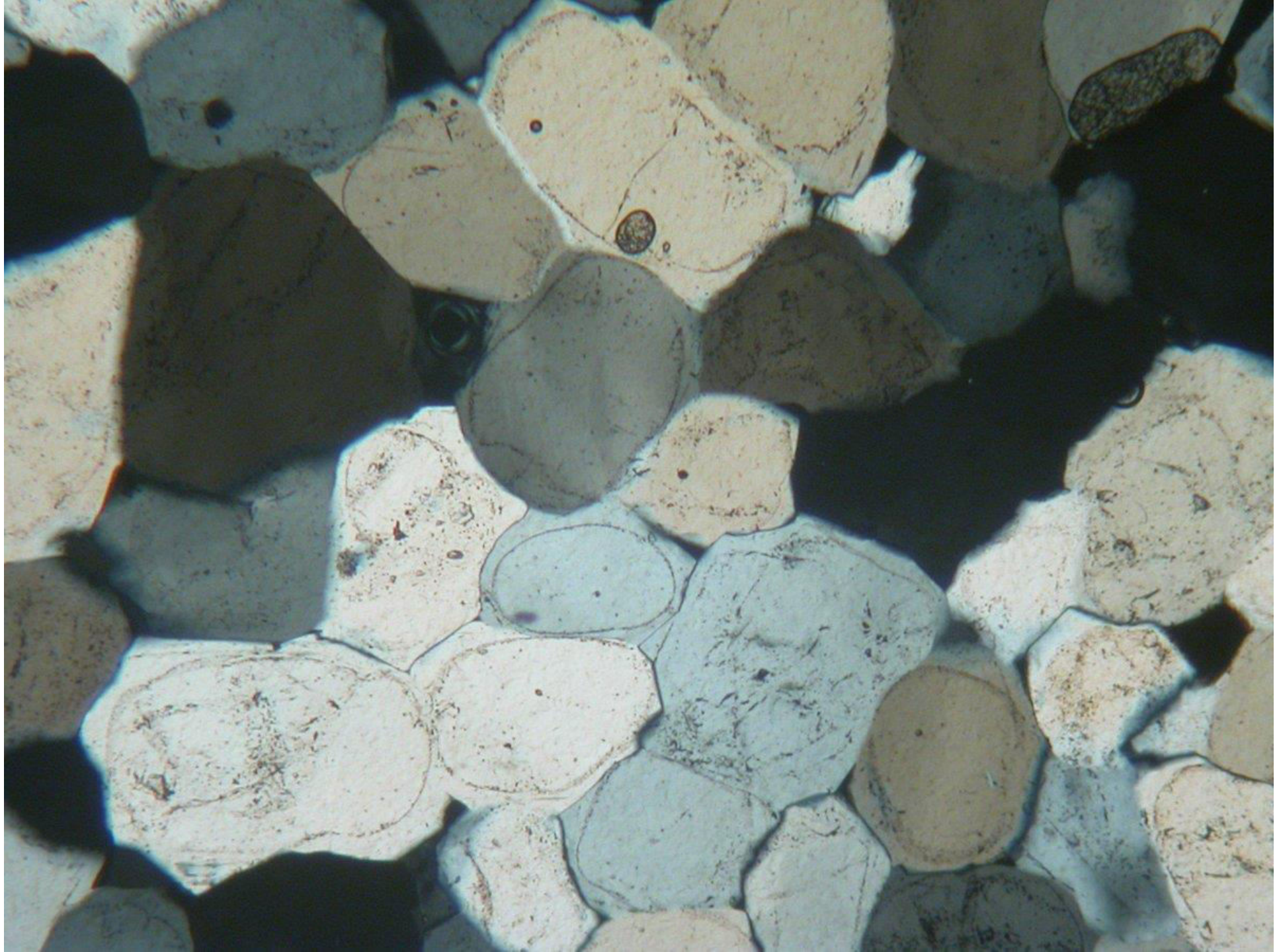
Sedimentary Rock Components



Sedimentary rocks are made up of three main components, framework grains (called allochems in carbonate rocks), matrix, and cement.



Field of view 7 mm across



Texture

Size & shape of the constituent grains and their mutual arrangement in the aggregate.

