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Abstract: The geological relationships between the rock units in the Dereiçi/Şavşat (Artvin) region and vein-type Cu-Pb-Zn deposits were presented in this paper. The study area comprises the Upper Cretaceous intermediate volcanic rocks and sedimentary rocks, with Post-Eocene dykes of andesitic and diabasic composition.

The mineral deposits are classified as (1) Sphalerite-Galena-Chalcopyrite-Pyrite veins (Talatın Madeni, Binektaşı and Fikrinin Madeni), (2) milky quartz-Chalcopyrite-Sphalerite-Galena-Pyrite veins and (3) Chalcopyrite-Pyrite veins. The general paragenetic sequence of the mineralizations is observed as quartz I-pyrite-chalcopyrite-sphalerite-galena-quartz II-chalcocite-covellite. The wall rocks are subjected to silicification, sericitic alteration, chloritization and carbonatization.

Dereiçi (Şavşat, Artvin) Cu-Pb-Zn Yataklarının Jeolojisi

Özet: Bu makalede Dereiçi/Şavşat (Artvin) bölgesindeki kaya birimlerinin ve damar tipi Cu-Pb-Zn yataklarının jeolojik ilişkileri sunulmuştur. Çalışma alanı Üst Kretase ortaç volkanik kayaçlar ve tortul kayaçlar ile Eosen sonrası yaşlı andezitik ve diyabazik bileşimli dayklar içerir.

Yataklar mineralojik açıdan (1) Sfalerit-Galen-Kalkopirit-Pirit damarları (Talatın Madeni, Binektaşı ve Fikrinin Madeni), (2) Süt kuvars-Kalkopirit-Sfalerit-Galen-Pirit damarları (Kayanın Madeni I&II) ve (3) Kalkopirit-Pirit damarları (Yeni Açması ve Hasanın Açması) olarak sınıflandırılmıştır. Genel mineral parajenezi kuvars I-pirit-kalkopirit-sfalerit-galen-kuvars II-kalkosin-kovellit olarak gözlenmektedir. Yan kayaçlar silisleşme, serisitleşme, kloritleşme ve karbonatlaşmaya maruz kalmıştır.

Introduction

The Dereiçi region lies in the eastern part of the eastern Black Sea Region, within the Artvin province (Figure 1). The region is crossed by the Şavşat-Meydancık road. Dereiçi village is located 15 km Northwest of Şavşat and 60 km Southeast of Artvin.

The geological and economical aspects of the Şavşat region at the eastern margin of the Eastern Pontides were the subjects of several studies. In this study, the first purpose is to determine and describe the characteristics of the rock units and determine the relationships between them, since the economical aspects are better defined with the understanding of the general geological characteristics of the area. The second purpose is to define the mineralogical properties of the Dereiçi polymetallic vein–type mineral deposits and the relations to their wall rocks.

Dereiçi deposits are the best-known polymetallic vein-type mineral deposits of the Şavşat area. Koprovica (1973) reported that 22 occurrences were being mined during the 1970s. In this study, samples from 6 deposits (Talatın Madeni, Binektaşı, Fikrinin Madeni, Kayanın Madeni, Yeni Açması and Hasanın Açması) were chemically analysed. Additionally, samples from 3 deposits (Binektaşı, Fikrinin Madeni and Kayanın Madeni) were examined by petrographic and ore microscopic techniques.

Regional Setting

The Dereiçi area lies at eastern part of the Eastern Pontides that is dominated by Jurassic-Tertiary island arc magmatic rocks formed on the Paleozoic Basement (Akıncı, 1980). Paleozoic granites and schists of older units form the Basement. The overlying volcanic and sedimentary units can be grouped as either Lower Basic

* In respectful memory of my teacher Prof. Dr. Ayhan Erler, whose guidance and support were of invaluable assistance to me in my doctoral thesis, and who is regrettably no longer with us.

series, Dacidic Series, Upper Basic Series, Tertiary Granitoids, Young Basic Series and Young Dykes (Schultze-Westrum, 1961; Akıncı 1985) or the First Cycle, the Second Cycle and the Last Cycle (Schneider and Özgür, 1988). The Upper Cretaceous volcanic and volcanosedimentary units of the study area can be included into the Dacitic Series and the dykes are included into the Young Basic Series and Young Dykes. The major structural elements of the study area are normal faults forming four fault sets. The first set trends NW-SE and is cut by a NE-SW trending fault set. E-W and N-S trending faults are rare.

Rock Units

The rock units exposed within the study area are divided into three as (1) Dereiçi Formation (2) Akkavak Tuffite and (3) Dykes including andesite and diabase dykes. Geologic map of the region is shown on figure 1.

Dereiçi Formation

The andesitic, latitic and dacitic lavas which alternate with a volcanosedimentary unit is named as the Dereiçi formation (Soylu, 1994). It consists of Şarabul Latite, Gigaziler Hornblende Andesite, Çağlayan Dacite and Meydancık Volcanosedimentary Members. In this study Şarabul Latite and Çağlayan dacite members are out of the study area limits.

Meydancık Volcanosedimentary Member. The Meydancık Volcanosedimentary member is characterised by the alternations of well-bedded limestones, dacitic tuffs and andesitic-tuff-microbreccias. The unit was first named by Koprovica (1973) as tuffaceous sandstone-andesitic microbreccia-limestone and diabase. Soylu (1994) included this member in the Dereiçi formation and named it as the Meydancık Volcanosedimentary member.

