Electrum enrichments in submillimetre scale colloform veinlets – representative of the bonanza low-sulfidation gold ores (case study from the Khan Krum deposit, SE Bulgaria)

Обогатявания с електрум в субмилиметрови коломорфни жилки – представител на богатите нискосулфидни златни руди (на примера на находище Хан Крум, ЮИ България)

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Introduction

In the Paleogene low-sulfidation Khan Krum deposit bonanza electrum enrichments are exclusively observed in submillimetre scale colloform quartz-adularia veinlets as well as micron-sized sprinkles on the surface of some colloform bands due to open-space deposition. Bonanza electrum is visible by naked eye rarely (Marinova et al., 2013). In the latter paper we presented a lot of electrum, quartz, and adularia micro-textures indicating colloidal origin of these minerals.

The aim of this report is to explain the specific distribution of electrum agglomerations along bonanza sub-vertical sub-millimetre-wide quartz-adularia veinlets. The latter appear to be a representative of the bonanza precious-metals ores in the epithermal low-sulfidation deposits worldwide. The author hopes that this study will be useful for explaining the formation of similar spectacular electrum agglomerations.

Material

The studied polished section (Fig. 1A) is obtained from a sub-vertical veinlet with colloform-banded texture about 2.5 cm wide. Veinlets composition, texture and trace element distribution were reported by Marinova et al. (2013). The studied polished section consists of 10 bands, 9 of which are almost barren and visible by naked eye. The electrum-rich band is hair thin (0.3 mm wide) with distinct brown colour and a lot of oval voids inside. Under optical microscope the hairline band consists of 4 individual micro-bands, separated by thin interrupted syneresis cracks. Only the right-most micro-band that is a subject of the present study is abundant of electrum aggregates and pyrite as well as of adularia as compared with the rest three micro-bands (Fig. 1B).

Results and interpretation

Under optical microscope it is observed that electrum forms considerable accumulations only in parts of the studied micro-band which have comparatively large aperture (up to about 200 μm). As a rule these parts contain dense micron-sized electrum aggregates, while the narrow ones (up to about 40 μm wide) are almost barren. The ratio of the wide sections to the narrow ones reaches 4 to 5 (Fig. 1B). This apparent influence of the joints aperture reveals a laminar flow under the laws of Bernoulli and Poiseuille, where the volume flow rate (F) changes in direct proportion to the fourth degree of the channel (joint) radius (R): $F=\pi R^4 \Delta P/8\eta L$, where ΔP is the difference of the flow pressure in narrowed part and next widened one; η is the dynamic fluid viscosity, and L is the length of the channel (Batchelor, 1967; Sutera, Skalak, 1993). In such a flow the colloidal particles of electrum and silicates should be distributed randomly (Fig. 1C, a). Thus, the volume flow rate in the wide parts increases 256 to 625 times as compared to the narrow sectors. This significantly decreases the flow speed in widened parts and according to the energy conservation law (Batchelor, 1967) should delay more the heavy electrum colloidal particles than the light silicate ones. As a result, the wide sectors will be enriched in electrum as compared to the colloidal silicate particles which continue their flow along the joint together with the dispersion medium (Fig. 1C, b). If it was a true solution, then such an effect would not occur. During subsequent coagulation of the colloidal solution electrum

