



Mineral Formation

Mineral Chemistry

General Notes
– jot form

Mineral Formation

Precipitation

Definition:
Examples -

Solid state reactions

Definition:
Examples -

Magma

Crystallization

Definition:
Examples -

Mineral Chemistry

- Minerals are made from elements and compounds
- The bonds between atoms creates a structure

Covalent Bonding

- sharing of electrons between atoms
- weaker type of bond
- very common in minerals

Example: SiO_2 = Quartz

Ionic Bonding

- transferring of electrons
- one atom has + charge and one - charge
- stronger type of bond

Example: Halite = NaCl (salt)

Metallic Bonding

- electrons move from one atom to another
- Responsible for shiny metallic appearance

Examples: Gold and Silver

Protons, Neutrons, Electrons

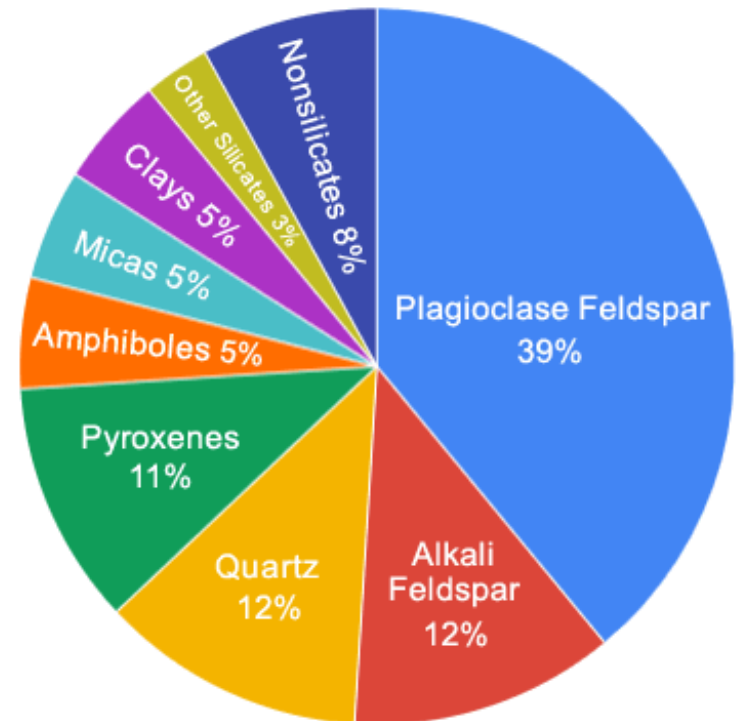
↓
Atoms

↓
Molecules

↓
Mineral

↓
Rocks

Most Abundant Minerals in Earth's Crust



Mineral Chemistry


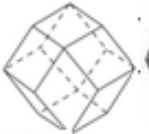






Minerals can be described by their chemical formula.

Sometimes multiple elements can fill the same spot in a mineral structure.

Example

Garnets $A_3B_2 (Si_3O_{12})$



| Garnet $X_3Y_2 (Si_3O_{12})$ | |  |  |  |
|---|---------------------------------------|---|--|---|
| Optical Properties | Hand Specimen Properties |  |  |  |
| Isometric / Cubic | Vitreous Luster | | | |
| Rhomb dodecahedron 12 sides | Mostly red but can vary | | | |
| Isotropic | Hardness 6 – 7.5 | | | |
| High Positive Relief | Conchoidal + Parallel Fracture | | |  |
| Habit – Rhombododecahedra or Trapezohedra | Alters to the green mineral Chlorite. | | | |
| Euhedral – well developed faces | No Cleavage | | |  |

Garnets $X_3Y_2(Si_3O_{12})$

| Name | Color | Occurrence | Formula |
|-------------|-------------------------------|--------------------------|-------------------|
| Pyrope | Deep red - Black | Ultramafic igneous rocks | $Mg_3 Al_2 \dots$ |
| Almandine | Violet to brown Red | Regionally Metamorphosed | $Fe_3 Al_2 \dots$ |
| Spessartine | Brown, red to Pink | Mn Skarns | $Mn_3 Al_2 \dots$ |
| Uvarovite | Emerald Green | Cr rich rocks | $Ca_3 Cr_2 \dots$ |
| Grossular | Pale tints | Meta impure limestone | $Ca_3 Al_2 \dots$ |
| Andradite | Pale tints to brown and black | Meta impure Fe limestone | $Ca_3 Fe_2 \dots$ |

