Mineral Formation

Mineral Chemistry

General Notes
– jot form

Mineral Formation

Precipitation

Definition:
Examples -

Magma Crystallization

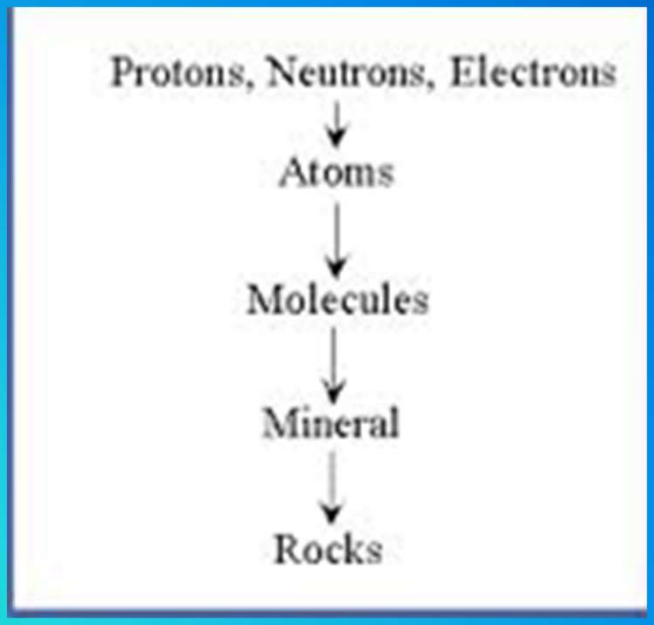
Definition:
Examples -

Solid State Reactions

Definition:
Examples -

Mineral Chemistry

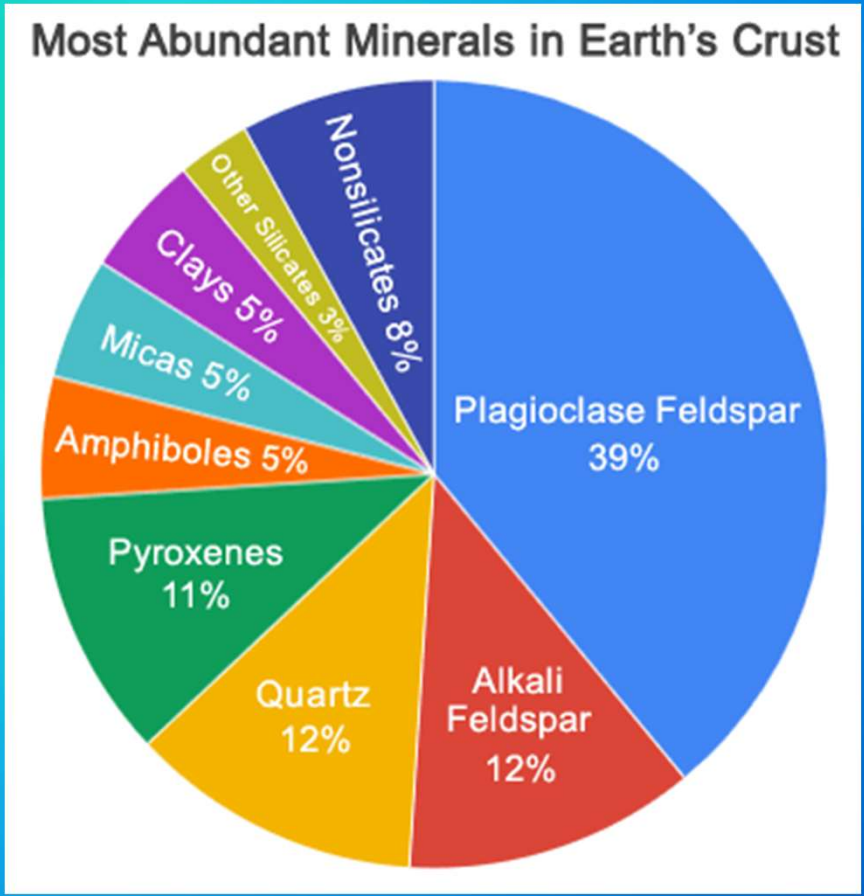
Minerals are made from atomic elements and the attraction between different types of atoms creates a structure.



