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TREPÇA MINERALS ATLAS

Mitrovicë, 2011

Besim Beçaj

For the coming years, the Government of the Republic of Kosovo considers the sustainable economic development of the country as priority. Our work is focused in the development of the strategic sectors, where the mining sector plays a leading role. Thus, the Ministry of Economic Development has prepared a clear Mining Strategy for the years 2012 - 2025.

Our Strategy includes a detailed plan on the future steps towards a more efficient exploitation of mines, focusing on the Trepça mines. The lead, zinc and silver deposit in Stanterg is considered to be one of the most important deposits in the world and the primary mineral reserve in Kosovo. Considering the average minerals production capacity of 600.000 tons per year in the period of time 1945 - 1990, we believe its exploitation is crucial not only for the mining sector growth, but also for the economic growth of the entire country.

In this context, the publishing of the Trepça Minerals Atlas is of great importance for the information of potential investors on typologies, qualities and quantities of the mineral reserves in Trepça. Furthermore, the Atlas together with the newly established Museum of Crystals and Minerals of Kosovo, based in Mitrovica, will be a very important illustrated database for the work of many researchers and students in the fields of mining and minerals.

He who becomes the slave of habit,
who follows the same routes every day,
who never changes pace,
who does not risk ...

Pablo Neruda




CONTENT

PREFACE

The Mineralogical Atlas of *Trepça* minerals has been prepared for the first time by authors of geology profile. This Mineralogical Atlas contains sufficient data about the deposits in general, theoretical information about properties of minerals and brilliant pictures of crystals taken in Crystals' Museum in Stantërg.

Stantërg, lead, zinc and silver (Pb-Zn-Ag) deposit, was known as the largest producer of Pb-Zn ore in Europe. Its largest importance and grandiosity is also a result of its complexity of minerals and glorious collection of marvelous crystals. The entire collection of minerals extracted so-far from the sulfide polymetallic deposit of Stantërg is exhibited in the Crystals' Museum of *Trepça*, as well as in other places in Europe.

In this case, we are making a small step, but nevertheless an important one, for knowing and rendering *Trepça's* minerals-crystals, always in macroscopic aspect.

The Atlas is divided into eight chapters, whereas their content is shown in the following parts of the book.

Atlas of minerals will be useful for students of geology, but also for the students of other disciplines of the science, as well as for visitors who are not familiar with the amazing beauty of minerals-crystals of Crystals' Museum of *Trepça.*

Diversity and beauty of exhibited specimens are what mostly surprise the visitors in a Museum of Minerals. In a specific manner they are attracted by their colours and geometric shapes.

The publication of this Atlas will fill a gap that has existed in the literature of geology, and especially in the field of mineralogy.

It is up to the readers in general, and experts of this field in particular, who can evaluate if we have achieved this aim. Hence, we will welcome their suggestions with deep kindness, so the eventual re-publication of this Atlas would be more complete in the scientific and professional aspect.

Authors

PREFACE

Republic of Kosova, with a territory of 10887 km², consists of all characteristics for a normal economic development of the country.

Around about 54% or 5890 km² of the total surface is agricultural land, 42% or 4600 km² are woods and 3,64% or 397 km² is loam.

Our country is rich with natural assets, especially it is well known for Pb-Zn-Ag mineralization, for what is known from ancient times. Since that time Kosova's wealth was used by our predecessors - Illyrians (the oldest nation in Ballkans), then by Byzantine, Saxons, Turks and lastly by Serbian occupier.

Kosova is located in the middle of Southeast Europe, in the central part of the Balkan Peninsula, and representing the important linkage between Central Europe with Southern Europe, Adriatic Sea and Black Sea, (fig.1).

In Southwest it borders with Albania, in the West it borders with Montenegro, in North-Northeast it borders with Serbia and in Southeast it borders with Macedonia.

Kosova's landscape is a flat basin, surrounded with high mountains (fig.2).

As for as the road traffic is concerned, Kosova is an important and strategic linkage in Balkans, (fig. 3).

Figure 1. Geographical positioning of Kosova

Source: ESK, Cartography & GIS

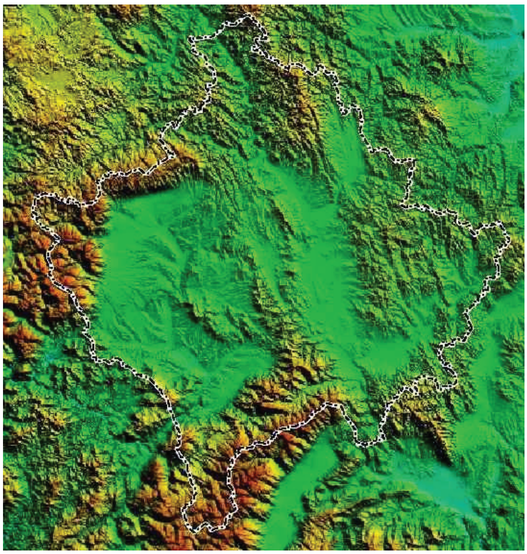


Figure 2. Map of Kosova relieve

Through rivers jaw valleys (Ibri, Drini i Bardhë, Lepenci, Morava e Binçës), our country is linked with neighbouring countries, as well as with Balkan countries, Europe and wider.
Regarding to these, our country has all conditions for a strong economic development.
From the point of geological formation, Kosovo region is quite diversified and has a great importance for exploitation of raw minerals with which Kosova is distinguished not only by their number and variety, but also by their quantity, (fig. 4).

In Kosovo there are large reserves of caustobiolites (coal- lignite), metal minerals of Pb, Zn, Ag, Cr, Ni-silicates, Mg, bauxite, etc.

All these resources create a good basis for normal economic development of the country and perspective for the future. Thus, economic development of Kosova is based on exploitation of mineral resources, which once were important for the of the country and further.

Best known productions were non-ferrous metal products, such as Pb, Zn, Au, Ag, Bi, Cd, etc. It is estimated that there are about 50 million tons of ore reserves of lead-zinc along with the ore belt *Trepça*.

Figure 3. Kosova's map according to the aspect of road-network and rivers

1 HISTORY OF TREPÇA

HISTORY OF TREPÇA

Polimetalic sulphide deposits of Pb, Zn, Ag and Au in Kosova where known ever since the ancient times. This is proven by many discovered mining activities: stopes, shafts, tools which have been used for ages for exploitation of these mineralizations, as well as their remainings after smelting.

Figure 5. Certificate of minerals for enterprise Trepça Mines Ltd, date 1926.

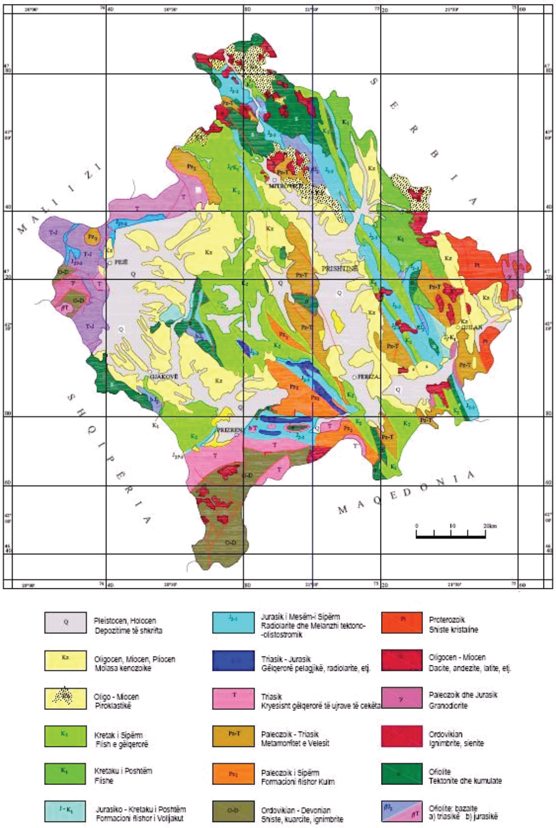


Figure 4. Geological map of Kosova

Some of sulphide deposits (Trepça at Stantërg, Bellobërdë, Cërnac, Përroi i Ngjyrosur-Artanë), even these days after the last war in Kosova (1998/99), are being mined, whereas deposits such as: Hajvalia, Badovc and Kishnica, are flooded with water and without supervision although before the war (period 1998/99), these used to be important producers of lead, zinc and silver ores.

For the first time in literature, designation Trepça was mentioned in 1303, in documents preserved in Dubrovnik (Republic of Croatia) as well as in archives dating from Ottoman time, mainly for the region of Artana.

Mining activity in the territory in which Trepça mines are located was known since the Ilyrian and Roman

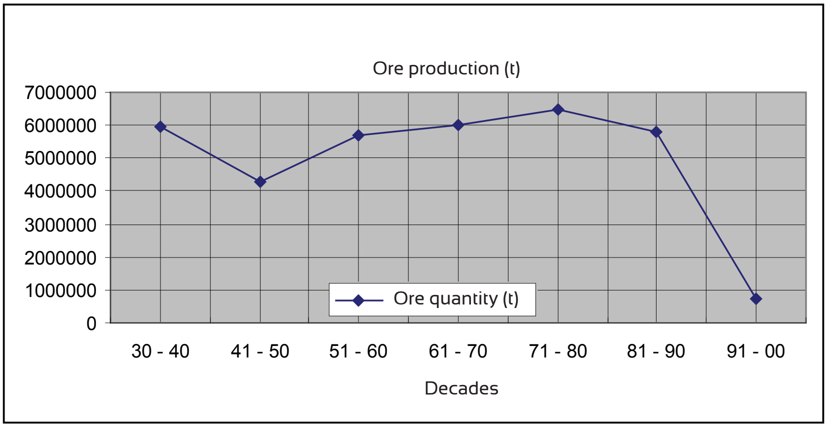


Figure 6.
Ore production: Trepça Stantërg mine, as per decades

period, further stretching to the Middle age.

Meanwhile, in the 13th century, the mining acitivity marked the fastest development.

First geological explorations began in 1924, when English geologists began their geological exploration works for sulphide polimetalic mineralizations of Pb- Zn in the Trepça ore-field in Stantërg. In 1926, in London, Trepça Mines Limited, was created as a joint-stock company, thus taking with concession the mining of this mineral deposit for 50 years, (fig. 5).

In 1930, the pilot production of sulphide Pb and Zn mineralisations was launched in this deposit.

During the World War II, the Trepça mine in Stantërg was run by Germans, but with a lowered production level.

From 1945 till 1990 the mine operated uninterruptedly, with a capacity of about 600.000 tons per year.

During this period mines that were actively mined included: Trepça in Stantërg, Cërnac, Bellobërdo, Koporiq and Zhuta Perlla-Albanik (ex-Leposaviq); Kishnica, Hajvalia, Badovc and Përroi i Ngjyrosur - Artanë. Based on the statistics of production, Stantërg Trepça mine, from 1930 till 2000, had a production flow as shown in (fig.6) and (fig.7).

Figure 7.
Quantitative production of Pb and Zn metals from the Stantërg *Trepça* mine, as per decades.

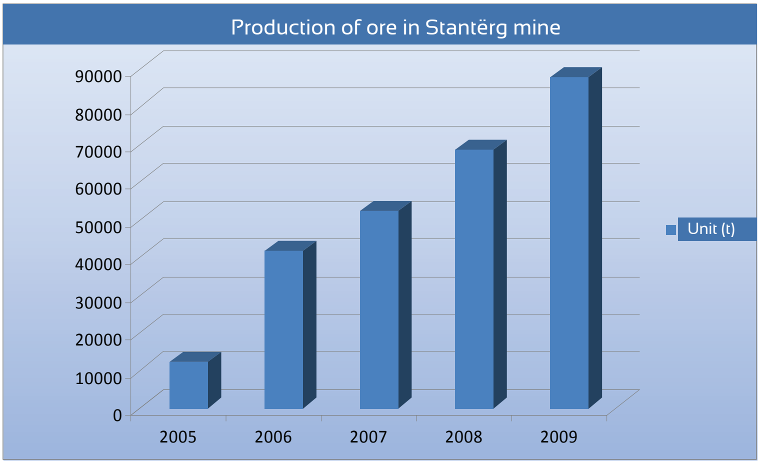


Figure 8. Production of Pb - Zn ore from the Stantërg *Trepça* mine

After the war, from 2000-2004, the mine was not producing at all, but it was on permanency, exploration and preparation of stopes for production. So in 2005, the mine began the production of lead and zinc ore at minimal capacity, which increased every year (fig.8 and fig.9).

The biggest success of Trepça complex was achieved in 1983, the time when Trepça exported goods valued at about 103 billion US $, being the fifth biggest exporter in ex-Yugoslavia, (Akad. M. Dushi 2006). During 58 years of production, Trepça complex produced 33 milion tons of ore, with an average grade of 9% (Pb+Zn), or about 3 million tons of metals (Pb+Zn). In addition to this, in Trepça metallurgy and enrichment factory (fig.10 and fig.18), for diverse duration were produced quantities of valuable metals, as shown in following:

» silver (Ag) 4.572 t for 45 year;
» gold (Au) 8.675 kg for 34 year;
» bismuth (Bi) 4.115 t for 43 year;
» cadmium (Cd) 1.655 t for 20 year.

Ten-year period: 1975 - 1985,
Average yearly production in the complex was:

» refined lead 74.216 t/year;
» electrolytic zinc 32.000 t/year;
» clean silver 8.8500 kg/year;
» gold 216 kg/year;
» bismuth 7.3714 kg/year;
» cadmium 9.1302 kg/year;
» pyrite and pyrrhotite 120.000 t/year;
» sulfuric acid 80.000 t/year;

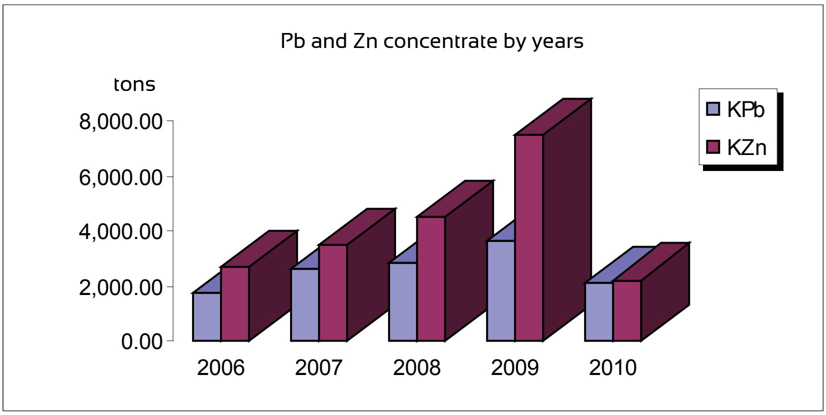


Figure 9. Production of Pb and Zn concentrate from the *Trepça's* mine in Stantërg till the first half-year of 2010.

» hunting ammunition 1.000.000 pcs/year
» final products from Pb 35.000 t/year;
» zinc metall plates 65.000 t/year;
» bijouterie,contactElec.mat. 8.814.000US$/year
» pipes,ropes,dishes etc. 4.600.000US$/year

Figure 10. Lead metallurgy of Trepça in Zveçan (1) and zinc metallurgy in Mitrovica (2)

Polymetalic mineral deposits of Pb, Zn, Ag and Au in Stantërg, is among the most known polymetalic mineral deposit in Europe, in terms of size and the most attractive in terms of diversity of minerals and crystals' beauty that this deposit has. Based on the marvellous beauty of crystals, an idea emerged for establishment of Crystal's Museum in Stantërg. So, in 1964 the Museum of Trepça Crystals was established in Stantërg. At this time was initaited the first collection of crystals and their exibiton in the Museum. Initially, the number of crystals extracted and collected was small, but later on this number increased. There is a high number of extracted crystals from the mineral deposit of Trepça, and it is hard to know their exact number.

However, there are 1560 specimens of crystals exhibited at the Trepça Museum of Crystals.

TREPÇA

2 GEOGRAPHICAL POSITION

GEOGRAPHICAL POSITION

Trepça mine of Stantërg belongs to the city of Mitrovica. Mitrovica, without any doubt, is one of the most important cities not only in Kosova but even in Balkan Peninsula and wider, because of its mineral wealth. Extending in the alluvions field of rivers: Ibër,Sitnica and Lushta, and surrounded by hills (fig. 11), Mitrovica has an elevation of 508-510 m above the sea level, with a convenient geographical position. This is created by a landscape with layout N-S, through the valleys of rivers Ibër-Sitnica. The city is surrounded by hillsides of Kreshbardha (Kopaonik, Rogozna, Mokra and Çyqavica). The territory of this municipality is accros border-line with Zveçan in the North, with Besiana in the East,In the Southeast with Vushtrri, whereas in the Southwest with Skenderaj municipality and in Northwest with Zubin Potok.

In the direction of Sitnica River, Mitrovica is linked with Kosovo basin. Mitrovica region has an important geographical and strategic position, given that all important roads, which lead inside the Balkan Peninsula, Adriatic seacoast, Aegean Sea and Black Sea, lead to this territory.

From this point of view, the railroad which links-up the Southern and Northern parts of Balkan Peninsula is also of high importance.

As a micro-regional part of Kosovo basin, Mitrovica valley is closed with volcanic cupola in Zveçan (799m), from volcanic hilltop of Sokol (918m) and Majdan (1268m). From East, Mitrovica is border-lined with "Kodra e Lisit" hill (665m), from the Southeast with "Kodra e Shkelzenit" hill (Cërnusha, 1010m) and from the West with "Kodra e Zmiqit" hill (822m) and Gërmova (782m).

