EVERETT RESOURCES LTD.

About Precious Minerals

pre·cious - Show Spelled Pronunciation [**presh** -*uh* s] Pronunciation Key - Show IPA Pronunciation –*adjective*

1. of high price or great value; very valuable or costly: *precious metals.*

min·er·al - Show Spelled Pronunciation [**min** -er-*uh* l, **min**-r*uh* l] Pronunciation Key - Show IPA Pronunciation –*noun*

1. any of a class of substances occurring in nature, usually comprising inorganic substances, as quartz or feldspar, of definite chemical composition and usually of definite crystal structure, but sometimes also including rocks formed by these substances as well as certain natural products of organic origin, as asphalt or coal.

2. a substance obtained by mining, as ore.

Minerals are natural compounds formed through geological processes. The term "mineral" encompasses not only the material's chemical composition, but also the mineral's structure. Minerals range in composition from pure elements and simple salts to very complex silicates with thousands of known forms (organic compounds are excluded). The study of minerals is called mineralogy.

An assortment of minerals. Photo from US Geological Survey.

Mineral definition and classification

To be classified as a "true" mineral, a substance must be a solid and have a crystal structure. It must also be an inorganic, naturally-occurring, homogeneous substance with a defined chemical composition. The chemical composition may vary between end members of a mineral system. For example the plagioclasefeldspars comprise a continuous series from sodium-rich albite ($NaAlSi_3O_8$) to calcium-rich anorthite ($CaAl_2Si_2O_8$) with four recognized intermediate compositions between. Mineral-like substances that don't strictly meet the definition are sometimes classified as mineraloids. Other natural-occurring substances are Nonminerals. Industrial minerals is a market term and refers to commercially valuable mined materials (see also Minerals and Rocks section below).

A **crystal structure** is the orderly geometric spatial arrangement of atoms in the internal structure of a mineral. There are 14 basic crystal lattice arrangements of atoms in three dimensions, and these are referred to as the 14 "Bravais lattices". Each of these lattices can be classified into one of the six crystal systems, and all crystal structures currently recognized fit in one Bravais lattice and one crystal system. This crystal structure is based on regular internal atomic or ionic arrangement that is often expressed in the geometric form that the crystal takes. Even when the mineral grains are too small to see or are irregularly shaped, the underlying crystal structure is always periodic, and can be determined by X-ray diffraction.

Chemistry and crystal structure together define a mineral. In fact, two or more minerals may have the same chemical composition, but differ in crystal structure (these are known as *polymorphs*). For example, pyrite and marcasite are both iron sulfide, but their arrangement of atoms differs. Similarly, some minerals have different chemical compositions, but the same crystal structure: for example, halite (made from sodium and chlorine), galena (made from lead and sulfur) and periclase (made from magnesium and oxygen) all share the same cubic crystal structure.

Crystal structure greatly influences a mineral's physical properties. For example, though diamond and graphite have the same composition (both are pure carbon), graphite is very soft, while diamond is the hardest of all known minerals. This happens because the carbon atoms in graphite are arranged into sheets which can slide easily past each other, while the carbon atoms in diamond form a strong, interlocking three-dimensional network.

There are currently just over 4,000 known minerals, according to the International Mineralogical Association, which is responsible for the approval of and naming of new mineral species found in nature. Of these, perhaps 150 can be called "common," 50 are "occasional," and the rest are "rare" to "extremely rare."

Minerals and rocks

A mineral is a naturally occurring, inorganic solid with a definite chemical composition and a crystalline structure. A rock is an aggregate of one or more minerals. (A rock may also include organic remains.) Some rocks are predominantly composed of just one mineral. For example, limestone is a sedimentary rock composed almost entirely of the mineral calcite. Other rocks contain many minerals, and the specific minerals in a rock can vary widely. Some minerals, like quartz, mica or feldspar are common, while others have been found in only one or two locations worldwide. The vast majority of the rocks which we see around us every day consist of quartz, felspar, mica, chlorite, kaolin, calcite, epidote, olivine, augite, hornblende, magnetite, haematite, limonite and a few other minerals. [1] Over half of the mineral species known are so rare that they have only been found in a handful of samples, and many are known from only one or two small grains.

