CRYSTRAL MUSEUM

International Mining Investors Conference
Konferenca ndërkombëtare e investitorëve për miniera

MEM
MINISTRIA E ENERGJISË DHE MINIERAVE
MINISTARTSVO ENERGIJE I RUDARSTVA
MINISTRY OF ENERGY AND MINING

Ministry of Energy and Mining – Kosovo Government

Mining Department

TREPÇA



2007

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INTRODUCTION

Deposits of lead, zinc and silver in Kosovo have been known from the ancient times. This is proven by many found works of ore such as galleria, wells, smelting remnants and many working tools used in different times for utilization of these minerals. A part of these are active even today (Stantërgu, Kizhnica, Artana, Hajvalia, etc.) and their activity is undertaken within the Trepca Complex.

The lead, zinc and silver deposit “Trepça” in Stantërg is one of the most attractive and known deposits in the world, because of diversity, size and beauty of crystals discovered so far in this deposit.

Crystals discovered in the deposit have been collected by the staff and engineers, and in 1964, a Museum of Crystals of Trepca was established. In the beginning, the number of samples was modest, but in mere time, this Museum was widely known in the world.

Trepca Crystals are still exposed in many famous world museums, and they take an important place as valuable exemplary. But today, the Trepca Crystal Museum, despite possessing over 1500 samples of beautiful crystals, is in a rather difficult situation, without any defined status, funding nor adequate maintenance.

Aiming to raise awareness on the very difficult condition of the Museum, the Department of Mining within the MEM, following talks with the representatives of Trepca and the Museum, had established a working group, which in cooperation with the Museum guide would engage in cleaning, picturing crystals, and prepare a promotional book for informing and raising awareness of the wide public and potential donors on the wealth and value this Museum has, and the difficult condition of the Museum. Also, in cooperation with the Trepca management, the Government and the KTA we have to define the status of the Museum into a National Museum.

The Working Group

Following talks and discussions by MEM/Department of Mining and Trepca and Museum representatives, the stance taken was to initiate the work in informing the wide local and international public on assistance required for the Trepca Crystal Museum in Stantërg.

For this reason, a working group was established with members from the Department of Mining and Museum representatives.





Members of this Working group were:

Dukagjin Shala, Skender Sallahi (who took photographs of crystals), Vjollca Meha.

Contribution was also provided by:

Lorik Haxhiu, Shaip Blakqori, Sylejman Bejta, Ismet Shala, Rinol Nishevci, Vehbi Duraku and Sherif Begu. In the beginning, it must be stated that the working conditions within the Museum were tough, without any heating or water.

On 06.11.2006 the Group begun its work in cleaning and photographing crystals.



The first stage of the works (cleaning and photographing) concluded on 15.12.2006. In this period, a total of 1560 crystals, 12 old means and tools of work, and 4 maps were photographed and registered.

Following cleaning and photographing of crystals, registration by numbers took place. All these data wereprinted and were submitted to the Museum guide to verify.

History

In the Illyrian and Roman times, in the Middle Ages, and later, many deposits in Janjeva, Kishnica and Artana, as well as other parts of Kosovo, had been exploited for lead, zinc, gold and silver. This is proven by numerous discoveries of melted metals, old works and many primitive working tools.

Trepça (Trebza) is mentioned in the literature for the first time in 1303, although known even earlier. This document is located in the Dubrovnik's Archive.

The mining went through a speedy development in the 13th century in Kosovo, with the coming of Sas, a people which even at that time had laws and rules on extraction of ground assets.

Since 1455, these mineral deposits have been under the rule of the Ottoman Empire. The first complex geological surveys came in 1924, when the English geologists begun a geological prospecting of the Stanterg ore field. Following positive results of these surveys, in 1926, a limited liability association called "Trepca Mines Limited" was established in London, in 1926, which was awarded the concession of utilization of this deposit for 50 years.

IN 1930, the probation production started. During the World War Two, Germans held the Stanterg Trepca mine into operation, but only with reduced production capacities. Since 1945, the mine has consistently been in operation, until 1990, at the capacity of 600.000 tons per year.

Kosovar lead-zinc mines in use were: "Trepça" in Stantërg, Crnac, Belo Bërdo, Koporiq and Zhuta Përlina -Albanik (Leposaviq), Kizhnicë, Hajvali, Badovc and Prroi i Ngjyrosur (Kishnica-Artana Complex).

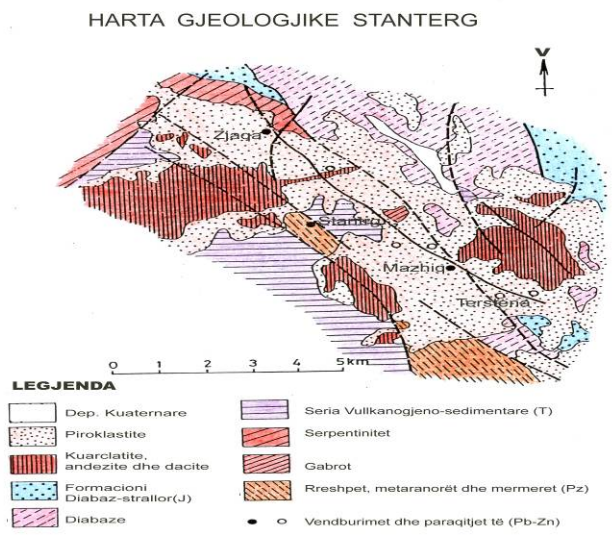
Researched deposits, which are ready for opening and utilization are: Zjaça, Melenica, Mazhiqi (Stantërg), Prroi i Thartë and Badovc-Gnilicë (Kizhnicë), Çuka e Batllavës (Podujevë) and Plakaonica dhe Kallugjer (Albanik)

The lead-zinc ore in Kosovo is used for industrial purposes since 1930, when the "Trepca" Mine utilization in Stanterg begun.

Since 1930 until 2000, the Kosovar mines have produced 61.750.000 t ore or 3.045.404 tons of Pb, 2.230.167 tons of Zn, 5.538,134 kg. Ag.

Geological composition of the Trepca District

The geological structure of the Trepca District is composed of these formations and rocks: “The Trepca Series” (sand and metamorphosed conglomerates, black lime schist of Smrekonica, metamorphosed schist, and the age of these formations has been estimated as Middle Triasic), serpentine peridotites, gabro-amphybolites, diabase-flint formations, deposits of Upper Cretac, volcanogenic-sedimentary complex of Tertiary, plyocene and quaternary deposits.
The Trepca District pertains to the Vardar Area. The studies and surveys so far have



concentrated on the deposit of Trepca. Serious studies related to the tectonics of this district have been undertaken by British geologists, A. Bramall and Forgan.
According to them, the basic structural form of Trepca and its surroundings is represented by a synclinal prone structure, where in the east there is a prominent asymmetrical anti-clinal of Stanterg, while at the western slope, the Melenica anti-clinal.

The deposit Trepça-Stantërg, according to Forgan, represents an asymmetrical anti-clinal. The mineral deposit is located at the southern part of Kopaonik, and has a NW-SE spread.
Lead and zinc mineralization is conditioned by structural, lithological and magmatic factors. Mineralogical studies carried in the deposit have found 51 different minerals (by some authors around 67).

The main minerals are: pyrite, pyrrhotite, sphalerite and galenite. The ore mass is made of: 23% pyrite, 22% pirotine, 8.7% sphalerite, 7.6% galenite, silicate and carbonate minerals 25%, and other compositions 13.7%.
The minerals occurring at a greater intensity are: quartz, Mn-siderite and marcazite, while a lower intensity is found in: granates, magnetites, ilvaites, hedenbergites, chalcopyrite, Mn-calcyte, aragonite and rodocrozite.

The previous para-genetic studies of the minerals of this deposit have concluded that the minerals have differentiated in these stadiums:

- Pneumatolite stadium (or meta-somatic contact). This paragenesis had differentiated: granates, epidotes, actinolites, volastonies, magnetites, pirotines, chalcopyrites and pyrites.
- Pneumatolite-hydrothermal stadium (or the transitional stage contact-metasomatic-hydrothermal). In this stadium, there was a formation of: hedenbergites, ilvaites, pyrrhotite, quartz, sheltie, chalcopyrite, valleriites, cubanites and sphalerites, and
- Hydrothermal stadium, in which stage the formation of mineral components was made in three stages: catathermal, mezzothermal and epithermal.

  In the oxidation zone, as a result of weathering on minerals formed, the products of superficial oxidation stage were formed: coveline, cerusite, anglesite, vivianite, ludlamite, childrenite, smithsonite, psylomelanite, gypsum, melanterite and chalcantyte.

  Crystals are usually found in wider cracks, and down to very small clefts, where conditions of their formation have been favorable.

The lead-zinc and silver deposit of Trepça in Stantërg is known for its:

Diversity of crystals discovered in a single deposit,
Size, beauty and shapes of crystals discovered,
Transformation of pyrite into pyrrhotite,
Association of many minerals into a single community, etc.

The Trepça deposit has a great importance also in representation of rare elements. From the studies made earlier, the presentation of these elements has been concluded, and we shall only name a few.

No.	Mineral	Pyrite	Pyrrhotite	Sphalerite	Galena
		ppm	ppm	ppm	ppm
1	**Gold**	25	27	-	-
2	**Wolfram**	129	245	-	-
3	**Molybdenum**	4	3	1	-
4	**Cobalt**	23	22	-	-
5	**Silver**	20	35	24	-
6	**Bismuth**	30	73	8	100
7	**Cadmium**	14	32	2450	20
8	**Arsen**	7480	820	80	200
9	**Indium**	9	16	115	3

Cadmium is found in all analyzed minerals, and is largely concentrated in sphalerite. Indium is also more concentrated in sphalerites.

Cobalt has a greater concentration in pyrite and pyrrhotite.

Importance of Trepca and the Museum for the national identity

Utilization of lead, zinc and silver in Kosovo represents a tradition. For many years, these ores have had the most important position in the place's economy. For this reason, appreciation and continuous addressing is a special duty to us all.

The Trepça complex, although in a difficult condition (permanent underinvestment, outworn equipment, considerable environmental legacy, etc.) still has a great place in the Kosovars' hearts.

Its mineral resources represent basis of economic development. The Stanterg Mine is one of the richest mines in Europe, and used to be one of the most profitable Pb and Zn mines.