Covalent Bonding: sharing of electrons forms a weaker bond and very common in minerals.
Example – SiO_2 = Quartz

Ionic Bonding: trading electrons
Example - salt = Halite = NaCl

Metallic Bonding: migrating electrons or floating in a sea or electron cloud.
Examples – Gold and Silver
Responsible for shiny metallic appearance.



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 – Rhombodecahedra or Trapelzahedra	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	Mg3 Al2 ...
Almandine	Violet to brown Red	Regionally Metamorphosed	Fe3 Al2 ...
Spessartine	Brown, red to Pink	Mn Skarns	Mn3 Al2 ...
Uvarovite	Emerald Green	Cr rich rocks	Ca3 Cr2 ...
Grossular	Pale tints	Meta impure limestone	Ca3 Al2 ...
Andradite	Pale tints to brown and black	Meta impure Fe limestone	Ca3 Fe2 ...

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 shape, they are called polymorphs (e.g., graphite and diamond).

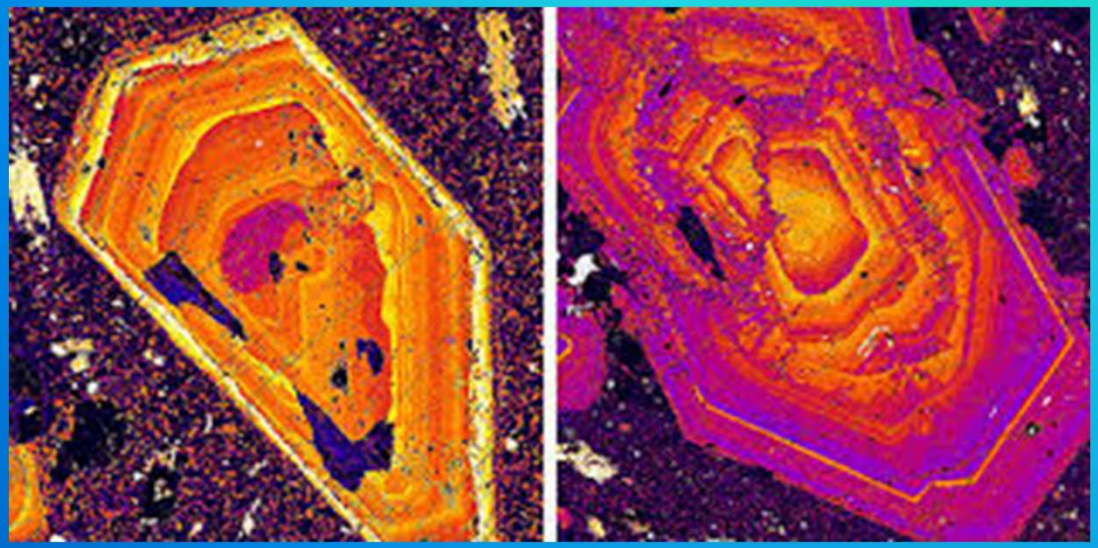
Carbon = C

Mineral Formation

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

Watermelon Tourmaline

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



Plagioclase Zoning (Ca and Na)

