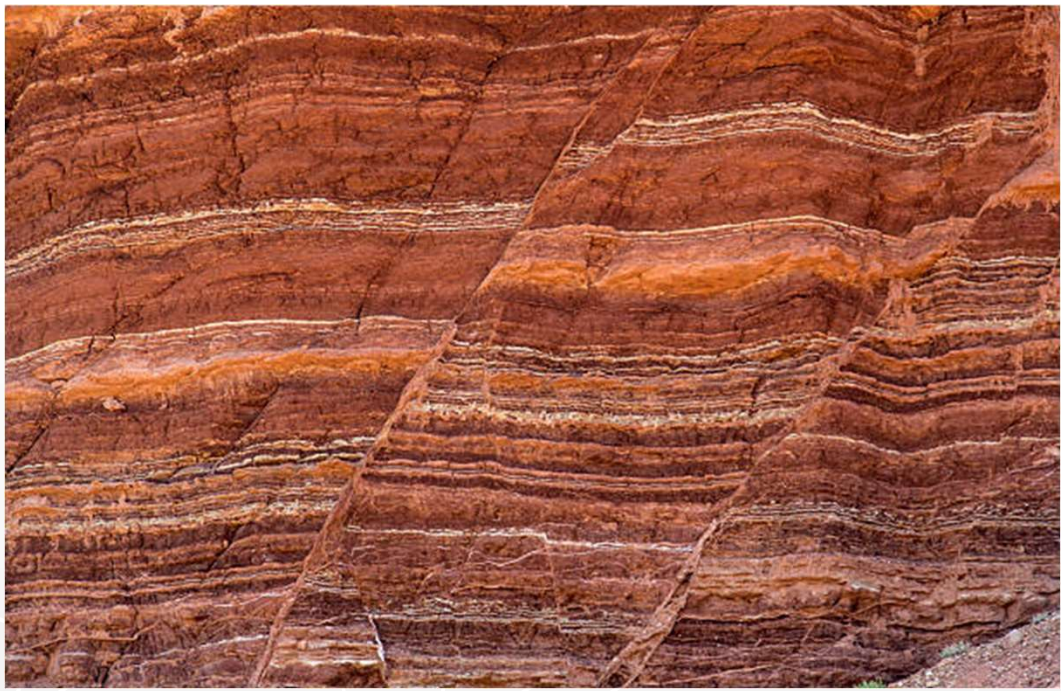
GEPM 375

Geology and Geomorphology

Geology

Sedimentary Rocks



Definition:

- **Loose sediments** when hardened.
- **Stratification** is the single most characteristics.

Amount of sediments

About 5% by volume of outer 10 km of crust.

- Sediments to ocean/year:

Rivers	10 billion tons
Glaciers	100 million to 1 billion ton
Wind	100 million ton
Others	0.03 to 0.3 million ton
Ganges River	403 to 660 × 10^6 tons/year

Sedimentary Rocks

Types based on Formation/Deposition of Sediments:

- **Detrial Deposits:** (worn out)

  -derived from erosion of existing rocks.

  -rocks formed are **detrial sedimentary rocks**.

- **Non-detrial or chemically deposits**:

  -Produced by chemical process

  -Rocks formed are **Chemical Sedimentary rocks**.

Sedimentary Rocks

Types based on the environment on which sediments are accumulated.

- **Marine Limestone**: Limestones contain remnants of **sea-lived animal.**
- **Fluvial**: rocks formed from **deposits laid** down by **river**
- **Eolian**: Rocks made up of **wind deposit** of materials.
- **Lacustrine**: Rocks made up of **lake deposits** of materials.
- **Tillite:** rock made by glaciers deposite

Sedimentary Rocks

Weathering:

- **Destruction** of rocks
- **Changes** that takes place in minerals and rocks **at or near the surface** of the earth in **response to the atmosphere, to water, to plant and to animal life**.

Types of weathering:

- **Mechanical weathering**:

  -referred to as **disintegration**

  -Processes by which **rocks are broken** down to smaller and smaller fragments **as a results of energy developed by physical process**.