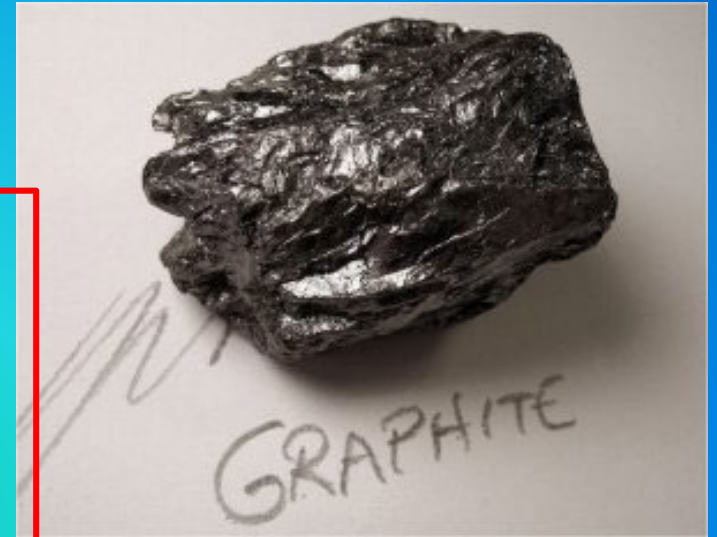
Mineral Chemistry

Every mineral is a combination of elements; the atoms are organized into geometric structures called crystals or crystal lattices.

The shape of the mineral is determined by how the atoms creating the mineral are organized.

If two different minerals have the same chemical formula but different crystal structure, they are called polymorphs (e.g., graphite and diamond).

They are both made up of Carbon = C



Mineral Formation

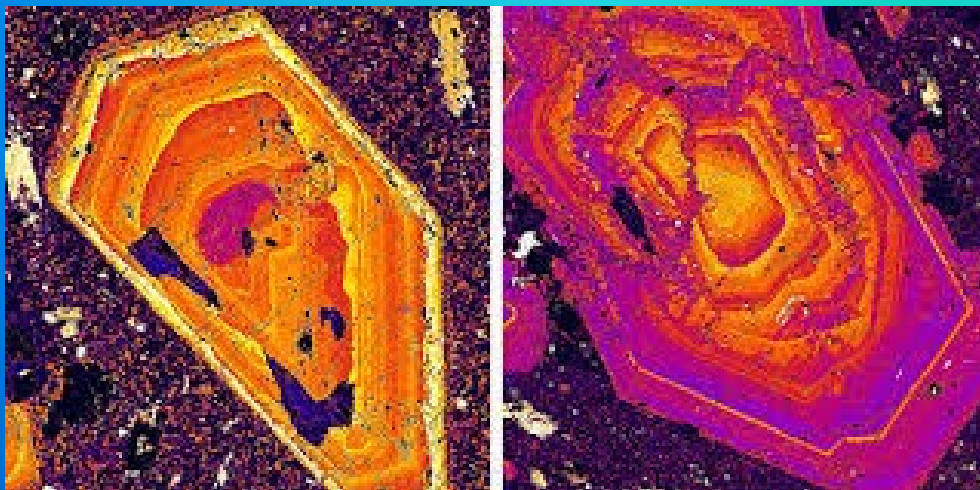


Watermelon
Tourmaline

Crystals form by a seed (nucleation), which other atoms attach to through bonding. The youngest part of the crystal is at its outer edge.

If the atoms available in the environment change, the composition of the mineral can change, thus creating compositional zoning.

If space to grow is not constrained then crystals will form a characteristic shape based on their structure. However, growth is often restricted, and their shape is controlled by the shape of their surroundings.



Plagioclase Zoning (Ca and Na)

