MINERALS IN THE KARSTIFIED TRIASSIC OREBEARING CARBONATE ROCKS OF THE NORTHERN KARAVANKE

MINERALI V ZAKRASELIH TRIASNIH RUDONOSNIH KARBONATNIH KAMNINAH SEVERNIH KARAVANK

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Abstract UDC 552.54:551.761(234.323.61)

Fajmut Štrucl, Suzana & Ivo Štrucl: Minerals in karstified triassic orebearing carbnonate rocks of the Nothern Karavanke

In the Mežica deposit two kinds of mineralizations can be distinguished according to their age, the Triassic and post-Triassic one. The first mineralizations are sedimentogenic (sedimentary - diagenetic),and the second were formed by migration of ore substances into younger (post-Triassic) tectonic structures within the orebearing Wetterstein limestone. The most important of the latter are the ores in the mineralized Union faults, which are treated in the present article as mineralization phenomena of karstic processes.

Izvleček UDK 552.54:551.761(234.323.61)

Fajmut Štrucl, Suzana & Ivo Štrucl: Minerali v zakraselih triasnih rudonosnih karbonatnih kamninah Severnih Karavank

V mežiškem rudišču ločimo po starosti dva sistema orudenenj - triasnega in posttriasnega. Prvi je sedimentogenega porekla, drugi pa je nastal s premeščanjem rudnih snovi znotraj rudonosnega wettersteinskega apnenca v mlajše (posttriasne) tektonske strukture. Najpomembnejši med slednjimi so orudenele unionske prelomnice, katerih orudenenj v pričajočem sestavku obravnavamo kot mineralne posebnosti kraških procesov.

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INTRODUCTION

In the Mežica mines there are more than 800 km of galleries. The highest ones (the Knieps pits on the Peca mountain) are on an altitude of about 2060 m, and the lowest ones on 270 m in the Graben district near Žerjav, 230 m below the lowest karst spring of the area.

The Mežica mines certainly cannot be considered as karst caves, which, however does not mean that they are of no interest to karst explorers. Missing are in fact only huge caverns with speleothem formations, but various other karst phenomena, mineral in particular, can be found instead.

More than 90 % of the mine workings (adits, galleries, pits, drifts and stopes) are driven in the Wetterstein limestone of Ladinian-Carnian Age, and the rest are in Carnian and Norian beds.

The 1000 to 1200 m thick succession of the Wetterstein beds consists of various types of limestone and dolomite. Pure limestone is scarce. As a rule some dolomite is present either in the form of dispersed crystals and crystal aggregates, or of diagenetic cement in pores and fissures. Often also the opposite is true,in the dolomite matrix the fissures are cemented by calcite.

Wetterstein limestone is strongly fractured and karstified, especially on the Peca and Mala Peca mountains (see Fig.1). The fissures originated mostly during the Alpidic orogenesis, but certain also during diagenesis or Triassic paleokarstic processes.

In the present contribution we shall limit ourselves to the so-called system of orebearing Union faults that were generated during and after the Alpidic orogenesis.

ABOUT THE SYSTEM OF UNION FAULTS

The Union faults appear in the whole area of the Northern Karavanke, but the most interesting ones are in the central Mežica mines, not only because of lead and zinc mineralization, but also because of karst processes developed in them. The most imposing and conspicuous on the surface is the Sumah fault with the orebodies of Staro Igercevo.The faults in generally strike N-S with small deviations to NE or to NW, and they dip from 25 to 80. In the upper parts of the mine the dip is steeper (50-80), and in the lower parts more gentle (25-50).

The width of the fissures differs from place to place. Commonly they are only some millimetres to several decimetres wide, but sometimes they spread to a few metres. Prior to mining almost all of these orebearing faults and fissures were below the groundwater level, and therefore flowstones and speleothems could not be formed in them. Instead, the fissures were cemented with large amounts of middle and very coarse grained calcite, sometimes also with beautiful calcite druses.

Besides calcite there is a lot of other minerals like galena, sphalerite, pyrite, melnikovite-pyrite, marcasite and various oxide minerals of lead, zinc, iron, manganese and molybdenum among which wulfenite is the most important.

