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Preliminary data on auriferous colloform banded textures from high-angle veins in the low-sulfidation Khan Krum gold deposit, SE Bulgaria

Предварителни данни за златоносни коломорфно-ивичести текстури от стръмни жили в нискосулфидното златно находище Хан Крум, ЮИ България

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Introduction

Ore bodies in the Khan Krum gold deposit appear as: 1) low-angle layer-like pervasive silicifications with disseminated electrum replacing clastic sediments; 2) stockwork bodies with disseminated electrum in the low-angle layer-like pervasive silicifications and 3) bonanza high-angle veins of open-space filling along East-West trending faults. The high-angle veins are composed of massive, banded and colloform banded textures. The objective of the present paper is mineralogical characteristics of colloform banded textures from some auriferous high-angle veins.

Material

The studied textures came from 10 auriferous high-angle veins (which number 170 totally), cropping out on the top of Ada Tepe ridge. The sampling was carried out in 2007 and 2008. About 200 hand specimens were examined and 30 thin sections and polished thin sections, and 20 polished sections were prepared from auriferous hand specimens.

Results and discussion

In the high-angle veins the colloform banded texture is more rarely met in comparison to the massive and banded ones. It reaches 50 cm in width, but commonly the first few cm, and characterizes with rounded, botryoidal surfaces of the single bands. There is macro- and micro-scale banding. The width of the macro-scale bands varies from the first few mm to some cm. The micro-scale banding has millimetre and submillimetre range and includes up to about 20 bands of sharp boundaries and minimal width of about 50 μm. This finest banding is rarely met – in some intervals of the high-angle veins, and it traces in centimetre distances. The colloform banded macro- and microtextures are represented by alternating white, pale grey, pale beige (due to abundance of pale beige adularia) and brown in colour (due to dispersed iron hydroxides) bands. The macrobands have clear, sharp boundaries and porcelain-like outlook when observed by naked eye. Under the optical microscope the boundaries are more uneven and not so sharp, but are not diffuse. They are healed and sealed, which indicates hydrofracturing origin (Phillips, 1972). Some bands have comb texture, but bands of irregular (random) mineral growth over the substrate predominate. Other bands are entirely composed of bladed texture – presumable replacement of quartz and adularia after platy calcite (Dong et al., 1995). Some bands display along their strike primary macro- and microvoids as well as such of dissolution, both incrustrated with millimetre-sized drusy quartz crystals. Besides the sharp banding there is one, rich in electrum, of unclear boundaries, called by Saunders (1990, 1994) pseudosedimentary textures represented by less sharp, more diffuse boundaries and less sustained in length. At places such bands display a gradation in the grain size. Another peculiarity of the colloform banded textures studied is the presence of spheres up to 1–2 mm in diameter confirmed by optical and X-Ray data to correspond to quartz. Such spheres are comparatively rare.

