

A close-up photograph of a large, rough, purple amethyst crystal cluster. The crystals are faceted and translucent, with some showing internal inclusions. The cluster is held in a person's hand, with fingers visible at the bottom. The background is a blurred green, suggesting an outdoor setting.

Mineral

What is a Mineral?

A mineral is a naturally occurring, homogeneous inorganic solid that has a crystal structure and a definite chemical composition.



Pyromorphite

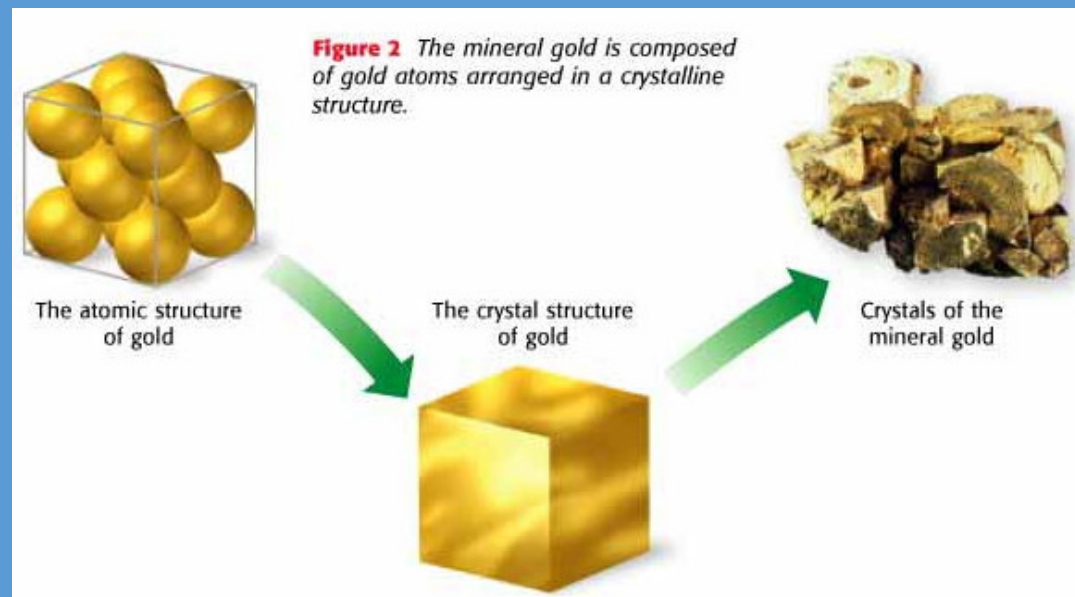
For a substance to be a mineral it must have 5 characteristics:

1. Formed by **natural** processes on or inside Earth- no help from humans
2. Is **inorganic**- was never alive. For example, although coal was formed naturally in earth's crust it came from plants and is therefore, not a mineral
3. Is a **solid**, with definite volume and shape. Liquids cannot be minerals.

4. Minerals always contains certain elements that give it a **unique chemical composition** (makeup). Some minerals are compounds which are made up of more than one element.

5. Have a **crystalline shape**- the particles of a mineral line up in a pattern that repeats forming a crystal.

Crystal- solid with atoms arranged in an orderly, repeating pattern



How do minerals form?

There are 2 ways that crystals form:

- The cooling of hot, liquid rock called **magma** causes compounds to combine
 - Magma cools slowly= crystals are large
 - Magma cools quickly= crystals are small
- The evaporation of water that has minerals dissolved in it



Properties of Minerals

Properties of Minerals

The following physical properties of minerals can be easily used to identify a mineral:

- 1.Colour
- 2.Streak
- 3.Hardness
- 4.Cleavage / Fracture / Parting
- 5.Crystalline Structure
- 6.Diaphaneity or Amount of Transparency
- 7.Tenacity
- 8.Magnetism
- 9.Luster
- 10.Odor
- 11.Taste
- 12.Specific Gravity

1.Colour

Minerals are coloured because certain wavelengths of light are absorbed, and the mineral colour results from the combination of those wavelength which reach the eye--*if light is not absorbed, the mineral is colorless in reflected or refracted light and is black if all wavelength of light are absorbed*

Idiochromatic colour-mineral colour caused by the presence of element(s) in the chemical composition of the mineral -*Cu in azurite (blue); Cu in malachite (green); Mn in rhodonite and rhodochrosite (pink)*

Chromaphore (Chromophores are the parts of the molecule that absorb colour) colour- Caused by the presence of a small concentration of element(s) (Fe, Mn, Cu, Cr, Co, Ni, V) or which do not comprise the chemical composition of the mineral, these elements are called chromophores *Cr and V in beryl--deep green of emerald; Fe in quartz--purple of amethyst; V in zoisite--rich sapphire blue*

Idiochromatic and Chromophore elements can cause colour by the following mechanisms:

