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Barite Deposits on Mount Međuvršje South and South-East of the Town of Kreševo, Bosnia

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In this paper the author gives an account of the basic characteristics of the nine most important barite deposits on Mount Međuvršje south and southeast of the town of Kreševo. The forms in which the ore deposits occur are described, the parageneses of hypogenic and hypergenic minerals are established, the microphysiographic characteristics of all the minerals are given, along with the sequence of mineralization and a tabular scheme of the intensity and extensiveness of the primary mineralization.

In the case of tetrahedrite, barite and the calcite of the deposit at Jelica measurements of reflectivity are given for three standard spectral ranges in air and in cedar oil, and in the case of calcite the reflective pleochroism in oil and in air is also measured.

By means of a comparison of the paragenesis of the Međuvršje barite deposits (type of minerals, intensity and extensiveness) with the wider adjacent Kreševo ore-bearing area, the general characteristics of their metallogeny are stated.

U ovom radu autor je dao prikaz osnovnih karakteristika devet najvažnijih baritnih pojava planine Međuvršje južno i jugoistočno od grada Kreševa. Opisani su oblici pojavljivanja rudnih ležišta, utvrđene su parageneze hipogenih i hipergenih minerala, date su mikrofiziografske karakteristike svih minerala, redoslijed mineralizacije te tabelarni prikaz intenziteta i ekstenziteta pojavljivanja primarne mineralizacije.

Za tetraedrit, barit i kalcit baritne pojave Jelica izneseni su podaci mjerenja moći refleksije za tri standardna spektralna područja u zraku i u cedrovom ulju, a za kalcit je izmjeren i refleksioni pleohroizam u ulju i u zraku.

Komparacijom parageneza (vrsta minerala, intenziteta i ekstenziteta pojavljivanja) baritnih pojava Međuvršja sa rudnim pojavama pripadne šire rudne oblasti Kreševa date su opće karakteristike njene metalogenije.

INTRODUCTION

The barite deposits of Mount Međuvršje are part of the wider ore-bearing area represented by the central Bosnian Ore Mountains (I. Jurković, 1956, 1957). This region extends in the east from Toplica on the River Lepenica to Zečeva Glava and Smiljeva Kosa in the west. This belt runs east-northeast-west-southwest in its western part, and east-west in its eastern part. It is about 22 kilometers long and 2 to 4 kilometers wide.

GEOLOGY

Historical data

The first geological data concerning the remoter hinterland of Sarajevo, including the Kreševo district, were provided by A. Boué (1840, 1858 59, 1862). O. Sendtner (1848) assigned the schistose mountains between Travnik and Donji Vakuf to the Palaeozoic period. The first geological survey map, published by A. Boué (l. c.) appeared in 1862 and showed the southern part of Bosnia, Herzegovina and Montenegro. The area of the River Rama was described by J. Roskiewics (1864). Detailed geological and mining information was provided by A. Conrad (1870). E. v. Mojsisovics — E. Tietze — A. Bittner (1880) worked out the first geological map of Bosnia and Herzegovina, complete with commentary, on a scale of 1 : 576.000. This work included K. v. John's first studies (1880) of the schists and magmatic rocks of the central Bosnian Ore Mountains. On the basis of their lithological characteristics and comparisons with other Palaeozoic locations in Bosnia, E. v. Mojsisovics et al. (l. c.) assigned the Palaeozoic rocks of the central Bosnian Schistose Mountain to the Permian-Carboniferous.

In his work »Geologischer Führer ...« and in the interpretation of the 1 : 200.000 geological map of the Sarajevo area F. Katzer (1903, 1906) gives a survey of the Archaic, Upper Palaeozoic, Mesozoic and Tertiary formations in the central Bosnian Schistose Mountains. In his map of the Sarajevo area E. Kittl (1904) identified a complex of Palaeozoic and Werfenian sediments with Dinaric orientation of the folding axis in the Kreševo region.

F. Katzer (1925) gives a detailed description of the geological structure of the central Bosnian Schistose Mountains, which in his view consist predominantly of Palaeozoic rocks, especially of the Carboniferous and Permian period, with a lesser component of Azoic and Lower Palaeozoic origin. The Azoic is found from Busovača and Fojnica to Šćit. It includes paragneisses, mica schists, ottrelite schists and, as the most widely distributed component, crystalline phyllite. In this series there are also younger strongly schistose quartzporphyres. The Upper Paleozoic adjoins the Azoic as the sole tectonic unit (Carboniferous and Permian). The commonest rocks are phyllites, then limestones, dolomites and quartzporphyres. The belt of thick layers of limestones extends from Kreševo to Bugojno and Gornji Vakuf, the more recent of phyllites, and the older of Gröden layers. F. Katzer considers that the limestones have undergone regional dynamometamor-phosis and contact metamorphosis through the action of quartzporphyres, he claims that they stem from the Permian era, although he concedes that there are also Mesozoic types. They are massive only in the Mount Vranica area, otherwise they are schistose and sericitized. The central Bosnian Schistone Mountains in F. Katzer's view are »horst«, bounded on the west by the Voljevac fault of the Miocene period and on the east by the Busovača fault of the Quaternary period. The Palaeozoic and Azoic folding with its axis running NE—SW is older than the fault tectonic.

In his dissertation I. Jurković (1956) published a 1 : 25.000 geological map of the area round Kreševo, Dusina and Deževica (made together with M. Jakovljević, A. Ferenčić, S. Gregor, A. Kučar and B. Tribuson). In the absence of palaeontological findings F. Katzer's (l. c.) scheme of sequences was adopted in this map. M. Jeremić (1963). basically accepts the stratigraphical column published by F. Katzer (l. c.) only committing himself, on the basis of findings of quartzporphyres and barites in Permian breccias and conglomerates, to the view that the quartzporphyres and the barite deposits arose between the Lower and Upper Permian.

Recent results

The Sarajevo sheet of the outline geological map on scale 1 : 100.000, along with interpretation, was recently prepared by R. Jovanović — M. Mojičević — S. Tokić — Lj. Rokić (1977 and 1978). This geological map also covers the southeastern part of the central Bosnian Ore Mountains, which includes the district of Kreševo. On this map, and in the explanatory text, the Palaeozoic rocks are represented on lower horizons by chlorite and muscovite schists, as well as by phyllites and argillaceous schists, quartzites and lidites. Metamorphic rocks cover dolomites, dolomitic limestones and marbles. On the analogy of the corresponding deposits on the neighbouring sheet (J. Sofilj — M. Živanović — J. Pamić, 1980) the age of this complex has been determined as Devonian. Magmatic rocks are represented by porphyrites and quartzporphyres. The former form sills in the chlorite and muscovite schists, while the latter form extrusions on the verge of the dolomites and limestones of the Devonian period. The youngest Palaeozoic sediments are represented by conglomerates, sandstones, phyllites with Permian flora and cavernous, breccia-like limestones. The Lower Triassic is developed in regard to sandstones, clay-like schists, marls, more rarely limestones. Locally there are differences in the development of the Seissian (sandstones, marls and clay-like schists) and the Campilian (marllike limestones and marls). The Middle Triassic (Anisian) is developed in terms of dolomites and limestones with scanty fauna. The Ladinian at lower horizons contains sandstones, hornstones, marls, clay-like schists, more rarely limestones, while at the upper horizons limestones prevail with intercalations of hornstones, less frequently of marl-like limestones and clay-like schists.