Sedimentary Rocks

Example: A **boulder moved by gravity** down a rock slope, may be shattered into smaller fragments.

Chemical weathering:

- Referred as **decomposition**
- Transform the original materials into somethings different.
- Transformed minerals have **different composition** and **physical characteristics** from the original rocks.
- **Example**: Mineral feldspar to clay minerals.

Sedimentary Rocks

Example of chemical weathering:

- Chemical weathering or **decomposition of orthoclase feldspar** (K-feldspar), $KAlSi_3O_8$ into a clay mineral called Kaolinite, $Al_4(OH)_8Si_4O_8$.
- A **source of hydrogen ions** is necessary.
- **Atmosphere** contains a small amount of CO_2, and **soils** also contains much greater amounts CO_2.

Sedimentary Rocks

- Chemical process changes orthoclase feldspar into a clay mineral called Kaolinite.
- Process begins when **water** acquires carbon dioxide as it falls through the atmosphere and seeps through soils, thus forming a weak carbonic acid (H_2CO_3) solution.

- $H_2O + CO_2 = H_2CO_3 \longrightarrow H+ + (HCO3)^-$

- Acids reacts with orthoclase feldspar according to the following chemical formula:

- $4KAlSi_3O_8 + 2H_2CO_3 + 2H_2O = 2K_2CO_3 + Al_4(OH)_8Si_4O_8 + 8SiO_2$

Orthoclase + Carbonic Acid + Water = Potassium carbonate +Kaolinite+ Silica

Sedimentary Rocks

Cont…

- Orthoclase comes in contact with **hydrogen ions, which force the potassium ions** out off the orthoclase, disrupting crystalline structure to form new clay minerals.

- Finally Potassium carbonate and silica are **carried off in solution** by ground water, ultimately deposited elsewhere, **leaving Kaolinite clay where orthoclase feldspar once existed.**

Sedimentary Rocks

- Process called hydration.
- Second product, potassium ions join with by-carbonate ions to form potassium bicarbonate.
- And third product Silica, SiO_2 are **carried by solution** to form other silicate minerals.

Agents of Transportation of sediments:

- Water
- Glaciers
- Wind
- Gravity
- Underground and ocean current.

Sedimentary Rocks

Minerals of Sedimentary Rock composition:

- **Clay:**

  -develop by chemical weathering

  -important **constituents** of **mudstone** and **shale**

  -**Kaolinite** and **Illite** are the most common clay minerals and **Montmorillonite** is rare.

Clay Minerals:

- Various chemical weathering processes form **sheet-like chemical structure.**

Two Types of Sheets:

- **Tetrahedral Sheet:** Silica sheet, consists of silicon and oxygen atoms.

Sedimentary Rocks

Octahedral Sheet:

- Alumina Sheets have aluminum atoms and hydroxyls
- Magnesia Sheets have magnesia instead of aluminum atoms.