Terrigenous sedimentary rocks show fragmental texture – broken, abraded or irregular grains in contact.

Matrix- smaller grains within framework grains – mechanically deposited.

Cement- chemically precipitated components of texture.

Components of texture

1. Size
2. Sphericity
3. Roundness
4. Sorting

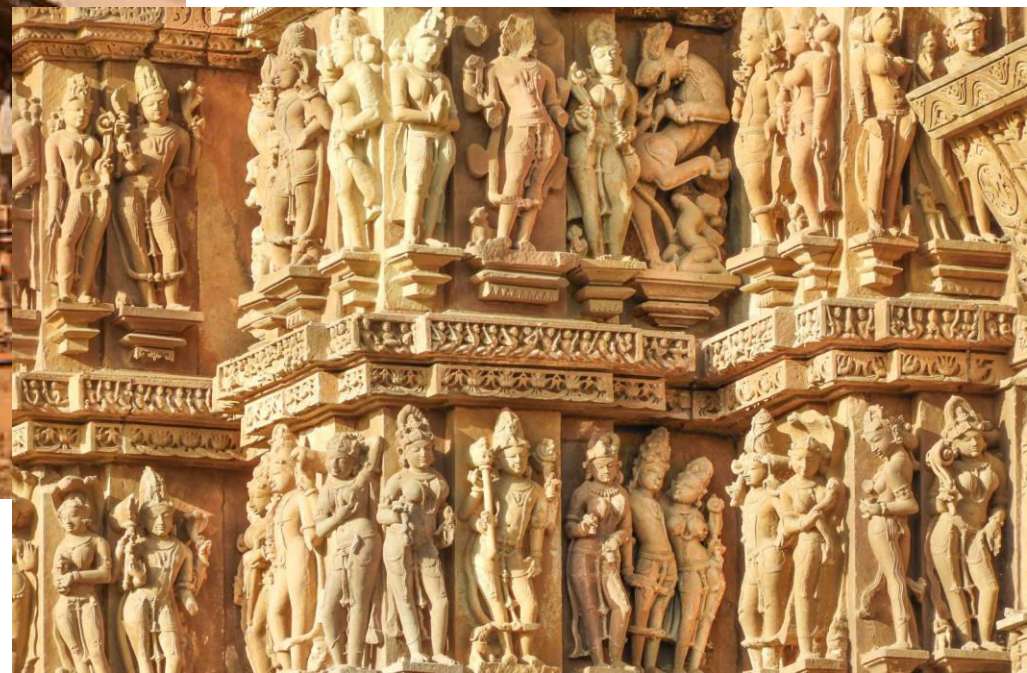
The concept of grain size of clastic sedimentary rocks (depends on the energy of flow and the size of the sediments supplied to the transporting medium)