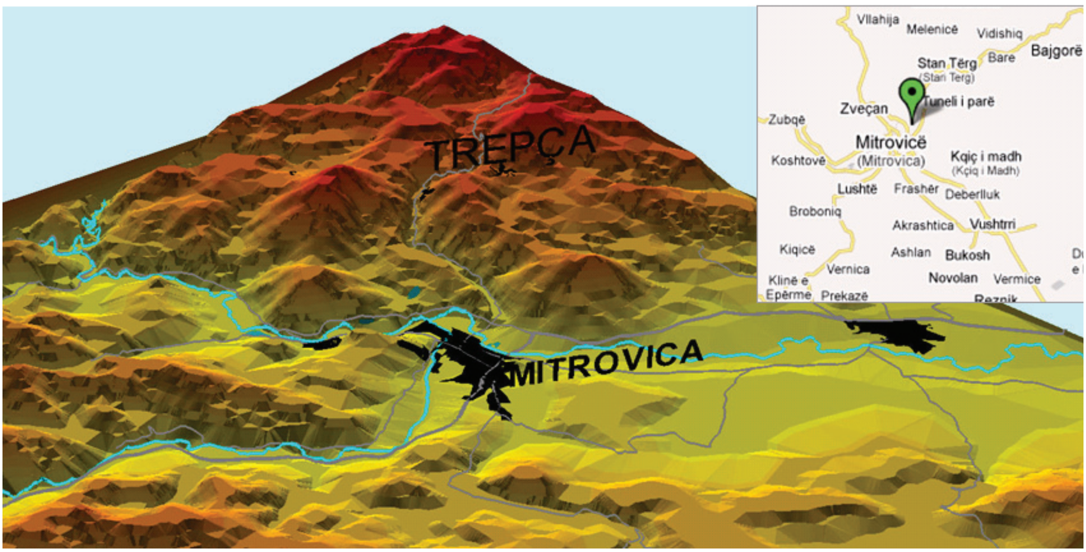


Figure 11. Geographical position of Mitrovica, with surroundings

Morphological dominating characteristics of Mitrovica territory are mountainous-hilly areas. Traffic is satisfying, since except the roadways there is also the railway Belgrade Mitrovica - Shkup (Skoplje). Stantërg deposit is located 9 km far from this railway. The road Mitrovicë - Prishtinë Shkup serves as a main road for the region where Trepça mines are located. In addition to this, there are also other alternative roads, which are unusable during the winter season. With the existing road Mitrovicë - Stantërg - Bare - Podujevë, the region has also a perspective for development of mountain tourism.

3 ASPECTS OF GEOMETALOGENY IN POLIMETALIC MINERALISATIONS OF TREPÇA MINERAL BELT

ASPECTS OF GEOMETALOGENY IN POLIMETALIC MINERALISATIONS OF TREPÇA MINERAL BELT

Regarding the genesis of the formation of magmatic hydrothermal deposits in Balkan and wider, according to the prism of plate tectonics, we have given interpretations of S. Jankoviç (1977, 1997), S. Karmanata (1997), Groves (1998), Pettake (2000), Marchev (2000), Franz Neubauer (2001), etc (fig. 12). In this Atlas we present only those processes concerning the plate tectonics, and show to be of an interst on formation of mineral deposits and their spatial layout. These processes can not be limited on specific spatial sectors because they are associated with subduction of oceanic and continental plate.

Geohistorical evolution of the terrain in our country and neighbouring territories and wider, in the period after Paleosoic, was in a tight relation with Tethys evolution.

In addition to the processes related to the Tethys, we should also take into consideration the relative movements of these plates (European, Asian, African and Arabian), in general function of plate tectonics.

Geodynamic evolution of Vardar zone involves early Triasic processes, along the tectonic borders of the microplate on the Norhteast (NE) of Gondwana, (Dimitrijević, 1982; Pamić, etc. 2002, Robertson 2002, Dilek etc 2005).

So, on the NE side of the Gondwana there was an oceanic rift development during the mid and late Triassic (Bortolotti and Principi, 2005; Bortolotti etc. 2007). As a result of the riftogene phase, a big oceanic basin was formed, which is characterized with MOR oceanic/lithosferic oceanic (Çollaku etc, 1992, Bebien 1998, Pamić 2002, Bortolotti 2004, 2008, Saccani 2004 etc.).

Convergence started during the early Jurassic, with in-oceanic subduction, followed by creation of new oceanic lithosphere in the forearc basin (Beccaluva

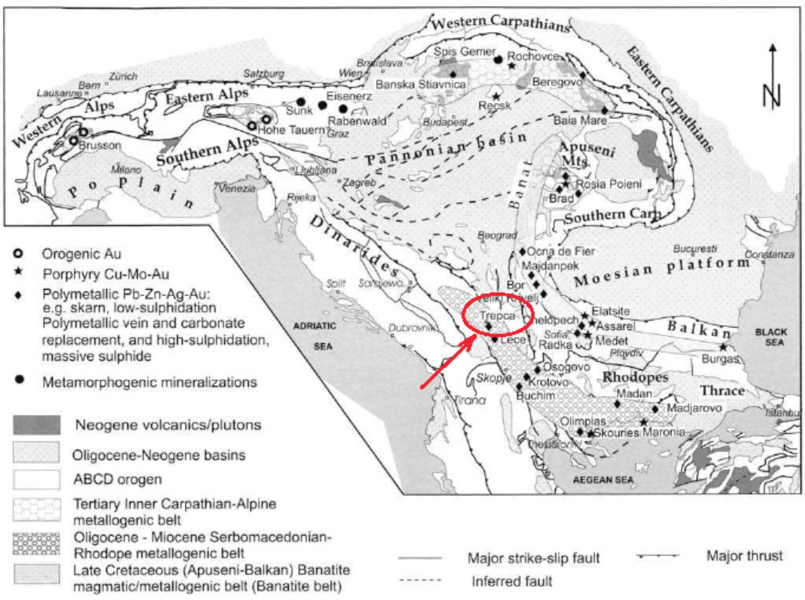


Figure 12. Schematic presentation and distribution of main tectonic units, with mineral deposits in region Alpine-Balcanic-Carpate-Dinaride (ABCD) according to Neubauer 2001.

1994, Shallo 1994, Bortolotti 2002, Hoeck 2002, Dilek 2007, Saccani 2008a). During the plates convergence, oceanic lithosphere is totally consumed, whereas continental borders get closer to subduction zone in mid-Jurassic to the late Jurassic, where the oceanic lithosphere was obducted over the continental plate of Adria (Çollaku 1992, Robertson and Karamata 1994, Dimitrijević 2001, Pamić 2002, Bortolotti 2004b, 2005, Djeric´ 2007, Gawlick 2008 etcj.). The convergence between the plates of Adria and Auroasia resulted with a collision Convergence between Adria and Eurasian plates resulted in a collision then, as a result of compressive forces. The age of this phase is still contentious issue of some authors (Pamić 2002), for what they suggested the Late Jurassic and Early Cretaceous. While others (Schmid 2008), suggest that continental collision occurred later, in the upper Cretaceous Early Paleocene.

However, tectonics continued in the interior area of the Dinaric Hellenic Belt, meaning in the Vardar Zone and the Serbo-Macedonian-Kosovar massif, where with a turning from the forces of deformation into the expansion, assumed to have occurred in the early Tertiary (Dinter, 1998, Zelic 2010 etc.).

Vardar Zone, continental collision was followed by the granitoides intrusions chalco-alcalined, mainly in the late Eocene early Olygocene (Pamić and Bale, 2001).

Vardar Zone was considered as a suture developed after the collision between the Euro-Asian plate and Adrias, as identified with Adrias plate deformation forces (Kilias et al.1999, Zelić 2010 etc.).

These processes have been developed in the former Tethys spaces, but for us it is important the part of the segment that corresponds to the Vardar zone (where the Trepça ore belt, occures) and the area continues to Izmir-Ankara-Anatolia (Jankovic.S. 1977).

Special group of deposits represent those related to subduction of oceanic crust under the continental crust during Eocen-Olygocene to Plyocene.

Figure 13. Vardar zone with *Trepça* mineral belt .

Deposits that occur in the area of subduction of oceanic crust and continental crust, can be classified into:

- Magmatogenous deposits, associated with magmatic complex (intermediate), Plutonic volcanic-deposits related with volcanogenous-sedimentary complex, and
- sedimentary deposits in the basin of Neogene, to the line of depression in the zone of a continents collision.

The collisions of these continents in terms of thermodynamics have been analyzed by Birdi (1975). Magmatism (hybrid) that emphasizes Karamata (1982), displayed on the area of continental crust, so it responds to the same area where the ophiolitic melange occurs. Ophiolitic complex in the Vardar Zone has a great expansion and belongs to evolution of oceanic crust of Jurassic.

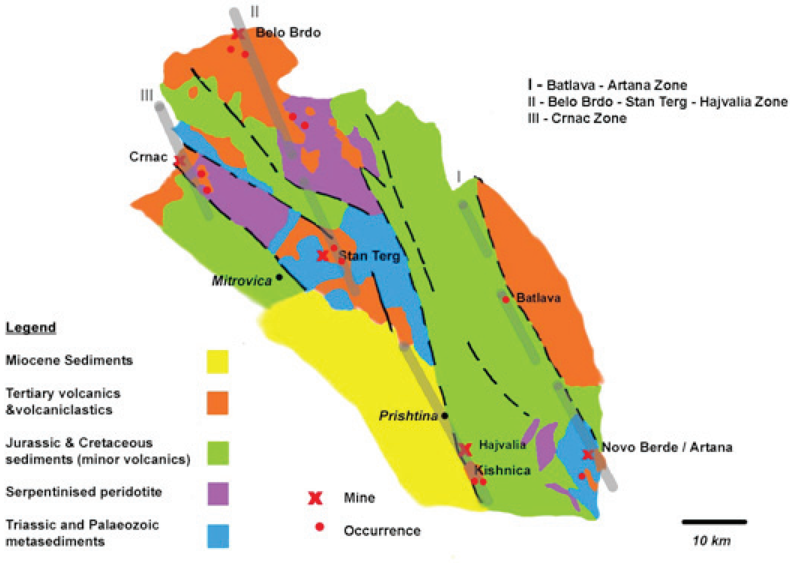


Figure 14. Mineralisation belt of *Trepça* and its main structures

Continental magmatism occurences, which are a consequence of the Aegean subduction, under which all calcium-alcaline magmatism of the Vardar zone was developed in the Tertiary with typical polymetalic scarn and hydrothermal-metasomatic mineralisations of Pb- Zn-Ag.

The lead-zinc deposits are located in the area of subduction in Central Balkan (Cenozoic) and lie on the territory of former Yugoslavia, then in Kosovo, partly in Greece and continues in the central part of Anatolia, (fig. 13). Today, the known deposits of lead and zinc, are genetically linked with the Plutonic-volcanogenous complex, formed by collision of plates and divided into many types:

- Mineral deposits linked with volcanic mechanism, as Stantërg main ore body.
- Hydrothermal metasomatic deposits in carbonatic rocks. Mineral deposit "Përroi i Ngjyrosur" in Artana, and deposits under exploration: Kaltrina, Përroi i Thartë and some ore bodies of Stantërg, Hajvalia and Sase-Toranicë (Macedonia).
- Skarn deposits in contact with limestones; for example, ore bodies in Stantërg and Bellobërdë.

Based on the petrochemical studies of volcanic rocks in Trepça mineralization belt, we have to do with a orogenic magmatism.

Calcium-alcaline and potasic calcium-alcaline, are characteristics for the Tertiary volcanism in Kosova, which explains the phenomena of the continent-continent, or continent - island arc collision (Inoccenti etc 1982). These are generative zones of typical orogenic volcanism of the calcium-alcaline, calcium-alcaline-potasium serie, mainly belongin to andesite and acidic magmas, which dominate in this mineralisation belt. From the aspect of time and space, the complex of these structures in this region, generally belongs to magmatism genesis with a serial tectonic movements with priority of convergence collision.

3.1
Regional geology of Trepça

From geological point of wiev, as a characteristic and a significant importance, by local and foreign authors, has been given to "Trepça Serie", which has been interpreted in different ways, whereas, from the geological age it has been ranked in Paleozoic. According to Çiriq (1956), "Trepça Serie" belongs to Palezoic and corresponds with "Veles Serie". More detailed division of "Trepça Serie" is presented by M. Kandic (1970). Besides studying of "Trepça Serie", geologists have paid attention also to the research about the Tertiary volcanics which hosted ore mineralizations in the Trepça belt (fig. 14). In geological formation of the ore fields, these are main formations: Trepça Series (sandstone, conglomerate, black schists-phyllite, limestones and metamorphosed schists) serpentinized peridotites, gabroamphybolites, siliceous formation, upper Cretaceous depositations, Tertiary volcanic-sedminentary complex and formations of the Plyocene and Quaternary.

From the structural aspect, Stantërg deposit is located in the center of the Trepça mineralization belt, (fig. 15).

In structural terms, can distinguish three types of tectonic structures:

- **Tectonic Structures of Vardar type, with direction NNW-SSE (340-350°),**
- **Tectonic Structures of Albanik type, with direction NE-SW (30-70°),**
- **Tectonic Structures of Dinarides type, with direction NW-SE (290-310°),**

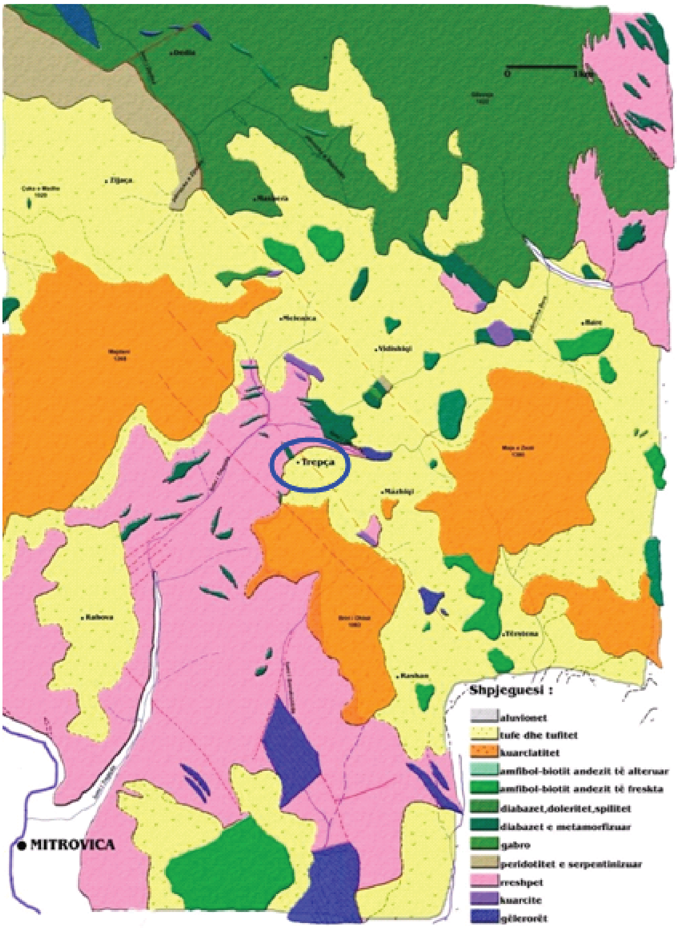


Figure 15. Geological-structural map of *Trepça* region

3.2

Morphology of ore bodies, and their positioning

Based on the geological explorations, it results that positioning and morphology of ore bodies is directly related to structural and lithological properties of the deposit. For localizing of ore bodies, of a high importance are limestones in contact with crystallized schists (phylites), and more rarely sandstones and conglomerates, (fig. 16). Structural characteristics of fractures and lithologic serie have determined this morphology of ore bodies in the deposit, as: lentil-vein ore bodies, metasomatic, pillar and shtockwerk.

With exploration mining developments and deep drillings, it is verified that central ore body has a vertical continuance more than 1500 m (fig. 17). Vertical mineralization in the Stantërg deposit, having as base all permisses of sub-volcanic deposits, and informations underlined from the study, we conclude that: It is supposed that deposit is continuing to the depth of 2500 m, which is not case for sub-volcanic deposits (Hyseni, S., Durmishaj, B., 2009). In the deposit, the central ore body as well as ore bodies around it, are characterized with changes in the horizontal and vertical plan. Main structure for depositation of ore bodies has a strike according to NW-SE direction. Sizes of ore bodies are in limits, from 100-7000 m2, with an average angle of 45-65°.

Thickness of ore bodies vary from level to level, whereas, the central ore body has an average thickness round 78.5 m.

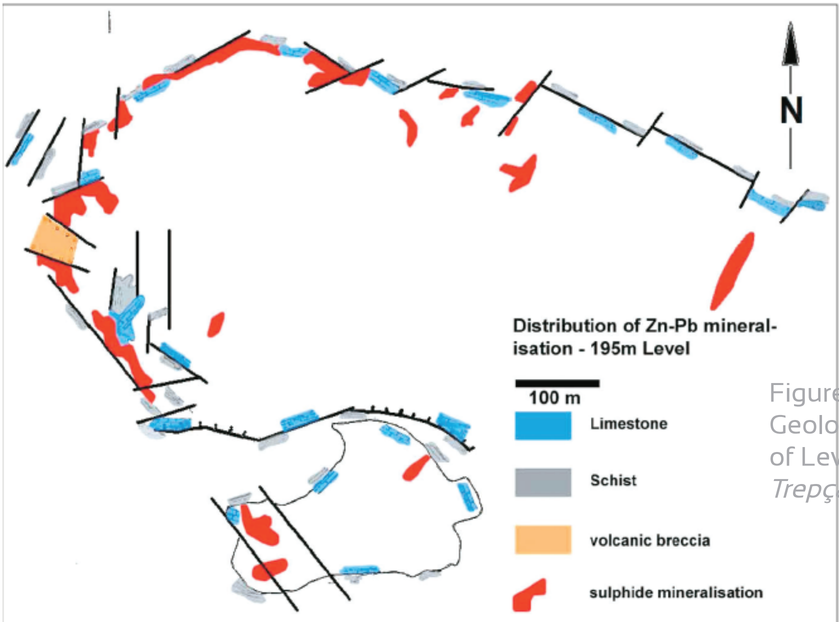


Figure 16. Geological map of Level IX (75m), *Trepça* - Stantërg.