The Trepca Metallurgy has produced (after Ak. M. D.):

Silver - 4.572 t (for 45 years)
Gold - 8.675 kg (for 34 years)
Bismuth - 4.115 t (for 43 years)
Cadmium - 1.655 t (for 20 years)

The Trepca Crystal Museum is of a great national importance for Kosovo. Crystals which are found in this Museum have a great value, and are of regional interest. The majority of its pieces have a rare size and beauty. As per value of crystals, the Museum may find a high rank in comparison with similar museums in the world. This Museum can and should have an important role for the new generations, in the manner of knowing the mineral assets of Kosovo, orientate and enhance their interest in science and new technology.

The current situation in the Museum

One of the priority tasks of the Working Group was to assess the current situation of the "Trepca" Crystal Museum in Stantërg.

Following the visits to the museum, it was concluded that the physical condition of the museum is very difficult.

The Museum building is at the stage of total destruction. Firstly, the roof is damaged, and due to that, in each precipitation, there are leaks in many parts of the museum.

The walls and the ceiling are damaged, the façade and plaster in many places are damaged, and drops fall on the crystals, which are laying down on the floor.

The Museum does not have any water supply, heating is damaged and does not work. There are no ventilation or climatization systems. Electrical lighting is inappropriate, and is already damaged. The windows of the building are damaged and unsafe.



The crystals are placed almost one on top of the other in existing showcases, and a large number of these showcases are damaged and pose risk of total destruction.

Too large a number of crystals is laying on the floor or the window, without any protection from the dust, humidity or physical destruction.





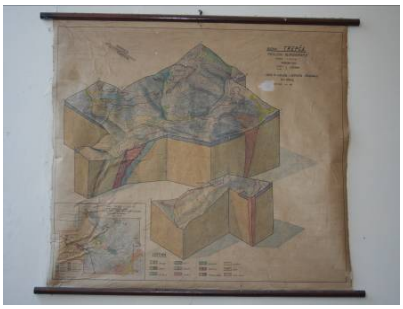
Due to these reasons, a considerable number of crystals has been damaged, clefted, dusted, and especially the pyrrhotite crystals, which in the Stanterg mine are found in large and attractive crystals, have almost been squandered totally, and it is difficult to move them.





For this reason, a certain number of damaged crystals has been photographed in their own positions. Apart from the crystals, humidity in the Museum has damaged the old maps, and the few ancient working tools and means discovered in the mines of the past.





Suggestions of the working group

Following a considerable engagement, and concluding on a much degraded Museum building and many damaged crystals in the Museum, the Working Group suggests undertaking these measures:

- An analysis of the total cost of renovation of the Museum Building should be made, including all necessary parameters for a modern museum, or see possibilities of transferring the Museum to a more appropriate location and venue;
- As soon as possible, find means for protecting and securing crystals against further deterioration;
- In cooperation with the Trepca Management, the Government and the KTA, define the Status of the Museum as a National Museum;
- Inform the wide public on the values of the museum;
- Draft a regulation on the activities, operation and funding of the Museum;
- Information and awareness-raising of domestic and international institutions on the difficult condition of the Museum;
- Prepare a catalogue of museum-pieces in the Museum;
- Publish a brochure on the “Trepca Crystal Museum in Stanterg”. This shall be a promotional publication, including pictures of crystals in the Museum.

Publication of the brochure, inviting all stakeholders who can provide assistance and financial support for the capital overhaul of the object, the enterior and the surroundings of the Museum.

Minerals

Minerals are chemical compositions rather than linked components. They are formed due to various physical-chemical processes in the Earth core.

The term “mineral” has several definitions:

- Individual physical or chemical product (created in chemical reactions of the earth and comprised of chemical molecules);
- Integral part of the Earth core, fully or partially homogeneous in chemical and physical aspects;
- A product of natural physical and chemical processes, taking the shape of simple bodies or other compositions in the crystal, liquid, gas or dispersed state.

Mineral matters are composed of basic particles (atoms, ions or molecules).

Minerals, which are characterized by placement of these particles in a certain geometrical order, have an internal crystalline composition, while the minerals in which this placement is irregular have an amorphous structure internally.

Minerals with a crystalline composition not always have a regular external shape of ordered crystals, since this is dependant on the conditions of their formation.

Crystals are characterized by a certain symmetry, expressed in the form of facets, their replication and reciprocal positioning. Some crystals are more symmetrical, and some less. Based on this, crystals are divided into groups called syngonies.

In the majority of cases, the minerals are found in a form of granulate assemblies, without any regular crystalline attributes. Well-shaped crystals are rare to find.

Minerals are found in a shape of singular crystals, combined crystals and different aggregates.

Since each mineral has a certain crystalo-graphic which are helpful in their determination. On the other hand, since the form of crystals and their aggregates is dependant on the conditions of their formation, which is also helpful to judge on the conditions of formation of minerals, ores and rocks.

The lead-zinc deposit Trepça in Stantërg is one of the most famous world deposits for its presence, and size, beauty and diversity of crystals found.

In a way of facilitating the presentation of minerals discovered in the deposit Trepça in Stantërg, there are eight groups to classify them, in which the eighth group includes the unclassified minerals.

Group I - Elements
Group II - Sulphites
Group III - Oxides and hydroxides
Group IV - Nitrates, carbonates and borates
Group V - Sulphates, chromites, molibdates and tungstites
Group VI - Phosphates, arsenates and vanadates
Group VII - Silicates
Group VIII - Unclassified minerals

Group I

Elements

Gold – Au

It has a cubical syngony, yellow color and metallic brightness.





Molecular weight : 196.97 gm

Compound : Most cleanness found till now is 99.7% Au.
Density : 15.6-18.3 g/cm^3
Hardness : 2.0-3.0

It is met in different mixtures: with Ag (up to 20%), Fe, Cu, Bi and Pd, Rh, Pt, Ir, etc.

As a primary mineral, it is formed in a hydrothermal manner, associated with acidic rocks, mainly in quartz veins in association with other sulphites (pyrite, arsenopyrite). As a secondary mineral, in scarification (which is formed as a result of destruction of ore deposits of gold-retaining rocks) with other resistant and heavy minerals such as monocites, granates, corundes, zirconium, etc.

Bismuth – Bi .

It has trigonal syngony, metallic brightness, yellow or white color.

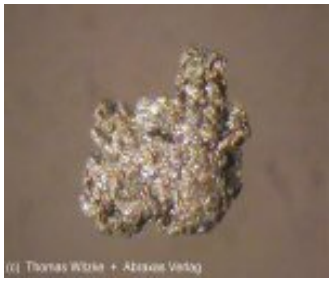




Molecular weight :208.98 gm
Compound : 100.0% Bi
Density : 9.7-9.83 g/cm^3
Hardness : 2.0-2.5
It is presented in pegmatites, scarnes, hydrothermal veins associated with minerals such as Sn, Co, Ni, Ag, As, Mo, W, U, and rarely in the area of oxidation of scarification.

Indium – In .

It has tetragonal syngony, grey color with yellowish nuances, metallic brightness.



Molecular weight : 114.82 gm
Compound : 100.0% In
Density : 7.2-7.42 g/cm^3
Hardness: 3.0Usually it is found in greyzenized and albitized granites, in which lead is formed.

Group II

Sulphides

Arsenopyrite – FeAsS

It has a white color as tin, up to steel color, metallic brightness. Rhomboid syngony.





Molecular weight : 162.83 gm
Compound : 34,3% Fe, 46,01% As, 19,69% S,
Density : 5.9-6.3 g/cm^3
Hardness : 5.5-6.0
Arsenopyrite is a pretty dispersed and can be found in different types of deposits. It is considered a mineral of high temperatures, although it is formed almost in all temperature levels.
It is found in pegmatite and metasomatic formations, in deposits of contact-type. It is found in association with albites, biotites, calcites, epidotes, galenites, pyrites, pyrrhotite, siderites, sphalerites, etc.
It is a key mineral of arsenic.

Bornite – Cu_5FeS_4

It has cubical syngony. Crystals are very rare. It has a red copper color, up to grey, with metallic brightness.





Molecular weight :501.84 gm
Compound : 63.31% Cu, 11.13% Fe, 25.56% S
Density : 4.9-5.3 g/cm^3
Hardness : 3.0

It mainly is found in hydrothermal deposits. It is frequently associated with eruptive basic rocks. Pneumatolic and contact-pneumatolize deposits are important. It is also known as a sedimentary and metamorphic product. In the oxidation regions, it is transformed in carbonates and oxides of copper and limonite. It is an important copper by-mineral.

Boulangerite – $Pb_5Sb_4S_{11}$

It is presented in the form of extended and cordial crystals (granulate and fibrous aggregates), monocline syngony.



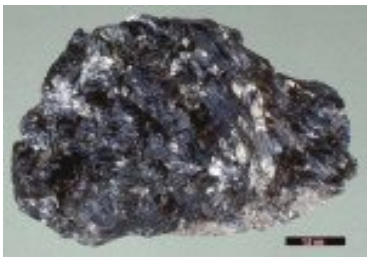


Molecular weight : 1,887.90 gm
Compound : 26.44% Sb, 54.88% Pb, 18.68% S.
Density : 6.0-6.23 g/cm^3
Hardness: 2.5-3.0

It has the color of lead, blue up to the ferrous black, metallic brightness. It may contain Cu up to 1%, Fe, Zn, Sn, Hg and As. A mineral of low and middle temperatures, in association with antimonites, sphalerite, gallenite, pyrite, arsenopyrite, quartz and carbonates (is found in poly-metallic hydrothermal deposits). In the oxidation stage, it transforms into cerusite and oxides of antimony.

Falkmanite – $Pb_5Sb_4S_{11}$

It has a monocline syngony, grey color similar to lead, brown, metallic brightness.





Molecular weight : 1,842.83 gm
Compound : 25.77% Sb, 55.09% Pb, 19.14% S.
Density : 6.31 g/cm^3
Hardness: 2.0-3.0

Bournonite – $PbCuSbS_3$

It is presented in tiled, short prismatic crystals, granulate aggregates, etc. It has rhomboid syngony.



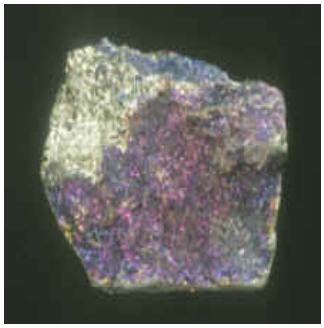




Molecular weight : 488.69 gm
Compound : 42.40% Pb, 24.91% Sb, 13.0% Cu, 19.68% S.
Density : 5.83 g/cm^3
Hardness: 2.5-3.0
Antimony in many cases can be replaced (up to 3.18% As), while Cu with Mn, Zn and Ag.It has a dark grey up to black color. It is met in poly-metallic deposits of the mid-epithermal zone, in association with gallenite, sphalerite, tetraedrite, jamesonite and boulangerite. In the Stanterg mine it appears in the form of beautiful crystals.

