PRELIMINARY INVESTIGATIONS OF QUARTZ-FELDSPAR VEINS IN ELATSITE PORPHYRY COPPER DEPOSIT

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Introduction

The thin quartz-feldspar bodies in Elatsite porphyry copper deposit described already as aplitic dykes (Vutov, 1968) are looked upon in the present study as quartz-feldspar veins.

Results from field and laboratory investigations on samples from this deposit are presented. The aim of the study is to obtain more detailed mineralogical description of these veins on the basis of characterization of structural and textural features and description of micro-textural relations between the main minerals – quartz and feldspar. Petrographic and ore microscopy investigations are used as well as microprobe analysis for determination of the potassium (K) feldspar composition.

Geological setting

Elatsite Cu–Au porphyry deposit is located on the Etropole ridge of Western Balkan Mountains at the northern end of the Panagyurishte ore district, Central Srednogorie zone (Bonchev 1970). The Srednogorie zone is part of Banatitic Magmatic and Metalogenetic Belt (Berza et al. 1998) of the Alpine-Balkan-Carpathian-Dinaride orogenic system.

The textural aspects and the petrographic units in Elatsite deposit have been described by Kalaidziev et al. (1984). The porphyry copper mineralization is associated with Late Cretaceous sub-volcanic bodies and porphyry dykes intruded in the rocks (phyllites, diabases, chlorite and actinolite schists, metamorphosed greywackes and sandstones) of Berkovitsa group (Cambrian age, Haydoutov et al., 1979) and the granodiorites of Vezhen pluton (Carboniferous age, 314±4.8 Ma, Kamenov et al., 2002). The emplacement of the rocks of Vezhen pluton caused contact-metamorphism in the rocks of Berkovitsa group, forming biotite–feldspar and hornblende–pyroxene hornfelses and amphibolites as well as actinolite and andalusite–cordierite schists (Trashliev, 1961). Von Quadt et al. (2002) distinguished four dyke generations in the area of Elatsite deposit. The first generation includes mainly quartz-monzodiorite porphyries. The so-called "big dyke", striking east – west across the contact between the Vezhen pluton and Berkovitsa group has the same composition. The second generation of dykes is built up from granodiorite porphyries (with minor granite porphyries and quartz-syenite porphyries). Porphyritic textures with needle-like amphiboles are characteristic for all rock varieties of this group. The third dyke generation is presented by K-feldspar-rich thin aplitic dykes. They are mainly oriented NNE – SSW. These authors assume that the third generation represents apophyses of the second one. The fourth dyke generation is comprised of mafic dykes (micro diorites, micro monzodiorites, diorite porphyries and their quartz-bearing varieties).

Three types of alteration are distinguished at Elatsite porphyry copper deposit (Dragov & Petrunov, 1996; Strashimirov et al., 2002): K-silicate alteration; propylitic and sericitic alteration.

The K-silicate alteration consists mainly of K-feldspar, biotite, some quartz and chlorite on places. Intensive K-alteration is well developed in granodiorites and is less intensive in phyllites and biotite-hornfels. Metasomatic K-feldspar and biotite replace the primary K-feldspar and plagioclase. In some places hydrothermal K-feldspar forms halos along the ore-quartz veins. Small veinlets and nests of magnetite-bornite-chalcopyrite and pyrite-chalcopyrite paragenesis are related to this type of alteration. The propilitic alteration in Elatsite deposit includes chloritization, epidotization, sericitization and actinolitization of the Paleozoic granodiorite and the Late Cretaceous hypabyssal intrusions.

Sericitic alteration is represented by quartz, sericite, pyrite, and some chlorite. Sericite dominates but also there is minor illite. This alteration occurs mainly in phyllite and monzodiorite porphyries but it is more expressed in the phyllites.

Field characterization

The quartz-feldspar veins are intruded in the low-grade metamorphites from Berkovitsa group, in the granodiorites of Vezhen pluton as well as in the quartz-monzodiorite porphyries. Their main orientation is NNE – SSW, sub vertical or steeply dipping (75 - 85), or with NW – SE orientation, steeply dipping to NE. The veins are well cropped out on levels 1180, 1195 and 1210 in the eastern part of the pit. They have a small thickness of several cm down to a few mm.

Petrographic description

The characteristic features of three specimens - samples 1, 2 and 3 of quartz and K-feldspar from the quartz-feldspar veins are studied. The host rocks in sample 1 and 2 are granodiorites from Vezhen pluton, and for sample 3 the host rock is from the schists.

Sample 1. Contains an early vein (I) with quartz (Q1) and a later quartz-feldspar vein (II) composed of symmetrically positioned quartz (Q2) in the salband and quartz+feldspar (Q2a-Fs2) in the central part. Vein II crosscuts and dispositions vein I along which there are feldspar grains (Fs1). Both veins I and II are cut by numerous ore veinlets not wider than 2 mm, built up mostly from quartz, chalcopyrite, and bornite with or without magnetite. In the Q2a-Fs2 vein there are also disseminated magnetite, bornite and chalcopyrite grains.

Fs1 is represented mostly by deformed and fragmented grains with size up to 5-6 mm. It is most probable that Fs1 is one of the earliest minerals in the sample.