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

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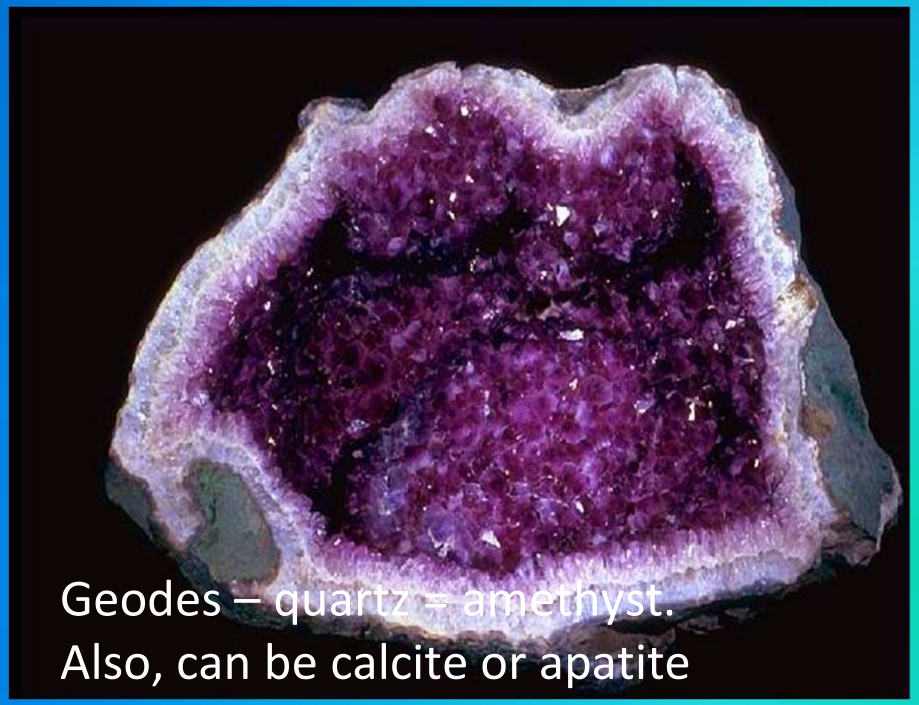
Mineral Formation: Precipitation

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 contains dissolved minerals – e.g., oceans, lakes, underground water, etc.
- Water can only hold a certain amount of dissolved minerals before they become saturated.
- When the amount is too great to stay dissolved in the water (supersaturated) the particles come together to form mineral solids and precipitated 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.

