Minerals

WHAT IS A MINERAL?

- There are five characteristics of a mineral

A mineral is **Naturally Occurring**

- A diamond created deep in the earth's crust is a mineral, but a diamond made in a laboratory by humans is not.

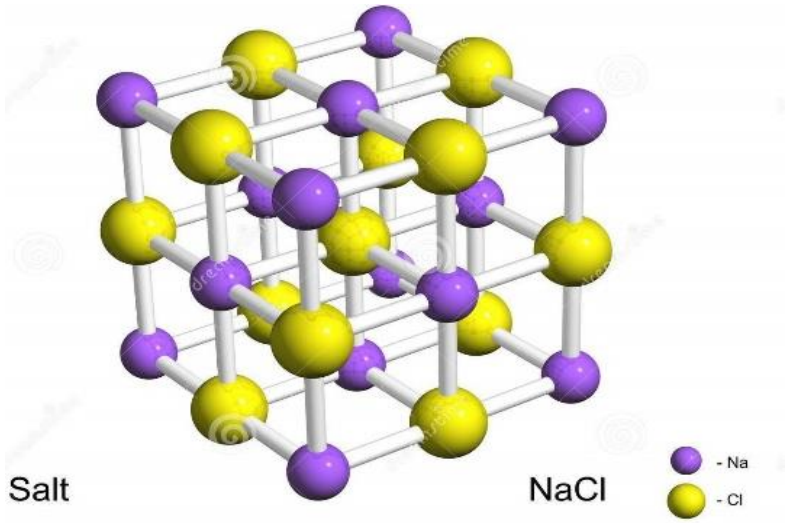
Exist in **SOLID** form

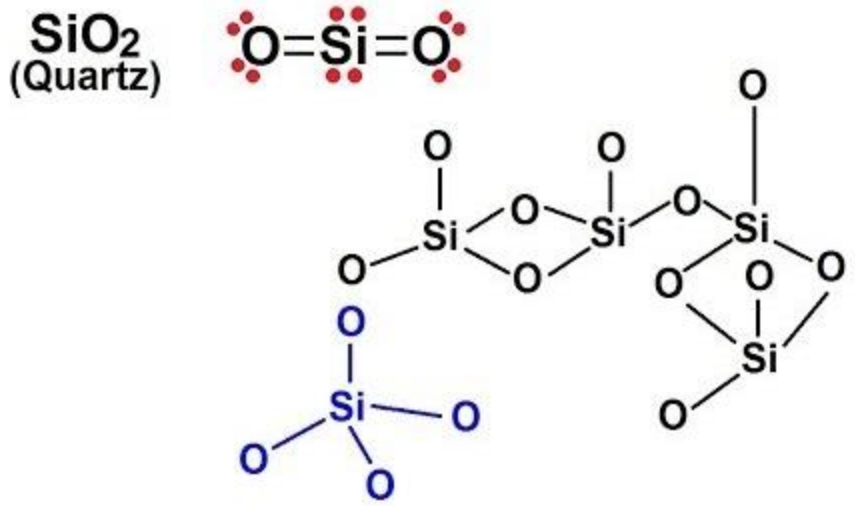
Have definite <u>CHEMICAL COMPOSITION</u>

- Eg. Halite (NaCl)
- Eg. Quartz (SiO_2) is always made up of two oxygen atoms bonded to a silicon atom.

Atoms arranged in ORDERED PATTERN

- Minerals are “crystalline” solids
- A crystal is a solid in which the atoms are arranged in a regular, repeating pattern





INORGANIC

- Means - Not living nor made from living things.
- Organic substances are carbon-bases compounds made by living creatures (includes proteins, carbohydrates, and oils)
- Inorganic substances are non-living materials

Definition of a Mineral:

- A naturally occurring, inorganic, solid that has a definite chemical composition and crystal shape.

Spot the Minerals

- diamond,
- Water
- gold,
- quartz,
- window glass,

pearl

ice

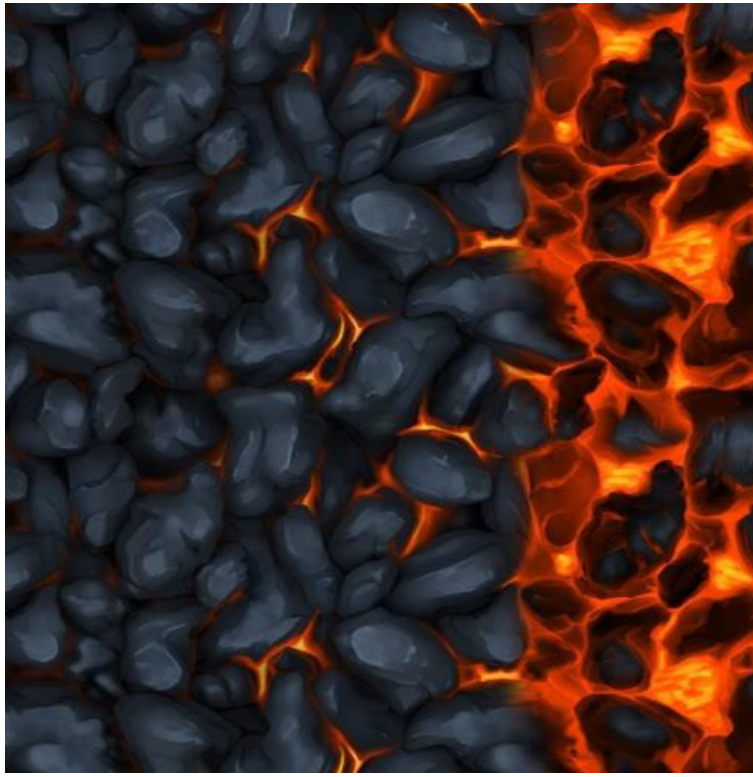
coal

rock salt

Answers:

