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OPEN-SPACE FILLING TEXTURES FROM THE ELECTRUM-BEARING, LAYER-LIKE PERVASIVE SILICIFICATION IN THE LOW SULFIDATION KHAN KRUM GOLD DEPOSIT, SE BULGARIA

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Abstract

Representative open-space filling textures of the electrum-bearing, layer-like pervasive silicification of sedimentary breccias and breccio-conglomerates in the epithermal, low sulfidation of adularia-sericite type Khan Krum gold deposit are presented.

Key words: textures, electrum-bearing layer-like pervasive silicification of sediments

Introduction. Khan Krum gold deposit is located in the vicinity of Ada Tepe Peak (height of 492.4 m), Eastern Rhodope Mt, SE Bulgaria. The gold mineralization is epithermal, low sulfidation, of adularia-sericite type [1–4], and is around 35 Ma of age [7]. The deposit is hosted in the breccias and breccio-conglomerates of Shavar Formation (Maastrichtian-Paleocene of age) and it is related to the low-angle Tokachka Detachment Fault [6]. The geological setting is described in more details in [4, 7]. The style of mineralization includes ore bodies of two types entirely developed above Tokachka Fault: a massive, tabular (layer-like) body within the sediments of Shavar Formation, and an open-space filling along E-W-trending high-angle listric faults [2–4]. An industrial mineral in the ore bodies of both types is electrum which composition is given in [4, 7]. The mineral composition of the layer-like body is characterized in [1, 8]. It is accompanied by quartz-adularia metasomatites (± sericite, ± kaolinite) [4]. The quartz-adularia metasomatites are widely manifested alteration in Eastern Rhodope Mt, in particular in the near Madjarovo ore field and they have proved metallogenic importance there [9].

The following genetic textures of the layer-like pervasive silicification were recognized in outcrops, hand specimens and in polished and thin sections: 1) replacement textures; 2) open-space filling textures and 3) brecciation textures. The replacement textures are described in [8]. The aim of the present work is to describe the representative open-space filling textures of the layer-like body in order to evaluate the deposition conditions of the electrum.

Sampling. The layer-like body was sampled in 2004 in its best outcrop – Stenata (The Wall) outcrop by vertical channel samples downwards and upwards Tokachka Fault plane covering about a 5-metre interval. The sampling sites are documented by photographs in [8]. Hand specimens of Balkan Mineral and Mining from trenching are also used.

Results and discussion. From the open-space filling textures described in numerous works [10–15] the banded, colloform banded, crustiform and comb textures were recognized in the Stenata outcrop. These textures were observed at places within the layer-like pervasive silicification, where primary open space, open space of dissolution and open space in result of brecciation exist. These observations show that the above-mentioned textures were formed later than the massive one, which is the main texture in the layer-like pervasive silicification [8].

The banded and the colloform banded textures in the Stenata outcrop are represented by a rhythmic alternation of bands different in colour, grain size, mineral composition and mineral proportions (Fig. 1). The individual bands at the colloform banded texture have colloform border surfaces which lack at the banded texture. The bands are composed of quartz (clear, milky, gray and brown), pale opal (partially crystalized in microcrystalline quartz) (Fig. 1, c; Fig. 2, c–f), light beige adularia (Fig. 1, a, b), electrum (Fig. 1, a, b) and of supergene goethite. The bands break in length as their length is from 20–50 μm to 20–50 cm. Their thickness is from 10 μm to few centimetres, commonly few millimetres. A spectacular feature of these textures is the frequent presence of visible electrum filling short, centimetre-long banding with thickness of the individual bands from 10–20 μm to 100–200 μm (Fig. 1, a, b; Fig. 2, g, h). Most often the electrum bands alternate with quartz bands (rhythmic alternation of clear, milky and brown quartz) as the total thickness of electrum-quartz bandings is below 1 mm. Electrum in these bands occupies up to 10–30 vol. % of them. In reflected light one can see that the banded electrum appears as grains into lines as irregular clots and as dendrites in the banded quartz.

Adularia is microcrystalline, most often anhedral and subeuhedral, rare euhedral (rhombic cuts). Adularia below 10 μm of size predominates; its coarsest grains are large as around 30–40 μm across (Fig. 2, a). It composes mixed adularia-quartz bands which are predominantly quartz in composition and containing 1–2 vol. % adularia or quartz-adularia with adularia reaching to 50 vol. % or almost adularia ones containing 98–99 vol. % adularia.

