Mineralia Slovaca, Web ISSN 1338-3523, ISSN 0369-2086
53, 2 (2021), 91 – 102,

Hydrothermal Bi-Te-(Hg) mineralization with coloradoite (HgTe) in the Kujnišova dolina valley, Mníšek nad Hnilcom, Gemeric Unit, W. Carpathians

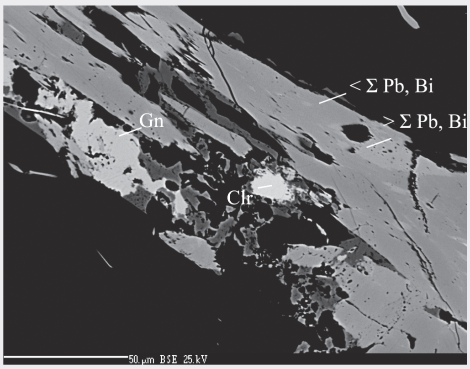
DUŠAN KÚŠIK [1], TOMÁŠ BANCÍK[2], PETER TOTH[3] and JOZEF SAKMÁR[4]

[1] State Geological Institute of Dionýz Štúr, Mlynská dolina 1, SK-817 04 Bratislava, Slovak Republic; dusan.kusik@geology.sk
[2] Slovak Mineralogical Association, Viestova 6623/26, SK-974 01 Banská Bystrica, Slovak Republic
[3] Comenius University, Faculty of Natural Sciences, Department of Mineralogy, Petrology and Mineral Resources, Ilkovičova 6, SK-842 15 Bratislava, Slovak Republic
[4] Slovak Mineralogical Association, Bystrická 36, SK-040 11 Košice, Slovak Republic

Abstract: The occurrence of hydrothermal vein Bi-Te-(Hg) mineralization is located ca 1.9 km north of the village of Mníšek nad Hnilcom (Slovak Ore Mountains, Eastern Slovakia). Mineralization occurs in Paleozoic black pelitic schists of the Betliar Formation of Gemeric Unit. The following ore minerals were identified: coloradoite $(Hg_{0.95}Bi_{0.01})0,96(Te_{1.00}S_{0.01})_{1.01}$, chalcopyrite, galena, giessenite, unidentified sulphosalt, pyrite, sphalerite and ullmanite. The siderite part of mineralization has underwent a prospect mining. Present is also quartz with unspecified carbonate. Coloradoite, unambiguously identified in this locality, represents the first confirmed occurrence of this mineral in Slovakia.

Key words: coloradoite, giessenite, unidentified sulphosalt, Kujnišova dolina valley, Mníšek nad Hnilcom, Gemeric Unit, Western Carpathians, Slovakia

Graphical abstract



Highlights

- Using the quantitative WDS EPMA, the rare mercury telluride – coloradoite (HgTe) – was revealed in locality of Mníšek nad Hnilcom - Kujnišova dolina valley. Until the coloradoite has not yet been detected from any locality in the territory of the Slovak Republic, so this occurrence represents its first confirmed occurrence in this country.
- Coloradoite, besides inclusions in galena, occurs also at the margins of galena grains and aggregates, or forms individual grains and aggregates intergrown with cobellite, galena and products of supergene disintegration (anglesite, cerussite).

Introduction

So far the ore occurrences north of the village of Mníšek nad Hnilcom have attracted less than those located south of this village. Archival data dealing with this northern area have not been preserved, and no significant deposit survey has taken place here recently. After World War II this area was described marginally by several authors (Fusán & Kantor, 1952; Bergfest, 1953; Kubíny & Bergfest, 1957; Lázár, 1962) and more recently by Grecula et al. (1995), eventually these occurrences became a part of exploration and reports of other deposit occurrences, generally present in the ore belt of Švedlár – Mníšek nad Hnilcom – Prakovce, located south of the Hnilec river.

The aim of this work is a detailed characterization of newly discovered Bi-Te-(Hg) hydrothermal mineralization with coloradoite (HgTe), present in the area of Kujnišova dolina valley at the village of Mníšek nad Hnilcom. This mineralization type is rare also within the hydrothermal mineralization types present in the Gemeric Unit, and our results now complete the general information about the metallogenesis within the Western Carpathians.

Location and previous geological investigation

The Gemeric Unit is formed of prevailing Early Paleozoic volcano-sedimentary sequences with various grades Variscan metamorphic overprint, and their Carboniferous (mainly marine) and Permian (lagoon-continental type) cover. Small bodies of specialized S-type granites within Gemeric basement are of Permian age (Broska & Uher, 2001; Radvanec et al., 2009). The geological setting of Early Paleozoic sequences of Gemeric Unit is interpreted by two general concepts, having reflection also in the approved geological maps at a scale of 1 : 50 000 (Bajaník et al., 1983, 1984; Grecula, 1982; Grecula et al., 2009, 2011; Németh et al., 2012). Anticlinal setting of the Spiš-Gemer Ore Mts. is built of Cambrian-Devonian ***Gelnica Group*** of flyschoid character, consisting mainly of metasandstone-phyllitic sequences with interbeds of lydites, metacarbonates and volcanites. Northern part of Gemeric Unit is built of the belt of ***Rakovec Group*** of supposed Devonian age (Bajaník et al., 1981). It is characterized by abundant products of basic volcanism and together with the gneiss-amphibole complex (so-called *Klátov nappe*) they represent the dismembered metaophiolite suite (cf. Hovorka et al., 1984; Radvanec et al., 2017). The North-Gemeric Unit is rimmed by the Lower Carboniferous (volcano)-sedimentary sequence of so-called *magnesite Carboniferous*, codified as *Ochtiná Group and Črmeľ Formation* (Vozárová & Vozár, 1988; Vozárová, 1996) having a special tectonic position in the area between Veporic and Gemeric units (Németh et al., 2004; Radvanec et al. – eds., 2010, and references therein).

The locality of Kujnišova dolina valley (Keilova baňa mine) is located ca 1.9 km north of the village of Mníšek nad Hnilcom in the Spiš-Gemer Ore Mts. It is built of black pelitic phyllites of the Betliar Fm. (Early Paleozoic). Studied mineralization occurs in two adits, mined westward on the right bank of a nameless stream, representing the left tributary of the Hnilec river. They are located 400 m to NE of the altitude point 640 in local part named the “Kujnišova dolka” (eventually the Keilova štôlňa adit). Lázár (1962) describes the 50–80 m long dump of lower adit, consisting of graphite schist with larger pieces of pyrite penetrated with siderite veinlets. In front of upper adit the dump contains app. 25 m^3 of good quality siderite ore (Horal, 1971; Fe 33.35 %, Mn 2.32 %, SiO_2 4.13 %) with sporadic chalcopyrite, tetrahedrite and antimonite, locally with rich content of pyrite. Horal (1971) states that locally in the siderite there was found acicular bismuth ore, similar to Sb ore.

It is not clear whether these are two occurrences or only one. It is possible that the upper adit was established directly at cropping out vein, because there is no tailing rock material in the dump and the lower tunnel intended to undermine the upper adit.

Research methodology

The microscopic study of polished sections in reflected light has applied the JENAPOL microscope with the Olympus CAMEDIA C5060 camera, controlled by the QuickPHOTO MICRO software.

Tab. 1

Electron microprobe analyses of coloradoite (wt. %).