- Minerals: diamond, gold, quartz, halite
- Nonminerals: water, glass, pearl, coal

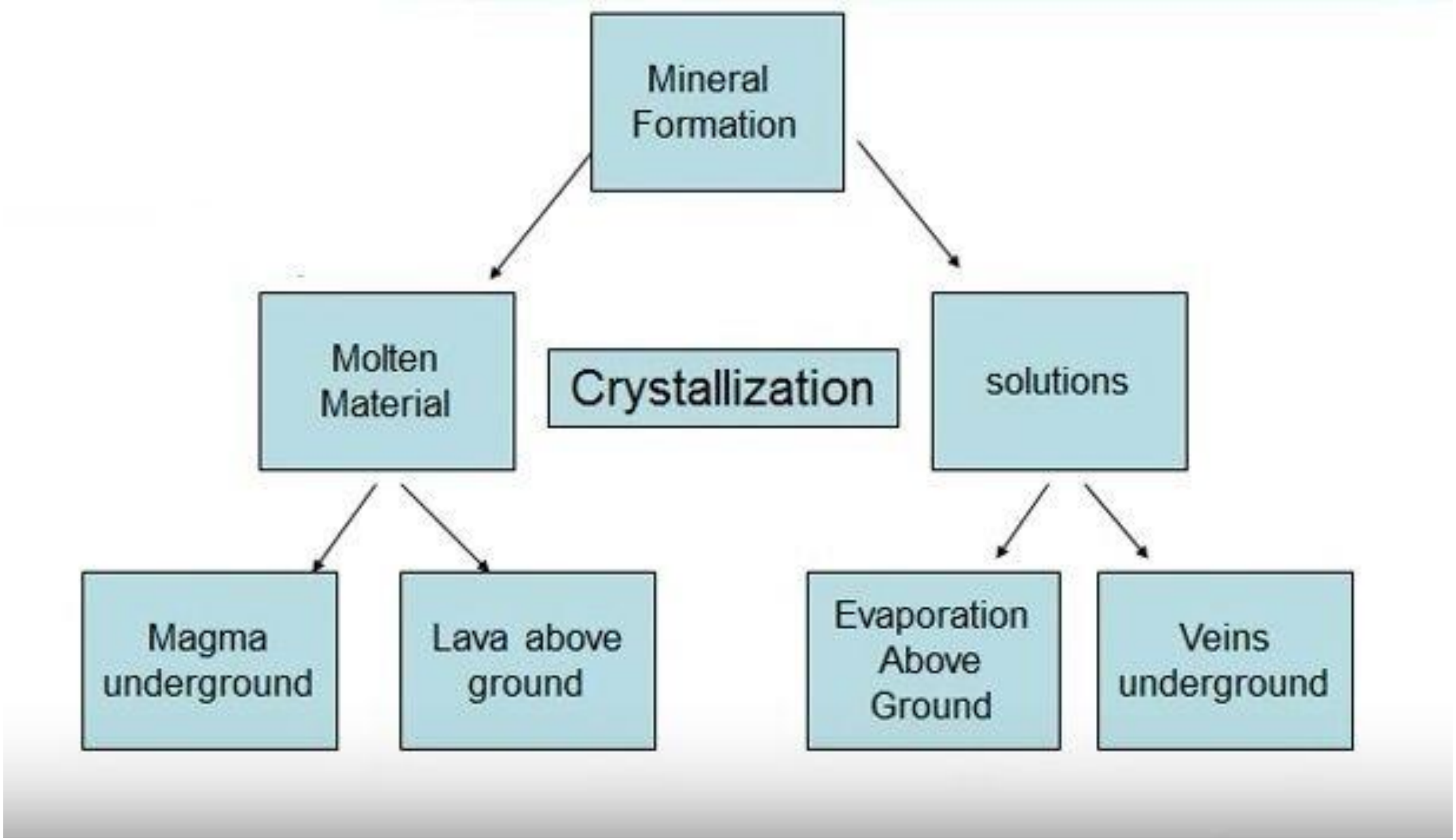
How do Minerals Form?



- Mostly from **cooling magma**:
- *When magma cools, its atoms slow down and move closer together and arrange in different patterns.*
- *More than one type of mineral can form from the same mass of magma.*
- *The types of minerals that form depends on the types of elements present in the magma*