1. **Crystal Field Transitions:** wavelength of light quanta are absorbed by "d" electrons in transition elements resulting in transmissions of wavelengths of light giving the mineral its color

<u>Transition Element</u>	<u>Mineral</u>	<u>Resulting Color of Mineral</u>
Cr ⁺³	beryl-Be ₃ Al ₂ Si ₆ O ₁₈ --emerald	green
Cr ⁺³	corundum-Al ₂ O ₃ --ruby	red
Mn ⁺²	beryl-Be ₃ Al ₂ Si ₆ O ₁₈ -morganite	pink
Fe ⁺²	olivine-(Mg,Fe) ₂ SiO ₄ -peridot	yellow-green

2. **Molecular Orbital Transitions :** metal ions undergo charge transitions

<u>Transition</u>	<u>Mineral</u>	<u>Resulting Color of Mineral</u>
Fe ⁺² > Fe ⁺³	beryl-Be ₃ Al ₂ Si ₆ O ₁₈ -aquamarine	blue to yellow
Fe ⁺² > Ti ⁺⁴	corundum-Al ₂ O ₃ -sapphire	blue

Inclusions of Other Minerals

green quartz caused by chlorite dispersions

black calcite caused by MnO_2 dispersions

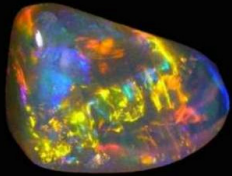
red color in many minerals caused by hematite dispersions

Special Mineral Properties Related to Light, Heat, and Electricity

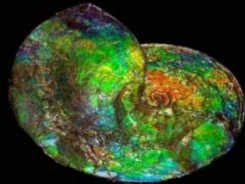
1. Play of Colors (Iridescence) : results from diffracted and reflected light from closely spaced fractures, cleavage planes, exsolution, or minute inclusions in parallel orientation.

in opal--reflected light from submicroscopic layers of spherical SiO_2 particles

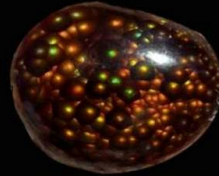
labradorite--reflected light from exsolution laminae



Opal



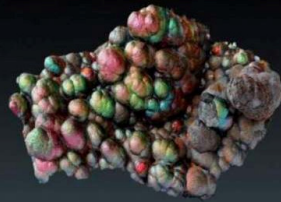
Ammolite



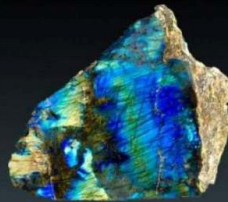
Fire Agate



Moonstone



Geothite



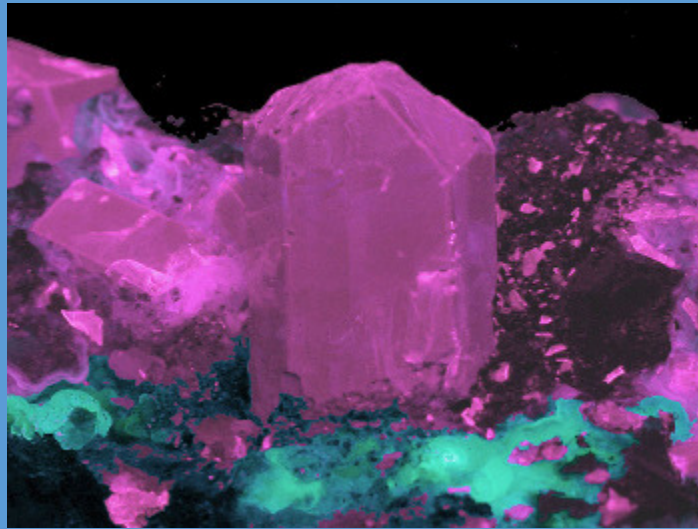
Labradorite



2 –Asterism: a star like figure appearing on the surface of a mineral caused by reflection or scattering of light off needle inclusions of minerals which parallel crystallographic axes.
rubies and sapphires-- corundum



Luminescence: a special glowing of the mineral caused by the presence of impurities (activators) in a mineral



Fluorescence: emission of light wavelength caused by electron excitation in transition metal during bombardment of a mineral with ultraviolet or x-rays--examples are: *some specimens of fluorite, scheelite, calcite*

Phosphorescence: continuous emission of light wavelength after the excitation source is removed.

Thermoluminescence: emissions of light wavelengths when mineral is subjected to heat below the "red hot" temperature--examples are: *some specimens of calcite and apatite*

Certain minerals develop an electrical charge when subjected either to a temperature change (*Pyroelectric*, mineral) or to a change in stress (*Piezoelectric* minerals)

Tourmaline is an example of a Pyroelectric mineral.

Quartz is a Piezoelectric mineral.

Note: Colour is not useful as a diagnostic property