THE MINERAL COMPOSITION OF OREBEARING UNION FAULTS

The mineralization of the Union system is different from leadzinc sedimentary - diagenetic mineralizations of the Karavanke district chiefly in large quantities of calcite. In general the veins of Triassic orebodies are composed 90-95% of dolomite and only 10-5% of calcite, while this relation in the ore bodies of the Union system is just opposite. In the Union system we find predominantly milky white or grey calcite, the latter of light to dark shades. Often the calcites are yellowish or yellowbrown colour. The colour of calcite mostly depends on various inclusions or different types of coating on it. Inclusions and coatings can be composed of galena, cerussite, pyrite, limonite, wulfenite, clay or mudstone. In calcite crystals sometimes occur millimetric inclusions of limestone and dolomite. Grey calcite with larger amounts of isomorphically admixed galena is called plumbocalcite. Calcite is usually coarse or middle grained, and occasionally very coarse grained. The grains are intergrown in mosaic structure. In fissures, caves and in geodes which are not completely cemented beautiful calcite druses with several cm large calcite crystals can be found.

Calcite occurs in different shapes of the hexagonal-trigonal system (see Fig. 2 and 3). The most common habits are tabular,prismatic, acute or obtuse rhombohedral, and scalenohedral (dogtooth spar). Twinning is commonly according to two main laws; in the first the twin plane is the basal pinacoid, and in the second the twin plane has a rhombohedral face.

When talking about calcite from the Union fault system we must be careful about its origin. We must distinguish calcite which originated in sedimentary and diagenetic processes from calcite which formed through epigenetic processes. The last one was formed by recrystallization of limestone or by precipitation from meteoric respectively underground water.

Many years ago some geologists believed that calcite had been formed indeed at different times, but within a single, for example the hydrothermal-metasomatic process. Each of the mentioned processes includes more than one generation of calcite. They have distinct structure characteristics, grain sizes and isotopic compositions.

The data of isotopic composition of different types of calcite are represented in Table 1. The original data are taken from the reference in T.DOLENEC et al.(1983).

The isotopic composition is given in relative values with respect to standards SMOW (CRAIG, 1961) and PDB (CRAIG, 1957).

Aragonite is usually found in old drifts and stopes . In general it is of recent origin ,always younger than mine workings. It occurs in various flowstone formations, as encrustations and speleothems. Hydrozincite is also often a component of flowstones. Various color shades of flowstone indicate the

Tabele 1. Isotopic Composition of Oxygen and Crbon from various calcites in the Union district

	O^{18}(SMOW) in %	C^{13}(BDB) in %
early and late diagenetic calcite	+20.45 - +27.12	+2.20 - +3.35
late diagenetic calcite	+19.26 - +22.90	+1.95 - +2.86
gangue calcite in association with ore minerals	+11.01 - +23.40	-5.32 - +3.02
calcite I in association with wulfenite	+09.06 - +15.02	-4.27 - +2.17
calcite II in association with wulfenite	+20.35 - +21.80	-4.59 - -2.42

presence of admixed limonite, clay etc. Older aragonite crystals, respectively pseudomorphs of calcite after aragonite, were found only in the Fridrih district. These are several mm long needles which grew of dendritic crystal druses (see Fig. 4).

Wulfenite (Fig.5) is also a typical mineral of the orebearing Union faults, although we find it in traces everywhere in the Mežica mine. However, within the system of Union faults more than 70 important occurences of wulfenite were found, while in the primary interstratified orebodies only about ten of them, and the mineral quantity in them is not worth mentioning. With wulfenite occur always also other oxide minerals like cerussite (Fig.6), limonite, hydrozincite (Fig. 7) and descloizite. Of sulfide minerals only strongly oxidized and corroded galena (Fig 8) is generally present.

The most common habits of wulfenite crystals are tabular forms of various thickness from 0.2 to 1 mm, and sometimes pseudocubes, pyramidal or bipyramidal forms.

The origin of wulfenite is connected with oxidation or hydatogenic processes,but the origin of molybdenum is still debatable.

For the alpine lead-zinc deposits with wulfenite the molybdenum is mostly believed to have originated in the Upper Triassic Carnian or Norian beds. Regarding the somewhat higher content of Mo in these rocks this might be right, but there are other opposing facts. Molybdenum mostly migrates in acid environment, while the pH of the present waters in Norian dolomite is from 7.0 to 8.6 (the average value of 77 measurements is 7.8).

