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FEATURES AND ORIGIN OF BİLLURİK DERE (ELAZIĞ) MINERALIZATIONS

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ABSTRACT.— Mineralization of Billurik dere is located in and on the contact zone of granitic and dioritic magmatics of the Yüksekova complex. The mineralization which occur in the magmatic, emplaced along E—W striking tension fractures and of vein type in nature. The mineral assemblages of these veins are pyrite, chalcopyrite, sphalerite, galena, magnetite, specularite and some of these minerals are dominant ore minerals in some veins. The mineralizations which occur on the contact zones are contact type in nature and they bear additional minerals such as Cu-sulphosalts, Bi-sulphosalts and Ag-fahlore. The mineralizations are associated with serialization, kaolinization, silicification, tourmalinization and epidote formation. The mineralizations developed possibly during thrusting of the Keban metamorphics on the Yüksekova complex in a time span from Upper Cretaceous to Paleocene and related with the tectonic evolution of the area.

INTRODUCTION

The Billurik dere mineralizations which are the subject of this study, placed approximately 25 km. north of Elazığ township (Fig.l). The mineralizations occur in the Yüksekova complex and show various features. The

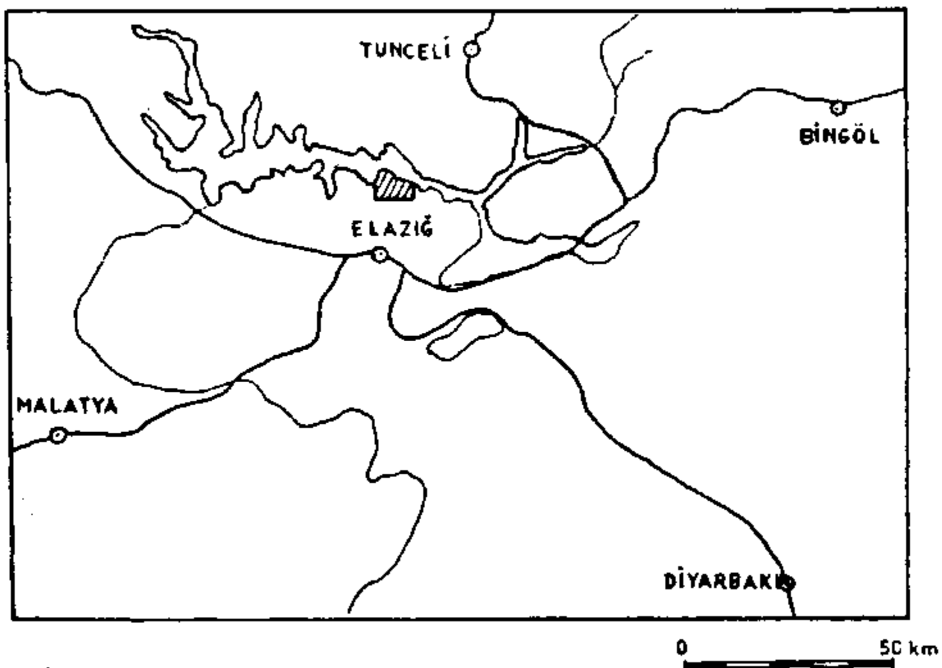

Fig.1— Location map.

mineralizations have not been studied before and because of their small size they have not attracted interests of the mining sector. However, Eastern Taurus belt where the mineralizations placed, is studied by many workers for various reasons: Perinçek (1979), Hempton and Savcı (1982), Yazgan (1981,1984), Bingöl (1982,1984), Asutay

(1985) and Akgül (1987) studied petrological and petrographic aspects of the Yüksekova complex. Published first studies of the mineralizations of the Yüksekova complex in Elazığ- vicinity were carried out by Sağıroğlu (1986, 1987) on the Kızıldağ (Elazığ) mineralizations.

Within the framework of this research following studies,were carried out; geological'mapping of Billurik dere vicinity in 1: 25.000 scale, structural analysis of the area, and, mineralogy and petrography of country rocks, mineralized bodies and alteration zones. In the light of findings of these studies a mineralization model and origin of the mineralization are discussed.