Chalcopyrite – $CuFeS_2$.

It has tetragonal syngony. The structure of chalcopyrite is similar to the structure of sphalerite, but the order of atoms is different.

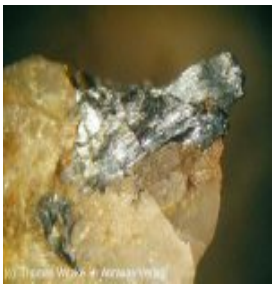




Molecular weight : 183.53 gm
Compound : 30.43% Fe, 34.63% Cu, 34.94% S,
Density : 4.1-4.3 g/cm^3
Hardness: 3.5-4.0

Chalcopyrite has rich crystal forms and it appears in beautiful crystal forms. It appears as a massive aggregate, in a form of grapes, etc. It has a yellow color with various nuances, a metallic brightness. Externally it is similar to pyrites, gold, marcazite, pyrrhotite and millerite. It is formed in various genetic conditions. The most frequent deposits have a hydrothermal origin, and appear in pegmatite, pneumatolite and contact-metamorphic deposits. It usually comes in association with pyrite, sphalerite, gallenite and copper sulphite. It is one of the key by-minerals for extracting copper.

Cosalite – $Pb_2Bi_2S_5$

Crystals have ortho-rhomboic and prismatic forms, grey color, metallic brightness.





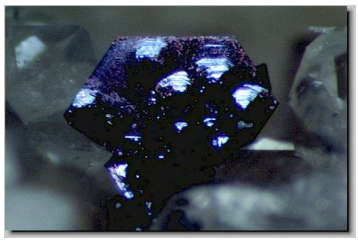
Molecular weight : gm
Compound :
Density : g/cm^3
Hardness:

It appears in association with pyrite, sphalerite, chalcopyrite, bornite, bismuth, calcyte, epidote and quartz.It appears in hydrothermal deposits, associated with primary sulphites with by-minerals of lead and bismuth, in metasomatic contacts and pegmatites.

Covellite – CuS

It has a hexagonal syngony, blue or black color, semi-metallic brightness.





Molecular weight: 95.61 gm
Compound : 66.46% Cu, 33.54% S,

Density : 4.59-4.67 g/cm^3
Hardness: 1.5-2.0
It is associated with the zone of oxidation and destruction of other sulphite minerals of copper, associated with copperite. Both these minerals are formed at the account of chalcozine. It is often found in the zone of secondary enrichment of copper deposits. Covellite is a copper by-mineral.

Cubanite – $CuFe_2S_3$

It has a rhomboic syngony, yellow and bronze color, metallic brightness.





Molecular weight :271.44 gm
Compound : 41.15% Fe, 23.41% Cu, 35.44% S.
Density : 4.03-4.18 g/cm^3
Hardness: 3.5-4.0

It is mainly found in magmatic deposits, associated with basic and ultrabasic rocks. In its paragenesis, it is associated with chalcopyrite in magmatic, metasomatic and hydrothermal deposits of high temperatures. It is discovered also in contact-metasomatic deposits, and rarely in veined poly-metallic deposits.
It is rarely presented in crystal form, it is usually found in individual granulate forms.

Enargite – Cu_3AsS_4

It has rhomboic syngony, grey to black ferrous color, semi-metallic brightness.





Molecular weight : 393.82 gm
Compound : 48.41% Cu, 19.02% As, 32.57% S.
Density : 4.3-4.5 g/cm^3
Hardness: 3.0-3.5

It may also contain primese of Sb (up to 6.5%), Fe (up to 7.5%) and small amounts of Pb, Zn, Ag and Au. It appears in crystals of pillar, tile shapes, and often as granulate aggregates, etc.
A characteristic mineral of hydrothermal deposits of medium temperatures. It is found in mezothermal and epithermal deposits of copper. It is a by-mineral of copper and arsenic.

Galena – PbS

Sulphite mineral, with a cubical syngony. It is mainly found in hydrothermal poly-metallic deposits, and it is the most important by-mineral of lead.



Molecular weight : 239.27 gm
Compound : 86.60% Pb, 13.40% S.
Density : 7.2-7.6 g/cm^3
Hardness: 2.0-3.0

It may also contain primese of Ag, Cu, Se, Bi, Fe, As in small percentages.
It has a grey color, metallic brightness. It appears in beautiful crystalline forms. As an ore, it forms massive and granulate aggregates.Galena is a mineral of low and medium temperatures, usually found in combination with sphalerite, chalcopyrite, arsenopyrite, pyrite and other sulphite minerals. It is an important mineral for extracting Pb.In the Stanterg Mine it appears in a crystalline form, getting up to the size of 5 cm. It is found frequently in rounded forms which look as melted, “or hot Galena”. It is associated with marmatite, pyrite, burnonite and chalcopyrite.

Jamesonite – $Pb_4FeSb_6S_{14}$

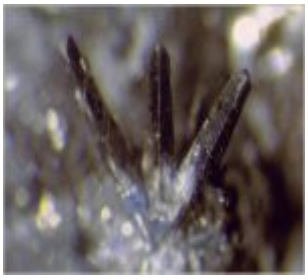


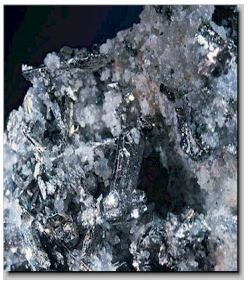


Monocline syngony, grey color similar to lead, metallic brightness.
Molecular weight : 2,064.07 gm
Compound : 2.71% Fe, 35.39% Sb, 40.15% Pb, 21.75% S.
Density : 5.5-6.0 g/cm^3
Hardness: 2.0-3.0
The Fe percentage may amount to 10%, from primese it may contain Cu, Zn, Ag. The variety without Fe is called plumosite.
It appears in needled crystals, fibrous, etc. it appears in hydrothermal deposits of medium and low temperatures of Pb-Zn, Au-Sb etc.

Lollingite – $FeAs_2$

It has a white color, metallic brightness.



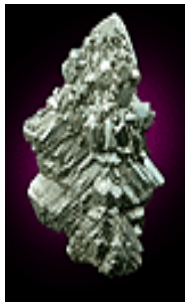


Molecular weight : 205.69 gm

Compound : 27.15% Fe, 72.85% As.
Density : 7.1-7.7 g/cm^3
Hardness: 5.0-6.0
It is located in meso-thermal deposits, together with other sulfites, associated with calcyte and in pegmatites. It is usually in association with sidetire and arsenopyrite.

Marcasite – FeS_2

It has rhomboid syngony, yellow bronze color, metallic brightness.


Molecular weight : 119.98 gm
Compound : 46.55% Fe, 53.45% S.
Density : 4.9 g/cm^3
Hardness: 6.0-6.5
It contains small amounts of As, Sb, Ni, Co, Bi and Cu. Although considered an endogeneous and exogeneous mineral, it is not prevalent as pyrite. It is mainly located in veined hydrothermal formations and sedimentary rocks. As an exogeneous mineral, it appears in the sedimentary cycle in pyrrhotite unbundling and other minerals in the oxidation stage. It serves as a primary matter for the composition of sulphur acid.

Pyrargyrite – Ag_3SbS_3 .

It has trigonal syngony, dark red to black color, a diamond brightness.

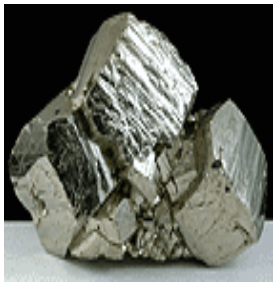




Molecular weight :541.55 gm
Compound : 59.75% Ag, 22.48% Sb, 17.76% S.
Density : 5.85 g/cm^3
Hardness: 2.0-2.5
It often appears in the form of crystals, a dentritic aggregate, sprinkled and as vesture.It is located in hydrothermal veins of lead-zinc-silver formation. It is a silver by-mineral.

Pyrite - FeS_2.

It is located in various by-minerals and rocks. It has a yellow color, metallic brightness, cubic syngony.





Molecular weight :119.98 gm
Compound : 46.55% Fe, 53.45% S
Density : 5-502 g/cm^3
Hardness: 6.0-6.5

It may contain primese of Co, Ni, Cu, Mn, As, Sb, Au and Ag, which come from mechanical remnants. Au and Ag in pyrite are found in a dispersive state. Pyrite is the most prevalent sulphite mineral, which may form in endogeneous and exogeneous processes. In the economic view, the most important pyrites are the ones formed in hydrothermal or metasomatic manners. It is often found in association with various sulphite minerals. In the oxidation stadium, it transforms into ferrosulphates and limonite. It is used for mixtures of copper and zinc sulphates and the sulphur acid.

Pyrrhotite – FeS

It has hexagonal and monoclinal syngony, yellow to bronze color, metallic brightness.





Molecular weight : 85.12 gm
Compound : 62.33% Fe, 37.67% S,
Density : 4.58-4.7 g/cm^3
Hardness: 3.5-4.5

It usually contains primese of Ni, Co, Cu, rarely Mn and Zn under 1%. It appears in the form of granulate and compact aggregates, and rarely in the form of tiled crystals. Formation is connected with endogeneous processes, for various genetic types. It is rare as an exogeneous mineral. It is linked with basal rocks, in association with pentlandite and chalcopyrite. It can also appear in environments of contact-metamorphic type. It is located in magmatic rocks, connected to basals and hydrothermal deposits. It is one of the most interesting crystals of Trepca, it appears in large tiled-hexagonal crystals.

Sphalerite – ZnFeS

It has cubic syngony, variable color – white, fulvous, dark brown, and rarely yellow, a brightness of diamond.





Molecular weight : 96.98 gm
Compound : 64.06% Zn, 2.88% Fe, 33.06% Fe.
Density : 3.9-4.2 g/cm^3
Hardness: 3.5-4.0

Zinc is partially replaced with Fe (up to 26%), and Mn, Cd, In, Ga, etc. It appears in large and beautiful crystals. It mainly appears in hydrothermal poly-metallic deposits. It is frequent also as a metasomatic product, but it can also form in the process of diagenesis of sedimentary rocks, when they are rich with sulphur compositions. It also appears as an accessory mineral in several pegmatites. It is a main by-mineral of zinc.

Marmatite – (Zn,Fe)S

It is a variety of sphalerite, it has a black color.





Contain Fe up 26% (3ZnS + FeS).

Stannite – $Cu_2(Fe,Zn)SnS_4$

Tetragonal syngony, green to black color, metallic brightness.