Mineral Chemistry

General Notes
– jot form

Mineral Formation

Precipitation

Definition:
Examples -

Solid state reactions

Definition:
Examples -

Magma

Crystallization

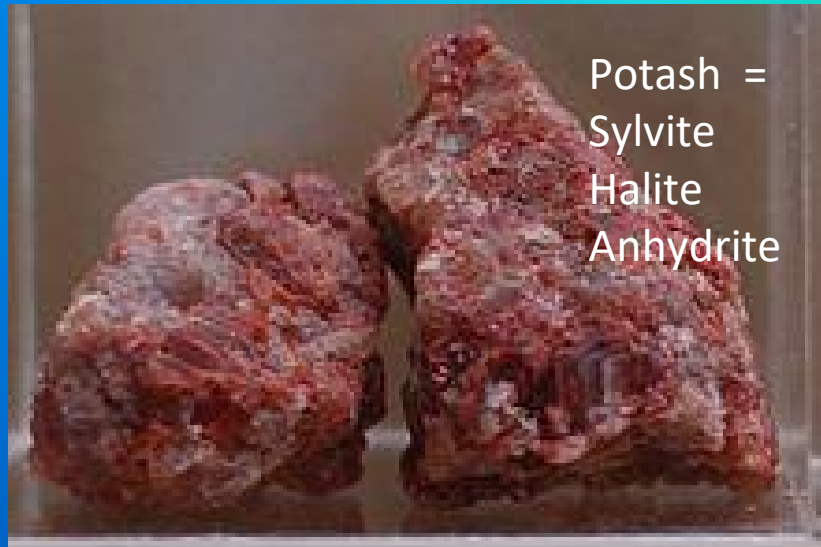
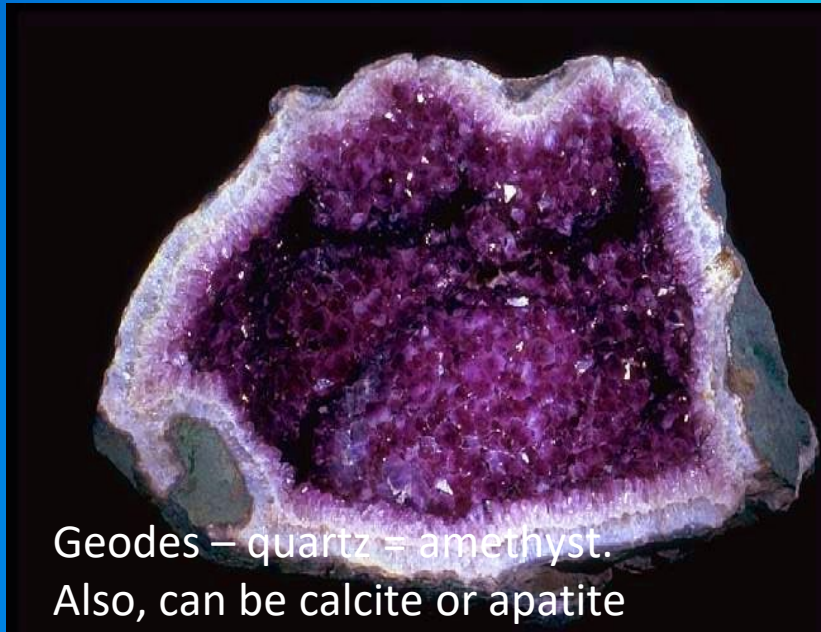
Definition:
Examples -

Mineral Formation: Precipitation

Mineral Precipitation: is when a mineral forms by crystallization from a solution (for example salt precipitating from a salty lake when the water evaporates).

- Natural waters like lakes, oceans and groundwater contain dissolved minerals such as salt or iron.
- Water can only hold a certain amount of dissolved minerals before it becomes saturated.
- When the amount is too great to stay dissolved in the water (supersaturated) the particles come together to form mineral solids and precipitate out.
- For example, when water **evaporates** from a lake or ocean, it leaves behind a solid “precipitate” of minerals.
- When minerals precipitate below earth’s surface it is because hot water (hydrothermal fluid) changes temperature, pressure or composition, such that the fluid becomes supersaturated and deposits the dissolved minerals. If the water is flowing through cracks, the precipitated minerals form veins.

Mineral Precipitation Examples



Mineral Precipitation Examples

Limestone cave



Quartz veins (Box Mine, SK)