LITHOLOGY

Coniasian-Campanian Yüksekova complex forms the basement rocks of the studied area. Middle to Upper Eocene Kırkgeçit formations overly the complex with angular disconformity'and are covered by Upper Miocene Karabakır basalts in places (Fig.2).

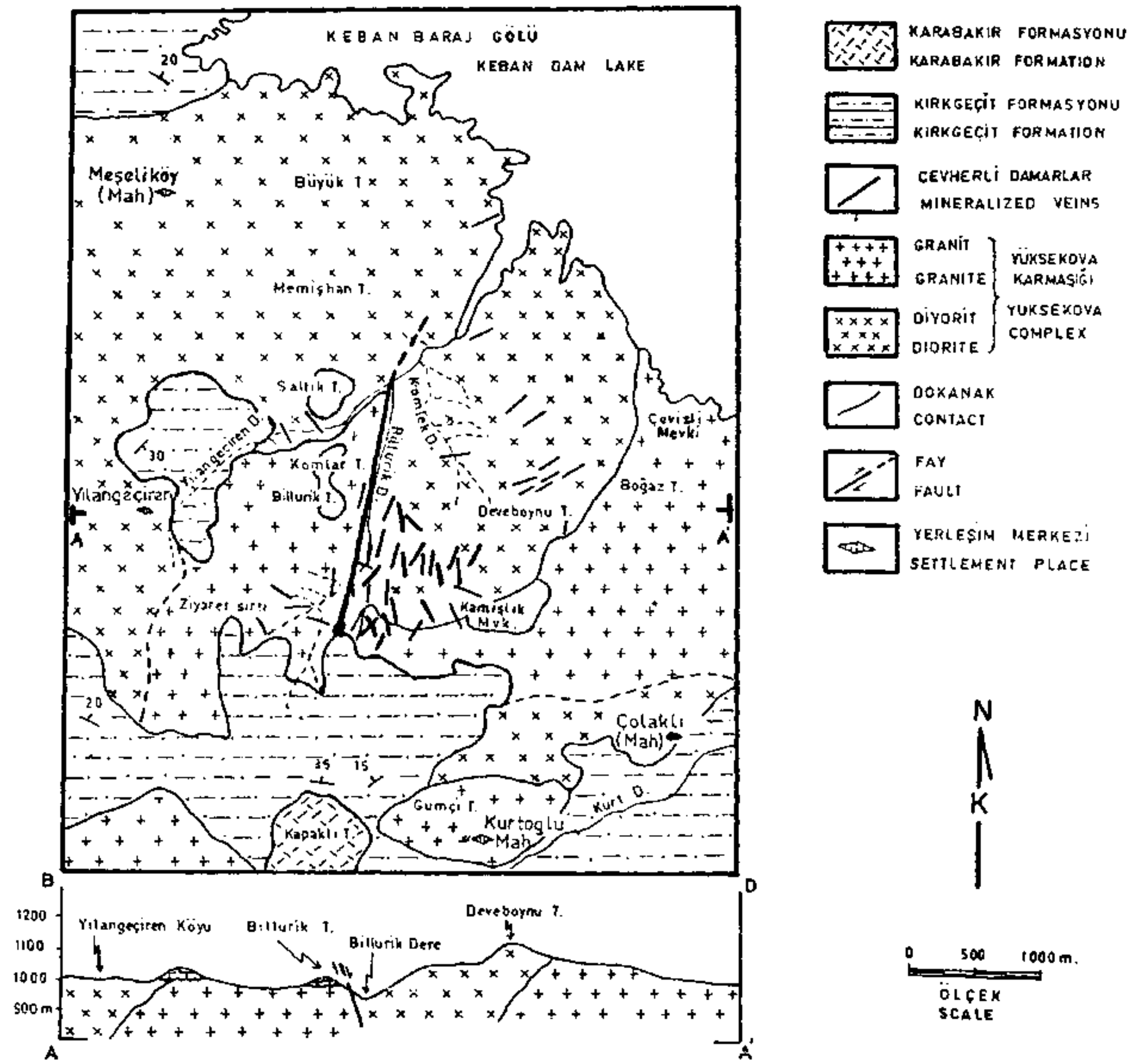

Fig.2 Geology and cross-section of the studied area.

The Yüksekova complex

This complex was first described by Perinçek (1979) and its typical locality is Yüksekova (Hakkari) area.

