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Introducing Minerals

Many minerals are objects of great beauty. Known as gems, they are cut and polished and used to adorn the human body or to beautify precious objects. Other minerals are refined to provide our technological society with transport, shelter, electronics and many other 'necessities'. Minerals and rocks have been used by Homo sapiens ever since the first stone tool was used.

Minerals can be considered from two perspectives; either as crystals or grains that we can view with the naked eyes or as assemblages of submicroscopic atoms linked in three- dimensional lattices.

Minerals are the building blocks of rocks which in turn comprise the outer part of our planet. A rock may be composed of a single mineral or several minerals. Over 3000 minerals have been identified from the earth's crust. However, only about 100 occur commonly and are known as the rock forming minerals. A much smaller group is highly significant in the study of crustal processes and together with a selected group of ore minerals.

Definition of Mineral and Mineraloid

A mineral is a naturally occurring homogeneous solid with a definite (but not generally fixed) chemical composition and a highly ordered atomic arrangement, usually formed by an inorganic process.

A **mineraloid** is a mineral-like substance that does not demonstrate crystallinity. Mineraloids possess chemical compositions that vary beyond the generally accepted ranges for specific minerals. For example, obsidian is an amorphous glass and not a crystal. Jet is derived from decaying wood under extreme pressure. Opal is another mineraloid because of its non-crystalline nature. Pearl, considered by some to be a mineral because of the presence of calcium carbonate crystals within its structure, would be better considered a mineraloid because the crystals are bonded by an organic material, and there is no definite proportion of the components.

Because minerals are naturally occurring elements and compounds we need some basic chemistry to understand the physical properties of minerals and the chemistry of rocks and minerals.

Minerals with similar chemistry, atomic structure and properties belong to the same mineral group or family.

- Orthoclase and Plagioclase are **Feldspars**
- Muscovite and Biotite are **Micas**
- Hornblende is an **Amphibole**
- Augite is a **Pyroxene**

The first six minerals listed are most commonly occurring minerals in Igneous Rocks. The pale colored minerals:

- Quartz
- Plagioclase
- Orthoclase
- Muscovite

are called **Felsic Minerals** (name is derived from **Feldspar** and **Silica**).

The dark colored minerals:

- Biotite
- Hornblende
- Augite
- Olivine

are called **Mafic** minerals. They all contain large proportions of Iron (Fe) and Magnesium (Mg) in their chemistry and the name is derived from **Magnesium** and **Ferric**.

Conditions to be a Mineral

- Naturally Occurring - Means it forms by itself in nature. Human made minerals are referred to as synthetic minerals
- Homogeneous - means that it is a compound that contains the same chemical composition throughout, and cannot by physically separated into more than 1 chemical compound.
- Solid - means that it not a gas, liquid, or plasma
- Definite chemical composition - means that the chemical composition can be expressed by a chemical formula. Examples: Quartz has the chemical formula SiO2. Whenever we find quartz it consists of Si and O in a ratio of 1 Si to 2 O atoms. Olivine is an example of a mineral that does not have a fixed chemical composition. In nature we find that Mg and Fe atoms have the same size and charge and therefore can easily substitute for one another in a mineral. Thus, olivine can have the chemical formula Mg2SiO4 or Fe2SiO4 or anything in between. This is usually expressed with a formula indicating the possible substitution - (Mg,Fe)SiO
- Highly ordered atomic arrangement - means that the atoms in a mineral are arranged in an ordered geometric pattern. This ordered arrangement of atoms is called a crystal structure, and thus all minerals are crystals. For each mineral has a crystal structure that will always be found for that mineral, i.e. every crystal of quartz will have the same ordered internal arrangement of atoms. If the crystal structure is different, then we give the mineral a different name. A solid compound that meets the other criteria, but has not definite crystal structure is a said to be amorphous.

One of the consequences of this ordered internal arrangement of atoms is that all crystals of the same mineral look similar. This was discovered by Nicolas Steno in 1669 and is expressed as Steno's Law of constancy of interfacial angles - angles between corresponding crystal faces of the same mineral have the same angle. This is true even if the crystals are distorted as illustrated by the cross-sections through 3 quartz crystals shown below

Another consequence is that since the ordered arrangement of atoms shows symmetry, perfectly formed crystals also show a symmetrical arrangement of crystal faces, since the location of the faces is controlled by the arrangement of atoms in the crystal structure

- Usually formed by an inorganic process−the traditional definition of a mineral excluded those compounds formed by organic processes, but this eliminates a large number of minerals that are formed by living organisms, in particular many of the carbonate and phosphate minerals that make up the shells and bones of living organisms. Thus, a better definition appends "usually" to the formed by inorganic processes. The best definition, however, should probably make no restrictions on how the mineral forms

The definition of mineral excludes the following:

- synthetic gemstones
- coal and oil.

Refer back to the definitions to find out why.

Did your answers include these reasons?

- synthetic gems stones are not naturally occurring
- coal and oil are organic substances
- they are composed of a large number of organic compounds and do not have fixed chemical composition and atomic structure.

Definition of Mineralogy

Mineralogy is a subject of geology specializing in the scientific study of chemistry, crystal structure, and physical (including optical) properties of minerals. Specific studies within mineralogy include the process of origin and formation, classificationof minerals, their geographical distribution, as well their utilization (source: https://en.wikipedia.org/wiki/Mineralogy)

Scope of Mineralogy

- Identification of rocks
- Foundation soil layer selection while engineering development
- Exploration of ores for industrial use
- Mining minerals for use as gem−as commodity
- Production of atomic energy
- Understanding of the Earth, it's crustal formation processes, and it's dynamics

Scope: the extent of the area or subject matter that something deals with or to which it is relevant.