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GEOLOGY AND ECONOMIC SIGNIFICANCE OF Cu-Pb-Zn DEPOSITS IN THE YÜCEBELEN AND SURROUNDING AREA (TORUL-GÜMÜŞHANE)

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Abstract Study area is in the zone named "Eastern Pontide Zone" which is located in the northeastern part of Turkey. On the bottom of the study area, Cretaceous aged volcanic, pyroclastic and sedimentary rocks intercalated with pyroclastic rocks take place. All these lithologic units were intersected by Upper Cretaceous-Late Eocene aged granitoids. This pluton that generates mineralization underwent low/sub-propylitic alteration. Cu-Pb-Zn mineralization occurs in the fracture zones of a granodiorite intrusion located in the southwestern part of the study area. Same mineralization has been determined in the northeastern part of this intrusive, where intrusive contact with sedimentary rocks and also, fracture zones developed in sedimentary rocks. It is determined that quartz veins with various dimensions, generally strike N40-50°W. As a result of microscope investigation, a paragenesis including galena, sphalerite, pyrite, chalcopyrite, gold, smithsonite, malachite, azurite, covellite, goethite, lepidocrocite, hematite, and limonite was determined. This paragenesis is similar to that of the porphyry-copper deposits from the region. In this study, preliminary results of detailed geological study are given for this area, which has been never studied before.

Key Words: Torul-Gümüşhane, Eastern Pontides, Pb-Zn-Cu deposits, Ore-rich quartz veins.

1. Introduction

The study area is located in the tectono-stratigraphic zone named "Eastern Pontide Zone" from the northeastern part of Turkey (Figure 1). This is a Cu-Pb-Zn-rich zone, named "Eastern Black Sea metallogenic zone". Eastern Pontides were formed by the subduction of Tethys Ocean under the Eurasian plate, during the Early Cretaceous - Late Eocene. Eastern Pontide orogenic zone can be divided in two tectono-stratigraphic subgroups as the northern and southern zones. The northern zone consists of Senonian and Eocene volcanic and volcaniclastic rocks. Additionally, pre-Senonian rocks crop out in the southern zone, which preserves its pre-Senonian fore-arc basin location. Also, in the southern zone, due to continental collision that took place during the Early Tertiary, the deformation is stronger than in the northern zone (Okay and Şahinturk, 1997). The study area is located very close to border of these two subgroups but located in northern zone.

2. Materials and methods

In this project, the first geological map of the study area at the scale 1:5000 was made. Subsequently, detailed geological maps at the scale 1:2000 were made for the areas rich in ores. Based on these maps, the location and dispersion of the mineralization were determined. 129 samples were collected and examined under the microscope. Additionally, 10 polished sections of samples taken from the mineralized rocks were prepared in order to determine the paragenesis of the mineralization. Systematic sampling has been done from test pits opened on ore-rich zones, which are mapped in detail for this study. 46 geochemical

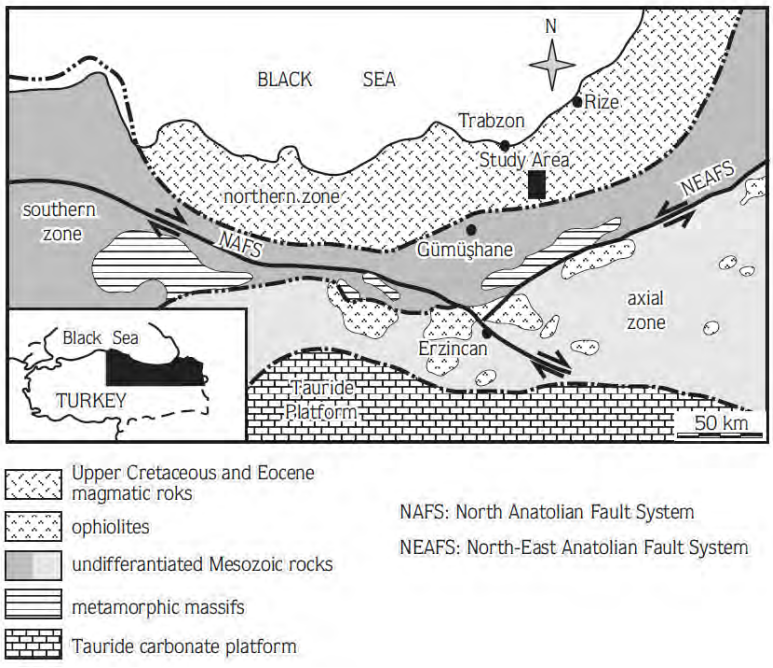

Fig. 1. Map showing the structural location of the studied area (Karslı et al., 2004).