The complex is the dominant unit in the studied area and covers large areas around Yılangeçiren and Meşeliköy villages, Boğaz Tepe and Billurik Dere. The complex is made up from various units in Elazığ region. The rocks of the complex are studied in three groups in this study. These are; granitic rocks, dioritic rocks and subvolcanics (aplites and microdiorites) what cut the first two.

Granitic rocks.— These rocks occur in the middle and eastern parts of the studied area and are distinguished easily by their lighter colours. Equigranular texture is the dominant texture of these rocks. Mineral constituents of these rocks are quartz, K—feldspar, plagioclase, biotite and amphibole. Accessory minerals are zircon, apatite, sphene and magnetite.

Dioritic rocks.— Felsic minerals of these rocks are plagioclase and quartz and mafic minerals are amphibole. Although compositions of these rocks vary between monzonite-diorite it is not possible to determine these variations macroscopically. Dioritic rocks show different textures, granular texture being the most common. Another common feature of dioritic rocks is extensive alteration.

Subvolcanic rocks.— The plutonic rocksof the studied area are cut by aplites and microdiorites whose thicknesses are 1 to 200 cm. According to K/Ar radiometric dating of Yazgan (1984) the subvolcanic rocks of Baskil area, which are thought to be equivalent of the subvolcanic rocks of the studied area, are of Campanian age.

The Kırkgeçit formation

This formation first described by TPAO geologists and named after its typical locality in the south of Van (Tuna, 1979). Kırkgeçit formation overlies Yüksekova complex with an angular disconformity. Its lithologies are conglomerate, sandstone, sandy limestone, limestone and marble from the bottom to the top. According to paleontologic studies of Avşar (1983) the formation is of Middle to Upper Eocene.

The Karabakır formation

This unit first described by Naz (1979) in Karabakır village of Pertek. In the studied area the Karabakır formation is represented by basaltic lava flows. Sirel et al. (1979) gave Upper Miocene age to this unit on the basis of the fossils they fourid in this unit around Palu.

STRUCTURAL GEOLOGY

In the studied area magmatic rocks form the basement and therefore fractures are the major structural features instead of folding. The Yüksekova complex fractured densely because of tectonic movements. Analysis of the strikes of the fracture planes indicate jthat the main fracture strikes are in N20° to 40° E (Fig.3). Because of extensive alteration minor fracture and fault planes are not openly visible. The main fault in the studied area is the one which strikes parallel to Billurik dere. This fault can be traced from the surface along a length of 2 km and forms the contact line of granite and diorite. This fault is thought to be a gravity fault, however its displacement distance can not be determined (Fig.2). The Kırkgeçit formation is not affected from the faulting and for the equivalents of the granites and diorites in Baskil Yazgan (1984) gave Coniasian-Campanian age. Therefore it is reasonable to conclude that the faultings took place during a time span of end of Cretaceous-Paleocene. This age