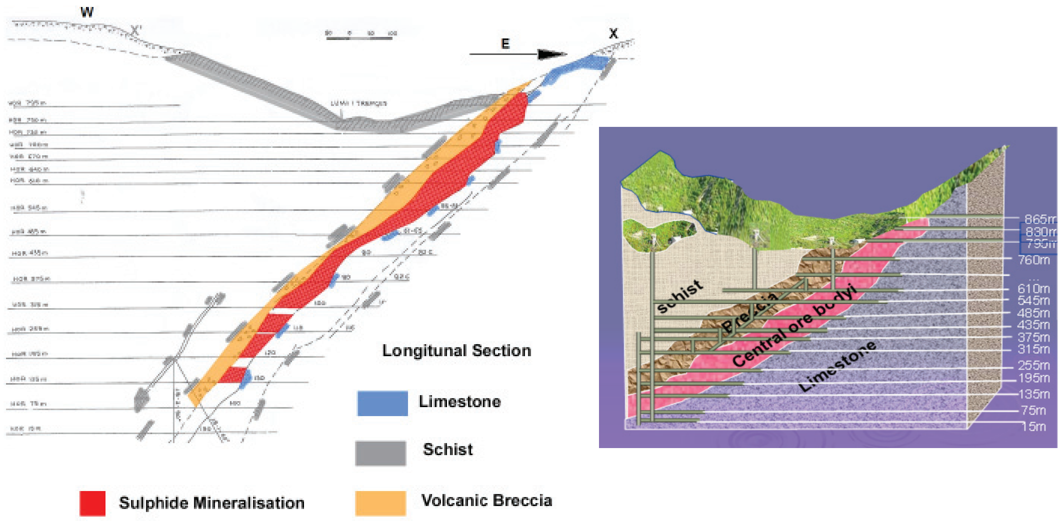
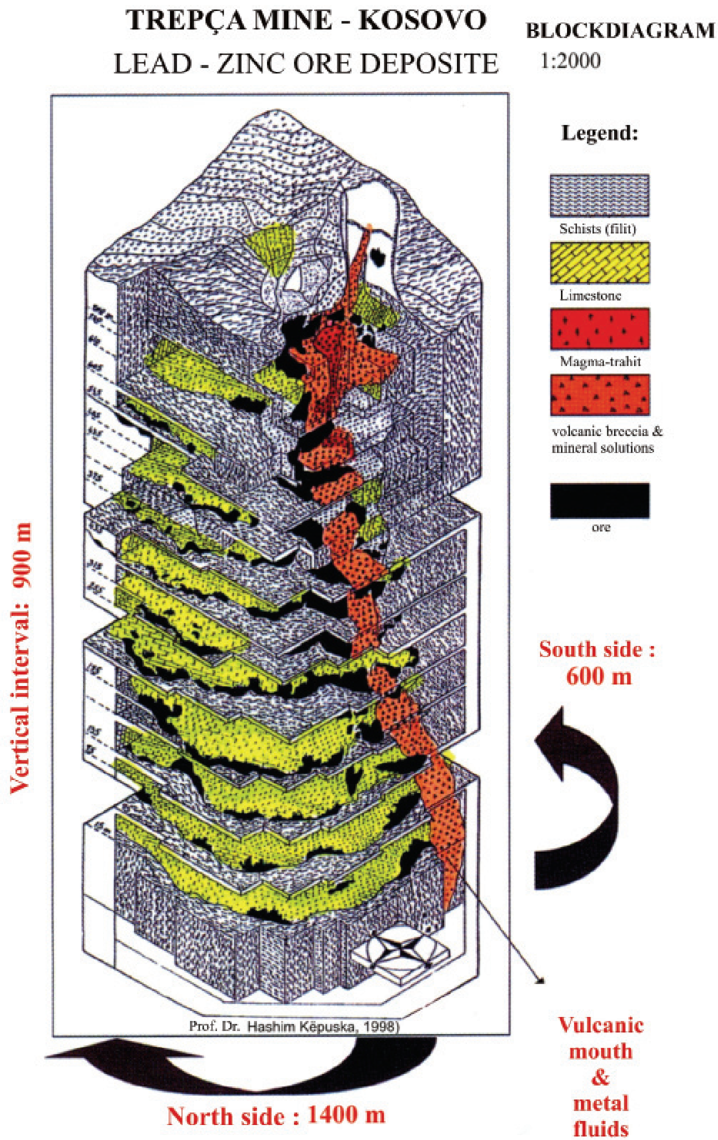
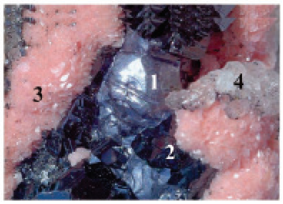


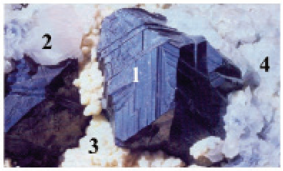
Figure 17. Longitudinal profile of central ore body in Stantërg *Trepça* deposit

Figure 18.
Picture of the Flotation plant of lead and zinc ore in *Trepça*-Tuneli i Parë.





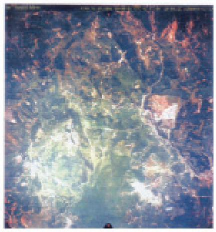
1. Galena; 2. Sphalerite
3. Rhodocrosite, 4. Calcite

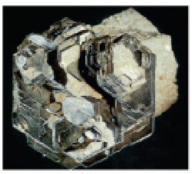


1. Sphalerite; 2. Rhodocrosit
3. Aragonite, 4. Calcite

1. Pluomosite; 2. Aragonite
3. Siderite

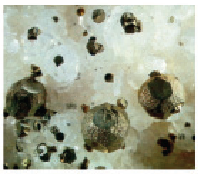
Map of Trepça Mine by Satelite





Pirotine

Dolomite, Aragonite



Pirite in the carbonate

Vivianite

Figure 19. Block diagram from Trepça deposit in Stantërg

3.3 Mineralogy and genesis of the Trepça deposit in Stantërg

Determining the types of minerals that comprise the ore deposit, pregenetic relations, as well as their ranking in continuity of their forming, represents the most important value in determining the genesis of the deposit.

Studying the genetic-pregenetic characteristics of the Trepça deposit in Stantërg, was conducted by some authors, such as Duhovnik Nikitin, 1937; Forgan, 1948; Schumaher, 1950; Smejkel, 1960; Kepuska, 1972. This shows few and very old studies related to problems of mineral genesis, and the possibility of finding new minerals in this deposit, but also in other deposits of this type.

Hydrothermal solutions from which ore has been deposited in the deposit, include electrolytes containing many compounds, such as: NaCl, KCl, CaCl2, MgCl2, ZnCl2, PbCl2, AgCl2, etc. From these solutions many associations of elements have been deposited, such as S, Fe, Pb, Zn, Ag, Bi, Cd, Cu, As, Au, Sn, Ga, In, Co, Mn, etc. Out of all these elements, concentrations of: Pb, Zn, Ag, Bi, Cd, Au, As, while less: Sn, In, Te, Se, Co, etc. have a more economic value.

Mineralogic Researches has shown that more than 60 minerals have been identified in this deposit. Associaciations of minerals in the deposit are created by hydrothermal solutions, whereas, depositation of formed minerals from solution one, two or more components, was done in a progressive continuity of a quite complex mineralization, created in the following stages:

1. Metasomatic Contact stage (with skarns and magnetites);
2. Passing stage of metasomatic-hydrothermal contact (with pyrrhotite and carbonates of Fe-Mn);
3. Hydrothermal stage (with pyrites mineral phases: pyrite-Galena-sphalerite);
4. Supergenous transformation stage.

In the deposit, from the mineral solutions of earliest phase in the stage of metasomatic contact these minerals are deposited: granate, epidote, actinolite, wollastonite, magnetite, pyrites I, pyrrhotite I and chalchopyrite I.

In the stage of metasomatic-hydrothermal contact are deposited: hedenbergite, ilvaite, pyrrhotite II, quartz I, vallerite, cubanite.

In the hydrothermal stage depositation of minerals in the deposit happened in three phases: Cata-thermal, meso-thermal and epi-thermal.
In the cata-thermal phase, or high temperatures, are created: pyrrhotite III, chalchopyrite II, pyrite II, sphalerite I, arsenopyrite II, galena I, native Bi and Mn-syderite.

In the meso-thermal phase, or middle temperatures, are created: pyrrhotite IV, chalchopyrite III, pyrites III, sphalerite II, arsenopyrite II, galena II, native Au, rhodochrosite, tetrahedrite, jamesonite, buolangerite and plumosite.

In the epithermal phase, or low temperatures, are created: quartz III, aragonite, chalcedone and barite.

In the oxidation zone, from the supergene factors, in the earlier created minerals, are formed the products of the supergene phase, as: covelite, cerusite, anglesite, vivianite, ludlamite, smith-sonite, getite, psilomelane etc.

As mentioned above, we can come to a conclusion that: magmatous bodies in the ore field of Trepça, which have given a colosale quantity of mineral resources, have hardly been formed on the subvolcanic level, therefore, according to all these premises we should look for them in deeper level then hypoabisal level. In regard of genetic classification, the Stantërg deposit is determined as a polymetalic deposit of pneumatolite forming, of metasomatic-hydrothermal contact, meaning that it has a plutonic origin.

4 MINERALS AND THEIR CLASSIFICATION

4.1

General information on minerals and their classification

Minerals are all around us. Explorations of meteorites have proven that also other celestial bodies are composed from minerals. If we search rocks in the earth, we will notice they are formed by granules of different colors, some of the granules sometimes may be of thin petal shape, some are transparent as glass, and some may be with white or black color. These different granules, simply present minerals.

Geological science, which in general studies minerals is mineralogy, whereas mineralogists study mineralogy. Word "mineral" derives from a Latin word "mineralis" that means: Everything what belongs to mine. The old word "minera" means: ore specimen or rock, from which with a pre technological-processing can obtain metals.

For better understanding of minerals, firstly must understand and know to differentiate notion "**mineral**" and "**rock**", to better explain conditions of geological stratification and distinguishing properties of minerals.

Term "mineral" has few meanings:

• "A mineral is an element or chemical compound that is normally crystalline and that has been formed as a result of geological processes". (Nickel, E. H., **1995**).

• "Minerals are naturally-occurring inorganic substances with a definite and predictable chemical composition and physical properties". (O' Donoghue, **1990**).

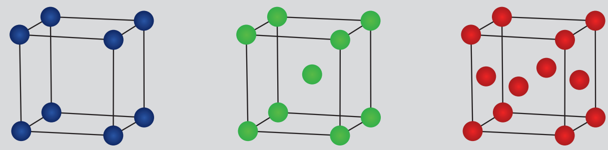
• "A mineral is a naturally occurring homogeneous solid, inorganically formed, with a definite chemical composition and an ordered atomic arrangement" (Mason, et al,**1968**).

• "Minerals can be distinguished from one another by individual characteristics that arise directly from the kinds of atoms they contain and the arrangements these atoms make inside them". (Sinkankas,**1966**).

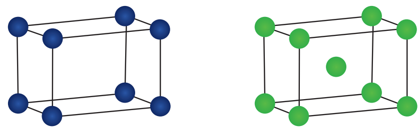
In general, minerals are natural inorganic solid bodies, with chemical composition and homogeneous setting, created as a result of physical-chemical processes which take place in the earth crust, and expressed through the crystal-chemical formula (galena-PbS, pyrite-FeS_2, etc.).

Whereas the term "**crystal**" (greek. kristalos- ice, mountain crystal) is a solid homogenous body, formed in natural or artificial conditions, inclosed from outside with flat faces and with different geometrical shapes, fig. 20a.

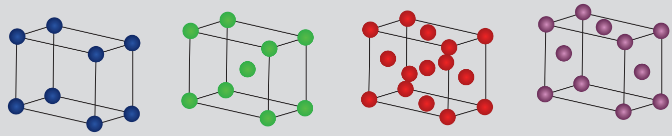
CUBIC
a = b = c
α = β = γ = 90°



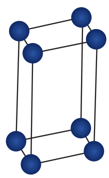
TETRAGONAL
a = b ≠ c
α = β = γ = 90°



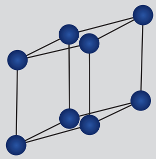
ORTHORHOMBIC
a ≠ b ≠ c
α = β = γ = 90°



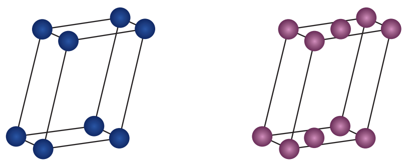
HEXAGONAL
a = b ≠ c
α = β = 90°
γ = 120°



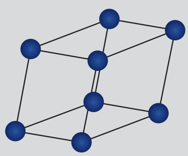
TRIGONAL
a = b = c
α = β = γ ≠ 90°



MONOCLINIC
a ≠ b ≠ c
α = γ = 90°
β ≠ 120°



TRICLINIC
a ≠ b ≠ c
α ≠ γ ≠ β ≠ 90°



4 Types of Unit Cell

P = Primitive
I = Body centered
F = Face centered
C = Base centered

Figure 20.
Crystal systems and unit cells for 14 types of lattices, August Bravais.

Figure 20a. Galena - cubic shape crystal

Since the emplacement of elementary particles in space is characterized by a certain symmetry, then, even the external form of crystals (which reflects the internal setting thereof), is characterized by a certain symmetry and expressed by the shape of faces, their repetition and reciprocal position. Based on what we said above, we note 7 singonies (systems) of crystalization (Fig. 20).

Minerals are characterized as individual crystals, conjoined crystals, and in the shape of various aggregates.

Because each mineral has certain crystalline shape, this helps in their identification. On the other hand, since the shapes of crystals and their aggregates depend on the conditions of formation, it helps to evaluate the conditions of minerals formation, ores and rocks.

The shape of crystals can be expressed in two concepts: concept of, and concept of their habit.

The appearance of crystals represents their general form, wich is conditioned by the character of crystals' growth.

Can distinguish:

- isometric view (for crystals which are more or less equaly developed in all three directions);
- pillar view (for crystals which are more developed by one direction);
- plate view (for crystals which are developed more by two directions, extended in one plane) and
- board-like view (for crystals which are developed in three directions, but in unequal way).

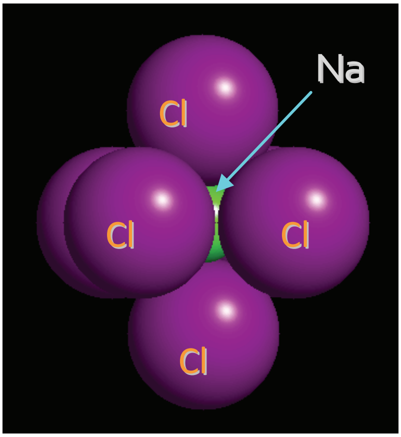
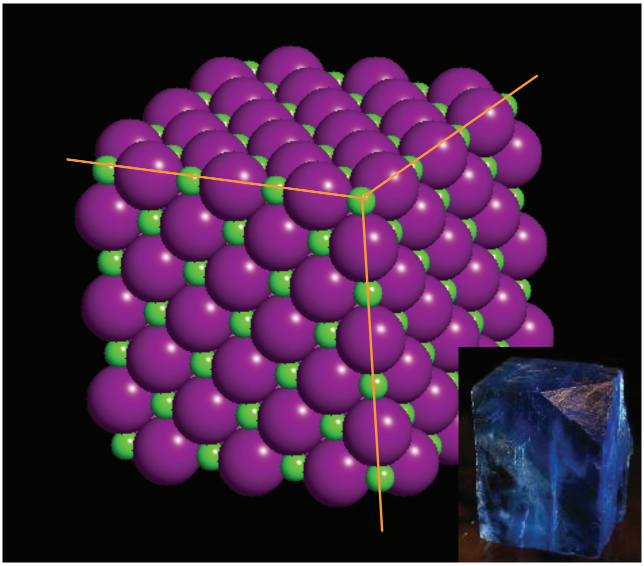


Figure 21. Crystalline lattice of halite mineral (native salt)



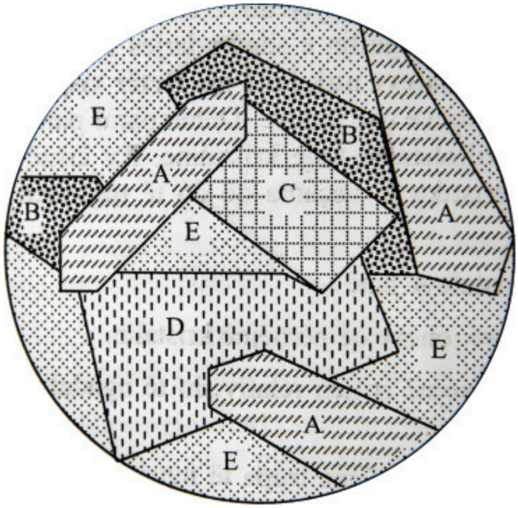


Figure 22. Microscopic wiev of an mineral, where we can distinguish five different minerals, which based on their morphology can be grouped in three main types:

A - automorphic,
B, C, D hypidiomorphic and
E xenomorphic

Crystals habit represents the completness of the faces that form a closed polyhedron. Each singoni includes crystals with certain habit.

Minerals are basic constituents of the crust of solid rock to Earth. The term mineral is not just about chemical composition, but also the structure of minerals. Two minerals may have the same chemical composition but different crystal structure. When the substance passes from the liquid aggregate state in the solid state (the phenomenon of crystallization), are formed crystals that have a regular crystalline structure, such as sodium chloride-pomeranians (popularly known as native salt), (fig. 21).

Crystallization begins with the formation of embryones, which have regular crystallographic shapes. Further, created embryones increase in a uniforme manner, until over-impregnation of feeding environment is eliminated, or until crystals block each other. Later are formed granule masses, namely crystalline aggregate, where if not all, a part of the grain do note keep their crystalline faces. Size and forms of such grains in the aggregate, depend on the shape and velocity of embryones, composition and uniformity of the surrounding, as well as velocity of the growing. In the scientific literature, for shape characterizing, is used the term morphology (from morpho- form). Mineral granules which are presented in their authentic form are called automorphe, or idiomorphic (with their form), whereas those which do not have their natural form, but they have a form which is determined by the adjoining granules are called xenomorphic (from cenos-foreign). To characterize the grains morphology when it is intermediate between the first two, so when in some parts it keeps its form, whereas in other parts no, in such cases it is used the term hypidiomorphic (fig. 22).