gravel

Conglomerate

Sand

Sandstone



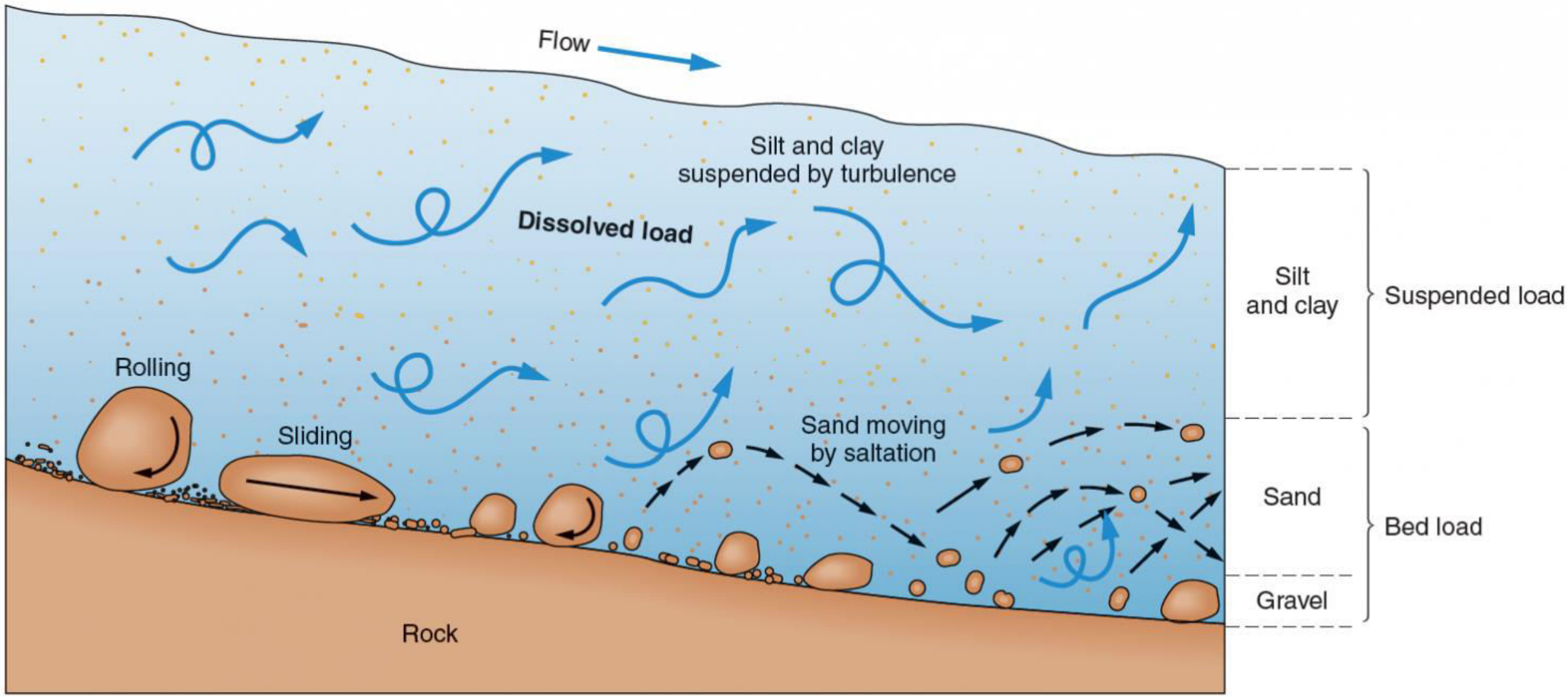
Sandstone under Microscope (XPL)