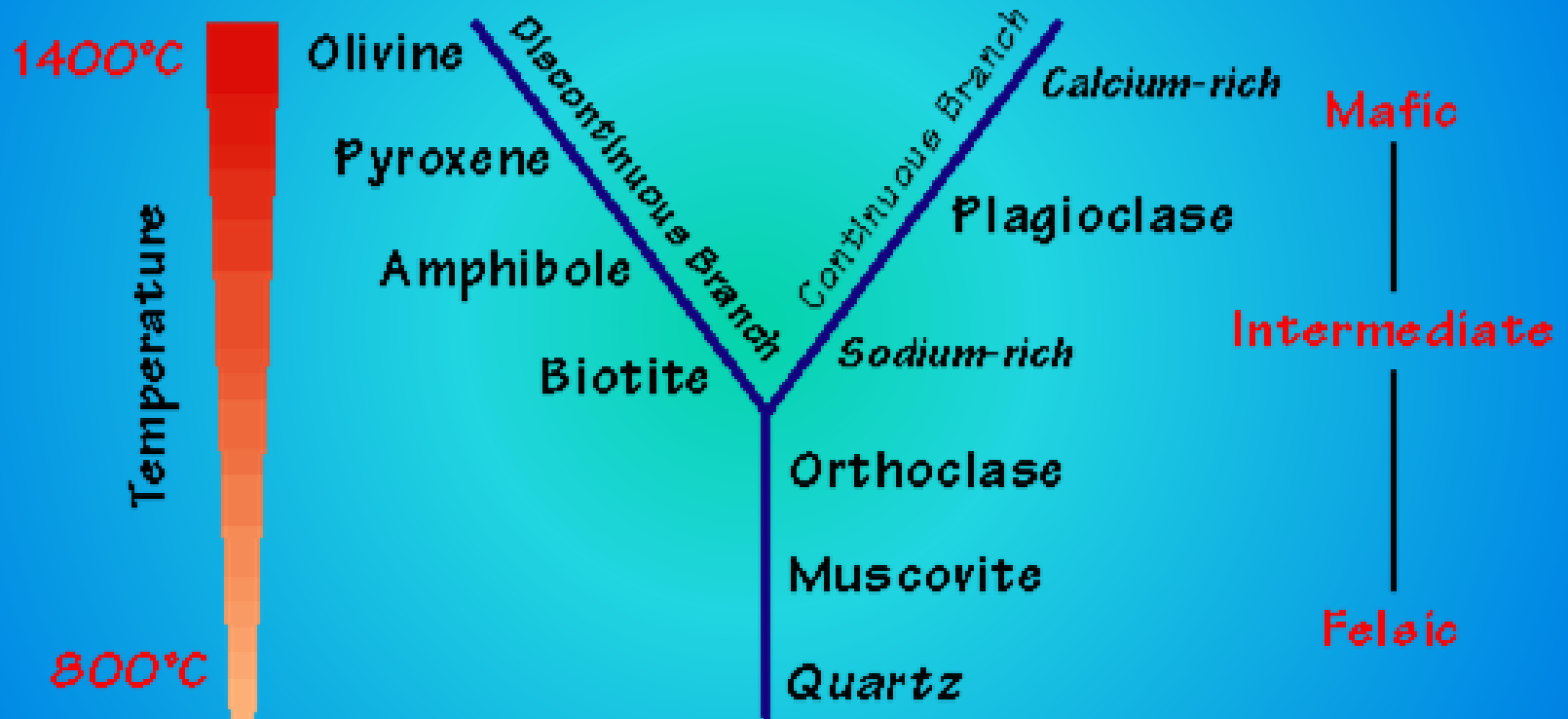


Mineral Formation: Igneous Crystallization

Igneous Crystallization: is when a mineral forms by solidification of magma (deep in the earth) or lava (on the surface) .

- The magma composition changes over time as different minerals crystallize out of the magma.
- The sequence of minerals that grow is called Bowen's Reaction Series.
- When magma cools slowly larger minerals can form, when it cools more quickly the crystals are smaller.
- Lava on Earth's surface can cool so quickly that minerals don't have time to nucleate and grow and then you get volcanic glass (obsidian).