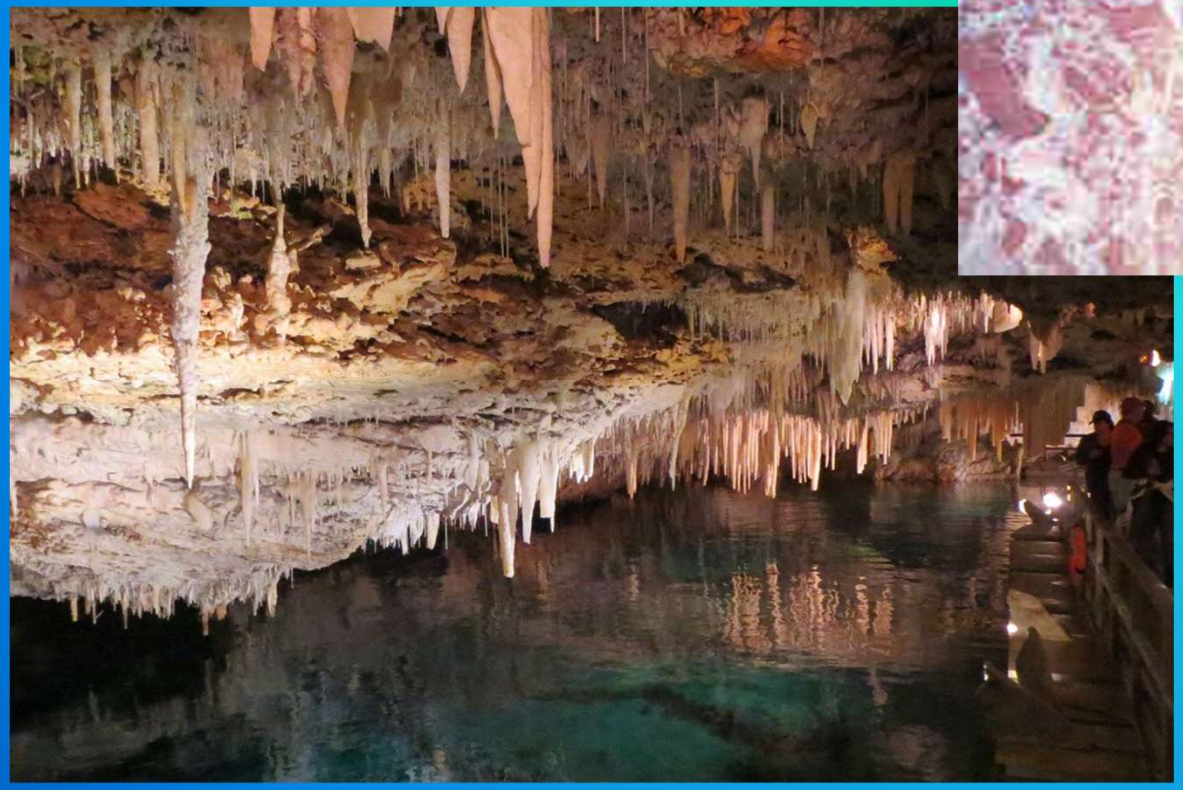
Mineral Precipitation Examples



Mineral Precipitation Examples

Quartz veins

Limestone cave

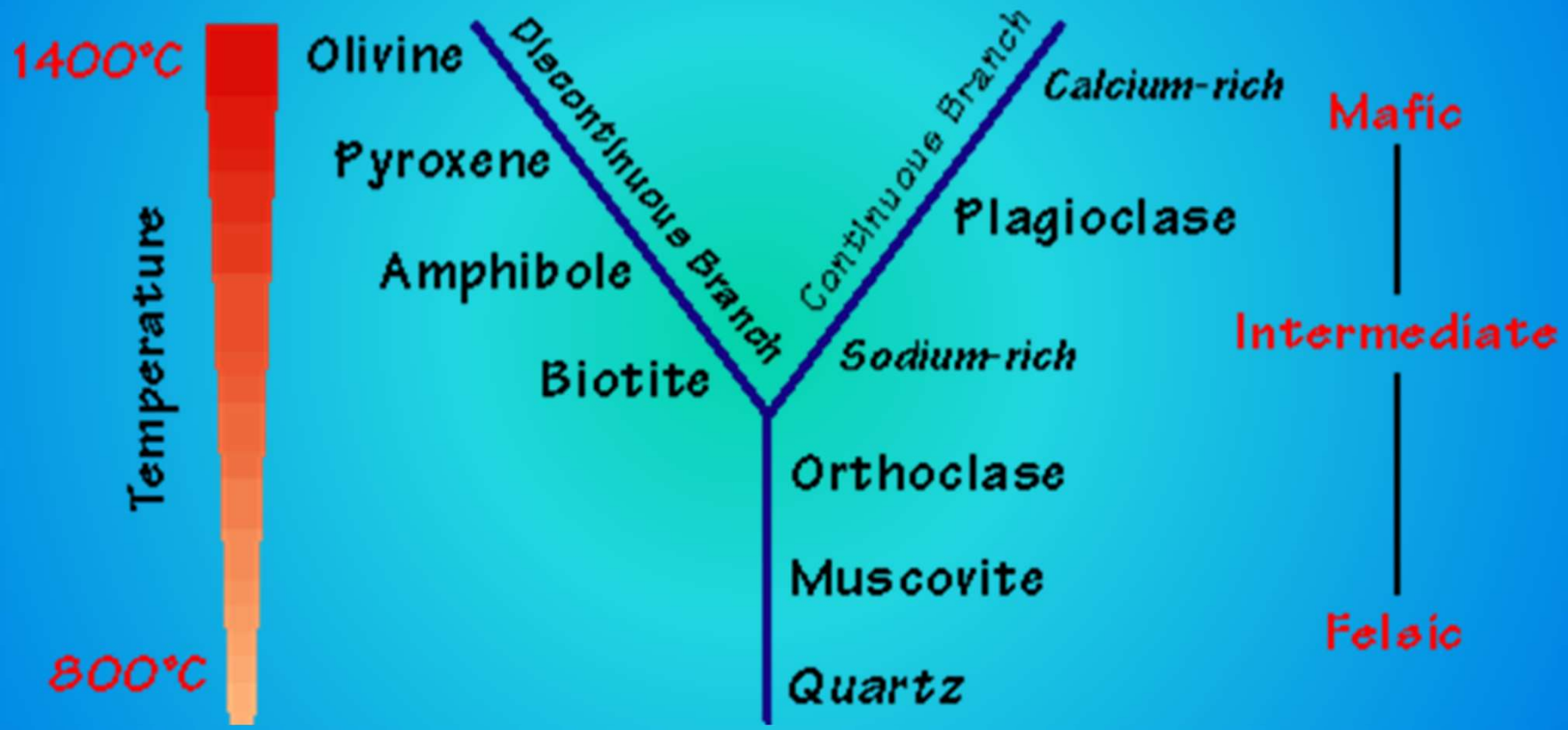


Mineral Formation: Igneous Crystallization

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

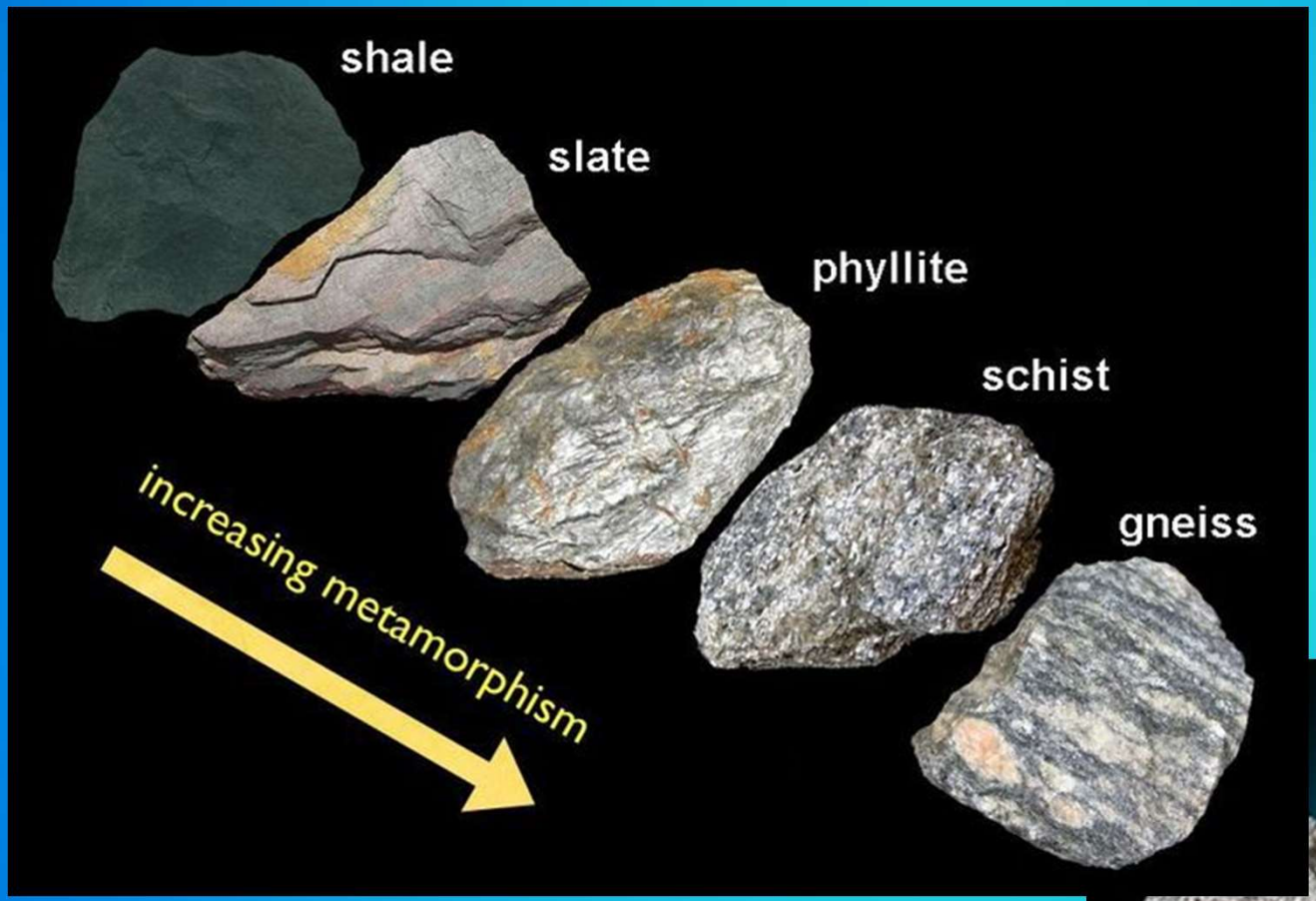