Mud

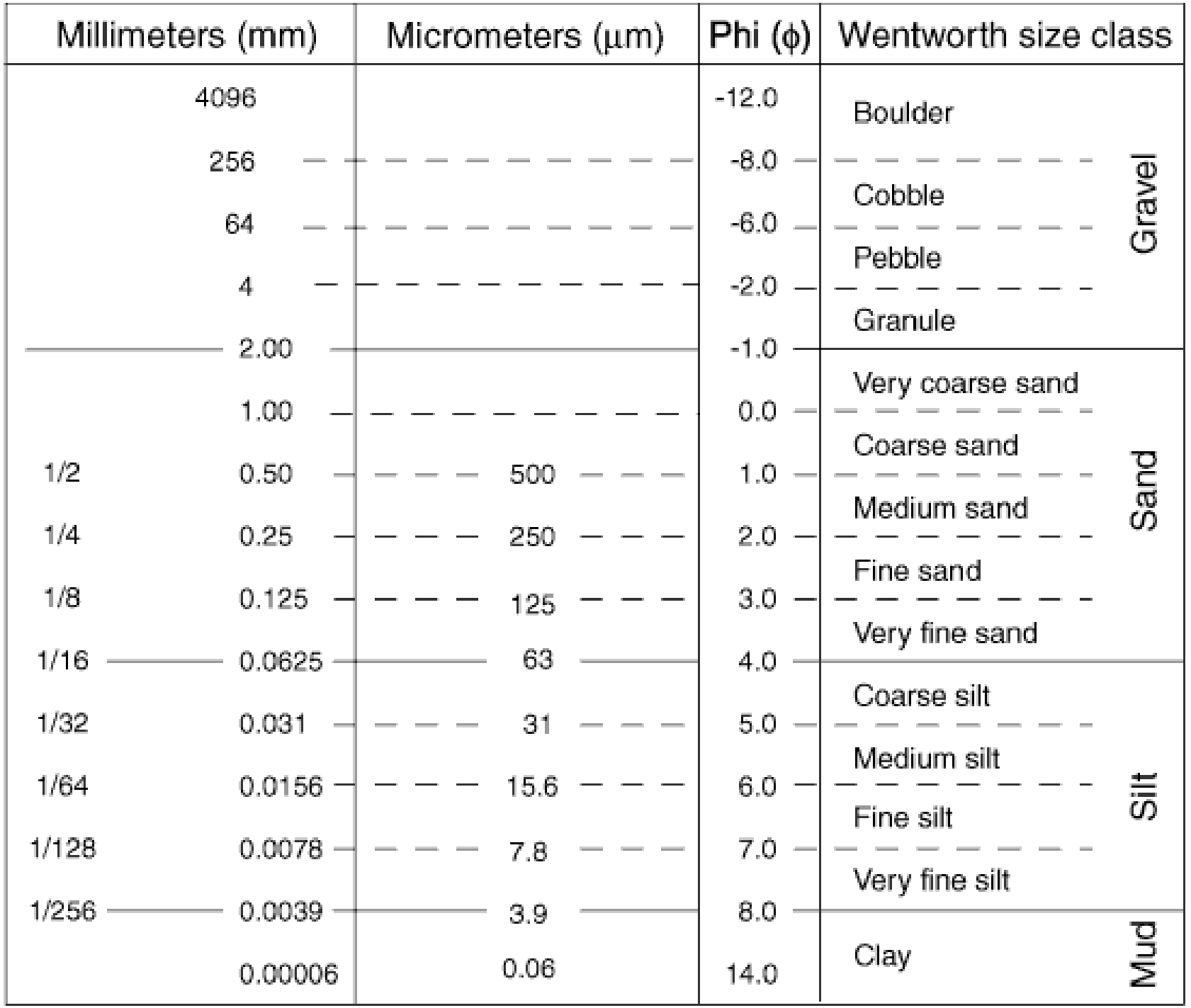
Shale

Mud house

Sediment transport



Udden-Wentworth Grade scale



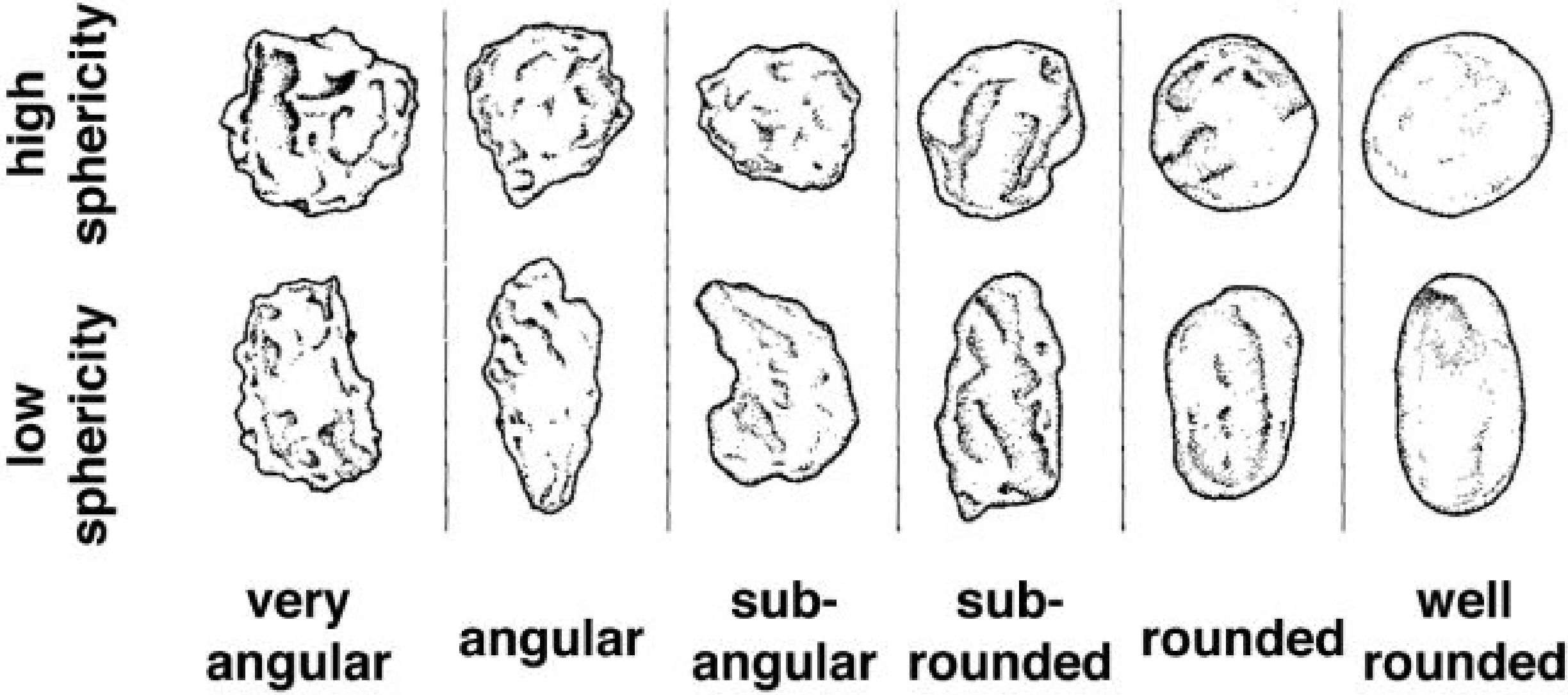
<u>Advantage</u>

1. Geometric – small no of classes for a large range of grain size

A change from 1-2 mm is more meaningful than 101-102 mm

2. Larger class used for larger sizes

Grain roundness and sphericity



Roundness: refers to the degree of sharpness of the corners and edges of grain.

Depends on abrasion of grains due to collision during transport.