Bowen's Reaction Series



Igneous Crystallization Examples

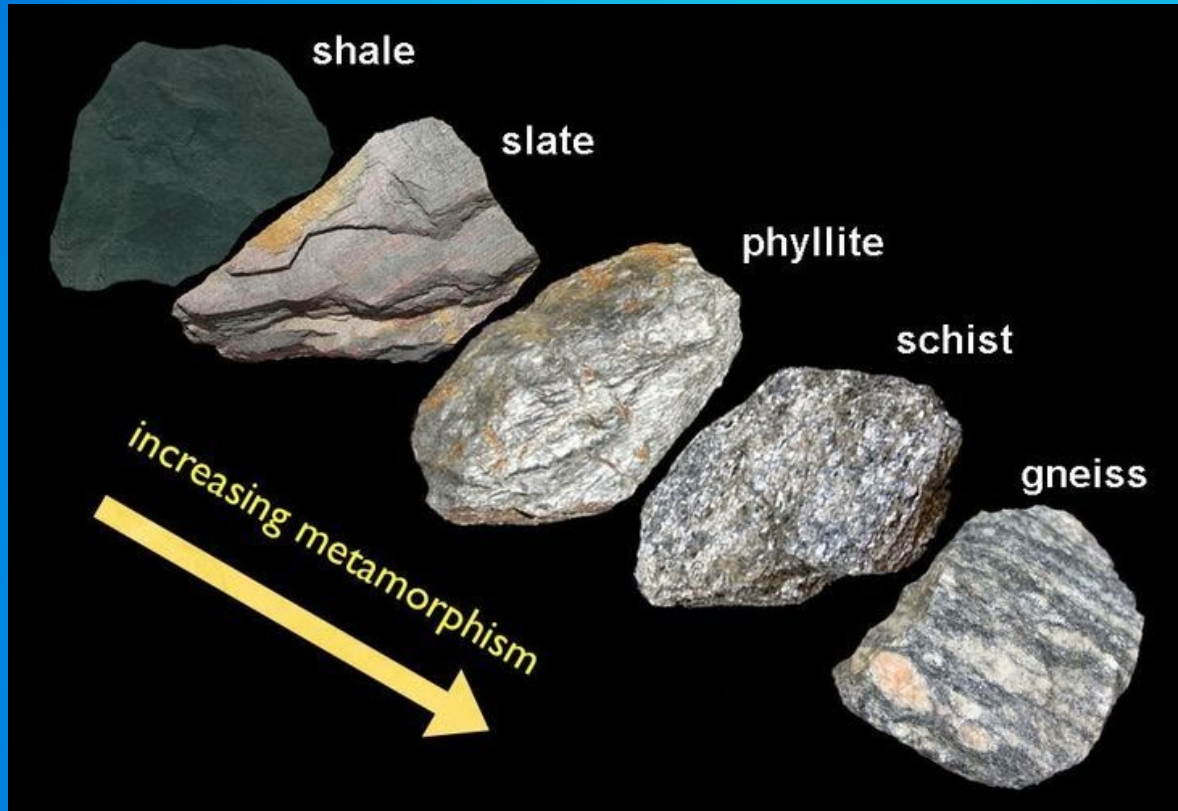


Diabase is a mafic rock that in this case contains plagioclase (white), pyroxene (brown) and amphibole (black).



Granite is a felsic rock that contains the minerals quartz (grey), plagioclase feldspar (shiny white), potassium feldspar (pale pink) and biotite (black).

Solid State Reactions (Metamorphism)

