DSPMU UNIVERSITY, RANCHI.
DEPARTMENT OF GEOLOGY

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CLASSIFICATION OF MINERALS

A mineral, by definition, is any naturally (not man-made) occurring inorganic (not a result of life plant or animal) substance having a regular internal atomic arrangement and fixed chemical composition. Its chemical structure can be exact, or can vary. They can be classified on basis of different criterias.

Minerals classified according to their chemical properties-

All minerals belong to a chemical group, which represents their affiliation with certain elements or compounds. Except for the native element class, the chemical basis for classifying minerals is the anion, the negatively charged ion that usually shows up at the end of the chemical formula of the mineral. For example, the sulfides are based on the sufur ion, S^{2-}. Pyrite, for example, FeS_2, is a sulfide mineral. In some cases, the anion is of a mineral class is polyatomic, such as $(CO_3)^{2-}$, the carbonate ion.

The major classes of minerals are-

1) **Native elements** - The native elements include all mineral species which are composed entirely of atoms in an uncombined state. Such minerals either contain the atoms of only one element or else are metal alloys. These include the elements gold (Au), silver (Ag), copper (Cu), and lead (Pb). Sylvanite (Ag, Au)Te_2 or silver gold telluride is one of the few minerals that is an ore of gold, besides native gold itself.

2) **Silicates**- Most minerals in the earth's crust and mantle are silicate minerals. All silicate minerals are built of silicon-oxygen tetrahedra $(SiO_4)^{4-}$, based on the polyatomic anion, $(SiO_4)^{4-}$, which has a tetrahedral shape, in different bonding arrangements which create different crystal lattices.

   The silicate minerals are classified structurally into 7 groups-

   a) **Nesosilicates**-also called island silicates, the silicate tetrahedra are separate from each other and bonded completely to non silicate atoms. E.g. Olivine
   b) **Sorosilicates** or paired silicates- such as epidote, the silicate tetrahedra are bonded in pairs.
   c) **Cyclosilicates**, also called ring silicates- the silicate tetrahedra are joined in rings. E.g. Beryl or emerald is a ring silicate.
   d) **Phyllosilicates** or sheet silicates- the tetrahedra are bonded at three corners to form flat sheets. E.g. Biotite is a sheet silicate.
   e) **Single-chain inosilicates**- the silicate tetrahedra are bonded in single chains. E.g. Pyroxenes are singele-chain inosilicates.
   f) **Double-chain inosilicates-** the silicate tetrahedra are bonded in double chains. E.g. Amphiboles are double-chain inosilicates.
   g) **Tectosilicates**- also known as framework silicates, all corners of the silicate tetrahedra are bonded to corners of other silicate tetrahedra, forming a complete framework of silicate tetrahedra in all directions. E.g. Feldspar, the most common mineral in earth's crust, and quartz are both framework silicates.

3) **Sulfides** -Minerals of the sulfide class are compounds which contain the non-metallic element sulfur in combination with atoms of a metal or a semimetal. E.g. Pyrite(FeS_2), Galena (PbS), Sphalerite (ZnS).

4) **Sulphates**-These have the polyatomic sulfate ion, $(SO_4)^{2-}$, as the anion. E.g. Anhydrite ($CaSO_4$).

5) **Oxide**s-The minerals of the oxide class are those which contain oxygen bonded to one or more metallic elements. Hydroxides are compounds of a metallic element and water or the hydroxyl anion $(OH)^-$. The oxide minerals tend to be relatively hard, and some of them may be used as gemstones. Many provide economically important metal ores. E.g. Magnetite (Fe_3O_4), a common ore of iron on earth is found in the crusts. Corundum (Al_2O_3)- This mineral is what rubies and sapphires are made.

6) **Halide**s- In members of the halide class an element of the halogen group such as fluorine (F), chlorine (Cl), bromine (Br), or iodine (I) bonds to a metal or semimetal cation such as sodium (Na), potassium (K), magnesium (Mg), calcium (Ca), aluminum (Al), copper (Cu), or silver (Ag). Halides are constructed entirely of ionic bonds. The halide minerals tend to be soft, brittle, easily soluble in water, and possess medium to high melting points. They are poor conductors when in solid state. E.g. Fluorite CaF_2 or calcium fluoride is another common halide mineral; Halite (NaCl) or rock salt.

7) **Carbonates**- come from the combination of carbon, oxygen, and a metal or semimetal element. This group of minerals is soft and easily dissolved by even mild acids. Some of these minerals form by the acidic action of air and rain. Calcite, $CaCO_3$, and dolomite, $CaMg(CO_3)_2$.

8) **Phosphate** minerals- contain phosphorus and oxygen in a 1:4 ratio.Written as PO_4 this compound combines with other elements to form phosphates. E.g. Apatite $Ca_5(PO_4)_3(F,Cl,OH)$.

Minerals classified on basis of their economic importance into-

1) **Rock-forming minerals** are minerals that forms igneous, sedimentary, or metamorphic rocks and that typically, or solely, forms as an intimate part of rock processes. The six minerals Amphibole, Felsdpar, Mica, Olivine, Pyroxene, and Quartz are the most common rock forming minerals.
2) **Ore forming mineral** is defined as a mineral which contains a metallic element in a quantity that can be exploited and extracted for use at an economical cost. These minerals are a result of special geologic processes and often occur in small, localized rock masses and termed as called ore deposits. Some of the most common ore minerals are galena, sphalerite, hematite. Galena, a lead sulfide (PbS), is heavy, brittle, and readily breaks into cubes from which lead is extracted. Sphalerite is a zinc sulfide (ZnS) mineral that is brownish, yellowish, or black. It ordinarily occurs with galena and is a major ore of zinc. Hematite is used for extraction of iron.