Magma above ground, magma underground

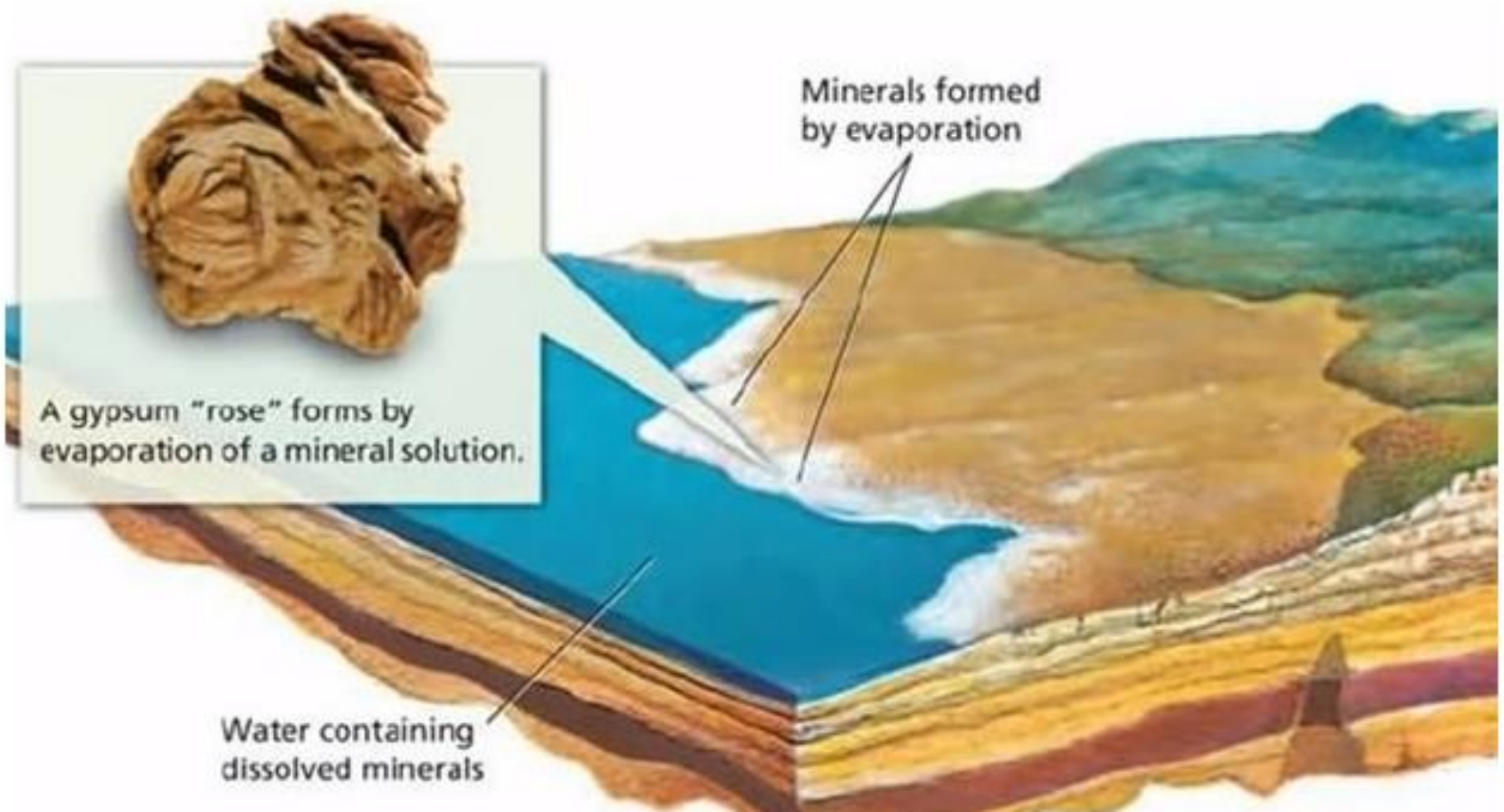
- *When molten material like magma (melted minerals) cools, the minerals start to crystallise.*
- *In general, the faster it cools, the faster the crystals form, so only smaller the crystals form.*
- *Magma deep under ground takes longer to cool off, giving minerals longer time to form --> making bigger because of long.*