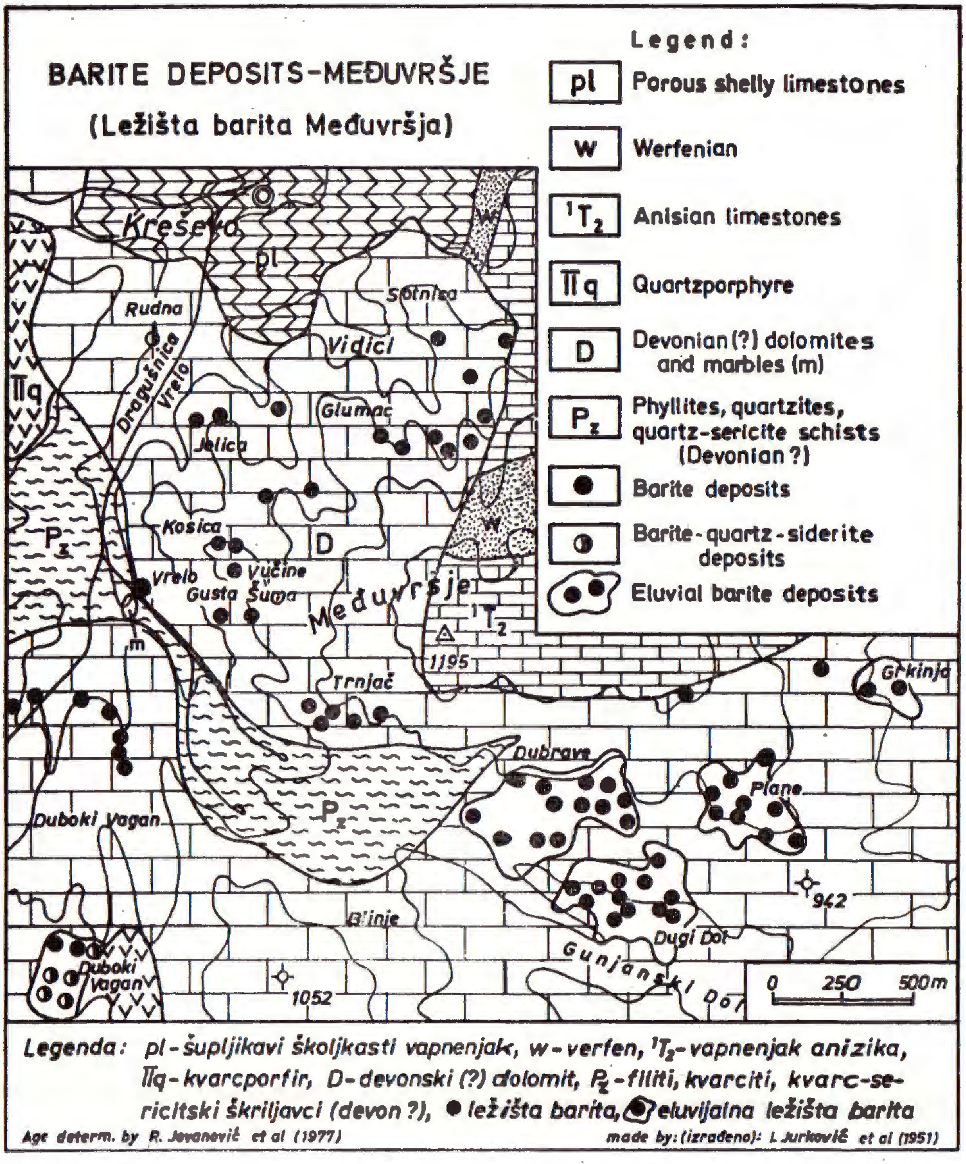
Devonian(?) thick layered dolomites, thick layered or bedded marble-like limestones and occasionally marbles lie across the metamorphic complex but their relationships are not clear. The boundary between them is represented by a broad dislocation along which quartzporphyres have intruded. They are over 300 m thick and contain deposits of barite. The quartzporphyres are linked to the surface of the metamorphic complex and the Devonian dolomites along the line Gunjani—Vidosavići—Banja Jela—Opogor. These are porphyry schists rocks, rarely massive.

Annex No 1 shows the geological map referred to earlier (I. Jurković, 1956), namely that section which covers the area south of Kreševo, and which has been prepared entirely on the basis of dating suggested by R. Jovanović et al. (1977). It is obvious from this map that the barite deposits occur exclusively in the Devonian(?) dolomites.

DEPOSITS OF BARITE ORE

In the Mount Međuvršje area, on the northwest, west and southeast slopes of the mountain deposits of barite have been discovered and exploited to a greater or lesser extent in the following localities: (1) Sotnica, Vidici, Glumac, (2) Rudna, (3) Jelica, (4) Vučine, Kosica and Gusta Šuma, (5) Trnjač, (6) Dubrave and Dugi Dol, (7) Plane, (8) Grkinja and (9) Vrelo.

The first indication of ore deposits in the Kreševo region was given by D. Wolf (1847), quoting mining for cinnabar. We have more detailed information from A. Conrad (1870), who supervised prospecting for tetrahedrites and mercury ores in the vicinity of Kreševo. After the occupation of Bosnia and Herzegovina the excavation of tetrahedrite and cinnabar was described by F. Herbich (1880), F. Vogt (1880) and B. Walter (1887). In these operations de-



BARITE DEPOSITS-MEĐUVRŠJE
(Ležišta barita Međuvršja)
Legend:
pl Porous shelly limestones
W Werfenian
$^1T_2$ Anisian limestones
Πq Quartzporphyre
D Devonian (?) dolomites and marbles (m)
P_z Phyllites, quartzites, quartz-sericite schists (Devonian ?)
Barite deposits
Barite-quartz-siderite deposits
Eluvial barite deposits
Kreševo
Rudna
Dragušnica
Vrelo
Sotnica
Vidici
Glumac
Jelica
Kosica
Vrelo
Vučine
Gusta Šuma
Međuvršje
1195
Trnjač
Grkinja
Dubrave
Plane
Duboki Vagan
942
Blinje
Dugi Dol
Gunjanski Dol
1052
0 250 500m
Legenda: pl-šupljikavi školjkasti vapnenjak, w-verfen, $^1T_2$-vapnenjak anizika, Πq-kvarcporfir, D-devonski (?) dolomit, P_z-filiti, kvarciti, kvarc-sericitski škriljavci (devon ?), ● ležišta barita, eluvijalna ležišta barita
Age determ. by R. Jovanović et al (1977)
made by: (izrađeno): I. Jurković et al (1951)

Anex 1

posits were reported in Vrelo, Rudna, Jelica, Kosica and Glumac, and a number of chemical analyses of tetrahedrites are given. Thus, for the barite deposits with tetrahedrite in Vrelo it is reported that the tetrahedrite contains 1.5 g/t Au and 127 g/t Ag, while the tetrahedrite ore from Rudna contained 12.45 % Cu, 0.43 % Hg and 0.1158 % Ag, or, in another sample, 3.45 % Cu and traces of Hg and Ag. The pyritic ore from Jelica was reported as having 0.6 g/t Au and 6.9—49.5 g/t Ag; limonitic ore had 0.6 g/t Au and 8.6 g/t Ag; average tetrahedrite ore had 1.09 % Cu, sifted ore 7.9 % Cu, quartzitic ore 1.94 % Cu. On the Kosica location barite and calcite waste contained traces of Au and 34.9 g/t of Ag.

F. Katzer (1903) writes of mining in the Kreševo area for tetrahedrites, and refers to significant deposits of barite with tetrahedrite in the form of veins. The same author (F. Katzer, 1907), describing deposits of tetrahedrites in the vicinity of Kreševo, states that the tetrahedrites are exclusively associated with Palaeozoic limestones and dolomites. Deposits are numerous, but individually small, in the form of stockwerk and tabular in shape. Tetrahedrite is almost always associated with barite, in larger deposits with quartz, sometimes with calcite or ankerite, but it may itself occur sprinkled in carbonate rocks. It weathers into malachite, and more rarely into azurite and cinnabar. Deposits are genetically linked with neighbouring quartzporphyres. Mining operations involving gold-bearing tetrahedrites and cinnabar in the Kreševo area were resumed for barites in the Međuvršje area in 1936, once more interrupted during the war, and restored in 1946. The Kreševo district is the most important mining site in Bosnia for the production of barite.

Deposits of barite in the locations Glumac, Dubrave—Dugi Dol are reported by Lj. Barić (1942, 1952), and referred to by A. Polić (1951) and M. Ramović (1956). I. Jurković (1956) has published detailed results of his microscopic investigations into samples of ore deposits from Mount Međuvršje, confirming the paragenesis, the intensity and extensiveness of the occurrence of ore and gangue minerals. In the context of his account of the metallogeny of the barite beds in the Bosnian Palaeozoic formations, M. Jeremić (1963) refers to particular localities, namely Blinje, Trnjač, Dubrave, Vučine, Gusta Šuma as a barite type of ore formation, the localities of Glumac and Grkinja as barite-fluorite type, and the Plane location as a barite-quartz type, but he gives no further details. The exception is the barite deposits at Potplana, for which he gives the paragenesis with the intensity of occurrence (l. c., p. 32). In his latest paper I. Jurković (1986) gives the detailed results of his optical and physicochemical investigations into tetrahedrites and the paragenesis of the barite deposits at Sotnica, Vidici and Glumac.

FORMS OF BARITE DEPOSITS (Annex No 1)

(1) Location Sotnica, Vidici, Glumac is situated 800 to 920 metres above sea level on the furthermost northern slopes of Međuvršje. The ore bodies are very irregular and varied in form. Wall-rocks are uneven, rarely with sharp, smooth edges. Apart from impregnation, nests of varying size, larger or smaller irregular veins and irregular ore-bodies, breccia-like bodies are in evidence in which fragments of dolomite are cemented with barite. The main mineral is barite, calcite and tetrahedrite being much less prominent.

(2) Location Rudna is situated at an altitude of 650 to 700 m. between the stream Kreševica on the west and a stream called Dragušnica on the east, south-east of Kreševo.

The Rudna deposit is situated on the eastern slopes of Rudna, immediatelly above the Dragušnica in highly recrystallized and silicified dolomites. The tetrahedrites are sprinkled in silicified dolomite in a 30 to 50 m. wide belt running from north to south, and there are minor nests of barite with calcite.