The electrum-rich banded and colloform banded textures from the Stenata outcrop are similar to these observed in the epithermal, low sulfidation, adularia-sericite type gold deposits like Hishikari (Japan) [13, 14, 16], Golden Cross (New Zealand) [12, 16], Sleeper (Nevada, USA) [15], Pajingo and Cracow (Australia) [11, 16] and many others.

It is clarified from numerous works that the presence of opaline silica in the ores is evidence for participation of colloidal solutions at their formation. On the other hand, the presence of adularia in the epithermal, low sulfidation, adularia-sericite type gold deposits is explained by intensive boiling of fluids [17, 18]. At the same time the forma-

Fig. 1. Polished hand specimens from the layer-like pervasive silicification. Hand specimens a) and b) contain visible electrum; the quartz-electrum bands are below 0.5 mm of thickness and are outlined by yellow colour for clearness. Hand specimen c) contains isolated electrum grains of μm size: a) a massive, microcrystalline quartz replaced semi-rounded rock clasts of various size is brecciated and the open space is filled by microcrystalline adularia (ad)+quartz. Quartz druses → are grown over crustiform banded quartz (an alternation of clear and milky quartz) in a void; b) a colloform banded texture – rhythmic alternation of quartz, quartz+adularia and adularia (ad) and an electrum-rich banded quartz; f) a colloform banded texture – a rhythmic alternation of clear and milky quartz, and partially crystallized opal. The sample is treated with epoxy resin

tion of the banded and the colloform banded textures (most often they are also rhythmic) remains unclear. All offered explanations till now which concern the hydrothermal environment are brought to two mechanisms responsible for their formation: a) boiling of fluids [11–13, 15, 19] and, b) mixing of ascending hydrothermal solutions with steam-heated ground waters [20] both causing rapid cooling and oxidation. They are based on observations in active and fossil geothermal systems and on computer modelling. Boiling of fluids realizes through repeated hydrofracturing and respective repeated influx of deep fluids due to episodic release of overpressure in depth. A spatial relationship of the banded textures with dilation of a subvertical fault-fracture system is noted in [13].

According to all mentioned above, we could connect the presence of adularia and of banded and colloform banded textures in the Stenata outcrop to boiling of fluids or to mixing with ground waters. It is obvious that this process has also favoured the deposition of significant quantity of gold and silver in visible banded electrum as in many other epithermal gold deposits [21–23].

The crustiform texture forms through infilling of veinlets and voids, when the infilling mineral (usually quartz) grows perpendicular to the walls (Fig. 1, a). Commonly, the crustiform texture is combined with the banded and the colloform banded textures as gives crustiform banded (Fig. 1, a) and crustiform colloform banded textures.

The comb texture forms from quartz druses of microscaled, well developed prismatic crystals deposited in cracks and in voids perpendicular to the walls. Very often the quartz druses grow over crustiform banded quartz toward the central part of cracks (Fig. 1, a).

Conclusions.

1. Representative open-space filling textures from the layer-like pervasive silicification in the Stenata outcrop are: (i) banded; (ii) colloform banded; (iii) crustiform and, (iv) comb ones. These textures are widespread in the epithermal, low sulfidation, adularia-sericite type gold deposits worldwide.

2. The banded and the colloform banded textures are formed by rhythmic alternation of bands of quartz, partially crystallized opal, quartz+adularia, adularia and electrum.

3. The formation of banded and colloform banded textures is likely connected to boiling of fluids or to mixing with ground waters as well as to repeated influx of fluids. These processes have also favoured the precipitation of visible electrum.

4. The adularia-containing colloform banded texture can serve as textural indicator for high grade electrum.

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← Fig. 2. Banded and colloform banded microtextures from the layer-like pervasive silicification, a–f – in transmitted light, g–h – in reflected light: a) banded, microcrystalline adularia – euhedral and subeuhedral grains, //N; b) same field, +N; c) a colloform banded texture – a rhythmic alternation of bands of microcrystalline quartz and of partially crystallized opal. The opal is outlined by iron hydroxides, //N; d) same field, +N; e) a banded texture – a rhythmic alternation of bands of microcrystalline quartz and of partially crystallized opal; black band of iron hydroxides coinciding with the opal, //N; f) same field, +N; f) electrum-rich banded quartz, detail of the hand specimen in Fig. 1, a); h) electrum-rich banded quartz, detail of the hand specimen in Fig. 1, b)

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