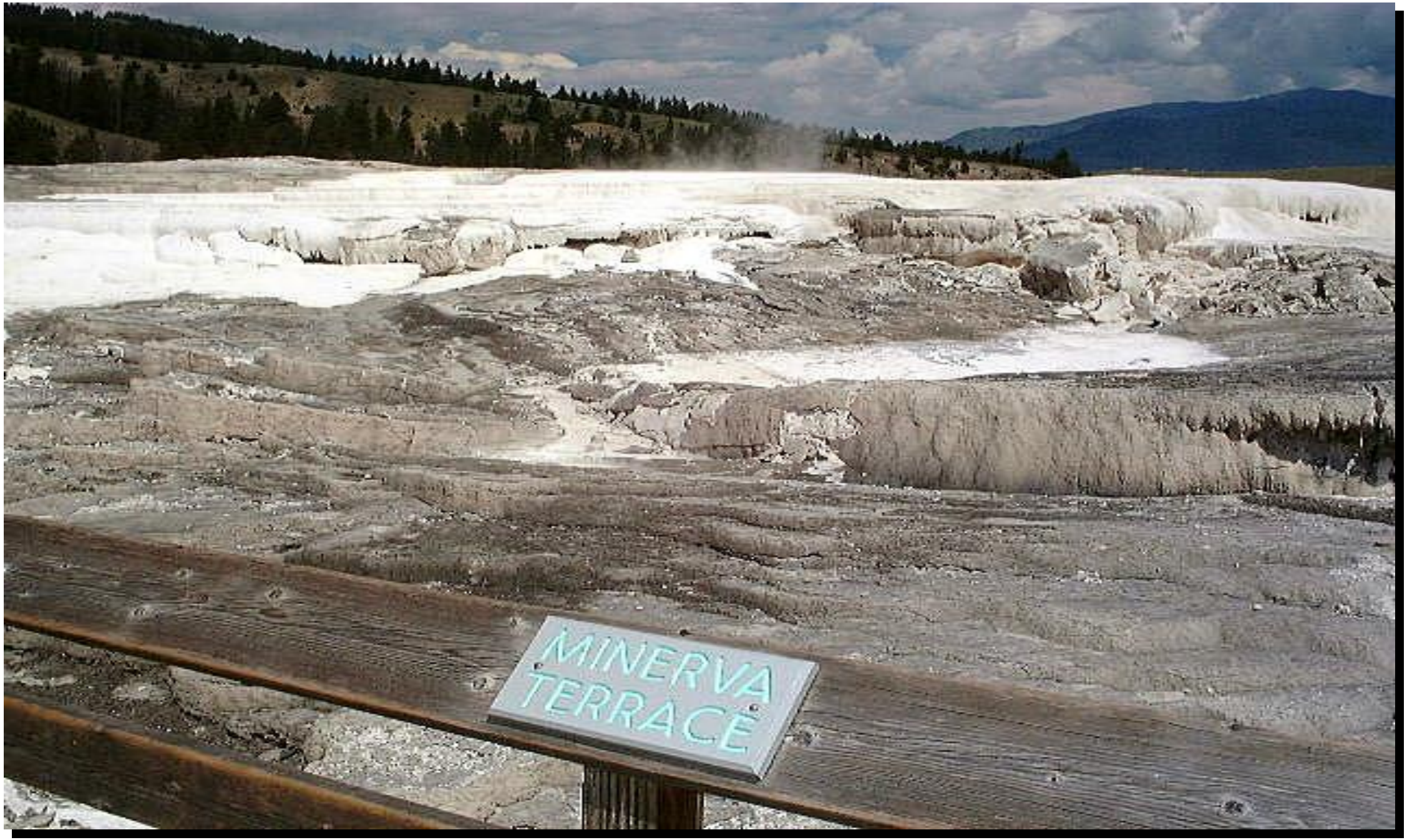

Mineral Formation
Molten Material
Crystallization
solutions
Magma underground
Lava above ground
Evaporation Above Ground
Veins underground

Process	Examples
Cooling	Cooling of Magma below ground or Cooling of Lava above ground. Eg. Mica, feldspar, quartz
Evaporation	Water carrying dissolved minerals evaporates: Gypsum, halite
Deposition	Water carrying dissovled minerals deposits minerals: Calcite, dolomite
Reaction	Minerals formed by Chemical Reactions: Gold, copper, sulfur, pyrite, galena
Metamorphism	Minerals subject to extreme heat and pressure can change to NEW minerals: Garnet, gaphite, magnetite, talc

Crystallisation by evaporation above ground

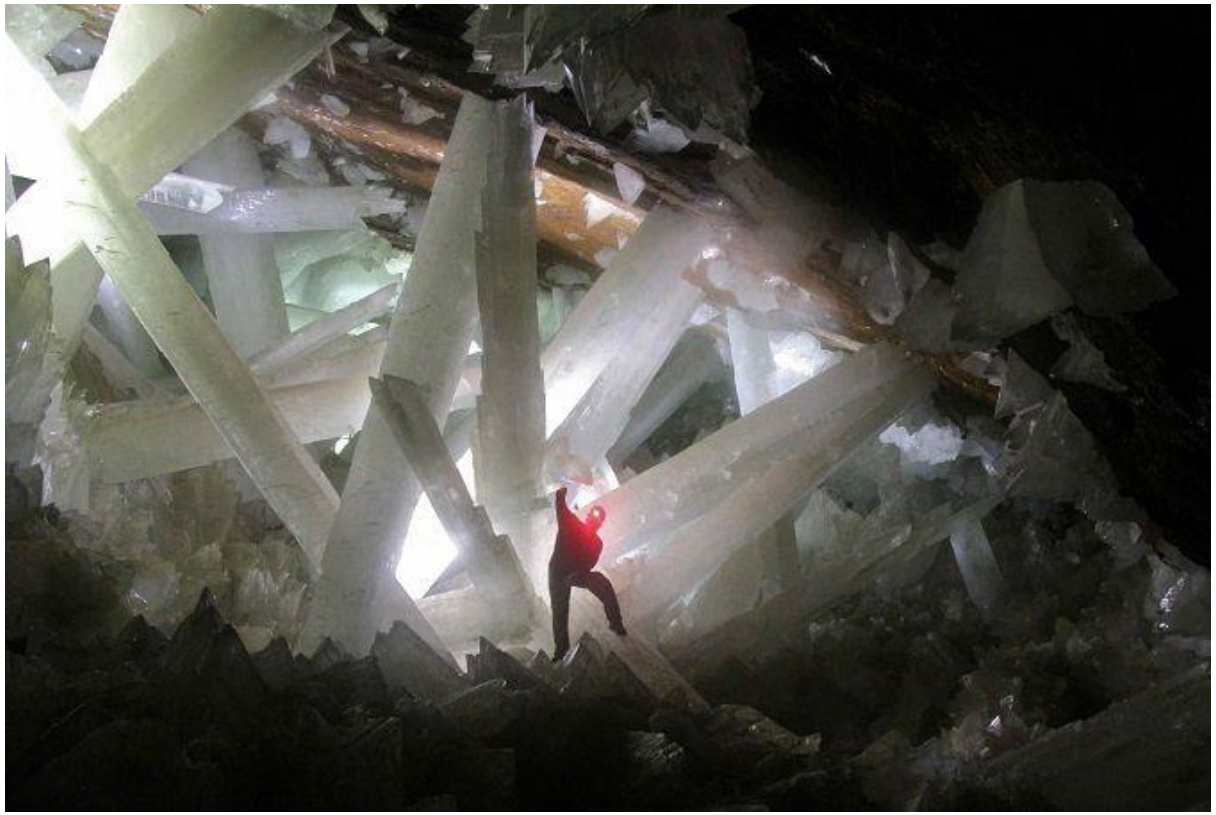
Crystallisation by evaporation above ground:




MINERVA
TERRACE

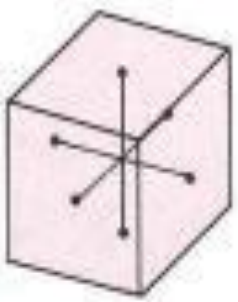
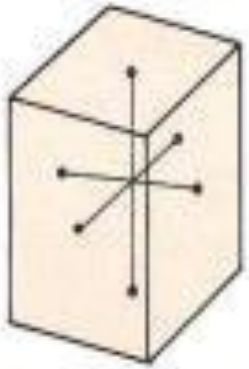
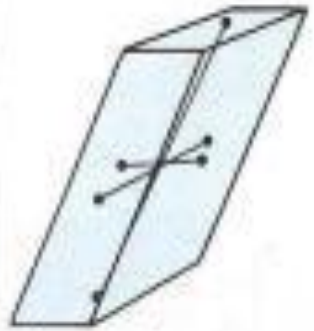
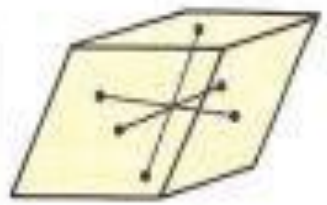
Veins underground