(3) Location Jelica is on the western slopes of Mount Međuvršje at a height of 750 to 800 m. The ore deposits are associated with a tectonic zone running from north to south. Relatively short irregular veins, stockwerks and nests of barite with perceptible quantities of quartz are evident in highly tectonized and recrystallized dolomite. There are also epigenetic barite breccias. Lower down towards the Dragušnica a change in paragenesis appears, and just above the Dragušnica may be seen excavations of a quartz-pyritic vein, with mining of barite and a small amount of tetrahedrite further up.

(4) Location Kosica, Vučine, Gusta Šuma is situated about 1 km. further west from the summit of Međuvršje: Vučine at heights between 780 and 800 m., Gusta Šuma from 800 to 900 m. and Kosica from 900 to 950 m. All three deposits are on the Kosica ridge, with Kosica on the ridge itself, the Gusta Šuma deposits on the northwestern slopes, and Vučine in the valley between the Kosica ridge and the Jelica ridge. The Kosica deposits are associated with a tectonic fracture running northwest. The deposits are in the form of a vein about 100 m. long and 0.5 to 0.7 m. thick. The main minerals are barite with calcite and some tetrahedrite.

(5) Location Trnjač is situated immediatelly southwest of the summit of Međuvršje at heights between 970 and 1000 m. with a series of barite deposits in a 30 to 50 m. wide belt running from east to west, in dolomites bordering on quartz-sericite schists. The fractures filled with barite were irregular, slightly curving in a southeastern direction, associated with numerous satellite cracks and fractures running in various directions. There are also epigenetic breccias, and signs of talcisation of the dolomite. The deposits are characterized by numerous sulphides and sulphosalts in microscopic quantities.

(6) Location Dubrave and Dugi Dol is situated about 1 km. southeast of the summit of Međuvršje. The Dubrave deposits are at heights from 970 to 1000 m. in a belt 30 to 50 m. wide, and the Dugi Dol deposits are at heights from 880 to 930 m. The primary barite bodies are in the form of nests of irregular shape, lense-shaped veins, networks of veins and veinlets in tectonically much dislocated dolomite, and it may be observed how the barite cements angular fragments of dolomite. The ore deposits run from east to west. Apart from the primary bodies there are significant allochtonous deposits of barite on a karstified relief of dolomite which arose during dissolution of dolomite and atmospheric weathering. Fragments of barite are found in limonitic yellow diluvial clays. Such beds were the object of intensive exploitation. At some points in the clay there are blocks of barite measuring 1 m^3. Barite in allochtonous deposits is purified by a natural process which removes the tetrahedrite and its weathering products.

(7) Location Plana is situated 1 km. eastsoutheast of the summit of Međuvršje at altitudes between 980 and 1040 m. Barite ore occurs in a belt about 400 m. long, lying in a generally east-west direction. There are nests, stockwerks, irregular veins with marked thickening. There are also allochtonous deposits of barite in diluvial clays.

(8) Location Grkinja is southeast of the Plana location at a height of 800 m. The deposits are predominantly lense-shaped bodies extending east to west in a belt that is 30 to 50 m. wide. The main mineral is barite.

(9) The Vrelo location is on the upper reaches of the Vrelo watercourse, west of the location Gusta Šuma, in the form of an irregular ore stockwerk in strongly tectonized dolomite. The main mineral is barite with some tetraledrite.

PARAGENESIS

A detailed microscopic examination of thin ground and polished sections from all nine barite deposits revealed following hypogene and hypergene minerals (Table I):

Hypogene minerals — tourmaline, muscovite (sericite), rutile, pyrite I, arsenopyrite, quartz I, chalcopyrite I, tetrahedrite I, barite type IV^a, calcite type II, fluorite, chalcopyrite II, tetrahedrite II, sphalerite, enargite, luzonite, »sulphosalt«, »mineral D«, chalcocite, covellite, antimonite, gelpyrite, ascendent goethite, ankerite, neodolomite (ferrodolomite), quartz II, calcite type III, talc and magnesite.

Hypergene minerals — »basic sulphates«, malachite, azurite, goethite, lepidocrocite, cinnabar, chalcocite, covellite, cuprite, native copper.

Table (Tabela) 1.

Intensity of hypogene minerals (Intenzitet hipogenih minerala)

Hypogene minerals (Hipogeni minerali)	Sotnica Glumac Vidići	Rudna	Jelica	Vučine Kosica Gusta Šuma	Trnjač	Dubrave Dugi Dol	Plane	Grkinja	Vrelo
Tourmaline - turmalin					[|]				
Muscovite (sericite) - muskovit-sericit	[:]					[:]			
Rutile - rutil					[:]	[:]			
Pyrite I - pirit I	[|]	[|]	[I]	[|]	[|]	[|]			[|]
Arsenopyrite - arsenopirit	[:]								
Quartz I - kvarc I	[|]	[■]	[I]	[|]	[|]	[|]	[|]	[|]	[|]
Chalcopyrite I - halkopirit I			[:]			[:]			
Tetrahedrite I - tetraedrit I		[|]			[|]	[|]	[|]	[|]	
Barite Type IIIa - barit tip IIIa	[■]	[|]	[■]	[■]	[■]	[■]	[■]	[■]	[■]
Calcite Type II - kalcit tip II	[I]	[|]	[I]	[I]			[|]		[|]
Fluorite - fluorit	[|]				[|]	[|]	[|]	[|]	
Chalcopyrite II - halkopirit II	[:]		[:]			[:]	[:]		
Tetrahedrite II - tetraedrit II	[|]	[|]	[I]	[|]	[|]	[|]	[|]	[|]	[|]
Sphalerite - sfalerit				[:]	[:]				
Enargite - enargit				[:]	[:]				
Luzonite - luzonit					[:]				
"Sulphosalt" - sulfosol			[:]	[:]	[:]	[:]			[:]
Mineral "D" - mineral "D"						[:]			
Chalcocite - halkozin					[:]				
Covellite - kovelin					[:]				
Antimonite - antimonit	[:]								
Gel-pyrite - gel pirit						[|]			
Goethite - ascedentni getit						[|]			
Ankerite - ankerit	[I]		[|]	[|]	[|]	[I]	[|]	[|]	
Neodolomite - neodolomit	[|]	[I]	[I]	[I]	[I]	[|]	[|]	[|]	[I]
Quartz II - kvarc II		[|]				[|]			
Calcite Type III - kalcit tip III	[|]				[|]	[|]	[|]		
Talc - talk					[I]				
Magnesite - magnezit					[|]				

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MICROPHYSIOGRAPHIC CHARACTERISTICS OF THE MINERALS

Hypogene minerals

Tourmaline is observed solely in the Trnjač location in the immediate wall-rock of the ore deposits. It is developed as minute, columnar, clearly pleochroitic crystals shorter than 100 microns, very similar to the tourmaline found in the realgar and orpiment deposits of the Hrmza area (I. Jurković, 1961).

Muscovite (sericite) has been investigated in the Trnjač and Dugi Dol locations, while M. Jeremić (l. c.) refers to it in the Potplana location. It is found on the wall-rock of barite deposits, filling the interstices of barite crystals or else replacing them. It crystallizes as individual foliate crystals 20 to 50 microns long, or else as dense bunches of foliate crystals. It is not out of the question that further investigations will confirm the presence of some minerals of the argilaceous group.

Rutile is observed in association with muscovite (sericite) in locations Trnjač and Dubrave—Dugi Dol. It is developed in the form of needlelike crystals, sometimes in the form of knee-joint twins.

Pyrite I is present in all the Međuvršje barite deposits. It occurs in significant amounts, clearly visible to the naked eye in the Rudna location and in the lower horizons of the Jelica location, in heavily silicified zones of dolomite. At medium absolute altitudes, where the silicification is weaker, there is significantly less, although it can still be seen with the naked eye in places, while in barite deposits on higher horizons, or in those which are at higher absolute altitudes it can be observed only as an accessory under the microscope. Most frequently it is in the immediate wallrock, whether in dolomite or in barite. It is regularly in association with quartz I, sometimes with tetrahedrite I and chalcopyrite I. It is developed or idiomorphic, with the minute crystals growing to at most 70 microns or else forming fine-grained masses. Tetrahedrite I and calcite type II very often replace and resorb it. Locally cataclasis of quartz grains may be observed, and optical anomalies in consequence of the pressures to which it was subjected in the postgenetic plase. Pyrite I is fresh or in various stages of oxidation in goethite and lepidocrocite. (Phot. 1, 3, 8.)

Arsenopyrite we noted only in the Sotnica, Vidici and Glumac locations: it fills fine veinlets of up to 50 microns thickness in the dolomite of the immediate wall-rock, or at some points replaces grains of dolomite, crystallizing in the interstices. M. Jeremić (l. c.) mentions the presence of arsenopyrite in the paragenesis of the Potplana location.

