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New Mineral Names*,†

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This New Mineral Names has entries for 21 new minerals, including alexkhomyakovite, andreadiniite, arsenmedaite, barwoodite, bodieite, ciriottiite, clino-oscarkempffite, ferrovorontsovite, ilirneyite, kannanite, magnesiohornblende, merelaniite, oyonite, pararaisaite, petříčekite, quijarroite, staročeskéite, tantalowodginite, topsøeite, tsygankoite, and vorontsovite.

ALEXKHOMYAKOVITE*

I.V. Pekov, N.V. Zubkova, V.O. Yapaskurt, I.S. Lykova, N.V. Chukanov, D.I. Belakovskiy, S.N. Britvin, A.G. Turchkova, and D.Yu. Pushcharovky (2019) Alexkhomyakovite, $K_6(Ca_2Na)(CO_3)_5Cl \cdot 6H_2O$, a new mineral from the Khibiny alkaline complex, Kola peninsula, Russia. European Journal of Mineralogy, 31(1), 135–143.

Alexkhomyakovite (IMA 2015-013), ideally $K_6(Ca_2Na)(CO_3)_5Cl \cdot 6H_2O$, hexagonal, was discovered in a few lumps of the peralkaline pegmatite in the south part of the Koashva open pit (Vostochnyi mine), Mt. Koashva, Khibiny alkaline complex in Kola peninsula. Alexkhomyakovite is a hydrothermal mineral and occurs associated with villiaumite, natrite, potassic feldspar, pectolite, sodalite, biotite, lamprophyllite, titanite, fluorapatite, wadeite, burbankite, rasvumite, djerfisherite, molybdenite, and incompletely characterized Na-Ca silicate. White powdery aggregates of thermonatrite, villiaumite, fluorite, and sylvite are products of the supergene alteration of natrite, alexkhomyakovite, and primary red villiaumite, which are unstable on the air. Most commonly alexkhomyakovite found as a part (up to 40 vol%) of massive polymineralic pseudomorphs after large (up to 3 × 5 × 15 cm) delhayelite crystals where it forms massive fine-grained aggregates (up to 2 × 4 cm) intimately intergrown with other minerals (monomineralic area up to 10 × 20 μm). It also found as main part of veinlets up to 3 cm × 1 mm at the border of delhayelite pseudomorphs with natrite nests, and as grains up to 0.2, rarely up to 1mm and their clusters with micro inclusions of pectolite, lamprophyllite, and/or villiaumite within massive natrite. Alexkhomyakovite is transparent to translucent, colorless, white or gray, with vitreous to greasy luster and a white streak. No cleavage or parting is observed; the fracture is uneven. Alexkhomyakovite is brittle with Mohs hardness ~3. D_{meas} = 2.25(1) g/cm^3; D_{calc} = 2.196 g/cm^3. In plane-polarized light alexkhomyakovite is colorless non-pleochroic but has a distinct pseudo-absorption from colorless to grayish due to a large birefringence (0.067). It is optically uniaxial (–), ω = 1.543(2), ε = 1.476(2) (589 nm). The bands of IR spectrum (cm^{-1}; w – weak, s – strong, sh – shoulder) are: numerous bands in the 3400–2900 range (O-H stretching vibrations of H_2O molecules forming strong hydrogen bonds), in particular 3156s and 2920s (corresponding to symmetric and antisymmetric vibrations of symmetric H_2O molecules coordinating Ca^{2+}); 1600sh (H–O–H bending vibrations of H_2O); strong bands in the range from 1550 to 1300 (degenerate antisymmetric C–O-stretching vibrations); weak bands in the range 1086–1047 (non-degenerate symmetric C–O-stretching vibrations); 870–860 (in-plane bending vibrations of CO_3^{2-}); 760–670 (out-of-plane bending vibrations of CO_3^{2-}); 957, 906, 639, and 590 (librational vibrations of H_2O molecules); low-frequency bands below 430 (lattice modes involving Ca–O stretching vibrations); 2314 (potentially due to a superposition of combination modes involving antisymmetric C–O-stretching and in-plane bending vibrations of CO_3^{2-} anions); 1752w (overtone of out-of-plane bending vibrations of CO_3^{2-}). The averaged 17 point WDS electron probe analyses is [wt%, (range/standard deviation)]: Na_2O 4.09 (3.73–4.48/0.19), K_2O 35.72 (35.20–36.33/0.33), CaO 14.92 (14.49–15.34/0.28), MnO 0.01 (0.00–0.03/0.01), FeO 0.02 (0.00–0.06/0.02), SO_3 0.11 (0.00–0.38/0.11), Cl 4.32 (4.17–4.40/0.06), CO_2 2.28, H_2O 13.90, –O=Cl –0.98, total 100.39; the amounts of H_2O and CO_2 were calculated for 6 (H_2O) and 5 (CO_3) groups pfu, respectively. The empirical formula is $K_{5.90}Ca_{2.07}Na_{1.03}(CO_3)_5(SO_4)_{0.01}O_{0.05}Cl_{0.95} \cdot 6H_2O$ based on 9 metal cations pfu. The strongest lines of the powder X-ray diffraction pattern are [*d* Å (*I*%; *hkl*)]: 7.96 (27; 002), 3.486 (35; 113), 3.011 (100; 114), 2.977 (32; 221), 2.676 (36; 300), 2.626 (42; 213,115), 2.206 (26; 311), 1.982 (17; 008). The crystal structure of alexkhomyakovite was solved by direct methods and refined to R_1 = 5.78%. The new mineral is hexagonal, $P6_3/mcm$, a = 9.2691(2), c = 15.8419(4) Å, V = 1178.72 Å^3, Z = 2. Its structure is unique and is based on (001) heteropolyhedral layers of pentagonal bipyramids $(Ca,Na)O_5(H_2O)_2$, interconnected via carbonate groups of two types, edge-sharing and vertex-sharing ones. The Ca and Na atoms in the bipyramids are disordered. Tenfold-coordinated K cations center $KO_6Cl(H_2O)_3$ polyhedra on either side of the heteropolyhedral layer. A third type of carbonate groups and Cl atoms are located the interlayer. The mineral name honors the outstanding Russian mineralogist Alexander Petrovich Khomyakov (1933–2012), a renowned specialist in the mineralogy of alkaline rocks, of the Khibiny and Lovozero alkaline complexes in particular, being a senior author for 73 new minerals discovered there. The type specimen is deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **Yu.U.**

ANDREADINIITE*

C. Biagioni, Y. Moëlo, P. Orlandi, and W.H. Paar (2018) Lead-antimony sulfosalts from Tuscany (Italy). XXIII. Andreadiniite, $CuAg_7HgPb_7Sb_{24}S_{48}$, a new oversubstituted (Cu,Hg)-rich member of the andorite homeotypic series from the Monte Arsiccio mine, Apuan Alps. European Journal of Mineralogy, 30 (5), 1021–1035.