Mineral Crystallization Examples

Obsidian (volcanic glass) – lava that cools so fast that minerals cannot form = not a mineral.

Granite is a type of rock that forms from magma. It contains minerals quartz (grey), plagioclase feldspar (shiny white), potassium feldspar (pink) and biotie (black).

Solid State Reactions (Metamorphism)



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

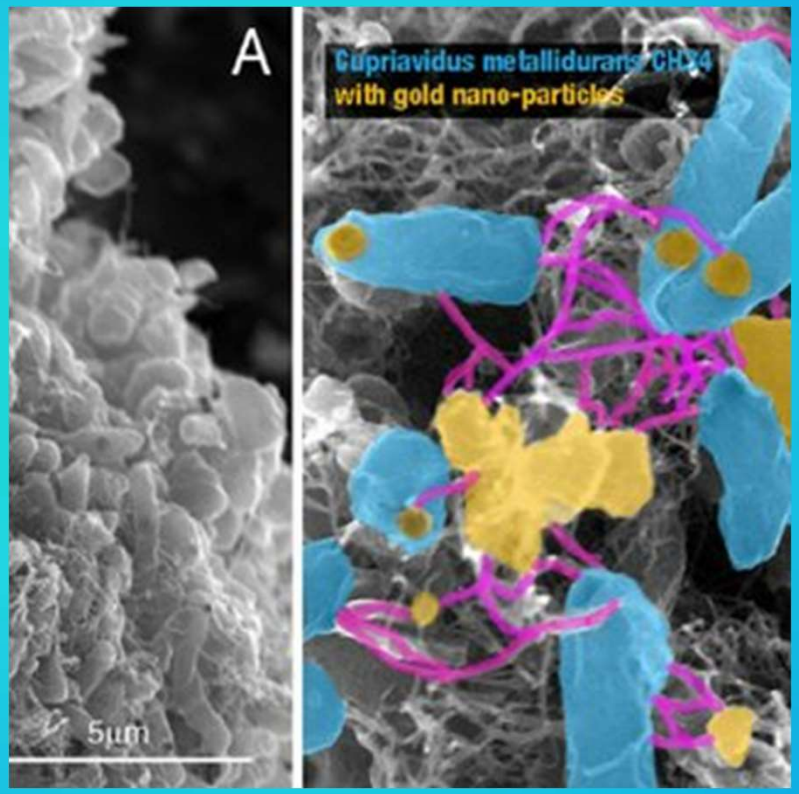
Mineral Formation: Biomineralization

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.

Biomineralization 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.