GOLD AND POLYMETALLIC MINERALIZATION IN THE BANDED IRON FORMATIONS DEPOSIT, KRYVYI RIH, UKRAINE

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Introduction

Since 1934, gold prospecting in the area of Kryvyi Rih and its surroundings has been carried out on a regular basis. Up to now, despite identification of many occurrences of gold and manifestations of mineralization, no regularities in its occurrence have been found. It has been noticed that gold in small amounts occurred in all rocks of the Kryvyi Rih Basin.

Kryvyi Rih Iron Ore Basin (KRIOB) is located in the middle part of southern slope of the Ukrainian Shield. It represents outcropping suite of ferruginous quartzite 7 km bright strike from north to the south along Kryvyi Rih city and Ingulets and Saksagan Rivers. The length of this structure containing BIF rocks is 85 km. This zone is related to the border of two megablocks: western Ingulets Block (very often called Kirovograd Block) which comprise Lower Proterozoic volcanic-sedimentary and granitoid rocks, and Eastern bloc called Middle Dniepr Block composed of Lower Archaean plagiogranites located within the greenstone belts of the Upper Archaean.

The BIF ores were discovery by Vasiliy ZUEV on the bank of Ingulets River and described by him first in 1781 year. Archaeological artefacts suggest earlier epoch of the beginning of the first mining and smelting. The beginning of mining is dated for 1881 year.

Samples and methods

Several samples were investigated using ore microscope and both EDS and WDS measurements. The chemical analyses of coffinite were performed using a JEOL Super Probe JXA-8230 electron microprobe (EMP) at the KGHM PM S.A. - AGH-UST Laboratory of Critical Elements at the University of Science and Technology, Krakow. The EMP was operated in the wavelength-dispersion mode at an accelerating voltage of 15 kV, a probe current of 40 nA, focused beam with a diameter of 3 μm.

Results

In the Ingulets deposit zones containing arsenopyrite enrichments have been found on the -134 m mining horizon in the Proterozoic quartz-mica schists (phyllites) of the Skelevatska Suite, a section with metasomatic alteration was uncovered (Photo 1). Massive altered phyllites body is 20 m long and 5 m thick. It is composed of the biotite, actinolite metasomatites and metasomatic quartzites. This body is located nearby contact of phyllites with talc horizon (it is contact of the Middle and the Upper Subsuites of the Skelevatska Suite), and tectonic zone. Arsenopyrite crystals are random distributed within the metasomatic altered phyllites. In this zone occurring quartz veins up to 35 cm thick which are cut with low angle schistosity of phyllites from the top to the bottom of the phyllite horizon. In general arsenopyrite bearing quartz veins are located within the zones of secondary silicification.

During investigation six gold generation have been recognized (Sukach et al. 2013) as follow:

- Sedimentary gold which is occurring in metaconglomerates, metasandstones, quartzite and different schist types.
- Metamorphogenic gold. This gold is related to the alpine quartz veins.
- Gold type related to the Na-metasomatic processes. This gold is located within the quartz metasomatic bodies.

- Gold within the hydrothermal-metasomatic rocks located between amphibolites of the Novokryvorizka Suite and granitoids.
- Gold in supergenic oxidation zones developed within the Kryvyi Rih Series and accompanied granitoids.
- Gold in alluvial sediments deposited along Ingulets, Saksagan and Yellow Rivers and their tributaries.

Gold was found in association with arsenopyrite, pyrite, pyrrhotite, tetrahedrite, sphalerite, chalcopyrite, galena, Sb-native, miargyrite, and other rare sulphosalts (chalkostibite, andorite, plagonite, zinkenite). Last four minerals were identified using WDS quantitative measurements. Lead and silver sulphosalts and Sb-native are a new phases described first time in the KRIOB.

Arsenopyrite is the major mineral in this association. It formed well developed euhedral crystals and irregular in shape massive aggregates. The size of the biggest crystals reach 3 cm. BSE images show multi zoned crystals (Fig. 1).

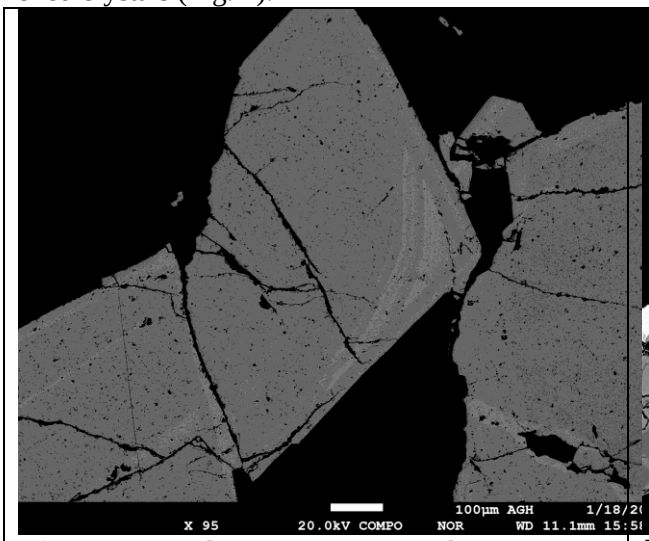

Figure 1. *Zoned arsenopyrite crystals, BSE image.*

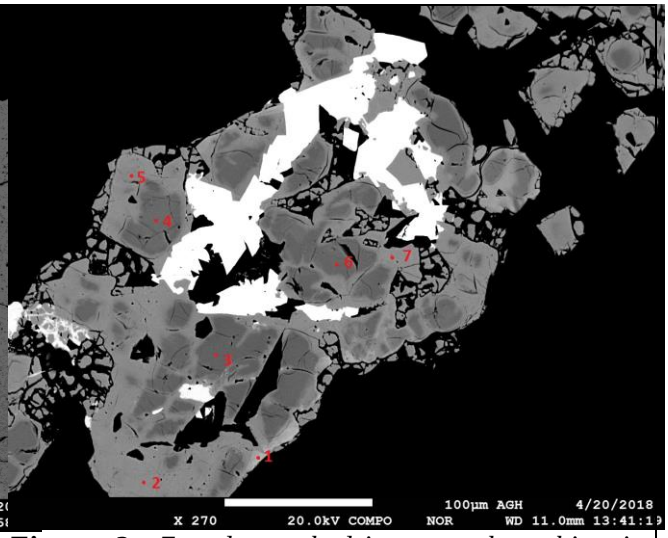

Figure 2. *Zoned tetrahedrite crystals, white is arsenopyrite, BSE image.*

Tetrahedrite is one of the most common copper minerals occurring in association with arsenopyrite. This minerals form intergrowth often (Fig. 2). EDS images show very big contrast of tetrahedrite crystals. This contrast is developed because of different silver contents. The outer (more brittle) rims of crystals reveal Ag concentration up to 33 wt.%. Therefore internal part are characterized with low Ag values ranging between 2-6 wt.%. Several gold grains have been found in zones with Pb-Sb-sulphosalts. Single gold aggregate was identified during routine WDS measurements.

Conclusions

Based on ore microscope observations and EDS-WDS quantitative measurements can be concluded that study quartz-arsenopyrite veins were deposited during multi-stages processes which were characterized by the variable composition of hydrothermal fluids. Fluids containing silver were younger

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