Composition of electrum from different styles of epithermal mineralization in the Au-Ag Khan Krum deposit, SE Bulgaria

Състав на електрума от различни стилове на епитермална минерализация в Ag-Au находище Хан Крум, ЮИ България

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Introduction

Electrum in Khan Krum deposit (also known as Ada Tepe deposit) observes microscopically in high-angle banded, colloform-banded, and massive veins; layer-like bodies of replacement of breccias and breccio-conglomerates, and network of stockwork hair-line joints. It is well known that the composition of every mineral reflects the conditions of formation and the composition of parental hydrothermal solutions. That is why the composition of electrum from Khan Krum deposit could help us to clarify the depositional environment of mineralization in different styles. Moreover, Marchev et al. (2004), Marton (2009), and Marton in earlier works suggested different conditions of formation for the high-angle veins and the layer-like bodies. At the same time, the composition of electrum in Khan Krum deposit is not investigated systematically. Fragmentary data exist mainly for electrum from high-angle veins, where the electrum grades are highest and the gold abundance reaches 639 g/t (Kunov et al., 2001; Jelev, 2007) as well as single spot analyses of electrum from the layer-like body immediately above the Tokachka detachment fault (Marinova, 2005; Jelev, 2007). In addition, indirect data about the composition of electrum come from the Au/Ag ratio in channel samples taken by Balkan Mineral and Mining and used by Marchev et al. (2004), and Marton et al. (2006).

In this report data on the composition of electrum from high-angle colloform-banded veins and from the layer-like body of massive silicification immediately above the Tokachka detachment fault are presented.

Material and methods

Electrum from the layer-like body of replacement immediately above the Tokachka detachment fault is obtained from a sample of massive quartz of 4 kg taken near-by the trench AT052 of Balkan Mineral and Mining. The sample was crushed and milled in a ball mill down to 0.20 mm, and electrum was pan-concentrated by washing of the milled massive quartz with water. After that, individual coarser electrum particles were hand-picked under stereomicroscope and then prepared for electron microprobe analysis (EMPA). Electrum from high-angle veins came from bonanza sub-millimeter-wide colloform-banded veinlets, and its composition was determined in polished sections cut perpendicularly to the banding. The composition of both types of electrum was obtained with an energy-dispersive spectrometer EDAX 9100/60(5) equipped with a Philips-515 SEM, at a 20 kV voltage and with standards for Au, Ag, and Cu – pure metals.

Results and discussion

The electron microprobe analyses of electrum from colloform micro-bands have found out the presence only of silver and gold as constituent elements. The content of gold ranges from 69.54 to 76.27 wt.%, while that of silver from 23.73 to 30.61 wt.% (according to 27 electron microprobe analyses). In average, the composition of electrum is: Au=70.83 wt.% and Ag=29.17 wt.%. The average Au/Ag ratio is 2.4 (from 2.3 up to 3.2) and the average fineness is 708‰ (Fig. 1).

Electrum from the lowermost low-angle, layer-like pervasive silicification of replacement has the following composition: gold from 68.51 to 82.33 wt.%, silver from 16.36 to 28.14 wt.%, and copper up to 4.00 wt.% (according to 11 electron microprobe analyses). In average, the composition of this kind of electrum is: Au=74.03 wt.%, Ag=24.73 wt.%, and Cu=1.24 wt.%. The average Au/Ag ratio is 2.99 (from 2.5 up to 5), and the average fineness is 740‰ (Fig. 1).

The revealed in this study compositional distinction (the EPMA data and Fig. 1) between the two types of electrum speaks in favour of their formation under different conditions. The presence of copper in electrum from the low-grade, layer-like massive silicification indicates higher concentration of chorine in the

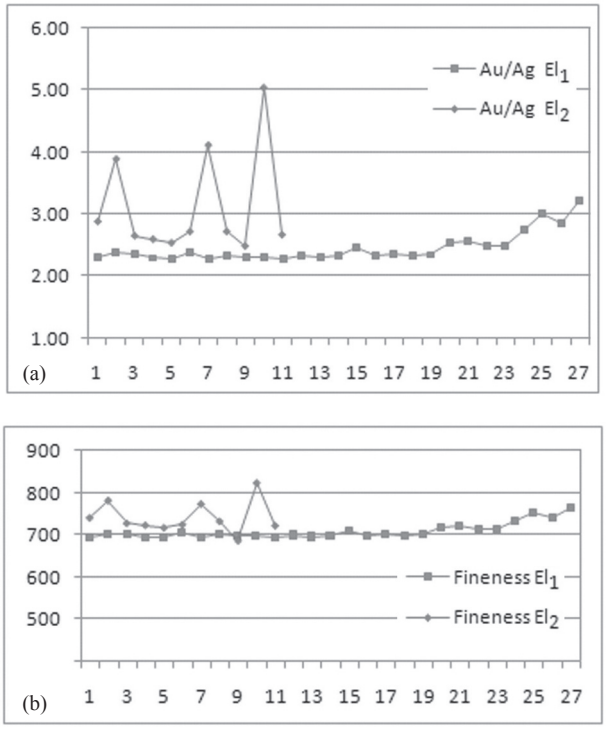

Fig. 1. Comparison between electrum from high-angle open-space filling veins (El_1) and electrum from the layer-like body of replacement immediately above the Tokachka detachment fault (El_2) in respect of the Au/Ag ratio (a) and the fineness (b). The horizontal axis denotes number of EMPA analysis.

paleofluids compared to this one in the paleofluids deposited colloform-banded veins since chloride complexes are responsible for the entering of copper into hydrothermal solutions (Weihua, McPhail, 2005, and references therein). Most probably, the paleofluids deposited electrum in the layer-like massive silicification have gained their composition through intense interaction with the metamorphic rocks of the basement and the host breccio-conglomerates unlike the paleofluids deposited electrum in bonanza colloform micro-bands. The metamorphic rocks like amphibolites and mica schists are possible sources of Cu for the first type of electrum. The more variable composition of electrum from the layer-like body compared to this one from high-angle veins probably resulted from the large volume of the used sample versus the few number of polished sections. It is most likely that when one further analyzes widely the high-angle veins also will obtain wider range of compositions.

Different extent of interaction fluid-host rock during the electrum mineralization in the prospects of Krumovgrad area has been proposed earlier by Marton (2009) based on textural features, while different temperature of formation was suggested by Marchev et al. (2004) for both styles of mineralization.

Conclusions

The electron microprobe analysis carried out on electrum from the layer-like body of replacement immediately above the Tokachka detachment fault and from high-angle colloform-banded veins revealed distinction between the two styles of electrum mineralization concerning composition, Au/Ag ratio, and fineness. Electrum from the first style of mineralization contains Au, Ag, and Cu, has average Au/Ag=2.99, and average fineness 740‰. Electrum from the second style of mineralization contains only Au and Ag, has average Au/Ag=2.40, and average fineness 708‰.

The distinctive compositional characteristics of electrum from the two styles of epithermal mineralization under study are interpreted herein as resulted from electrum formation during different mineral-formation stages at different extent of interaction fluid-host rock, and from different fluids.

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