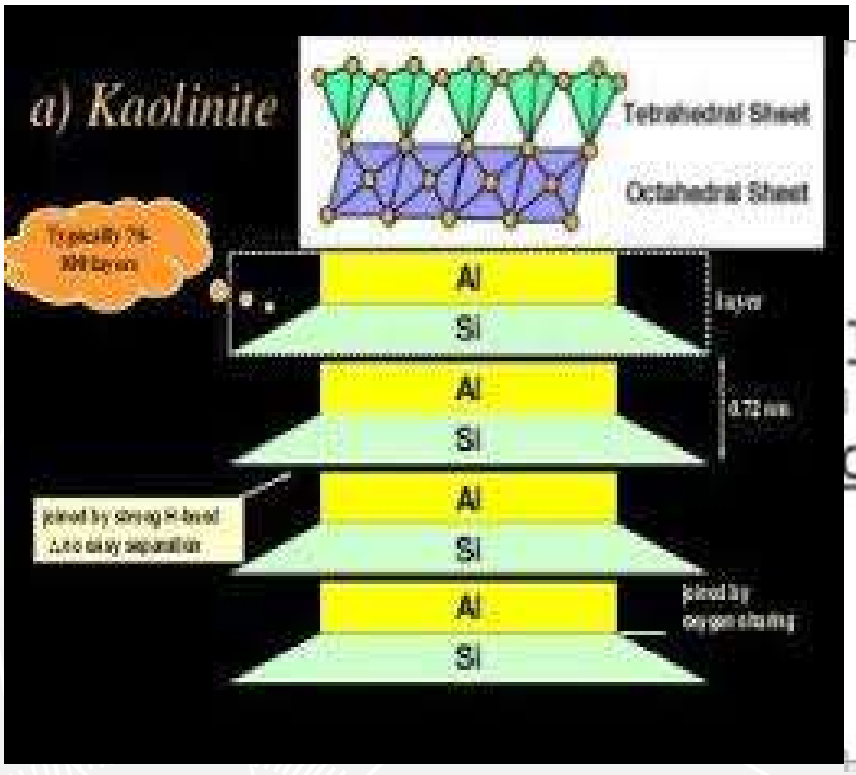
Types of Clay Minerals:

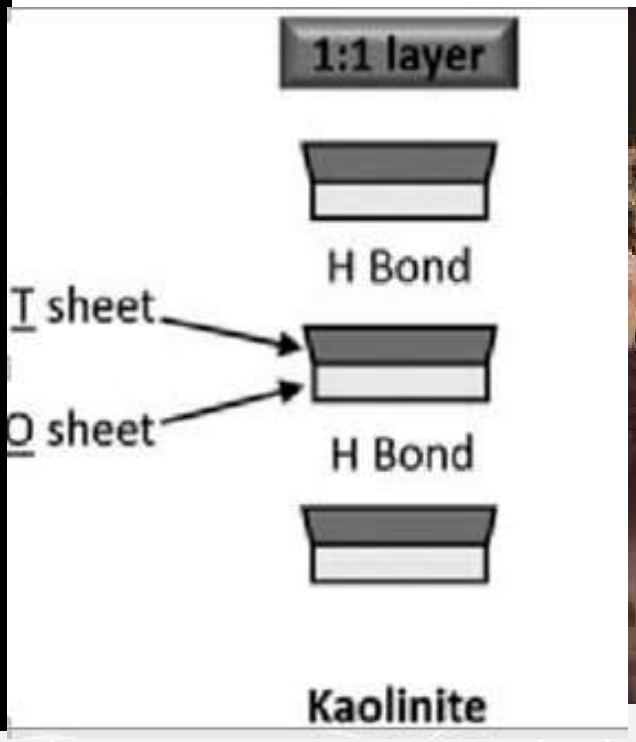
Sheet like chemical structures combine in various ways to form **dozen** of different clay minerals. Three common clay minerals are:

Kaolinite:

- Consists of alternating silica and alumina sheets.
- Sheets are held together with **strong chemical bonds**, **so kaolinite is a very stable clay.**

Clay Minerals







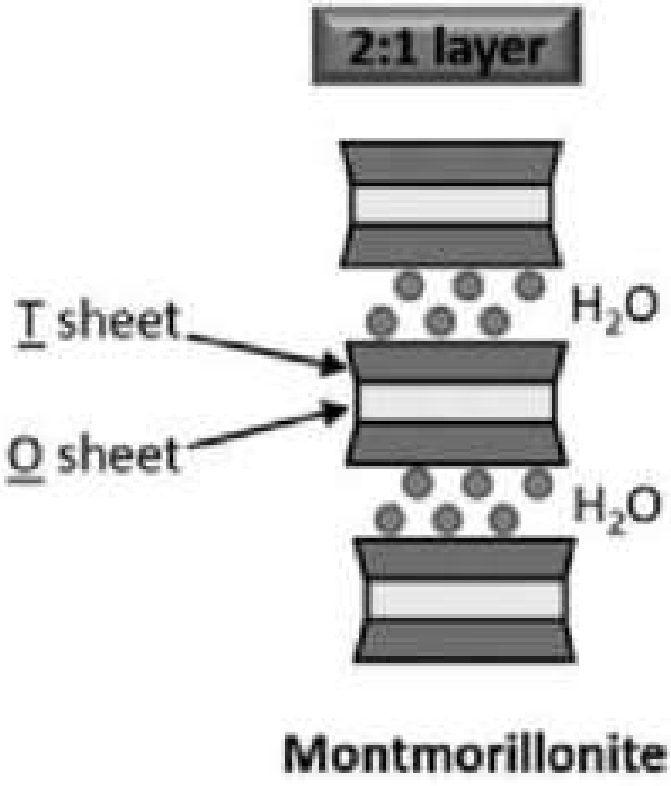
- Kaolinite **does not expand appreciably** when wetted, so it is used to **make pottery**.