Andreadiniite (IMA 2014-049), ideally $CuAg_7HgPb_7Sb_{24}S_{48}$, monoclinic, is a new $^{4,4}L$ homologue belonging to the andorite sub-series of Sb-rich members within the lillianite homologous series. It was discov-

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* All minerals marked with an asterisk have been approved by the IMA CNMMC.
† For a complete listing of all IMA-validated unnamed minerals and their codes, see http://pubsites.uws.edu.au/ima-cnmnc/.

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ered in a quartz vein embedded in dark gray metadolostone enriched with microcrystalline pyrite from the Sant'Olga tunnel, Monte Arsiccio mine, Stazzema, Apuan Alps, Tuscany, Italy (43°58′16″N, 10°17′05″E). The Monte Arsiccio mine exploited a pyrite ± baryte ± iron oxide ore deposit located at the contact between the Paleozoic basement, formed by a metavolcanic-metasiliclastic sequence, and the Triassic metadolostone belonging to the Grezzoni Formation. Andreadiniite forms millimeter-sized lead-gray compact masses associated with sphalerite and stibnite. In the same vein, the thallium sulfosalts boscardinite, protochabournéite, and routhierite were identified, associated with Hg-rich tetrahedrite. The crystallization of this sulfosalt assemblage could be related to the circulation of (Pb,Tl,Ag,Hg,Sb,As)-rich hydrothermal fluids in the fractures of the metadolostone during the Tertiary Alpine tectono-metamorphic events. The mineral has a metallic luster and is brittle, with a conchoidal to uneven fracture. The indentation hardness VHN_{25} = 223 (218–229) kg/mm^2, corresponding to ~3.5 of a Mohs scale. Density was not measured, because of the scarcity of homogeneous material; D_{calc} = 5.36 g/cm^3. In plane-polarized incident light, andreadiniite is white with a slight yellow bronze tint. No internal reflections, and no pleochroism were observed. Bireflectance is extremely weak. In crossed polars, it is weakly anisotropic, in shades of gray to bluish gray. Twinning was not observed but revealed by the X-ray study. The reflectance values in air [R_{max}/R_{min} % (nm)] (**COM** wavelengths bolded) are: – /35.0 (400), 36.4/35.3 (420), 36.0/35.9 (440), 36.1/34.7 (460), **36.4/34.8 (470)**, 36.6/35.1 (480), 36.4/34.8 (500), 36.1/34.3 (520), 35.3/33.8 (540), **35.1/33.5 (546)**, 34.8/33.0 (560), 35.2/33.1 (580), **35.0/32.9 (589)**, 34.4/32.9 (600), 33.7/32.3 (620), 33.1/31.9 (640), **32.4/31.8 (650)**, 32.5/31.5 (660), 32.4/31.6 (680), 31.7/30.9 (700). The average of seven spot WDS electron probe analyses [wt%, (range)] is: Cu 1.06 (1.03–1.09), Ag 11.25 (11.05–11.56), Tl 0.45 (0.31–0.58), Hg 2.76 (2.59–2.87), Pb 19.95 (19.76–20.26), As 1.55 (1.51–1.64), Sb 40.45 (40.24–40.81), S 22.23 (22.05–22.42), total 99.70. The empirical formula is $Cu_{1.14}Ag_{7.12}Tl_{0.15}Hg_{0.94}Pb_{6.57}(Sb_{22.68}As_{1.41})_{\Sigma 24.09}S_{47.33}$ based on ΣMe= 40 pfu. The strongest lines of the Gandolfi X-ray diffraction pattern are [d Å (I; hkl)]: 3.719 (ms; 241,$\bar{2}$41), 3.406 (s; 341,$\bar{3}$41), 3.277 (s; 502,$\bar{5}$02), 2.885 (s; 243,$\bar{2}$43), 2.740 (ms; 343,$\bar{3}$43), 2.131 (ms; 080), 2.055 (s; 841,$\bar{8}$41), 1.788 (s; 582,$\bar{5}$82). The single-crystal X-ray data shows andreadiniite has monoclinic pseudo-orthorhombic unit cell, space group $P2_1/c$, a = 19.0982(14), b = 17.0093(11), c = 13.0008(10) Å, β = 90.083(4)°, V = 4223.3 Å^3, Z = 2. The crystal structure was refined to R_1 = 0.067 for 9756 $F_o > 4\sigma(F_o)$ reflections. The structure contains 20 independent cation sites and 24 S sites, shows a fourfold superstructure with respect to the short 4 Å axis of the substructure and can be described as formed by alternation of $(311)_{PbS}$ slabs, four octahedra thick along $(100)_{PbS}$ and unit-cell twinned by reflection on $(311)_{PbS}$ planes. Two kinds of $(311)_{PbS}$ slabs indicated as "central" (C) and "marginal" (M) owing to its positions in the unit-cell. Small chemical differences between the two slabs induce the monoclinic symmetry of with a small β angle, favoring twinning and OD phenomena related to slab stacking. The crystal-chemical formula $Cu_{1.14}Ag_{6.93}Hg_{0.89}Pb_{6.82}(Sb_{22.84}As_{1.38})_{\Sigma 24.22}S_{48}$ obtained through the crystal-structure refinement is in good agreement with chemical data. The homologue order value from chemical analysis is 4.10, close to the crystallographic value N = 4. Thus, andreadiniite is a $^{4,4}L$ lillianite homologue of andorite sub-series $Ag_xPb_{3-2x}Sb_{2+x}S_6$ within which classification can be indicated by the percentage of the andorite component And_n, where n(%) = 100x. Homeotypes with n values over 100% (i.e. x > 1) correspond to the "oversubstituted" andorite derivatives, where (2x – 1) Pb is replaced by Sb. For andreadiniite this substitution percentage n = 107.1 [for empirical or 106.25% for ideal formula ($And_{106.25}$)]. Despite the same (4x) superstructure along the 4.25 Å axis, andreadiniite is distinct from quatrandorite, which is "undersubstituted" ($And_{93.75}$) and presents an immiscibility gap with the intermediate member senandorite (And_{100}). Andreadiniite is a close homeotype (same supercell and space group) of arsenquatrandorite, an As-rich oversubstituted andorite member ($And_{112.5}$). Distribution of minor cations (Hg, Cu, Tl, As) is detailed and the role of Hg and Cu for the stabilization of andreadiniite through a complex substitution rule is discussed. The name of the mineral honors Andrea Dini (b. 1966) for his contribution to the knowledge of magmatic activity in the Tuscan Magmatic Province and the related ore deposits, in particular, the geology and mineralogy of Hg ores of Apuan Alps. The holotype specimen is deposited in the Museo di Storia Naturale, Università di Pisa, Italy. **D.B.**

ARSENMEDAITE*

C. Biagioni, D. Belmonte, C. Carbone, R. Cabella, F. Zaccarini, and C. Balestra (2019) Arsenmedaite, $Mn^{2+}_6As^{5+}Si_5O_{18}(OH)$, the arsenic analogue of medaite, from the Molinello mine, Liguria, Italy: occurrence and crystal structure. European Journal of Mineralogy, 31(1), 117–126.