The colloform banded textures are composed of massive micro- to cryptocrystalline quartz and adularia of various quartz/adularia ratio, grain size, porosity and quantity of opaque inclusions. They also contain disseminated electrum and pyrite as well as bands, highly enriched in electrum. Micro-scale sericite and chalcedony are rarely met. The grain size distribution is extremely non-uniform as the grains of close size are arranged in spots. In every band there is a grain size, which is of greatest frequency. The spots are of quartz, adularia and quartz-adularia composition. Adularia is pale beige, its quantity varies in wide range: from 5 up to 80 vol.%, but commonly is 30–50 vol.%. Adularia up to 20 µm in size, of anhedral outlines predominates; its coarser grains are subhedral, of rhombic outlines and size up to 200–300 µm. Quartz is represented by an alternation of white, milky, pale grey and water clear bands. Commonly it also is sized to 20 µm, of anhedral outlines; its coarser grains are subhedral and reach about 200 µm. The finest quartz and adularia grains are sized below 2–3 µm and are of anhedral outlines. Bands of comb quartz and adularia are rare in general; the comb texture is more often met in the finest bands. In some cases a comb columnar adularia of size up to 500 µm along "c" axis was observed. In the colloform banded textures microcrystalline chalcedony was sporadically observed disseminated in spots among quartz-adularia aggregates and as microbands of fibrous aggregates. The chalcedony fibers are from 5–10 up to 100–150 µm long. Part of chalcedony aggregates are intergrown with euhedral adularia of rhombic outlines, which is sized to about 20 µm and is in quantity of 10–15 vol.%. Chalcedony microbands are rare and unsustained in length; they alternate with quartz-adularia ones. Generally, chalcedony does not exceed 1–3 vol.%, in some cases reaches 3–5%. Pyrite is less than 1 vol.%, occasionally is up to 3 vol.%. It is microscopic, euhedral (square outlines) to anhedral and was observed intersticially to quartz and adularia and in microscopic voids. In the colloform banded textures studied electrum forms dispersed grains less than 20–30 µm in size, intersticial to and intergrown with quartz and adularia and takes part in quartz-adularia bands, very rich in electrum. The bands differ in quartz/adularia ratio, grain size, porosity and participation of opaque inclusions. The optical observations displayed that electrum is highly enriched (up to 50 vol.%) in the finest microcrystalline to cryptocrystalline and thinnest quartz-adularia bands (ginguro bands, called by the nineteenth century Japanese miners), 50–500 µm wide, of 1–2 mm total width, with quartz and adularia less than 3–5 µm in size and adularia content of 50–80 vol.%. Electrum in these bands is visible under the microscope and more rarely – by naked eye. It forms dendrite-like aggregates developed transversely and obliquely to the banding or comparatively coarse clots. Electrum aggregates pass through several bands, which indicate that these very fine bands have been deposited from one portion of solution having slightly variable characteristics. At places electrum is intergrown with pyrite. In other cases electrum is deposited over corroded and comparatively coarse adularia and is again "sunk" in crypto- to microcrystalline quartz-adularia matrix.

In the examined colloform banded macrotextures, and millimetre- and submillimetre-scale electrum-rich bands we found out pronounced increasing of volume content of adularia as follows: colloform banded macrotextures (adularia in the range of 30–50 vol.%) → millimetre- and submillimetre-scale electrum-rich bands (adularia in the range of 50–80 vol.%). Following the outcomes of Browne (1978) and Dong, Morrison (1995) that adularia is a mineral indicator of boiling of hydrothermal fluids we infer intense boiling for the colloform banded macrotextures and extreme boiling for the millimetre- and submillimetre-scale electrum-rich bands. In this succession the saturation of SiO_2 has also increased. The positive correlation between adularia and electrum contents found out in our thin sections we relate to dissociation of gold complexes during the boiling of fluids. As Seward (1973) and Shenberger and Barnes (1989) pointed out every small change of pH and Eh-conditions of hydrothermal fluid as well as decreasing of activity of H_2 and H_2S lead to destabilization of gold complex compounds and voluminous deposition of gold in the epithermal deposits that we see in fact in the electrum-rich bands from our hand specimens and thin sections.

Conclusion

1) The colloform banded textures from the Khan Krum deposit have been formed through repeated reopening of the high-angle veins, most likely as a result of hydrothermal eruptions; 2) The colloform banded macrotextures are composed of micro- to cryptocrystalline quartz and adularia sized below 20–30 µm, the latter commonly in the range of 30–50 vol.%. They also include chalcedony to 1–3 vol.%, disseminated pyrite to 1–3 vol.% and electrum. The banding is due to differences in the quartz/adularia ratio, grain size, porosity and content of opaque inclusions. We infer their formation by intense boiling of fluids, high supersaturation of SiO_2 and rapid crystallization; 3) The millimetre- and submillimetre-scale electrum-rich bands are composed of crypto- to microcrystalline adularia (50–80 vol.%), electrum (to 50 vol.%), quartz, and pyrite and chalcedony (1–3 vol.%). Quartz and adularia are anhedral and sized below 3–5 µm. We infer their formation by more intense boiling of fluids, higher supersaturation of SiO_2 and more rapid crystallization in comparison to the colloform banded macrotextures.

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