Quartz I is a typical mineral of the first phase of mineralization in the Međuvršje barite deposits. This phase is characterized by a greater or lesser degrees of silicification of dolomites. Silicification may be noted in the formation of small nests, or small irregular masses or systems consisting of more or less dense arrays of quartz I veinlets. As the degree of silicification increases, especially at lower absolute altitudes (Rudna) or lower horizons (Jelica, Gusta Šuma) the metasomatic processes become more pronounced and the surfaces with quartz spread and join up, forming greater or smaller areas of completely silicified dolomite. The barite deposits at the upper absolute levels have relatively little quartz I. The quartz grains are up to 100 microns in diameter, rarely more, but there are coarser grains in some places, predominantly idiomorphically developed transparent crystals of 1—3 cm. in length. During later stages of mineralization the silicified parts of the dolomite were desintegrated by replacement from younger minerals such as barite, tetrahedrite and especially calcite type II (Vučine, Kosica, Gusta Šuma). This resorption of quartz I leaves behind spherically corroded grains or wormlike relicts. Pyrite I may be seen in individual grains of quartz I. Quartz I is predominantly transparent, but some of the larger crystals are clouded on account of occluded mineral dust. Quartz I is very often cataclased and optically anomalous to a greater or lesser degree. (Phot. 1, 3, Fig. 5, 6, 7.)

Calcopyrite I we identified only in the Jelica and Dubrave—Dugi Dol locations although it is probably present in other deposits at lower absolute altitudes.It is associated with tetrahedrite I in pyritized and silicified dolomite in the form of fine-grained masses.

Tetrahedrite I belong to the older generation of ore formation. We find it only in the wall-rocks of ore deposits filling the interstices of quartz I or dispersed in dolomite.It is full of residues of resorbed dolomite forming characteristic sieved structures. It is found as fine grains in pyrite I that is embedded in barite. In Rudna it is dispersed in strongly silicified and recrystallized dolomite (neodolomite). In the Trnjač location we find it at the interface of barite and dolomite, within the dolomite as nests or accumulation of grains, rarely as thin veinlets, while in the Plana and Grkinja locations it occurs as small rounded masses in the dolomite of the wall-rock. The creamy colour with a tint of brown is characteristic (Dubrave—Dugi Dol and Rudna).

Barite type III[a] (Erztyp nach W. Maucher, 1914) occurs in a number of structural types. The platy habit is relatively frequent, flat crystals of barite from a few mm. to several cm. in thickness, with bent faces in places because of pressure. Of the granular structure that most frequently occur we may mention the polygonal structure with clusters of rounded grains with slightly polygonal rims, 0.1 to 0.5 mm. in diameter, and allotriomorphic and hypidiomorphic structures of jagged grains with diameter from 0.1 to 1 mm. We observe granular structures most frequently in the interstices of platy crystals of barite, in some places in association with fluorite. Optically anomalous structures appear in almost all the barite deposits, although to varying degrees. Cataclasis is evident in the deposit, with bent cleavages, translations, thin twinning lamellae of individual or dual system, many of them distorted. These processes are accompanied by numerous forms of optical anomaly and undulose extinction visible in crossed nicols. (Phot. 6.)

Recrystallized structures of barite are also noted. They originate around individual, relative large and optically anomalous barite grains forming girdles of recrystallized, optically normal grains, and continue until recrystallization has affected the entire grain. Recrystallized structures are at points clearly spatially aligned. A special type of structure is represented by the barite breccias. These are markedly epigenetic processes. In fragments of these breccias the barite crystals are optically anomalous to a high degree.

Looked at with the naked eye, barite is white or milky in colour, of sugary appearance, dense. In barite may be seen relicts of an older generation of minerals (pyrite I, quartz I, and tetrahedrite I) alongside the wall-rock. The younger minerals replace the barite along the edges of the grains or along small cracks and minor fissures, especially tetrahedrite II, which is the most plentiful ore mineral in barite deposits. Major tectonic dislocations which bring about recrystallization at some points make identification of a younger generation of barite difficult, although we consider there is a probability of its development. (Phot. 4, 6; Fig. 2, 5, 7, 8.)

Calcite type II (nach F. Braun, 1932), of rhombohedral habit, crystallized in the phase of barite crystallization. It is present in perceptible quantities in locations Sotnica, Vidici, Glumac, Jelica, Vrelo, Vučine, Kosica and Gusta Šuma. It is predominantly in the form of large crystals which are prone to cleavage and up to several cm. in length, transparent but clouded by submicroscopically fine substance. Calcite type II also occurs in the form of fine grains. Many larger crystals of calcite type II are markedly laminar, often polysynthetic with indications of translation and recrystallization. (Phot. 2; Fig. 1.)

Fluorite is most abundant on the Vidici location, much less prominent on the others. In the deposits of Vidici, Trnjač, Dubrave—Dugi Dol, Plana and Grkinja it occupies the interstices of platy barite crystals, and we find it in the dolomite of wall-rock (Vidici) or in ankerite next to the wall-rock of the barite ore-body (Trnjač) or within the barite (Dubrave—Dugi Dol). It is frequently associated with sericite. The fluorite crystals are noticeable corroded. Its cleavage is perfect (100). It is violet in colour with darker or lighter shades or colourless, transparent. The proportion of violet and colourless fluorite varies. In the Dubrave—Dugi Dol location violet predominates, in the other locations the proportion is more nearly equal. The simultaneous presence of strikingly violet fluorites along with colourless varieties in the same deposit indicates the possibility that crystallization began at higher temperatures, at which the octahedral habit evolves, and continued at lower and lower temperatures, at which the hexahedral habit of fluorite crystallized. (Fig. 5.)

Chalcopyrite II forms fine-grained masses in barite or tetrahedrite II (Vidici) or occurs together with »sulphosalt« embedded in tetrahedrite II (Jelica). Very small amounts of chalcopyrite II are also found in the localities Dubrave—Dugi Dol and Plana.

Tetrahedrite II is the most abundant mineral among the sulphides and sulphosalts of Međuvršje. In barite ore-bodies it forms nests, veinlets, incrustations, small rounded masses replacing the barite along the verge of the grains or along fine craks and fissures. (Phot. 3, 4; Fig. 1, 2, 3, 5, 6, 8.) In the Trnjač location we also noted »banded structure« tetrahedrite. In the deposits at Sotnica, Vidici, Glumac, Trnjač, Plana and Grkinja the tetrahedrite showed a creamy yellow colour in reflected light with or without a faint brown tint. Its luster is more powerful than that of »normal tetrahedrite« (possibly because of the presence of mercury), it is totally isotropic and does not manifest internal reflexes. In the locations at Vučine, Kosica and Gusta Šuma the tetrahedrite has a relatively high luster and a greyish-white colour in reflected light with a distinct cream tint. It is also isotropic. In tectonically dislocated parts of the deposit tetrahedrite II manifests numerous blood-red and reddish-brown internal reflexes (possibly because of a higher content of As ?).

Tetrahedrite is in almost all the barite deposits of Međuvršje more or less highly cataclased. It is very strongly cataclased in the Trnjač location, also in places in the Dubrave—Dugi Dol location, while in the Vučine, Kosica and Gusta Šuma locations it is almost totally milonitized in individual parts of the ore-bodies, especially where it is in association with calcite type II. This tetrahedrite is highly friable, while under microscope angular microfragments of tetrahedrite may be observed rolled up in a cement of calcite. (Phot. 2.)

In the Međuvršje ore deposits tetrahedrite is often associated with other sulphides and sulphosalts: with very small masses of chalcopyrite and »sulphosalt« (Jelica), with sphalerite, enargite, covellite, chalcocite (Trnjač), chalcocite (Trnjač), or chalcocite and covellite (Trnjač), sphalerite, covellite and chalcocite (Trnjač), sphalerite, covellite and chalcocite (Trnjač), or with sphalerite, luzonite, enargite and »sulphosalt« (Gusta Šuma). All combinations of minerals given here are found within tetrahedrite II, or else form separate small masses of 0.1 to 0.3 mm. in diameter within the barite. Fairly often we find in tetrahedrite relicts of pyrite I and quantz I. Replacement of tetrahedrite II by barite and calcite II is also clearly visible. The presence of cinnabar in the weathering zone in all the barite deposits of Međuvršje shows that the tetrahedrite in question is mercury-bearing tetrahedrite, as identified by detailed analyses at the Vidici location (I. J u r k o v i ć, 1986).

S p h a l e r i t e is visible only under the microscope (Trnjač, Kosica, Vučine, Gusta Šuma). The tints of its inner reflexes, which suggests a low iron content in the sphalerite molecule. It is intimately associated with tetrahedrite II, luzonite and »sulphosalt« (Gusta Šuma), or with tetrahedrite II, chalcocite and covellite, or alternatively with covellite and chalcocite (Trnjač). In the Trnjač location we also note corroded forms of sphalerite, frequently of skeletal appearance.