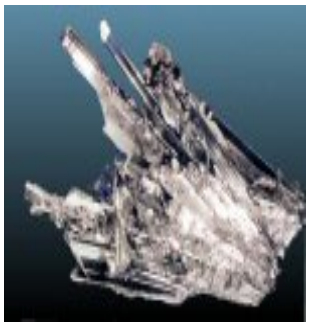
Molecular weight : 429.91 gm
Compound : 12.99% Fe, 29.56% Cu, 27.61% Sn, 29.83% S.
Density : 4.3-4.5 g/cm^3
Hardness: 3.0-4.0

Crystals are very rare. It is more frequently found in the form of irregular granules. Primeses contained are Zn (up to 10.01%), Sb (up to 3%), Cd (up to 1.5%), Pb (up to 2%) and Ag (up to 1%).
It is a rare mineral. It is found in hydrothermal poly-metallic deposits. It may also be a product of the pegmatite-pneumatolite stage. In the oxidation stadium, it easily transforms into limonite and casiterite.It is a tin by-mineral.

Stibnite – Sb_2S_3

Synonym: Antimonite

It has rhomboid syngony, a grey lead color, metallic brightness.
It also contains small amounts of As, Pb, Fe, Cu, but rarely also Au and Ag.



Molecular weight : 339.70 gm
Compound : 71.68% Sb, 28.32% S.
Density : 4.63 g/cm^3
Hardness: 2.0

It is frequently found in idiomorphic crystals, which are usually in the form of prisms or needles. It also appers in forms of granulate, radial and needle aggregates.
It is a characteristic mineral of low temperatures. In lower temperatures, it is associated with gold. In the oxidation stadium, it easily transforms into oxide compositions of valentinite, senarmonte (Sb_2O_3), stibconite ($Sb_2O_4 \cdot H_2O$), etc.
It is the key by-mineral for antinomy.

Tennantite – $Cu_{11}FeAs_4S_{13}$ $(Cu, Ag, Fe, Zn)_{12}Sb_4S_{13}$)

It has cubic syngony, dark grey color, metallic brightness.





Molecular weight : 1,471.40 gm
Compound : 3.80% Fe, 47.51% Cu, 20.37% As, 28.33% S
Density : 4.6-4.7 g/cm^3
Hardness: 3.0-4.5

In the literature, it also appears by the name of **Binit**, which is variety with Ag and Zn. It is widely dispersed in hydrothermal deposits of copper.

Tetrahedrite – $Cu_9Fe_3Sb_4S_{13}$ (Cu,Fe,Ag,Zn)12Sb4S13)

It has cubic syngony, grey metallic color, metallic or semi-metallic.



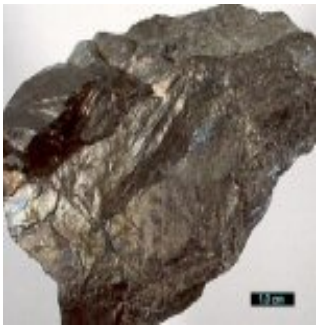


Molecular weight : 1,643.31 gm
Compound : 10.20% Fe, 34.80% Cu, 29.64% Sb, 25.37% S.
Density : 4.6-5.4 g/cm^3
Hardness: 3.5-4.0

It is quite distributed in hydrothermal copper deposits. In its paragenesis, it is associated with minerals of Cu, Pb, Zn, Fe, As, etc. It also appears in formations of contact-metasomatic and pegmatite types.

Valleriite – $(Fe,Cu)_4(Mg,Al)_3[(OH,O)_6/S_4]$

It has hexagonal syngony, dark grey color, bronze yellow, metallic brightness.





Molecular weight : 475.92 gm
Compound : 8.68% Mg, 7.37% Al, 25.82% Fe, 24.03% Cu, 0.42% H, 26.95% S, 6.72% O.
Density : 3.09-3.14 g/cm^3
Hardness: 1.0-1.5

It is located in sulphur deposits of copper-nickel, poly-metallic deposits, etc.

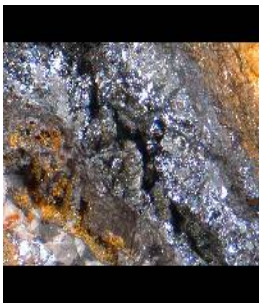
Group III

Oxides and hydroxides

Chalcophanite – $(Zn,Fe,Mn)Mn_3O_7.3H_2O$

It has tricline syngony, black to blue color up to ferrous black, and metallic brightness.



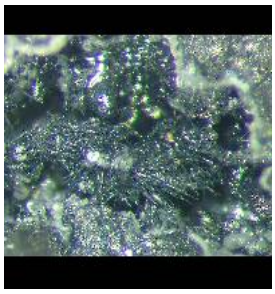


Molecular weight :459.22 gm
Compound : 40.68% Mn, 17.09% Zn, 6.08% Fe, 1.32% H, 34.84% O, (6.18% MnO. 56.79% MnO_2, 21.27% ZnO, 7.82% FeO, 11.77% H_2O).
Density : 4.0 g/cm^3
Hardness: 2.5
It is a secondary mineral in metamorphosed by-minerals. It is co-associated with Mn and Fe hydroxides.

Coronadite – $Pb(Mn,Mn)_8O_{16}$.

It has trigonal syngony, and an unstable composition.





Molecular weight : 933.55 gm
Compound : 1.47% Ba, 45.31% Mn, 0.29% Al, 1.09% V, 24.41% Pb, 27.42% O, (1.64% BaO, 3.80% MnO, 67.05% MnO_2, 0.55% Al_2O_3, 1.95% V_2O_5, 26.30% PbO).
Density : 5.44 g/cm^3
Hardness: 4.5-5.0

It has a grey color, silver up to black, sub-metallic brightness. It is located in the oxidation stadium of poly-metalic and Mn deposits.

Hematite – Fe_2O_3

It has trigonal syngony, steel grey up to black, metallic brightness.





Molecular weight : 159.69 gm
Compound: 69.94% Fe, 30.06% O, (100% Fe_2O_3)
Density : 5.26 g/cm^3
Hardness: 5.0-6.0

It may contain mixtures of Ti, Mg and water in small amounts.
There are various manners of formation and occurrence. In smaller amounts, it can form in magmatic ways. It can form as a result of pegmatite-pneumatolite activities. As a contact-metasomatic product in scarification. As a hydrothermal product in a wide range of temperatures, in the oxidation stadium it is formed through oxidation of sulphite minerals of Fe. As a sediment, it is more frequently found in marine deposits, formed with the escalation of geo-synclinal vulcanization, and evaporation of earth disheveling. It is one of the most important ferrous by-minerals.

Magnetite – Fe_3O_4 ($FeFe_2O_4$)

It has cubic syngony, black iron color, semi-metallic brightness.





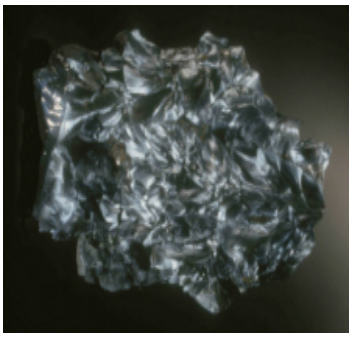
Molecular weight : 231.54 gm
Compound : 72.36% Fe, 27.64% O, (31.03% FeO, 68.97% Fe_2O_3).
Density : 4.8-5.3 g/cm^3
Hardness: 5.5-6.5
Types containing up to 25% TiO_2 are called titanomagnetites, and they can contain also Cr, MgO, Al_2O_3 and other elements.
It is an accessory mineral of eruptive and metamorphic rocks.
It is formed in magmatic deposits, rarely in fumarole deposits, in metasomatic contact deposits, hydrothermal deposits of high temperatures, in scarifications, and in metamorphogeneous deposits.
It is one of the most occuring minerals in almost all types of rocks.
It is an iron by-mineral.

Psilomelane – $[(Ba,H_2O)_2Mn_5O_{10}]$, $Ba(H_2O)Mn_5O_{10}$

Monoclinal syngony, grey to black color, semi-metallic brightness.







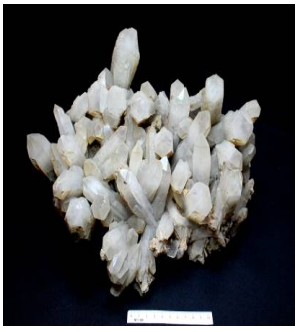
Molecular weight : 590.03 gm
Compound : 23.27% Ba, 46.56% Mn, 034% H, 29.83% O, (25.99% BaO, 66.89% Mn_2O_3, 3.05% H_2O).
Density : 3.95-4.71 g/cm^3
Hardness: 5.0-6.0

Mangane may be substituted with W, Fe, Al, V, Mg, Co, Cu, Barium with Ca, U, Sr, and Na. the water has the attributes of zeolytic water, which can be divided until 500°C.
It appears in the form of water-rich aggregates, a zonal concentric structure, and in the form of dendrites.
It appears in the oxidation stadium, in the core of alienation and deposits of sedimentary origin.

Quartz – SiO_2

It has trigonal and hexagonal syngony, without color, fumed up to black color (morion), yellow (citrine), violet (amethyst), etc., with a glassy brightness.





Molecular weight :60.08 gm
Compound : 46.74% Si, 53.26% O, (100% SiO_2)
Density : 2.65 g/cm^3
Hardness: 7.0

It is very frequent in idiomorphic occurrence and diverse crystals.It is one of the most prevalent minerals in nature. It is formed in many ways: pegmatite, pneumatolic, hydrothermal and magmatic. For this reason, it occurs in almost all types of acidic magmatic rocks. In metamorphic rocks, it is characteristic as a re-crystallized quarts, formed with the metamorphosis of the previosly formed quartz, or formed through metamorphic reactions. In sedimentary rocks, it may have allotigeneous or autogeneous origins, formed in the stage of diagenesis. Clear crystals of quartz are used in radio technology and optics. Colored types are used as semi-precious stones.

Group IV

Nitrates, Carbonates and Borates

Ankerite – $Ca(Fe^{2+},Mg,Mn^{2+})(CO_3)_2$

It has a trigonal syngony. It pertains to the group of carbonatic minerals.





Molecular weight : 206.39 gm
Compound : 19.42% Ca, 3.53% Mg, 2.66% Mn, 16.24% Fe, 11.64% C, 46.51% O, (27.17% CaO, 5.86% MgO, 3.44% MnO, 20.89% FeO, 42.65% CO_2).
Density : 2.75-3.01 g/cm^3
Hardness: 3.5-4.0

It is found in hydrothermal deposits of sulphur and sideritic ores, in modified Fe-Mn stones. It is found in association with albite, group of chlorites, epirotes, marcasite and sphalerite.
It was discovered by Prof. M. J. Anker (Austrian mineralogist) in 1825.