Q1 from vein I forms dense, fine-grained aggregates with grain size not greater than 2 mm and milky color due to the great amount of fissure fluid inclusions. It must be noted that the Q1 – Q2 border is sharp.

Q2 in the salband of the quartz-feldspar vein has almost the same grain size as Q1. In comparison Q2 is less fissured and contains less fluid inclusions and as a result is more transparent than Q1. The well-developed zonal texture of Q2 is remarkable. It has a growth direction from the salband towards the axial part of the vein. The zonal texture, clearly developed in rhombohedra is typical for the quartz crystals formed in hydrothermal conditions. Another remarkable feature of Q2 is the presence of short to elongated prismatic apatite crystals and whiskers of, probably, ore minerals in its crystals.

Q2a-Fs2 vein consists of simultaneously crystallized quartz and feldspar with close or same grain size and relatively regular borders between them. Fs2 is brown-pinkish colored, which, according to Vutov (1968), is caused by hematite pigmentation. In some places hexahedral sections of quartz crystals and rhombus-shaped feldspars or elongated irregular feldspar crystals and aggregates are observed. Generally, the quartz crystals are embraced by feldspar aggregates. Individual well-shaped rhombuses of transparent adularia are included in the quartz grains. It must be pointed out that, as in Q2, analogous forms of zonal texture are also observed in the Q2a crystals. Q2a contains the same uniform inclusions of apatite and whiskers.

Sample 2. Similar to the quartz-feldspar vein in sample 1, Q2 also displays a two-sided zonal growth from salband towards the axial part of the vein. However, the vein in the sample has some different textural features. There is a fine grained quartz-feldspar aggregate presented, which embraces coarser quartz and feldspar grains. These coarse-grained aggregates remarkably resemble the whole texture of the Q2a-Fs2 vein from sample 1. The quartz crystals have the same zonal texture. There is also transparent adularia, included in the quartz grains. Magnetite, bornite and chalcopyrite are the representatives from the ore mineral group.

Sample 3. This sample represents black schist with intruded aplitic and quartz veins, which are parallel to each other. There is a K-feldspar halo around the quartz vein. Most probably the occurrence of this feldspar is caused by K-silicate alteration. The quartz-feldspar vein has the same texture as vein II from sample 1 (including zonal quartz crystals); it is distinguished only by the lack of individual quartz in the salband. There are transparent inclusions of adularia in the quartz grains. The ore minerals are presented mainly by pyrite, with less hematite and chalcopyrite.

Chemical composition of the potassium feldspars

Microprobe analyses were performed to determine the composition of K-feldspar in the three samples studied. Content of Ca was not found in any of the K-feldspars analyzed. All of the K-feldspars from sample 2 (from the coarser-grained quartz-feldspar aggregates) are of high purity (Or_{100}) and those from sample 1 have some albite content (Ab_{12-16}). Variations in the content of the albite constituent are established in the mineral grains from sample 3. There is a characteristic decrease in the content of the albite constituent from the centre (Ab_{11-12}) towards the periphery, with its total absence in the most exterior parts of some of the mineral grains.

Discussion and conclusions

Such quartz-feldspar veins described as vein dykes are also known from Endeavour porphyry copper deposits, Australia (Heithersay and Walsh, 1995). The authors assume the presence of the so-called vein dykes as one of the most illustrative evidence for coeval processes of magmatism, hydrothermal activity and mineralization. According to Lickfold et al. (2003), the composite igneous-hydrothermal structures (vein dykes) in the porphyry copper-gold deposit Endeavour 26N are formed during an igneous-hydrothermal transitional stage. The presence of thin hydrothermal selvages with prismatic quartz in the salband and a central infill of quartz and alkali feldspar (assumed as aplitic by the authors) is characteristic for those vein dykes. During the igneous-hydrothermal transitional stage fine-grained hydrothermal quartz is formed in the salbands of the cracks and later a residual melt is intruded in the unfilled cracks which gave birth to a quartz-feldspar mineralization defined by the authors as aplitic.

In the samples from Elatsite deposit the elongated prismatic quartz from the hydrothermal veins and from the so-called aplitic dykes displays a zonal growth, which could be in support of the argument for existence of a genetic relation between both quartz types. It is probable that they both are formed in hydrothermal conditions.

In hydrothermal low-temperature conditions adularia is the formed representative from the group of the K-feldspar minerals. Arnaudov and Arnaudova (1995) define all K-feldspars formed at low-temperature conditions (below 400°C) as adularia. Structurally, they could be monoclinic and triclinic, i.e. sanidine, orthoclase and microcline, having different degree of Si/Al order. The temperature conditions control to a great extent the chemical composition of adularia. Similar to the majority of adularia specimens described in literature the studied K-feldspars in the present paper are also characterized by high K and low Na content; the content of the orthoclase constituent varies between 81 and 100 percent. In contrast to the main components K, Na and Ca, with content depending mostly on the crystallization temperature, the content of the trace elements characteristic for K-feldspars, depends mainly on their concentration in the hydrothermal solutions and the nature of the environment. The K-feldspars studied here are poor in trace elements. From data obtained in the present work it can be concluded that the formation of the quartz-feldspar veins has been accomplished in hydrothermal conditions.

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