Analysis #	1	2	3	4	5
Mn	0.01	0.00	0.03	0.01	0.07
Fe	0.05	0.07	0.02	0.08	0.04
Cu	0.09	0.04	0.02	0.04	0.03
Zn	0.05	0.02	0.01	0.04	0.03
Ag	0.20	0.09	0.05	0.06	0.04
Cd	0.00	0.02	0.03	0.05	0.08
Sb	0.00	0.00	0.00	0.00	0.00
Hg	58.71	59.38	58.30	57.50	58.20
Pb	0.12	0.08	0.25	0.52	0.16
Bi	1.22	0.69	0.59	0.71	0.51
S	0.13	0.10	0.12	0.20	0.15
Se	0.02	0	0.05	0.00	0.00
Te	39.61	39.87	38.85	38.65	39.13
Total	100.22	100.36	98.30	97.86	98.45

Calculated empirical formula

Analysis #	1	2	3	4	5
Mn	0.001	0.000	0.002	0.001	0.004
Fe	0.003	0.004	0.001	0.005	0.003
Cu	0.005	0.002	0.001	0.002	0.001
Zn	0.003	0.001	0.001	0.002	0.002
Ag	0.006	0.003	0.001	0.002	0.001
Cd	0.000	0.001	0.001	0.001	0.002
Sb	0.000	0.000	0.000	0.000	0.000
Hg	0.946	0.958	0.960	0.945	0.950
Pb	0.002	0.001	0.004	0.008	0.002
Bi	0.019	0.011	0.009	0.011	0.008
Total	0.983	0.979	0.980	0.976	0.974
S	0.013	0.010	0.012	0.020	0.015
Se	0.001	0.000	0.002	0.000	0.000
Te	1.003	1.011	1.006	0.998	1.004
Total	1.017	1.021	1.020	1.018	1.018

For quantitative WDS analyses there was applied the electron microanalyser CAMECA SX 100 at the State Geological Institute of Dionýz Štúr in Bratislava. The measurement conditions and standards used at analyses are as follows: accelerating voltage 25 kV, beam current 10 nA (for carbonates) and 15 nA (tellurides, sulphides and sulphosalts), beam diameter 3–10 μm. Standards and spectral lines used: chalcopyrite (CuKα, FeKα, SKα), Sn (SnLβ), galena (PbMα), Ag (AgLα), sphalerite (ZnKα), Bi (BiLα), GaAs (AsLα), Sb (SbLβ), Bi_2Se_3 (SeLβ), Te (TeLα), Cd (CdLα), Mn (MnKα), HgS (HgLα), Pd (PdLα), Ni (NiKα), Rh (RhLα), Au (AuLα). BSE images were done at accelerating voltage of 25 kV and beam current of 10 nA.

Mineralogical characteristics of the occurrence

Locality consists of two exploration adits and related dumps. The upper adit with its dump is formed of massive, coarse-crystalline siderite with sulphidic minerals mainly in the form of massive, locally also disseminated ores. Because the dump is practically free of tailings, siderite vein formed probable the whole profile of this adit. Vein estimated thickness is therefore up to 1.5 m. Sulphidic minerals occur mainly in upper part of the dump, in lower parts of the dump they are less frequent. This fact corresponds with the opinion by Horal (1971) that in the overlier of siderite the bismuth ore occurs. The dump of lower adit contains only pyrite mineralization, forming disseminations in black pelitic phyllites of the Betliar Formation.

Primary minerals

Coloradoite (HgTe) forms inclusions at the margins of galena grains and aggregates, or it forms individual grains and aggregates intergrowths with cobellite, galena and products of supergene disintegration (anglesite, cerussite) (Fig. 2a, b). Coloradoite is large max. 20 μm, but its smaller dimensions are more common. When studied by electron microanalyser, the measurable aggregates were found in three samples. The chemical composition of the coloradoite from the Mníšek nad Hnilcom locality (Tab. 1) converges to theoretical member with 61.12 wt. % Hg and 38.88 wt. % Te (Anthony et al., 2001–2005). Slightly increased contents of Bi (0.74 wt. %), Pb (0.22 wt. %) and S (0.14 wt. %) were detected. The average crystallochemical formula of coloradoite recalculated to 2 atoms is $(Hg_{0.95}Bi_{0.01})_{0.96}(Te_{1.00}S_{0.01})_{1.01}$.

Unidentified sulphosalt represents the most common sulphosalt in this occurrence. It forms aggregates of fibrous to thin-stemmed, in some places radial crystals, as well as needles up to 1.5 cm long, intergrown in quartz, or overgrown with chalcopyrite. In some places, the cobellite clusters are observable in the cracks and in the intergranular spaces of siderite. It forms needle- and stem-shaped aggregates in the cavities. The BSE images (Fig. 2a, b) show the lighter and darker phases in unidentified sulphosalt acicular aggregates. They represent two phases of unidentified sulphosalt – lighter one has higher sum of Pb and Bi, but the darker one the smaller sum.

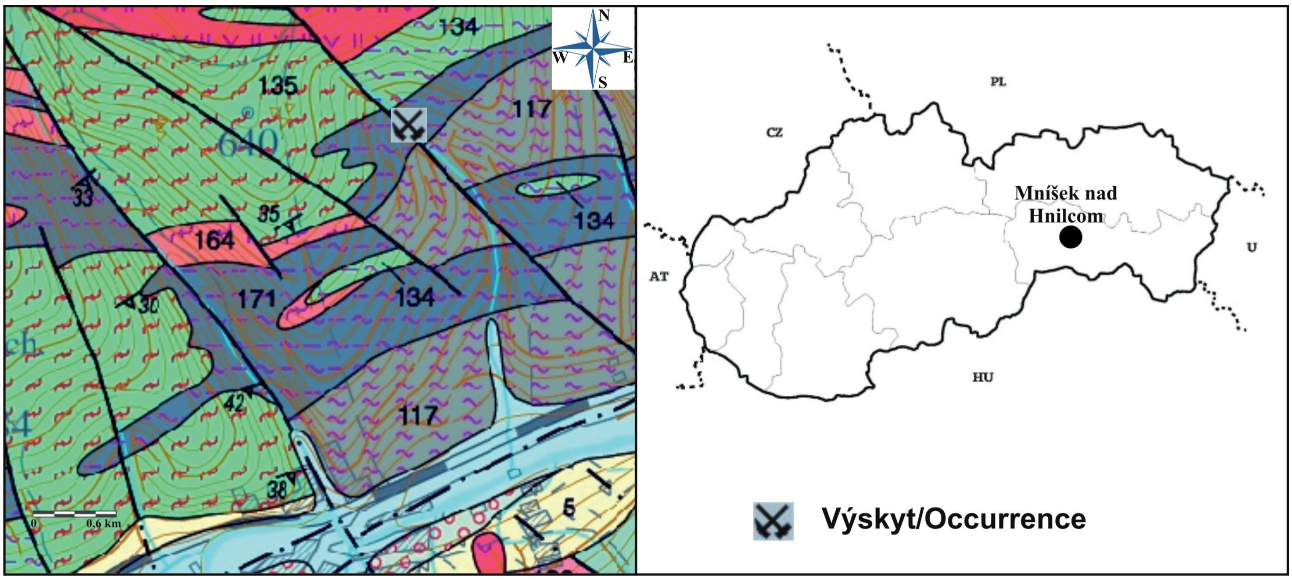


Fig. 1. Map of occurrence and geological map of the Kujnišova dolina valley according Grecula et al. (2011). Explanations: 117 – black metapelites and metapsamites of Betliar Fm., 134 – green phyllites of Smolník Fm., 135 – greenish metapelites of Smolník Fm., 164 – metamorphosed rocks of the variegated volcanic complex of Smolník Fm., 171 – black pelitic phyllites with intercalations of lithic clasts, carbonates and volcanic rocks of Betliar Fm.

Tab. 2

Electron microprobe analyses of giessenite (wt. %).

Analysis #	1	2	3	4	5	6	7
Fe	0.06	0.05	0.14	0.04	0.12	0.02	0.06
Cu	1.18	1.24	1.30	1.25	1.15	1.21	1.21
Zn	0.00	0.00	0.00	0.00	0.01	0.02	0.00
Ag	0.78	0.64	0.88	0.68	0.56	0.68	0.73
Cd	0.00	0.05	0.05	0.01	0.05	0.04	0.05
Sb	4.57	7.76	5.95	8.14	6.71	7.60	6.58
Hg	0.71	0.80	0.57	0.94	0.99	0.97	0.86
Pb	44.93	46.02	45.59	46.22	45.89	46.18	46.12
Bi	31.60	26.57	28.93	25.58	27.30	26.12	27.00
S	16.71	17.18	16.97	16.99	16.87	17.05	16.94
Se	0.02	0.05	0.02	0.00	0.00	0.00	0.02
Te	0.08	0.11	0.08	0.18	0.16	0.15	0.11
Total	100.64	100.48	100.46	100.03	99.81	100.05	99.69