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samples collected from the test pits were analyzed in ACME labs (Canada) by ICP-MS device and the results were evaluated.

3. Stratigraphy and petrology

In the study area, volcanic rocks consisting of basalts and basaltic andesites take place at the bottom of the rock sequence; they are overlain by concordant pyroclastic and dacitic-rhyodacitic rocks. These rocks are overlain by sedimentary rocks intercalated with pyroclastic rocks. All those units mentioned above, were intruded by granitoids of supposed Upper Cretaceous-Eocene age. Also, all lower units are cut by Late Eocene andesitic and dacitic dykes (Fig. 2). Granitoids that crop out in the area were classified in terms of Q-ANOR parameters as granodiorites (Adile Hamlet occurrence - investigated in detail), diorites (Tuzlak Hill occurrence- eastern-part of study area) and quartz monzodiorites (İstavroma Hill occurrence-northern part of study area). It has been determined that granitoids are alkaline (Tuzlak Hill occurrence) and calc-alkaline (Adile Hamlet and Istavroma Hill occurrences) in terms of alkali-silica diagrams.

4. Mineralization

The mineralization depends on the quartz veins developed in the fracture zones of the granodiorite body. In the detailed map of the study area, nine ore-rich zones were identified (Fig. 3). Five of them developed on the fracture zones in granodiorites, one displays on intrusive contacts with the sedimentary rocks and the rest of them occur in sedimentary rocks. Hydrothermal textures were especially identified in the quartz veins and at the wall rock contacts. It is determined that quartz veins with various dimensions, generally strike N40-50^{o}W, which is the same as that of the fracture zones developed in the mineralized granodiorite. Strikes and locations of these zones have been obtained from the strikes of the widespread quartz veins. Ore-rich zones are 4-5 m to 30 m wide and 500 m long according to the dispersion of the silicified blocks originating in the silicified zones.