Commercially valuable minerals and rocks are referred to as industrial minerals. Rocks from which minerals are mined for economic purposes are referred to as ores (the rocks and minerals that are left over, after the desired mineral has been separated from the ore, are referred to as tailings).

Mineral composition of rocks

A main determining factor in the formation of minerals in a rock mass is the chemical composition of the mass, for a certain mineral can be formed only when the necessary elements are present in the rock. Calcite is commonest in limestones, as these consist essentially of carbonate of lime; quartz in sandstones and in certain igneous rocks which contain a high percentage of silica.

Other factors are of equal importance in determining the natural association or paragenesis of rock-making minerals, principally the mode of origin of the rock and the stages through which it has passed in attaining its present condition. Two rock masses may have very much the same bulk composition and yet consist of entirely different assemblages of minerals. The tendency is always for those compounds to be formed which are stable under the conditions under which the rock mass originated. A granite arises by the consolidation of a molten magma (a fused rock mass) at high temperatures and great pressures and its component minerals are such as are formed in such circumstances. Exposed to moisture, carbonic acid and other subaerial agents at the ordinary temperatures of the earth's surface, some of these original minerals, such as quartz and white mica are permanent and remain unaffected; others "weather" or decay and are replaced by new combinations. The felspar passes into kaolin, muscovite and quartz, and if any black mica (biotite) has been present it yields chlorite, apidote, rutile and other substances. These changes are accompanied by disintegration, and the rock falls into a loose, incoherent, earthy mass which may be regarded as a sand or soil. The materials thus formed may be washed away and deposited as a sandstone or grit. The structure of the original rock is now replaced by a new one; the mineralogical constitution is profoundly altered; but the bulk chemical composition may not be very different. The sedimentary rock may again undergo a metamorphosis. If penetrated by igneous rocks it may be recrystallized or, if subjected to enormous pressures with heat and movement, such as attend the building of folded mountain chains, it may be converted into a gneiss not very different in mineralogical composition though radically different in structure to the granite which was its original state. [1]

Physical properties of minerals

Classifying minerals can range from simple to very difficult. A mineral can be identified by several physical properties, some of them being sufficient for full identification without equivocation. In other cases, minerals can only be classified by more complex chemical or X-ray diffraction analysis; these methods, however, can be costly, time-consuming, and even risk damaging the sample.

Physical properties commonly used are :

- *Crystal structure and habit* : See the above discussion of crystal structure. A mineral may show good crystal habit or form, or it may be massive, granular or compact with only microscopically visible crystals.
- *Hardness* : the physical hardness of a mineral is usually measured according to the Mohs scale. This scale is relative and goes from 1 to 10. Minerals with a given Mohs hardness can scratch the surface of any mineral that has a lower hardness than itself. The minerals that define the scale are given below:
- - talc
- - gypsum
- - calcite
- - fluorite
- - apatite
- - orthoclasefeldspar
- - quartz
- - topaz or beryl
- - corundum

- - diamond
- *Luster* indicates the way a mineral's surface interacts with light and can range from dull to glassy (vitreous).
  - Metallic -high reflectivity like metal, e.g. galena
  - Sub-metallic -slightly less than metallic reflectivity, e.g. magnetite
  - Vitreous -the lustre of a broken glass, e.g. quartz
  - Pearly -a very soft light shown by some layer silicates, e.g. talc
  - Silky -a soft light shown by fibrous materials, e.g. gypsum
  - Dull/earthy -shown by finely crystallized minerals, e.g. the kidney ore variety of hematite
- *Color* indicates the appearance of the mineral in reflected light or transmitted light for translucent minerals (i.e. what it looks like to the naked eye).
- *Streak* refers to the color of the powder a mineral leaves after rubbing it on an unglazed porcelain *streak plate*.
- *Cleavage* describes the way a mineral may split apart along various planes. In thin section, cleavage is visible as thin parallel lines across a mineral.
- *Fracture* describes how a mineral breaks when broken contrary to its natural cleavage planes, e.g. a *chonchoidal fracture* is a smooth fracture with concentric ridges of the type shown by glass.
- *Specific gravity* relates the mineral mass to the mass of an equal volume of water, namely the density of the material. While most minerals, including all the rock-forming minerals, have a specific gravity of 2.5 - 3.5, a few are noticeably more or less dense, e.g. several sulphide minerals have high specific gravity compared to the common rock-forming minerals.
- Other properties: fluorescence (response to ultraviolet light), magnetism, radioactivity, tenacity (response to mechanical induced changes of shape or form), and reactivity to dilute acids.