When considering the source of Mo for formation of wulfenite also the hydrological conditions in the Upper - Triassic rocks must be considered which are separated from the orebearing Wetterstein limestone with three horizons of impermeable mudstones and marls. Therefore it is easier to imagine the migration of molybdenum within the orebearing rocks only.

From the economical point of view the most important ore minerals are galena and sphalerite which are present in orebodies of the Union system in quite large amounts. The ratio of lead to zink is about 2:1. Their presence was always the main problem in explanation of mineralization. It is known that galena is scarcely soluble either in water, acids or in alkaline solutions. Therefore a number of questions arises on migration of lead from the oldest mineralization into younger geological structures.

It is supposed that transport of ore took place in several forms: as true solution, colloid solution and suspension. For all forms in the Union system characteristic types of mineralization can be found. In this case we are thinking about appearances of melnikovite-pyrite and all kinds of colloform ores. These ores have elements of deposition from colloid and true solutions. The only positive aspect is, that they are formed with alternating separation of different ore components on walls of fissures or caverns from cool solutions.

Similar colloform structures of ore components can be found also at hydrothermal springs - in black smokers on the sea floor. That means they can be formed also in other hydrothermal processes. In Cave di Predil (Rabelj) in Italy, the most famous colloform sphalerites were also connected with Tertiary fissures which strike like the Union faults.

The so-called schalenblende from the orebearing Union faults differs from similar ores of other systems. It contains less iron sulfides and less galena. It appears in fissures, caverns or in breccias where pieces of limestone or other rocks are encrusted with sphalerite.

Sphalerite occurs usually together with galena, but often also alone. Grained sphalerite contains low iron (0.07 to 0.3 %). The colour of sphalerite depends on the amount of iron; it ranges from pale yellowish brown, grayish orange to dark yellowish brown.

Galena appears in ores of the Union faults in different forms: in veins,in replacement textures and in cement of breccia. The grains are usually xenomorphic. They are idiomorphic only in the case when formed by breaking of bigger xenomorphic grains in the direction of cubic cleavage. In general galena is pure, but sometimes it contains some dolomite, sphalerite or pyrite inclusions. Fine grained galena occurs mostly in ore breccias which are composed in part of completely crushed material.

Pyrite and marcasite are rare minerals in the Union faults, especially with respect to other parts of the Mežica mines. There is also no framboidal pyrite present.

HYDROLOGICAL CHARACTERISTICS ON THE MEŽICA MINES

Although the underground waters were very important in the formation of secondary epigenetic mineralizations like those of the Union system, the explorers devoted too little attention to them. For this reason there are not enough exact chemical analyses.

While mining took place on higher levels, the underground waters from Peca, Mala Peca and Kranjcev vrh discharged like valley or typical karst springs. Such kinds of springs still exist in Wetterstein dolomite on the northern foot of the Karavanke. In the nearest surroundings of Mežica valley all springs have become dry.

Hydrological and hydrochemical conditions have changed several times during more than a hundred years of mining.The first hydrological changes at the Peca mountain and in the surrounding of the Mežica mines happened more than hundred years ago. The largest changes were caused by the Glancnik adit (+500 m), and later by other drifts and galleries below the level of +500 m. The piezometric level of underground water in the central mine has fallen for more than 350 m because of underground workings. At the same time hydrogeological conditions in other Triassic rocks did not change.

At the same time the chemical composition of underground waters changed too. Their present chemical composition is represented in Table 2.

Water samples were collected in November 1982. Analyses change from year to year, but the differences are clear. We can imagine that these differences were even bigger before mining activities. From this area more than 18 million tons of ores were mined, which corresponds to 870.000 tons of lead and 540.000 tons of zinc.

From the analyses we can calculate the extent of corrosion and migration of ore and other components. For example, on the basis of the analysis from the Moring district, at least 1.5 t of Zn metal and 189kg of Pb metal per year are washed yearly out of the mine with groundwater flowing on the average of 600 l/s. In the past these amounts could have been only higher.