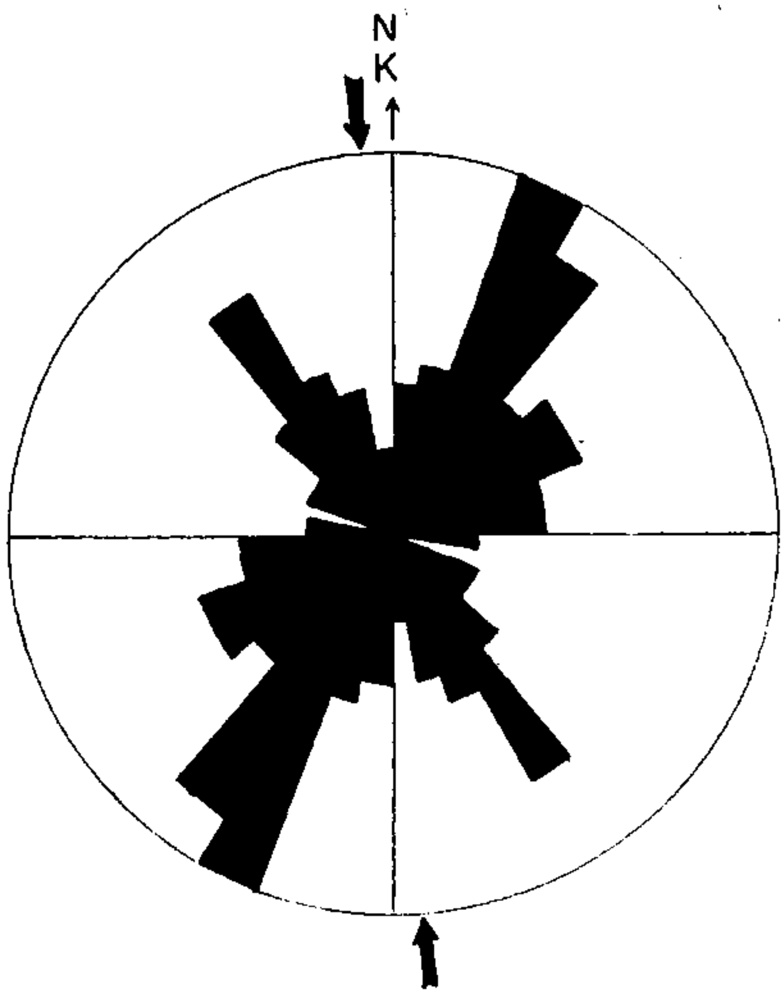

Fig.3– Joint diagram of Yüksekova complex (total measurements 100).

span is given by Yazgan (1984) as the period during which the Keban metamorphics thrusted over the Yüksekova complex.

The Kırkgeçit formation show good layering which strikes E—W and dips to north with angles between 15-30°.

The analysis of the fractures strikes show that they concentrate in two maximums at 25° and 325° (Fig.3). Thus, the main compression direction was N—S and the area gained its structural pattern with this compression. This direction is in good agreement with the compression direction determined by Tatar (1986) for the Elazığ region, using the fracture analysis techniques on Lanstad remote sensing images. This compression should be the cause of the thrusting of the Keban metamorphics over to the Yüksekova complex.

MINERALIZATION

Although numerous mineralizations are known in the Yüksekova complex in Elazığ region, published studied on these mineralizations are scarce. The first studies of this kind carried out by Sağıroğlu (1986, 1987) on the Kızıldağ (Elazığ) mineralizations.

Billurik dere mineralizations are located in granitic and dioritic rocks and on the contact zone of granite and diorite, of the Yüksekova complex. The first ones are vein type and the second ones are contact type mineralizations. The mineralizations are studied in 3 groups on the basis of their placements:

The mineralizations in granitic rocks

These are vein type and occur around Ziyaret Sırtı densely (Figs.2 and 6). The thicknesses of the mineralizations vary between 10-30 cm and their continuations on the surface are 4 to 5 m. The mineralizations are placed in the joints and fractures and the exposed parts are completely oxidized. Their textures are either stockwork or disseminated type. The ore minerals of this group are; galena, sphalerite, chalcopyrite, pyrite and specularite.

Galena.— Galena is found in veins of 7-8 cm thicknesses and as large (0.5 cm) euhedral crystals. Galena replaces the chalcopyrite exsolutions in sphalerite and as a result chalcopyrite grains are placed on the borders of galena-sphalerite grains (Plate I, fig.l). The galena is altered to anglesite and cerussite along its grain boundaries and cleavage planes. This replacement causes the kidney-like textures to form in galenas.

Sphalerite.— This is a rare mineral in the veins placed in granitic rocks. Their grain size vary between 0.3-0.5 mm and they are often altered to smithsonite along their grain boundaries. Some sphalerites bear chalcopyrite exsolutions (Plate I, fig.l).

Chalcopyrite.— Found along joints of granitic rocks. Their grain sizes are in 0.5 to 1 mm and they bear galena inclusions of 100 to 150 in size. Chalcopyrite also accommodate "sphalerite stars" (Plate I, fig.2) what are interpreted as indicators of high temperature formation (Ramdohr, 1980,p.529). In the exposed portions chalcopyrite is altered to chalcocite-covellite first then to limonite (Plate I, fig.3).

Pyrite.— This is the earliest forming ore minerals in the granitic rocks. Their grain sizes are between 1-2 mm and they are euhedral. The pyrites are replaced by chalcopyrite and therefore they are older than chalcopyrites (Plate I, fig.4).

