ENVIRONMENTAL GEOSCIENCES

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Lecture-23

Properties of Common Sulphide & Oxide Minerals

Welcome to the SWAYAM NPTEL course on Environmental Geosciences. We are continuing the module four. In this last lecture, lecture five, we will discuss about the common properties of sulphide and oxide minerals. In this lecture, the important concepts will be covered like non-silicate minerals, sulphide minerals, properties of common sulphide minerals, oxide minerals and properties of common oxide minerals. We have already discussed about the silicate minerals.

In this lecture, we will put emphasis on the non-silicate minerals. Silicates are the most important group of rock forming minerals. We have known this thing. Non-silicate minerals are less important as rock forming minerals. These are oxides, hydroxides, carbonates, sulfide and sulfates etc.

Among the non-silicates, the sulfide and oxides are the most important since many of them occur as minor accessories of rocks. The sulfide minerals. Sulphides include a large group of minerals predominantly metallic in character. The general formula AmXp where X is typically sulphur may also include arsenic, antimony, bismuth, selenium or tellurium and A represents the metals. Sulphide minerals exhibit ionic, homopolar that is zinc sulphide or metallic alloy bonding types.

Most sulphide minerals are opaque but non-opaque ones have high refractive indices and often transmit only red light. The most common examples of sulphide minerals are Argentite, Ag_2S, Chalcosite, Cu_2S, Bornite, Galena, Sphalerite, Chalcopyrite, Millerite, Pyrite, Arsenopyrite, etc. Now properties of common sulphide minerals. One by one we will discuss this thing. Argentite

The first one, Argentite, typically occurs with the ruby silvers and native silver. It also occurs as microscopic inclusions in galena, the material being called Argentiferous galena. Probably the most important primary silver mineral, Argentite, occurs widely in

hydrothermal sulphide ore deposits. Crystal system, it is isometric system. Cleavage, we are finding cleavage, indistinct, fracture, subconchoidal, hardness 2 to 2.5, tenacity very sectile, specific gravity 7.2 to 7.4, color black, streak black and shining, lusture and light transmission metallic and opaque.

Argentite is primarily used as a source of silver. Second one is Chalcosite. Chalcosite occurs most commonly as fine-grained, massive material, showing alteration to covellite, malachite or azurite. The principal occurrence of chalcosite is in the supergene-enriched zone of sulphide deposits. Crystal system, it is belonging in the monoclinic system, cleavage, indistinct.

Fracture, conchoidal. Hardness, 2.5 to 3. Tenacity, brittle to somewhat sectile. Specific gravity, 5.5 to 5.8. Color and streak, dark gray to black.

Lusture and light transmission, metallic and opaque. Chalcosite has been one of the most important source of copper. Third one is the bornite. Bornite, a common and widespread copper mineral, occurs in many of the important copper deposits of the world. It is present in dikes in basic intrusives disseminated in basic rocks in contact metamorphic deposits in pegmatites and in quartz veins. It is of isometric system, cleavage traces

Fracture conchoidal to uneven, hardness 3. Specific gravity 5.06 to 5.08. Color and streak copper-red to golden brown or bronze like on fresh fracture surfaces. Lusture and light transmission metallic and opaque. Bornite has been one of the most important sources of copper.

Fourth one is the galena. It occurs in many types of deposits, in sedimentary rocks, in hydrothermal veins and also in pegmatites. Galena also occurs in deposits of contact metamorphic origin. It is of the isometric system. Cleavage is highly perfect and easy.

Hardness is 2.5. Specific gravity 7.58. Color and streak lead gray. Lusture and light transmission metallic and opaque. Galna is the most important source mineral for lead.

Next one is the sphalerite. It occurs intimately associated with galna in most of the important lead-zinc deposits. Crystal system, isometric system, cleavage perfect, hardness 3.5 to 4, specific gravity 4.096, coloristic, brown to yellow, lusture and light transmission, resinous to nearly metallic, sphalerite is the most important source mineral for zinc. Next one is the chalcopyrite. It has been formed under a great variety of conditions.

Most sulphide ore deposits contain some chalcopyrite. A few carry important amounts of the mineral. In veins of moderate to high temperature origin, it usually occurs as irregular blebs and masses. Crystal system, it is belonging in the tetragonal system. Cleavage distinct, fracture uneven.

Hardness 3.2 to 4. Specific gravity 4.1 to 4.3. Color and streak brass yellow. Lusture and light transmission metallic and opaque. Chalcopyrite has been one of the most important source of copper.

Next one is the Millerite. Millerite a mineral of low temperature origin. Millerite occurs rather commonly as tufts of capillary crystals in cavities in limestone or dull stone or in carbonate veins. It also occurs as an alternation of other nickel minerals. Crystal system it is belonging in the hexagonal system, cleavage is perfect, hardness is 3 to 3.5, tenacity brittle, but capillary crystals are elastic, specific gravity 5.5, color, streak, pale brass-yellow, greenish black.

Lusture and light transmission, metallic and opaque, Millerite is of only minor importance as a source of nickel. Next one is pyrite, FeS_2. Pyrite is by far the most widespread and commonly occurring sulphide mineral. It can be found in almost any type of geological environment as a necessary mineral in igneous rock, both acidic and basic types. As a magnetic segregation from igneous rocks in pegmatites, in contact metamorphic deposits, in hydrothermal sulphide veins and replacement deposits as a sublimation product; and in sedimentary and metamorphic rocks.