The member crops out along Meydancık Stream, Çağlayan Stream, at Büyükçukur and Aşağıtatireket villages. The member conformably overlies and underlies Gigaziler Hornblende Andesite member. This relationship can be explained by pauses in the volcanism. It is conformably overlain by the Akkavak Tuffite.

The thickness of the beddings is not uniform and varies from 10 cm to 1 m. The strike of the unit varies from N05E to N70E and the dip direction varies from 10°-40° towards SE. The colour of the unit ranges from grey to green.

Microscopically, the limestone is fossiliferous, and includes volcanic clasts, which are in a matrix made up of fine-grained sparry calcite with some clay. The volcanic clasts are poorly sorted, angular to subangular, and include chloritized basalt with flow texture, carbonatized/ argillized/ or silicified plagioclase, cryptocrystalline and crystalline quartz and chloritized hornblende. The unit contains small amount of pyrite disseminations.

The dacitic tuff comprises crystal fragments of altered plagioclase and quartz in a fine-grained matrix of glass and quartz fragments. Few rock fragments with trachytic texture are also observed. Plagioclases are totally altered to calcite and the matrix is partly replaced by clays and sericite. Pyrite occurs as fine-grained disseminations and coarse idiomorphic crystals.

Andesitic tuff microbreccia consists of altered angular to subangular volcanic fragments, plagioclases and hornblendes. Volcanic fragments appear to be of andesitic composition. Plagioclases display ghost polysynthetic twinning and are replaced by sericite and calcite. Hornblendes are totally chloritized and partly opacitized starting from the edges. The matrix is made up of glass, partly altered to sericite and carbonate. The rock is crossed by veinlets of coarse-grained quartz with pyrite.

According to fossil contents of limestones (Koprovica, 1973), the lower part of the unit is of Coniacian, and the upper part is Campanian-Maastrichtian age.

Gigaziler Hornblende Andesite Member. The Gigaziler Hornblende Andesite member consists of andesitic lavas with very limited pyroclastic rocks and hosts vein type mineralizations in the area. It was mapped as two different units by Koprovica (1973). He mapped the hydrothermally altered part of the unit as amygdaloidal andesite and breccias of Upper Cretaceous age. However the fresh parts were mapped as hornblende andesite of Tertiary age which was accepted as cutting amygdaloidal andesite and breccias. Soylu (1994) observed that the rocks mapped as amygdaloidal andesite and breccias are altered equivalents of the hornblende andesite and then named them together as Gigaziler Hornblende Andesite included this unit in the Dereiçi formation.

The member which covers the central portion of the study area, is exposed at Gigaziler, Biril, Urzenalan and Dereiçi villages. It conformably overlies the Meydancık Volcanosedimentary Member at the Southeast of Dereiçi village. However, it is conformably overlain by the same member along Meydancık Stream, at the north of Biril and the east of Aşağıtatireket and Büyükçukur villages. The diabase and the andesite dykes intensely cross the unit throughout the prospect.

In the field, it is easily recognised by phenocrysts of feldspars and hornblendes forming a porphyritic texture when it is fresh. Locally, the lengths of hornblendes reach up to 2 cms. Very limited outcrops of tuff breccias are also observed within the unit.

The tuff breccias that are dominated by subrounded clasts of andesite with maximum diameter of 5 cm are hardly recognised because of hydrothermal alteration. The colour of the member changes from light brown to green and appears to be highly fractured and jointed.

Although the rock is named as hornblende andesite, the petrographical composition of the rock changes from hornblende andesite to hornblende-biotite andesite (north of the Binektaşı Mine), biotite andesite (west of the Kurdiçvan Village and east of the Binektaşı Mine). However, these compositional differences are local and other petrographical samples taken a couple of meters around these units are all observed as hornblende andesite.

Microscopically, the unit has a porphyritic texture. Main constituents are plagioclase, hornblende, biotite and secondary quartz in a micro to cryptocrystalline groundmass. Plagioclases (Oligoclase-Andesine) are subhedral and zoned and they display polysynthetic twinning. Seriate and intersertal textures are also observed. Plagioclases are altered to sericites, clays and carbonates. Hornblendes are subhedral and display twinning. In some sections, they have opacitic rims and are altered to chlorites and partly to carbonates. Subhedral, tabular biotites are completely altered to chlorites. Quartz occurs as glomeroporphyritic masses where the rock is silicified. It is also observed as corroded grains when the rock appears to be dacite. Micro to cryptocrystalline groundmass is glassy and argillized, sericitized and silicified in some sections. Pyrite occurs as tiny disseminated crystals in the groundmass, as coarser grains in altered mafic minerals and as veinlets.

Akkavak Tuffite. The Akkavak Tuffite is dominated by andesitic tuff-breccias, tuffs and rarely sandy limestones. It was first named by Koprovica (1973) as stratified andesitic breccias and tuffs. Soylu (1994) mapped the unit as the Akkavak Tuffite formation.

The unit is exposed at the northwest of the study area around Akkavak and to the north of Büyükçukur villages. It conformably overlies the Meydancık Volcanosedimentary Member at the north of Büyükçukur and Aşağıtatireket villages. It also conformably overlies the Gigaziler Hornblende Andesite Member at the north of Gigaziler Village. Upper boundary of the unit is not observed in the study area.