Aragonite – $CaCO_3$

It appears in the form of crystals, oolites, in fibre form, etc. it has rhomboid syngony.





Molecular weight : 100.09 gm
Compound : 40.04% Ca, 12.0% C, 47.96% O, (56.03% CaO, 43.97% CO_2,
5.6% Sr, Fe, Mg, Zn, and Pb 15.0%
Density : 2.95 g/cm^3
Hardness: 3.5-4.0

It has white, grey and reddish colors (it may be colored in different colors), up to the black color.
Aragonite is an unstable modification of $CaCO_3$, which transforms itself into calcite. In usual temperatures, transformation occurs in a very slow manner.
It is a rare mineral, and it is rarely found in nature in comparison with calcite. As a hydrothermal product of low temperatures, it appears in clefts of ultrabasic rocks, and is found in branches in the stadium of oxidation of sulphite minerals found in carbonatic rocks rich in Mg. As an exogeneous mineral it is formed in proximity to warm springs, but passes to stable modification of calcite under effect of diagenesis. It is also formed in marine deposits, gypsum, lime, hypergeneous minerals, etc.

Calcite – $CaCO_3$

It appears in different forms (rhomboid), in tiled forms, granulate and massive aggregates, etc. it has trigonal syngony.





Molecular weight : 100.09 gm
Compound : 40.04% Ca, 12.0% C, 47.96% O, (56.03% CaO, 43.97% CO_2).
Density : 2.6-2.72 g/cm^3
Hardness : 3.0

It has no color, it is whittish, but can be colored in different colors (yellow, reddish, green, etc.). the Iceland spat is a transparent calcite. Pseudomorphosis are often formed of quartz, calcedone, opal and rarely in calcite and aragonite carbonates.
It is one of the most prevalent minerals, and it is the main component of many rocks.
The origin may be biogeneous, chemical, hydrothermal, metamorphic and magmatic. It is thought to be formed in several alkaline rocks. It appears also as a cement of several terigeneous sediments. In sedimentation of marine basins it forms large lime layers. In caves and clefts, forms ornaments in the form of stalactites and stalagmites.
It has a wide use, in the optics industry, engineering, metallurgy, etc.

Manganon Calcite – $(Ca,Mn)CO_3$





Cerussite – $PbCO_3$

A typical exogeneous mineral, formed in the stadium of oxidation of sulphite deposits of lead, where it also appears as a pseudomorphosis of gallena and other lead minerals.





Molecular weight : 276.21 gm
Compound : 77.54% Pb, 4.49% C, 17.96% O, (83.53% PbO, 16.47% CO_2).
Density : 6.40-6.582 g/cm^3
Hardness: 3.0-3.5

It has rhomboid syngony, white color, grey or black, may be colorless, diamond brightness. It is an important lead by-mineral.

Dolomite – $CaMg(CO_3)_2$

It has trigonal syngony, grey, white, reddish or colorless, glassy brightness.



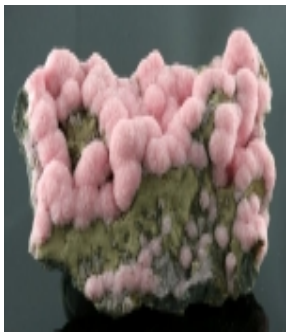


Molecular weight : 184.40 gm
Compound : 21.73% Ca, 13.18% Mg, 13.03% C, 52.06% O, (30.41% CaO, 21.86% MgO, 47.73% CO_2).
Density : 2.86 g/cm^3
Hardness: 3.5-4.0

In composition of dolomite, contents may include isomorph mixtures of Fe, Mn (up to some percent), and also Zn, Ni, Co etc. If the Fe and Mn percentage increases dolomite transforms into tankerite.
It is formed with the activity of warm dissolutions, which are rich in Mg haloids in lime. As a hydrothermal product, it is rarer than calcite, and usually in association with magnezite, calcite, quartz and several sulphite minerals. It may form with dishevellation of silicate minerals, which contain Mg and Ca, and with sedimentation. It may form with dolomitization of calcareous, dolomitization of calcite precipitation in the primary stage of diagenesis, with the precipitation from dissolution at greater contents of Mg in water.

Rhodochrosite – $MnCO_3$

Trigonal syngony, red color, rose and dark brown, glassy brightness.





Molecular weight : 114.95 gm
Compound : 47.79% Mn, 10.45% C, 41.76% O, (61.71% MnO, 38.29% CO_2)
Density : 3.69 g/cm^3
Hardness: 3.5-4.0

It is rare in crystal forms, mainly appeearing as granulate aggregate. It may contain primese of Fe, Mg, Ca, and rarely even Zn and Co.
Formation is connected with the upper horizons of veined hydrothermal by-minerals (epithermal and meso-thermal), in metasomatic precipitation deposits, and in the core of Fe-Mn deposit conveyance.

It is one of the important by-minerals for extracting ferro-mangane.

Siderite – $FeCO_3$

Trigonal syngony, yellow and fulvous color, in conveyance takes darker color, glassy brightness.





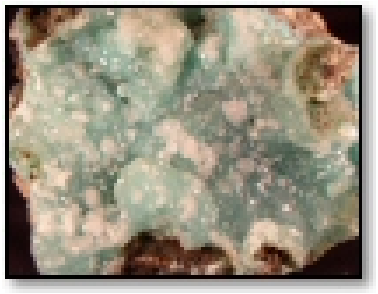
Molecular weight : 115.86 gm
Compound : 48.20% Fe, 10.37% C, 41.43% O, (62.01% FeO, 37.99% CO_2).
Density : 3.96 g/cm^3
Hardness: 3.5-4.5

Crystals are rare, it often appears in the form of granulate, compact and tiled aggregates.Its origin is in the calcareous metasomatic and precipitation transformation, unbundling of iron silicates in reduction conditions, hydrothermal veins.It is one of the important by-minerals for extracting iron.

Smithsonite – $ZnCO_3$

Trigonal syngony, green, yellov or white color, glassy brightness.



Molecular weight : 125.40 gm
Compound : 52.15% Zn,9.58% C, 38.28% O, (64.90% ZnO, 35.10% CO_2).
Density : 4.4-4.5 g/cm^3
Hardness: 4.0-5.0

Crystals are rare. It appears in spheroid form, grape and calcareous, etc. it forms in the stadium of oxidation of sulphite and sphalerite by-minerals. With the activity of zinc sulphate in $CaCO_3$ it forms anhydrite and smithsonite. It is a zinc by-mineral.

Group V

Sulphates, chromites, molibdates and tungstites

Anglesite – $PbSO_4$

It appears in forms of prismatic and tiled crystals. It has rhomboid syngony.





Molecular weight : 303.26 gm
Compound : 68.32% Pb, 10.57% S, 21.10% O, (73.60% PbO, 24.60% SO_4, are known and some types vich contains 8.45% BaO).
Density : 6.3 g/cm^3
Hardness: 2.5-3.0

It is usually without color, whittish, but it may have yellow, grey and green nuances.
It has a greasy diamond brightness.
It is a typical exogeneous mineral, forming in the upper oxidation stadium of lead deposits. Its hydrothermal origin is rare. It is found in association with arsenopyrite, gallena, pyrite and sphalerite.
It is a lead mineral.

Barite – $BaSO_4$

It is characterized with rich crystal forms. It can be white, grey, yellow, green, blue or colorless. It has rhomboid syngony.





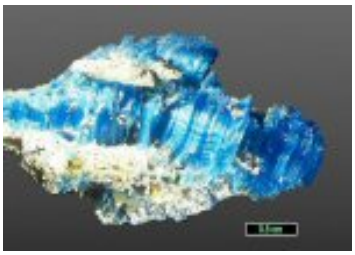
Molecular weight : 233.39 gm
Compound : 58.84% Ba, 13.74% S, 27.42% O, (65.70% BaO, 34.30% SO_3).
Density : 4.3 – 4.5 g/cm^3
Hardness : 3.0 – 3.5

It is met in hydrothermal veins and often in sedimentary rocks. It is dispersed in the core of unbundling of various rocks. It is used in chemical industry, to obtain white color, etc.

Chalcanthite – $CuSO_4 \cdot 5(H_2O)$

It has triclinal syngony, light to dark blue or green, glassy brightness. Is fragile.





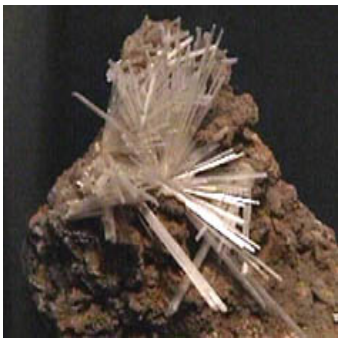
Molecular weight : 249.69 gm
Compound : 25.45%Cu ; 4.04%H ; 12.84%S ; 57.67% O, (31.86% CuO, 36.08%

H_2O).
Density : 2.3 g/cm^3
Hardness : 2.5

It forms in oxidation of copper by-minerals.

Gypsum – $CaSO_4 \cdot 2H_2O$

Monoclinal syngony. It has no color, or whittish, and it may have different nuances from primese, glassy brightness.

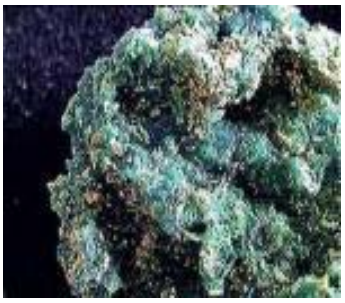




Molecular weight : 172.17 gm
Compound : 23.28% Ca ; 2.34% H ; 18.62% S ; 55.76% O, (32.57% CaO, 20.93% H_2O, 46.50% So_3).
Density : 2.32 g/cm^3
Hardness : 1.5 – 2.0

As a mineral it is chemically clean, but it may contain argyle primese, organic matters and sulphite minerals.
It is a typical chemical sediment. It forms in lagunes, together with anhidrite, halite, etc. It is found also in argyle deposits, formed with the unbundling of sulphite minerals, and activity of H_2SO_4 in carbonates.
In the Trepça deposit it has a limited prevalence, it often appears in upper horizons of the mine. It is used as a primary matter in the civil engineering industry, and to extract sulphur acid.

Melanterite – $FeSO_4 \cdot 7H_2O$

It has monoclinal syngony, light green to whittish color, which takes a yellow color in unbundling, glassy brightness.