Arsenmedaite (IMA 2016-099), ideally $Mn^{2+}_6As^{5+}Si_5O_{18}(OH)$, monoclinic, is a new mineral discovered in the Molinello mine, Graveglia Valley, Ne, Genova, Liguria, Italy (~N 44°20′43″; E 9°27′32″) in small quartz veinlets, a few millimeters in thickness, cutting the braunite ore bodies hosted by Jurassic metacherts ("Diaspri di Monte Alpe" Formation). The ore contains polyphase mineral assemblages of manganese, metamorphosed under prehnite–pumpellyite facies (P = 0.25 ± 0.05 GPa, T = 275 ± 25 °C) followed by hydrothermal mobilization along fractures under decreasing thermobaric conditions, which led to further concentration of dispersed elements such as As, V, and Te in extensional fractures. Arsenmedaite has been found associated with braunite, quartz, calcite, As-rich medaite, calcian rhodochrosite, talc, and ganophyllite. The mineral forms orange-reddish prismatic crystals, up to 200 μm, with a vitreous luster and a white streak. Arsenmedaite is brittle, with a good {100} cleavage and a parting normal to the elongation; fracture is irregular. Hardness, density, and optical properties were not measured due to small amount of available material; D_{calc} = 3.772 g/cm^3 and n_{calc} = 1.766. The Raman spectra (between 200 and 1200 cm^{-1}) is, within experimental uncertainties, very similar to that of medaite. It shows bands (cm^{-1}): 355 (overlapping of the symmetrical bending of AsO_4 groups and the Mn–O stretching and bending vibrations), 650 (bending modes of Q^2Si-centered tetrahedra), 853s and 875s (symmetrical stretching of AsO_4 groups and Q^1Si-centered tetrahedra), 771 (antisymmetrical stretching of the AsO_4 groups). Weak bands between 922 and 995 cm^{-1} could be related to the symmetrical stretching of Q^2Si-centered tetrahedra. The average of 10 WDS electron probe analyses [wt%, (range)] is: V_2O_5 1.84 (1.26–2.40), As_2O_5 6.81 (5.30–9.54), SiO_2 38.75 (37.73–39.41), CaO 0.70 (0.62–0.76), MnO 50.28 (50.04–50.63), H_2O 1.42 (1.18–1.55) [by electroneutrality], total 99.80. The empirical formula based on 12 cations pfu (except H^+) is $(Mn_{5.89}Ca_{0.10})_{\Sigma 5.99}[(As_{0.49}V_{0.17})_{\Sigma 0.66}Si_{5.35}]_{\Sigma 6.01}O_{17.69}(OH)_{1.31}$. Gandolfi camera test was unsuccessful. The strongest lines in the calculated X-ray powder diffraction pattern are [d_{calc} Å (I_{calc}%; hkl)]: 3.266 (100; 081), 3.159 (72; 052), 3.094 (82; $\bar{2}$21), 2.963 (83; 091), 2.953 (79; 211), 2.788 (68; 072), 2.612 (98; 082). Single-crystal X-ray studies on a crystal of 0.09 × 0.09 × 0.04 mm show the mineral is monoclinic, space group $P2_1/n$, a = 6.7099(3), b = 29.0008(13), c = 7.5668(3) Å, β = 95.469(3)°, V = 1465.74 Å^3, Z = 4. The crystal structure of arsenmedaite [refined to R_1 = 0.0623 for 3526 $F_o > 4\sigma(F_o)$ unique reflections] is isotypic to that of medaite [$Mn^{2+}_6V^{5+}Si_5O_{18}(OH)$]: sixfold- to sevenfold-coordinated Mn-centered polyhedra form wavy ribbons linked to TO_4 tetrahedra centered by Si and (As,V). In the crystal structure of arsenmedaite there are six independent Mn positions, six independent tetrahedral sites, 19 oxygen sites, and one hydrogen position. The tetrahedral sites form the arsenato-pentasilicate group $[AsSi_5O_{18}(OH)]_{12}$, which is terminated on one side by the T(5) tetrahedron, showing a silanol group $SiO_3(OH)$, and on the other side by the T(6) tetrahedron hosting As and minor V and Si. Chemical analyses of the studied samples show intermediate compositions that can be classified as As-rich medaite with a clear correlation between

Si in excess over 5 apfu and ^{7}(As+V) apfu, showing that the finding of Si-dominant medaite cannot be excluded. The mineral is named owing to this chemical relationship with medaite. The holotype fragments are deposited in the of the Museo di Storia Naturale, Università di Pisa, Italy, and in the collection of the Dipartimento di Scienze della Terra, dell'Ambiente e della Vita (DISTAV), Università degli Studi di Genova, Genova, Italy. **F.C.**

BARWOODITE*

A.R. Kampf, A.J. Celestian, and B.P. Nash (2018) Barwoodite, $Mn^{2+}_6(Nb^{5+},\square)_2(SiO_4)_2(O,OH)_6$, a new member of the welinite group from Granite Mountain, Arkansas. Canadian Mineralogist, 56(5), 799–809.