The Akkavak Tuffite is characterised by alternation of bedded andesitic tuffs, limestones and andesitic tuff-breccias. It is difficult to differentiate this unit from the Meydancık Volcanosedimentary member due to their similar compositions and physical properties. On the other hand the Akkavak Tuffite is made up of more tuffaceous material and is poorly bedded. Its colour changes from grey to green. The thickness of the beddings is not uniform and varies from 20 cm to 1 m. Strike and dips of the unit are variable and there is no general trend.

Microscopical properties of the unit are also same as the Meydancık Volcanosedimentary Member. Andesitic tuffs and breccias consist of altered fragments of andesite, plagioclases and amphiboles. Andesitic fragments are silicified, argillized and chloritized. Plagioclases are replaced by sericites and carbonates. Hornblendes are chloritized. The cement is tuffaceous, intensively silicified and chloritized, rarely carbonatized and limonitized.

The limestone is dominated by volcanic clasts in a fine-grained matrix, which is made up of calcite and some clay. The clasts are andesitic, angular and poorly sorted.

Koprovica (1973) stated that, in the upper part of the tuffite, limestone lenses were probably formed in reefs and they contain rudists; according to micropalaentological work, the unit is of Campanian-Maastrichtian age.

Dykes

The Dereiçi area contains several andesite and diabase dykes which, intrude the Şavşat formation around Şavşat region (Yılmaz et al., 1992), are accepted as Post Eocene.

Andesite dykes. The andesite dykes are exposed at the east of Kayanın Madeni. They intrude the Gigaziler Hornblende Andesite and the Meydancık Volcanosedimentary members. The contacts between these members and the dykes are sharp.

The andesite dykes occur as wall-like bodies. They are mostly oriented NW-SE and rarely E-W. Their colour ranges from grey to green.

Microscopically, they are characterised by porphyritic texture. The main constituents are phenocrysts of zoned plagioclases and subhedral hornblendes in a microcrystalline matrix. Plagioclases (andesine) display polysynthetic twinning and contain chloritized inclusions. They are slightly altered to sericites. Hornblendes are green coloured and are faintly chloritized. Some opaque minerals are observed as accessories.

Diabase dykes. The diabase dykes are exposed all over the study area, mainly concentrated at the north of Dereiçi village at the central portion of the prospect. They intrude the Gigaziler Hornblende Andesite, the Meydancık Volcanosedimentary member and the Akkavak Tuffite. They also cross the andesite dykes.

The diabase dykes are observed as long, continuous wall-like bodies. They are black coloured and are very hard and compact. They are mostly oriented NE-SW and NW-SE, also rarely E-W.

Microscopically, they are fine grained and have diabasic texture. They consist of plagioclase, clinopyroxene, hornblende and opaque minerals. Plagioclase (labradorite) laths show polysynthetic twinning and are slightly altered to carbonates. Clinopyroxenes, which are subhedral and diopsidic augite in composition, are chloritized along the edges. Hornblendes are subhedral and almost totally altered to chlorite, actinolite and carbonate. The opaque minerals form euhedral crystals or skeletal grains, sometimes intergrown with pyroxenes.

Mineral Deposits

Dereiçi polymetallic vein-type mineral deposits are located in the vicinity of Dereiçi village (Şavşat-Artvin), at the eastern part of the F48-a3 quadrangle of 1/25.000 scale topographical map of Turkey. Yeni Açması is situated 1 km east of Aşağıtatireket village and Hasanın Açması is at 300 m east of Yeni Açması. Talatın Madeni is at 400 m Northeast Dereiçi village on the Meydancık road. Binektaşı is at 750 m north of Dereiçi and 600 m east of Urzenalan villages. Fikrinin Madeni is located 500 m north of Binektaşı. Kayanın Madeni is at 600 m north of Kurdiçvan village (Figure 1).

The Şavşat-Meydancık road provides easy access to Talatın Madeni. Binektaşı is connected to Şavşat-Meydancık road by a dirt road, which can only be used during the summer. Other deposits are connected by old mine roads which are not suitable for driving, but are used as good walking paths.

The Dereiçi vein type Cu-Pb-Zn deposits were first mined during 1970s by Bamaş mining company of Ankara (Koprovica, 1973). During operation, several adits and trenches were driven in the majority of localities: Binektaşı, Talatın Madeni, Fikrinin Madeni, Hasanın Açması, Yeni Açması and Kayanın Madeni. Koprovica (1973) carried out an exploration program and defined 22 occurrences including the above deposits. Copper-rich ore-grade material was hand-selected and transported by lorry to Murgul and sold there. The portions rich in galena and sphalerite remained at the stock. In 1972, the construction of a flotation plant was started near the junction of Meydancık and Şavşat streams. However no data have been recorded that the plant has ever been in operation.

Prospecting and geological studies in the area were carried out by Obuz and Başçoban (1969), Koprovica (1973,1979), Nonovic (1979), Erendil et al. (1989), Karanis (1991) and Yılmaz et al. (1992). They described the types of mineralization and geology of the Dereiçi and surrounding areas.

All the mineral deposits are hosted by the Gigaziler Hornblende Andesite member of the Dereiçi formation.