For crystallographers, who love more the crystalline faces, to express the perfection of crystals, they prefere terms: euhedral - for crystals which are inclosed by their crystallographic faces; subhedral - for crystals which are partly inclosed by their crystallographic faces; anhedral - for crystals which are not inclosed by their crystallographic faces (hedre-face). In this context, every research of minerals begins with the assessment of mineral's crystallographic characteristics, or in different saying, can not begin with studying of minerals without previously studying their crystallographic characteristics. Mineral properties determine their usage as well as their behaiving in the nature. So, all theoretical or applicative studies in the field of geology, environment, processing technology etc., have their commencement from mineralogical observations.

Rocks are mineral aggregates (lat.agregare-collection or union).

Thus, for example, limestone is a rock consisting only calcite ($CaCO_3$), such rocks are called monomineral (greek. mono-one). Whereas, those which are composed by two and more minerals are called polymineral (greek. polis-many), expl., granite (quartz, orthoclase and mica); gabbro (pyroxene, olivine and plagioclase) etc.

Therefore, rocks are not homogenous bodies and can not be expressed through their mineral formula but through their composition of minerals. Minerals and rocks can be distinguished in macroscopic mean, as it is shown in the figure, (fig. 23).

4.2 Minerals' classification and some of their characteristics

Until today, around 7000 names of minerals are known, from which round 4000 are individual minerals, whereas others are only denomination of types. Minerlals' denominations are different and based on their properties, chemical content and place in which they were found, or according to the name of different scientists.

Such a big number of minerals is hard and difficult to be studied without their classification.

In today's classification, basic is the crystalochemical principle, meaning, relation of mineral properties from the chemical content point of vire, physical properties and crystalline structure.

As stated above, the minerals are divided into: groups, types, classes and subclasses, taking into account the content of their silicon component, the types of chemical bonds, and the type of composition, crystal structure and similarities between them.

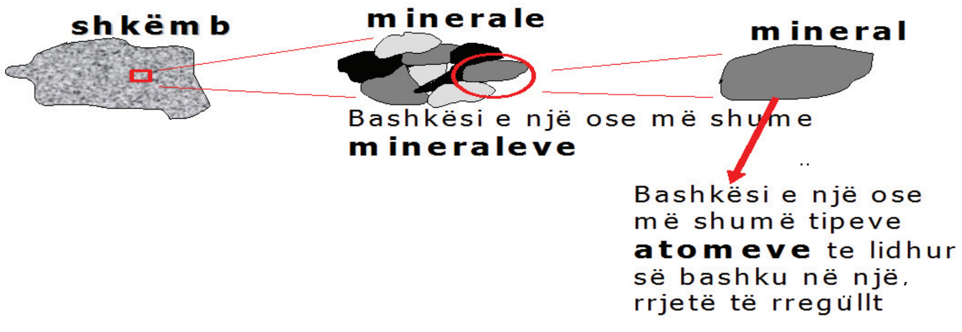


Figure 23. The interconnection scheme between terms:
Rock - Minerals - Mineral

5 MUSEUM OF TREPÇA CRYSTALS

5.1 IMPORTANCE OF THE MUSEUM OF TREPÇA MINERALS

Many years of mining activity in *Trepça* mine, besides the production of lead-zinc ore, mineral specimens have been taken out from the underground continuously, what makes this deposit even more valuable.

The entire collection of specimens that the old museum in Stantërg has today, (fig. 24) is a merit of many generations: of workers and engineers of the mine, who have been working in exploration and exploitation of Pb-Zn mineralisations in *Trepça*. All this illustrates the importance of Crystals' Museum and the *Trepça* mine itself.

Furthermore, minerals' museum has its own importance and will grow in importance in the near future, for numerous visitiors from all over Republic of Kosovo and visitiors coming from other countries.

Figure 24. Pictures of the old museum in Stantërg

It has even more importance for the new generations, because the museum of minerals-crystals we have today, in the future, this museum will present an even better possibility to understand mineral wealth the deposits of *Trepça* in Stantërg in a better manner. The museum serves as an impulse for their orientation and increasing of the conscience with a purpose of advancing the science and new technologies.

The following graph shows a road scheme from Mitrovica town to the old Trepça Minerals' Museum in Stantërg, (fig. 25). It is of an importance to mention that while we are preparing this mineralogical atlas for the marvelous collection of crystals; at the same time, new building for the Minerals' Museum of *Trepça* in Stantërg is under construction (in the final stage).

Figure 25. Scheme: Roadway Mitrovicë Minerals' Museum of *Trepça* in Stantërg

6 TREPÇA MINERALS

Trepça Minerals

There are more than 60 known minerals in the mineral deposit of Trepça in Stantërg, (tab.1 and fig.26). Currently, 20 of them are in the collection of Trepça museum

Elements

Bismuth	Bi
Gold	Au
Sulfur	S

Oxides and Hydroxides

Chalcophanite	$(Zn,Fe,Mn)Mn_3O_7 \cdot 3H_2O$
Coronadite	$Pb(Mn^{4+},Mn^{3+})_8O_{16}$
Hematite	Fe_2O_3
Magnetite	Fe_3O_4
Limonite	$FeOOH$

Phosphates

Childrenite	$(Fe,Mn)AlPO_4(OH)_2 H_2O$
Crandallite	$CaAl_3[(OH)_5 \mid (PO_4)_2] \cdot H_2O$
Ludlamite	$Fe_3(PO_4)_2 4H_2O$
Struvite	$NH_4MgPO_4 \cdot 6H_2O$
Vivianite	$Fe_3(PO_4)_2 8H_2O$

Sulphides and Sulfosalts

Arsenopyrite	$FeAsS$
Bornite	Cu_5FeS_4
Boulangerite	$Pb_5Sb_4S_{11}$
Bournonite	$PbCuSbS_3$
Chalcopyrite	$CuFeS_2$
Cosalite	$Pb_2Bi_2S_5$
Covellite	CuS
Cubanite	$CuFe_2S_3$
Enargite	Cu_3AsS_4
Falkmanite	$Pb_{5.4}Sb_{3.6}S_4$
Galena	PbS
Jamesonite	$Pb_4FeSb_6S_{14}$
Löllingite	$FeAs_2$
Marcasite	FeS_2
Pyrargyrite	Ag_3SbS_3
Pyrite	FeS_2
Pyrrhotite	$Fe_{1-x}S$
Sphalerite	ZnS
Stannite	Cu_2FeSnS_4
Antimonite	Sb_2S_3
Tennantite	$(Cu, Ag)_{12}As_4S_{13}$
Tetrahedrite	$(Cu, Ag)_{12}Sb_4S_{13}$
Valerite	$4(Fe,Cu)S\text{-}3(Mg,Al)(OH)_2$
Plumosite	$Pb_2Sb_2S_5$
Marmatite	$(Zn,Fe)S$

Carbonates

Ankerite	$CaFe(CO_3)_2$
Aragonite	$CaCO_3$
Calcite	$CaCO_3$
Cerussite	$PbCO_3$
Dolomite	$CaMg(CO_3)_2$
Kutnahorite	$Ca(Mn,Mg,Fe)(CO_3)_2$
Rhodochrosite	$MnCO_3$
Siderite	$FeCO_3$
Smithsonite	$ZnCO_3$

Silikates

Actinolite	$Ca_2(Mg,Fe)_5 OH(Si_4O_{11})_2$
Andradite	$Ca_3Fe_2(SiO_4)_3$
Diopside	$CaMg Si_2O_6$
Epidote	$\{Ca_2\}\{Al_2Fe^{3+}\}[O \mid OH \mid SiO_4 \mid Si_2O_7]$
Hedenbergite	$CaAlSi_2O_6$
Ilvaite	$CaFe_2Fe[O \mid OH \mid Si_2O_7]$
Quartz	SiO_2
Wollastonite	$CaSiO_3$

Sulfates

Anglesite	$PbSO_4$
Barite	$BaSO_4$
Chalcanthite	$CuSO_4 5H_2O$
Gypsum	$CaSO_4 2H_2O$
Melanterite	$FeSO_4 7H_2O$

Volframites

Scheelite	$CaWO_4$

Tabele 1. Minerals and mineral occurences in the deposit of *Trepça* in Stantërg.

Elements	Cd	In	Ga	Tl	Se	Bi	Cu	As	Sb	Sn	Ag	Mn	Ni	Co	Hg	W	Ti	Ba	Mo
Minerals																			
Sphalerite	2640	110	6	3	2	14	237	167	55	25	33	2780	1	2	16	4			
Galena	51	40		29		461	108	131	389	43	214	228	6	11	185		11	2	
Pyrrhotite	8	10	2			26	1060	436	72	4	19	185	3			20	2		2
Pyrite	14	9	3			20	144	3270	68	6	16	111	4			34	16		

Tabele 2. Average content (ppm), of diffusive and conductive elements in sulfide minerals in *Trepça* deposit of Stantërg (H.Këpuska, 1998).

Trepça Mineral Deposit of Pb-Zn

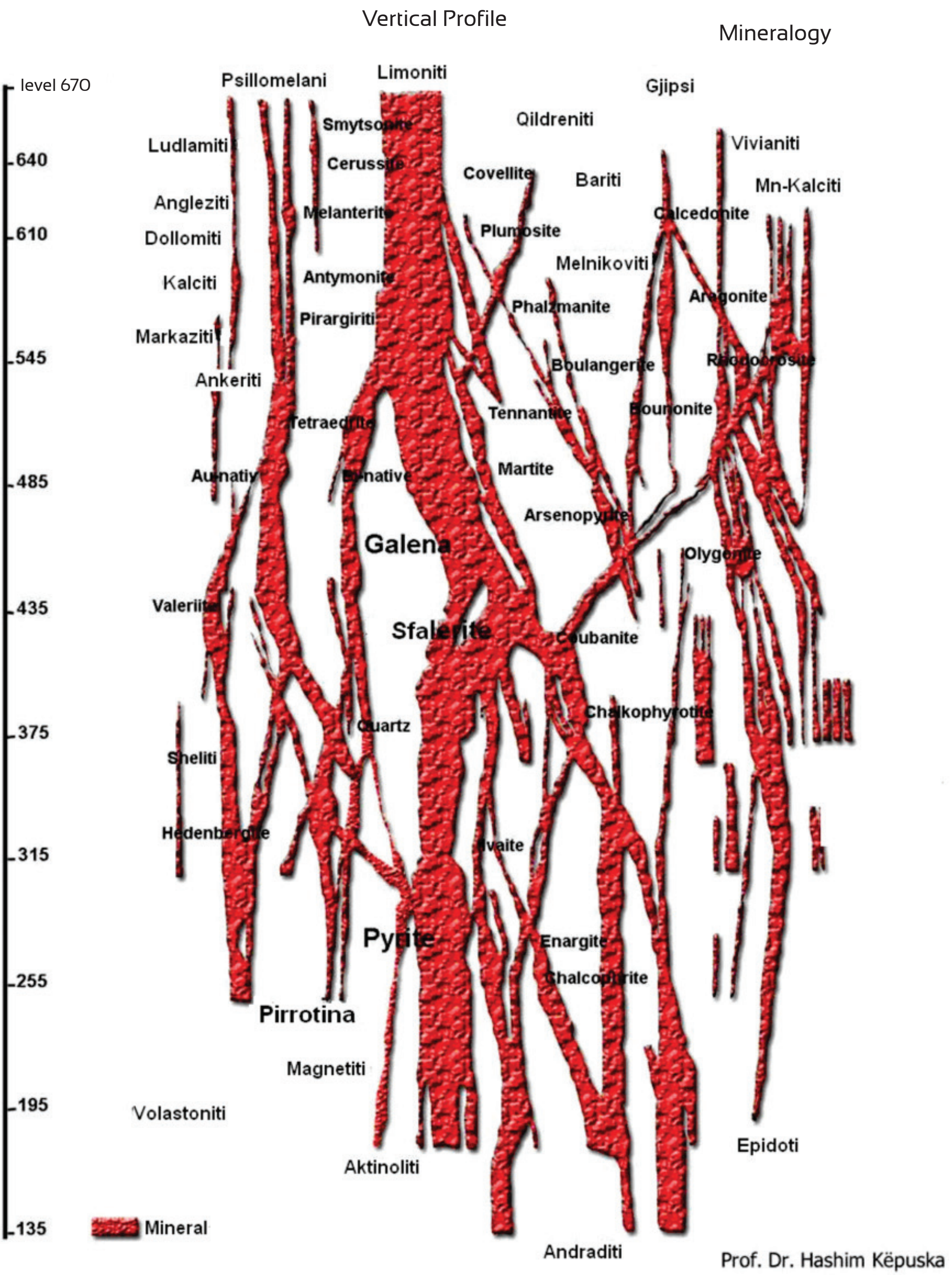


Figure 26

TREPÇA MINERALS

6.1 THEORETICAL INFORMATION FOR SOME PROPERTIES AND USAGE OF MINERALS

6.1.1 Native elements

Are simple and pure elements, which do not contain anions and poly-anions. Native elements may be: metals, semi-metals and non-metal, as: gold, bismuthe, sulfur, carbon, etc.

6.1.2 Sulphides and Sulfosalts

In general, these types of minerals in them contain sulfur (S), and represent their main anione. Minerals that contain elements: As, Se, and Te, as anione belong to this class of minerals and called arsenide, selenide and teluride respectively. Within the sulfur and sulfosalts, from microscopic studies on the Stantërg deposit, these minerals are met: sphalerite, galena, pyrites, pyrrhotite, chalchopyrite, enargite, cubanite, arsenopyrite, marmatite, tetrahedrite, burnonite, tennantite, jamesonite, boulangerite, marcasite, pyrargirite, falkmanite, antimonite, melnikovite, plumosite, covellite and chalchopyrite (Smejkal. S. 1960).

However, in the museum's fund of Trepça can be found these minerals of this class: sphalerite, galena, pyrites, pyrrhotite, chalchopyrite, arsenopyrite, marmatite, jamemsonite, antimonite, plumosite.

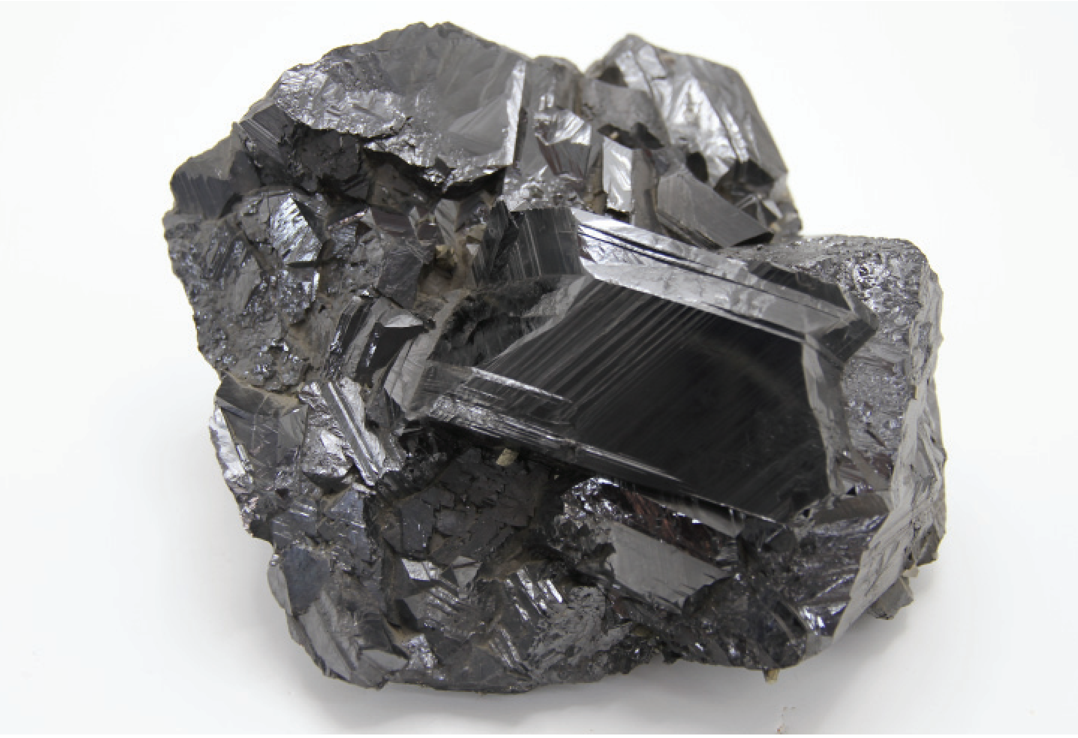
Sulphides and Sulfosalts

SPHALERITE - ZnS, zinc sulphide

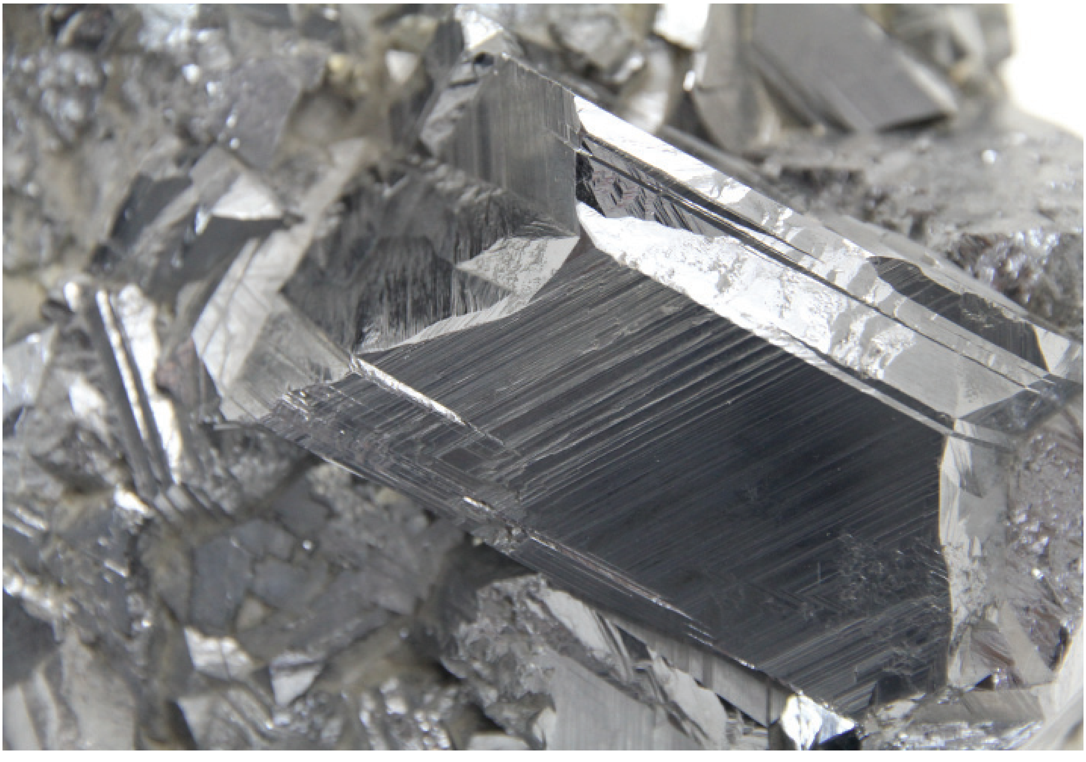
Chemical clssification	Sulphide
Sistem	Cubic
Hardness	3.5 - 4.0
Density	3.9 - 4.1 g/cm^3
Cleavage	Perfect, dodecahedral
Luster	Metallic
Colour	Pale yellow, light brown, black, red, green, white, colorless
Genesis	Magmatic-hydrothermal veins of high, middle and low temperatures. Possible to be sedimentogenous but rarely.
Associates	Galena, pyrite, chalcopyrite, quartz, calcite, as well as other minerals of same pre-genesis.
Usage	Primary zinc mineral, widely used for production of alloy with other metals, for production of galvanic equipments, for production of paintings, rubber industry, in medicine etc.