- *When water captured under ground gets heated, for example by magma veins close to it, it attracts minerals around it and it becomes rich mineral-rich.*
- *When this water cools, the dissolved minerals crystallise. Eg.Naica, Mexico*



MINERAL STRUCTURE

- A crystal is a regular geometric solid with smooth surfaces called **crystal faces**.
- ***Crystallographic axes*** *are used to describe the shapes.*

cubic	tetragonal	hexagonal	orthorhombic	monoclinic	triclinic
					
examples: halite galena	examples: zircon chalcopyrite	examples: quartz calcite	examples: sulfur staurolite	examples: mica gypsum	examples: feldspar rhodonite

How do we classify over 3,000 different minerals?

- *Minerals are grouped into **families** based on their **chemical composition** (what they are made of).*
- ***eight basic classes:** native elements, silicates, oxides, sulfides, sulfates, halides, carbonates, phosphates, and mineraloids.*

Three Main Groupings:

- Rock-forming minerals
- Ores
- Gemstones

Rock Forming Minerals:

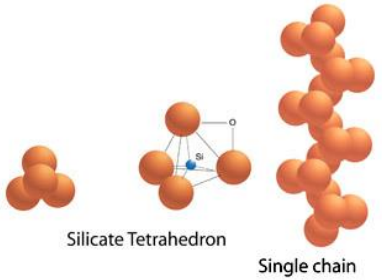
- Make up Ear**th's crust**.
- Most are **silicates.**
- *There are almost 5000 known mineral species, yet the vast majority of rocks are formed from combinations of a few common minerals, referred to as "rock-forming minerals".*
- Eg. feldspars, quartz, amphiboles, micas, olivine, garnet, calcite, pyroxenes.

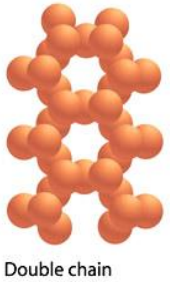
SILICATE MINERALS

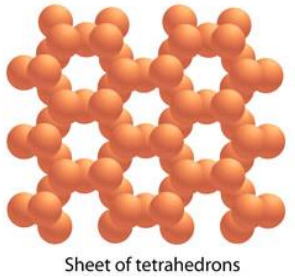
- **Largest** group, most important class of minerals (> 90% of minerals are silicates).
- Make up ~ **90%** of the Earth's crust.
- All contain **silicon** and **oxygen**

SILICA TETRAHEDRON

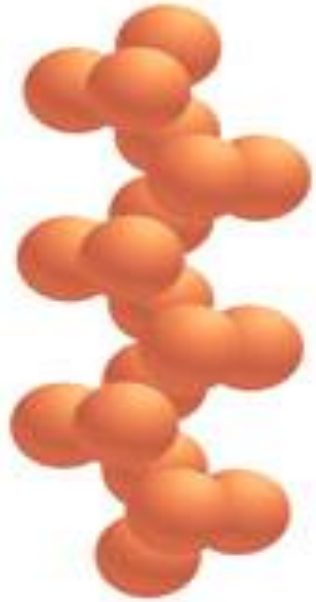
- Basic unit of structure of all silicate minerals is a **silica tetrahedron** (four oxygen atoms and one silicon atom) (SiO_4).
- Silicates are classified and named according to there **crystal structure** (the way the tetrahedra are **linked**
- (*6 different ways to create 6 different silicates*).