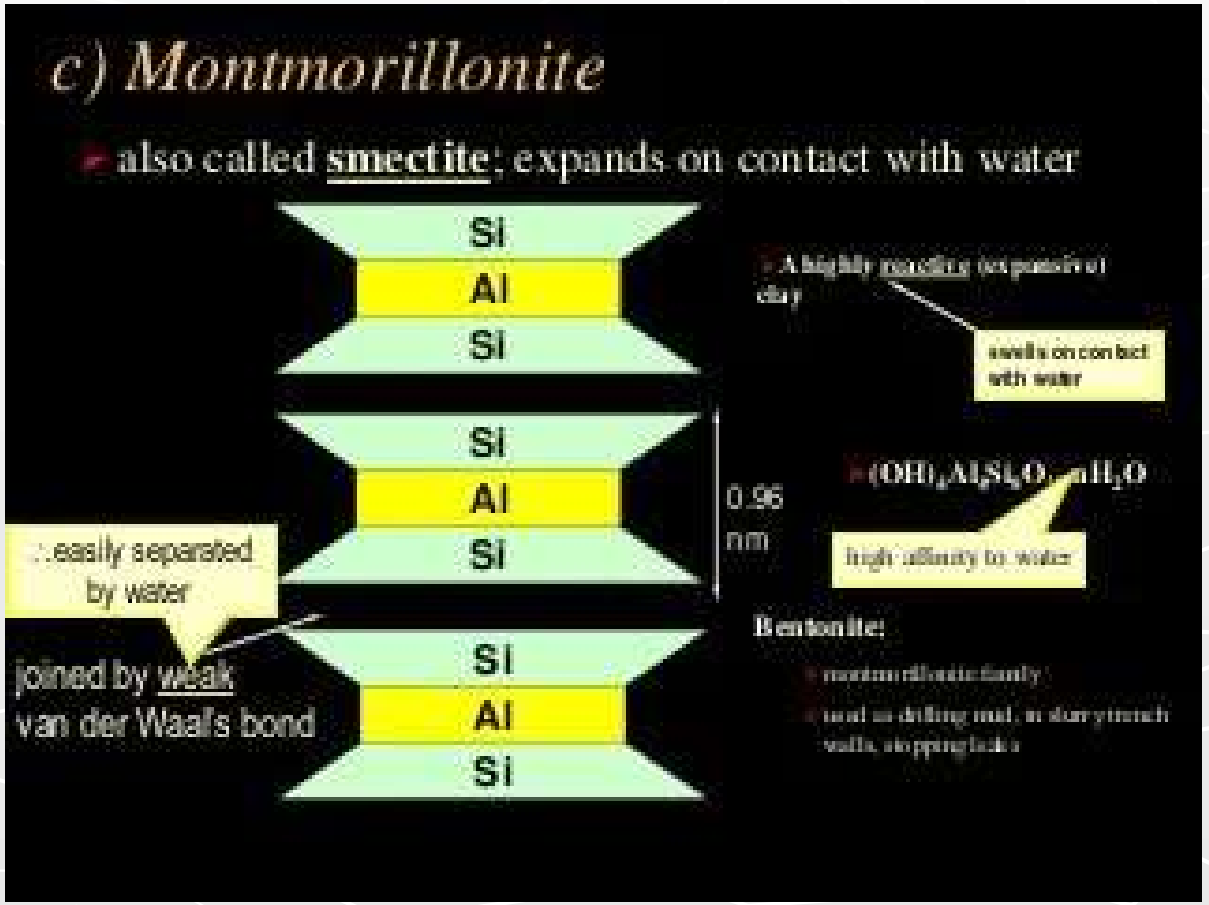
- Important gradients of **paper**, **paints** and other products including **pharmaceuticals**.