Crystalised granules of sphalerite (black) with some small pyrite crystals (yellow), calcite (white), and quartz (white)

Marmatite-(Zn, Fe)S with some granules of quartz and dolomite crystals



MARMATITE - (Zn, Fe)S, zinc sulphide with iron
(Sphalerite variety)

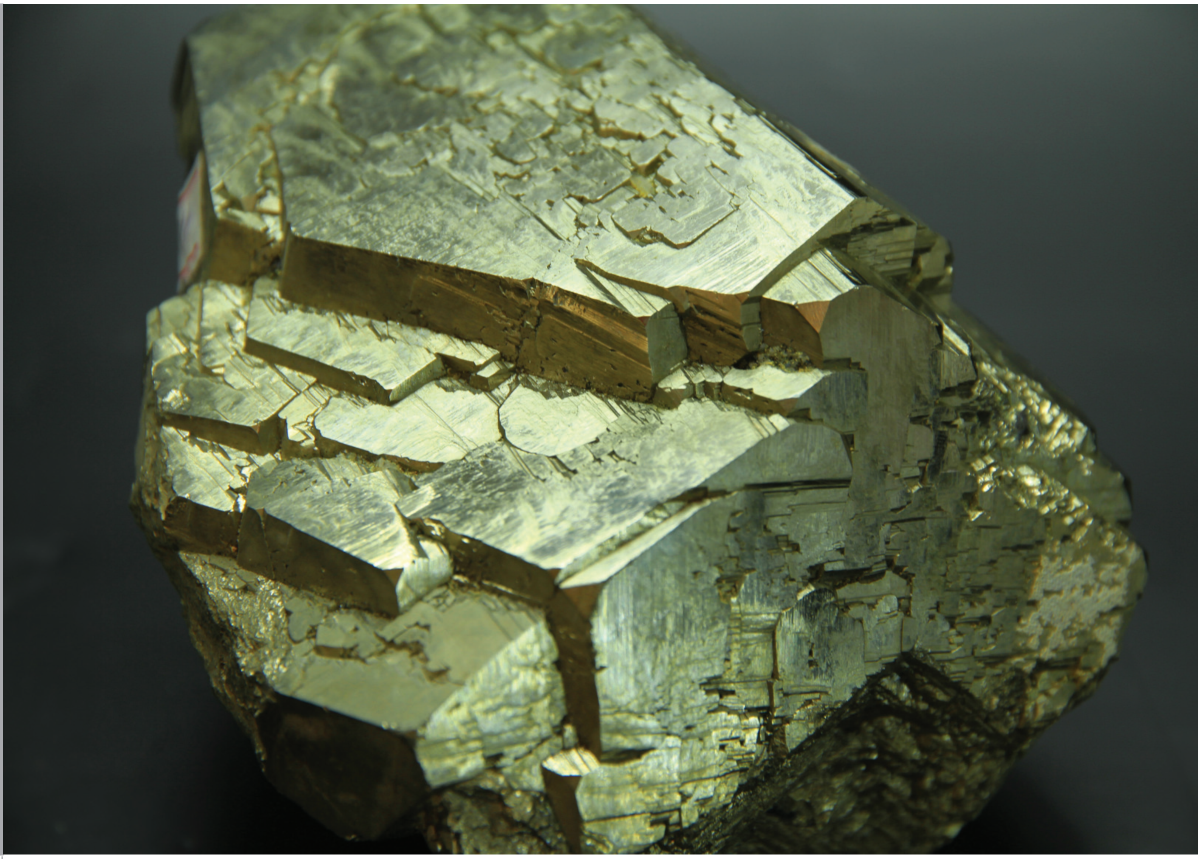


GALENA - PbS, lead sulphide

Chemical clssification	Sulphide
Sistem	Cubic
Hardness	2.5-3.0
Density	7.4 - 7.6 (g/cm^3)
Cleavage	Perfect, cubic
Luster	High metallic
Colour	Gray to lead
Genesis	Magmatic- vein-hydrothermal of high, middle and low temperatures.
Associates	Always with sphalerite, but also with pyrite and pyrrohtite, chalchopyrite, arsenopyrite, calcite, dolomite, rhodochrosite, as well as with anglesite and cerusite, etc.
Usage	Important lead mineral, in battery industry, for production of alloys with other metals, cables industry, military industry, typography and Rtg.technice, as well as in production of white colors, etc.

Galena crystals

PYRITE - FeS_2, iron sulphide



Chemical clssification	Sulphide
Sistem	Kubik
Hardness	6.0-6.5
Density	4.9-5.2 (g/cm³)
Cleavage	Not distinct
Luster	High metallic
Colour	Pale gold yellow, strawy color, yellow to brown, etc.
Genesis	Polygenetic, but the important one is the hydrothermal vein and metasomatic type.
Associates	Mainly with sphalerite and galena, pyrrhotite, arsenopyrite, chalchopyrite and many other minerals, as: barite, quartz, calcite, and other minerals of the same pre-genesis.
Usage	Mineral which is not used for extraction of iron, because sulfur is harmful component in the clean iron quality. Whereas, it is mostly used in the chemical industry for extraction of the sulfuric acid.

ARSENOPYRITE - FeAsS, iron and arsenic sulphide

Chemical clssification	Sulphide
Sistem	Monoclinic
Hardness	5.5-6.0
Density	5.9-6.2 (g/cm^3)
Cleavage	Distinct
Luster	Metallic
Colour	White to silver, metallic gray as tin, etc.
Genesis	Magmatic-vein hydrothermal, middle and low temperatures.
Associates	With chalchopyrite, sphalerite, enargite, cuprite, casiterite, siderite and other sulphide minerals.
Usage	Is a mineral form which can extract arsen which after is widely used in different economic fields and especially in agroculture, glass industry, medicine, chemical industry, in military, etc.

Arsenopyrite

ANTIMONITE - Sb_2S_3 , antimonite sulphide

Chemical clssification	Sulphide
Sistem	Orthorhombic
Hardness	2
Density	4.6 - 4.7 (g/cm^3)
Cleavage	Perfect
Luster	High metallic
Colour	Gray to lead
Genesis	Hydrothermal, mainly of middle and low temperatures, related to volcanic acitvity and is found in eruptive-volcanic rocks in form of apophysis in Pb and Ag ore.
Associates	Auripigment, realgar, galena, pyrite, cinnabarite, carbonates and quartz, arsenopyrite, etc.
Usage	Is an important antimonite minreal. It is used in the industry of paints, and pharmaceutics and medicine industry, etc.

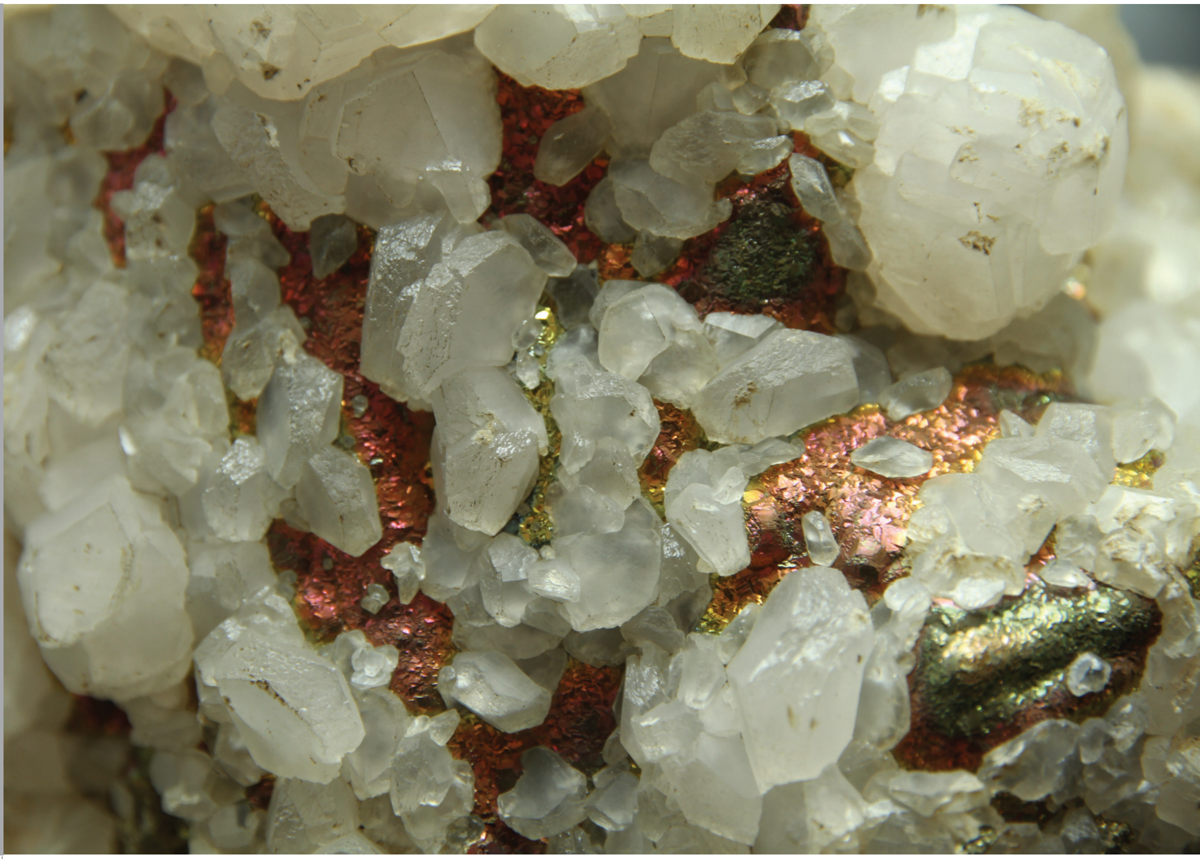
ANTIMONITE
antimonite sulphide

PYRRHOTITE - $Fe_{1-x}S$, iron sulphide

Chemical clssification	Sulphide
Sistem	Monoclinal (pseudohexagonal)
Hardness	3.5-4.5
Density	4.5-4.8 (g/cm^3)
Cleavage	None observed
Luster	Metallic
Colour	Bronze yellow, bronze red, dark brown
Genesis	Poligenetic (pegmatitogenetic, hydrothermal and metamorphic, more less to be exogene).
Associates	Pntlantite, pyrite, chromite, quartz, chalcopyrite, galena, sphalerite, but also with iron minerals of sedimentogenous origin (limonite, siderite) etc.
Usage	Is an iron mineral used to obtain sulphuric acide. It is important also for extraction of nikel and cobalt when there is high content in it.

Pyrrhotite with some galena granules (gray), quartz (white), calcite (white) and pyrite (yellow)

CHALCOPYRITE - $CuFeS_2$, copper and iron sulphide



Chemical clssification	Sulphide
Sistem	Tetragonal
Hardness	3.5-4.0
Density	4.1-4.3 (g/cm^3)
Cleavage	Indistinct
Luster	Metallic
Colour	Yellow to golden, usually dark brown or pale rainbow color, etc.
Genesis	Hydrothermal vein of high and middle temperatures and of metasomatic contact.
Associates	With main lead-zinc minerals (galena, sphalerite) as well as cooper minerals (bornite, chalcosine, coveline, etc).
Usage	Is a very important mineral for extraction of cooper. Wide usage of cooper in different fields caused a continous growth of requirements for this metal.

Kalkopiriti (e verdhë në të bronzt),
rodokrozit (rozë) dhe kalcit (e bardhë)

JAMEMSONITE - $Pb_4FeSb_6S_{14}$, lead sulphide with iron and antimony

Chemical clssification	Sulfosalt
Sistem	Monoclinic
Hardness	2.5-3.0
Density	5.5-6.3 (g/cm^3)
Cleavage	Distinct/good
Luster	Metallic
Colour	Grey to lead color
Genesis	Magmatic – hydrothermal of middle and low temperatures. Jamesonite type without iron is known as Plumosite, characteristic for Stantërg dposit.
Associates	With Pb-Zn sulphides (pyrite, sphalerite, galena, tetrahedrite, boulangerite, etc.), cooper minerals and carbonates, etc.
Usage	It does not have any economical importance.

PLUMOSITE - $Pb_2Sb_2S_5$, sulfur i plumbit me antimon

Chemical clssification	Sulfosalt
Sistem	Monoclinic
Hardness	2.5-3.0
Density	5.5-6.3 (g/cm^3)
Cleavage	None
Luster	Metallic
Colour	Gray to lead color
Genesis	Magmatic – hydrothermal of low and middle temperatures.
Associates	With sulphide minerals of Pb-Zn (pyrite, sphalerite, galena, tetrahedrite, boulangerite, jamesonite etc.), cooper minerals and carbonates etc.
Usage	It has no economic importance.

Needled plumosite in hair shape with quartz

Needle druse of antimonite

Sphalerite (black), with small pyrite granules (yellow)

Pyrite specimen

Plumosite with rhodochrosite

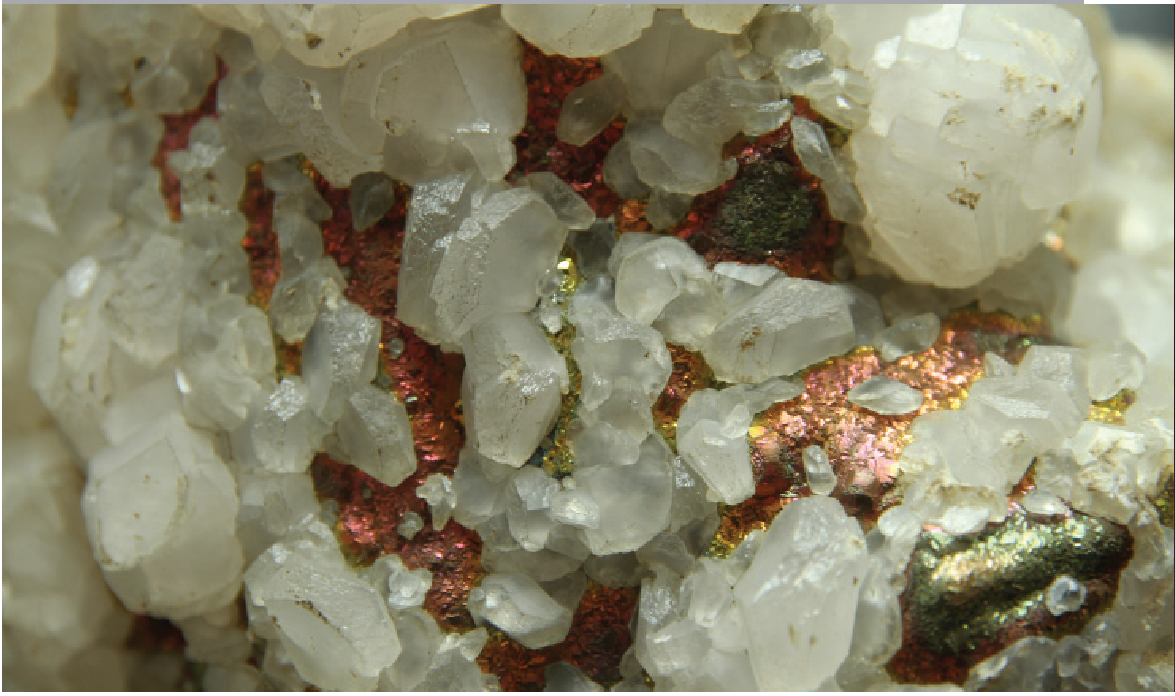
Pyrrhotite with some sphalerite granules (black)