Specularite.— Specularite is found as thin covers on fracture walls. Average grain size is about 0.5 mm and grains have tabuler shapes.

In the granitic rocks sericitization and kaolinization accompany to the mineralizations. These two alteration take place according to the following chemical reactions under 300°C (Barnes, 1979, p.195);

$$\underset{\text{K-feldspar}}{3/2\ KAlSi_3O_8} + H^+ \xrightarrow{300^oC} \underset{\text{Sericite}}{1/2\ KAl_3Si_3O_{10}(OH)_2} + 3SiO_2 + K^+$$

$$KAl_3Si_3O_{10}(OH)_2 + H^+ + H_2O \longrightarrow \underset{\text{Kaolinite}}{3/2Al_2Si_2O_5(OH)_4} + K^+$$

K—feldspar is altered to the sericite first and then to the kaolinite. This alteration stages can be easily determined under the microscope.

The mineralizations in dioritic rocks

Most of the mineralized bodies of the studied area are found in the dioritic rocks. The mineralized zones are again covered by gossans. Almost always an altered zone is present between mineralized body and country rocks

(Plate I, fig.5). The thicknesses of the mineralized zones change a great deal; from a few cm to 10 m and their exposure lengths can reach up to 40-50 meters. The strikes of the mineralized bodies (veins) are NNE—SSW. The mineralized bodies of the dioritic rocks have disseminated or stockwork textures and poor mineral assemblages; pyrite, magnetite, hematite and chalcopyrite.

Pyrite.— Its average grain size is 2-3 mm and often accomodates magnetite inclusions. Most of the pyrites are altered to limonite in the upper parts of mineralized bodies.

Magnetite.— Magnetite is usually found together with pyrite along the mineralized fracture zones. The magnetites are usually found in radiating pyrismatic shapes (muschketovite). The marginal parts of the magnetite grains show martitization. The magnetites are strongly magnetic.

Hematite and chalcopyrite are scarce minerals in the dioritic rocks. Hematite occurs as granular masses and chalcopyrite as minute grains.

The alteration types observed along the mineralized zones of the dioritic rocks are epidotization, chloritization and carbonatization. The altered parts usually placed along the mineralization-country rocks border.

Epidote and carbonate are thought to be formed as consequences of the following reactions (Winkler, 1979, p.149).

$$\underset{\text{Anorthite}}{4CaAl_2Si_2O_8} + H^+ \longrightarrow \underset{\text{Clinozoisite}}{2Ca_2Al_3Si_3O_{12}(OH)} + 2SiO_2 + Al_2O_3$$

$$KAlSi_3O_8 + CaAl_2Si_2O_8 + CO_2 + H_2O \longrightarrow KAl_3Si_3O_{10}(OH)_2 + 2SiO_2 + CaCO_3$$

The mineralizations along granite-diorite border

These mineralizations are of contact type. The ore texture is either disseminated or stockwork type; first type is found in the country rocks and second type along joints and fractures. The ore mineral assemblage of this type mineralization differs from the first two types and some additional minerals; Ag-fahlore (freibergite), Cu-sulphosalts and Bi-sulphosalts occur. The dominant minerals of the mineralizations along granite-diorite border are chalcopyrite, galena and sphalerite (Plate I, fig.6).

Galena.— This is the most dominant mineral along the contact and bears Ag-fahlore (freibergite) inclusions (Plate I, fig.7). The grain sizes of the inclusions are about 12-30 and inclusions are found as replacing chalcopyrite.

Sphalerite.— Sphalerite is present as large (1-1,5 cm) crystals and because of low Fe-content their internal reflections are white to light brown.

Cu-sulphosalt— It is found as replacing the chalcopyrite which occur along the cracks of pyrite grains (Plate I, fig.8). Its colour is beige and probably it is emplectite.

Bi-sulphosalt.—It is found as minute pyrismatic grains along the fractures of pyrite and chalcopyrite (Plate I, fig.8). Because of their very small grain sizes it is difficult to determine their kinds. However, they are strongly anisotropic and their colour creamy white and therefore they resemble bismuthinite, aikinite and cosalite.

The alteration products occur with this type of mineralizations are; epidote, carbonate (calcite), sericite, kaolinite and silica.