Clay Minerals

Montmorillonite/ Smectite Clay:

- Consists of **two silica sheets** and **one alumina sheet**.
- Bonding between these layers is **very weak**, so large quantity of water can easily enter and separate them, thus **causing clay to swell.**
- This property can be very **troublesome** or very **useful** depending on the situations.





Sedimentary Rocks

Problems with soil expansions:

- **Extensive distortions** in structures, highways, other civil engineering projects.

Expansive behavior and Low Permeability:

- Useful for **sealing borings**, or
- Providing ground **water barriers**

Bentonite: A type of montmorillonite which is commercially mined and sold for such purpose.



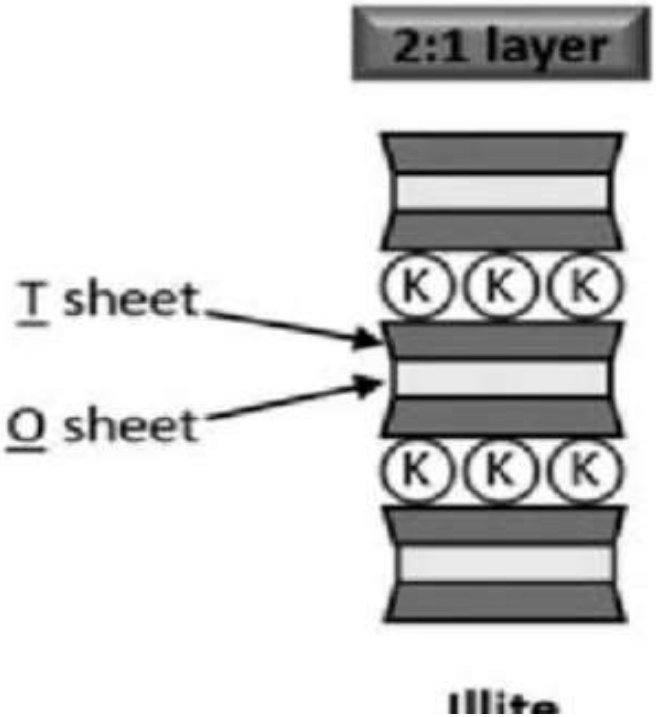




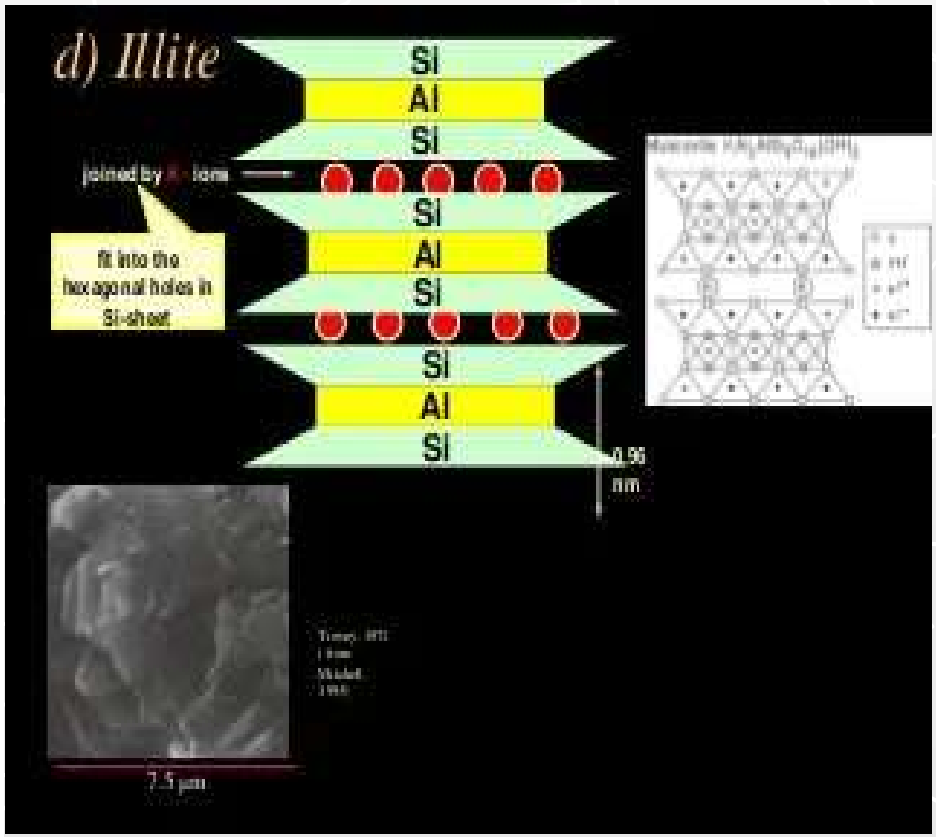
Clay Mineral

Illite Clay:

- Consists of **two silica sheets** and **one alumina sheet** same as montmorillonite.
- But **contains potassium ions** between each layer.
- Chemical bonds is stronger than montmorillonite and weaker than kaolinite.
- **Expand slightly** when wetted.



Illite



Sedimentary Rocks

Minerals of Sedimentary Rock composition:



- **Quartz (SiO_2):**

  -produce by **mechanical weathering**

  -very common minerals

- **Calcite ($CaCO_3$):**

  -Most common **cementing** materials

  -chief constituents of **limestone** and **marble**.





Sedimentary Rocks

Texture of sedimentary Rocks:

-Physical appearance

-Size, shape and arrangements of particles.