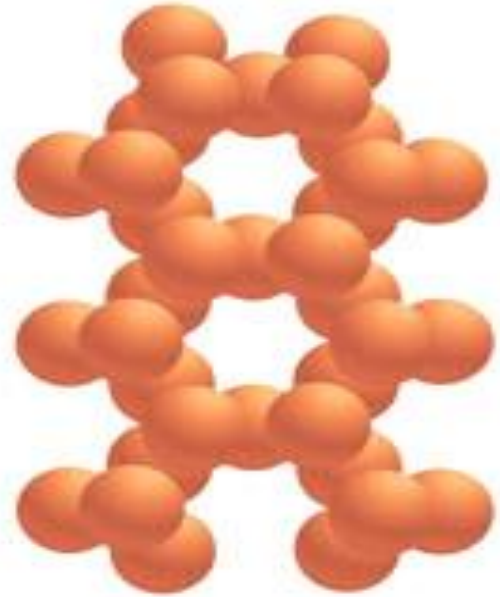




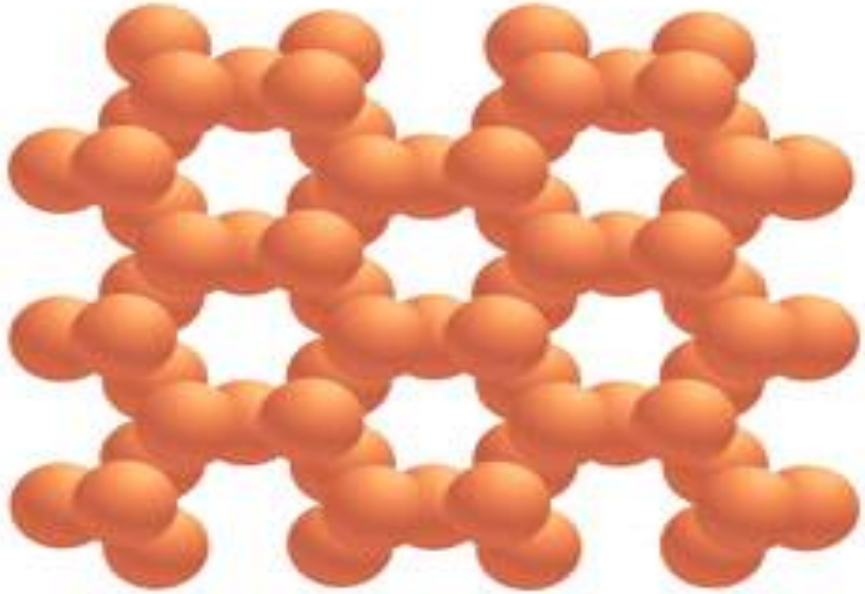
Silicate Tetrahedron



Single chain



Double chain



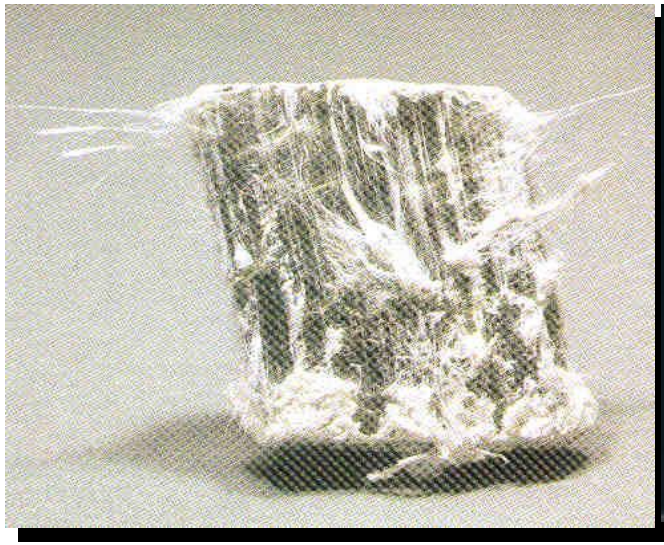
Sheet of tetrahedrons

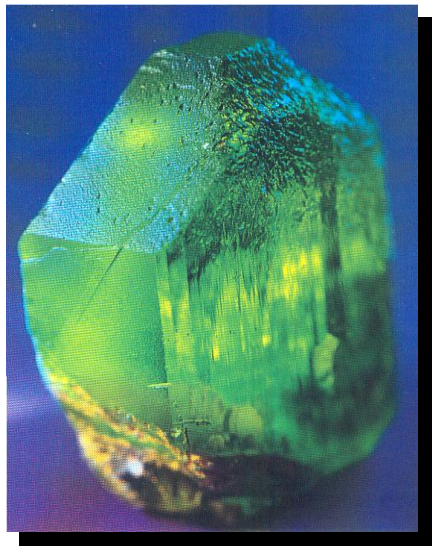
3-dimensional network
of tetrahedrons

COMMON SILICATES

- **Quartz** – silicon dioxide (SiO_2)
- **Mica** – soft, flat shiny, breaks into sheets
- **Feldspar** – most abundant family of minerals in Earth's crust, pearly luster
- **Ferromagnesian silicates** – contain iron and magnesium eg. **hornblende**

Other silicates





- **Asbestos** **Talc** **Olivine**

Nonsilicate Minerals

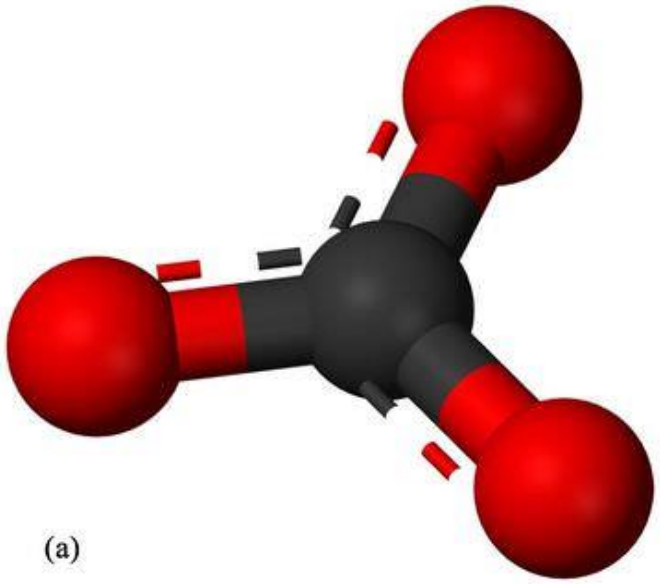
- *Minerals **without** silicon or oxygen (and therefore NO tetrahedral structure):*
- ***Native Minerals***
- ***Carbonates,***
- ***Sulfides,***
- ***Oxides,***
- ***Halides,***
- ***Phosphates.***

NATIVE MINERALS

- Only one type of element
- *Eg.* Gold, silver, copper, diamond, sulphur, platinum

Carbonate Minerals

- Contain carbonate group (CO_3^{-2}) joined to metallic element.
- Eg. calcite (calcium carbonate) is the most common of

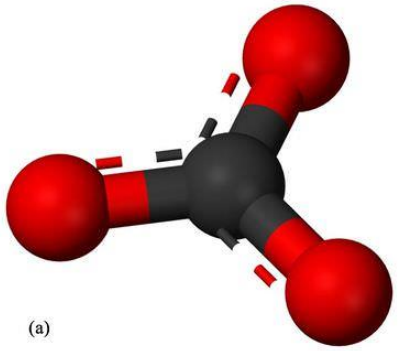


The carbonate ion is one carbon atom bonded to three oxygen atoms.

Calcite crystals in a bivalve shell.

Two most important carbonate minerals:

- **Calcite** $CaCO_3$ Calcium Carbonate
- most common, used in limestone and marble.
- Sea creatures build their shells with calcium carbonate.