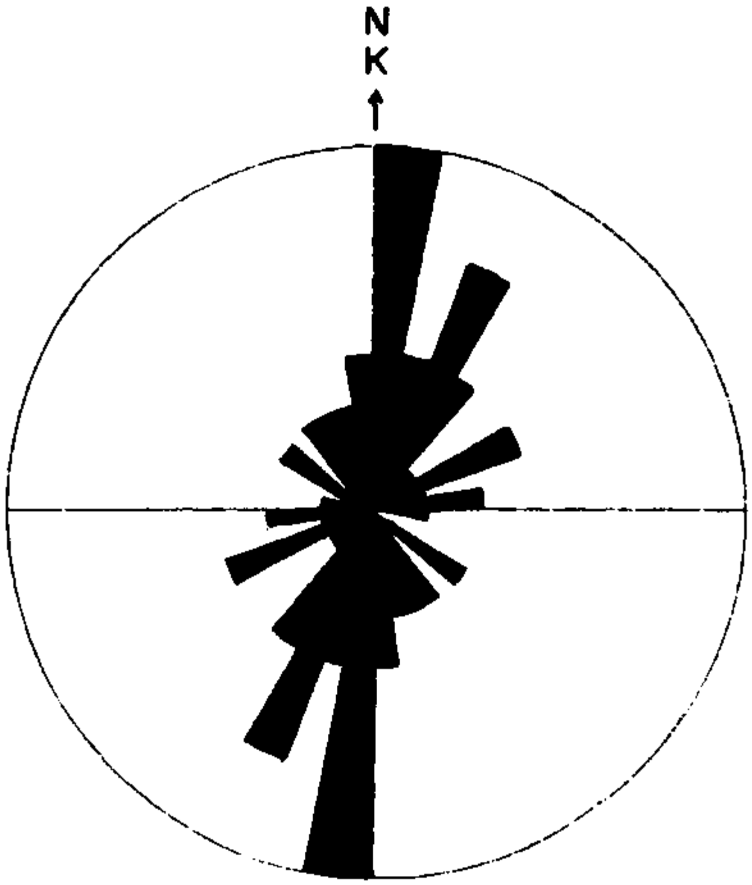

Fig.4— Analysis of the joint diagrams of mineralized zones.

THE STRUCTURAL GEOLOGY-MINERALIZATION RELATIONSHIP

As indicated before the mineralizations are placed in the fault and fracture zones. Because of close connection between structural geology and mineralization structural elements of the studied area are analyzed (Structural Geology part and Fig.3). In addition, strikes of the 38 exposed veins are analyzed (Fig.4) and correlated with structural analysis (Fig.5).

Most of mineralized veins strikes in N—S. As discussed before the main stress direction what caused fracturing in the area is N to S. Therefore, the fractures in Figure 5 represent shear fractures and the mineralized veins are tension fractures instead of shear fractures. This should be due to the suitability of tension fractures to the movement of the mineralized solutions.

DISCUSSIONS AND CONCLUSIONS

1— The analysis of fracture plane strikes (Fig.3) indicate that the area was subjected to a N—S (355°) compression. Evidences show that the compression took place during Coniasian-Middle/Late Eocene. These conclusions are in good agreement with the conclusion of the researchers who worked in the region (Yazgan, 1984; Sagiroglu,1986).

2— The geometry of the faults is in agreement with the areal structural geometry. The compression period coincides with the period, according to Yazgan (1984) and Bingöl (1984), during which the Keban metamorphics were thrusted over the Yüksekova complex.