Barwoodite (IMA 2017-046), $Mn^{2+}_6(Nb^{5+},\square)_2(SiO_4)_2(O,OH)_6$, trigonal, is a new member of the welinite group. It was discovered by Henry L. Barwood and Robert W. Stevens around 2005 at the Big Rock quarry (also known as the 3M quarry), Granite Mountain, Little Rock, Pulaski County, Arkansas (34°41′27″N, 92°17′17″W). Barwoodite is interpreted as crystallizing from pegmatitic fluids. The mineral is found in miarolitic cavities in pegmatite in association with aegirine, albite, analcime, chamosite–pennantite, eggletonite, kupletskite, muscovite, natrolite, orthoclase, quartz, and zircon. It occurs as plates to about 3 mm in diameter and 0.5 mm thick, in small vugs and only rarely exhibit hexagonal outlines with the forms {100}, {010}, and {001}. The mineral is brownish red with light orange streak and is non-fluorescent. Crystals are transparent and have vitreous luster. The mineral is brittle, with Mohs hardness ~3½. The fracture is curved, and cleavage is perfect on {001}. Observed density was close to the Clerici solution, but due to the color of the mineral, it was not determined; $D_{calc} = 4.227$ g/cm^3 (4.168 for ideal formula). Barwoodite is nonpleochroic and optically uniaxial (–) with $\omega = 1.873(3)$ and $\varepsilon = 1.855(5)$ (white light). The mineral loses color very slowly in dilute HCl and slowly in concentrated HCl at room temperature but does not dissolve. Raman spectroscopy is complex and has many features. The most intense features (cm^{-1}) are at 774 (possibly SiO_4 symmetric stretch) with a broad peak at 783 (possible NbO_6 chain stretch), 835 (SiO_4 symmetric stretch); weaker bands are observed at 886 (O–Si–O asymmetric stretch Si–O–M asymmetric stretch), 437 (M–OH deformations and O–Si–O bend). 224 (O–M_{oct}–O bending) and 120 (lattice modes, ring breathing vibrations). Very weak band are observed between 3222 and 3497 cm^{-1} corresponding to (OH) stretching. The average of 12 WDS electron probe analyses on 6 grains [wt%, (range)] is: MnO 60.01 (59.34–60.77) (MnO 58.97 and Mn_2O_3 1.21, according to assigned site occupancies), Fe_2O_3 1.96 (1.77–2.08), Nb_2O_5 17.39 (16.84–18.94), SiO_2 16.65 (16.44–16.96), H_2O 3.02 (calculated on the basis of charge balance and O = 14 apfu), total 99.20. No other elements were detected by EDS. The empirical formula based on 14 O pfu is $Mn^{2+}_6(Nb^{5+}_{0.94}Fe^{3+}_{0.18}Mn^{3+}_{0.11}\square_{0.77})_{\Sigma2}(SiO_4)_2[O_{3.58}(OH)_{2.42}]_{\Sigma6}$. The strongest X-ray powder diffraction lines are [*d* Å (*I*%; *hkl*)]: 3.125 (95; $11\bar{1}$), 2.858 (56; 021), 2.688 (57; 210), 2.349 (81; 300), 1.7930 (100; 212), 1.5505 (75; 140,$3\bar{2}\bar{1}$). Unit-cell parameters refined from the powder data are $a = 8.2031(15)$, $c = 4.8088(9)$ Å, and $V = 280.24$ Å^3. The parameters of the trigonal unit cell of barwoodite refined from single-crystal data collected on a 0.10 × 0.07 × 0.03 mm crystal are $a = 8.2139(10)$, $c = 4.8117(4)$ Å, $V = 281.14$ Å^3; space group $P3$, $Z = 1$. The crystal structure was solved by direct methods and refined to $R_1 = 0.0246$ for 746 $I_o > 2\sigma(I)$ reflections. The structure is based on the hexagonal close-packing of oxygen atoms with the layer sequence ABABAB along [001], with a AB layer pair per unit cell. The close-packed arrangement contains four different voids that can be occupied by cations in octahedral coordination (*M*1a, *M*1b, *M*2a, and *M*2b) and two different voids that can be occupied by Si in tetrahedral coordination (*Si*1 and *Si*2). Whereas *M*1a and *M*1b sites alternate along [001], yielding a chain of face-sharing octahedra, the *M*2a and *M*2b octahedra are each grouped in edge-sharing trimers; a single SiO_4 tetrahedron above the center of each trimer shares edges with each of the octahedra in the trimer, yielding a heteropolyhedral $[M2_3O_4(OH)_6(SiO_4)]$ unit. These units link to one another by sharing octahedra–octahedra and octahedra–tetrahedra corners and they link to *M*1 octahedra in the chain by sharing octahedral edges, thereby forming a 3D framework. Barwoodite, is isostructural with welinite $[Mn^{2+}_6(W^{6+},Mg)_2(SiO_4)_2O_4(OH)_2$, franciscanite $Mn^{2+}_6(V^{5+},\square)_2(SiO_4)_2O_3(OH)_3$, and örebroite $[Mn^{2+}_6(Sb^{5+}Fe^{3+})(SiO_4)_2O_6]$. The mineral name honors Dr. Henry ("Bumpi") L. Barwood (1947–2016), an American clay mineralogist (M.S., Auburn University) and surface chemist (Ph.D., Virginia Polytechnic Institute and State University, 1980). The four cotype specimens deposited in the collections of the Natural History Museum of Los Angeles County, California, U.S.A. **F.C.**

BODIEITE*

A.R. Kampf, R.M. Housley, G.R. Rossman, J. Marty, and M. Chorazewicz (2018) Bodieite, $Bi^{3+}_2(Te^{4+}O_3)_2(SO_4)$, a new mineral from the Tintic District, Utah, and the Masonic District, California, USA. Canadian Mineralogist, 56 (5), 763–772.

Bodieite (IMA 2017-117), ideally $Bi^{3+}_2(Te^{4+}O_3)_2(SO_4)$, monoclinic, was first discovered in a sample collected from ore dump in the about 0.2 km west of the North Star mine (but can originate from other nearby mines: Carisa, Boss Tweed, or Red Rose), Tintic district, Juab Co., Utah, U.S.A. It was later also discovered in the dump of the Pittsburg-Liberty mine located in ~19 km NNW of the town of Bodie in the Bodie Hills volcanic field, Masonic district, Mono Co., California, U.S.A. The mineral is named for its type locality. The mines of the Tintic district exploited polymetallic (Au-Ag-Cu-Pb) vein deposits emplaced in contact-metamorphosed dolomite. At that area the mineral occurs in vugs in quartz-baryte matrix in association with mixite, pyrite, and bismuthinite. In the Pittsbug-Liberty former gold mine (exploited a volcanogenic fault-breccia deposit emplaced in granodiorite), bodieite also occurs in vugs in quartz with embedded crystals of goldfieldite, bismuthinite, famatinite-luzonite, is closely associated with baryte, mixite, richelsdorfite, and a poorly crystalline phase containing variable amounts of Cu, Fe, Bi, Te, Sb, and O. Bodieite is an oxidation-zone mineral. It shows a variety of habits. In specimen from Tintic it forms olive green blades 0.3 mm in length. In the specimens from the Pittsburg-Liberty mine, bodieite forms acicular crystals, occasionally steep pyramidal, or stepped tabular. They are elongated on [001], and show the forms: {001}, {110}, {111}, {$11\bar{1}$}. No twinning was observed. The crystals are transparent to translucent, colorless to yellow to green, with subadamantine to greasy luster and a white streak. Bodieite is non-fluorescent under long- and short-wave UV light. The Mohs hardness is 2. It is brittle with stepped, irregular fracture and a fair cleavage on {001}. The density was not measured due to the material was too scarce; $D_{calc} = 6.465$ g/cm^3 (6.554 for an ideal formula). Bodieite is soluble in dilute HCl at room temperature. It is biaxial (–); all refractive indices are over 2; $2V_{meas} = 71.5°$; $X = \mathbf{b}$. The Raman spectra bands (cm^{-1}; w – weak, s – strong, sh – shoulder) are: 1097w, 1071w, and 978s (corresponding to SO_4^{2-} groups), 761s (TeO_3^{2-} symmetric stretching mode), 688w, 650sh, 631s, 600w, 469sh, 440s, 412s, 364s, 273s, 228s, 210sh, 187w, 153s, 132s, 119sh (stretching and bending modes of SO_4^{2-}, TeO_3^{2-}, and BiO_3^{3-} groups). All spectra were featureless in the region from 4000 to 1200 indicating no evidence of OH^- or H_2O groups The average of 6 electron probe WDS analyses is [wt%, (range/standard deviation)]: As_2O_3 1.58 (1.50–1.75/0.11), Sb_2O_3 0.25 (0.09–0.33/0.09), Bi_2O_3 52.14 (51.51–52.62/0.40), TeO_2 34.52 (34.22–34.80/0.22), SO_3 9.49 (9.22–9.56/0.15), total 97.89%. The empirical formula is $(Bi_{1.95}Te_{1.89}As_{0.14}Sb_{0.02})_{\Sigma4.00}(S_{1.02}O_4)O_6$ based on 10 O atoms pfu. The strongest lines in the powder X-ray diffraction pattern are [*d* Å (*I*%; *hkl*)]: 7.31 (20; 002), 3.331 (62; 202,$\bar{1}21$), 3.243 (100; 121), 3.039 (20; $\bar{2}13$), 2.716 (25; 220,015), 1.9013 (21; 323). The crystal structure was solved by direct methods and refined to $R_1 = 2.75\%$. Bodieite is monoclinic, $I2/a$, $a = 8.1033(8)$, $b = 7.4302(8)$, $c = 14.6955(17)$ Å, $\beta = 97.771(9)°$, $V = 876.68$ Å^3, $Z = 4$. The structure is based on $Bi^{3+}O_3$ and $Te^{4+}O_3$ pyramids that share O vertices and form an undulating sheet parallel to {001}. These sheets are connected through interlayered $[SO_4]$ groups that form long Bi–O and Te–O bonds. Bodieite is structurally distinct from known minerals, but it is isostructural with synthetic $Bi_2^{3+}(Te^{4+}O_3)_2(Se^{6+}O_4)$ and $Bi_2^{3+}(Se^{4+}O_3)_2(Se^{6+}O_4)$. Five cotype specimens are deposited in the Natural History Museum of Los Angeles County, Los Angeles, California, U.S.A. **Yu.U.**

