

Bożena GOŁĘBIEWSKA¹, Adam PIECZKA¹

**A POLYMETALLIC ASSEMBLAGE WITH Pb-Bi(Sb) AND Cu-Pb-Bi
SULPHOSALTS FROM RĘDZINY IN THE EASTERN METAMORPHIC
COVER OF THE KARKONOSZE GRANITE**

In the mineralized dolostones and amphibolitic rocks exposed in the Rędziny quarry, the authors have found Pb-Bi(-Sb) and Cu-Pb-Bi sulphosalts, bournonite, tetrahedrite and stannite, in addition to common, disseminated ore minerals such as cassiterite, arsenopyrite, tennantite, chalcopyrite, sphalerite, galena and others (Wołkowicz 1984, Gołębiowska and Pieczka 1997). Earlier, some rare Bi-Te-S minerals were identified by Parafiniuk (in press).

The Pb-Bi(-Sb) and Cu-Pb-Bi sulphosalts occur at the III exploitation level in a rich ore vein, dominated by arsenopyrite. Forming accumulations up to 3 mm, they coexist with galena as tabular crystals (max. 300 μm) or graphic intergrowths (max. 50 μm). In the latter the inclusions of bournonite (max. 20 μm) and relicts of tetrahedrite (max. 15 μm) have locally been observed (Fig. 1). In other parts of the vein stannite may be found, most frequently as small (max. 10 μm), drop-like exsolutions in sphalerite or as rare subhedral crystals (max. 50 μm) always associated and often intergrown with chalcopyrite. All the minerals listed are accompanied by arsenates of the tsumcorite group, philipsbornite, carminite and mimetite.

Optic observations were carried out using a universal Olympus BX51 microscope, while chemical analyses performed in microareas using a JEOL JCSA-733 microprobe.

Point analyses (in apfu) of the Pb-Bi(-Sb) and Cu-Pb-Bi sulphosalts are presented in Table 1 and in Fig. 2 (the ternary $\text{PbS-Bi}_2\text{S}_3\text{-Cu}_2\text{S}$ system). The positions of the projection points indicate the presence of three dominating phases.

1. The Pb-Bi(-Sb) sulphosalts of variable composition most often occur as well developed, elongated crystals, mainly in central parts of sulphosalt-galena concentrations. Creamy in reflected light, sometimes with noticeable blue tint, they reveal distinct anisotropy in blue, grey and brown colours. They bear high amounts of Cu (1.62 wt.%), Ag (1.12 wt.%) and Fe (0.20 wt.%), and in some cases also appreciable concentrations of Zn, Cd, Sn, Te and As. Few grains were even more enriched in Ag (up to 7.4 wt.%) and Cu (up to 6.41 wt.%).

2. Galena coexisting with the sulphosalts shows variable Bi (1.94 to 3.04 wt.%) and Ag (1.16 to 1.74 wt.%) contents. Such an enrichment has not been observed in

¹ Department of Mineralogy, Petrography and Geochemistry, University of Mining and Metallurgy, al. Mickiewicza 30, 30-059 Cracow, Poland; goleb@uci.agh.edu.pl

galena associated with the vanadates and the arsenates from the II exploitation level.

3. Aikinite forms grains finer and more frequently intergrown with galena, bournonite and tetrahedrite than the grains of the Pb–Bi(–Sb) sulphosalts, and concentrates in outer parts of the sulphosalt–galena accumulations. It is creamy with a slight yellowish tint, strongly anisotropic in willow-green, blue and brown colours. This mineral is devoid of significant admixtures, except for moderate contents of Fe, Zn, As and Sb in some grains.

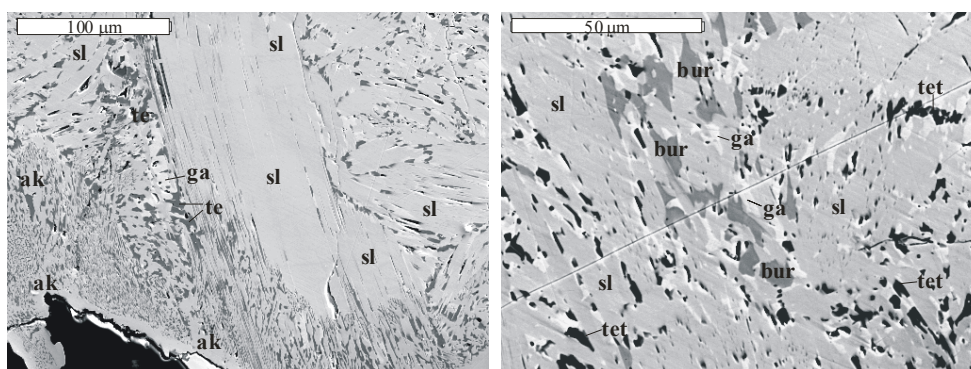


Fig. 1. BSE images of bismuth sulphosalts. Left: mineral association of Pb–Bi(–Sb) sulphosalts (sl), aikinite (ak), Bi-bearing galena (ga) and tetrahedrite (te). Right: fine-grained relicts of tetrahedrite (tet) within Pb–Bi(–Sb) sulphosalts (sl), bournonite (bur) and Bi-bearing galena (ga) intergrowths.