Chemical properties of minerals

Minerals may be classified according to chemical composition. They are here categorized by anion group. The list below is in approximate order of their abundance in the Earth's crust. The list follows the Dana classification system.

Silicate class

The largest group of minerals by far are the **silicates** (most rocks are >95% silicates), which are composed largely of silicon and oxygen, with the addition of ions such as aluminium, magnesium, iron, and calcium. Some important rock-forming silicates include the feldspars, quartz, olivines, pyroxenes, amphiboles, garnets, and micas.

Carbonate class

The **carbonate minerals** consist of those minerals containing the anion (CO 3) 2- and include calcite and aragonite (both calcium carbonate), dolomite (magnesium/calcium carbonate) and siderite (iron carbonate). Carbonates are commonly deposited in marine settings when the shells of dead planktonic life settle and accumulate on the sea floor. Carbonates are also found in evaporitic settings (e.g. the Great Salt Lake, Utah) and also in karst regions, where the dissolution and reprecipitation of carbonates leads to the formation of caves, stalactites and stalagmites. The carbonate class also includes the nitrate and borate minerals.

Sulfate class

Sulfates all contain the sulfate anion, SO 4 2-. Sulfates commonly form in evaporitic settings where highly saline waters slowly evaporate, allowing the formation of both sulfates and halides at the water-sediment interface. Sulfates also occur in hydrothermal vein systems as gangue minerals along with sulfideore minerals. Another occurrence is as secondary oxidation products of original sulfide minerals. Common sulfates include anhydrite (calcium sulfate), celestite (strontium sulfate), barite (barium sulfate), and gypsum (hydrated calcium sulfate). The sulfate class also includes the chromate, molybdate, selenate, sulfite, tellurate, and tungstate minerals.

Halide class

The **halides** are the group of minerals forming the natural salts and include fluorite (calcium fluoride), halite (sodium chloride), sylvite (potassium chloride), and sal ammoniac (ammonium chloride). Halides, like sulfates, are commonly found in evaporitic settings such as playa lakes and landlocked seas such as the Dead Sea and Great Salt Lake. The halide class includes the fluoride, chloride, and iodide minerals.

Oxide class

Oxides are extremely important in mining as they form many of the ores from which valuable metals can be extracted. They also carry the best record of changes in the Earth's magnetic field. They commonly occur as precipitates close to the Earth's surface, oxidation products of other minerals in the near surface weathering zone, and as accessory minerals in igneous rocks of the crust and mantle. Common oxides include hematite (iron oxide), magnetite (iron oxide), chromite (iron chromium oxide), spinel (magnesium aluminium oxide - a common component of the mantle), ilmenite (iron titanium oxide), rutile (titanium dioxide), and ice (hydrogen oxide). The oxide class includes the oxide and the hydroxide minerals.

Sulfide class

Many **sulfide minerals** are economically important as metal ores. Common sulfides include pyrite (iron sulfide - commonly known as *fools' gold*), chalcopyrite (copper iron sulfide), pentlandite (nickel iron sulfide), and galena (lead sulfide). The sulfide class also includes the selenides, the tellurides, the arsenides, the antimonides, the bismuthinides, and the sulfosalts (sulfur and a second anion such as arsenic).

Phosphate class

The **phosphate mineral** group actually includes any mineral with a tetrahedral unit AO 4 where A can be phosphorus, antimony, arsenic or vanadium. By far the most common phosphate is apatite which is an important biological mineral found in teeth and bones of many animals. The phosphate class includes the phosphate, arsenate, vanadate, and antimonate minerals.

Element class

The Elemental group includes metals and intermetallic elements (gold, silver, copper), semi-metals and non-metals (antimony, bismuth, graphite, sulfur). This group also includes natural alloys, such as electrum (a natural alloy of gold and silver), phosphides, silicides, nitrides and carbides (which are usually only found naturally in a few rare meteorites).

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