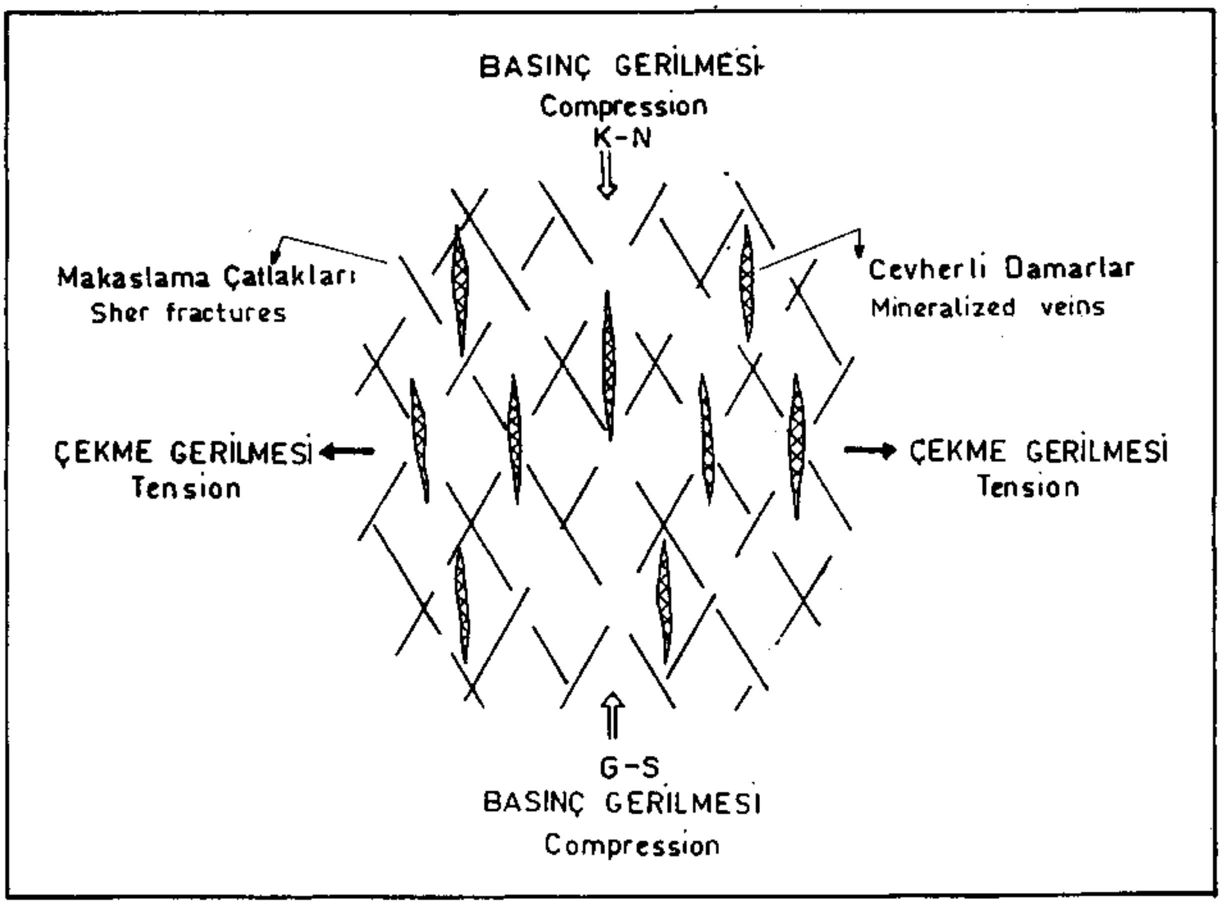

Fig.5— The relationship between main fractures and mineralized veins.

3— The mineralizations of Billurik Dere are related to the faults and the contact between the granite and the diorite. The analysis of the strikes of mineralized veins (Fig.4) indicates that the fractures are in N—S dominantly. The correlation between the mineralized veins analysis and general fracture analysis show that mineralized veins are placed in the tension fractures which formed by tension in E—W direction.

4— The mineralizations were formed with two different mechanisms and periods. The first period was emplacement period of the granites into the diorites and during this emplacement deep-seated hydrothermal solutions formed mineralizations along the contact zone. Therefore, in the contact zone high temperature minerals (Cu and Bi-sulphosalts, tourmaline, epidote and quartz veins),sphalerite with chalcopyrite inclusions and chalcopyrites with sphalerite stars were formed. All of these evidence indicate a formation temperature of 350° to 450°C.

In the second period the Keban metamorphics thrusted over to the Yüksekova complex and as a consequence the granites and the diorites of the complex were densely faulted and fractured. During these events magmatism was in progress and the fault zones and fractures were mineralized and veins type mineralizations were formed. The ore mineral assemblage and the related alterations of this type indicate a formation temperature in a region 300°350°C.