(a)

The carbonate ion is one carbon atom bonded to three oxygen atoms.

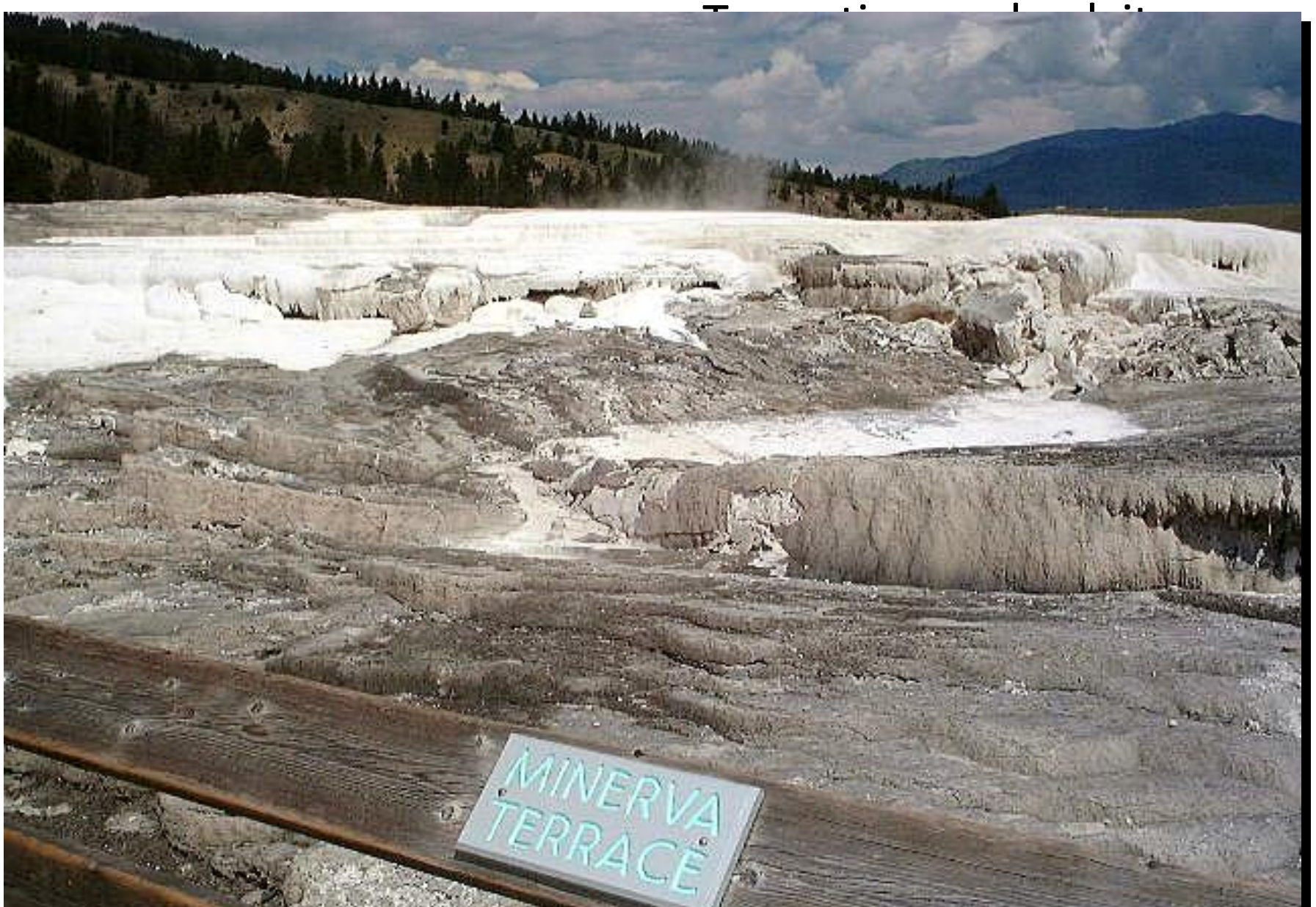
(b)

Calcite crystals in a bivalve shell.

- **Dolomite** $CaMg(CO_3)_2$
- type of limestone used in marble building blocks, plant fertilizer and dietary supplements.

Calcite

- Minerva Terrace at Mammoth Hot Springs, Yellowstone Park, Wyoming



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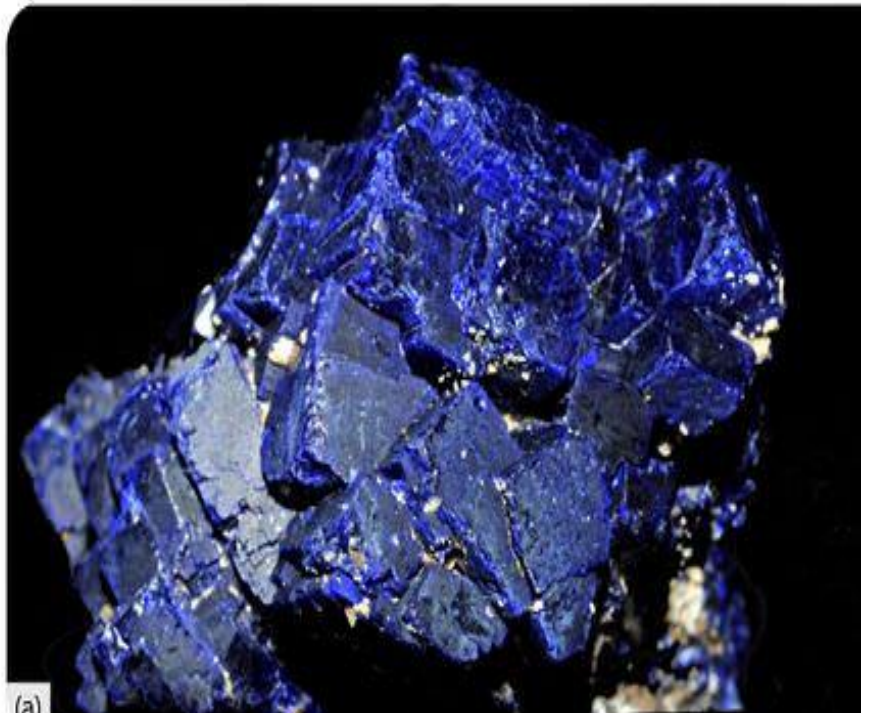
OTHER CARBONATES