CIRIOTTIITE*

L. Bindi, C. Biagioni, B. Martini, and A. Salvetti (2016) Ciriottiite, $Cu(Cu,Ag)_3Pb_{19}(Sb,As)_{22}(As_2)S_{56}$, the Cu-analogue of sterryite from the Tavagnasco Mining District, Piedmont, Italy. Minerals 2016, 6(1), 8.

The new mineral ciriottiite (IMA 2015-027), Cu analogue of sterryite, $Cu(Cu,Ag)_3Pb_{19}(Sb,As)_{22}(As_2)S_{56}$, monoclinic, has been discovered in one specimen collected at the Espérance superiore tunnel in the Tavagnasco Pb-Bi-Zn-As-Fe-Cu hydrothermal ore district, ~50 km N of Turin, Piedmont, Italy (45.5416 N; 7.8134 E). It was found in a complex sulfide assemblage with chalcopyrite, arsenopyrite, galena, minor amounts of bismuthinite, sulfosalts (cosalite, izoklakeite-giessenite), bismuth, and gold. Secondary alteration minerals include anglesite, azurite, langite, and tavagnascoite. In the holotype specimen, ciriottiite is associated with arsenopyrite and a kobellite-like mineral, within a vug of a quartz vein. Ciriottiite forms black tubular crystals, up to 150 μm and few micrometers thick with a black streak and metallic luster. It is brittle. The indentation hardness VHN_{10} = 203 (190–219) kg/mm^2, corresponding to ~3–3½ of Mohs scale. No other physical properties are given; D_{calc} = 5.948 g/cm^3. In reflected light, ciriottiite is light gray, distinctly anisotropic with brownish to greenish rotation tints. Internal reflections were not observed and there is no optical evidence of zonation. The reflectance values in air [R_{max}/ R_{min} % (nm)] for **COM** wavelengths are: 37.8/ 33.2 (471.1); 35.3/ 31.8 (548.3), 34.7/ 31.0 (586.6); 32.5/ 27.9 (652.3). Reflectance curves for sterryite and parasterryite are similar to those of ciriottiite, but reflectance values are lower for the latter. The average of 5 spot electron probe WDS analyses [wt%, (range)] is: Cu 2.33 (2.22–2.41), Ag 0.53 (0.48–0.60), Hg 0.98 (0.92–1.06), Tl 0.78 (0.74–0.81), Pb 44.06 (43.89–44.21), As 4.66 (4.58–4.75), Sb 23.90 (23.77–24.05), Bi 1.75 (1.65–1.83), S 20.37 (20.22–20.46), total 99.38. No other elements with $Z > 9$ were detected. The empirical formula based on 56 S apfu is $Cu_{3.23}Ag_{0.43}Hg_{0.43}Pb_{18.74}Tl_{0.34}Sb_{17.30}As_{5.48}Bi_{0.74}S_{56}$. The powder X-ray data was not obtained. The strongest lines of the calculated powder X-ray diffraction pattern are [d_{calc} Å (I_{calc}%; *hkl*)]: 3.641 (100; 075), 3.595 (35; $\bar{2}34$), 3.238 (82; 0.1.13), 3.208 (57; 078), 2.936 (54; 088); 2.928 (37; 229), 2.800 (36; $\bar{2}67$), 2.043 (78; $\bar{4}02$). Single-crystal X-ray data collected from the crystal 0.04 × 0.045 × 0.06 mm shows ciriottiite to be monoclinic, space group $P2_1/n$, a = 8.178(2), b = 28.223(6), c = 42.452(5) Å, β = 93.55(2)°, V = 9779.5 Å^3, Z = 4. The crystal structure was refined to R_1 = 0.118 for 21 304 observed $F_o > 4\sigma(F_o)$ reflections. It is topologically identical to that of ciriottiite Ag-analogue sterryite. $Cu(Ag,Cu)_3Pb_{19}(Sb,As)_{22}(As_2)S_{56}$. The structure is composed by the fishbone arrangement of complex columns along **b**. These complex columns delimited by the surfaces of weakest bonding, cutting the longest (Sb/As)–S bonds along distinct lone-electron-pair micelles. A single kind of complex column corresponds to one unit formula. It has a pseudotrigonal prismatic core and two "arms" (ribbon projections) of unequal length. Each complex column contains 16 Pb sites (with minor Bi and Tl), 10 pure Sb sites, 10 mixed (Sb/As) sites (five having As > Sb), and five mixed (Pb/Sb) positions. As in sterryite, one of the mixed (Pb,Sb) position located on the short arm is connected to a partially occupied Cu site. In the short arm there are two pure As sites, forming localized As–As bonds characterizing both ciriottiite and sterryite. The other Cu-hosting sites are located in the long arm. At its base, a mixed and split (Cu/Bi) site alternates with a mixed (Cu,Ag,Hg) site the former corresponds to a split (Cu/Ag) site in sterryite. At the end of the long arm, a (Cu,Hg) site alternates with a mixed (Sb,As) site. The chemical formula derived from the crystal structure refinement is $Cu_{0.80}(Cu_{1.93}Hg_{0.47}Ag_{0.40}Bi_{0.20})_{\Sigma 3}(Pb_{14.65}Tl_{0.35})_{\Sigma 15}(Pb_{3.89}Sb_{1.71}Bi_{0.40})_{\Sigma 6}Sb_{10}(Sb_{5.63}As_{4.37})_{\Sigma 10}(As_2)S_{56}$. Structurally ciriottiite can be considered as an expanded derivative of owyheeite, belonging to the owyheeite group. The name honors Marco Ernesto Ciriotti (b. 1945) Italian member of the IMA CNMNC since 2013, and president of the Italian Micromineralogical Association for his longstanding contribution to mineral systematics. The holotype specimen is deposited in the Museo di Storia Naturale, Università degli Studi di Firenze, Florence, Italy. **D.B.**

CLINO-OSCARKEMPFFITE*

E. Makovicky, D. Topa, and W.H. Paar (2018) The definition and crystal structure of clino-oscarkempffite, $Ag_{15}Pb_6Sb_{21}Bi_{18}S_{72}$. European Journal of Mineralogy, 30(3), 569–589.