Table 2. Chemical composition of the groundwater in Triassic Wetterstein beds in the mine area and outside it

Districts		Graben	Graben	Moring	Uršlja gora	
Altitude (m)		300	300	300	715	1030
Ca	mg/l	75.1	47.6	62.1	70.61	60.1
Mg	"	27.1	32.5	28.6	10.98	14.9
H CO	"	192	292	220	238	241
SO	"	111	35	71	16	13
Cl	"	2	2	2	2	2
K	"	1.2	1.5	1.2	2.3	0.2
Na	"	0.8	1.9	4.0	0.5	0.3
Zn	"	0.75	0.01	0.08	0.011	<0.01
Pb	"	0.03	0.01	0.01	<0.01	<0.01
pH		7.9	7.4	7.7	7.6	7.6
Tot.hardness	german	16.85	14.13	15.50	12.33	11.93
Ca hardness	"	8.82	13.37	10.08	10.92	11.06
Conductivity	µS/cm	547	454	508	401	371

ORIGIN OF THE UNION FAULT MINERALIZATION

With regard to the Alpidic orogenesis the Union type of mineralization is of posttectonic or syntectonic origin. There is relible evidence also of post-mineralization tectonic processes. Some can be seen with naked eye, for example tectonic mirrors, galena with lead tail structures and cataclasms of ore minerals; others can be seen by microscopic examination, which gives obvious indications of several phases of fracturing.

The origin of the orebearing Union faults has been considered a number of times at scientific meetings . One of them was in Mežica in 1964. Twenty experts from Austria, Italy, Germany and Yugoslavia took part in it.

The meeting was held at a time, when two conflicting scientific schools discussed the problem of genesis, either hydrothermalmetasomatic or sedimentogenetic, of the lead-zinc ores in the carbonate rocks of the Calcareous Alps. The mineralized Union faults at that time attracted most attention, and at the same time presented most problems.

MAUCHER (1965), one of the first and also the most fervent defender of the sedimentogenic theory, at that time mentioned three possibilities for the origin of the Union faults mineralization:

1. They are connected with the primary influx of solutions into the sediments. Hence they are the filling of the feeding channels.

2. During diagenesis the movement of solutions occurred with the squeezing out of water. The water moving through the porous rocks dissolved the ores in the form of complex salts. The substance was transported by "hydatogenic" solutions, descendant or ascendant, into areas of lowest pressure (fissures, caves in breccias, etc.). The substance migration could have been caused by descendant groundwater, and especially by thermal water.

3. Completely new hydrothermal solutions from other areas brought new substances. The veins were thus, by their genesis, separated from the primary ores in the sediments, and they originated from new solutions.

To MAUCHER (1965) the second alternative appeared the most probable. KOSTELKA (1965) who worked in the Mežica mines during the Second World War, saw in the Union faults the inflow channels of the Triassic sedimentary ores. I. ŠTRUCL (1965, 1971, 1984) at first spoke in favour of the third alternative, but shortly afterwards, he maintained that all younger mineralizations were formed by migration of ore substance either from the host-rock or from the Triassic ores.

Mineralizations of the Union system appear in post-Triassic tectonic structures. Tectonical processes had started when the Triassic rocks underwent over all phases of diagenesis, including the cementation of small fissures that were formed by compaction of the sediments. The start of tectonical processes is also younger than the dolomitization of the Wetterstein limestone.

At the end, also the question of the source of the solutions has to be answered, and on their nature - juvenile or vadose?

Calcitization can be explained by both ways, but with regard to the hydrological conditions in the Wetterstein limestone in case that there are no other typical hydrothermal changes, it is more possible that calcite had crystallized from vadose karstic water. This means that ore minerals (galena, sphalerite,wulfenite etc.) in calcite probably had been formed in the same way. The Union orebodies also do not show any changes of the mineral composition with depth, which is usually characteristic of hydrothermal orebodies.

Proceeding from the definition that karst is a territory owing to fissure permeability in the rocks underground (karstic) percolation of water with effective chemical dissolution processes takes place, and where typical surface and underground karst forms are present, we can consider also the mineralization of the Union System a karst phenomenon.

This does not mean that all the problems of formation of this type of mineralization have been solved. Without answers are still many questions from the domains of karstology, geomorphology and hydrology.

First the question of when the karst processes took place before or after Pliocene. It is also possible that karstification is a continuous process which has been in course since the first denudation of the Wetterstein limestone until the present. In fact that the Union mineralizations are more or less tectonic disturbed, although they are the youngest, the main quantity of ore could be deposited before Pliocene, for example in Oligo - Miocene. At that time the *tectonic processes along the Periadriatic Lineament* have achieved the culmination, the magmatic activity also, and for these reasons the temperature gradient was certainly higher than at present.