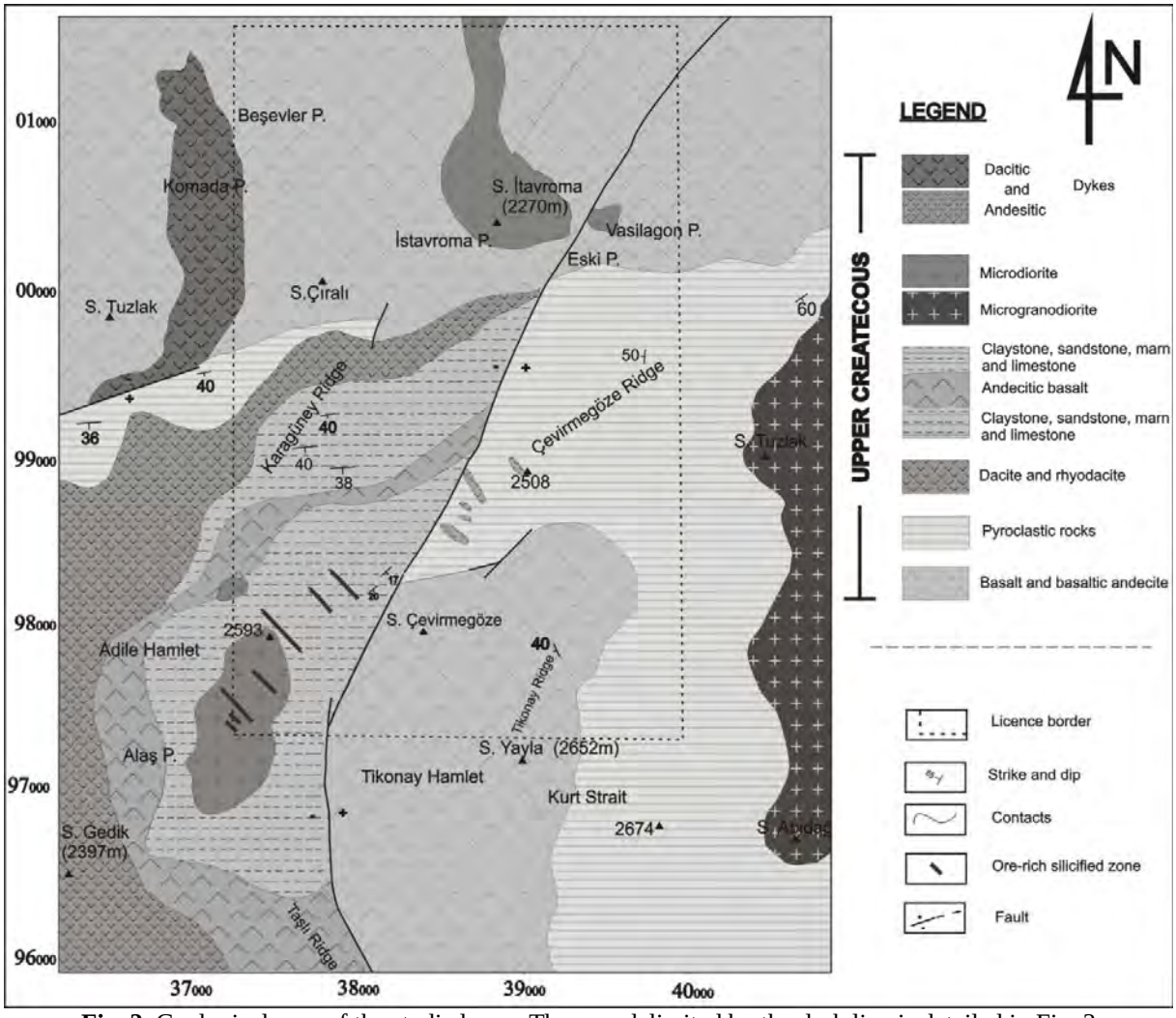

Fig. 2. Geological map of the studied area. The area delimited by the dash line is detailed in Fig. 3