Calculated empirical formula

Analysis #	1	2	3	4	5	6	7
Fe	0.120	0.090	0.270	0.070	0.240	0.040	0.120
Cu	2.020	2.070	2.190	2.110	1.960	2.040	2.050
Zn	0.000	0.000	0.000	0.000	0.020	0.030	0.000
Ag	0.780	0.630	0.870	0.680	0.560	0.680	0.730
Cd	0.000	0.050	0.050	0.010	0.040	0.040	0.040
Sb	4.090	6.760	5.260	7.170	5.960	6.680	5.820
Hg	0.390	0.420	0.300	0.500	0.530	0.520	0.460
Pb	23.670	23.570	23.670	23.930	23.930	23.830	23.960
Bi	16.500	13.490	14.890	13.130	14.120	13.370	13.910
Total	47.570	47.090	47.510	47.600	47.350	47.220	47.100
S	56.900	56.840	56.910	56.850	56.870	56.880	56.880
Se	0.030	0.070	0.020	0.000	0.000	0.000	0.020
Te	0.070	0.090	0.070	0.150	0.130	0.120	0.090
Total	57.000	57.000	57.000	57.000	57.000	57.000	57.000

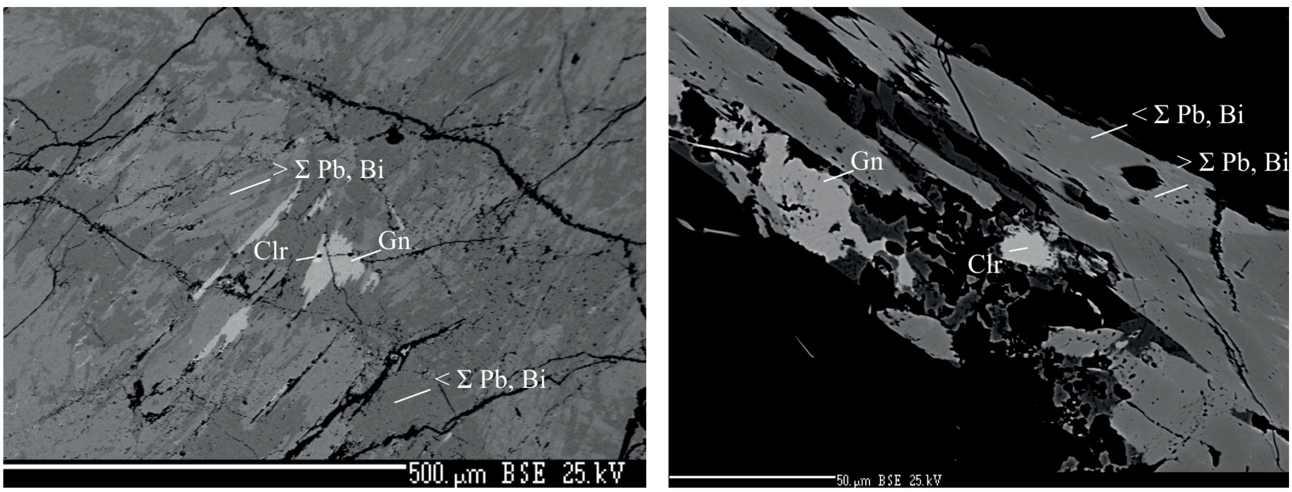


Fig. 2. a – BSE image of a unidentified sulphosalt crystal, with visible substitution in the phases, the lighter one having a higher content of Pb and Bi (>∑ Pb, Bi) and the darker one with a lower content (< ∑ Pb, Bi). In the centre is located a galena (Gn) aggregate that has a grain of coloradoite (Clr) on the rim. **b** – BSE image with a unidentified sulphosalt needle, with visible substitution in individual phases. In the middle is located a grain of coloradoite (Clr) on the left is a galena (Gn) aggregate, being replaced by the decomposition products.

Giessenite $Pb_{28}Cu_2(Bi, Sb)_{19}S_{57}$ is distinctly less common than unidentified sulphosalt. Usually it forms exsolutions in unidentified sulphosalt, exceptionally it forms also separate larger aggregates of acicular crystals up to 0.3 mm in size. Giessenite from this occurrence has a moderately lower proportion of Pb 45.85 wt. %, Bi 27.58 wt. %, the higher share of Sb 6.75 wt. %, substituting members Bi and Sb represent 34.33 wt. % (Tab. 2). From other elements the increased contents have Hg 0.83 wt. %, Ag 0.71 wt. % and Te max. 0.12 %.

Chalcopyrite represents after pyrite the second most common mineral. It forms allotriomorphic aggregates and veinlets not rarely up to cm dimensions. It occurs in assemblage with further sulphides and sulphosalts. Chemical composition of chalcopyritu is presented in the table 3. The average crystallochemical formula of chalcopyrite recalculated to 4 atoms is $Cu_{1.00}Fe_{1.01}S_{1.99.}$

Galena represents a common mineral in described locality, though macroscopically it is not visible. It forms grains and aggregates in association with unidentified sulphosalt, chalcopyrite and coloradoite. There are commonly observable the supergenous products of galena decomposion, mainly anglesite, less cerussite. Studies galena was enriched in structurally bound Bi (max. 5.44 wt. %, in average 2.44 wt. %), partly also Ag (max. 0.31 wt. %, average 0.18 wt. %).

Pyrite is the most abundant ore mineral in the occurrence. It forms allotriomorphic aggregates and grains large several mm, being intergrown in siderite. Very often it is replaced by products of decomposition, Fe oxides and hydroxides (limonite). It is the oldest mineral in this occurrence. The pyrite chemistry has not been studied.

Sphalerite occurs in studied locality in accessoric amount. It forms allotriomorphic aggregates of dimensions up to 50 µm. It is intergrown with chalcopyrite, galena and products of its decomposition (cerussite). Crystallochemical formula of sphalerite from one analysis recalculated to 2 atoms is $(Zn_{0.87}Fe^{2+}_{0.07}Cu_{0.05}Cd_{0.03})_{1.02}S_{0.98}$.

Ullmannite (NiSbS) represents accessoric mineral, found only in one sample. Chemical composition of ullmannite is presented in table 6. Average crystallochemical formula of ullmannite recalculated to 3 atoms is $(Ni_{0.93}\ Fe_{0.08}Co_{0.04})_{1.05}(Sb_{0.97}\ Bi_{0.01})_{0.98}S_{0.96}$.

Siderite represents prevailing vein mineral in studied occurrence, being in the past the subject of prospect mining. It occurs in light yellow-brown, light brown, dark brown to brown-grey, coarse-grained and more massive, sometimes also fine-grained aggregates. Younger sulphidic as well as Bi-Te-(Hg) mineralization is present in druse cavities, resp. cataclases (veins) of siderite.

Tab. 3
Electron microprobe analyses of chalcopyrite (wt. %).

Analysis #	1	2	3
Fe	30.44	30.66	31.32
Cu	34.59	34.69	34.61
Zn	0.03	0.06	0.07
As	0.06	0.05	0.01
Ag	0.01	0.02	0.02
Cd	0.05	0.02	0.00
In	0.00	0.00	0.03
Sn	0.00	0.06	0.02
Sb	0.00	0.02	0.00
Hg	0.04	0.00	0.00
Pb	0.22	0.20	0.00
Bi	0.03	0.01	0.00
S	35.14	34.98	34.71
Te	0.01	0.01	0.00
Total	100.63	100.80	100.79

Calculated empirical formula

Analysis #	1	2	3
Fe	0.996	1.003	1.024
Cu	0.995	0.997	0.995
Zn	0.001	0.002	0.002
As	0.001	0.001	0.000
Ag	0.000	0.000	0.000
Cd	0.001	0.000	0.000
In	0.000	0.000	0.000
Sn	0.000	0.001	0.000
Sb	0.000	0.000	0.000
Hg	0.000	0.000	0.000
Pb	0.002	0.002	0.000
Bi	0.000	0.000	0.000
Total	1.997	2.007	2.023
S	2.00	1.99	1.98
Te	0.00	0.00	0.00
Total	2.00	1.99	1.98

