NEW TYPE OF HYDROTHERMAL MINERALIZATION IN THE TATRIC UNIT (WESTERN CARPATHIANS): NI–BI–AS MINERAL ASSEMBLAGE IN THE BLACK SHALES.

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Abstract: Unusual new type of ore mineralization for Tatric Unit was found in the Strážovské vrchy Mts. (Suchý Mts.). Mineralization is hosted by amphibolites, graphitic schists and black shales. New minerals and paragenetic mineral assemblages in the Tatric Unit were described, some of which are also first finds in the Western Carpathians.

Key words: Suchý Mts., crystallinic basement, mineralogy, sulphosalts

Methods of study

Sulphides, sulphosalts, native elements, sulfoarsenides and arsenides were analysed using wave dispersion analysis (WDS) and photographed using backscattered electrons (BSE) imaging at Faculty of Sciences, Comenius University Bratislava using JEOL JXA 840A microprobe. Analyses of Bi minerals were conducted using JEOL SUPERPROBE 733 with on-line ZAF correction program at the Geologisk Institut at University of Copenhagen, Denmark. Carbonates were analysed by standardized energy-dispersion analysis (EDS) at GS SR Bratislava using JEOL SUPERPROBE 733. RTG diffraction. Analyses of Ni secondary minerals were performed by DRON-3 diffractometer at Geologic Institute of Faculty of Natural Sciences, Comenius University. RTG diffraction analyses of pararammelsbergite were performed using PHILIPS RTG machine at Geological Institute of Slovak Academy of Sciences. Infrared absorption spectroscopy of retgersite was made by NICOLET MAGNA 750 at Chemical Institute of Slovak Academy of Sciences.

Geological settings and ore mineralization

The Tatric Unit is an extensive thick-skinned crustal sheet composed of a pre-Alpine (generally Variscan) crystalline basement and its sedimentary cover. The Tatric basement has a generally well-preserved Variscan structures without a significant Alpine overprint. The Tatric basement is built of large Variscan granitoid plutons within medium to high metamorphic rocks such as gneisses, anatectic migmatites and amphibolites. Low to medium grade shales and basic rocks of the Devonian to Early Carboniferous are less abundant (Malé Karpaty Mts.). The crystalline complex of Suchý Mts., which is separated from Malá Magura Mts. by the Paleogene Diviaky fault, hosts studied mineralization. Granitoid rocks, paragneisses and migmatitic complexes are dominant in the core of Suchý Mts. The metamorphic rocks are mainly high temperature and quartz-rich paragneisses. Granitoid rocks (tonalites, granodiorites, granites) belong to the S-type granite group (Hovorka & Fejdi, 1983).

The age of granitoid rocks from the Suchý and Malá Magura Mts. determined by Rb-Sr isochron is 393 ±6 Ma (Kráľ et al., 1987). Variscan tectogenesis is dominant in the Suchý Mts. The Alpine restructuring of the crystalline complex is relatively poor (Maheľ, 1985). P-T-X parameters of metamorphic processes in the crystalline cores of Suchý and Malá Magura indicate differences in their prograde and retrograde metamorphic evolution. The determination of metamorphic temperatures and pressures are follows: Suchý Mts: 540-560° / 4-5 Kbar, XH_2O = 0,6-0,8; Malá Magura Mts: 620-640° / 4,5-5,5 Kbar, XH_2O = 0,8-1,0 (Dyda, 1994).

Studied mineralization is situated approximately 2 km SSE from village Čierna Lehota. Mining field has general SSW-NNE direction. Exploratory pits are situated in the tight zone of amphibolite, black shales and intensive graphitized rocks (graphitic biotitic gneisses, graphitic metaquartzite). This zone occurs within quartz-biotitic paragneisses. Hydrothermal Ni-As-Bi mineralization occurs as a sub-stage of metamorphosed syngenetic pyrite-pyrhotite mineralization. Syngenetic mineralization was developed during several stages:

I. pyrite – pyrhotite – sphalerite - amphiboles
II. quartz – dolomite – pyrite II – pyrhotite II – chalcopyrite - galena

The first stage was formed during volcano-sedimentary processes, presumably of Devonian age. The ore exhibits banded, impregnation and massive textures. The second stage was developed during

Variscan tectono-metamorphic processes. Ore textures are recrystallized. Cataclastic and metacrystalls are formed. Most prevailing mineral on the locality is massive pyrhotite. Sphalerite geobarometer (Scott, 1976) derived from coexisting pyrite+pyrhotite+sphalerite assemblage yielded unsatisfactory results. Hydrothermal epigenetic Ni-As-Bi mineralization was also formed during Variscan tectono-metamorphic evolution of the area. Several stages of crystallization within this mineralization were distinguished:

I. quartz - Fe-dolomite – arsenopyrite – pyrite – pararammelsbergite – löllingite - gersdorffite
II. quartz - bismuth I - bismuthinite I - matildite – kuprobismutite - aikinite – hodrushite - $Cu_8Bi_{10}S_{20}$ phase - Bi-tennantite - (bismuth II, bismuthinite II)
III. carbonate - sphalerite - galena - chalcopyrite
IV. calcite - hematite - magnetite
V. secondary minerals: annabergite, retgersite, copper, cuprite, malachite, gypsum