The principal mineralizations in the Dereiçi area are of vein type and can be grouped as (1) Sphalerite-Galena-Chalcopyrite-Pyrite veins (Talatın Madeni, Binektaşı and Fikrinin Madeni), (2) Milky quartz-Chalcopyrite-Sphalerite-Galena-Pyrite veins (Kayanın Madeni I&II) and (3) Chalcopyrite-Pyrite veins (Yeni Açması and Hasanın Açması). The veins are fault controlled and are typical fissure fillings. The ore minerals are chalcopyrite, sphalerite, galena, chalcocite, covellite and tetrahedrite. The gangue minerals are pyrite, quartz, sericite and calcite. The character of mineralization and wall rock alteration are similar to the other mesothermal vein type mineralizations (Koprovica, 1973; Erler, 1975; Nonovic, 1979; Aslaner et al., 1995).

Sphalerite-Galena-Chalcopyrite-Pyrite veins

Talatın Madeni, Binektaşı and Fikrinin Madeni are classified as Sphalerite-Galena-Chalcopyrite-Pyrite veins.

Talatın Madeni. The drift at the Talatın Madeni was collapsed due to groundwater activities. The vein is not observed at the gallery entrance, however Koprovica (1973) reported that the thickness of the mineralized zone is 6 meters. The vein strikes N-S and it is vertical. Sphalerite, galena and chalcopyrite were identified by Koprovica (1973).

Binektaşı. Three drifts driven along the same vein were reported by Koprovica (1973) at the Binektaşı deposit, however only one adit is still accessible for ten meters. The thickness of the vein is not uniform. At the gallery entrance the thickness is 50 cm and in the gallery the thickness varies from 10 cm to 70 cm (Figure 2). Koprovica (1973) measured the thickest section as 3m. The vein strikes N40-50W and dips 25°-35° SW.

Mineralogically, the vein is composed of sphalerite, chalcopyrite, galena, chalcocite, pyrite, quartz and covellite. Chalcopyrite occurs as anhedral masses, which

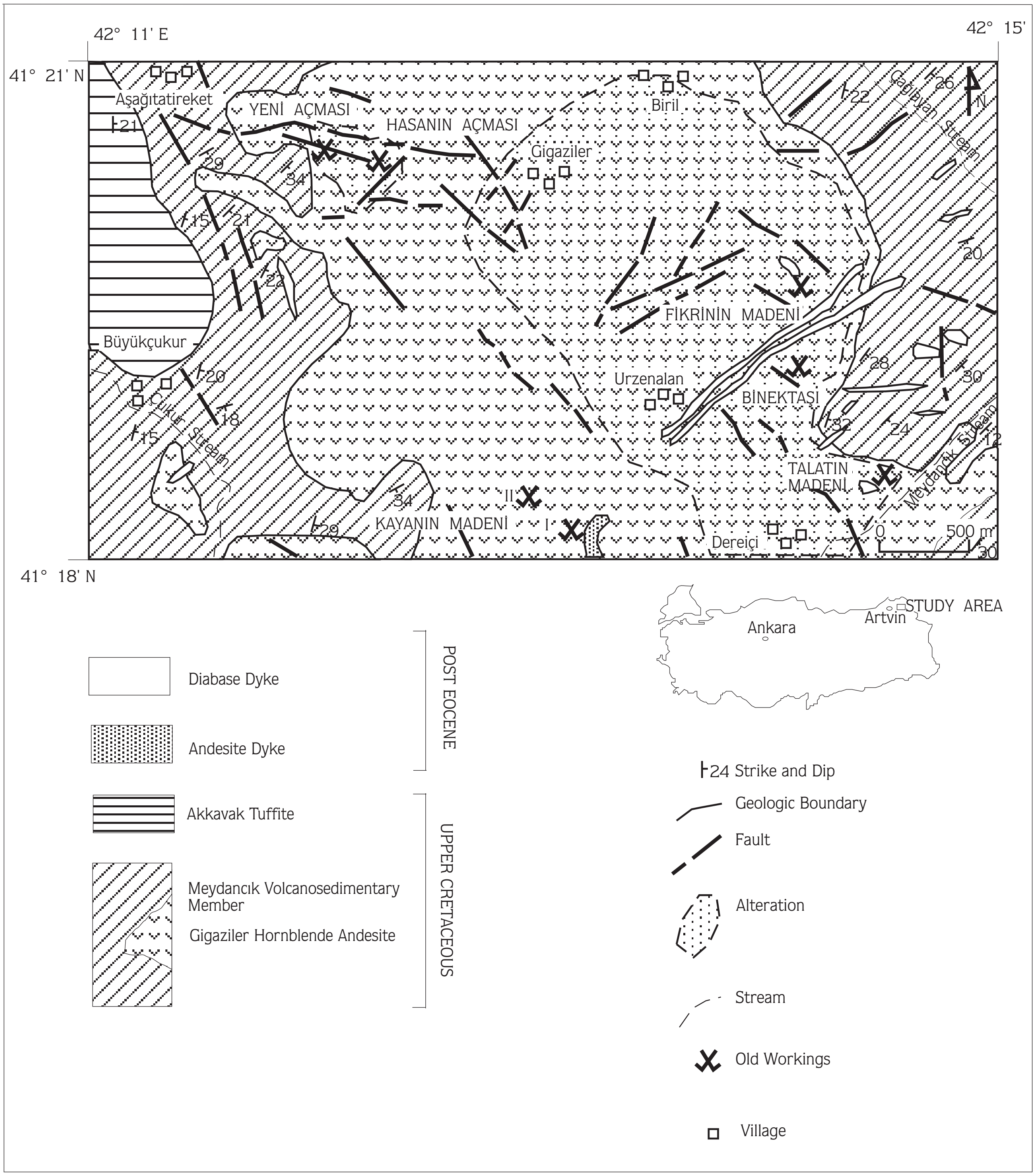

Figure 1. Geological map of the study area.