Clino-oscarkempffite (IMA 2012-086), simplified chemical formula $Ag_{1.25}Pb_{0.5}Sb_{1.75}Bi_{1.5}S_6$ (Z = 12) or $Ag_{15}Pb_6Sb_{21}Bi_{18}S_{72}$ (Z = 1), is a new monoclinic N = 4 member of the lillianite homologous series discovered in the old specimens originating from the 264 level of the Colorada vein, Animas mine, Chocaya Province, Department of Potosi, Sur Chichas, Bolivia, collected by the expeditions of W. Vaux in 1929–1930. The deposit is a typical for the hydrothermal Ag–Sn formation of Bolivia. In the upper parts of the Colorada vein, cassiterite is associated with freibergite and stannite–kësterite family members. Ore textures indicated open space filling by crystallization of ore minerals and telescoping of mineral assemblages. Clino-oscarkempffite is associated with aramayoite, oscarkempffite, arsenopyrite, ferrokësterite, freibergite, miargyrite, pyrite, and quartz. It occurs in close intergrowth with oscarkempffite forming discrete anhedral grains with different Sb/Bi ratios and aggregate portions (at least up to more than 1 mm) with continuous changes in this ratio. Physical and optical properties are practically no discernable from those of oscarkempffite (Topa et al. 2016). Clino-oscarkempffite is grayish black, opaque, with metallic luster and dark gray streak. It is brittle, with irregular fracture and no observable cleavage. Indentation hardness VHN_{50} = 200 (189–208) kg/mm^2 corresponding to 3–3½ of Mohs scale. Density was not measured; D_{calc} = 6.04 g/cm^3. In reflected light, the mineral is grayish white, with distinct pleochroism between white and gray tones. Anisotropism is distinct with rotation tints in shades of gray. The reflectance values in air [R_{max}/R_{min} % (nm)] (**COM** wavelengths bolded) are: 47.5 /43.0 (400), 44.9/38.4 (420), 44.3/37.3 (440), 44.0/37.3 (460), **44.1/37.4 (470)**, 43.9/37.4 (480), 43.0/37.2 (500), 42.9/36.9 (520), 42.9/36.3 (540), **42.7/36.2 (546)**, 42.5/36.2 (560), 42.2/36.1 (580), **42.1/36.1 (589)**, 41.8/35.9 (600), 42.3/36.0 (620), 41.8/35.7 (640), **42.0/35.6 (650)**, 41.7/35.5 (660), 41.2/35.2 (680), 41.7/35.3 (700). The R_{max} values for a bismuth-richer phase are higher by ~3% compare to oscarkempffite, with the difference varying by a wavelength. Opposite is true for the R_{min} values, explained by the orientations of the optically analyzed oscarkempffite grains being far from giving maximum ΔR. The average of six point WDS electron probe analyses [wt% (range)] is: Cu 0.08 (0.07–0.13), Ag 14.31 (14.11–14.42), Pb 10.66 (10.42–10.82), Bi 33.56 (33.36–33.71), Sb 21.39 (21.11–21.63), S 20.14 (20.07–20.22), total 100.14. The empirical formula based on 132 apfu is $Cu_{0.12}Ag_{15.24}Pb_{5.88}Sb_{20.16}Bi_{18.48}S_{72.12}$ (Z = 1) or for 11 apfu (Z = 12): $Cu_{0.01}Ag_{1.27}Pb_{0.49}Sb_{1.68}Bi_{1.54}S_{6.01}$. N_{chem} = 4.14. For oscarkempffite it is $Cu_{0.28}Ag_{9.89}Pb_{3.96}Sb_{17.36}Bi_{8.58}S_{47.92}$ based on 88 apfu (Z = 1). There is a substantial difference in the Sb/Bi ratio (1.13 and 2.02, respectively). Clino-oscarkempffite is heavily oversubstituted according to the Ag + (Bi, Sb) ↔ 2Pb substitution to 122.8% in comparison to gustavite, $AgPbBi_3S_6$. Powder X-ray data were not collected. The strongest lines of the calculated powder X-ray diffraction pattern are [d_{calc} Å (I_{calc}%; *hkl*)]: 3.367 (35; $\bar{4}32$), 3.362 (35; 232), 3.329 (100; 650), 2.984 (30; $\overline{10}$.1.2), 2.972 (29; 812), 2.882 (43; $\overline{10}$.2.2), 2.871 (43; 822), 2.070 (28; $\bar{2}04$). Single-crystal X-ray data obtained on a fragment 0.06 × 0.06 × 0.09 mm shows the mineral is monoclinic, space group $P2_1/c$, a = 39.811(25), b = 19.280(12), c = 8.278(5) Å, β = 96.195(9)°, V = 6317 Å^3, Z = 1. The crystal structure was solved by direct methods and refined to R [F_o>4σ(F_o)] = 0.0704. It contains 30 independent cation sites and 36 distinct sulfur sites and consists as a general N = 4 lillianite homologue of $(311)_{PbS}$ slabs four octahedra thick along $(100)_{PbS}$ connected via unit-cell twinning on the $(311)_{PbS}$ planes. It is a threefold superstructure of the lillianite aristotype, with a doubled 4 Å axis and, uniquely, a tripled ~13.3 Å a parameter. The structure of is full of mixed cation sites. The central octahedra of the PbS-like slabs are mixed (Bi,Sb), (Sb,Bi), and Sb sites in alternation along the 8.3 Å direction, whereas in the marginal octahedral (Sb,Bi) positions alternate with distorted tetrahedra of Ag. The bicapped trigonal prisms on meeting planes of two octahedral slabs are occupied by mixed (Pb,Bi) sites. Cation occupation schemes result in blocks with monoclinic overall symmetry which alternate along [100] with blocks with orthorhombic overall symmetry. The order–disorder implications of this division are discussed. The substantial difference between formula obtained from structure refinement, $Ag_{12}Sb_{25.32}Bi_{10.6}(Pb,Bi)_{12}S_{72}$, and chemical data might be related to variations in Sb/Bi ratio of deeper portion of the X-rayed sample and the analyzed surface as well as to the partial, variable overlap of cation positions. The name is given because of structural and chemical similarity to orthorhombic oscarkempffite. The holotype specimen is deposited in the Natural History Museum Vienna, Austria. **D.B.**

References cited

Topa, D., Makovicky, E., Paar, W.H., Stanley, C.J., and Roberts, A.C. (2016) Oscarkempffite, $Ag_{10}Pb_4(Sb_{17}Bi_9)_{26}S_{48}$, a new Sb–Bi member of the lillianite homologous series. Mineralogical Magazine, 80, 807–817.