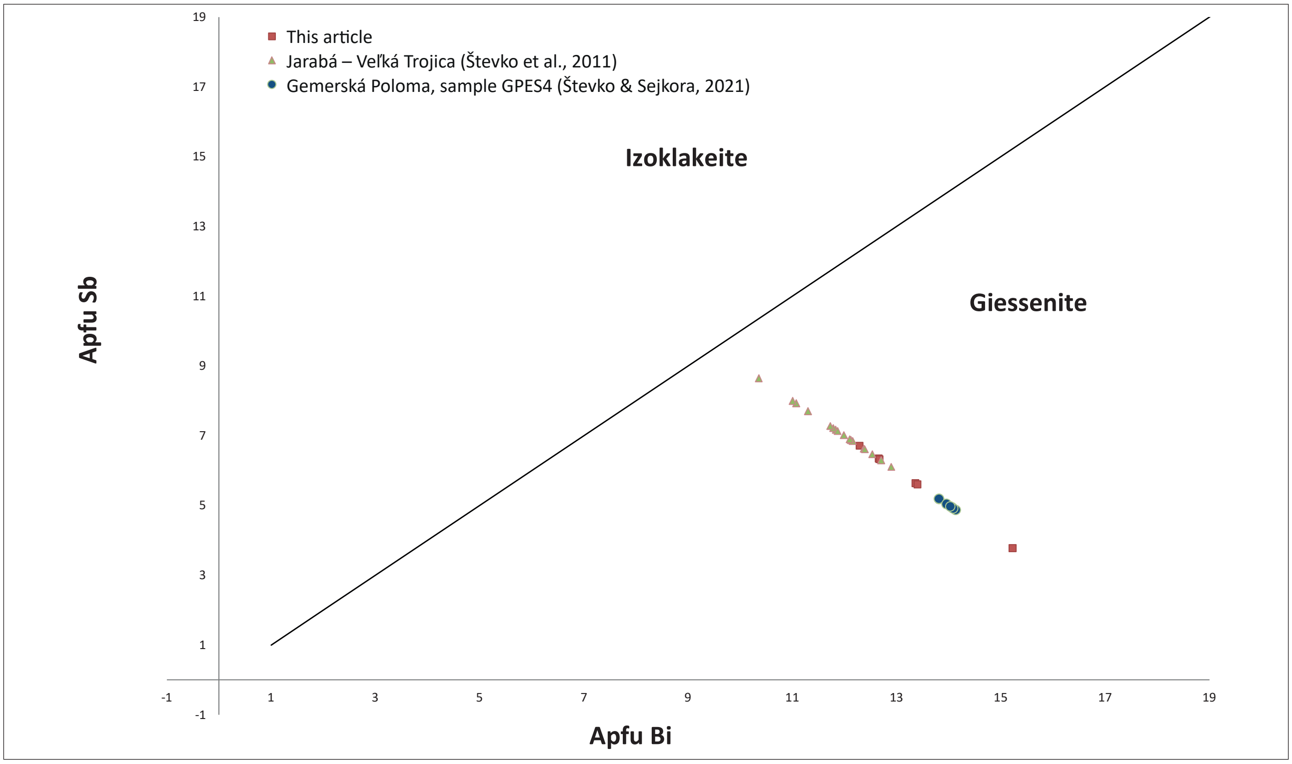


Fig. 3. Comparison of the dependence of Bi and Sb (apfu) in giessenite from the Kujnišova dolina valley occurrence and other occurrences.

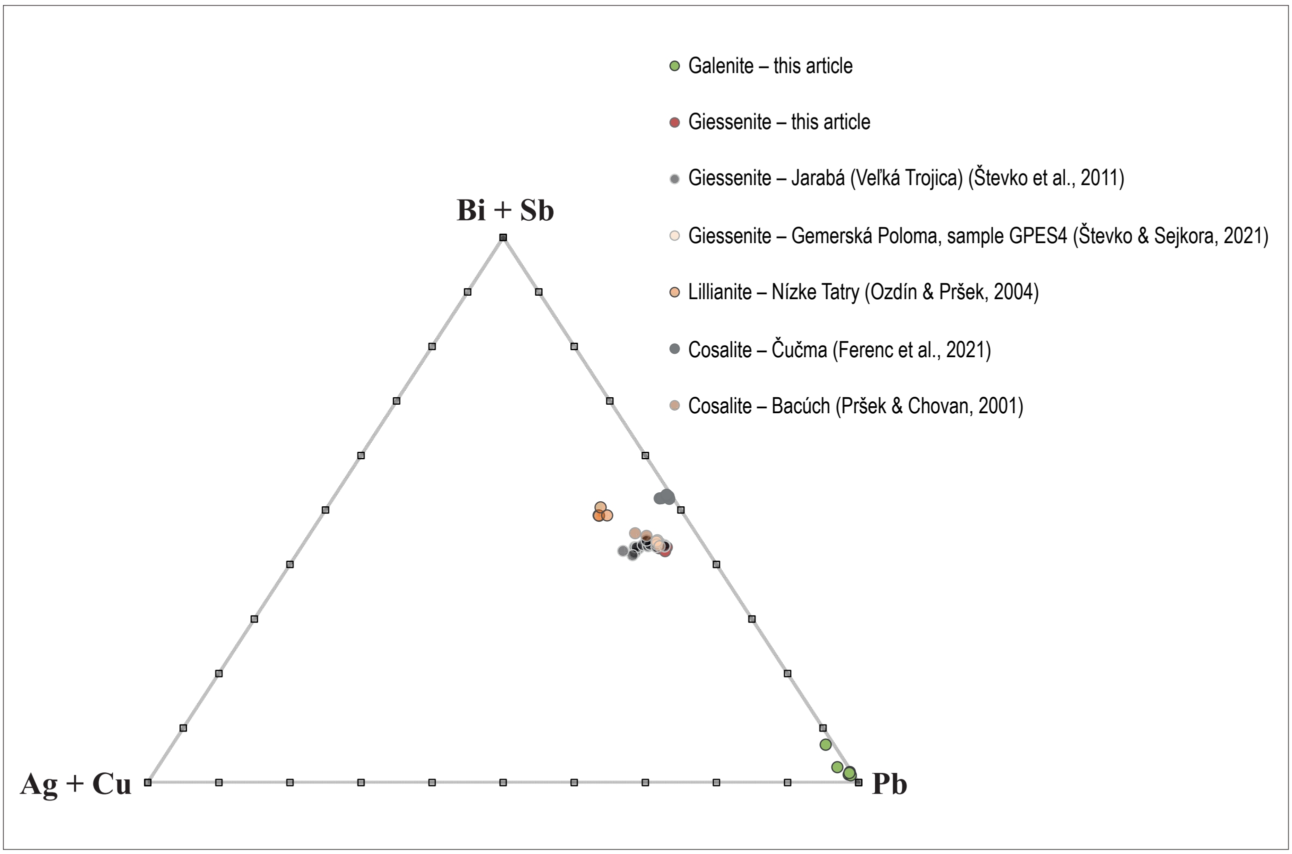


Fig. 4. Comparison of the chemical composition of giessenite, in the ternary plot (Ag + Cu) – Pb + (Bi + Sb).

Tab. 4

Electron microprobe analyses of galena (wt. %).

Analysis #	1	2	3	4	5	6
Fe	0.15	0.14	0.05	0.13	0.09	0.10
Cu	0.31	0.00	0.02	0.20	0.02	0.02
Zn	0.01	0.00	0.01	0.00	0.00	0.00
Ag	0.19	0.31	0.17	0.20	0.10	0.17
Cd	0.02	0.01	0.00	0.01	0.01	0.00
Sb	0.05	0.03	0.04	0.41	0.01	0.00
Hg	0.04	0.00	0.00	0.14	0.04	0.00
Pb	83.99	85.77	86.16	80.72	86.27	85.92
Bi	2.42	1.24	1.10	5.44	1.69	1.55
S	13.58	13.78	13.63	14.07	13.66	13.79
Se	0.00	0.05	0.08	0.03	0.00	0.04
Te	0.05	0.04	0.03	0.04	0.04	0.03
Total	100.81	101.36	101.29	101.36	101.93	101.62

Calculated empirical formula

Analysis #	1	2	3	4	5	6
Fe	0.006	0.006	0.002	0.005	0.004	0.004
Cu	0.012	0.000	0.001	0.007	0.001	0.001
Zn	0.000	0.000	0.000	0.000	0.000	0.000
Ag	0.004	0.007	0.004	0.004	0.002	0.004
Cd	0.000	0.000	0.000	0.000	0.000	0.000
Sb	0.001	0.001	0.001	0.008	0.000	0.000
Hg	0.000	0.000	0.000	0.002	0.000	0.000
Pb	0.952	0.967	0.978	0.899	0.975	0.968
Bi	0.027	0.014	0.012	0.060	0.019	0.017
Total	1.004	0.994	0.997	0.986	1.002	0.994
S	0.995	1.004	1.000	1.013	0.998	1.004
Se	0.000	0.002	0.002	0.001	0.000	0.001
Te	0.001	0.001	0.001	0.001	0.001	0.001
Total	0.996	1.006	1.003	1.014	0.998	1.006

Tab. 5

Electron microprobe analysis of sphalerite (wt. %).