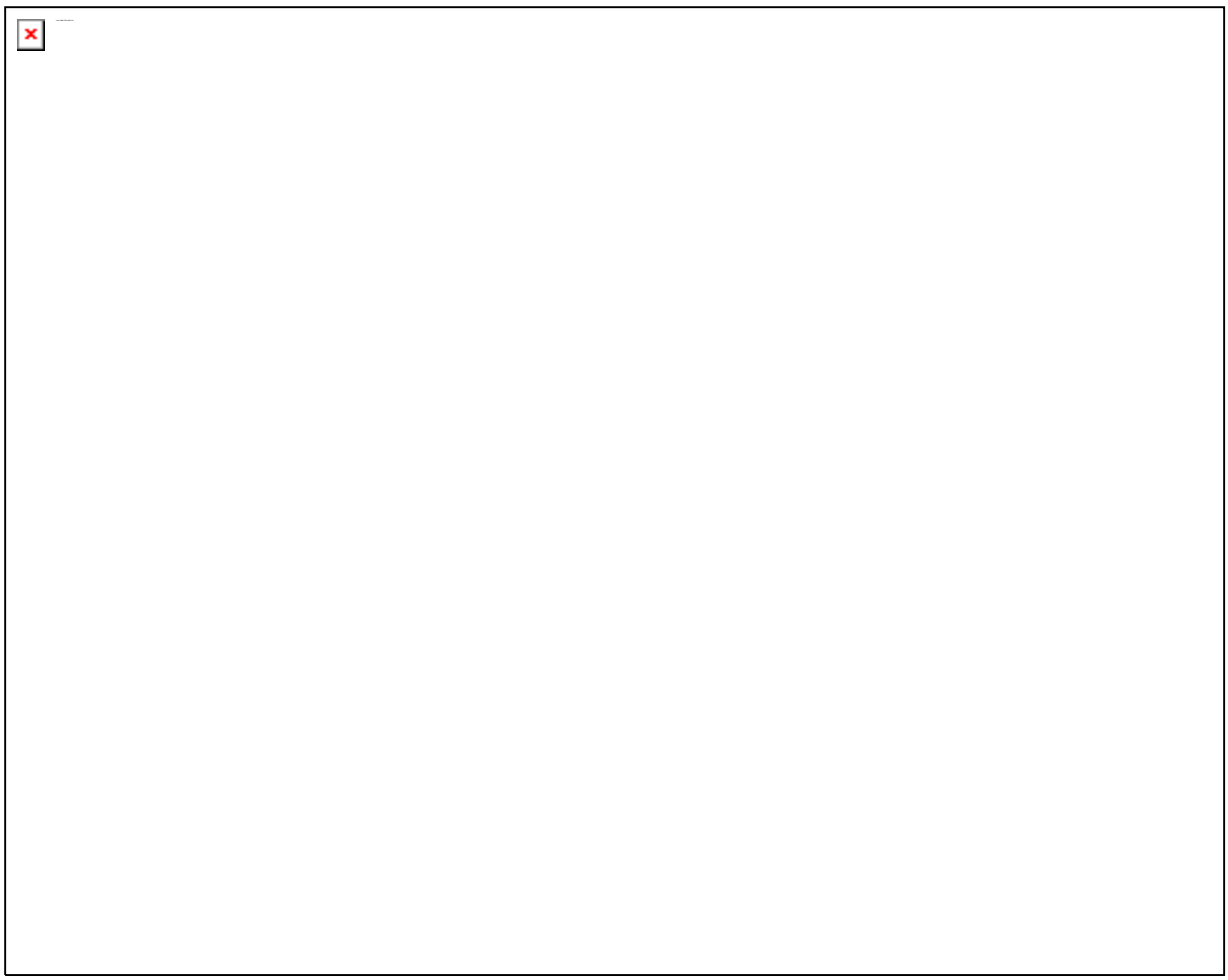

Fig. 3. Geological map of the Adile Hamlet and surrounding area.

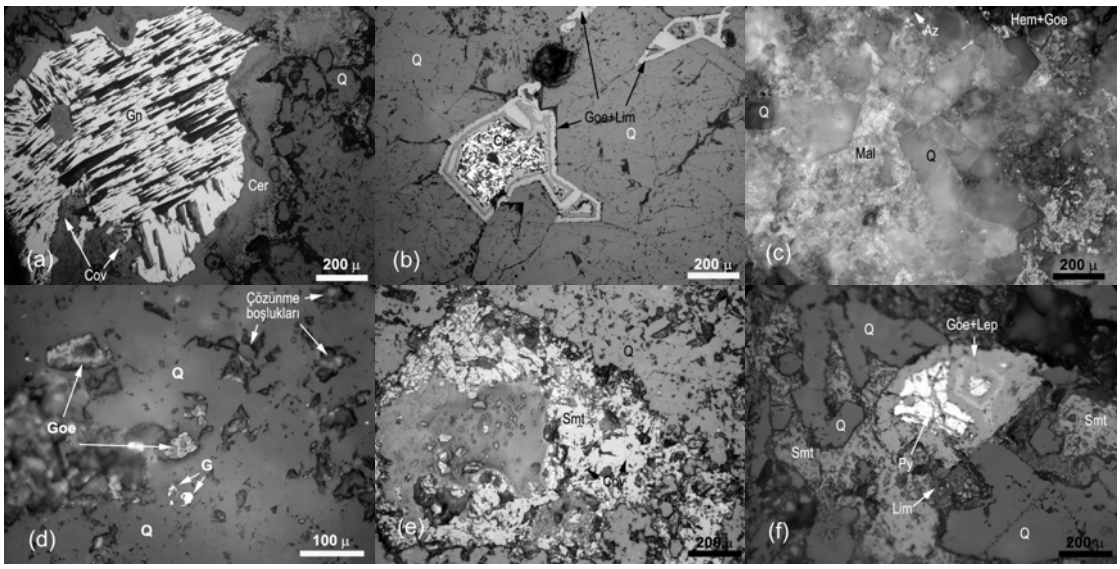

Fig. 4. Ore microscopy images: **(a)** Galena grain (Gn) and its substitution by covellite (Cov) and cerussite (Cer); **(b)** chalcopyrite grain (Cp) in quartz gangue (Q); **(c)** azurite (Az) and malachite (Mal); (d) Gold (G) in quartz (Q) gangue; **(e)** smithsonite (Smt) in highly altered sample; **(f)** fragmented pyrite (Py) with goethite (Goe) and lepidocrocite (Lep).