5— The reserves of Billurik dere mineralizations are small with what is seen on the surface they do not have an economic importance. However, the mineral assemblage and reserves may change with depth (Evans, 1980,

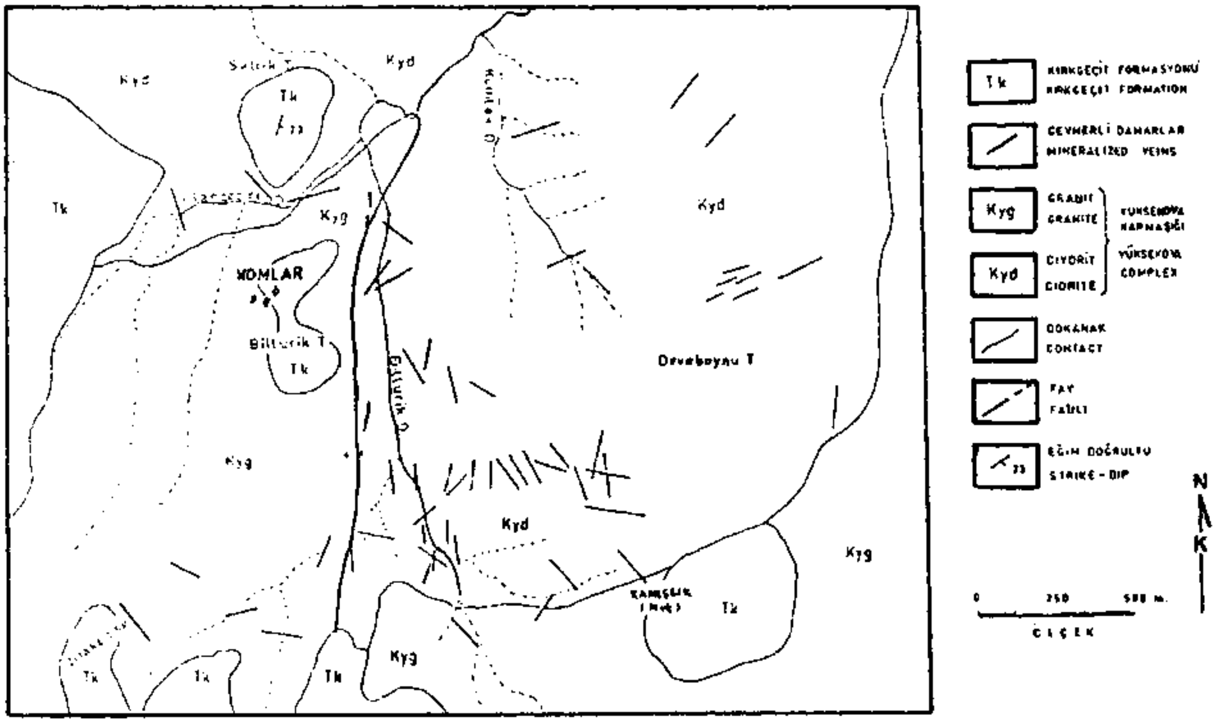

Fig.6— Locations of the ore bodies of Billurik dere.

p.60; Park and Diarmid, 1975, p.169).

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PLATES

PLATE-I

Fig.l— Chalcopyrite of sphalerite replaced by galena. Plain reflected light,
gl- galena; sf- sphalerite; kp- chalcopyrite.

Fig.2- Sphalerite stars in chalcopyrite. Plain reflected light.
Light parts are chalcopyrite and dark parts are sphalerite stars.

Fig.3— Chalcopyrite altered to covellite-chalcocite first and then to limonite.
Plain reflected light.
kp- chalcopyrite; kk- covellite-chalcocite; lm: limonite.

Fig.4— Age relationship between pyrite and chalcopyrite. Plain reflected light.
Light parts are pyrite and dark parts are chalcopyrite.

Fig.5— Field appearance of mineralized vein (1), altered zone (2) and country rock (3).

Fig.6— Massive ore of the contact zone. Plain reflected light,
gl- galena; sf- sphalerite; kp- chalcopyrite.

Fig.7— Ag-phases exsolved in galena. Plain reflected light.
Light parts are galena and dark parts are Ag-fahlore.

Fig.8- Cu and Bi-sulphosalts in the fractures of pyrite. Plain reflected light,
py- pyrite; Bis- Bi-sulphosalts; Cus- Cu-sulphosalt.

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