Excellent pyrite twin

Marmatite - (Zn, Fe)S with some dolomite granules on top

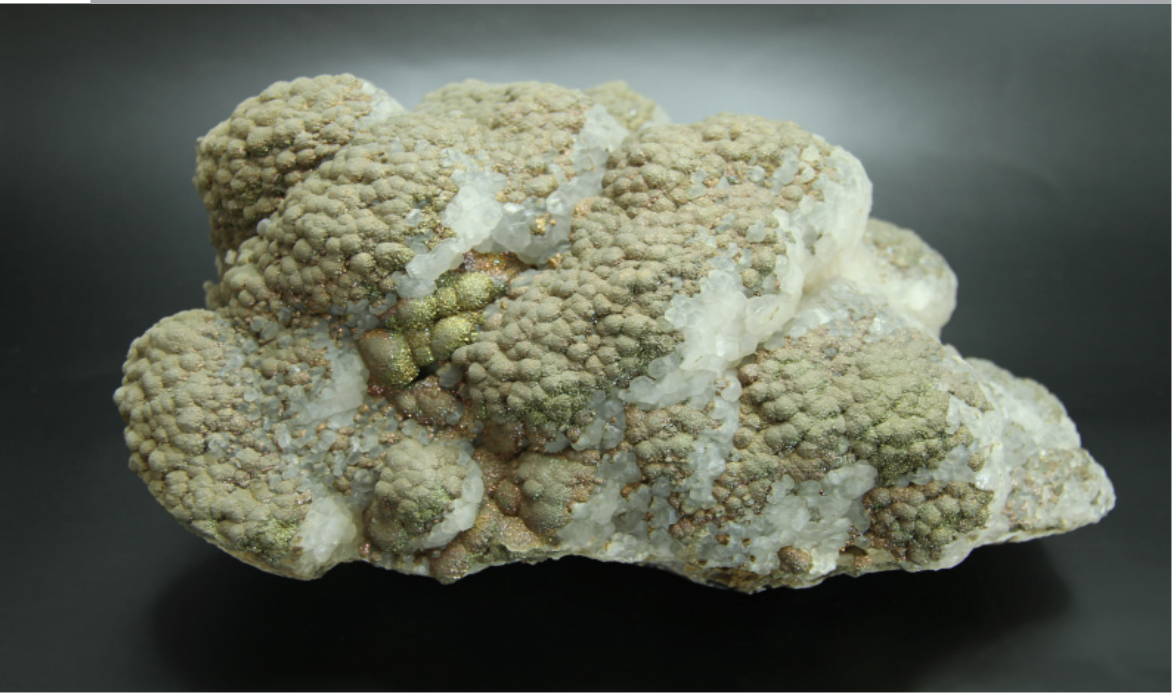
Marmatite (Zn, Fe)S

Chalcopyrite with calcite crystals



Arsenopyrite

Chalcopyrite, charachteristic crystal granules



Twin arsenopyrite crystals

Galena granules (gray)

Arsenopyrite with different granule sizes

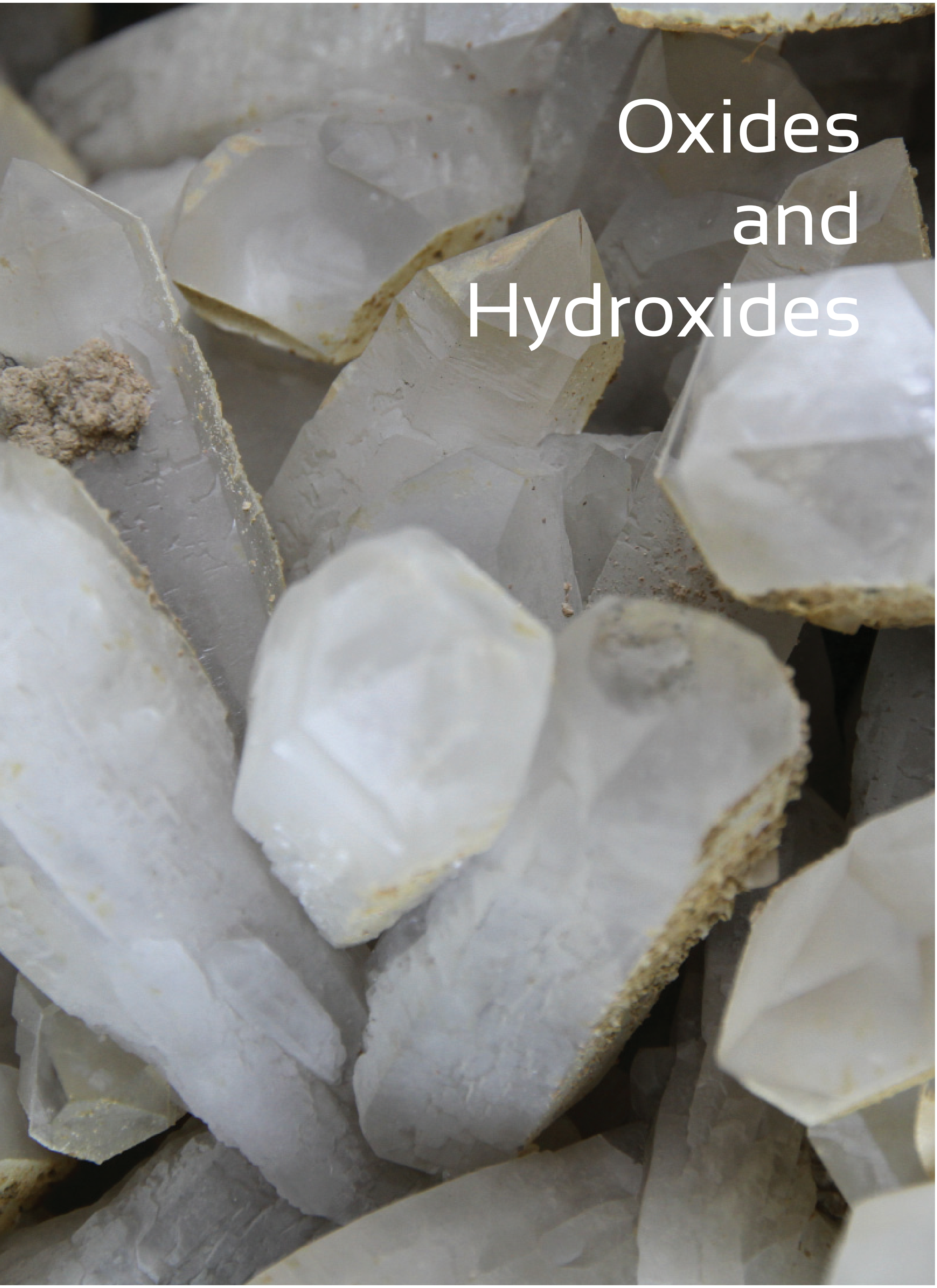
Marmatite (sphalerite variety)

Jamesonite, interlacing its needled crystals with galena granules inside (gray) and surrounded with dolomite

6.1.3

Oxides and Hydroxides

Characteristic for minerals of this class is anion (O^{-2}), radical (OH^{-}) respectively. Minerals of this class found in Stantërg deposit, are: Magnetite, limonite, psilomelane, chalcedone, but in the museum there is only quartz.



Oxides and Hydroxides

QUARTZ - SiO_2, silicon dioxide

Chemical clssification	Silicone dioxide
Sistem	Trigonal-Hexagonal
Hardness	7 according to Mohs scale
Density	2.65 (g/cm^3)
Cleavage	None
Luster	Vitreous
Colour	Colorless, colored (yellow, red, blue, white, etc) depending from isometric elements in its lattice.
Genesis	Magmatic-pegmatogenous, pneumatogenous and hydroithermal, found also in the sedimentary formations but of other varieties (crystobalite, chalcedone, opal) etc.
Associates	With feldspar, amphibolites, pyroxene and sulphide minerals of Pb, Zn, but also Cu etc.
Usage	Electronics, paste, clocks, glass, porcelain, ceramics, in construction and as a decorative stone, etc.

Beautiful and characteristic quartz crystal.

Quartz specimen

Prismatic and needled druse of quartz crystals

6.1.4 CARBONATES

On itself contains anion group $(CO_3)^{-2}$ where C^{+4} is surrounded by three anions (O^{-2}) in a plain triangle. In the Stantërg deposit, from minerals of this class are: Cerusite, smithsonite, Mn-calcite, dolomite, calcite, aragonite, rhodocrosite, ankerite, oligonite, malahite, azurite. Below we will present some theoretical data to those found in the museum's fund *Trepcça* crystals.

CARBONATES

KALCITI - $CaCO_3$, karbonat kalciumi

CARBONATES

Chemical clssification	Carbonate
Sistem	Trigonal/Hexagonal
Hardness	3.0
Density	2.7 (g/cm^3)
Cleavage	Rhomboedral Perfect
Luster	Vitreous
Colour	Usually whitw or colorless, can be of: gray, red, green, yellow, brown, orange, etc.
Genesis	Exogenous-sedimentary of chemical character, organic and fragmentation, but also hydrothermal of low temperatures.
Associates	Barite, dolomite, Celestine, as well as sulphides of lead, zinc etc.
Usage	Used as a construction material, abrasive, for soil treatment to neutralize acids, in pharmacy, etc.

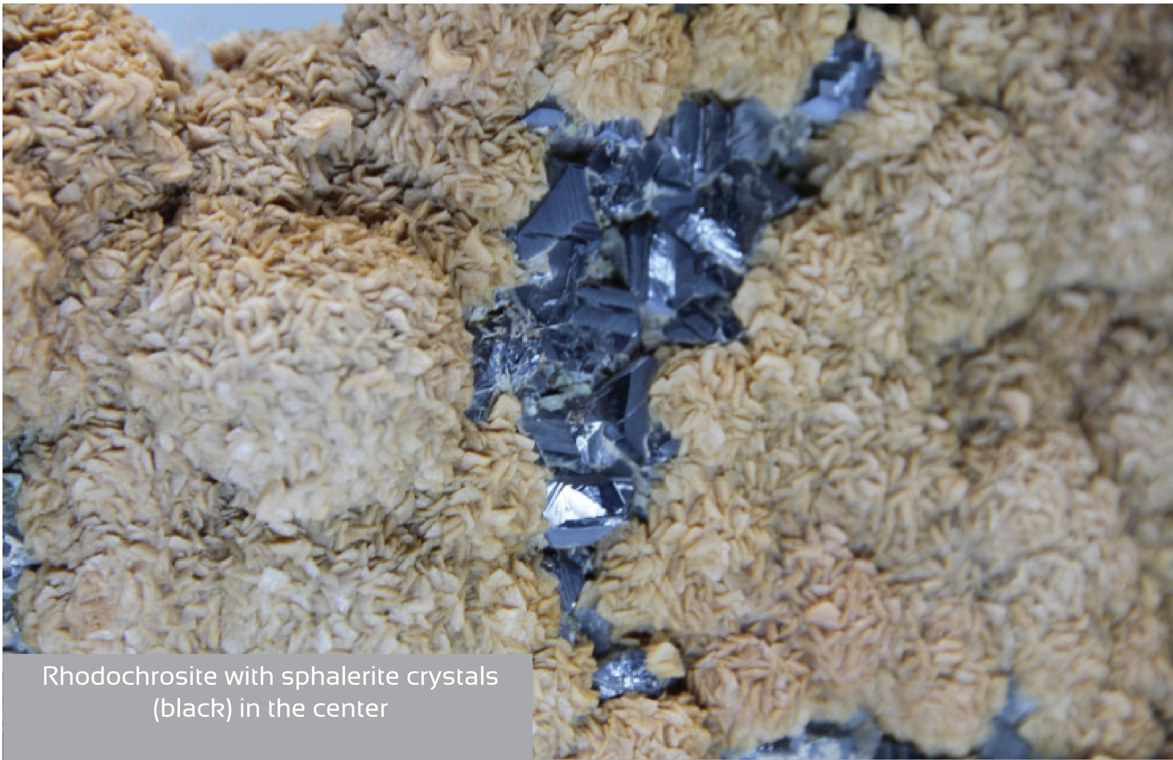
Beautiful calcite crystals

RHODOCHROSITE - $MnCO_3$, manganese carbonate

Chemical clssification	Carbonate
Sistem	Trigonal/Hexagonal
Hardness	3.5-4.0
Density	3.3-3.7 (g/cm^3)
Cleavage	Perfect rhombohedral
Luster	Vitreous
Colour	Rose with colors nuance (red, yellow, gray, brown, etc.).
Genesis	Vein hydrothermal in middle temperatures.
Associates	With other carbonate minerals, fluorite, barite, quartz and sulphide minerals of Pb, Zn, etc.
Usage	As a mineral for extraction of mangane, and as a decorative mineral, etc.


Rhodochrosite with calcite granules and galena crystals in the surface of the specimen


Rhodochrosite - panorama



Rhodochrosite with sphalerite crystals (black) in the center

Rhodochrosite covered with calcite

DOLOMITE - Ca, Mg $[CO_3]_2$, calcium and magnesium carbonate

Chemical clssification	Carbonate
Sistem	Trigonal/Hexagonal
Hardness	3.5-4
Density	2.8-2.9 (g/cm^3)
Cleavage	Perfect
Luster	Transparent to translucent
Colour	Colorless or white, rose and yellow to brownish, etc.
Genesis	Exogenous-sedimentary, but more rarely hydrothermal vein.
Associates	With carbonates in general, as well as sulphide minerals of Pb, Zn, etc.
Usage	As mineral for extraction of magnesium, construction material, fire-resistant material, decorative stone, etc.

Beautiful dolomite crystals with calcite on top

Dolomite covered with calcite and pyrite crystals (bottom)

Beautiful dolomite twin crystals with calcite on top

Beautiful dolomite crystals with calcite

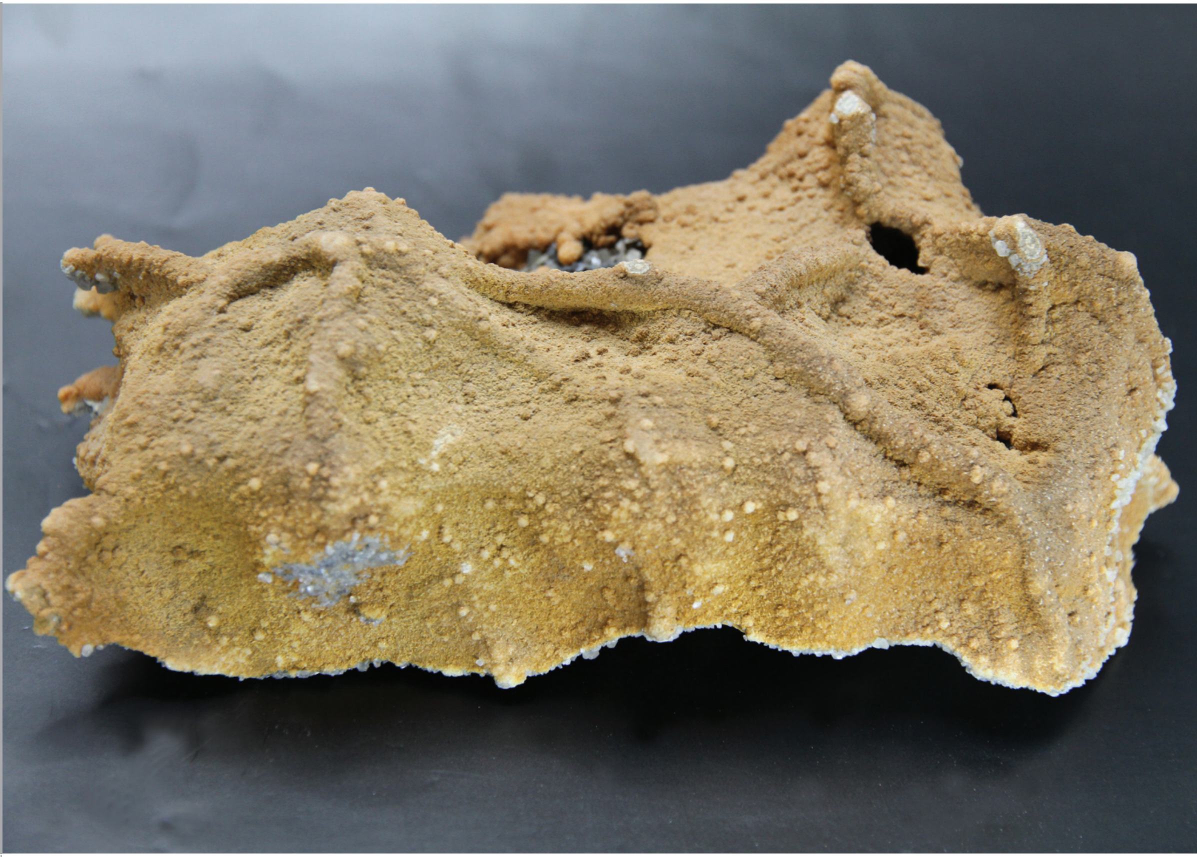
ARAGONITE - $CaCO_3$, calcium carbonate

CARBONATES

Chemical clssification	Carbonate
Sistem	Orthorhombic
Hardness	3.5-4
Density	2.9-3 (g/cm³)
Cleavage	None
Luster	Vitreous to dull
Colour	Usually white, but also gray, rose and brown, etc.
Genesis	Hydrothermal, organogenous and earth-crust decomposition of ultrabasic rocks rich in Mg. It is also formed near thermal-sources, as well as from the metamorphose of calcite in high and low preassure conditions.
Associates	Calcite, stroncianite, ankerite, etc
Usage	No practical importance.

Beautiful and charachteristic aragonite crystals

SIDERITE - $FeCO_3$, iron carbonate



Chemical clssification	Carbonate
Sistem	Tetragonal/Hexagonal
Hardness	3.8-4.0
Density	3.0 - 3.45 (g/cm^3)
Cleavage	Perfect (1011)
Luster	Vitreous
Colour	Yellow to dark, white, green, red and brown color, etc.
Genesis	Hydrothermal and pegmatitogenous, rarely metasomatic from sedimentary rocks which content Fe.
Associates	Chalchopyrite, tetrahedron, calcite, ankerite, barite, pyrite and quartz.
Usage	Basic Iron (Fe) mineral.

Siderite specimens (light to dark brown color)

6.1.5

SULFATES

For these minerals is characteristic the content in themselves of the radical $(SO_4)^{2-}$ as main polianion in which S^{6+} is surrounded by four oxygen atoms in tetrahedron. In the Stantërg deposit, from the sulfates class have been met these minerals: gypsum, barite, anglesite, melanterite, chalcanthite, but in the museum can be found the following minerals.