- **Clastic texture:** Forms by deposits of minerals and rock fragments.

  -Coarse Texture-bed of gravel and sands

  -Sugary Texture- rounded of uniform sand grains

  -Chemical Texture-biochemical deposits.

- **Non-clastic texture**: Form by chemical process

  -grains are interlocked.

  -fine, medium and **coarse grained**.

Sedimentary Rocks

Lithification (transform (a sediment or other material) into stone)**:**

- Lithos, means ‘rock’ and faecre, means ‘to make’
- Converting **unconsolidated** rock forming minerals into **consolidated** coherent rocks.

Ways/Processes of Lithification:

Cementation:

- **void spaces are filled** by cementing materials dissolved in water.
- unconsolidated deposits are get cemented.

Compaction and desiccation.

- by pressure from underlying soils
- by evaporation of water when exposed to air.

Sedimentary Rocks

Re-crystallization:

- process of crystallization.

Diagenesis:

- After deposition sediments or sedimentary rocks **undergo** **physical, chemical and biological changes,** which is called diagenesis.

Physical Processes

- One of the most common physical forms of diagenesis comes from the **application of pressure**.
- As younger sediments are deposited on top of older sediments, the **overlying pressure compacts** the existing sediments.

Biological Processes:

- **Burrowing organisms** are often accountable for **biological changes** that can **occur close to the surface** of new sedimentary deposits.