Karst processes took place also in Pliocene and after it, until the destruction of the natural hydrological conditions by mine workings. At present, the karstic processes produce in this area various flowstone formations of calcite and aragonite in which appear also ore minerals - especially limonite and hydrozincite (see Fig. 9 and 10).

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Povzetek

Mežiske jame so dolge preko 800 km, najvišje so na višini 2060 m, to so Kniepsove jame na Peci, najnižje pa so na nadmorski višini 270 m v Grabnu pri Žerjavu, kar pomeni, da so 230 m pod prvotnimi najnižjimi kraškimi izviri tega območja.

Mežiske jame sicer ne moremo obravnavati kot kraške jame, to pa še ne pomeni, da so za raziskovalca kraškega sveta nezanimive. V bistvu manjkajo le impozantne dvorane z večjimi kapniškimi tvorbami, zato pa najdemo namesto njih številne druge kraške zanimivosti, zlasti mineralne.

Preko 90 % rudarskih del (rovov,nadkopov,jaškov in odkopov) je v wettersteinskem apnencu ladinijsko-karnijske starosti, ostali pa so v karnijskih ali norijskih plasteh.

Wettersteinski apnenec je močno razpokan in zakrasel. Razpoke so povečini nastale med alpidsko orogenezo, deloma pa tudi med diagenezo ali med triasnimi paleokraškimi procesi. V pričujočem prispevku smo se omejili na tako-imenovani sistem unionskih prelomnic, ki so nastale med alpidsko orogenezo.

Prelomnice tega sistema se pojavljajo sicer na celotnem območju severnih Karavank, toda zanimive so predvsem orudene prelomnice na območju centralnega rudišča mežiškega rudnika.Njihova splošna smer slemenitve je sever-jug.

Orudenenja unionskega sistema so glede na alpskogorotvorno tektoniko v glavnem posttektonske narave, vendar večina od njih je bila pozneje podvržena poznejšim tektonskim deformacijam. O tem najdemo kar precej zanesljivih dokazov. Nekatere lahko ugotavljamo že s prostim očesom, na primer "tektonska ogledala", galenit s teksturo "svinčevega repa" in razne kataklaze rudnih mineralov, ostale pa z mikroskopskimi raziskavami. Te kažejo, da so unionska orudenenja pretrpela več faz drobljenja.

Pred nastankom orudenenj in seveda tudi pred rudarjenjem so te razpoke bile pod nivojem podtalnice, kar pomeni, da se v njih niso mogle oblikovati sigaste in kapniške tvorbe, vendar so se namesto njih izločile sorazmerno velike količine debelozrnatega kalcita, razen kalcita pa še rudni minerali: galenit, sfalerit, pirit in melnikovitpirit ter še cela vrsta oksidnih mineralov svinca, cinka, železa, mangana in molibdena.

Od sedimentogenih orudenenj karavanških svinčevo-cinkovih nahajališč se razlikujejo orudenenja unionskega sistema zlasti po velikih količinah kalcita. Po grobi oceni sestoji žilnina primarnih triasnih orudenenj 90 do 95 % iz dolomita in le 10 do 5 % iz kalcita, medtem ko je to razmerje v orudenenjih Unionskega sistema ravno obratno.

Pretežno imamo opravka z mlečnobelim in sivim žilnim kalcitom. Običajno je žilni kalcit srednje in debelozrnat, toda pogosto je tudi zelo debelozrnat. Zrna so med seboj zraščena v mozaično strukturo. V nepopolno zacementiranih razpokah, geodah in kavernah, najdemo tu in tam tudi zelo lepe kristalne kopuče v katerih so kristali tudi do nekaj centimetrov veliki.

Wulfenit je mineral, ki je precej tipičen za sistem unionskih prelomnic, pa čeprav ga najdemo v sledovih po vsem rudišču. V sistemu unionskih prelomnic je bilo registriranih preko 70 wulfenitnih nahajališč, v primarnih plastovnih orudenenjih pa le okrog deset in še to z nepomembnimi količinami wulfenita . Z wulfenitom se skoraj vedno pojavljajo tudi drugi oksidni minerali, zlasti ce-

rusit, limonit, hidrocinkit in descloizit. Od sulfidnih mineralov je praviloma prisoten le močno korodiran in oksidiran galenit.