Factors controlling roundness:

(1) Hardness: Hard resistant grains such as quartz rounded less readily during transport than weak grains such as feldspar and pyroxene.

(2) Grain size: Pebble- to cobble size grains commonly are more easily rounded by abrasion during transport than are sand-size grains.

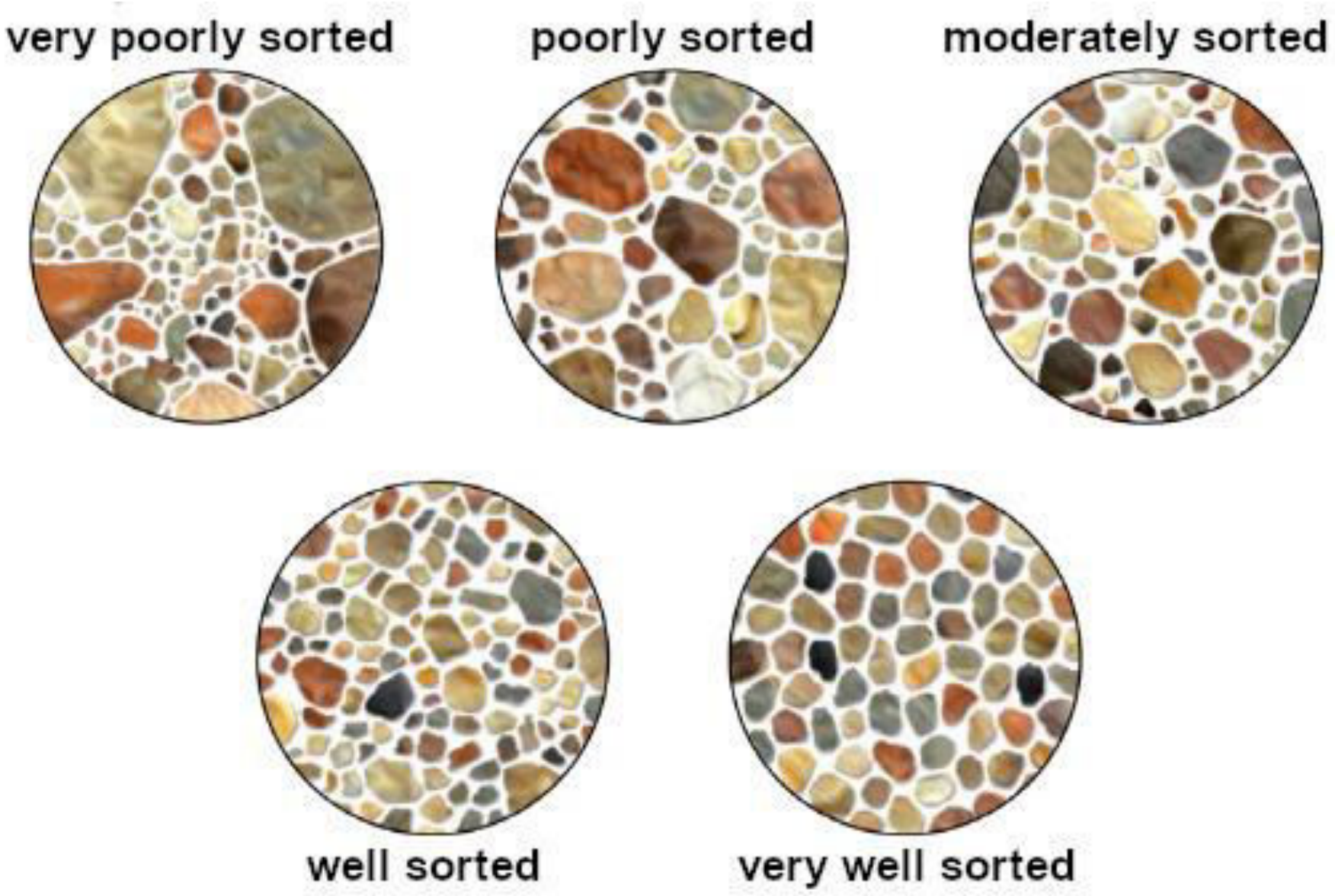
(3) Type of transport process: Transport by wind (desert) is more effective in rounding grains than transport by water.