Molecular weight : 278.02 gm
Compound : 20.09%Fe ; 11.53% S ; 5.08% H ; 63.30% O, (25.84% FeO, 45.36% H_2O, 28.80% SO_3).
Density : 1.98 g/cm^3
Hardness : 2.0

Isomorph primese of Mg, Ni, Zn, Cu and Mn have been also found.
It is formed from saturated sulphate waters when there is a lack of oxygen. It may form in the unbundling of pyrite, marcasite, phyrrotite and chalcopyrite, and it is often found in the stadium of oxidation of sulphite by-minerals, especially iron. In the nature, it is rarely found in greater amounts. It is used in chemical industry.

Scheelite – $Ca[WO]_4$

It has tetragonal syngony, white, yellow, green and grey color, glassy to diamond brightness.





Molecular weight : 287.93 gm
Compound : 13.92% Ca ; 63.85% W ; 22.23%O, (19.48% CaO, 80.52% WO_3).
Density : 5.9 – 6.12 g/cm^3
Hardness : 4.0 – 5.0

It forms in pneumatolite and hydrotherms. In pneumatolic deposits, it is connected with contact-metasomatic processes in scarnification, which are usually formed in contact of carbonatic rocks and granite intrustions. It is each time in association with Ca-Fe granates, diopside, epidotes, volastonite, magnetite, sulphite minerals, ets.
Hydrothermal deposits are rare and it is found in quartz veins, together with arsenopyrite, pyrite, carbonates, gold and gallena.
It is a wolfram by-mineral.

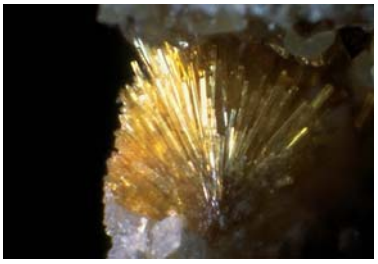
Group VI

Phosphates, Arsenates and Vanadates

Childrenite–Fe,Al/$(PO_4)(OH)_2(H_2O)$ (Fe,Mn)Al[$(OH)_2/PO_4$] H_2O

It has monoclinal syngony. It is a member of the isomorphic series eosphorite-childrenite with Mn and Fe.

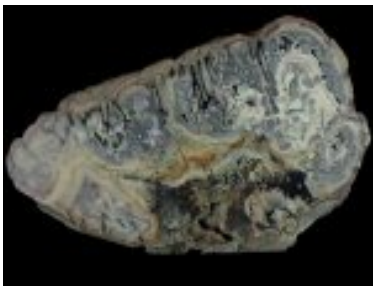




Molecular weight : 229.83 gm
Compound : 11.74% Al, 24.30% Fe, 13.48% P, 1.75% H, 48.73% O.
Density : 3.18 – 3.24 g/cm^3
Hardness : 4.5 – 5.0
It has a yellow to whittish and reddish color, etc.

Crandallite – $CaAl_3(PO_4)_2(OH)_5(H_2O)$

It has trigonal syngony, white, grey and yellow color, glassy brightness.





Molecular weight : 414.02 gm

Compound : 9.68% Ca ; 19.55% Al ; 14.96% P ; 1.70% H ; 54.10% O. (13.54% CaO, 36.94% Al_2O_3, 34.28% P_2O_5, 15.23% H_2O).
Density : 2.78 – 2.92 g/cm^3
Hardness : 5.0

Mineral of lateric deposits of phosphates and pegmatites.

Ludlamite – $(Fe,Mn,Mg)_3(PO_4)_2 4H_2O$

It has monoclinal syngony, green color, glassy brightness.



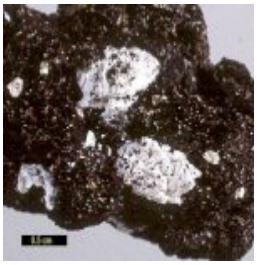


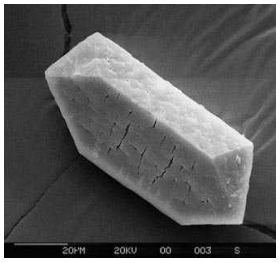
Molecular weight : 400.88 gm
Compound : 5.46% Mg ; 4.11% Mn ; 25.08% Fe ; 15.45%P ; 2.01% H ; 47.89% O, (9.05% MgO, 5.31% MnO, 32.26% FeO, 35.41% P_2O_5, 17.98% H_2O).
Density : 3.1 g/cm^3
Hardness : 3.0 – 4.0

It is found in phosphate pegmatites, in hydrothermal deposits, etc.

Struvite – $NH_4MgPO_4 \cdot 6H_2O$

It has an ortho-rhomboid syngony, without color, white, yellow, brown, etc. Glassy brightness.

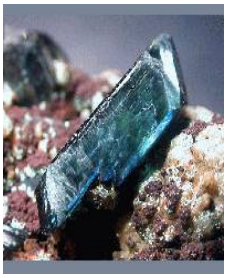




Molecular weight : 245.41 gm
Compound : 9.90% Mg ; 12.62% P ; 1.64% H; 5.71% N ; 65.20% O, (16.42% MgO, 28.92% P_2O_5, 44.05% H_2O), 10.61% $(NH_4)_2O$).
Density : 1.7 g/cm^3
Hardness : 1.5 – 2.0

Vivianite – $Fe_3(PO_4)_2 \cdot 8H_2O$

Monoclinal syngony, without color, white when fresh, but easily oxidated and takes the color formed from iron oxidation, glassy brightness.





Molecular weight : 501.61 gm

Compound : 33.40% Fe ; 12.35% P ; 3.22% H ; 51.03% O, (47.75% Fe_2O_3, 28.30% P_2O_5, 28.73% H_2O).
Density : 2.6 – 2.7 g/cm^3
Hardness : 1.5 – 2.0

It appears in crystals in the form of prisms, in fibrous aggregates, etc.It is formed with the activity of dissolutions rich with phosphor acid in composition with iron, such as pyrite, phyrrotite, si derite, etc. for this reason, it has attributes of exogeneous minerals.

Group VII

Silicates

Actinolite – $Ca(Fe^{2+},Mg)_5(Si_8O_{22})(OH)_2$

A mineral of amphibole group, with monoclinal syngony.





Molecular weight : 875.45 gm
Compound : 9.16% Ca ; 8.33% Mg 12.76% Fe ; 25.66% Si ; 0.23% H ; 43.86% O
Density : 3.2 g/cm^3
Hardness : 5.0 – 6.0

It usually appears in extended fibrous forms. It is of green color. A typical mineral of metamorphous rocks of low temperatures. It usually appears in contacts of eruptive rocks with calcareous and dolomites, and in crystalline schists. It is found in association with diopside, spinele, calcite, epidotes and chlorites. It may also appear in scarnes. With transformation they pass into talc. Practical use of these minerals is found in compressed fibrous aggregates such as asbestos**.**

Diopside – $CaMg(Si_2O_6)$

Monoclinal syngony, white color, glassy brightness.



Molecular weight : 216.55 gm
Compound : 18.51%Ca ;11.22% Mg ; 25.94% Si ; 44.33% O, (25.90% CaO, 18.61% MgO, 55.49% SiO_2).
Density : 3.25 – 3.55 g/cm^3
Hardness : 5.5 – 6.0

It is a mineral of explosive and metamorphic rocks of high temperatures. Diopside, together with augites are important minerals of the clinopiroxene group. Diopside may also be a mineral of contact-metamorphic deposits. It is characteristic of its isomorphic mixture forming with other pyroxenes.

It rarely appears in the form of crystals, and usually in granulate aggregate forms.

Epidote – $Ca_2(Fe,Al)Al_2[O/OH/SiO_4/Si_2O_7]$

Monoclinal syngony, green color with different nuances, yellow or grey (color depends from the contents of Fe, some types may have a black color, or reddish to violet), glassy brightness.







Molecular weight : 519.30 gm

Compound : 15.44% Ca ; 3.90%Al ; 24.20% Fe ; 16.22% Si ; 0.19% H ; 40.05% O,

(21.60% CaO, 7.36% Al_2O_3, 34.60% Fe_2O_3. 34.71% SiO_2, 1.73% H_2O).

Density : 3.21 – 3.51 g/cm^3

Hardness : 6.0 – 7.0

It appears in simple crystal forms and as a granulate aggregate. Substitutions of Al with Fe may occur, as can Mn, Cr and Ca with Na, Y, Ce, Th, U.

It is a typical contact-metasomatic and hydrothermal mineral. It is found in association with granates, actinolite, chlorite, quartz, albite, etc. it is also formed with transformation of pyroxene, amphiboles and plagioclase. It is met in metamorphic rocks, specifically in green schists and scarns of low temperatures.

Hedenbergite – $CaFe(Si_2O_6)$

Monoclinal syngony, dark green, glassy brightness.



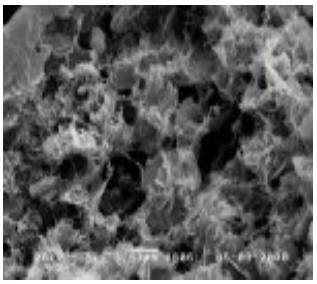


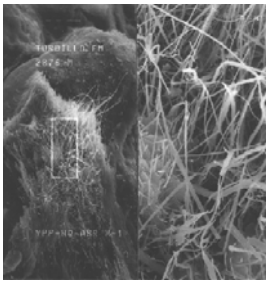
Molecular weight : 248.09 gm
Compound : 16.15% Ca, 22.51% Fe, 22.64% Si, 38.69% O, (22.60% CaO, 28.96% FeO, 48.44% SiO_2).
Density : 3.25 – 3.55 g/cm^3
Hardness : 6.0

It is met in deposits with Mg-Fe. It usually appears with magnetite and other iron minerals.

Illite- $(K,H_3O)(Al,Mg,Fe)_2(Si,Al)_4O_{10}[(OH)_2,(H_2O)]$

Monoclinal syngony, white or grey color.





Molecular weight : 389.34 gm
Compound : 6.03%K ; 1.87%Mg ; 9.01% Al ; 1.43 Fe ; 25.25% Si ; 1.35% H ;

55.06% O, (7.26% K_2O, 3.11% MgO, 17.02% Al_2O_3, 1.85% FeO, 54.01% SiO_2, 12.03% H_2O).
Density : 2.6 – 2.9 g/cm^3
Hardness : 1.0 – 2.9
It is met in argyle schists and argylites. It forms in unbundling of feldspats, in diagenesis of other argyle minerals, and in cristallization of coloids. Alcaline environments favor formation of illites.

Ilvaite – $CaFe^{2+}_3(SiO_4)_2(OH)$

Monoclinal and ortho-rhomboid syngony.