Element	An unidentified Pb–Bi(Sb) Sulphosalt Σ cat. = 52*	Aikinite Σ cat. = 3	Tetrahedrite Σ cat. = 16	Bournonite Σ cat. = 3	Galena Σ cat. = 1	Stannite Σ cat. = 4
Cu	3.093	1.052	8.909	1.009	0.012	1.798
Fe	0.110	0.004	0.702	0.003	0.003	0.848
Te	0.084	0.004	0.000	0.000	0.003	0.000
Ag	2.275	0.000	0.587	0.005	0.025	0.003
Zn	0.108	0.008	0.819	0.017	0.001	0.393
Cd	0.066	0.002	0.299	0.000	0.001	0.009
Sn	0.237	0.000	0.093	0.012	0.002	0.948
Pb	27.436	1.065	0.530	1.008	0.920	0.000
Bi	15.960	0.855	0.089	0.212	0.028	0.000
S	63.671	3.089	13.279	3.070	1.041	3.635
Se	0.000	0.000	0.000	0.000	0.000	0.000
As	0.137	0.006	0.012	0.000	0.002	0.000
Sb	6.329	0.007	3.960	0.734	0.003	0.000

Table 1. Chemical composition (atoms per formula unit) of an unidentified Pb–Bi(–Sb) sulphosalt, aikinite, tetrahedrite, bournonite, galena and stannite.* Σ cat. = (Ag+Pb+Bi+Sb)

The bournonite, grey-green in the reflected light, shows weak anisotropy. It contains significant amounts of Bi (3.26-3.70 wt.%) and traces of Zn, Ag and Fe.

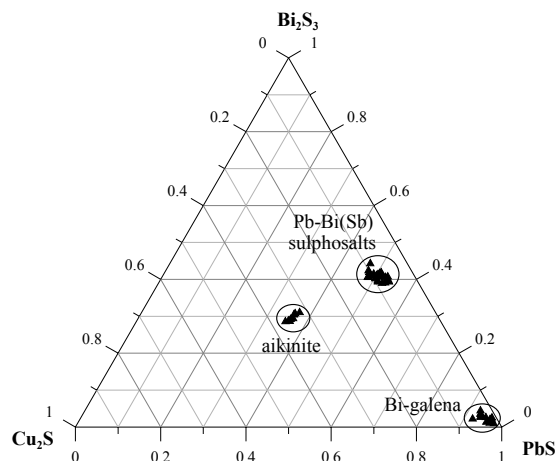


Fig. 2. The compositions of Pb-Bi(Sb) sulphosalts, aikinite and Bi-bearing galena plotted in the ternary PbS–Bi₂S₃–Cu₂S system.

The tetrahedrite is isotropic, grey with a brownish olive tint. Many of the analyses show elevated contents of Ag (4.72 wt.%), Fe (2.36 wt.%), Zn (1.12 wt.%), Sn (0.80 wt.%) and variable amounts of Pb (3.40-15.94 wt.%). In some of them the presence of bismuth has been noted.

The stannite is grey with an olive tint in the reflected light. It shows anisotropy in blue and violet shades. In its composition an admixture of zinc is significant (up to 5 wt.%) as well as a deficit of sulphur in relation to the sum of cations expressed as the ratio $S/(Cu+Fe+Sn+Zn) \approx 0.9$.

The results obtained supplement earlier data on the ore mineralization from Rędziny (Wólkowicz 1984), first of all the on Bi-sulphosalts.

Acknowledgements. This work was supported by the University of Mining and Metallurgy, grant No. 11.11.140.408. *Bożena Gołębiowska is the holder of the domestic grant for young scholars from the Foundation for Polish Sciences.*

REFERENCES:

- GOŁĘBIOWSKA B., PIECZKA A., 1997: Cassiterite from the Rędziny dolostone quarry, Lower Silesia (preliminary report). *Miner. Polon.* 28 (2), 101–105.
- PARAFINIUK J., 2001: Bi-Te mineral assemblage from dolostone quarry Rędziny, Rudawy Janowickie Mts. (SW Poland). *Mineralogical Society of Poland, Special Papers*, vol.18.
- WÓLKOWICZ K., 1984: Mineralizacja kruszcowa w kamieniołomie marmuru dolomitycznego w Rędzinach (Dolny Śląsk). *Kwart. Geol.* 28 (1), 23–38.