Ore exhibits veinlet-type textures. Pararammelsbergite has mostly colloform, concentrically zoned structure. It is most prevailing mineral at the locality. Lattice parameters of pararammelsbergite correspond with literary data (Berry, 1974). Löllingite intimately overgrows with pararammelsbergite and its sulphur content is up to 3,4 wt.%. Gersdorffite with younger minerals creates atoll structures, while skeletal aggregates are rare. It's Fe-content is elevated - up to 7,3 wt.%. Older pararammelsbergite grains host younger veins and impregnations of bismuth and the other (Cu-Pb-Bi-Ag) sulphosalts. Bi sulphosalts form lath-like grains up to 1 mm in size, disseminated in Ni arsenides or associated with chalcopyrite, sphalerite and tenantite. Bismuthinite I is associated with matildite, kuprobismuthite and sometimes also with native bismuth I. It forms platy crystals arranged into the small veinlets intersecting Ni arsenides. Hodrushite and aikinite form irregular grains (sometimes of lath-like shape), usually replaced by tenantite or decomposed to the mixture of bismuthinite, bismuth and bismuth. Hodrushite is rarely replaced by phase close to the $Cu_8Bi_{10}S_{20}$. Substitution of Bi for Ag+Pb and Cu for Fe in minerals of kuprobismuthite group can be seen in the ternary diagram (fig.1).

Diverse palette of secondary minerals is also present. Many unidentified secondary minerals are on the occurrence.

No suitable fluid inclusions for microthermometric study were observed in Fe-dolomite and calcite.

Possible source of Ni, As and Bi can found in the surrounding (host) rocks of the mineralization. During Variscan tectonometamorphic events, these compounds could have been leached and transported to form the studied mineralization. This type of mineralization has no equivalent in the Tatric Unit, even though similar types of mineralization occur in the Gemeric Unit (Dobšiná deposit). Syngenetic metamorphic pyrite – pyrhotite mineralization is in many aspects similar to mineralization in the Pezinok – Pernek crystalline complex in the Malé Karpaty Mts. and also other Tatric localities.

References

Berry L.G., (EDS.) 1974 : Selected powder diffraction data for minerals. Philadelphia, JCPDS.

Dyda M., 1994: Geothermobarometric characteristics of some Tatric crystalline basement Units (Western Carpathians). *Mitt. Österr. Geol. Ges.*, 86, 45-59.

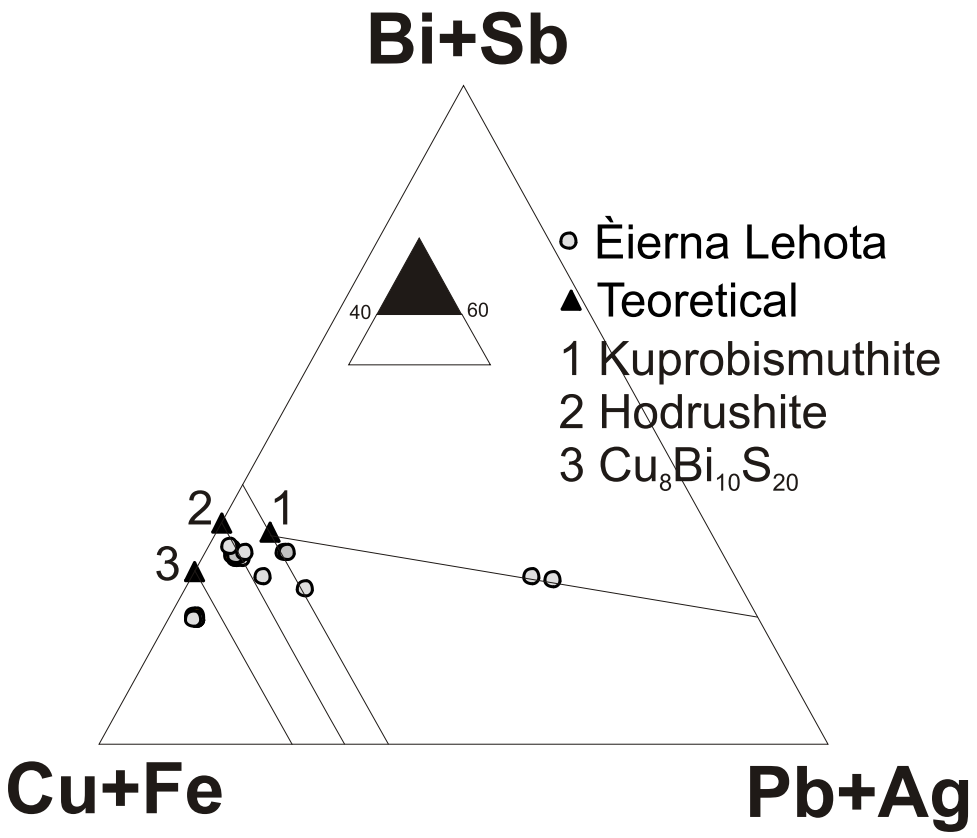
Hovorka D. & Fejdi P., 1983: Garnets of peraluminous granites of the Suchý and Malá Magura Mts. (the Western Carpathians) - their origin and petrological significance. *Geol. Zbor. Geol. carpath.,* 34, 1, 103-115.

Kráľ J., Goltzman Y. & Petrík I., 1987: Rb-Sr whole rock isochron data of granitic rocks from the Strážovské vrchy Mts.: the preliminary report. *Geol. Zbor. Goel. carpath*., 38, 171-179.

Maheľ M., 1985 : Geological building of the Strážovské vrchy Mts. *GÚDŠ Bratislava*, 221 (in Slovak).

Scott S.D., 1976: Application of the sphalerite geobarometer to regionally metamorphosed terrains. *American Mineralogist*, 61, 661-670.

Fig. 1 Triangle diagram of sulphosalts from Čierna Lehota (in at.%).


Bi+Sb
Èierna Lehota
Teoretical
1 Kuprobismuthite
2 Hodrushite
3 Cu8Bi10S20
40
60
1
2
3
Cu+Fe
Pb+Ag