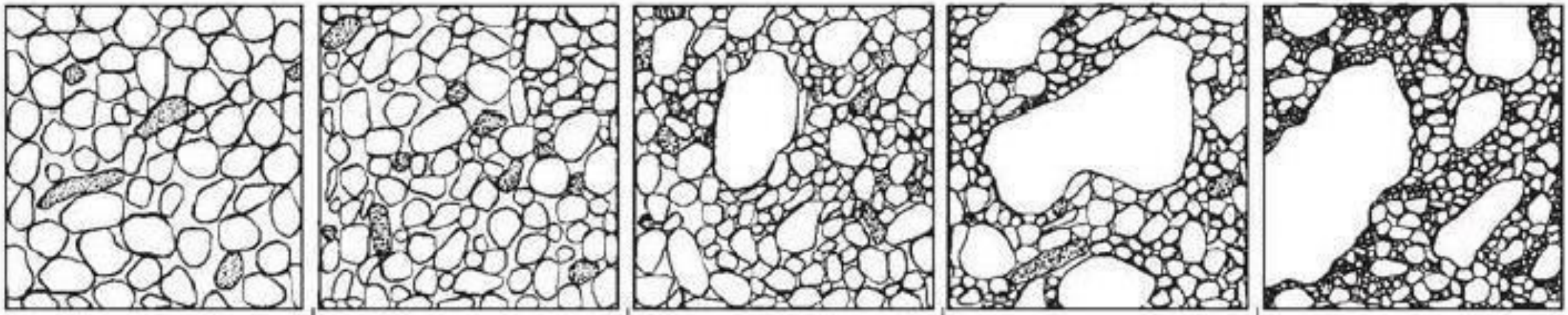
(4) Distance of transport: More distance travelled – more rounding.

Sorting is a measure of standard deviation i.e., spread or dispersion of grain size about the mean.

Indication of effectiveness of depositional medium in separating grains of different sizes.