Analysis #	1
Fe	4.10
Cu	2.91
Zn	56.57
Ag	0.13
Cd	2.97
Sn	0.05
Sb	0.35
S	31.36
Total	98.44

Calculated empirical formula

Analysis #	1
Fe	0.074
Cu	0.046
Zn	0.868
Ag	0.001
Cd	0.027
Sn	0.000
Sb	0.003
Total	1.019
S	0.981
Total	0.981

Carbonates of probable ankerite-dolomite raw form also smaller part of veinstone. They have not yet been the subject of more detail research.

Quartz represents significant non-ore mineral in studied locality. The ingress of quartz to older siderite was tied with sulphide and Bi-Te-(Hg) mineralization, of which quartz is the bearer. The quartz is milky white, translucent, brownish and sometimes greyish.

Supergene minerals

Cerussite ($PbCO_3$) and **anglesite ($PbSO_4$)**, replacing galena, as well as other secondary minerals (**Pb, Bi, Sb oxides**), replacing the unidentified sulphosalt – were identified in studied occurrence. These minerals will be the subject of further research.

Discussion and conclusion

Using the EPMA, the rare mercury telluride – **coloradoite (HgTe)** – was identified in locality of Mníšek nad Hnilcom-Kujnišova dolina valley. Coloradoite has not yet been detected from any locality in the territory of

Tab. 6

Electron microprobe analyses of ullmanite (wt. %).

Anal. #	1	2	3
Fe	2.67	1.71	2.04
Co	1.61	1.91	0.15
Ni	24.99	25.17	27.10
Cu	0.07	0.04	0.03
Zn	0.00	0.03	0.02
Ag	0.00	0.00	0.03
Cd	0.01	0.02	0.08
Sb	55.42	55.29	55.77
Hg	0.00	0.00	0.01
Pb	0.08	0.08	0.17
Bi	0.42	1.24	0.21
S	14.42	14.59	14.63
Total	99.68	100.07	100.24

Calculated empirical formula

Anal. #	1	2	3
Fe	0.102	0.065	0.077
Co	0.058	0.069	0.005
Ni	0.906	0.913	0.976
Cu	0.002	0.001	0.001
Zn	0.000	0.001	0.001
Ag	0.000	0.000	0.001
Cd	0.000	0.000	0.001
Sb	0.969	0.967	0.969
Hg	0.000	0.000	0.000
Pb	0.001	0.001	0.002
Bi	0.004	0.013	0.002
Total	2.042	2.031	2.035
S	0.958	0.969	0.965
Total	0.958	0.969	0.965

the Slovak Republic, so this occurrence represents its first confirmed occurrence in this country.

Coloradoite is relatively rare mineral, occurring in several hydrothermal occurrences, mainly in quartz veins enriched by Au and Ag, together with further tellurides, in the type locality Keystone Mine in Colorado (USA; Genth, 1878), Western Australia and other places (Bernard & Hyršl, 2015). Within the Carpathian range, the coloradoite was described in ore deposits present in Neogene volcanites, specifically in enargite and luzonite within the copper deposit Recsk in the Mátra Mts., Hungary (Szakáll et al., 2002), as well as in association with Au-Ag tellurides in localities of Săcărâmb, Stănija and Musariu in Romania (Popescu & Şimon, 1995; Szakáll et al., 2002, Săbău et al., 2013). Its genesis is tied with hydrothermal Te-enriched precious metal veins (Anthony et al., 2001–2005), with Cu-Au skarn deposits (Guiqing et al., 2019), highly sulphidation epithermal Au-Ag-Te-Se deposits (Voudouris et al., 2011a; Repstock et al., 2015; Yakich et al., 2021), as well as Au-enriched deposits in metamorphosed rocks related to intrusions in the depth (Voudouris et al., 2011b).

Coloradoites in other known occurrences have similar composition as studied samples from Mníšek nad Hnilcom--Kujnišova dolina valley, e.g. in locality Musariu (Săbău et al., 2013) the described contensts are Bi 0.14 wt. % and Pb 0.12 wt. %. In deposit Sentyabrsky, located in western part of Chukchi peninsula (Nikolaev et al., 2013), the contents of Bi 0.05 wt. % and Pb 0.12 wt. % are stated, too. The results from Musariu and Sentyabrsky localities show that the coloradoite studied by us is more significantly enriched by Bi. The coloradoite described from the Daté deposit (Yuningsih et al., 2018) has not specified the Bi and Pb content, but S content 0.42 wt. % is higher than in our samples of coloradoite.

So far, the coloradoite in locality Mníšek nad Hnilcom--Kujnišova dolina represents the only representant of Bi-Te-(Hg) mineralization. Besides this mineral, the sources of Bi, Te, Hg and partially also Se are also the unidentified sulphosalt, giessenite and galena. All these minerals are associated with coloradoite. Mineralogical study has revealed that all sulphidic minerals have originated during the single sulphidic mineralization period. In its frame we distinguish mineral associations – groups of minerals, crystallizing in individual mineralization stages. There were differentiated the association of Ni and Fe minerals (ullmannite and pyrite), association of Zn, Cu and Pb minerals (sphalerite, chalcopyrite and galena), association of Pb, Bi, Sb minerals (unidentified sulphosalt and giessenite) and finally coloradoite. We consider the association of Ni, Fe minerals to be the oldest. The youngest association is that of Pb, Bi, Sb minerals together with HgTe phase coloradoite. Occurrences of Te minerals in comparison with other sulphidic minerals are relatively rare in Slovakia. Except for relatively frequent occurrences in Neogene volcanics (Župkov, Banská Štiavnica, Hodruša, Kremnica, Zlatá Baňa, Poruba pod Vihorlatom), Te minerals were identified only in several other localities. Detailed processing of occurrences of Te mineralizations from the whole territory of Slovakia was a part of several works (E.g. Ferenc, 2004; Pršek & Peterec, 2008).

In the area of Slovak (Spiš-Gemer) Ore Mts., where is situated our investigated occurrence, only two localities with Te-Se mineralization were desribed. The first one is represented by Úhorná locality at the Smolník town, with identified minerals Te and Se tetradymite, laitakarite, ikunolite and hedleyite, together with association of sulphosalts (bournonite, jamesonite and tintinaite), containing the increased contents of structurally bounded Se: 0.9–2.6 wt. % (Pršek & Peterec, 2008). Similarly Se occurs also in studied locality, but in low concentrations (coloradoite average Se is 0.01 wt. %, giessenite 0.02 wt. %, unidentified sulphosalt 0.01 wt. %). Tellurium enters to structure of giessenite and unidentified sulphosalt also in lower concentrations: In unidentified sulphosalt it is from 0.01–0.11 wt. %, average 0.04 wt. %, in giessenite 0.08–0.18 wt. %, in average 0.12 wt. %.

Second locality of the mineralization with Te and Se is Čučma-Majerská dolina valley. An interesting U-Mo-(Pb, Bi, Te) mineralization was described here, encompassing galena, native bismuth, tetradymite, joséite A and B, ikunolite, members of the kobellite, cosalite series, as well as unspecified minerals having composition $Bi_3(TeS)_2$ and (BiPb)(TeS). The principal Te carriers are here tetradymite, joséite A and B, as well as $Bi_3(TeS)_2$ and (BiPb)(TeS) (Ferenc et al., 2021).