SULFATES

BARITE - $BaSO_4$, barium sulfate

SULFATES

Chemical clssification	Sulfate
Sistem	Orthorhombic
Hardness	3.0 - 3.5
Density	4.48-4.5 (g/cm³)
Cleavage	Very good, basal, prismatic.
Luster	Vitreous
Colour	Colorless, but also in white and other light colors (red, blue, yellow, green) etc.
Genesis	Mainly vein hydrothermal, but also exogenous in limestones veins.
Associates	Gypsum, Celestine, anglesite and other minerals of the same fore-genesis.
Usage	Basic barium mineral, used in chemical industry, drillings, etc.

Barite crystals

GYPSUM - $CaSO_4*2H_2O$, hydrous calcium sulfate

Chemical clssification	Sulfate
Sistem	Monoklinic
Hardness	2.0
Density	2.3 (g/cm^3)
Cleavage	Perfect from (100);(001);(010).
Luster	Vitreous
Colour	Usually white, rarely gray, yellow, brown, rose, etc. but also colorless.
Genesis	Exogene-sedimentary of chemical character, vein hydrothermal in sulfide Pb and Zn deposits, etc.
Associates	Halite, anhydrite, sulfur, calcite and dolomite.
Usage	Useful mineral. Used in cement industry, for plastering, as decorative stone, etc.

Crystal types of gypsum

6.1.6

Silikates, Wolframs and Phosphates Wolframites

Silikates,

This class is characterized by radical $(SiO_4)^{4-}$ as predominant polianion. In minerals of this class cation Si4+ is always surrounded by 4 oxygens under a tetrahedron, centered cation Si^{4+} whereas oxygen in corner tops. Depending from polianion $(SiO_4)^{-4}$ in the composition of minerals of this class we can distinguish subclasses of different minerals. In the Stantërg deposit more often are met these minerals: Hedenbergite, ilvaite, volastoniti, diopsiti, aktinoliti, epidoti, andraditi, but at the Museum of crystals there is no one.

Volframitet,

For this class of minerals it is characteristic the radical (WO_4). From minerals of this class only shelite was met, but it is not in the museum.

Phosphates,

They contain the tetrahedral group $(PO_4)^{3-}$ as predominant polianionin. From this class of minerals, in the deposit are found: childrenite, ludlamite, vivianite. Last two minerals are found in fund of minerals of the *TREPÇA* museum in Stantërg.

PHOSPHATES

LUDLAMITE - $Fe_3(PO_4)_2 4H_2O$, iron hydrated phosphate

Chemical clssification	Phosphate
Sistem	Monoklinic
Hardness	3.5
Density	3.1 - 3.2 (g/cm^3)
Cleavage	Perfect in direction (001), not clear in direction (100)
Luster	Vitreous
Colour	Colorless, but also with color (more often in green color).
Genesis	Ludlamites are formed as result of alteration processes of primary phosphates in pegmatites. Ludlamite is met in sedminets and vein type mineralisations of hydrothermal formations.
Associates	Carbonates and phosphates of the same fore-genesis.
Usage	Usually for different practical decorations.

Ludlamite granules (green color) and rhodochrosite

VIVIANITE - $Fe_3(PO_4)_2 8H_2O$, iron hydrated phosphate

Chemical clssification	Phosphate
Sistem	Monoklinic
Hardness	1.5 - 2
Density	2.6 – 2.7 (g/cm³)
Cleavage	Perfect
Luster	Vitreous - pearly
Colour	Colorless, on the oxidation zone it has a green to blue color.
Genesis	Vivianite is formed as a result of alteration processes of primary phosphates in pegmatites.
Associates	Siderite, limonite, as well as carbonates and other phosphates of the same fore-genesis.
Usage	Mainly as a decorative stone.

Beautiful vivianite crystal

7 COLLECTION OF AGREGATE MINERALS

Dolomite with needled quartz crystals

Dolomite granule covered with pyrite and calcite

Calcite crystals with a characteristic orientation


Gypsum extended prismatic crystals

Dolomite, quartz druse, calcite and some pyrite granules

Chalchopyrite
(yellow to bronze) with calcite on top (white), some sphalerite (black) and galena (gray) granules

Calcite crystals and sphalerite granules over the rhodochrosite

Beautiful dolomite crystals rounded with prismatic quartz crystals and calcite crystals in the periphery

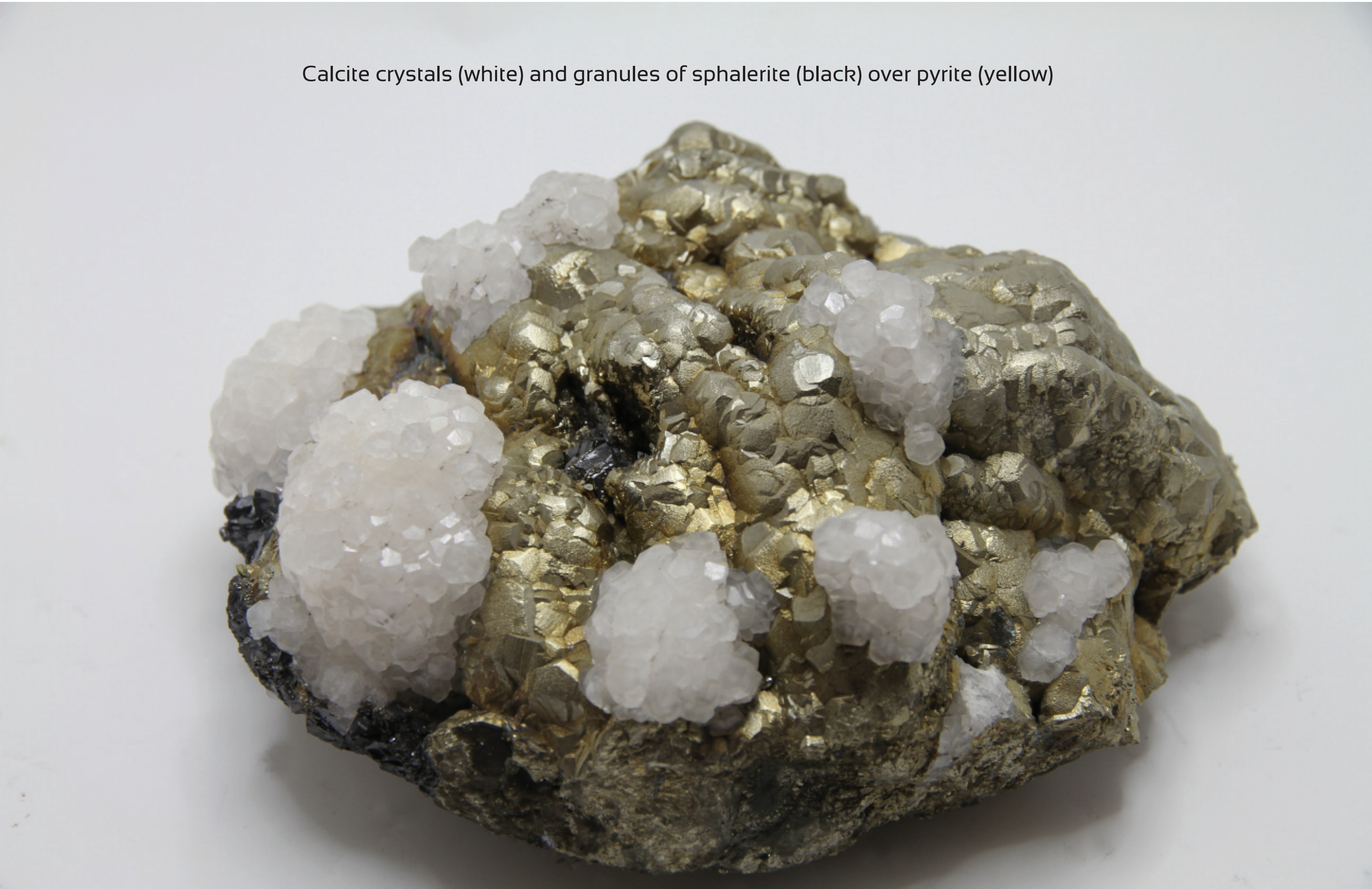
Quartz crystals

Rhodochrosite with prismatic quartz crystals
and pyrite granules in the center

Prism-needle shaped calcite crystals with rhodochrosite druse and sphalerite crystals

Marcasite (black) with calcite crystals (white)

Calcite crystals (white) and granules of sphalerite (black) over pyrite (yellow)



Calcite crystals (white) and Sphalerrite (black) over pyrite (yellow)

Pyrrhotite with pyrite crystals (yellow), sphalerite (black), rhodocrosite (rose-colored) and calcite (white)

Rhodocrosite (rose-colored)
with sphalerite (black)

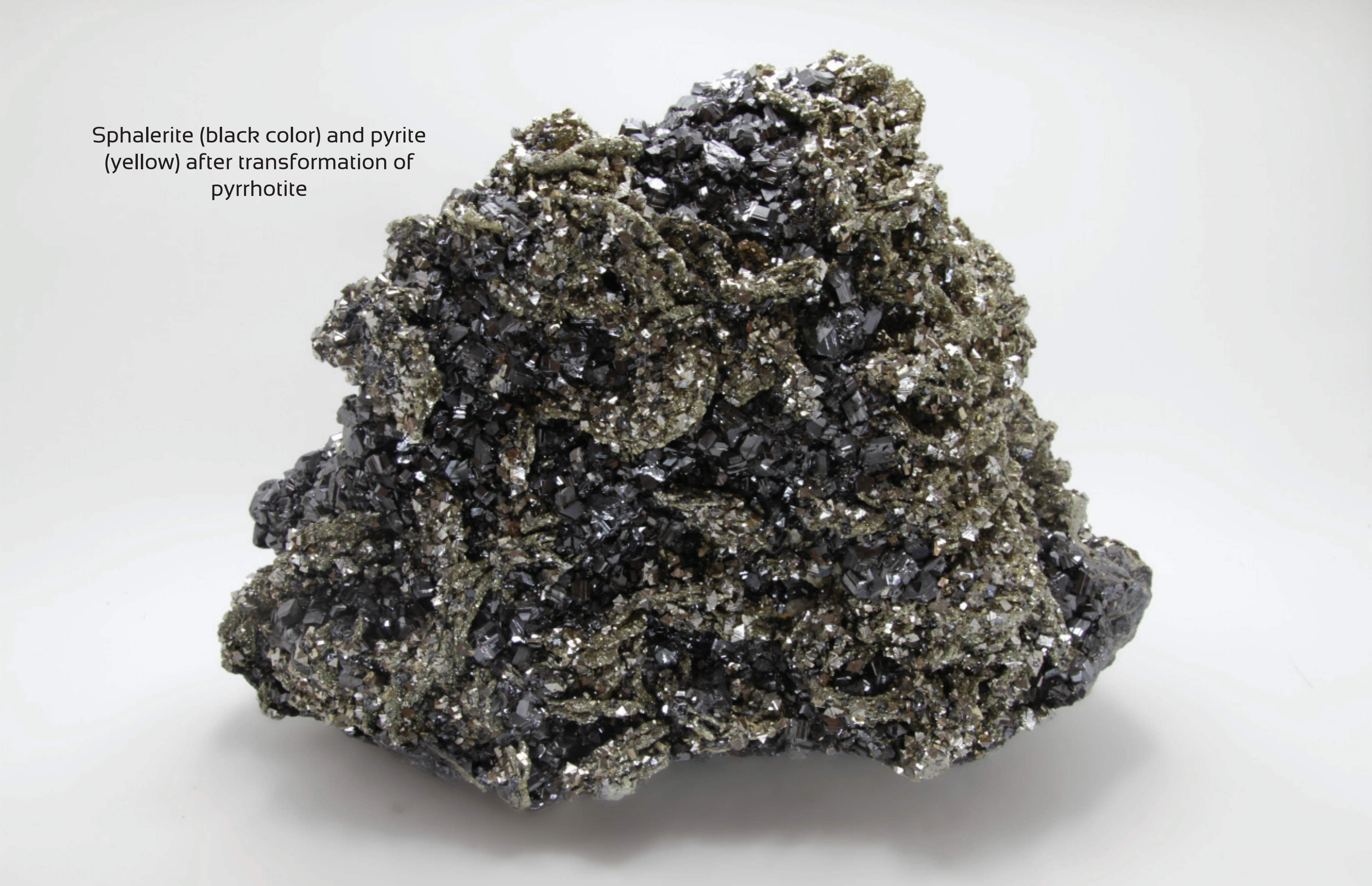
Rhodochrosite with small pyrite crystals
and Sphalerite granules in the top edge

Rhodochrosite in leafs shape,
Calcite crystals (white) and plumosite
(gray to black

Sphalerite (black) and quartz (white)
Over pyrite (yellow)

Pyrite with sphalerite crystals (black)
and quartz (white)

Pyrite (yellow) with sphalerite (black) and calcite (white)



Sphalerite (black color) and pyrite (yellow) after transformation of pyrrhotite

8 TREPÇA MINERALS IN THE FOCUS OF FOREIGNERS

Collection of Trepça specimens, taken from internet web-pages (publications of foreign authors), exhibited in different World museums, as well as in the Trepça Crystals Museum in Stantërg.

A typical specimen found on 1970. Big crystals glistered with dark gray colour of bornite, laying on quartz and chalcopyrite and some crystals of sphalerite.

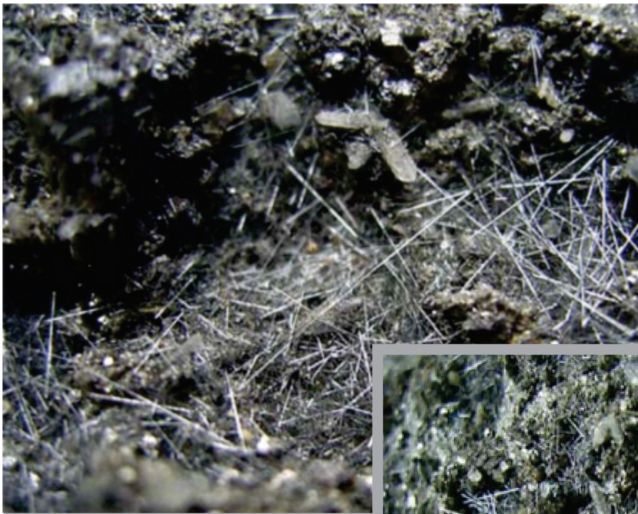
Burnonite, sphalerite, quartz
and chalcopyrite *Trepça* mine in Stantërg,
Mitrovicë - Kosovë

Arsenopyrite, quartz, sphalerite, *Trepça* mine in Stantërg - Mitrovicë, Kosovë

Two beautiful crystals of chalcopyrite
over quartz crystals

Pseudomorphose of pyrrhotite with granules of pyrite and quartz crystals,
Locality: *Trepça* mine, Mitrovicë-KOSOVË,
Exhibited at the mineralogical museum of Bon-Germany

Pyrrhotite with quartz crystals,
Locality: *Trepça* mine, Mitrovicë - KOSOVË,
Exhibited at the mineralogical museum of Bon-Germany

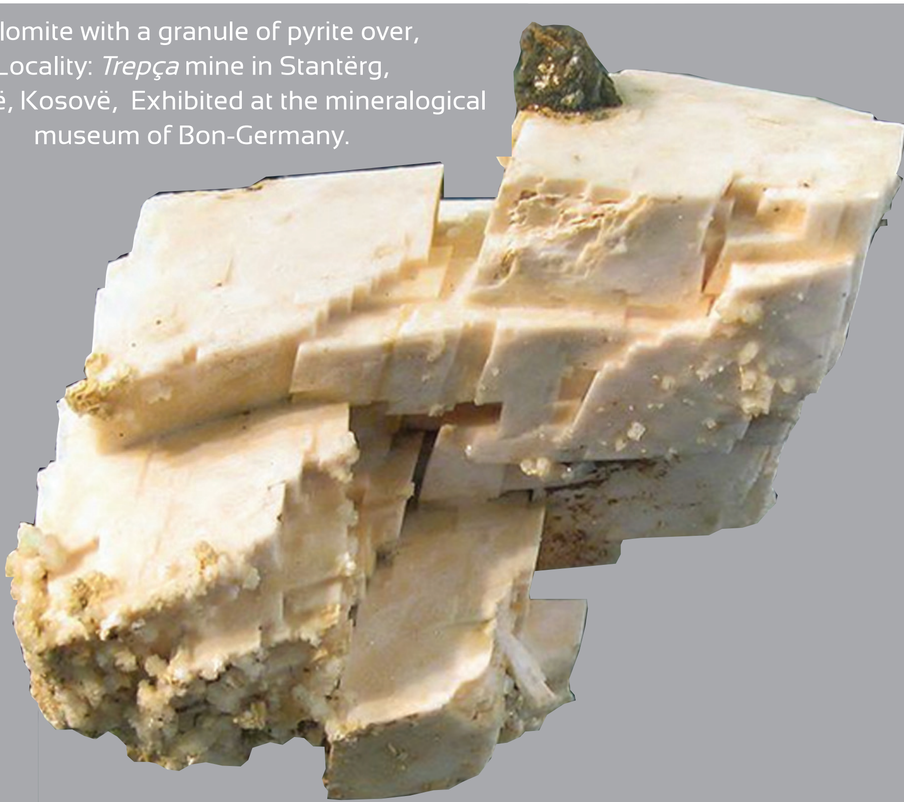


Beautiful Jamesonite needle shaped crystals with quartz and arsenopyrite, *Trepça* mine in Stantërg, Mitrovicë - Kosovë

Arsenopyrite with pyrite
and sphalerite,
Trepça mine in Stantërg,
Mitrovicë, Kosovë

Barite, locality: *Trepça* mine, Mitrovicë, Kosovë,
Exhibited at the mineralogical museum of Bon-Germany

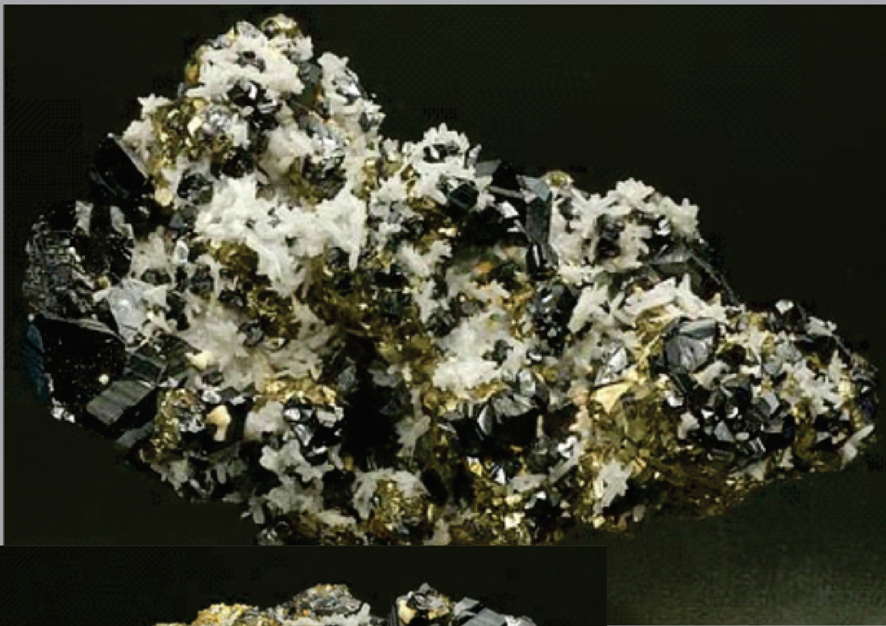
Dolomite with a granule of pyrite over, Locality: *Trepça* mine in Stantërg, Mitrovicë, Kosovë, Exhibited at the mineralogical museum of Bon-Germany.