- Organisms such as worms and crabs will mix the loose sediments, and often leave evidence of their behavior in the texture of the rock

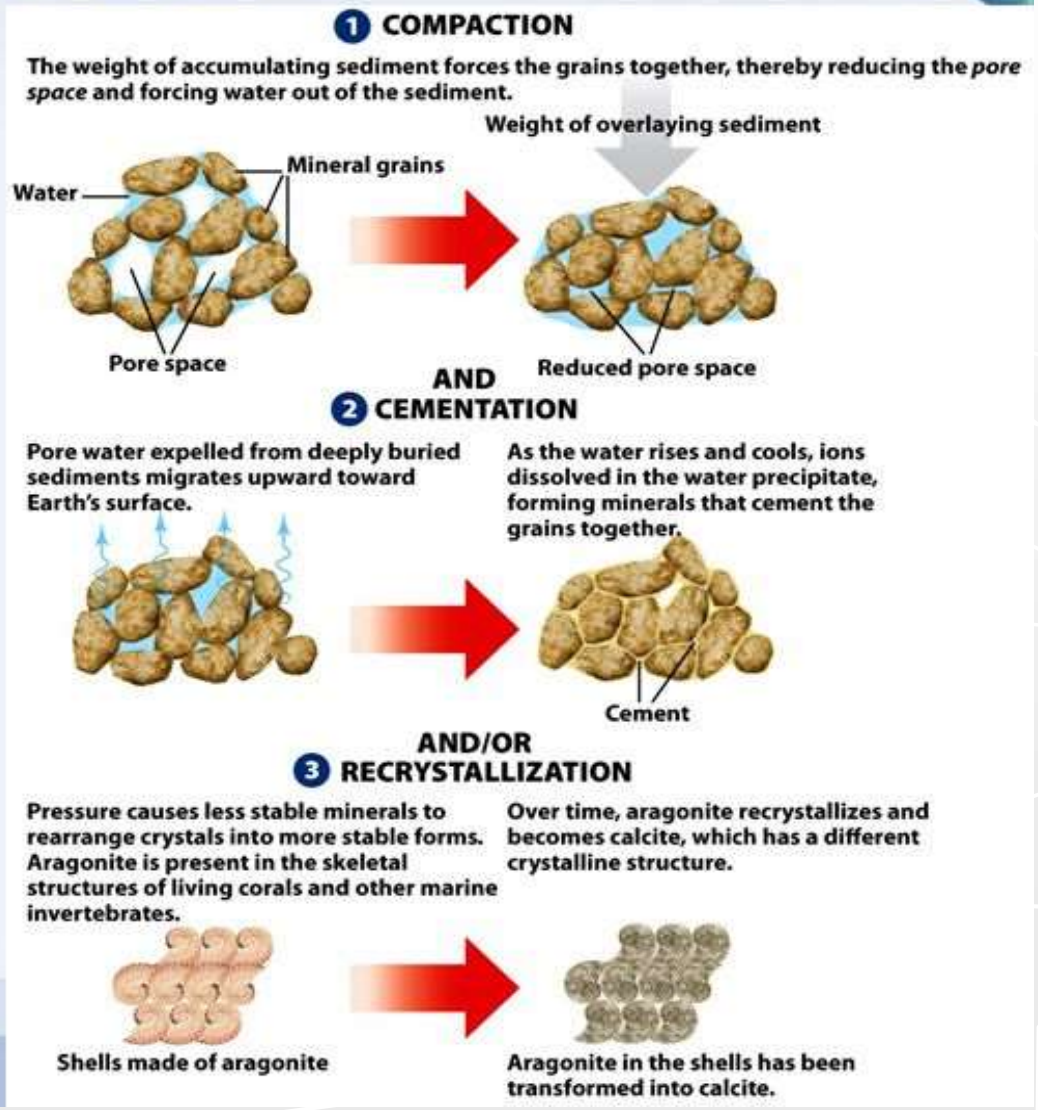
Chemical Processes

- **Chemical alternations** are often controlled by physical changes in **temperature** and **pressure.**

- **Solubility** of many different minerals **often increases** with an increase in temperature and pressure.

Lithification Processes

- Compaction
  - Reduced pore space due to weight of sediments above
- Cementation
  - Dissolved substances precipitate out & act as glue
- Recrystallization
  - Form new crystalline mineral grains from old ones
- Diagenesis
  - Low temperature/pressure changes



Thanks