is partly replaced by sphalerite (Figure 3). Development of chalcocite and covellite is observed on chalcopyrite. Few anhedral galena grains characterised by cleavage pits, sharply intrude into chalcopyrite and sphalerite. Sphalerite is observed as anhedral masses and is the most common mineral. Pyrite does not show widespread

Figure 2. Pb-Zn-Cu vein at Binektaşı Mine (north of Dereiçi village, the ruler is 20 cm long).

distribution and occurs as disseminated subhedral to euhedral crystals. Quartz is observed as matrix (quartz I) and as thin veinlets (quartz II). Paragenetic sequence of the mineralization is observed as quartz I-pyrite-chalcopyrite - sphalerite - galena - quartz II-chalcocite-covellite (Figure 4).

The range of analytical values in the grab samples collected from Binektaşı deposit are as follows: 0.53-8.43% Cu, 0.17-0.81% Pb, 1.11-22.77% Zn, 4-14ppb Au and 4.9-17.8g/ton Ag (Table 1).

Fikrinin Madeni. Seven drifts are driven along the same vein at different levels. The vein, which is controlled by a NW-SE trending fault, can be followed for 200 m at the surface. The thickness of the vein is not uniform, at the surface it varies from 60 cm to 90 cm (Figure 5). The thickest section was measured by Koprovica (1973) as 2.5 m. The vein strikes N25-35W and dips 50°-60°SW.

Mineralogically, the vein is composed of sphalerite, galena, chalcopyrite, pyrite, quartz and tetrahedrite. Sphalerite occurs as anhedral crystalline masses and characterised by its low reflectivity and dark grey colour. Galena occurs as medium to coarse anhedral crystalline masses and makes sharp contacts by several minute intrusions into the sphalerite (Figure 6). The association of galena with chalcopyrite is characterised by sharp edges along which galena penetrates into chalcopyrite. Chalcopyrite occurs as anhedral masses and as unreplaced islands within sphalerite and galena (Figure 7). Pyrite is observed as medium to coarse euhedral grains within the chalcopyrite and it is partly replaced by sphalerite. Tetrahedrite occurs as small anhedral grains within or along the margins of galena grains. Quartz which is observed as groundmass (quartz I) and as thin veinlets (quartz II) that cross the other minerals.

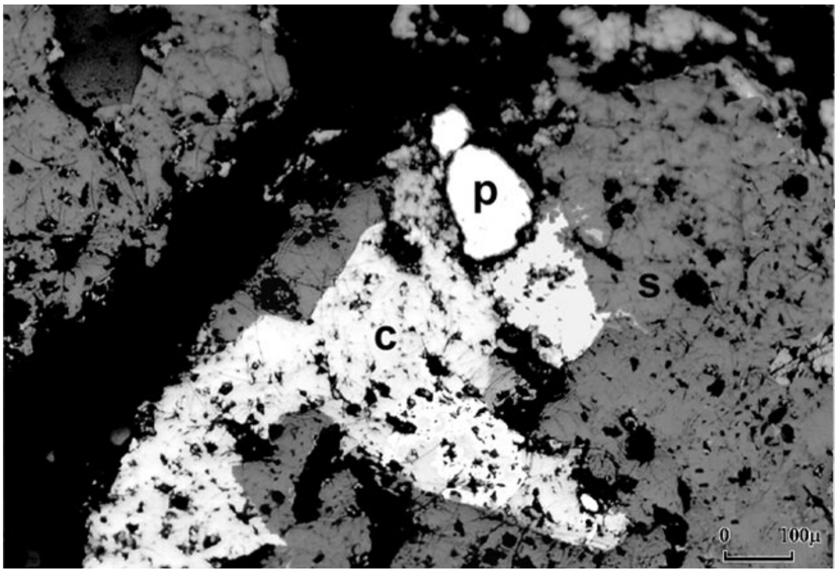

Figure 3. Photomicrograph of chalcopyrite partly replaced by sphalerite and pyrite (Binektaşı Mine), c: chalcopyrite, s: sphalerite, p: pyrite.

Table 1. Geochemical analysis results of the grab samples.

Deposit Name	Cu (%)	Pb (%)	Zn (%)	Au (g/t)	Ag (g/t)	As (ppm)	Cd (ppm)	Ba (ppm)	Fe (%)
Binektaşı	1.37	0.81	22.77	0.013	17.80	1430	1840	26	3.71
	0.53	0.20	2.38	0.004	4.90	9.6	150	42	4.57
	8.43	0.17	1.11	0.014	7.20	1430	54	33	4.84
Fikrinin Madeni	1.80	11.80	23.23	0.046	68.20	110	2250	4	7.03
Kayanın Madeni I&II	0.52	0.06	1.11	0.018	3.70	3	92	226	3.60
	1.77	2.65	22.01	0.350	64.20	326	1350	19	9.06
	1.30	0.03	0.13	0.012	14.90	17	11	28	15.00
	0.79	0.08	0.63	0.012	5.70	3	52	304	4.54
Yeni Açması	5.00	0.02	0.05	0.048	20.00	19	3	21	10.70
Hasanın Açması	2.41	0.00	0.03	0.015	6.50	22	1	36	9.85
	3.82	0.00	0.03	0.011	12.80	21	2	21	8.50