E n a r g i t e is rare. In the barite deposits of Vučine, Kosica, Gusta Šuma it arose by paramorphosis from luzonite. It differs from luzonite in its absence of twins and its tints under reflected light, especially when inspected in cedar oil. The tints of enargite are more grey and violet, and in oil it has significantly less luster then luzonite. In the Trnjač location enargite is more common, replacing tetrahedrite II at the verge of tetrahedrite masses or in cracks. Its habit is platy, aggregates display a typical rosy colour. It is anisotropic and manifests reflective pleochroism.

L u z o n i t e is a common mineral in ore samples from the locations Vučine, Kosica, and Gusta Šuma. It is found almost as a rule in tetrahedrite II, but sometimes by itself in calcite type II. In places it is associated with enargite, rarely with »sulphosalt« and sphalerite, but

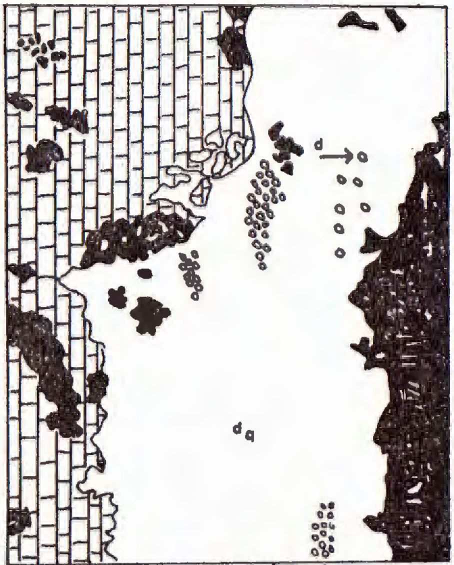

Fig. (Sl.) 1

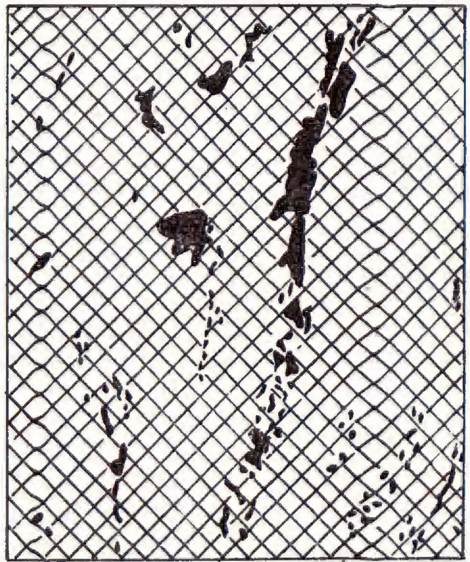

Fig. (Sl.) 2

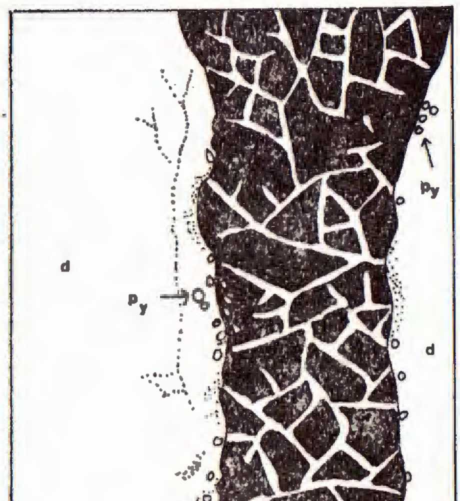

Fig. (Sl.) 3

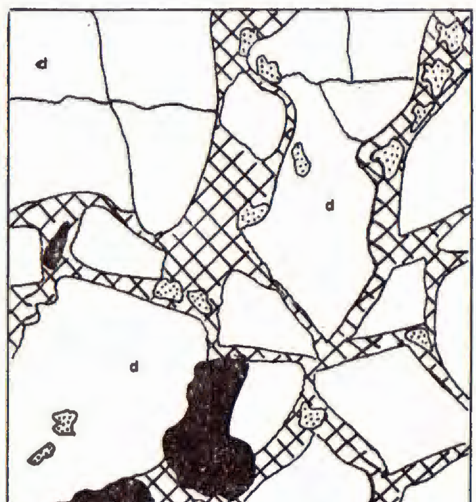

Fig. (Sl.) 4

d — dolomite — dolomit

tetrahedrite — tetraedrit

barite — barit

quartz — kvarc

calcite — kalcit

d_q — silicified dolomite — silificirani dolomit

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Fig. (Sl.) 5

Fig. (Sl.) 6

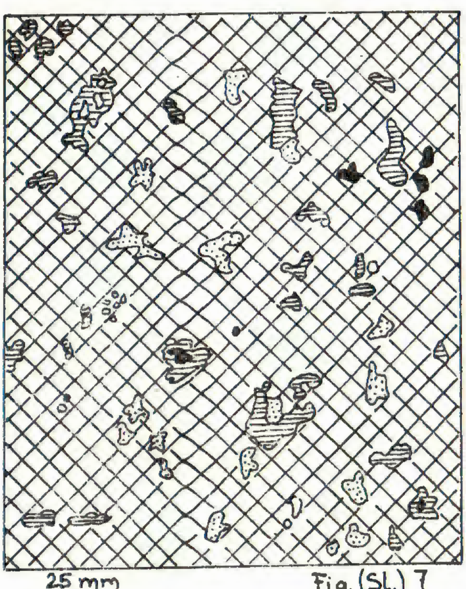


Fig. (Sl.) 7

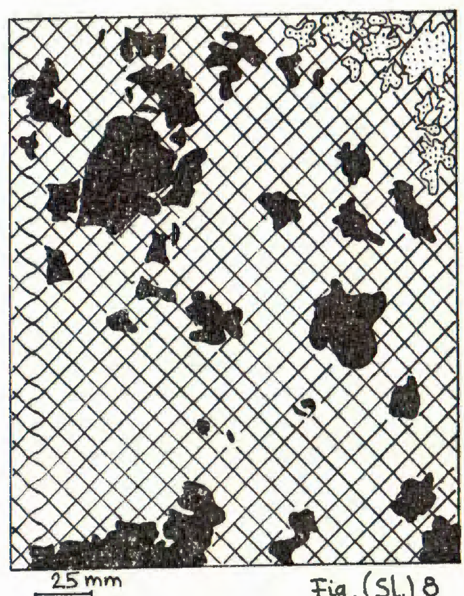
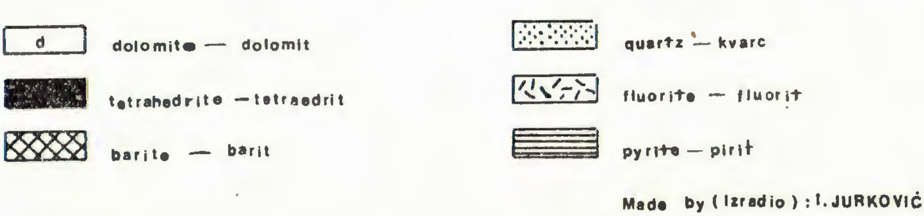


Fig. (Sl.) 8



even there inside tetrahedrite II. Viewed with the naked eye it displays a coppery grey colour and has a metallic luster. Grains of luzonite have an isometric form, they are more or less strongly lamellated, the grains on average are from 50 to 150 μm in size, they occur individually or aggregated in micromasses. Lamellar twinning is characteristic of luzonite, the lamellae are numerous and thin, twins are rare. Twinning amplifies the effect of reflective pleochroism and anisotropic effects. The pattern of bireflections is as follows: light orange — rose — violet (in air) and orange — rosy — violet (in cedar oil). The anisotropic effects are relatively marked, especially with not completely crossed nicols. Along some of the broader twinning lamellae or over entire grains of luzonite paramorphoses of enargite may be noted. (Phot. 2.)

»Sulphosalt« is fairly widespread but always of microscopic dimensions. It is intimately associated with tetrahedrite II (Vrelo, Trnjač), with tetrahedrite and luzonite (Gusta Šuma, Vučine, Kosica), with tetrahedrite II and mineral »D« (Dubrave—Dugi Dol). In reflected light it is white in colour with a creamy tint, clear pleochroism and strongly anisotropic. Inspected in cedar oil it retains its luster which is more powerful than the luster of tetrahedrite in both optical positions. It has low relief.

»Mineral D« has been noted to date only in the Dubrave—Dugi Dol location. It is associated with tetrahedrite II and »sulphosalt«. It takes the form of very small round masses, 50 to 70 μm in diameter. Its colour is cream with a distinct rosy tint, it has high luster, significantly greater than of tetrahedrite. Its relief is lower than the relief of tetrahedrite. It is probably isotropic.

Chalcocite is found in the Trnjač location in association with tetrahedrite and covellite which it surrounds and replaces. The chalcocite in question is rhombic chalcocite with very clearly pronounced cleavage (001). Eutectoid intergrowth between chalcocite and unknown sulphide (bornite ?) completely weathered in secondary minerals is also observed.

Covellite is found in location Trnjač in association with chalcocite in the form of small plates of 50 to 100 μm in diameter, many of which display undulose or anomalous extinction in crossed nicols. There are very marked effects of reflective pleochroism and anisotropy.