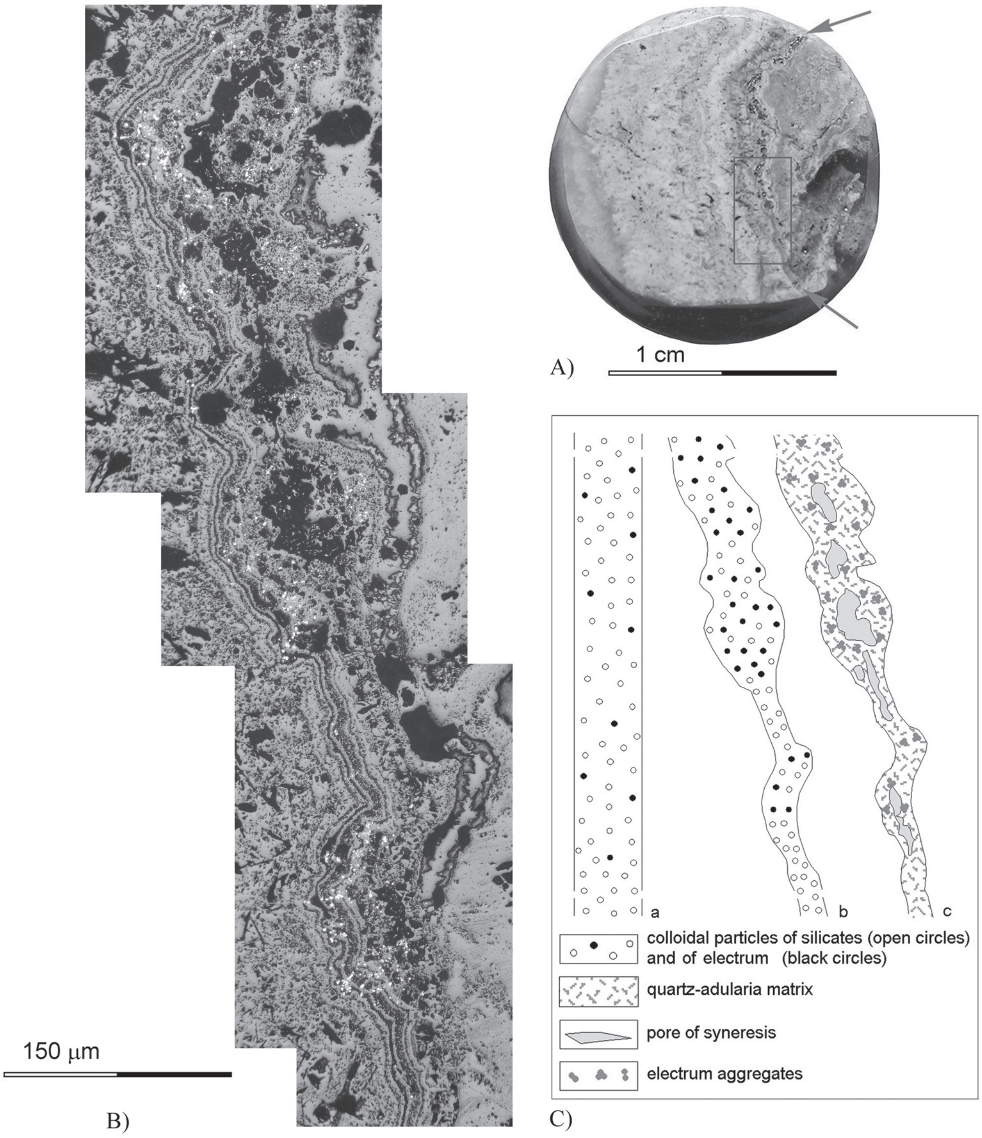

Fig. 1. Electrum-rich colloform micro-banding
A, in polished section, designated with arrows. Pores of syneresis seen as black spots and speckles (2×). The grey rectangle enlarged in (B); ***B***, photomicrograph of the micro-banding comprising four micro-bands; the rightmost one has a lot of pores of syneresis (black spots), and abundant electrum aggregates (white speckles) concentrated exclusively in widened portions; ***C***, descriptive model of electrum enrichment in the widened portions of the forth micro-band: *a*, random distribution of electrum and silicate colloidal particles along a joint of constant width; *b*, expected distribution of colloidal particles of electrum and silicates along a joint with variable aperture in a Poiseuille flow with enrichment in electrum of widened portions; *c*, real distribution of electrum (not to scale) and pores of syneresis (to scale) along the joint from (b) after coagulation of electrum-silicate colloidal solution with formation of silicate matrix, pores of syneresis, and electrum aggregations around the pores of syneresis

particles adhere, aggregate and form agglomerates in the widened joint parts (Fig. 1C, c).

Conclusions

1. The observed electrum micro-texture is evidence for transport of natural colloidal solution under epithermal conditions along micron size wide veinlets.

2. The electrum enrichment only of the widened submillimetre scale quartz-adularia veinlets demonstrates apparent influence of the joint's aperture under the laws of Bernoulli and Poiseuille, and means a laminar flow of two-phase colloidal solution that consists of heavy electrum particles and light silicate ones.

References

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