In this study, the paragenesis was determined in terms of mineral species, abundances, and relations with each other (Fig. 4): Phase I: Galena, sphalerite, pyrite, chalcopyrite, gold. Phase II: Pyrite, chalcopyrite,

gold. Supergene phase: smithsonite, malachite, azurite, covellite, goethite, lepidocrocite, hematite, limonite. Gangue mineral is Quartz. The sequence of mineral formation in the mineralized rocks from the study area is given in the Table 1. According to the aim of the study, 14 test pits were excavated in the investigated area. In every test pits, quartz veins were observed, even very thin. The maximum and minimum content values for the rock samples collected from the test pits are given in the Table 2.

5. Conclusions

Cu-Pb-Zn mineralization in the study area is associated with the calc-alkaline granodiorite intrusion located in the Adile Hamlet surroundings. Granodiorite was exposed to low and/or semi-propylitic alteration. Ore-rich quartz veins were developed by the metal-rich liquids moving throughout the fracture zones from the granodiorite, the granodiorite-sedimentary rock contacts and the fracture system developed in the sedimentary rocks.

In this study, test pits excavated many years ago were investigated and new test pits works were done. The investigation of the spoil piles revealed a paragenesis consisting of galena, sphalerite, pyrite, chalcopyrite, malachite and azurite. This shows that this mineralization is dominantly of Cu-Zn-Pb type. In addition, according to the analytical results, it appears that mineralization can be important in terms of Au contents.

Table 1. Formation phases of the ore-minerals determined in the study area.

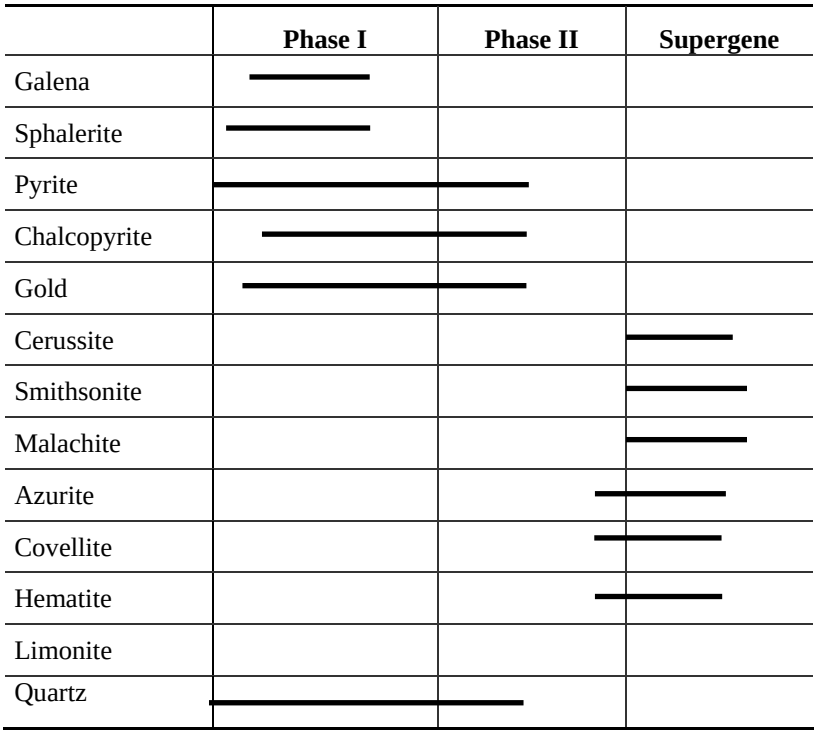

Table 2. Maximum and minimum amounts of some elements identified in 46 rock samples.

Element (ppm)	Cu	Pb	Zn	As	Mo	Ag	Au
Maximum	>10000.0	>10000.0	>10000.0	186.8	39.4	>100.0	7.428
Minimum	190.0	2206.0	163.0	15.1	0.6	1.7	0.018

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