Cuproneyite – Cu₇Pb₂₇Bi₂₅S₆₈, a new mineral from Băiţa Bihor, Romania

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Cuproneyite, with the ideal formula Cu7Pb27Bi25S68, is a new mineral species found in the skarn deposit of Băița Bihor, Romania. The mineral occurs in irregular aggregates, nests and veinlets of up to 5 cm, with predominant cosalite, bismuthiniteaikinite derivative bd₇₃₋₇₇, and calcite, within the diopside skarn. Cupronevite is opaque, has a silver-grey color, metallic luster and displays perfect cleavage along crystal elongation. The average Mohs hardness is about 3 (approximated from the average micro-indentation hardness of 222.5 kg/mm²). Under the microscope, cuproneyite forms irregular or short prismatic grains, 300 µm in length, intergrown with lamellae and irregular patches of cosalite and hammarite-friedrichite. Bireflectance is barely visible in air and moderate in oil immersion, with a grayish white color with faint yellowish tints in the lightest position to grayish white color with faint bluish tints in the darkest position. Between crossed polars, the rotation tints of the most anisotropic grains are dark brownish grey to light brownish grey. Internal reflections are absent. The reflectance data (measured in air) are: 40.4, 47.1 at 470 nm, 39.3, 45.7 at 546 nm, 38.3, 44.3 at 589 nm and 38.1, 43.9 % at 650 nm. The average results of 24 electron-microprobe analyses are Cu 3.36(11), Ag 0.30(3), Pb 40.08(29), Bi 39.55(22), Se 0.12(5), Te 0.12(4), S 16.13(8) wt.%, corresponding to Cu_{7.1}Ag_{0.38}- $Pb_{26.03}Bi_{25.47}S_{68}$, calculated on the basis of (S + Se + Te) = 68atoms per formula unit. The simplified formula (after reconversion of x(Ag + Bi) into 2x Pb) is $Cu_7Pb_{27}Bi_{25}S_{68}$ (Z = 2). It is in agreement with the empirical formula deduced from crystal-structure analysis. The density, 7.14 g/cm³, was calculated using the structurally derived formula for Z = 1. The unit cell of cuproneyite is monoclinic, with a 37.432(8), b 4.0529(9), c 43.545(9) Å, β 108.803(1)°, V = 6253.62(1) Å³, space group C2/m, and Z = 1. The strongest lines in the calculated X-ray powder pattern (d in Å, (I), hkl) are: 3.735, (96), -10.0.3; 3.347, (84), 4.0.10; 2.956, (77), 713; 2.867, (100), 714; 2.027, (81), 020.

Cuproneyite is an isotype of neyite [1]. The defining difference is the fact that the independent Ag position present in neyite is completely occupied by Cu in cuproneyite. Copper has a linear coordination in a flat-octahedral environment, situated in the central portions of the (001) walls of the crystal structure. This site displays a typical Cu-S bond length of 2.239 Å, to be compared with 2.415 Å of the Ag-S bond for silver in this position in nevite. The unit cell dimensions of cupronevite are reduced against nevite only by 0.1-0.2 Å and the monoclinic angle β is unchanged. The volume of the unit cell is reduced by 65 Å^3 . The name of the new mineral reflects this relationship. Both the mineral and its name have been approved by the Commission on New Minerals, Nomenclature and Classification (IMA 2008-053). Nevite has been classified as a typical sulfosalt with a 'box-work' structure (e.g., [1-3]).

Makovicky, E. et al. (2001) *Can. Mineral.*, **39**, 1365-1376.
Moëlo, Y. et al. (2008) *Eur. J. Mineral.*, **20**, 7-46.
Makovicky, E. & Topa, D. (2009) *Can. Mineral.*, **47**, 3-24.

The crystal-structural and paragenetic classification of minerals revisited (classes of nitrates, iodates and organic minerals)

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A dual crystal-structural and paragenetic principle introduced by Bulgarian mineralogist Ivan Kostov (1913-2004) has been applied to a rational classification of the classes of minerals [1-6]. Main divisions (associations) are based on geochemically allied metals in the composition of these minerals, and subdivisions (axial, planar, pseudoisometric and isometric types) on their overall structural anisometricity. The latter provides both structural similarity and genetic information, as manner of crystal growth in geological setting under different conditions of crystallization. The structural anisometricity may conveniently be presented by the c/a ratio of the minerals with high symmetry and by the 2c/(a+b), 2b/(a+c) and 2a/(b+c)ratios for the low symmetry minerals. The respective ratios are less, nearly equal, equal or above 1.00. The unit cell or sub-cell and the corresponding structures are denoted as axial or A-type, pseudo-isometric or (I)-type, isometric or I-type and planar or P-type, notations which correspond to chain-like, framework and sheet-like structures, respectively ino-, tecto- and phyllostructures. Crystal chemical approach to the classification of minerals has been applied in general mineralogical works [7]. The basic criteria used for classification of minerals are suitably summarized [8-10].

The notations A, (I) and P offered are further enriched by adding as superscript the direction of structural anisometricity for the low symmetry minerals $-A^c$, A^b and A^a , (I)^c, (I)^b and (I)^a, and P^c, P^b and P^a. Use is made of the indices (*hkl*) of the crystal habit form and [*uvw*] symbols for elongation added as subscripts. Combinations of both indicate form and elongation. Such type of systematic has been already applied to almost all mineral classes – oxides [11], silicates [12], sulphides [13], phosphates and related minerals [14], sulphates [15], borates [16], and carbonates [17; for review on different classes of minerals see 5, 6].

New examples are given in the last reviewed classes of minerals: nitrates within the Al-Mg-Fe, Na(K)-Ca-Ba and Cu-Pb-Zn associations, iodates within the Na(K)-Ca-Mg and Cu-Pb-Zn associations and organic minerals within the C-H-(O-N), Al-Mg-Fe, Na-Ca-Ba and Cu-Pb-Zn associations.

[1] Kostov, I. (1960) Zap. Vser. Mineral. Obshchest., 89, 1, 90-93 (in Russian). [2] Kostov, I. (1965) Bull. Inst. Geol., 14, 33-49. [3] Kostov, I. (1968) in V General Meeting, International Mineralogical Association, Cambridge, 100-109. [4] Kostov, I. (1977) Geochem. Mineral. Petrol., 7, 3-21. [5] Kostov, I. (1993) Mineralogy. Technika, Sofia. [6] Kostov, I. & Kostov, R.I. (1999) Crystal habits of minerals. Pensoft, Sofia. [8] Povarennykh, A.S. (1972) Crystal chemistry classification of minerals. Plenum Press, New York. [9] Lima-de-Faria, J. (1983) Garcia de Orta, Ser. Geol., 6, 1-24. [10] Strunz, H. (1984) in Proc. 27th Int. Geol. Congr.. Science Press, Utrecht, 10, 65-112. [11] Kostov, I. (1964) in Aspects of theoretical mineralogy in the U.S.S.R. Pergamon Press, New York, 221-224. [12] Kostov, I. (1975) Geochem. Mineral. Petrol., 1, 5-41. [13] Kostov, I. & Minčeva-Stefanova, J. (1982) Sulphide minerals. Schweizerbart'sche, Stuttgart. [14] Kostov, I. (1986) Geochem. Mineral. Petrol., 23, 3-13. [15] Kostov, I. (2000) Geochem. Mineral. Petrol., 37, 5-11. [16] Kostov, I. & Kostov, R.I. (2002) Mineral. Zhurnal, 24, 1, 5-9. [17] Kostov, I. & Kostov, R.I. (2006) Ann. Univ. Mining Geology, 49, 111-118.