ILIRNEYITE*

I.V. Pekov, O.I. Siidra, E.A. Vlasov, V.O. Yapaskurt, Yu.S. Polekhovsky, and A.V. Apletalin (2018) Ilirneyite, $Mg_{0.5}[ZnMn^{3+}(TeO_3)_3]·4.5H_2O$, a new mineral from Chukotka, Russia. Canadian Mineralogist, 56 (6), 913-921.

Ilirneyite (IMA 2015-046), ideally $Mg_{0.5}[ZnMn^{3+}(Te^{4+}O_3)_3]·4.5H_2O$, was discovered at the gold-silver Sentyabr'skoe deposit, Ilirney ore district, Western Chukotka, Russia. The new mineral was named for its locality, near the village of Ilirney, the Ilirney Lakes and Ilirneyveem River. Ilirneyite was found in the oxidation zone of sulfide- and telluride-bearing veins in association with gypsum, malachite, azurite, cerussite, anglesite, brochantite, linarite, posnjakite, chlorargyrite, acanthite, gold, goethite, coronadite, paratellurite, raisaite, and xocomecatlite. Ilirneyite occurs in intimate association with gypsum, in cracks and small cavities close to veins enriched with telluride minerals. Aggregates of the new mineral overgrow quartz, muscovite, hessite, petzite, and gold. Most typically ilirneyite occurs as earthy films. Interrupted coatings are up to 1.5 × 2.5 cm and usually not thicker than 0.01 mm. Occasionally, ilirneyite forms perfect, well-terminated long prismatic hexagonal crystals (up to 0.2 × 0.05 mm) {100} + {101} combined in sprays or open-work chaotic groups. More commonly, it is found as moss-like, soft, friable aggregates consisting of tiny acicular to hair-like (to 0.03 × 2 μm) crystals. Ilirneyite is reddish-brown to dark brownish-red (brown to light brown in moss-like aggregates), transparent in crystals and translucent in aggregates. The streak is brown. The luster is adamantine to semi-metallic in crystals and silky in aggregates. The micro indentation hardness VHN_{20} = 132 (122–142) kg/mm^2 corresponding to ~ 3 of Mohs scale. The mineral is brittle, with uneven fracture and no cleavage or parting. The density was not measured due to small crystal size; D_{calc} = 4.205 g/cm^3. In reflected light ilirneyite is dark gray, weakly bireflectant, non-pleochroic, and weakly anisotropic with distinct red brown internal reflections. The reflectance values in air (**COM** wavelengths are bolded) [R_{min}/R_{max}, (nm)] are: 7.1/8.2 (400), 7.7/8.8 (420), 7.9/9.1 (440), 7.8/9.0 (460), **7.8/9.0 (470)**, 7.7/8.9 (480), 7.6/8.8 (500), 7.5/8.8 (520), 7.4/8.7 (540), **7.3/8.7 (546)**, 7.3/8.6 (560), 7.2/8.6 (580), **7.2/8.6 (589)**, 7.2/8.5 (600), 7.1/8.5 (620), 7.1/8.4 (640), **7.1/8.4 (650)**, 7.0/8.3 (660), 7.0/8.2 (680), 6.9/8.2 (700). The average of 9 WDS analyses is [wt%, (range)]: CuO 0.58 (0.04–1.65), MgO 4.20 (3.72–4.84), ZnO 11.42 (7.07–14.85), [Mn_2O_3 total 8.54 (6.16–12.91) subdivided to MnO 1.25 and Mn_2O_3 7.14 by charge balance for the formula based on $Te^{4+}_3O_9$, in accordance with crystal structure data], Fe_2O_3·0.06 (0–0.11), TeO_2 65.06 (63.88–65.97), H_2O 11.01 (by stoichiometry for 4.5 H_2O pfu), total 100.72. The empirical formula is $Mg_{0.77}Mn^{2+}_{0.13}Cu_{0.05}Zn_{1.03}Mn^{3+}_{0.67}Fe^{3+}_{0.01}Te^{4+}_3O_9·4.5\ H_2O$ based on $(Te^{4+}O_3)_3$ and 4.5 H_2O pfu. The strongest lines in the powder X-ray diffraction pattern are [d Å (I%; hkl)]: 8.18 (100; 100), 4.088 (61; 200), 3.847 (14; 002), 3.087 (15; 120,210), 2.977 (16; 112), 2.864 (24; 211), 2.796 (52, 202). The crystal structure was attempted to be solved by direct methods in $P\overline{3}$ and $P3$ space groups. Both obtained models were transformed into $P6_3/m$ space group and the structure was refined to R_1 = 4.5%. Ilirneyite is hexagonal, $P6_3/m$, a = 9.423(1), c = 7.669(1) Å, V = 589.7 Å^3, Z = 2. Ilirneyite is a member of the zemannite structural family. Its crystal structure is based on $[Me_2(TeO_3)_3]^{n-}$ framework built of Me_2O_9 dimers sharing common corners with $Te^{4+}O_3$ pyramids with the Te^{4+} cation in the apex pointing into the channel. The dominant cations occupying the Me sites are Zn and Mn^{3+} with minor Mn^{2+}, Cu and Fe^{3+}. The channels in the $[Me_2(TeO_3)_3]^{n-}$ framework are filled by chains formed by Mg cations and H_2O molecules together with lone electron pairs associated with Te^{4+}. The type specimen is deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **Yu.U.**

KANNANITE*

D. Nishio-Hamane, M. Nagashima, N. Ogawa, and T. Minakawa (2018) Kannanite, a new mineral from Kannan Mountain, Japan. Journal of Mineralogical and Petrological Sciences, 113(5), 245–250.