Antimonite has to date been found only in location Vidici. It consists of rare microscopically minute needles which grow from barite into tetrahedrite and which until now we have regarded as »Sulphosalt« (I. Jurković, 1986). In his paper M. Jeremić (l. c.) mentions microscopic findings of antimonite from location Potplana.

Colloform pyrite, occurs as reniform, spheroidal masses in location Dubrave—Dugi Dol.

Ascedent goethite is noted only at location Dubrave—Dugi Dol. (Phot. 7.)

Ankerite is a mineral of the wall-rock in barite deposits. The size of ankerite grains is 0.1 to 0.5 mm., more rarely up to 1 mm., significantly larger than the grains of the dolomitic wall-rock. It is predominantly of an allotriomorphic granular structure. The grains have perfect cleavage. Invididual grains display undulose extinctions in crossed nicols, and pressure twins may be noted. Through oxidation it turns into »braunspat«, then into goethite.

Neodolomite (ferrodolomite) arose through recrystallization of the pale grey compact dolomitic wall-rock of the Međuvršje ore deposits. In the recrystallization process the grains were enlarged from 30 to 50 up to 100—150 μm, in places up to 300 μm. During this process a »refinement« of the dolomite grains takes place, they lose their grey colour and assume a distinctly pale colour. In the course of this process the dolomite in part builds in FeO into its molecule and turns into ferrodolomite, which becomes evident only on later oxidation. Recrystallization of dolomite is particularly noticeable in more strongly silicified zones.

Quartz II is of bipyramidal habit. It crystallizes in fine veins which replace barite.

Calcite type III is scalenohedral in habit. We find it in drusy spaces which develop in barite or in the dolomite of the wall-rock. The crystals of this calcite grow out of the walls of drusy spaces, are a few mm, long, elongated in shape, of scalenohedral habit with developed terminal faces of rhombohedar.

Talc and magnesite are observed in the zone where dolomites have undergone local dynamometamorphosis (Trnjač). We consider them to be epigenetic minerals arising in a later tectonic phase.

Hypergene minerals

The weathering process of sulphides, sulphosalts and ankerite in the Međuvršje barite deposits has been dealt in detail by microscopic and chemical methods, using the example of the barite deposits in Sotnica, Vidici and Glumac (I. Jurković, 1986).

Weathering of tetrahedrite begin on the edge of grains and the very fine network of cracks (Phot. 5), its steely surface turns dull, and secondary minerals make their appearance in the numerous microscopically small veins. Basic copper and other sulphates are the first products of tetrahedrite oxidation. This is a crypto-microcrystalline mixture of several minerals showing dark grey in the reflected polarized light of the microscope. Since weathering takes place in a carbonatic medium (dolomite) the basic copper carbonates malachite and more rarely azurite are produced in the following phase; they are characterized by their internal reflexes, green in one case, blue in the other.

Along with these minerals in the oxidization zone, goethite and lepidocrocite dominate as products of tetrahedrite weathering, to a lesser degree ankerite (ferrodolomite), pyrite and chalcopyrite. Most of these iron-hydroxides are in the barite deposits which are rich in pyrite (Rudna, lower horizon of Jelica). They are of pronounced collomorphic structure. Cinnabar, a less soluble compound, is deposited in the pores and cracks in the immediate vicinity of tetrahedrite. It is rarely clearly individualized, usually it is mixed with iron-hydroxides and copper oxides. In this veins it forms clusters of minute crystals of 10 to 20 μm, or else the crystals alternate with crystals of basic sulphates parallel to the walls of cracks. The pattern of pleochroism is: rose-coloured — cream-coloured. The anisotropic effects, which are very strong, can be observed only with not completely crossed nicols on account of the very pronounced blood-red internal reflexes of cinnabar.

Through descendent processes from the soluble copper sulphates in their reaction with tetrahedrite in the cementation zone there arise descedent chalcocite and, notably rarer, covellite in the form of minute plates with characteristic optical properties. In part these sulphides are transformed by further reduction into native copper (Trnjač) or by oxidation into cuprite (Trnjač).

REFLECTIVITY MEASUREMENTS OF TETRAHEDRITE, BARITE AND CALCITE FROM THE JELICA DEPOSIT

A »Spaltmikroskopphotometer nach Berek « (M. Berek, 1937), was used to measure reflectivity. A specially prepared polished galena from the mine at Dobrevo (Macedonia) served as the standard polished section. Measurements were made in air and in cedar oil. Ten measurements were made for each spectral area, and the mean value was calculated graphically and aritmetically. The results are shown in Ttable 2.

Table — Tabela 2.

Reflectivity of the tetrahedrite, barite and calcite Jelica

Moć refleksije tetraedrita, barita i kalcita — Jelica

Minerals Minerali	Spectral area Spektralno područje	Results in % in air (u uzduhu) graphical grafički	numerical računski	in cedar oil (u ulju) graphical grafički	numerical računski
Tetrahedrite	E	32,4	32,3	17,4	17,6
Tetraedrit	D	30,8	31,0	16,6	16,8
Jelica	C	29,1	29,0	15,6	15,8
Barite	E	6,2	6,4	0,4	0,3
Barit	D	6,0	6,3	0,4	0,32
Jelica	C	5,9	6,1	0,4	0,32
Calcite Kalcit Jelica	E	max. 6,1 min. 4,2	6,3 4,6	max. 0,49 min. 0,18	
	D	max. 5,9 min. 4,2	6,0 4,7	max. 0,44 min. 0,19	
	C	max. 5,8 min. 3,9	6,1 4,3	max. 0,42 min. 0,17	

A figure for the D line reflectivity of barite determined by photometer is known in the literature (I. S. Volinski, 1947). This coincides with our result, r = 6,0, but figures for E and C lines were not known. As far as the value for the reflectivity of barite in cedar oil is concerned, there is known figure of r = 0.4 %, arrived at arithmetically from the value for the refractive index (P. Ramdohr, 1960, p. 813). Our values were obtained by measurement in arithmetical and graphic terms.

By careful choice of polished section of a large calcite crystal from Jelica which displayed the maximum degree of reflective pleochroism we were able to obtain maximal and minimal walues for the reflectivity of this mineral. From these it appears that the reflective pleochroism of calcite is:

for the E line from 4.6 % to 6.3 %
for the D line from 4.7 % to 6.0%
for the C line from 4.3 % to 6.1 %

From the literature a figure is known for the D line (yellow sodium light) which ranges between 4.0 % and 6.0 % (I. S. Volinskij, 1. c.).

SUCCESSION OF MINERALIZATION

All nine barite deposits of Međuvršje have the same type of paragenesis (Table 1). In each case (except Rudna deposit) barite is the main mineral, differences are to be found only in the quantity of accompanying gangue minerals, the most significant of these being quartz, pyrite, ankerite, calcite and fluorite. These differences are in the main conditioned by the various depths of the erosion levels on the western slopes of Mount Međuvršje. The other minerals, apart from tetrahedrite, are accessories, barely visible to the naked eye, and most often to be seen only by microscopic examination. Further, more detailed microscopic investigations will suggest an even more uniform extensiveness in the occurrence of accessory minerals.

Mineralization developed in several phases. In the initial phase there occurred a weaker or more marked metasomatosis of the dolomite wall-rock along systems of cracks and fissures and breccia-like zones, marked by greater intensity at lower absolute altitudes. The most pronounced feature is silicification, followed by ankeritization and then pyritization. In this phase there my be noted very small amounts of tetrahedrite and chalcopyrite of the first generation and some sericite (muscovite), tourmaline and rutile.

The second phase is the main phase of ore formation, yielding significant quantities of barite type IV[a] of platy habit, allotrimorphic grained barite type III, octahedral fuorite and calcite type II of rhombohedral habit. In the third phase, the sulphosalt phase, Hg-tetrahedrite was crystallized with very small amounts of other minerals, mainly of copper (chalcopyrite, enargite, luzionite, covellite, chalcocite), and exceptionally small quantities of sphalerite, antimonite, »sulphosalt«, »mineral D«. In the fourth phase drusy, epithermal or hydatogenic minerals are mainly deposited: ascedent goethite, scalenohedral calcite type III, needle-shaped quartz type II, gel-pyrite.

