Mineralogy of Milin Kamak gold deposit – Breznik, Western Srednogorie

Минералогия на златно находище Милин Камък – Брезник, Западно Средногорие

***Ralica Sabeva*[1], *Vassilka Mladenova*[1], *Margarita Krumova*[2]**
***Ралица Събева*[1], *Василка Младенова*[1], *Маргарита Крумова*[2]**

[1] Sofia University, FGG, 15 Tzar Osvoboditel Blvd., 1505 Sofia; E-mail: Rali_Sabeva@abv.bg; vassilka@gea.uni-sofia.bg
[2] Euromax Resources Ltd., 1582 Sofia; E-mail: m.krumova@euromaxresources.com

Key words: Western Srednogorie, Milin Kamak, Breznik, ore minerals, gold.

Introduction

The Milin Kamak gold deposit is located 40 km western from Sofia, near the town of Breznik. This deposit is part of the Western Srednogorie zone in Bulgaria which in regional aspect belongs to the Late Cretaceous Apuseni–Banat–Timok–Srednogorie magmatic belt. This province hosts economically important ore regions with Cu- and Au-rich porphyry and high- and low-sulphidation deposits.

Geological settings

The Milin Kamak gold deposit is underlain by Precambrian gneiss and schists, Cambrian–Devonian mafic volcanic rocks, Paleozoic granitic intrusions, Permian–Triassic clastic sedimentary rocks and Jurassic–Cretaceous limestone, shale and sandstone, and is intruded by gabbrodioritic porphyry stocks and dikes. Host rocks belong to Western Srednogorie belt and are represented from Late Cretaceous andesite, trachyandesite and trachybasalt. There are three systems of faults – primary faults with NW–SE orientation which are parallel to the Srednogorie zone and secondary faults with NE–SW and W–E orientation.

The Milin Kamak gold deposit consists of three main vein systems – north, central and south ones hosting the economic part of the deposit. These vein systems are with W–E orientation and display similar morphological and textural characteristics, have a length from 350 m to 800 m, a width from 3–4 m to 10–15 m, dip steeply to the south to a maximum of 130 m.

Hydrothermal alteration

The processes of hydrothermal alteration are related to the interaction of wall-rocks with hydrothermal fluids, which transport heat and chemical constituents under evolving physico-chemical conditions. In Milin Kamak deposit, the ores associated with argillic, quartz-sericitic and sericitic types of alteration. The outermost alteration zone consists of propylitic alteration. Velinov (1967) and Crummy et al. (2001) described the hydrothermal alterations in this district and announced the presence of advance argillic alteration which in this study can not be shown.

Mineral composition

The ore minerals occur as nests, veinlets and disseminations in quartz, carbonate and sericitic matrix.

Pyrite is the most common opaque mineral and typically forms subhedral and anhedral crystals. Most often it is fractured and looks “shaggy”. Marcasite rims pyrite in some samples. Pyrite pseudomorphosis after pyrrhotite and marcasite can be also observed. On the basis of microprobe and LA-ICP-MS analyses pyrite can be determined as two types with different composition. The first one is “pure” pyrite – without any trace elements and the second one – with high concentration of As and Cu.

Despite relatively high As contents in some samples, it is observed only single grains of *arsenopyrite*.

Chalcopyrite and tetrahedrite-tennantite are the minerals with high Cu content. Chalcopyrite occurs as irregular aggregates or fine nest among pyrite. Often this mineral is observed within sphalerite as so called “chalcopyrite disease”and associate with tetrahedrite-tennantite.

Galena occurs as veins and nests in the quartz and carbonate matrix and as isometric inclusions and fine veinlets in pyrite, rarely in chalcopyrite. It is characterized by presence of Fe, Bi and Ag.

Sphalerite is often found in association with tetrahedrite-tennantite and with chalcopyrite. It is observed

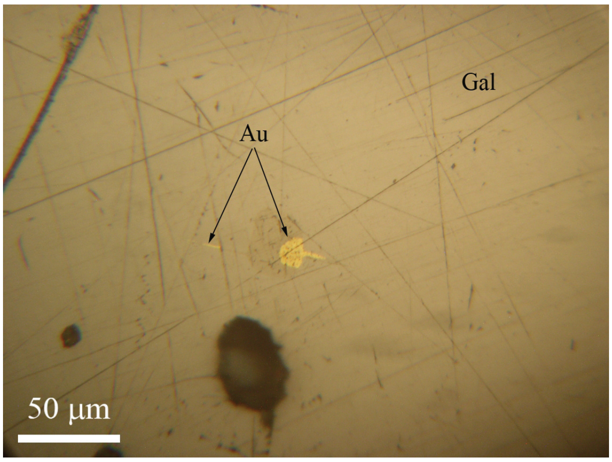

Fig. 1. Gold in galena with unspecified ore mineral

as small nests and fine veinlets among all the other minerals. Sphalerite is typically accompanied by chalcopyrite inclusions.

Phases from *tetrahedrite-tennantite* series can not be distinguished only by their optical charachteristics. Microprobe analyses on some grains confirm high Sb concentration and presence of Zn and Fe. These minerals associate with sphalerite and chlcopyrite and most often form rims around them.

Native gold is economically the most important mineral and is observed for the first time in the samples studied. It is found as grains in galena and associated with unspecified ore mineral with low reflectance (Fig. 1), also with pyrite and gangue minerals (most often calcite). Gold occurs as small isometric or elongated inclusions with size from 2 to 40 µm. LA-ICP-MS confirms that in so called "shaggy" pyrite gold is probably present as discrete inclusion smaller then 1000 Å ("nanoparticles") also known as "invisible gold" (Cook, 1990).

Silver is not detected in native form in the samples but ICP anlyses of bulk samples indicate high Ag concentration. Probably silver is present as electrum or Ag sulfosalts but data about these minerals are still very limited.

Hematite is often and occurs as small inclusions in gangue minerals.

The gangue minerals are represented by carbonates, quartz, sericite, clay minerals, adularia(?), baryte.

Microprobe analyses confirm that carbonate group includes calcite, dolomite and rodochrosite. The carbonates occur as bands or infilling vugs. The sequence of deposition is rodochrosite→dolomite→calcite. There is zoning in these vugs – from periphery to the centre. Therefore the calcite is the last one precipitated mineral.

Conclusions

Most important part of this work shows new data on native gold. As the major industrial component in this deposit it was extremely necessary to point out where the gold is and which are the associating minerals. Visible gold occurs as inclusions in galena and calcite, but analyses show "invisible gold" in pyrite. To clear the relation gold–mineral association–alterations more analytical work will be needed.

Acknowledgments: This work was supported by the Thrace Resources Ltd. and Sofia University Research Grant 042/2011.

References

Cook, N. J., S. L. Chryssoulis. 1990. Concentrations of "invisible" gold in the common sulfides. – *Canadian Mineral.*, *28*, 1–16.

Crummy, J., I. Mutafchiev, I. Velinov, R. Petrunov. 2001. The Breznik epithermal Au occurrence, Western Srednegorie – Bulgaria: an "atypical"(?) low-sulphidation hydrothermal system. – In: Piestrzynski, A. et al. (Eds.). *Mineral Deposits at the Beginning of the 21-st Century*. Proceedings of the 6-th biennial SGA meeting, Cracow, Poland. Lisse, Balkema, 723–726.

Velinov, I. 1967. Propylites and alunite quartzites in the region of Breznik. – *Bull. of the Geol. Inst.*, *16*, 205–220 (in Bulgarian with an English abstract).