Molecular weight : 408.79 gm
Compound : 9.80% Si ; 40.98% Fe ; 35.22% O, (13.27% CaO, 52.73% FeO, 29.40% SiO_2, 2.20% H_2O).
Density : 3.99 – 4.05 g/cm^3
Hardness : 5.5 – 6.0
It appears with magnetite ore together with zinc and copper ores, and in deposits of zeolite contacts.

Wollastonite – $CaSiO_3$ ($Ca_3[Si_3O_9]$)

It has triclinal syngony, white color, may be transparent, rarely in yellow and dark red, glassy brightness.





Molecular weight : 116.16 gm
Compound : 34.50% Ca ; 28.18%Si ; 41.32%O, (48.28% CaO, 51.72% SiO_2).
Density : 2.8 – 2.9 g/cm^3
Hardness : 4.5 – 5.0
From the primese, it may contain: Fe, Mg, Mn and even Al in cases.
It rarely appears in crystal forms, often in leafs or extended aggregates, radial forms.
Typical metamorphic mineral. It is found at contacts of calcareous and eruptive rocks.

Group VIII

Unclassified minerals

Chalcedony – SiO_2

Cryptocrystal mineral of quartz. I t may have different colors, mainly grey, milk, yellow to green, waxen brightness.





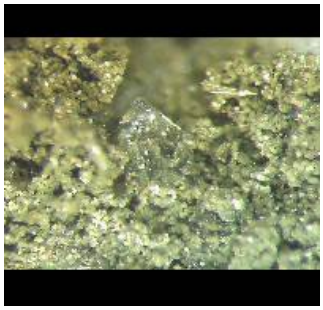
Molecular weight : 60.08 gm
Compound : 16.74% Si ; 53.26% O ; (SiO_2-100%)
Density : 2.57 – 2.64 g/cm^3
Hardness : 6.5 – 7.0

A mineral of low temperatures, formed during re-crystallization. It is used as a semi-precious stone.

Chlorite Group–$(Mg,Fe,Al)_6[(Al,Si)_4O_{10}/(OH)_8]$

A greater number of minerals pertain to this group. They have monoclinal syngony, characteristic green color, but color depends on chemical content, mangan-containing types have darker colors, chrome-containing types have a violet color, etc.





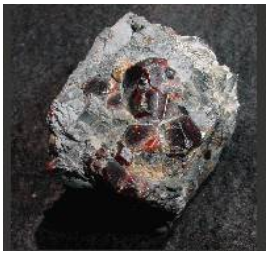
Density : 2.6 – 3.3 g/cm^3 (depending of iron contents)
Hardness : 2.0 – 3.0

These are metamorphic minerals of low temperatures, but several iron chlorites are exogeneous. Orthochlorites appear as products of ferro-magnesium minerals' transformation.

Garnet group – $X_3Z_2(SiO_4)_3$(X=Ca,Fe, etc. Z=Al,Cr, etc.)

Cubical syngony,different colors depending on content.







Compound : Pyrope (29.8% MgO ; 25.4% Al_2O_3 ; 44.8% SiO_2)

Density : 3.6 – 4.3 g/cm^3
Hardness : 7.0 – 7.5
Alamandine has red or dark red color, Grossular is white when clean, but it may also be yellow, green. Andradite is yellow, Uvarovite has a characteristic green, etc. they usually have a glassy brightness. An attribute of garnets is that they appear in idiomorphic crystals.
According to isomorphic substitutions, two series may be divided: the series of pyralspits (garnets of mangane-iron-magnesium), series of ugrandites (calcium garnets).
Rare garnets are kinceite and goldemanite.
Pyralspites have a mainly magmatic origin, although garnets in general are metamorphic minerals. Garnets are used in the abbrasive industry. Transparet garnets pertain to semi-precious stones.

Limonite – $FeO(OH)\cdot nH_2O$

Dark red to yellow color.





Compound : 86.88% Fe_2O_3, 12-14% H_2O,
Density : 2.7-4.3 g/cm^3

Hardness : 4.0-5.5

Is regular product of ferrominerals during terrene alteration and build partially Ferro-heat. It may be formed as a result of deposition in lake, backwater an I other pools.

Is ferro-mineral.

Melnikovite / greigite – $Fe^{2+}Fe^{3+}S_4$ ($FeFe_2S_4$)

Cubical syngony, yellow color like pyrite, metallic brightness.





Molecular weight : 239.96 gm
Compound : 46.55% Fe ; 53.45% S
Density : 4.05 g/cm^3
Hardness : 4.0 – 4.5

Oligonite / Manganospaerite – $(Fe,Mn)CO_3$





Compound : 28.20% Fe ; 20% Mn ; 10.37% C ; 41.43% O
Density : 3.96 – 4.0 g/cm^3
Hardness : 3.5 – 4.5
When in the crystalline grid of siderite, half of the Fe ions are substituted with ions of Mn, an isomorphic member of the series siderite-rodocrosite–oligonite is obtained.

Plumosite – $Pb_2Sb_2S_5$

Monoclinal syngony, lead grey color, metallic brightness.





Molecular weight : 818.23 gm
Compound : 29.76% Sb ; 50.65% Pb ; 19.59% S
Density : 5.5 – 6.0 g/cm^3
Hardness : 2.0 – 3.0

It appears in granulate and fibrous aggregates. It is found in hydrothermal and poly-metallic deposits.

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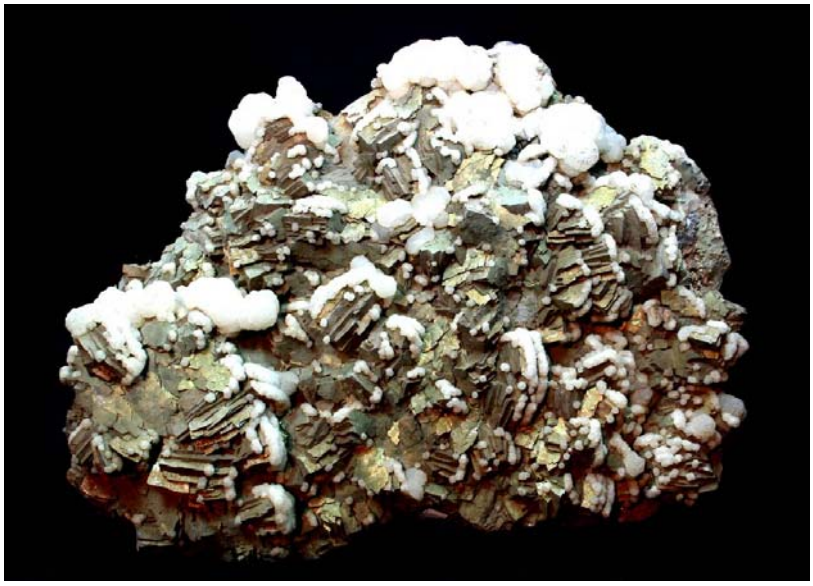


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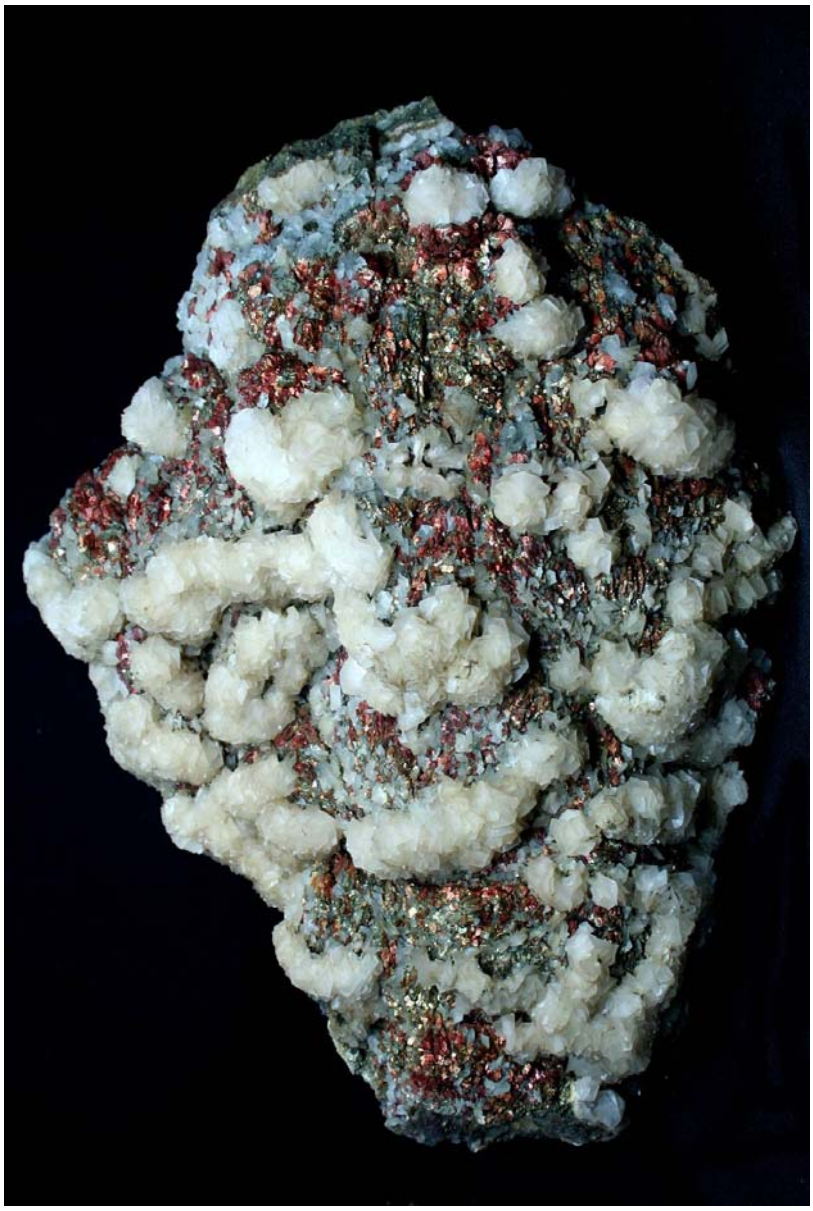