At the time of a later tectonic phase there arose at some points a talcization and magnesitization of the dolomite, as well as a partial weaker or stronger cataclasis, formation of breccia and even local milonitization of barite and other minerals with very pronounced optical anomalies and disturbances in crystallographic structure. In the hypergenic phase oxidation processes and barely perceptible traces of cementation have

Table 3 (Tabela 3)

Minerals found in the ore occurrences of the Kreševo region (Minerali rudnih pojava oblasti Kreševo)	Intensity of hypogene minerals (Intenzitet pojavljivanja hipogenih minerala)						
	I	II	III	IV	V	VI	I-VI
1. Rutile (rutil)	—	—	—	—	1	2	3
2. Tourmaline (turmalin)	—	—	—	—	1	1	2
3. Quartz I (kvarc I)	3	4	4	6	22	—	39
4. Pyrite I (pirit I)	1	1	1	3	16	9	31
5. Arsenopyrite (arsenopirit)	—	—	—	—	1	1	2
6. Tetrahedrite (tetraedrit I)	—	—	—	—	5	—	5
7. Chalcopyrite I (halkopirit I)	—	—	—	—	—	2	2
8. Barite type IV^{a} (barit Tip IV^{a})	39	9	2	1	—	—	51
9. Fluorite (fluorit)	—	—	—	1	8	—	9
10. Calcite Type II (kalcit tip II)	—	2	5	9	3	—	19
11. Tetrahedrite II (tetraedrit II)	—	—	—	10	36	—	46
12. Sphalerite (sfalerit)	—	—	—	—	1	3	4
13. Enargite (enargit)	—	—	—	—	1	4	5
14. Luzonite (luzonit)	—	—	—	—	1	1	2
15. Chalcopyrite II (halkopirit II)	—	—	—	—	5	6	11
16. Covellite (kovelin)	—	—	—	—	—	2	2
17. Chalcocite (halkozin)	—	—	—	—	—	2	2
18. Bornite (bornit)	—	—	—	—	2	—	2
19. »Sulphosalt« (sulfosol)	—	—	—	—	—	5	5
20. »Mineral D« (mineral D)	—	—	—	—	—	1	1
21. Bournonite (burnonit)	—	—	—	1	—	—	1
22. Galena (galenit)	—	—	1	1	1	—	3
23. Antimonite (antimonit)	—	—	—	—	1	2	3
24. Hematite (hematit)	1	—	—	—	—	—	1
25. Specularite (spekularit)	6	6	—	—	2	—	14
26. Cinnabar (cinabarit)	1	2	1	2	3	—	9
27. Gel-pyrite (gel-pirit)	—	—	—	—	2	—	2
28. Goethite (asced. getit)	—	—	—	1	1	1	3
29. Tennantite (tenantit)	—	—	—	—	1	—	1
30. Siderite-ankerite (siderit-ankerit)	1	2	8	24	—	—	35
31. Muscovite-sericite (muskovit)	—	—	—	—	1	2	3
32. Chlorite (klorit)	—	—	—	—	2	—	2
33. Quartz II (kvarc II)	—	—	—	2	1	—	3
34. Calcite Type III (kalcit tip III)	—	—	—	—	7	—	7
35. Chalcedony (kalcedon)	—	—	—	4	—	—	4
Total (ukupno)	52	26	22	65	125	44	334

Legend (legenda): I — main mineral (glavni mineral parageneze); II — in very significant amounts (u značajnim količinama); III — in observable amounts (male količine); IV — scarce (oskudne količine); V — accessory mineral (akcesorija); VI — in miroscopic amounts (vidljiv tek mikroskopom).

been visibly effected the weathering of hypogenic minerals into hypergenic minerals. Ore formation is the most pronounced in meso-epithermal phase, but it extends right into the hydatogenic phase.

PARAGENETIC CHARACTERISTICS OF THE BARITE DEPOSITS OF MOUNT MEĐUVRŠJE IN RELATION TO THE ORE-BEARING REGION OF KREŠEVO

The Mount Međuvršje barite deposits constitute the lesser part of the economically significant barite-bearing area of the Kreševo region which extends from the River Lepenica southeast of Međuvršje to Zečeva Glava and Smiljeva Kosa in the west. In that area 61 larger or smaller deposits of individual or grouped ores have been recorded and described (I. Jurković, 1956). These deposits are grouped within 7 more closely defined areas: Međuvršje (9 deposits), Tarčin (7), Duboki Vagan (8), Vranci (15), Deževice (8), Dusina (9) and Smiljeva Kosa (4). A more detailed analysis of these ore deposits will be provided in subsequent papers.

A synthetic survey of the paragenesis of ore deposits in the Kreševo region is given in *Table 3.* In that table 35 of the hitherto identified hypogene minerals from all 61 ore deposits in the Kreševo region are arranged according to the intensity of their occurrences into six categories (I—IV), from category I, in which the predominant (main) minerals are listed, down to category VI, in which are included minerals that can be detected in the deposits only by means of a microscope. The figures in the vertical columns indicate in how many of the ore deposits each hypogene mineral is present in quantities corresponding to the intensity category. The last vertical column gives the total number of ore deposits in which a given mineral occurs regardless of the intensity of its occurrence, or else this column gives an indication of its extensiveness in the region as a whole.

From an analysis of the figures in Table 3 the following conclusions and characteristics of the paragenesis of the Kreševo region ore deposits emerge:

(1) of 61 mineral deposits 52 are almost monomineral in character; of those 39 deposits are of barite, 6 of specularite, 3 of quartz, and one each of pyrite, hematite, cinnabar, and siderite. Of the remaining 9 ore deposits, 4 are barite-quartz, 4 barite-specularite, and 1 barite-calcite. Barite is therefore the dominant mineral or else one of the very significant minerals present in 48 of the ore deposits in the Kreševo region. These facts indicate that we are dealing with a typical barite ore region.

(2) As far as extensiveness of occurrence is concerned, the most widespread minerals are barite (in 51 ore deposits) and tetrahedrite (46); quartz (39), siderite or ankerite (35), and pyrite (31) are very prevalent, less common are calcite (19), specularite (14), chalcopyrite (11), fluorite (9), and cinnabar (9). All the other 25 minerals are found only in a few ore deposits, either as accessories, or only by microscopic investigation. Although further more detailed microscopic examination on a larger number of samples may show an increase in the extensiveness of particular minerals, and possibly some others as well (Šibenik — Stu-

den, 1976), the overall picture will not change substantially. From what has been stated it follows that the main characteristic of the extensiveness of occurrence in the case of the Kreševo region ore deposits is represented on the one hand by so-called »gangue minerals«, barite, quartz, pyrite and siderite (ankerite), and, on the other hand, by tetrahedrite with cognate sulphosalts, principally of copper, rarely of lead, although it should be stressed that the tetrahedrite group of minerals are of marginal significance as far as their intensity of occurrence is concerned.

(3) The economic significance of the Kreševo ore deposits has fluctuated throughout the course of history. In Roman times limited mining operations were conducted for alluvial gold arising from weathering of gold-bearing tetrahedrite products. Because of the requirements of gold amalgamation mining was also pursued on deposits of primary cinnabar or on cinnabar arising from weathering of mercury tetrahedrite. In the Middle Ages mining was carried on principally on the limonitic ores of gossans arising from oxidation of pyrite — and siderite (ankerite) — bearing ore deposits, as well as for gold and mercury. During the period of the Bosnian Occupation prospecting for gold and silver-bearing tetrahedrites and for mercury was intensified. From 1936 onwards mining operations became more and more intensively concentrated on the barite deposits, which in the course of time turned out to represent one of the most important barite-bearing regions in the Dinaric metallogenetic province.

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Baritna ležišta planine Međuvršje južno i jugoistočno od grada Kreševo, Bosna

I. Jurković

U uvodnom dijelu rada dat je osvrt na do sada publicirane rezultate geoloških istraživanja u području Srednjobosanskog Rudogorja s osobitim osvrtom na šire područje Kreševa. Posebna pažnja je posvećena baritnim ležištima planine Međuvršje.

Pri izlaganju rezultata svojih istraživanja baritnih ležišta autor daje opis njihove morfologije: priljepci, uprskanja, manja ili veća nepravilna gnijezda, prslinske i pukotinske nepravilne žice, nepravilna rudna tijela, mineralizirane breče te baritno kršje u diluvijanloj ilovini na kartificiranoj podlozi dolomita.

Na temelju detaljne mikroskopske analize u prolaznom i reflektiranom polariziranom svijetlu određena je ova parageneza primarnih i sekundarnih minerala svih baritnih ležišta Međuvršja:

A. Hipogeni minerali: turmalin, muskovit (sericit), rutil, pirit I, arsenopirit, kvarc I, halkopirit I, tetraedrit I, barit tip III i IV[a], kalcit tip II, fluorit, halkopirit II, tetraedrit II, sfalerit, enargit, luzonit, »sulfosol«, »mineral D«, halkozin, kovelin, antimonit, gel-pirit, ascendentni getit, ankerit (ferodolomit), kvarc II, kalcit tip III, talk i magnezit.

B. Hipergeni minerali: »bazični sulfati«, malahit, azurit, getit, lepidokrokit, cinabarit, halkozin, kovelin, kuprit, elementarni bakar.

Opisane su sve najvažnije mikrofiziografske karakteristike primarnih i sekundarnih minerala a u posebnoj tabeli 2 dat je za svakog od primarnih minerala intenzitet i ekstenzitet pojavljivanja.

Za tetrahedrit, barit i kalcit iz rudnog ležišta Jelica određena je moć refleksije pomoću »Spaltmikroskopphotometer nach Berek«, i to za sve tri spektralne linije C, D i E u zraku i u ulju. Za kalcit je određen i refleksioni pleohroizam uz iste uvjete.