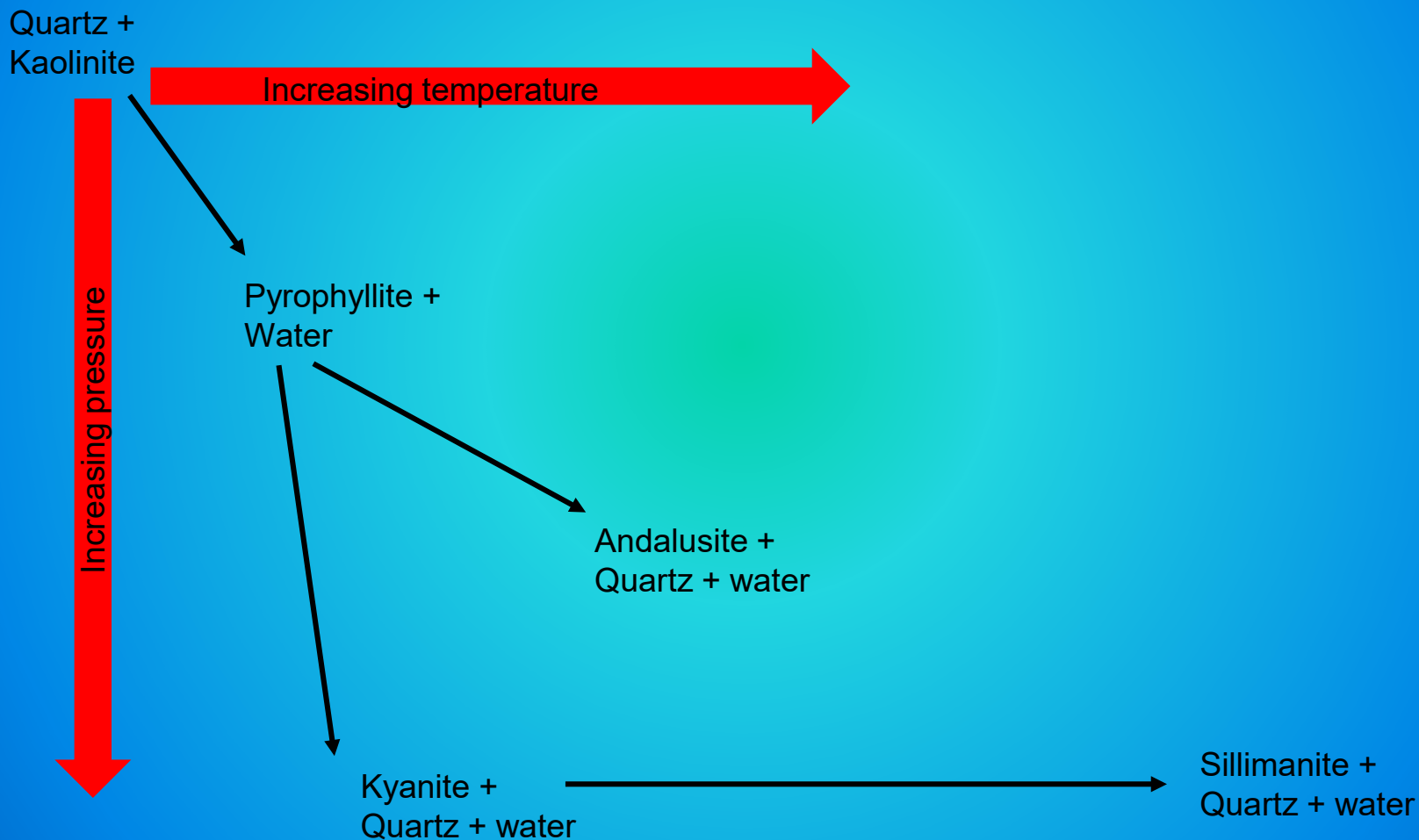


Garnet is a common metamorphic mineral that forms at moderate to high temperatures and pressures.



Metamorphic Reactions

Sedimentary rock = sand (quartz) plus clay (kaolinite)





Mineral Formation: Biomineralization

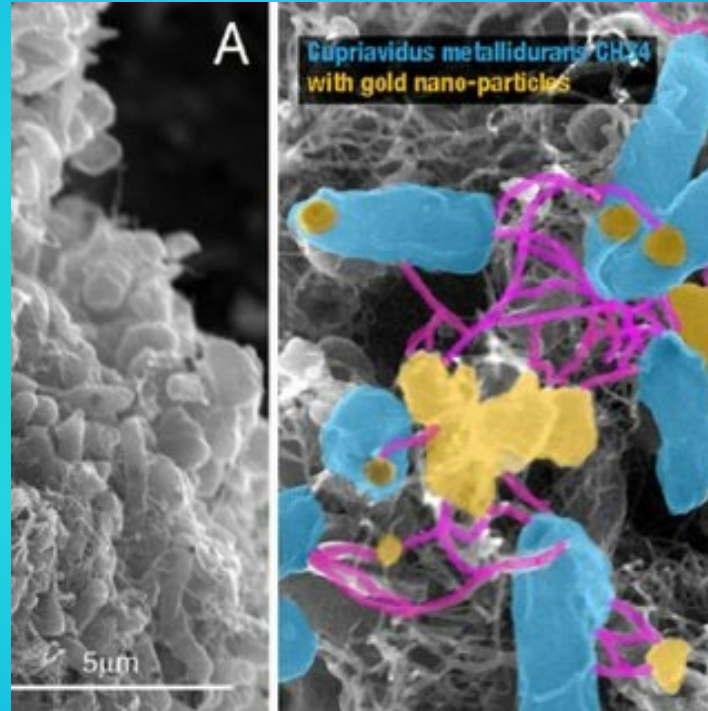
Biomineralization: is when a mineral is formed by living organisms - often in order to strengthen existing tissue.

- Over sixty different minerals have been identified in organisms.
- Most common bio-minerals are phosphate and carbonate salts of calcium that are used with polymers such as collagen and chitin to give structural support to bones and shells.
- There is a lot of research being done to try to understand it better.
- In humans biomineralization helps make up our bones and teeth.

Biomaterialization Examples



Seashells, crustaceans, turtle shells, and corals



Bacteria producing gold



Teeth and bone in mammals and birds

Safety: Geode Lab

- Tie long hair back
- Wear Goggles
- Alum powder may irritate your skin; wash your hands if you touch it
- Use extreme care around the boiling water.