Another interesting locality near to investigated occurrence, where the mercury enters in more distinct portion to sulphosalts structure is the Gelnica-Zenderling deposit. An unnamed Hg sulphosalt from this occurrence was firstly described by Háber and Babčan (1971) and later it was termed as "gelnicite" or "gelnicaite" (Háber, 1980; Háber et al., 2004). Later Laufek et al. (2007) and Sejkora et al. (2011), applying a detailed mineralogical study, have identified this mineral as marrucciite $Hg_3Pb_{16}Sb_{18}S_{46}$, being already described in Italy from the type locality of Buca della Vena (Orlandi et al., 2007). Marrucciite from the Gelnica locality is interesting by high content of mercury 7.3–8.4 wt. %. Sulphosalts studied by us contain mercury by significantly smaller amount (unidentified sulphosalt 0.6–1.0 wt. %, and giessenite 0.57–0.99 wt. %). Despite, in marrucciite there were not revealed Te and Se contents, but in sulphosalts from our studied case they were positively revealed, though not high (Tab. 2).

In the Veporic part of the Slovak Ore Mts. the tetradymite was described from Kokava nad Rimavicou--Bohaté (Zepharovich, 1873), Katarínska Huta, together with tellurobismutite (Ferenc, 2004; Ferenc & Bakos, 2006). In locality of Chyžné-Herichová the association of Bi tellurides and sulphosalts was described, consisting of joséite-A, joséite-B and baksanite (Bálintová & Ozdín, 2006).

Despite, in any of above stated localities both Te as well as Hg do not enter simultaneously to structures of minerals. First such occurrence in Slovakia is represented by coloradoite from the Mníšek nad Hnilcom-Kujnišova dolina occurrence. The origin of mercury in the studied occurrence is not yet clear, but an increased concentration of cinnabarite has been recorded in the surrounding watercourses (Bačo et al., 2004). Some authors link the source of ore-bearing fluids to the surrounding sediments, especially black schists, which can represent a significant source of metals (Rojkovič & Novotný, 1993). Other authors link the source of ore elements to hidden magmatic intrusions (Hurai et al., 2008).

Acknowledgement

Authors express their thanks to P. Konečný and V. Kollárová for their assistance during analysing minerals by an electron microanalyser, as well as R. Demko (all from the State Geological Institute of Dionýz Štúr Bratislava) for assistance in evaluating the results. Many thanks are devoted to reviewers P. Uher and Š. Ferenc for their valuable advice and comments, which significantly increased its scientific level. Authors are thankful to research possibilities within the project of the Operational Program of Environmental Quality *Ensuring the monitoring of environmental burdens in Slovakia – Part 2*, being co-financed by the European Union/Cohesion Fund (application code: NFP310010AXF2).

References

Anthony, J. W, Richard, A., Bideaux, K., Bladh, W. & Monte C. N. (eds.), 2003: Handbook of Mineralogy. *Mineral. Soc. Amer., Chantilly, VA 20151-1110, USA.* http://www.handbookofmineralogy.org/.

Bačo, P., Augustiňáková, B., Bačová, N., Bakoš, F., Bóna, J., Fodorová, V., Dzurenda, Š., Holický, I., Hvožďara, P., Karabínová, V., Knésl, J., Kovanicová, Ľ., Križáni, I., Kyseľová, M., Miháľ, L., Polubňáková, E., Repková, E., Repčiak, M., Smolka, J., Šofranec, M. & Stercz, M., 2004: Atlas ťažkých minerálov. Záverečná správa z úlohy Reinterpretácia šlichového prieskumu na území Slovenska. *Manuscript. Bratislava, archive St. Geol Inst. D. Štúr, 1–62.*

Bakos, F., Ferenc, Š. & Hraško, Ľ., 2006: Nový výskyt hydrotermálnej Au-Bi-Te mineralizácie v oblasti Krokavy (Slovenské rudohorie, veporikum). *Miner. Slov., 38, 241–252.*

Bajaník. Š., Vozárová, A. & Reichwalder, P., 1981: Litostratigrafická klasifikácia rakoveckej skupiny a mladšieho paleozoika v Spišsko-gemerskom rudohorí. *Geol. Práce, Spr., 75, 27–56.*

Bajaník, Š., Vozárová, A. (ed.), Hanzel, V., Ivanička, J., Mello, J., Pristaš, J., Reichwalder, P., Snopko, L. & Vozár, J., 1983:

Vysvetlivky ku geologickej mape Slovenského rudohoria, východná časť 1 : 50 000. *Bratislava, Geol. Úst. D. Štúra, 1–223.*

Bajaník, Š, Ivanička, J., Mello, J., Pristaš, J., Reichwalder, P., Snopko, L., Vozár, J. & Vozárová, A., 1984: Geologická mapa Slovenského rudohoria – východná časť, 1 : 50 000. *Bratislava, Geol. Úst. D. Štúra.*

Bálintová, T. & Ozdín, D., 2006: Sulphosalts from Chyžné - Herichová in the Western Carpathians (Slovakia). *Acta mineral. petrogr., Abstract Ser., 5, 8.*

Bergfest, A., 1953: Mníšek n/Hnilcom. Final Report. *Manuscript. Bratislava, archive St. Geol. Inst. D. Štúr, 1–15.*

Bernard, J. H. & Hyršl, J., 2015: Minerals and their localities. *Prague, Granit, 1–912.*

Broska, I. & Uher, P., 2001: Whole-rock chemistry and genetic typology of the West-Carpathian, Variscan Granites. *Geol. Carpath., 52, 2, 79–90.*

Ferenc, Š., 2004: Nové výskyty minerálov telúru v západnej časti Slovenského rudohoria. *Miner. Slov., 36, 3–4, 317–322.*

Ferenc, Š. & Bakos, F., 2006: Au-Bi-Te mineralizácia v sineckej strižnej zóne (Kokava nad Rimavicou) – nový typ mineralizácie v Západných Karpatoch. *Miner. Slov., 38, 223–240.*

Ferenc, Š., Števko, M., Mikuš, T., Milovská, S., Kopáčik, R. & Hoppanová, E., 2021: Primary minerals and age of the hydrothermal quartz veins containing U-Mo-(Pb, Bi, Te) mineralization in the Majerská valley near Čučma (Gemeric Unit, Spišsko-gemerské rudohorie Mts., Slovak Republic). *Minerals, 11, 629, 1–32.*

Fusán, O. & Kantor, J., 1952: Zpráva o geologickom mapovaní na liste Švedlár. *Manuscript. Bratislava, archive St. Geol. Inst. D. Štúr, 39 p.*

Genth, F. A., 1878: On some tellurium and vanadium minerals. *Proc. Amer. Philosoph. Soc., 17, 113–123.*

Grecula, P., 1982: Gemerikum – segment riftogénneho bazénu Paleotetýdy. *Miner. Slov. – Monogr. Bratislava, Alfa, 1–263.*

Grecula, P. (ed.), Gazdačko, Ľ., Kobulský, J., Kováčik, M., Miháľ, F. & Németh, Z., 2009: Geologická mapa Spišsko--gemerského rudohoria 1 : 50 000. *Bratislava, Št. Geol. Úst. D. Štúra.*

Grecula, P. a Kobulský, J. (ed.), Gazdačko, Ľ., Németh, Z., Hraško, Ľ., Novotný, L., Maglay, J., Pramuka, S., Radvanec, M., Kucharič, Ľ., Bajtoš, P. & Záhorová, Ľ., 2011: Vysvetlivky ku geologickej mape Spišsko-gemerského rudohoria 1 : 50 000. *Bratislava, Št. Geol. Úst. D. Štúra.*

Grecula, P., Abonyi, A., Abonyiová, M., Antaš, J., Bartalský, B., Bartalský, J., Dianiška, I., Drnzík, E., Ďuďa, R., Gargulák, M., Gazdačko, Ľ., Hudáček, J., Kobulský, J., Lörincz, L., Macko, J., Návesňák, D., Németh, Z., Novotný, L., Radvanec, M., Rojkovič, I., Rozložník, L., Rozložník, O., Varček, C. & Zlocha, J., 1995: Ložiská nerastných surovín Slovenského rudohoria., zv. 1. *Bratislava, Geocomplex,1–829.*

Grecula, P., Kobulský, J., Gazdačko, Ľ., Németh, Z., Hraško, Ľ., Novotný L. & Maglay, J., 2011: Geologická mapa Spišsko-gemerského rudohoria M 1 : 50 000 [online]. *Bratislava, Št. Geol. Úst. D. Štúra.* Available on web: http://apl.geology.sk/spisgemer.