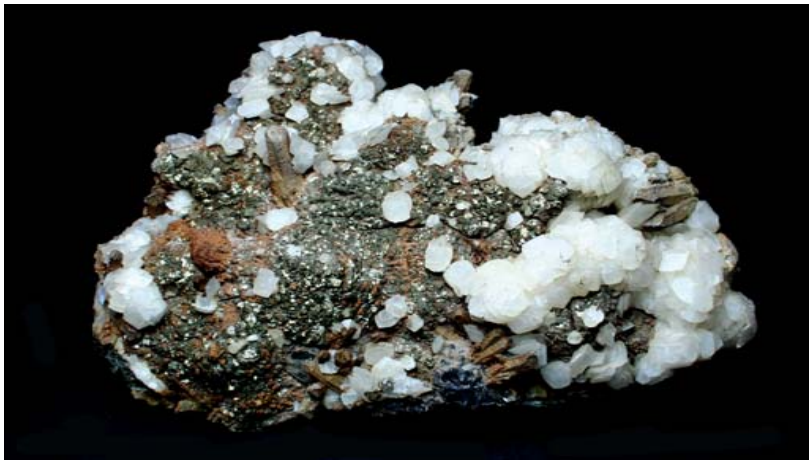


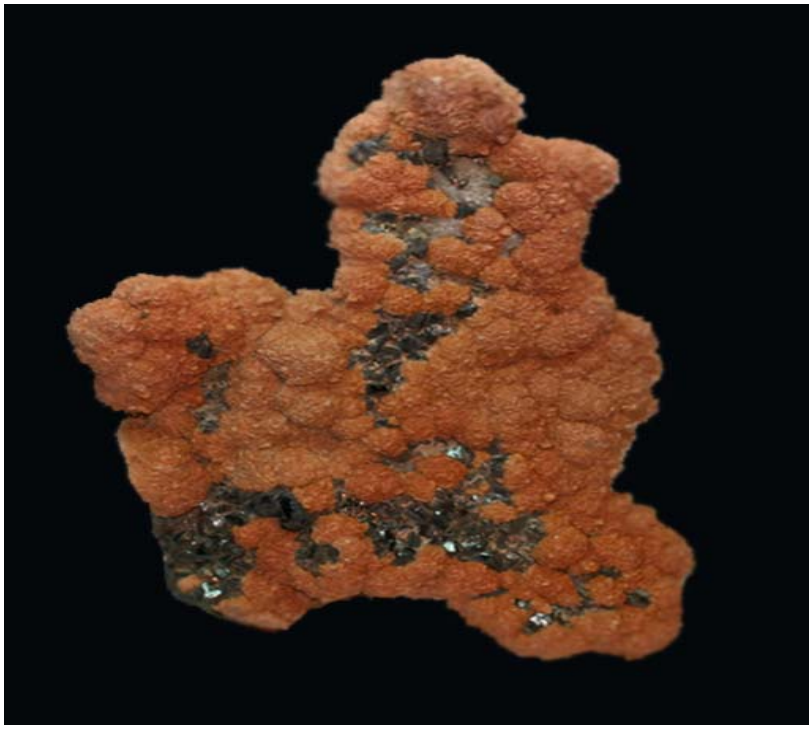
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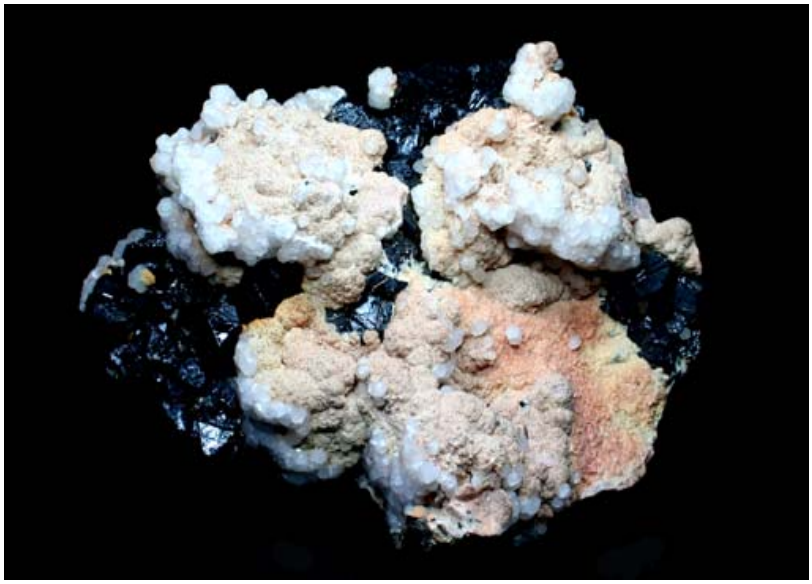








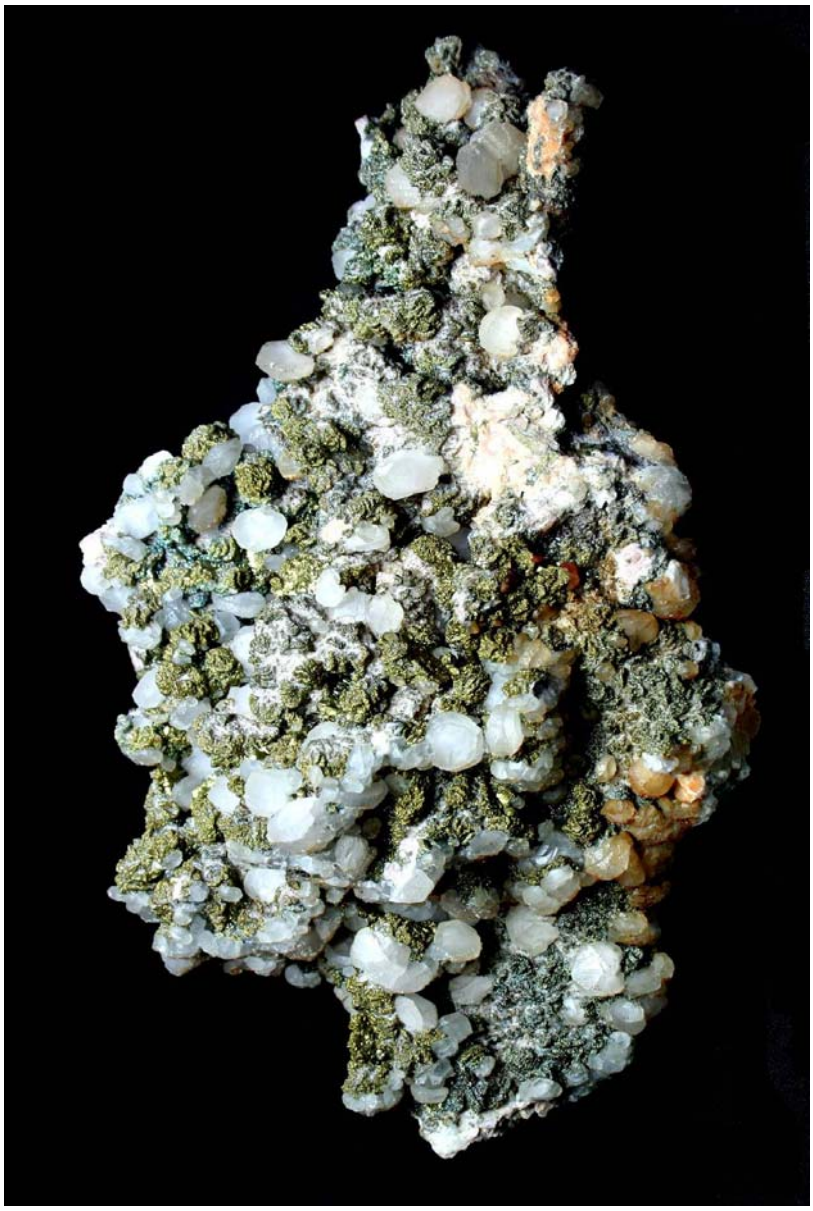
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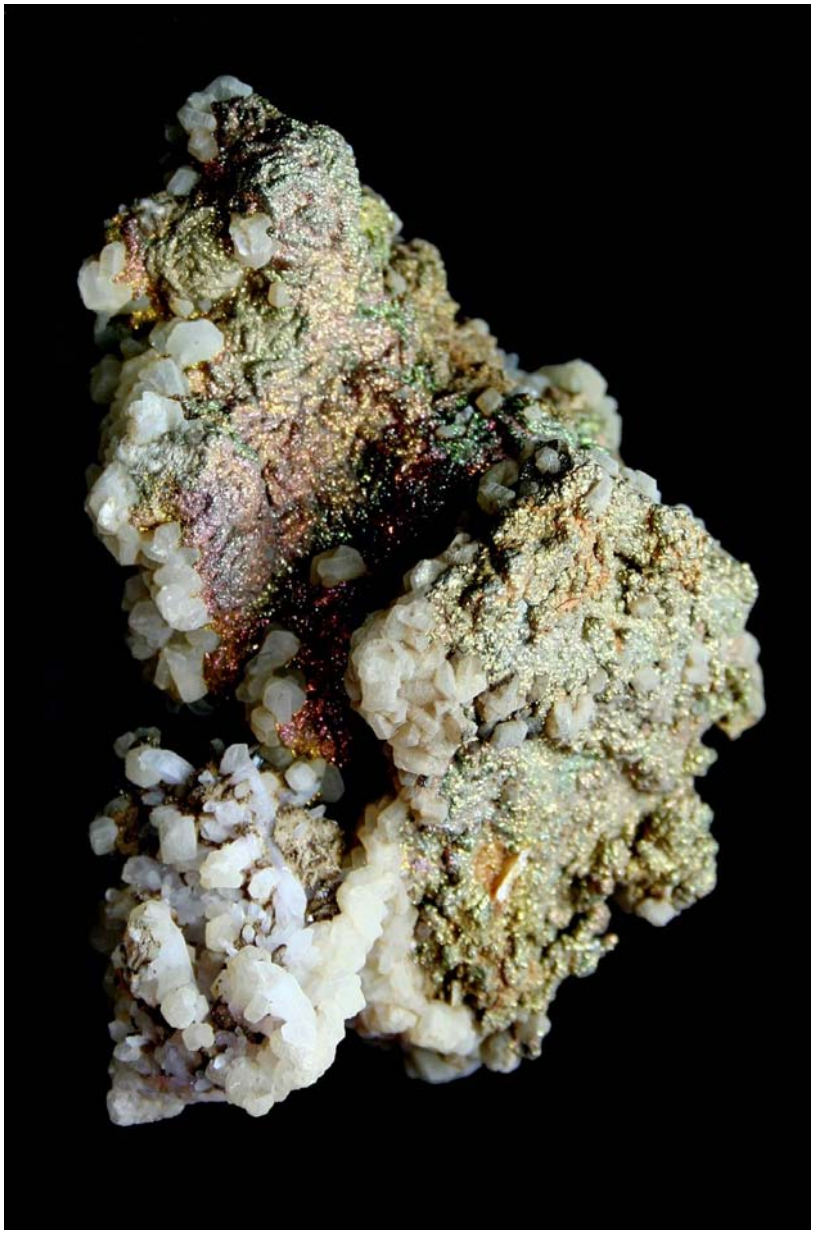




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