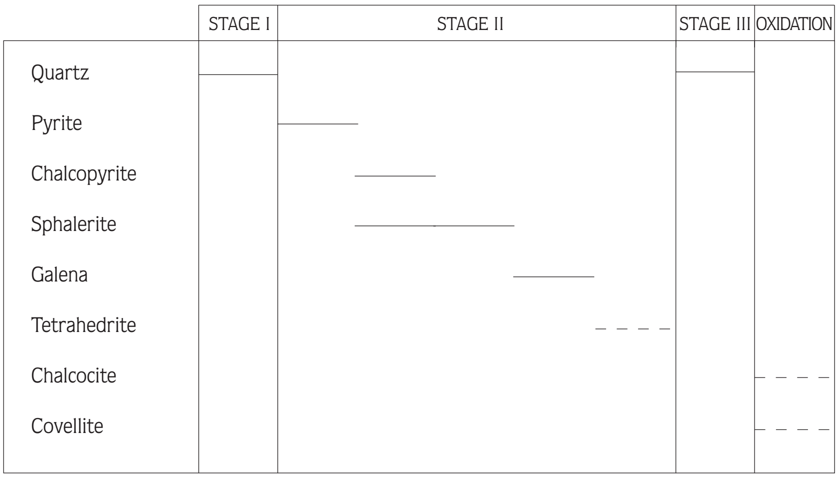

Figure 4. Generalized paragenetic sequence of the mineralizations.

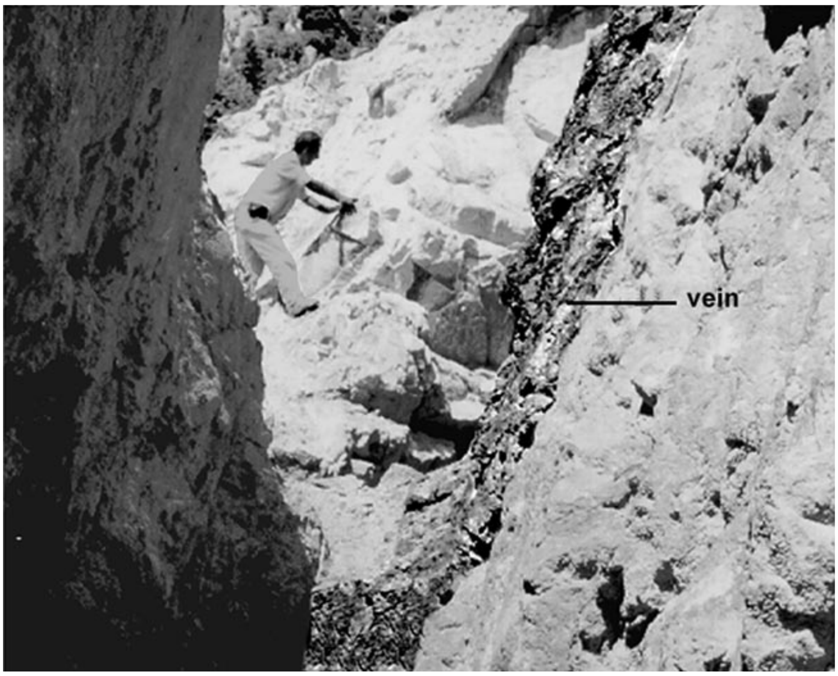

Figure 5. Pb-Zn-Cu vein at Fikrinin Madeni top gallery (northeast of Urzenalan village).

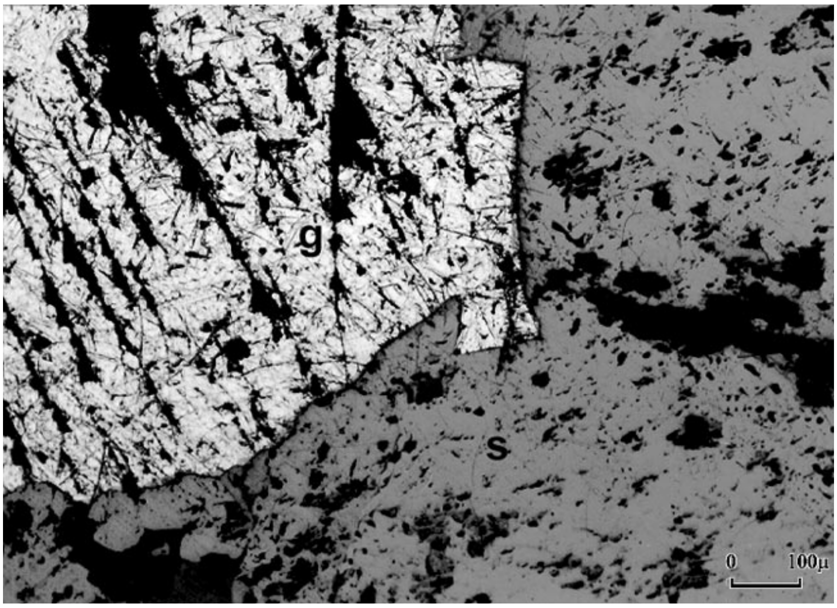

Figure 6. Photomicrograph of sphalerite partly replaced by galena (Fikrinin Madeni), s: sphalerite, g: galena.