Guiqing, X., Jingwen, M., Jeremy, P. R., Yingxiao, H. & Bin, F., 2019: *Econ. Geol., 114, 1, 127–142.*

Háber, M., 1980: Mineralogisch-geochemische und paragenetische Erforschung hydrothermaler Gänge im Gebiet zwischen Prakovce und Kojšov (Spišsko-gemerské rudohorie). *Západ. Karpaty, Sér. Mineral. Petrogr. Geochém. Metalogen., 7, 7 – 131*

Háber, M., Babčan, J., Burke, E. A. J., Simonov, M. A. & Ozdín, D., 2004: Gelnicait – nová sulfosoľ(?) z lokality Zenderling pri Gelnici. *Natura Carpat., 45, 229–230.*

Horal, A. K., 1971: Moje funkcie a prevedené práce u Geologického prieskumu. *Manuscript. Bratislava, archive St. Geol. Inst. D. Štúr, 164 p.*

Hovorka, D., Ivan, P. & Spišiak, J., 1984: Nappe with the amphibolite facies metamorphites in the Inner Western Carpathians – its position, origin and interpretation. *Miner. Slov., 16, 1, 73–86.*

Hurai, V., Lexa, O., Schulmann, K., Montigny, R., Prochaska, W., Frank, W., Konečný, P., Kráľ, J., Thomas, R. & Chovan, M., 2008: Mobilization of ore fluids during Alpine metamorphism: evidence from hydrothermal veins in the Variscan basement of Western Carpathians, Slovakia. *Geofluids, 8, 181–207.*

Kubíny, J. & Bergfest, A., 1957: Mníšek – Štirkenberg – Prakovce. *Manuscript. Bratislava, archive St. Geol. Inst. D. Štúr, 3 p.*

Laufek, F., Sejkora, J., Fejfarová, K., Dušek, M. & Ozdín, D., 2007: The mineral marrucciite: monoclinic $Hg_3Pb_{16}Sb_{18}S_{46}$. *Acta Cryst., E63, i190.*

Lázár, V., 1962: Archívno-výskumná zpráva Mníšek nad Hnilcom, Švedlár – Stará Voda, Tichá Voda. *Manuscript. Bratislava, archive St. Geol. Inst. D. Štúr, 86 p.*

Moëlo, Y., Makovicky, E., Mozgova, N. N., Jambor, J. L., Cook, N., Pring, A., Paar, W., Nickel, E. H., Graeser, S., Karup-Møller, S., Balic-Zunic, T., Mumme, W., Vurro, F., Topa, D., Bindi, L., Bente, K. & Shimizu, M., 2008: Sulfosalt Systematics: A Review Report of the Sulfosalt Sub-Committee of the IMA Commission on Ore Mineralogy. *Eur. J. Mineral., 20, 7–46.*

Németh, Z., Prochaska, W., Radvanec, M., Kováčik, M., Madarás, J., Koděra, P. & Hraško, Ľ., 2004: Magnesite and talc origin in the sequence of geodynamic events in Veporicum, Inner Western Carpathians, Slovakia. *Acta Petrol. Sinica, 20, 4, 837–854.*

Németh, Z., Radvanec, M., Gazdačko, Ľ. & Kobulský, J., 2012: Variscan tectonic setting vs. Alpine overprint in Gemericum (Inner Western Carpathians): Their role in recent distribution of tectonic units in the eastern part of the territory as expressed in significant localities. *Miner. Slov., 44, 1, Geovestník, 8–15.*

Nikolaev, Y., Prokofev, V., Apletalin, A., Vlasov, E., Baksheev, I., Kalko, I. & Komarova, Y., 2013. Gold-telluride mineralization of the Western Chukchi Peninsula, Russia: Mineralogy, geochemistry, and formation conditions. *Geol. Ore Depos., 55, 2, 96–124.*

Orlandi, P., Moëlo, Y., Campostrini, I. & Meerschaut, A., 2007: Lead–antimony sulfosalts from Tuscany (Italy). IX. Marrucciite, $Hg_3Pb_{16}Sb_{18}S_{46}$, a new sulfosalt from Buca della Vena mine, Apuan Alps: definition and crystal structure. *Eur. J. Mineral., 19, 267–279.*

Ozdín, D. & Pršek, J., 2004: Sulfosoli homologického radu lillianitu z hydrotermálnych mineralizácií Nízkych Tatier. *Miner. Slov., 36, 3–4, 279–285.*

Popescu, G. C. & Şimon, G., 1995: Contributon to the study of tellurides from Săcărâmb (Nagyág), Romania. *Rom. J. Mineral., 76, 2, 37–42.*

Pršek, J. & Chovan, M., 2001: Hydrothermal Carbonate and Sulphide Mineralization in the Late Paleozoic Phyllites (Bacúch, Nízke Tatry Mts.). *Geolines, 13, 27–34.*

Pršek, J. & Peterec, D., 2008: Bi-Se-Te mineralization from Úhorná (Spišsko-Gemerské Rudohorie Mts., Slovakia): A preliminary report. *Mineralogia, 39, 3–4, 87–103.*

Radvanec, M., Konečný, P., Ondrejka, M., Putiš, M., Uher, P. & Németh, Z., 2009: Granity gemerika ako indikátor extenzie kôry nad neskorovariskou subdukčnou zónou a pri ranoalpínskej riftogenéze (Západné Karpaty): Interpretácia podľa veku monazitu a zirkónu datovaného metódou CHIME a SHRIMP. *Miner. Slov., 41, 381–394.*

Radvanec, M., Németh, Z. & Bajtoš, P. (eds.), 2010: Magnesite and talc in Slovakia – Genetic and geoenvironmental models. *Bratislava, Št. Geol. Úst. D. Štúra, 1–189.*

Radvanec, M., Németh, Z., Kráľ, J. & Pramuka, S., 2017: Variscan dismembered metaophiolite suite fragments of Paleo-Tethys in Gemeric unit, Western Carpathans. *Miner. Slov., 49, 1, 1–48.*

Repstock, A., Voudouris, P. & Kolitsch, U., 2015: New occurrences of watanabeite, colusite, “arsenosulvanite” and Cu-excess tetrahedrite-tennantite at the Pefka high-sulfidation epithermal deposit, northeastern Greece. *Neu. Jb. Mineral. Abh., 192, 2, 135–149.*

Rojkovič, I. & Novotný, L., 1993: Uránové zrudnenie v gemeriku. *Miner. Slov., 25, 368–370.*

Săbău, G., Berbeleac, I. & Negulescu, E., 2013: The coloradoite occurrence of the Musariu (Metaliferi Mountains) tellurium and telluride vein mineralization and its position in the depositional sequence. *Rev. roum. Géol., 57, 57–65.*

Sejkora, J., Ozdín, D., Laufek, F., Plášil, J. & Litochleb, J., 2011: Marrucciite, a rare Hg-sulfosalt from the Gelnica ore deposit (Slovak Republic), and its comparison with the type occurrence at Buca della Vena mine (Italy). *J. Geosci., 56, 399–408.*

Szakáll, S., Udubaşa, G., Ďuďa, R., Kvasnytsya, V., Koszowska, E. & Novák, M., 2002: Minerals of the Carpathians. *Prague, Granit, 480 p.*

Števko, M., Ozdín, D. & Pršek, J., 2011: Hydrotermálna karbonátovo-kremeňovo-sulfidická mineralizácia v lokalite Jarabá-Veľká Trojica (Nízke Tatry), Slovenská republika. *Miner. Slov., 43, 3, 285–304.*

Voudouris, P., Melfos, V., Spry, P. G., Moritz, R., Papavassiliou, C. & Falalakis, G., 2011a: Mineralogy and geochemical environment of formation of the Perama Hill high-sulfidation epithermal Au-Ag-Te-Se deposit, Petrota Graben, NE Greec. *Mineral. Petrol., 103, 79–100.*

Voudouris, P., Spry, P. G., Sakellaris, G. A. & Mavrogonatos, C., 2011b: A cervelleite-like mineral and other Ag-Cu-Te-S minerals [Ag_2CuTeS and $(Ag,Cu)_2TeS$] in gold-bearing veins in metamorphic rocks of the Cycladic Blueschist Unit, Kallianou, Evia Island, Greece. *Mineral. Petrol., 101, 169–183.*

Vozárová, A., 1996: Tectono-sedimentary evolution of Late Paleozoic basins based on interpretation of lithostratigraphic data (Western Carpathians; Slovakia). *Slovak Geol. Mag., 3–4/96, 251–271.*