V ekonomskem pogledu sta seveda najbolj zanimiva galenit in sfalerit, ki se pojavljata v orudenenjih unionskega sistema v sorazmerno velikih količinah in to v razmerju 2:1 v korist galenitu. Njuna prisotnost je glavni kamen spotike pri razlagah o nastanku mineralizacij unionskega sistema. Znano je, da je galenit zelo malo topen v kislih in alkalnih raztopinah, da o topnosti v vodi niti ne govorimo. Zato so razlage o njegovi migraciji iz starejših orudenenj v mlajše geološke strukture še polne dilem.

Pirita je v unionskem sistemu v primerjavi s količinami le-tega v plastovnih orudenenjih zelo malo. Enako velja za markazit, ki igra v unionskem sistemu sploh zelo podrejeno vlogo. Prav tako ni piritnih framboidov.

Hidrološke razmere so se v času večstoletnega rudarjenja sproti spreminjale. Glavne hidrološke spremembe v nedrih Pece in širšem območju mežiškega rudnika segajo več kot sto let nazaj. Spremenila pa se ni le piezometrijski gladina talne vode, spremenila se je tudi njena kemična sestava. Današnja je razvidna iz tabele 2.

Nastanek unionskih orudenenj je bil v preteklosti večkrat predmet živahnih znanstvenih razprav. A. Maucher (1965) je v zvezi z orudenenji unionskega sistema omenil tri možnosti nastanka:

1. Da so v zvezi s primarnim dovodom raztopin v sedimentacijski prostor,to pomeni, da predstavljajo zapolnitve dovodnih poti.
2. Da so diskordantne žile nastale predvsem v zvezi s tektonskimi procesi, pri čemer ima njihova snovna vsebina izvor v primarnih rudah,transportirana pa naj bi bila s hidatogenimi raztopinami, descendentno ali ascendentno v območju najmanjših pritiskov (to je v razpokah in votlinah itd.). Do hidatogenih prenosov snovi pa naj bi prišlo že med diagenezo.
3. Da so žilna orudenenja nastala genetsko ločeno od primarnih rud v usedlinah in, da imajo svoj vir v novih raztopinah.

Orudenenja unionskega sistema se pojavljajo zanesljivo v posttriadnih tektonskih strukturah, zato za njih po vsej verjetnosti odpade razlaga o migraciji med diagenetskim strjevanjem usedlin. Ostane nam predvsem, da odgovorimo na vprašanje, odkod so prišle raztopine in kakšne so bile - juvenilne,ali vadozne. Kalcitizacijo je možno razlagati z obema, toda z ozirom na hidrološke razmere v wettersteinskem apnencu in odsotnosti drugih tipičnih hidrotermalnih sprememb, je večja verjetnost, da je kalcit kristaliziral iz vadoznih (kraških) voda, kar pa pomeni, da so na podoben način morali nastati tudi rudni minerali v kalcitu, naj gre za wulfenit, galenit ali sfalerit. Z ozirom na dejstvo, da so unionska orudenenja, kljub temu, da so najmlajša, tektonsko precej prizadeta, je velik del rude in kalcita nastal pred pliocenom, verjetno v oligo-miocenu. Ker so se pa kraški procesi dogajali tudi v pliocenu in pozneje, se je mineralizacija unionskih prelomnic nadaljevala vse dokler z rudarskimi deli niso orušili naravne hidrološke razmere.