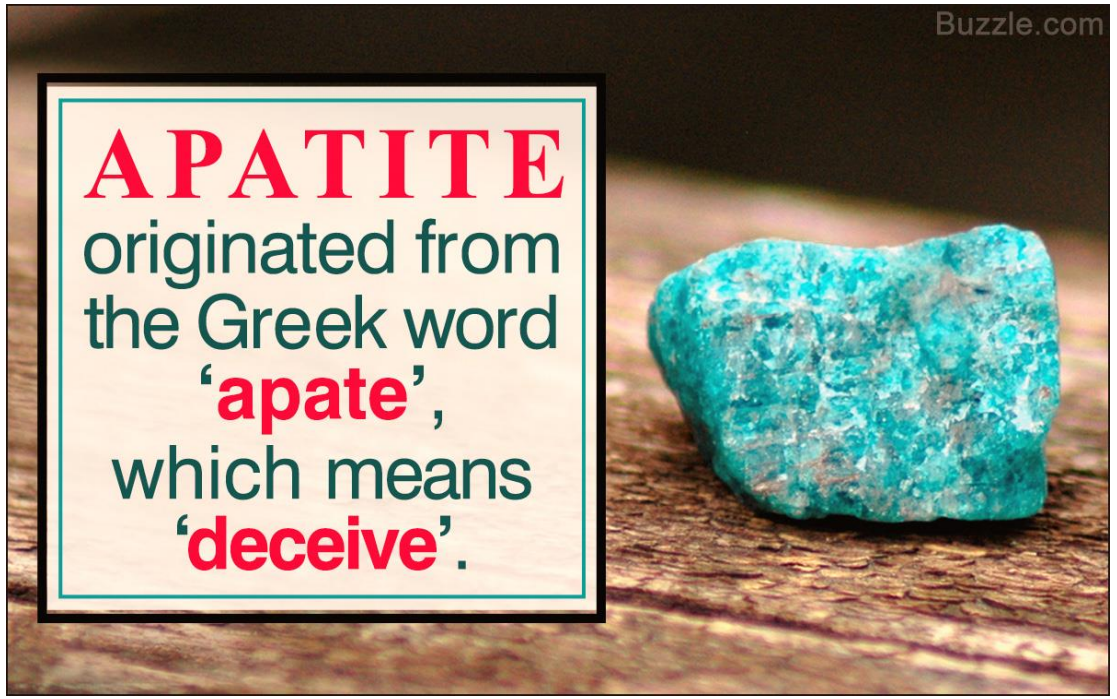
- **<u>Malachite</u>** (always green)
- **<u>Azurite</u>** (always blue) both contain copper carbonates



SULPHATES

- SO_4 plus other elements.
- tend to be soft and translucent
- Eg. Gypsum
- Eg. Barite

PHOSPHATES



- PO_4 plus other elements.
- not as common.
- often brightly colored
- often formed when other minerals are broken down by weathering.
- EG. Apatite

HALIDES

- Contain a **halogen**: fluorine, chlorine, iodine, bromine, combined with metallic elements.
- very soft and easily dissolved in water.
- Eg. Halite (NaCl)
- Eg. Fluorite

ORE FORMING MINERALS

- Used in industry.
- Minerals from which a usable amount of metal or non-metal can be removed for profit economically:
- Sulfides
- Oxides

SULFIDES

- Contain **sulfur** and another element other than oxygen, such as iron, lead, or nickel.
- *tend to be heavy and brittle.*
- *Several important metal ores come from this group like the pyrite is an iron ore*
- **Galena –** lead ore
- *Sphalerite - zinc ore*
- *Chalcopyrite – copper ore*
  Pyrite (an iron sulfide is **fool's gold**)

OXIDES

- contain **oxygen** and another element, such as iron or aluminum.
- Range from dull ores like bauxite to gems like rubies and sapphires.
- **Hematite** is the most common iron oxide mineral.
- **Magnetite** – iron oxide, magnetic.
- Eg. Lodestone was used to make first compass needles.

Mineraloids

- term used for those substances that do not fit neatly into one of these eight classes.
- Opal, jet, amber, and mother of pearl.

Gemstones

- Valued because of their beauty
- Value based on colour, which is caused by **impurities**.
- *Rubies and Sapphires are both forms of the mineral corundum*
- **Rubies** have chromium impurities
- **Sapphires** have iron impurities
- **Emerald** *is a variety of the mineral beryl* ($Be_3Al_2(SiO_3)_6$)
  colored green by trace amounts of chromium and sometimes vanadium

Second Largest Rough Diamond

Largest Diamond in the World

- On January 25, 1905, in South Africa, a 3,106-carat diamond is discovered during a routine inspection.
- Weighing 1.33 pounds, and christened the “Cullinan,”
- Was cut into 9 large stones and about 100 smaller ones

Homework

- Read Textbook p 34-36
- Answer # 8, 9, 10, 12 on page 37 – due in 2 classes
- Study for quiz next class: Branches of ES, Formation, Atomic Theory.

- Mineral formation and Characteristics Quiz: Oct 7/8

- I hate people who trade with minerals:
- They take everything for granite

Giant crystal cave in Mexico

- Sci Show video
- https://youtu.be/O7yfx0ejELg