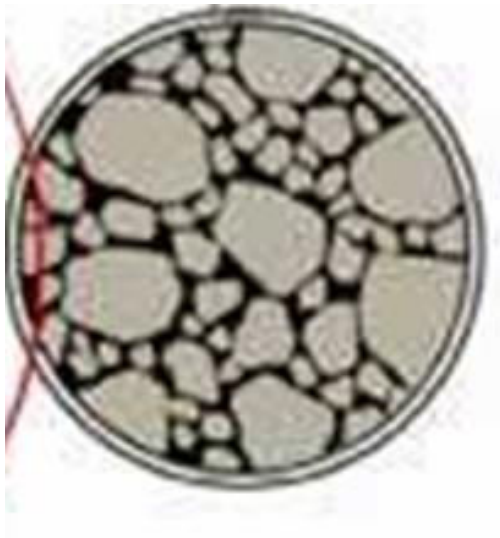
Grain sorting




Very well sorted
0.35
Well sorted
0.5
Moderately sorted
0.7
Poorly sorted
2.0
Very poorly sorted

1

2



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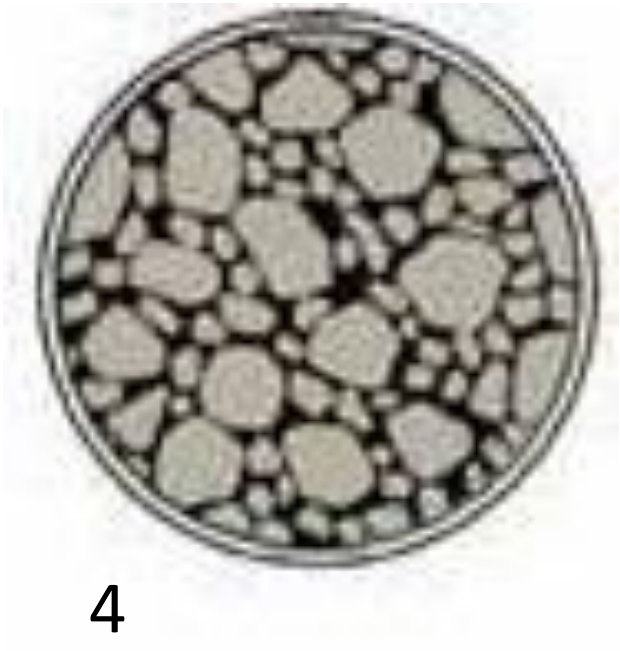

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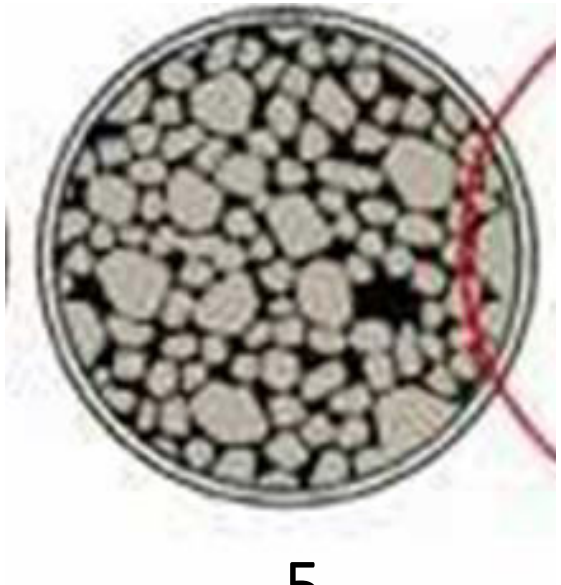


5

Factors determining sorting

1. **Sediment source** - sediment derived from granite will be quite different from the sediment supplied by reworking of a sediment.

2. **Grain size** - coarse sediments (gravels & conglomerates) and fine sediments (silts and clays) more poorly sorted than sand-sized sediments
-Because, sand is more easily transported and therefore sorted by wind and water.

3. **Depositional mechanism**

- Sediments deposited quickly such as storm beds or that deposited from viscous flows, such as mud flows, are generally poorly sorted.
- Sediments worked or reworked by wind and water, the sandy deposits of deserts, beaches and shallow shelf seas etc., are much better sorted.

Better sorted sediment – where?