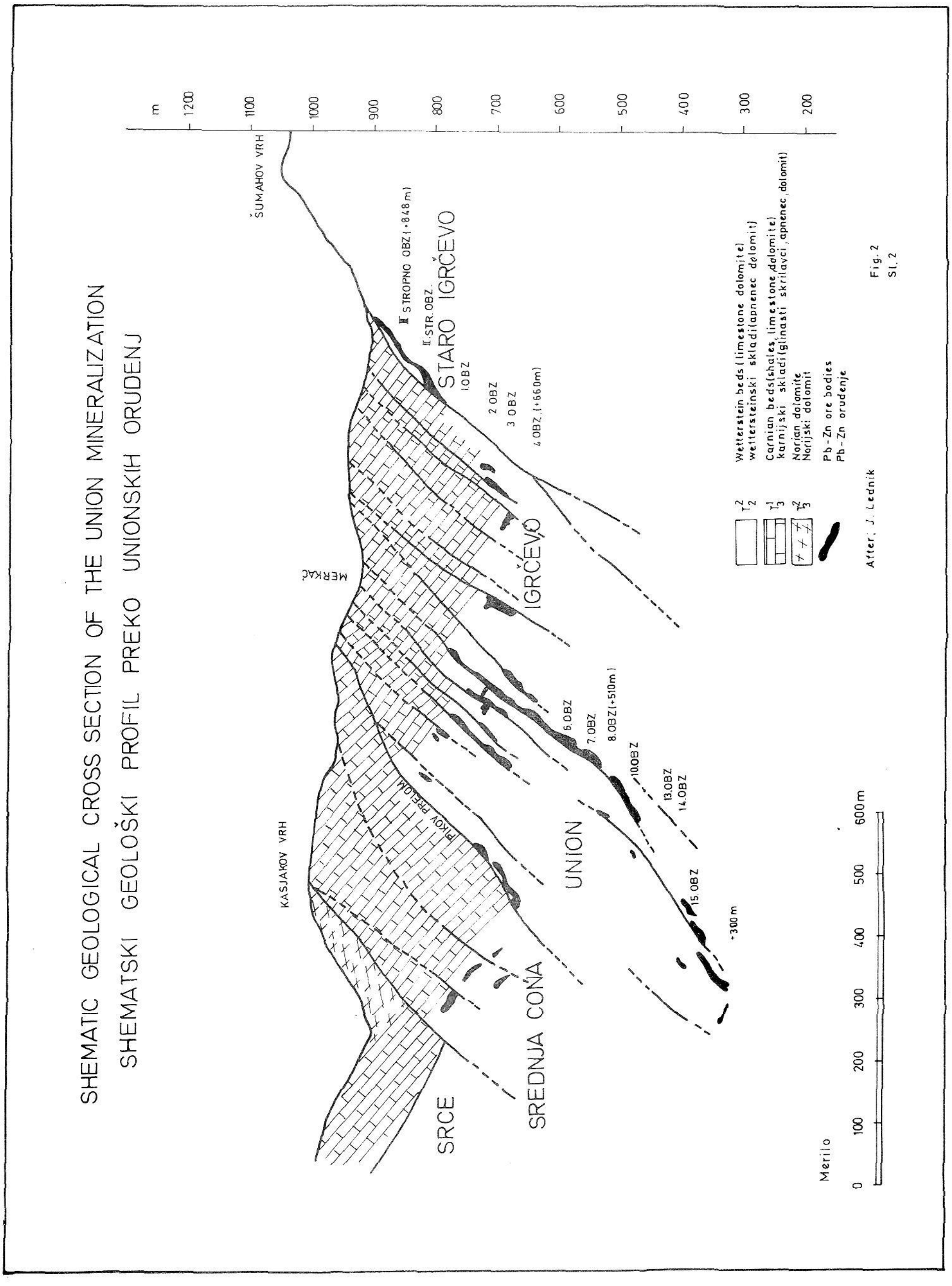

Fig. 2. Shematic geological cross-section of the Union mineralization.
Sl. 2. Shematski geološki profil preko unionskih orudenj.

Fig. 1. Karstified surface on the Peca mountain.
Sl. 1. Zakraselo površje Pece

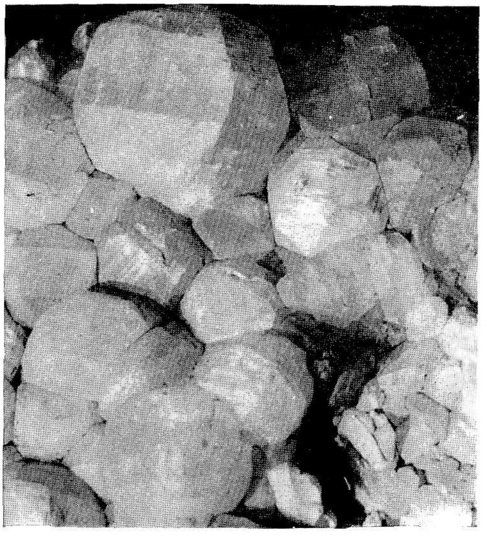

Fig. 3. Aggregate of milky white rhombohedral calcite crystals. 0.6 x.
Sl. 3. Skupek mlečno belih romboedričnih kristalov kalcita. Zmanjšanje 0.6 x.