It is belonging in the isometric system, cleavage indistinct, fracture conchoidal, hardness 6 to 6.5, specific gravity 5.01, color and streak brass yellow, luster and light transmission metallic and opaque, magnetism paramagnetic, pyrite has been one of the most important sources of sulphur. Next one is arsenopyrite. Arsenopyrite occurs most commonly in high temperature gold quartz veins as in South Dakota and Quebec. In high temperature cassiterite veins as in Cornwall, England and with scheelite or in some contact metamorphic deposits with gold and other sulphides. It is belonging in the triclinic system.

Cleavage is distinct. Fracture uneven. Hardness 5.5 to 6. Specific gravity 6.07. Color and streak silver white to steel gray. Dark gray is black.

Lusture and light transmission metallic and opaque. Arsenopyrite has been one of the most important sources of arsenic. Now we will discuss the oxide minerals. The oxide

minerals includes compound in which atoms or cations, typically of one or more metals, are combined with oxygen. For the most part, the oxide minerals exhibit ionic bonding.

The oxide class does not include those compounds that have discrete anionic radicals in their structures. For example, the carbonates and sulphates. The oxides are classified conveniently on the basis of A-two-X ratio. The most common example of oxide minerals are cuprite, zincite, magnetite, chromite, hematite, ilmenite, rutile, pyrolusite, etc. So now we will discuss some of the common oxide minerals.

The first one is the cuprite, Cu_2O. Cuprite commonly occurs in the oxidized zone of copper deposits. It is typically associated with copper, malachite, azurite, iron oxides, clays and the black copper oxide tenorite. It is belonging in the isometric system, cleavage, distinct and interrupted, fracture, conchoidal, hardness 3.2 to 4, specific gravity 6.10. Color red, nearly black, streak brownish red.

Luxury light transmission, submetallic and red by transmitted light. It is used in the extraction of copper metal. Next one is zincite. Zincite is a rare mineral except in the zinc deposits of Franklin and Sterling Hill, New Jersey, where it is amounted to about one percent of the ore. It occurs with willemite and franklinite in calcite,

largely in granular form. It is belonging in the hexagonal system. Cleavage perfect but commonly difficult. Fracture conchoidal. Hardness 4.

Specific gravity 5.68. Color and streak orange-yellow to deep red and orange-yellow. Lusture Subadamantine. Light transmission Translucent in thin silvers. Zincite is one of the most important source of zinc. Magnetite is one of the most widespread of oxide minerals.

It is common as a minor accessory mineral in igneous rocks. Magnetite occurs in several deposits, large enough for commercial recovery as iron ore. It is belonging in the isometric system, cleavage none, hardness 5.5 to 6.5, specific gravity 5.17, color and streak black, luster and light transmission splendent to dull metallic and opaque. Magnetite is one of the most important source of iron. Next one is chromite.

Most chromite occurs as a accessory mineral in ultrabasic igneous rocks, such as peridotites. The chromite occurs as segregated masses, lenses or as disseminated grains locally in sufficient quantities to serve as an ore. It is belonging in the isometric system, cleavage none, fracture uneven. Hardness 5.5 to 6. Specific gravity 4.5 to 4.8. Color and streak black and brown. Lustre and light transmission metallic and opaque.

Chromite is only ore mineral of chromium. Next one is hematite. Hematite occurs as an uncommon accessory in igneous rock. It also occurs as minor constituent in high temperature hydrothermal waste and in contact metamorphic deposits. Crystal system is hexagonal, cleavage none, hardness 5 to 6, tenacity crystals brittle, specific gravity 5.26, color and streak, dull to bright red, earthy and compact material, steel gray, crystals and specularite and red brown.

Lusture metallic to submetallic, light transmission, thin splinters, deep blood red by transmitted light. Hematite is one of the source of iron for steel production. Next one is Ilmenite. Most Ilmenite occurs in close association with gabbros, diorites and anorthosites as veins, disseminated deposits or large masses. It also occurs as a necessary mineral in igneous rock, in pegmatites and in quartz veins with chalcopyrite and hematite. It is belonging in the hexagonal system, cleavage, none, hardness 5 to 6, specific gravity 4.72, color and streak iron black and black, lusture and light transmission metallic to submetallic and opaque.

Ilmenite has been one of the most important sources of titanium. Next one is Rutile. Rutile is the most common of the three polymorphic forms of titanium dioxide. It is often formed as an alteration product of other titanium minerals, especially titanite and ilmenite. It also occurs in greisens, pegmatites, veins and in several metamorphic rocks.

It is belonging in the tetragonal system, cleavage distinct, fracture conchoidal, hardness 6 to 6.5, specific gravity 4.25, color and streak, brown, luster, adamantine to metallic, light transmission, transparent in thin pieces, Rutile is used as a source of titania for paint pigments. Next one is pyrolusite. It is formed under highly oxidizing conditions. It occurs in bogs, lakes and shallow marine deposits in the oxidized zone of ore deposits or rocks that contain manganese and as deposits formed by circulating meteoric waters. It is belonging in the tetragonal system, cleavage perfect, fracture uneven, hardness 6 to 6.5, specific gravity 5.06, color and streak, commonly bluish and black, luster and light transmission, metallic and opaque, pyrolusite is the most common manganese mineral.

Now we are concluding the module four. The study of crystal systems and crystal classes helps to categorize minerals based on their internal symmetry and external shape, providing a framework for understanding mineral structure and behavior. Minerals possess unique physical properties such as hardness, lusture, color and streak, which are key in their identification and classification in various geological contexts. Silicate minerals, the most abundant group, display a wide range of properties due to diverse

arrangements of silicate tetrahedra influencing their occurrence and usage in industries. Sulfide and oxide minerals, while less common than silicates, are critical to various industrial processes including ore extraction and display distinctive properties such as metallic structure and high density.

These are the references. We have taken the module four. Thank you very much to all.