Vozárová, A. & Vozár, J., 1988: Late Paleozoic in West Carpathians. *Bratislava, Geol. Úst. D. Štúra, 1–314.*

Yuningsih, E. T, Matsueda, H. & Syafrie, I., 2018: Ore-microscopy and Geochemistry of Gold-Silver Telluride Mineralization in Southwestern Hokkaido, Japan. *J. Mineral. Petrol. Sci., 113, 293–309.*

Zepharovich, V., 1873: Mineralogisches Lexicon für das Kaiserthum Österreich. II. *Wien, Wilhem Braumüller, 436 p.*

Hydrotermálna Bi-Te-(Hg) mineralizácia s coloradoitom HgTe (Mníšek nad Hnilcom-Kujnišova dolina, gemerikum)

Rudným výskytom severne od obce Mníšek nad Hnilcom sa venovala menšia pozornosť ako rudným ložiskovým výskytom situovaným južne od obce. Z minulosti sa nezachovali archívne údaje o tejto oblasti a ani neskôr tu neprebiehal žiadny významnejší ložiskový prieskum. Po 2. svetovej vojne opísali toto územie viacerí autori (Fusán a Kantor, 1952; Bergfest, 1953; Kubíny a Bergfest, 1957; Lázár, 1962; Grecula et al., 1995), ale iba okrajovo. V niektorých prípadoch boli tieto výskyty súčasťou opisu v prácach z iných významnejších ložiskových výskytov nachádzajúcich sa v rudnom páse Švedlár – Mníšek nad Hnilcom – Prakovce, ktoré ležia na juh od rieky Hnilec. Cieľom tejto práce je detailná charakteristika novozistenej Bi-Te-(Hg) hydrotermálnej mineralizácie s prítomnosťou coloradoitu (HgTe) v oblasti Kujnišovej doliny pri Mníšku nad Hnilcom. Tento typ mineralizácie je ojedinelý aj v rámci hydrotermálnych mineralizácií v gemeriku a dopĺňa celkový obraz metalogenézy v rámci Západných Karpát.

Lokalita Kujnišova dolina (Keilova baňa) sa nachádza asi 1,9 km severne od obce Mníšek nad Hnilcom v Slovenskom rudohorí. Jej okolie budujú čierne pelitické fylity betliarskeho súvrstvia (staršie paleozoikum). Výskyt študovanej mineralizácie tvoria dve štôlne, ktoré sú vyrazené západným smerom na pravom brehu bezmenného potoka, ľavostranného prítoku rieky Hnilec.

Odval na hornej štôlni je tvorený masívnym hrubokryštalickým sideritom, v ktorom vystupujú sulfidické minerály väčšinou vo forme masívnych rúd, miestami aj vtrúsených rúd. Pretože je halda prakticky bez hlušiny, sideritová žila tvorila pravdepodobne celý profil chodby. Jej hrúbku odhadujeme na 1,5 m. Sulfidické minerály sa nachádzajú najmä vo vrchnej partii odvalu, smerom dole do haldy sa strácajú. Tento fakt korešponduje s názorom Horala (1971), že v nadloží sideritu vystupujú steblá bizmutovej rudy. Na odvaloch dolnej štôlne je z rudných minerálov zastúpený len pyrit, ktorý tvorí vtrúseniny v čiernych pelitických fylitoch betliarskeho súvrstvia.

Pomocou kvantitatívnej WDS EPMA bol na výskyte v Mníšku nad Hnilcom-Kujnišovej doline identifikovaný vzácny telurid ortuti – coloradoit (HgTe). Coloradoit sa doteraz nezistil zo žiadnej lokality na území Slovenskej republiky, a tak je výskyt v Kujnišovej doline jeho prvým potvrdeným výskytom u nás. Na výskyte tvorí inklúzie v galenite, vystupuje aj na okraji galenitových zŕn a agregátov alebo vytvára samostatné zrná a agregáty, prerastajúc s bližšie neidentifikovanou sulfosoľou, galenitom a produktmi jeho supergénneho rozpadu (anglesit, ceruzit). Dosahuje veľkosť maximálne 20 µm, väčšinou má ale menšie rozmery. Coloradoit z Mníška nad Hnilcom sa chemickým obsahom blíži k teoretickému členu s 61,12 hm. % Hg a 38,88 hm. % Te (Anthony et al., 2001 – 2005). Mierne zvýšený obsah vykazuje Bi, a to 0,74 hm. %, Pb 0,22 hm. % a S 0,14 hm. %. Priemerný kryštalochemický vzorec coloradoitu prepočítaný na 2 atómy je $(Hg_{0,95}Bi_{0,01})_{0,96}(Te_{1,00}S_{0,01})_{1,01}$.

Coloradoit je relatívne zriedkavý minerál, ktorý sa vyskytuje na niektorých hydrotermálnych výskytoch, najmä kremenných žilách obohatených o Au a Ag, spolu s ostatnými teluridmi na typovej lokalite Keystone Mine v Colorade (USA) (Genth, 1878), v Západnej Austrálii a inde (Bernard a Hyršl, 2015). V oblasti Karpát bol coloradoit opísaný z rudných ložísk v neogénnych vulkanitoch, konkrétne v enargite a luzonite na ložisku medi Recsk v pohorí Mátra v Maďarsku (Szakáll et al., 2002), ako aj v asociácii s Au-Ag teluridmi na lokalitách Săcărâmb, Stănija a Musariu v Rumunsku (Popescu a Şimon, 1995; Szakáll et al., 2002; Săbău et al., 2013). Jeho genéza je spojená s hydrotermálnymi drahokovovými žilami obohatenými o Te (Anthony et al., 2001 – 2005), s Cu-Au skarnovými ložiskami (Guiqing et al., 2019), vysoko sulfidačnými epitermálnymi ložiskami, Au-Ag-Te-Se ložiskami (Voudouris et al., 2011a; Repstock et al., 2015; Yakich et al., 2021), ako aj s ložiskami žíl obohatených o Au v metamorfovaných horninách, sú-visiacimi s intrúziou v hĺbke (Voudouris et al., 2011b).

Coloradoity z iných dostupných výskytov majú podobné zloženie ako študované vzorky z Mníška nad Hnilcom-Kujnišovej doliny. Napríklad z lokality Musariu (Săbău et al., 2013) sa uvádza obsah Bi 0,14 hm. % a Pb 0,12 hm. %. Z ložiska Sentyabrsky na západnom polostrove Chukchi (Nikolaev et al., 2013) sa spomína obsah Bi 0,05 hm. % a Pb 0,12 hm. %. Z tohto vidieť, že nami študovaný coloradoit je výraznejšie obohatený o Bi. V coloradoite, ktorý bol opísaný z ložiska Daté (Yuningsih et al., 2018), Bi a Pb neboli zmerané, ale obsah S je 0,42 hm. %. Je vyšší ako v nami študovaných vzorkách coloradoitu.

Na lokalite Mníšek nad Hnilcom-Kujnišova dolina je coloradoit zatiaľ jediným predstaviteľom Bi-Te-(Hg) mineralizácie. Okrem tohto minerálu sú nositeľmi Bi, Te, Hg a čiastočne aj Se aj bližšie neidentifikovanej sulfosoli, giessenit a galenit. Všetky tieto minerály sú navzájom prepojené s vzácnou fázou Bi-Te-(Hg) mineralizácie, coloradoitom. Mineralogickým štúdiom sa zistilo, že všetky sulfidické minerály vznikli počas jednej mineralizačnej periódy – sulfidickej. V rámci nej vyčleňujeme minerálne asociácie – skupiny minerálov, ktoré kryštalizovali v jednotlivých štádiách mineralizácie. Vyčlenila sa asociácia Ni a Fe minerálov (ullmannit a pyrit), asociácia Zn, Cu a Pb minerálov (sfalerit, chalkopyrit a galenit), asociácia Pb, Bi a Sb minerálov (bližšie neidentifikovaná sulfosoľ a giessenit) a nakoniec coloradoit HgTe. Za najstaršiu považujeme asociáciu Ni a Fe minerálov, za najmladšiu asociáciu Pb, Bi a Sb minerálov spoločne s coloradoitom HgTe.

Doručené / Received: 9. 11. 2021
Prijaté na publikovanie / Accepted: 15. 12. 2021