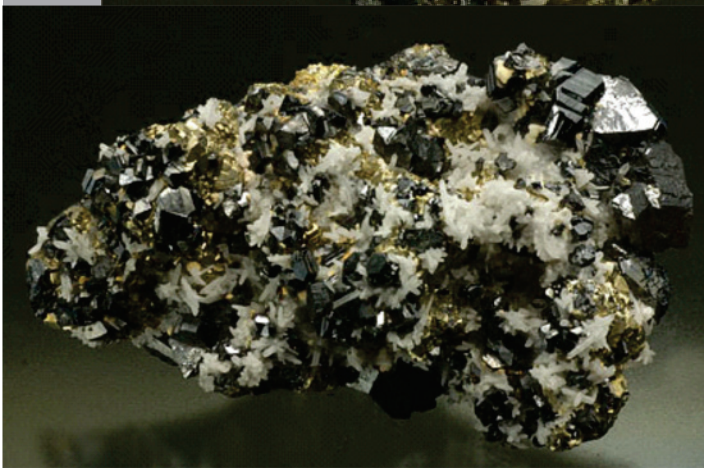


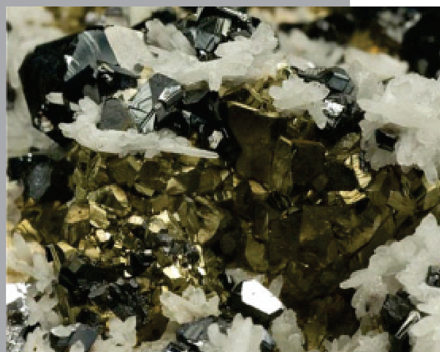
Ilvaite with hedenbergite, Locality: *Trepça* minea in Stantërg, Mitrovicë - Kosovë, Exhibited at the Mineralogical Museum of Bon-Germany.

Boulangerite (Capillary) over calcite, Locality: *Trepça* mine in Stantërg, Mitrovicë-Kosovë, Exhibited at the Mineralogical Museum of Bon-Germany.

Quartz with pyrite, *Trepça* mine in Stantërg, Mitrovicë-Kosovë







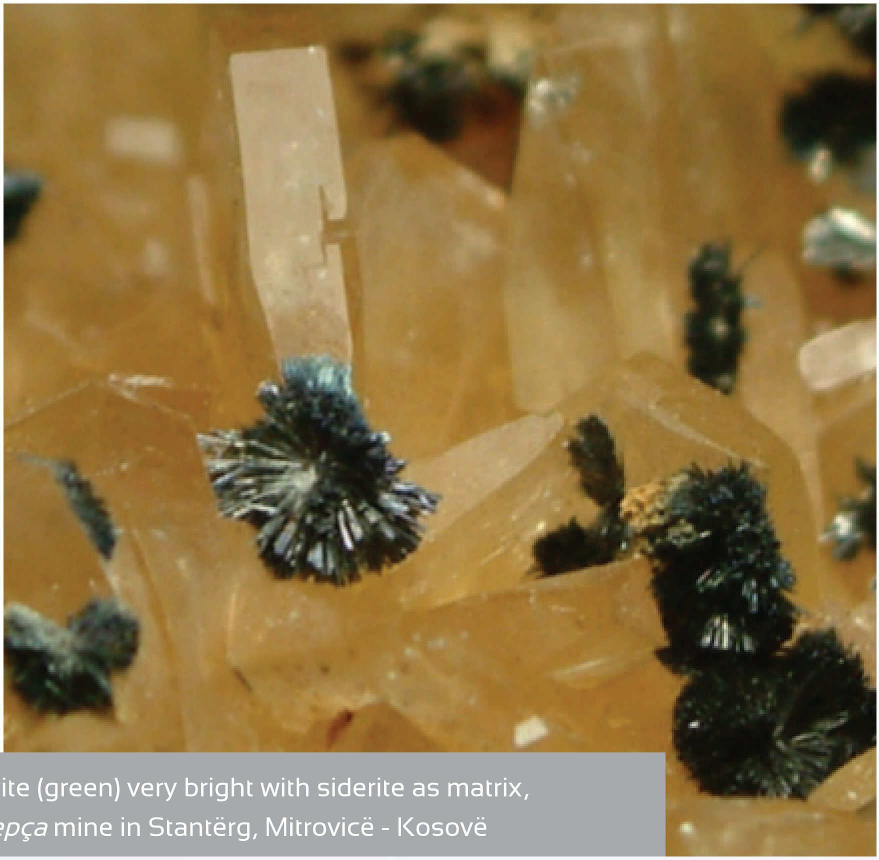
Sphalerite, pyrite and quartz,
Trepça mine in Stantërg,
Mitrovicë - Kosovë

Syderite, arsenopyrite, pyrite and quartz,
Trepça mine in Stantërg, Mitrovicë - Kosovë

Marmatite (sphalerite variety) perfect crystal of octahedral shape,
Trepça mine in Stantërg, Mitrovicë - Kosovë

Quartz with pyrrhotite and siderite,
Trepça mine in Stantërg, Mitrovicë - Kosovë

Antimonit, barit, miniera e *Trepçës* në Stantërg, Mitrovicë-Kosovë

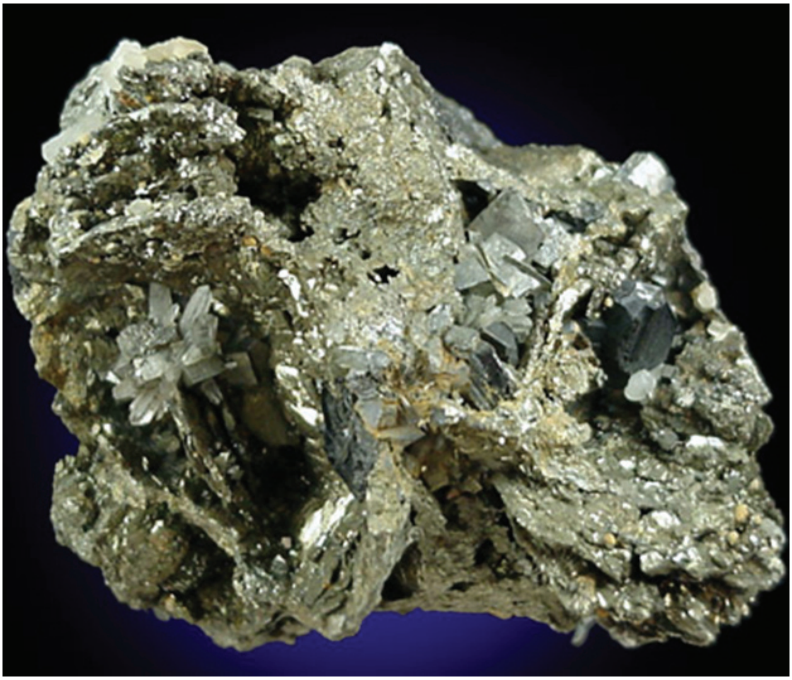


Vivianite (green) very bright with siderite as matrix, *Trepça* mine in Stantërg, Mitrovicë - Kosovë

Marvelous vivianite crystal, *Trepça* mine in Stantërg, Mitrovicë - Kosovë

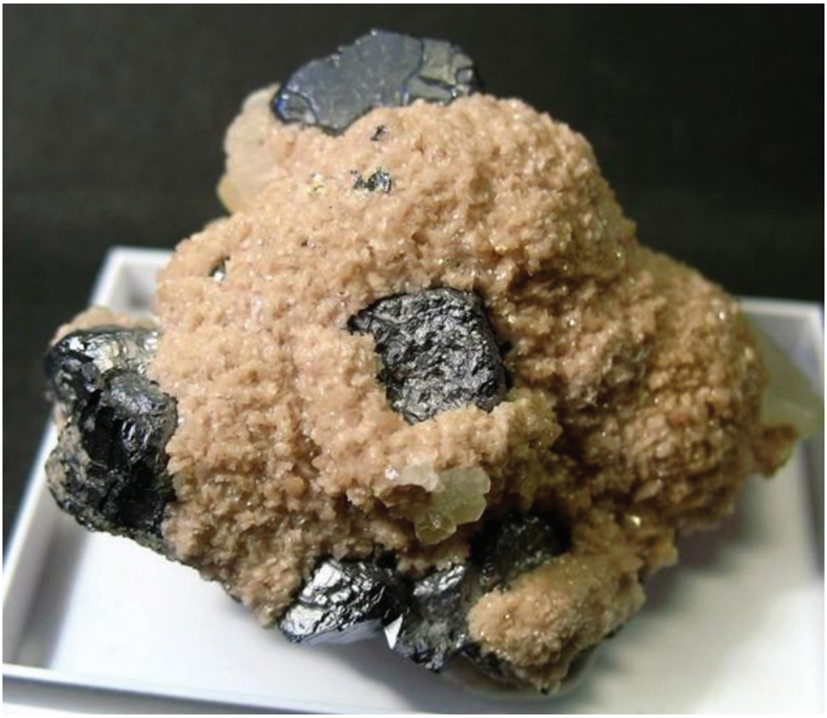
Vivianite, quartz, *Trepça* mine in Stantërg, Mitrovicë - Kosovë

Vivianite crystal
on siderite and quartz,
Trepça mine in Stantërg,
Mitrovicë- Kosovë



Arsenopyrite,
sphalerite, pyrite and
quartz, *Trepça* mine
in Stantërg,
Mitrovicë - Kosovë

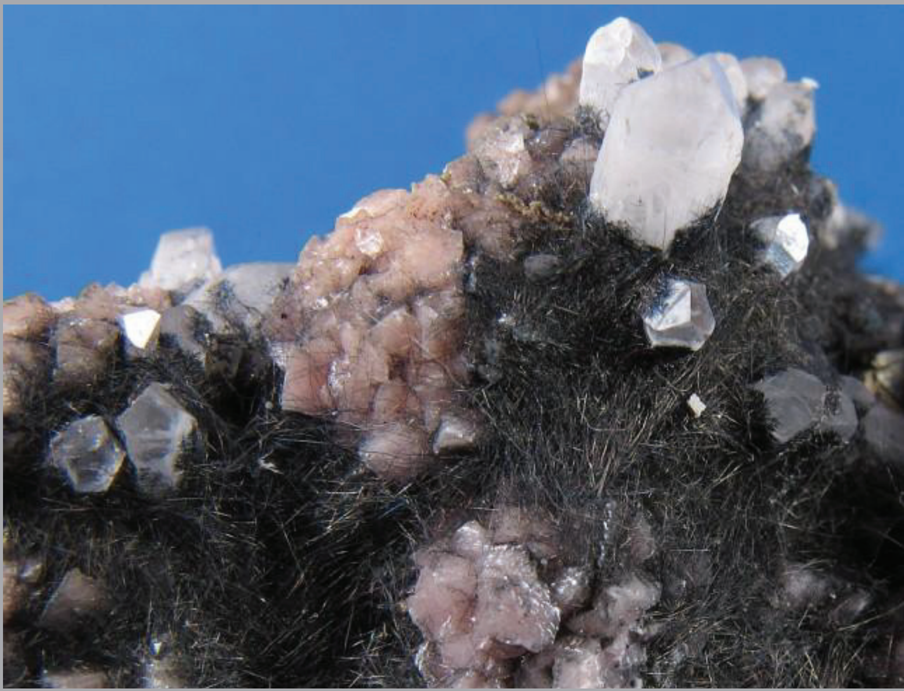
Dollomit me pikëzime të piritit sipër, miniera e *Trepçës* në Stantërg, Mitrovicë -Kosovë



Galena crystal (gray color) in dolomite, Locality: *Trepça* mine in Stantërg, Mitrovicë, Kosovë

Boulangerite with granules of arsenopyrite and siderite,
Locality: *Trepça* mine in Stantërg, Mitrovicë, Kosovë

Pyrite crystals, size to 3mm, with rhodochrosite, quartz and calcite, Locality: *Trepça* mine in Stantërg, Mitrovicë, Kosovo



Boulangerite with quartz and rhodochrosite, *Trepça* mine in Stantërg, Mitrovicë, Kosovë

Arsenopyrite, quartz, size of the specimen (5,3 x 6,7 x 2,4 cm), *Trepça* mine in Stantërg, Mitrovicë - Kosovo

Arsenopyrite, quartz, chalcite, syderite, galena,
Trepça mine in Stantërg, Mitrovicë - Kosovo

Arsenopyrite, quartz, chalcite, syderite, galena,
Trepça mine in Stantërg, Mitrovicë - Kosovo

Arsenopyrite
in rhodochrosite,
Locality: *Trepça* mine in
Stantërg, Mitrovica - Kosovo

Arsenopyrite
With quartz,
Locality: *Trepça* mine
in Stantërg,
Mitrovica - Kosovo

Arsenopyrite on top of siderite with jamesonite,
Locality: *Trepça* mine in Stantërg, Mitrovica - Kosovo

Arsenopyrite in quartz and sphalerite,
Locality: *Trepça* mine in Stantërg, Mitrovica - Kosovo

Ludlamite granule (green in colour) with quartz (on top) and galena (on the bottom), from *Trepça* mine in Stantërg, Mitrovica, Kosovo.

Granule of ludlamite in the center of mineral, Locality: *Trepça* Mine in Stantërg, Mitrovicë-Kosovë.

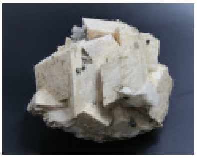


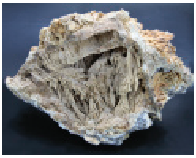


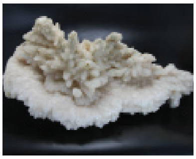




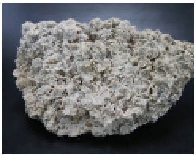


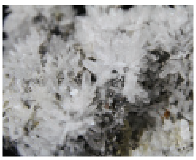











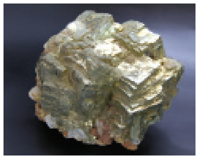








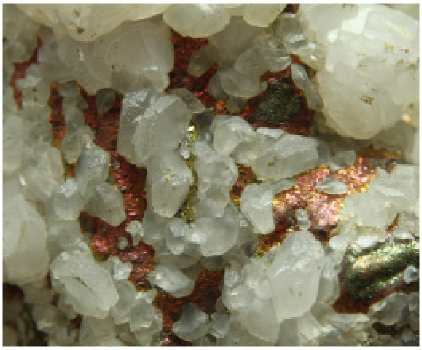


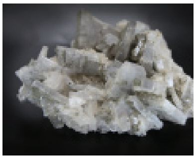
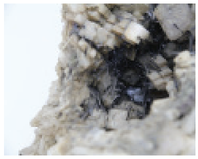









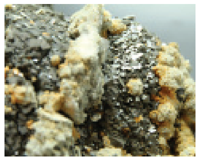




















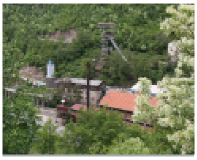








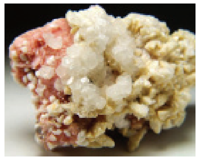




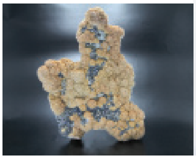










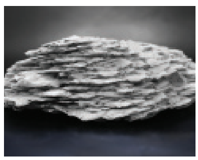






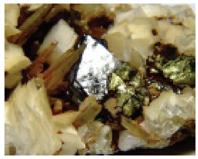
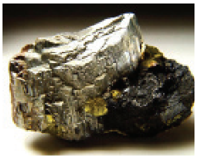
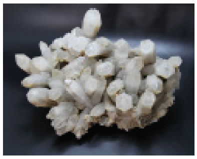






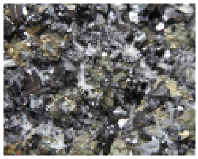










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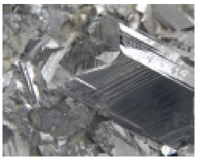










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Republic of Kosovo
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TREPÇA

Atlas of *Trepça* Minerals, primarily, serves to students of the geology, then mining specialists, and student of other profiles. This atlas will be in service to minerals museum *Trepça* in Stantërg.

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