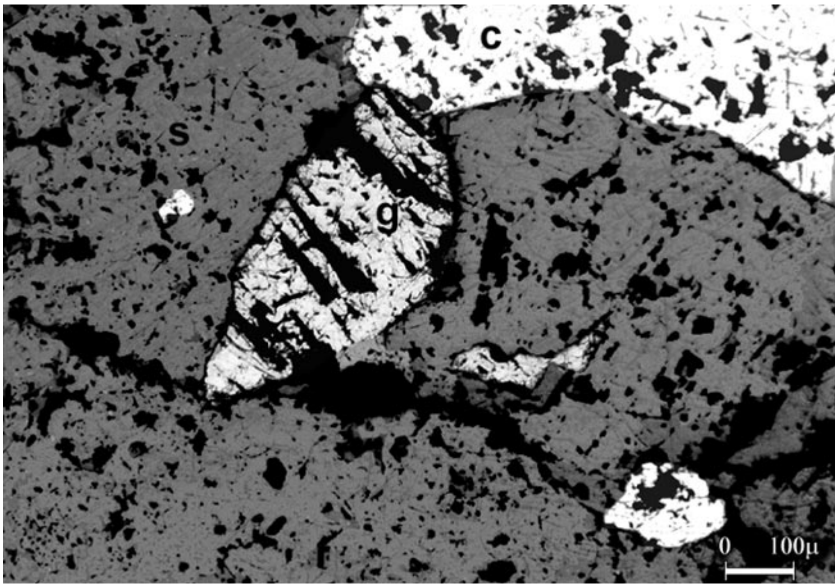

Figure 7. Photomicrograph of chalcopyrite partly replaced by sphalerite and galena (Fikrinin Madeni), c: chalcopyrite, g: galena.

Paragenetic sequence of the mineralization is observed as quartz I-pyrite-chalcopyrite-sphalerite-tetrahedrite-galena-quartz II (Figure 4).

Fikrinin Madeni deposit is characterised by high zinc and lead values: 1.8% Cu, 11.8% Pb, 23.23% Zn, 46ppb Au and 68.2g/ton Ag (Table).

Milky quartz-Chalcopyrite-Sphalerite-Galena-Pyrite veins

Kayanın Madeni I and II are classified as milky quartz-chalcopyrite-sphalerite-galena-pyrite veins.

Kayanın Madeni I and II. Kayanın Madeni I and II consist of two brecciated quartz veins. Three drifts were reported by Koprovica (1973), however only two of them give partial access. The thickness of the veins range from 1 m to 2 m, he measured the thickest section as 3.90 m. The strike of the veins is N30-40W and they dip almost vertically.

Mineralogically, they are composed of chalcopyrite, sphalerite, galena, tetrahedrite, pyrite and quartz. Chalcopyrite occurs as coarse to medium crystalline masses and disseminations. Pyrite is partly replaced by chalcopyrite and sphalerite. Sphalerite is observed as anhedral crystalline masses and replaced by tetrahedrite. Galena is characterised by cleavage pits and is partly replaced by sphalerite. Tetrahedrite occurs in sphalerites as fine to medium anhedral masses. Pyrite is observed as euhedral cubes or anhedral crystalline masses surrounded by chalcopyrites. Matrix is made up of coarse crystalline brecciated quartz (quartz I). All the minerals are crossed by thin quartz veins (quartz II). Paragenetic sequence of the mineralization is observed as quartz I-pyrite-chalcopyrite-galena-sphalerite-tetrahedrite-quartz II. The grab samples were collected from the drifts and dump materials from Kayanın Madeni deposits contain 0.52-1.77% Cu, 0.03-2.65% Pb, 0.13-22% Zn, 12-350ppb Au and 3.7-64.2g/ton Ag (Table). Since copper rich materials were selected and sold, remnants in the dump material is rich in lead and zinc.

Chalcopyrite-Pyrite veins

Yeni Açması and Hasanın Açması are classified as fault controlled chalcopyrite-pyrite veins.

Yeni Açması. The gallery at Yeni Açması is totally collapsed and very difficult to recognise. The vein is not observed from the surface. Koprovica (1973) stated that the vein trends WNW-ESE and dips 85° N. The thickness of the vein reaches up to 2 m. It is composed of chalcopyrite and pyrite. Yeni Açması is dominated by high-grade copper with very low-grade lead and zinc. The grab sample collected from the dump material contains 5% Cu, 182ppm Pb, 516ppm Zn, 48ppb Au and 20g/ton Ag (Table).

Hasanın Açması. The entrance of the gallery at Hasanın Açması was also collapsed, but mineralised zone is still partly observable. The thickness of the vein is not uniform and ranges from 15 cm to 90 cm. The vein trends E-W and dips 80° S. Koprovica (1973) reported two galleries on the vein at two different levels. Main constituents of the vein are chalcopyrite, pyrite and minor sphalerite. The composition of the grab samples taken from the Hasanın Açması deposit are similar to the Yeni Açması deposit, but with lower grades: 2.41-3.82% Cu, 4-11ppm Pb, 255-320ppm Zn, 11-15ppb Au and 0.5-12.8g/ton Ag (Table).

Wall Rock Alteration

The central portion of the study area is dominated by hydrothermal alteration with a general trend of NW-SE, and covering an area of approximately 1 km by 4 km including Gigaziler, Urzenalan and Dereiçi villages. In general, the wall rock at the Dereiçi deposits was subjected to silicification, sericitic alteration, carbonatization and chloritization, which were later overprinted by supergene clay alteration.

Silicification is associated with the veins and is laterally followed by sericitic alteration and by chloritization. The boundaries of these alterations are observed as transitional.