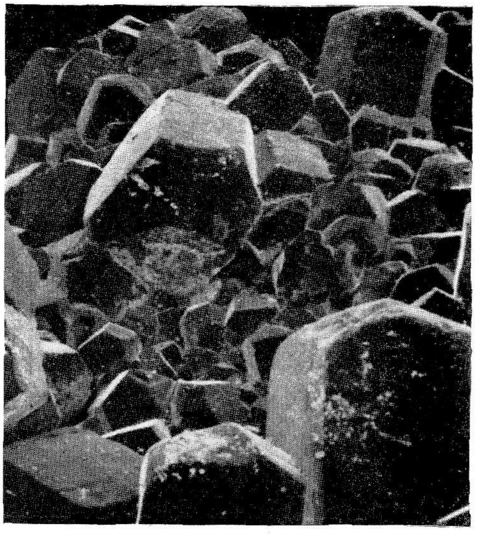

Fig. 4. Aggregate of greyish blue prismatic calcite crystals (without lead). 40 x.
Sl. 4. Skupek sivomodrikastih prizmatičnih kristalov kalcita (brez svinca). Povečava 40 x.

Fig. 5. Dendritic crystal druses of calcite probably after aragonite. 0,7 x.
Sl. 5. Dendritični kristalni skupek kalcita po aragonitu. Zmanjšanje 0.7 x.

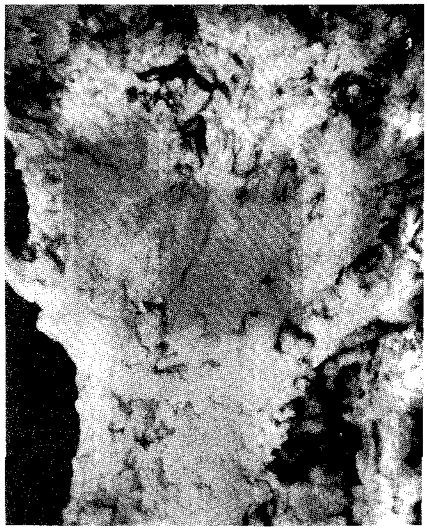

Fig. 6. Crust of fine grained brownish wulfenite crystals with corroded crystal planes on limestone. 48 x.
Sl. 6. Skorja na apnencu z drobnozrnatimi bledo rjavimi kristali wulfenita s korodiranimi kristalnimi ploskvami. Povečava 48 x.

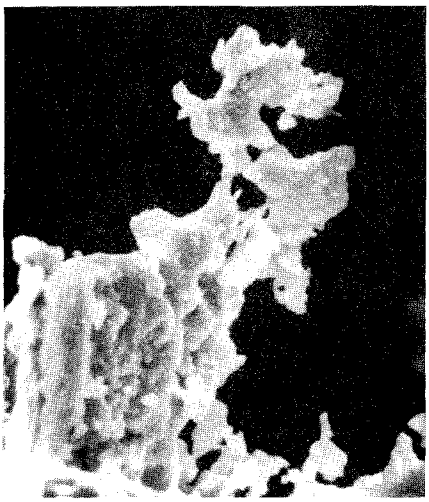

Fig. 7. Aggregate of transparent to very light grey fine grained cerussite crystals. 60 x.
Sl. 7. Skupek prozornih do zelo svetlo sivih drobnozrnatih cerusitovih kristalov. Povečava 60 x.

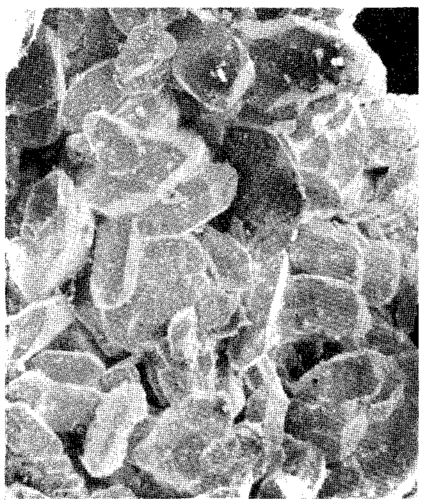

Fig. 8. Detail of intensively corroded galena which is typical for galena--wulfenite ores. 3100 x.
Sl. 8. Detajl močno korodiranega galenita tipičen za galenitno-wulfenitna orudenenja. Povečava 3100 x.