Autor je posebno prikazao sukcesiju procesa mineralizacije. U prvoj fazi izvršena je putem ograničene metasomatoze koja je bila najintenzivnija u nižim apsolutnim nivoima, piritizacija, silifikacija i ankeritizacija (ferodolomitizacija) duž salbandi u dolomitu. U drugoj, glavnoj fazi orudnjenja, kristalizirao je barit, dominantan mineral svih rudnih pojava, i uz njega manje količine romboedrijskog kalcita i oktaedrijskog fluorita. U trećoj fazi, fazi sulfosoli, kristalizirao je živin tetraedrit, sporedan sastojak baritnih ležišta s vrlo malim količinama drugih sulfida i sulfosoli. Mineralizacija završava četvrtom fazom, fazom drugih minerala u kojoj kristaliziraju skalenoedrijski kalcit, igličasti kvarc, gel-pirit i ascedentni getit.

U epigenetskoj fazi ležišta prolaze kroz jača tektonska naprezanja koja se očituju u kataklazama, milonitizaciji, brečiiranju, stvaranju mjestimičnog talka i magnezita te brojnim optičkim anomalijama kao što su undulatorna ili nepravilna potamnjenja, tlačni sraslaci, rekristalizacija.

Na kraju rada autor daje komparativnu analizu parageneza 61 rudne pojave šireg područja Kreševo od Toplice do Smiljeve Kose. Analiza je pokazala (tabela 3) da je u 48 rudnih pojava barit ili dominantan (u 39 pojava) ili jedan od dva glavna minerala (u 9 pojava) parageneze. Barit je i najučestaliji mineral tog područja, jer se javlja u 51. od 61 rudne pojave. Ostale pojave: spekularitske (6), kvarcne (3), piritska (1), hematitska (1), cinabaritska (1) i sideritska (1) su ili vrlo malene ili tek mineraloškog značaja. Između sulfida i sulfosoli najučestaliji je tetraedrit (javlja se u 46 pojava), ali je prisutan u vrlo podređenoj količini ili se javlja kao akcesorija. Analiza je pokazala da je šire područje Krševa izrazito baritonosno područje, jedno od najproduktivnijih rudarskih područja na barit u Dinaridima.

PLATE I — TABLA I

Phot. 1. Location Guta Šuma, Međuvršje. Polished section, N
Finegrained and idiomorphically developed pyrite (py) in quartz (q).

Fot. 1. Lokacija Gusta Šuma, Međuvršje, Nabrus, N
Finozrnati i idiomorfno razvijeni kristalići pirita (py) u kvarcu (q).

Phot. 2. Location Gusta Šuma, Međuvršje. Polished section, N
Cataclased tetrahedrite (t) cemented by calcite. In tetrahedrite small rounded masses of luzonite (f).

Fot. 2. Lokacija Gusta Šuma, Međuvršje. Nabrus, N
Kataklazirani tetraedrit (t) cementiran kalcitom (crnosivo). U tetraedritu male zaobljene masice luzonita (f).

Phot. 3. Location Jelica, Međuvršje. Polished section, N
Quartz (q) replaces dolomite (d). Tetrahedrite (t, white) with relics of replaced dolomite (grey). Corroded grain of pyrite (py) in tetrahedrite (t).

Fot. 3. Lokacija Jelica, Međuvršje. Nabrus, N
Kvarc (q) potiskuje dolomit (d). Tetraedrit (t, bijelo) s ostacima potisnutog dolomita (sivo). Korodirana zrnca pirita (py) u tetraedritu (t).

Phot. 4. Location Trnjač, Međuvršje. Polished section, N
Tetrahedrite (white, t) replaces coarsegrained barite (b, darkgrey)

Fot. 4. Lokacija Trnjač, Međuvršje. Nabrus, N
Tetraedrit (bijelo, t) potiskuje krupnokristalasti barit (b, tamnosivo).

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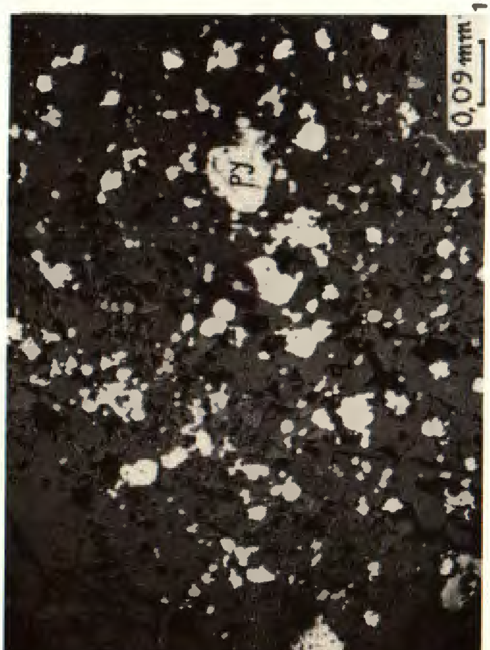

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PLATE — TABLA II

Phot. 5. Location Trnjač, Međuvršje. Polished section, N
Weathering of tetrahedrite (light-grey) into »basic sulphates« (bs, black).

Fot. 5. Lokacija Trnjač, Međuvršje, Nabrus, N
Trošenje tetraedrita (svijetlosivo) u »bazične sulfate« (bs).

Phot. 6. Location Dubrave, Međuvršje. Thin section, N
Tetrahedrite (black) replaces barite (b, white). In tetrahedrite relics of barite. Crystals of barite very strongly cataclased by tectonic movements.

Fot. 6. Lokacija Dubrave, Međuvršje. Izbrusak, N
Tetraedrit (crno) potiskuje barit (b, bijelo). U tetraedritu ostatci potisnutog barita. Kristali barita su vrlo jako kataklazirani djelovanjem postgenetskih tektonskih procesa.

Phot. 7. Location Dubrave — Dugi Dol, Međuvršje, Polished section, N
Ascedent goethite, limonite (1) in barite (b). Goethite replaces barite. Small corroded grain of pyrite (py) in barite.

Fot. 7. Lokacija Dubrave — Dugi Dol, Međuvršje. Nabrus, N
Ascedentni getit (limonit, 1) u baritu (b). Getit potiskuje barit. Sitna zrnca korodiranog pirita (py) u baritu.

Phot. 8. Location Dubrave — Dugi Dol, Međuvršje, Polished section, N
Zoned crystals of pyrite (py) in barite (b, dark grey). Tetrahedrite (light grey) replaces pyrite along distinct zones.

Fot. 8. Lokacija Dubrave — Dugi Dol, Međuvršje. Nabrus, N
Zonarno građen pirit (py) u baritu (b). Tetraedrit (svijetlosivo) potiskuje pirit po određenim zonama.

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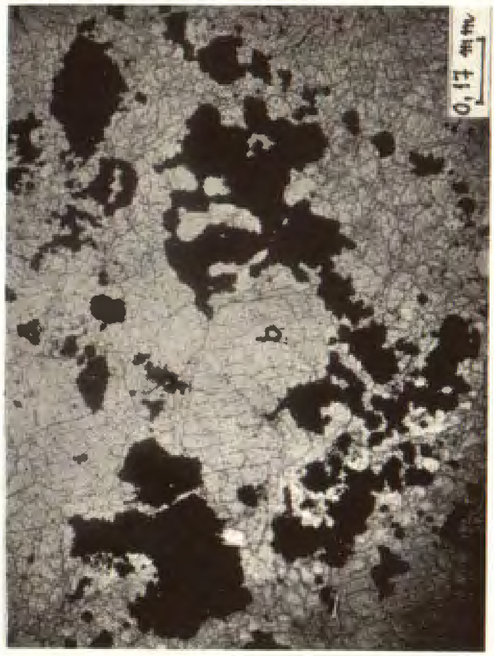

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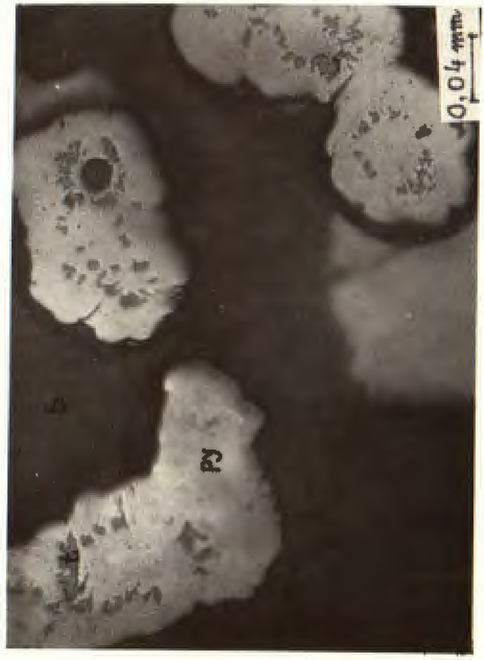

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