Silicification. Silicification dominates in all the deposits and occurs in different forms. At Talatın Madeni, Binektaşı, Fikrinin Madeni, Kayanın Madeni, Yeni Açması and Hasanın Açması. The silicification is observed as replacements and glomeroporphyritic masses in the groundmass of the wallrock. It is also observed as network of 2-3 cm thick quartz veinlets around the main mineralised veins (Figure 8). The average thickness of this zone is about 10 meters. Microscopically, these quartz veinlets cross the main fabric. Silicification gradually changes into sericitic alteration.

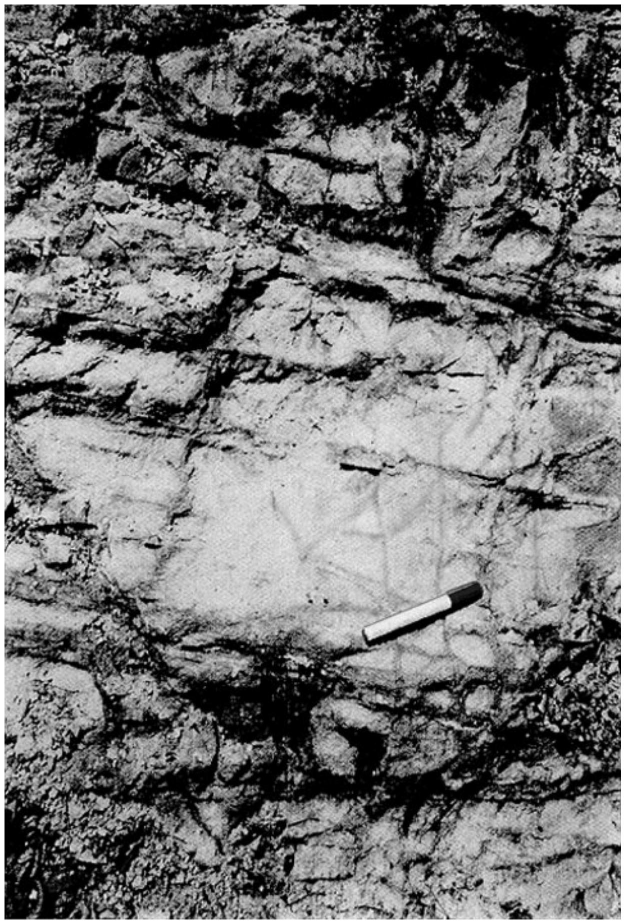

Figure 8. Stockwork of quartz veinlets (around Fikrinin Madeni, northeast of Urzenalan village).

Sericitic Alteration. Sericitic alteration is the most widespread alteration type in the study area and always associated with all the mineral deposits. It is characterised by sericite-quartz-pyrite mineral association. Microscopically, plagioclases and matrix of the wall rock are completely replaced by sericites. The silica is observed as microcrystalline quartz and glomeroporphyritic grains in the matrix. Pyrite is observed as disseminated idiomorphic grains. Sericitic alteration laterally grades into chloritization with a transition zone in which minerals of both types are recognised.

Carbonatization. Carbonatization is almost always associated with sericitic alteration and chloritization. It is observed as replacements of the anorthite-rich zones of plagioclases by calcite. Hornblendes are first chloritized, then carbonatized starting from the central parts. The main constituent of carbonatization is calcite, which is observed as interstitial coarse crystals associated with quartz veins.

Chloritization. Chloritization of the mafic constituents of the wall rock is common. Hornblendes and biotites are replaced by chlorite. Chloritization is formed as a by-product of sericitic alteration, if magnesium is present (Guilbert and Park, 1986). Since the wall rock contains hornblende and biotite, magnesium is supplied from these minerals. Lateral extent of this alteration is not known.

Conclusions

The Dereiçi deposits are the best-known polymetallic vein-type mineral deposits of the Şavşat area and are hosted by the Gigaziler Hornblende Andesite member of the Dereiçi formation. The wall rock alteration includes silicification, sericitic alteration, carbonatization and chloritization.

The vein-type mineralizations are grouped as (1) Sphalerite-Galena-Chalcopyrite-Pyrite veins (Talatın Madeni, Binektaşı and Fikrinin Madeni), (2) Milky quartz-Chalcopyrite-Sphalerite-Galena-Pyrite veins (Kayanın Madeni I & II) and (3) Chalcopyrite-Pyrite veins (Yeni Açması and Hasanın Açması). The veins are fault controlled and are typical fissure fillings. The ore minerals are chalcopyrite, sphalerite, galena, chalcocite, covellite and tetrahedrite. The gangue minerals are pyrite and quartz. The generalised paragenetic sequence of the mineralizations is observed as; quartz I-pyrite-chalcopyrite-sphalerite-tetrahedrite-galena-chalcocite-covellite-quartz II.

Binektaşı, Fikrinin Madeni and Kayanın Madeni deposits are associated with high grade Cu-Pb-Zn, whereas Yeni Açması and Hasanın Açması deposits contain only high Cu values. High Ag values were observed at Fikrinin Madeni (68.2 g/t) and Kayanın Madeni I & II (64.2 g/t). The deposits are poor in gold mineralization, only one sample from Kayanın Madeni I & II assayed 0.35 g/t Au.

The vein-type mineralizations in the study area are controlled mainly by NW-SE and rarely by E-W trending normal faults. The character of the mineralization and wall rock alteration are similar to the other mesothermal vein-type mineralizations in the Eastern Pontides.

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