Turbulent river

High energy gravelly beach

Low flow velocity

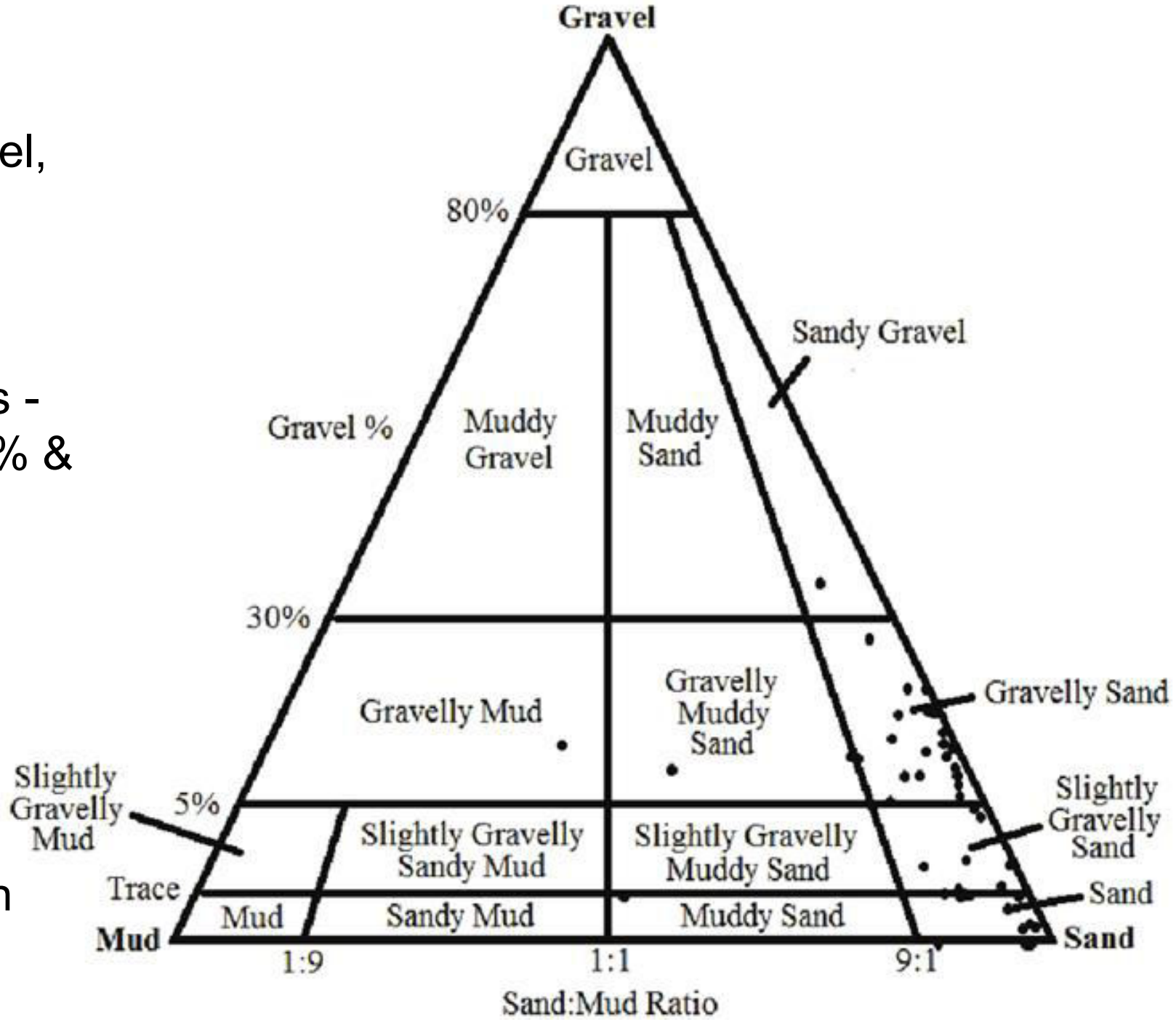
Grain size nomenclature for sediment

- Relative proportions of gravel, sand & mud.
- Two properties need to be determined

a. How much gravel it contains - boundaries at 80%, 30%, 5% & trace.

b. The ratio of sand to mud with boundaries at 9:1, 1:1 & 1:9

Mud is a loose term – mixture of clay & silt grade material with former dominant.



The concept of textural maturity of clastic sediments

Mature sediments: Better sorting, less matrix, grains are more rounded

Immature sediments: Poorer sorting, more matrix, grains are more angular.

Two sandstones under microscope (crossed nicols)