Kannanite (IMA 2015-100), $Ca_4[(Al,Mn^{3+},Fe^{3+})_5Mg](VO_4)\ (SiO_4)_2\ (Si_3O_{10})(OH)_6$, orthorhombic, is a new Ca-dominant member of the ardennite series. It was discovered in Kannan Mountain, Ozu, Ehime Prefecture, Japan (33°31′02″N 132°37′58″E). The metamorphic rocks of the Kannan unit consist of metamorphosed basaltic tuff and lava, metagabbro, metadolerite, and metachert, exposed to metamorphism in the pumpellyite–actinolite facies. Kannanite was found in an approximately 50 cm thick layer of iron–manganese ore in the metachert. The ore consist mainly of quartz and hematite, in association with braunite. Kannanite occurs in fine quartz veins crossing the hematite-rich part, associated to ardennite-(V). Both kannanite and ardennite-(V) are considered to be formed by the activities of metamorphic fluid accompanied with the Sanbagawa metamorphism. The mineral forms brownish orange to orange several micrometers (and rarely up to 15 μm) vitreous crystals, fragmented into anhedral grains with tabular and columnar shapes, with frequent voids. No fluorescence in UV range was observed. Cleavage is not observed but expected to be perfect on {010} by analogy with ardennite. Mohs hardness is 6. Density and optical properties were not measured, owing to the small grain size; D_{calc} = 3.43 g/cm^3, n_{calc} = 1.788. Kannanite is weakly pleochroic from orange to brownish orange. of arsenmedaite. In Raman spectrum peaks are evident at 300–1000 and 3000–3700 cm^{-1} and by analogy with ardennite-(As) have been assigned as 371 cm^{-1} ($ν_2$ symmetric bending vibrations), 421 cm^{-1} ($ν_4$ out-of-plane bending modes for VO_4 units), 779–881 cm^{-1} (VO_4 antisymmetric and symmetric stretching vibrations), and 3400–3600 cm^{-1} (O–H stretching vibrations). The average of 12 WDS electron probe analyses on grains from a single vein [wt% (range)] is: V_2O_5 6.04 (5.49–6.53), As_2O_5 1.52 (1.38–1.78), SiO_2 29.73 (28.73–29.84), Al_2O_3 14.40 (13.85–15.13), Fe_2O_3 5.18 (4.83–5.44), MnO 12.65 (11.86–13.99) (MnO 3.89 and Mn_2O_3 9.74, according to electroneutrality), CaO 19.02 (17.34–19.68), MgO 2.70 (2.57–2.82), CuO 0.34 (0.23–0.46), NiO 0.40 (0.30–0.51), H_2O 5.22 (according to electroneutrality, 28 anions and 16 cations), total

97.83. The empirical formula based on 28 anions and 16 cations (Si + V + As = 6 and others = 10) pfu is $(Ca_{3.60}Mn^{2+}_{0.40})_{\Sigma4}(Al_{3.00}Mn^{3+}_{1.31}Fe^{3+}_{0.69}Mg_{0.71}Mn^{2+}_{0.19}Ni_{0.06}Cu_{0.05})_{\Sigma6}[(V^{5+}_{0.70}Si_{0.16}As_{0.14})_{\Sigma1}O_{3.84}(OH)_{0.16}](SiO_4)_2(Si_3O_{10})(OH)_6$. The strongest X-ray powder diffraction lines are [*d* Å (*I*%; *hkl*)]: 3.234 (37; 204), 3.001 (100; 115,020), 2.809 (35; 121), 2.715 (66; 122), 2.658 (67; 116,310), 2.531 (47; 024), 2.306 (37; 207). Orthorhombic unit-cell parameters refined from the powder data are a = 8.8802(14), b = 5.9919(13), c = 18.882(3) Å, and V = 1004.7 Å^3. The **c** periodicity and the space group *Pnmm* were confirmed by electron diffraction. No single-crystal X-ray data are provided. Ardennite-series minerals are classified in terms of cations in *A* (A^{2+} cations), *T*4 (As or V), and *M* site (M^{2+} and M^{3+} cations). Kannanite is V-dominant in *T*4 site, Ca dominant at the *A* sites, and the *M*1 and *M*2 sites are occupied only by trivalent cations, whereas the *M*3 site is shared by both trivalent and divalent cations (half by Mg and small amount of Mn^{2+}, and other half by the trivalent cations). The order of amount of the trivalent cations in kannanite is Al > Mn^{3+} > Fe^{3+}, and Al is dominant compared to $Mn^{3+} + Fe^{3+}$. The mineral is named for its type locality. The holotype specimen has been deposited in the National Museum of Nature and Science, Tokyo, Japan. **F.C.**

Magnesio-hornblende*

R. Oberti, M. Boiocchi, F.C. Hawthorne, and M.E. Ciriotti (2018) Magnesio-hornblende from Lüderitz, Namibia: mineral description and crystal chemistry. Mineralogical Magazine, 82(1), 145–157.

Magnesio-hornblende (IMA 2017-059), ideally $^{A}\square^{B}Ca_2{}^{C}(Mg_4Al){}^{T}(Si_7Al)O_{22}{}^{W}(OH)_2$, monoclinic, is a new mineral of the amphibole supergroup (Hawthorne et al. 2012). It was found in 1970 by M.E. Ciriotti in the sand dunes of the Lüderitz, Karas Region, Namibia (~26°38′52″S, 15°09′28″E). Dune sands in the coastal Namibia are invariably lithofeldspatho–quartzose volcaniclastic and have a homogeneous composition from Lüderitz to Walvis Bay. Plagioclase exceeds K-feldspar. Mafic volcanic rock fragments predominate over granitoid, sedimentary (quartzose to feldspatho–quartzose siltstone/sandstone, shale, minor limestone and hybrid carbonate) and metamorphic (quartz–sericite, quartz–mica, quartz–epidote, amphibolite) grains. Samples enriched in heavy minerals are usually dominated by clinopyroxene, with subordinate opaque Fe–Ti–Cr oxides, garnet, epidote and amphibole. The holotype specimen is a friable block of subhedral to anhedral magnesio-hornblende crystals up to a few millimeters. The crystals are green to dark green, vitreous with good cleavage on {110}. The mineral is non fluorescent. Density and hardness are not reported; D_{calc} = 3.137 g/cm^3. In transmitted plane-polarized light, magnesio-hornblende is pleochroic (X – pale yellow < Y – bluish green < Z – dark green). It is optically biaxial (–), α = 1.640(2), β = 1.654(2), γ = 1.666(2) (589.9 nm) $2V_{meas}$ = 82(1)° and $2V_{calc}$ = 84.9°; $X \wedge \mathbf{a}$ = 33.7° (in β obtuse), $Y \parallel \mathbf{b}$, $Z \wedge \mathbf{c}$ = 18.2° (in β acute) The dispersion of optical axis is weak ($v > r$). The average of 10 electron probe WDS analyses [wt% (range)] is: SiO_2 50.24 (49.16–51.10), TiO_2 0.24 (0.22–0.25), Al_2O_3 6.52 (6.26–6.72), Cr_2O_3 0.10 (0.08–0.11), FeO_{tot} 10.82 (10.69–10.98) (FeO 8.87 and Fe_2O_3 2.17 by structure refinement), MnO 0.25 (0.23–0.28), MgO 16.52 (16.44–16.59), NiO 0.03 (0–0.06), ZnO 0.02 (0–0.07), CaO 11.68 (11.64–11.75), Na_2O 0.92 (0.87–1.01), K_2O 0.30 (0.23–0.35), H_2O 2.02 [based on 2 = (OH,F,Cl), F 0.11 (0.00–0.31), Cl 0.10 (no variation reported)]; $–O{=}F_2$ 0.05, $–O{=}Cl_2$ 0.02, total 100.05. The empirical formula is $^{A}(\square_{0.73}Na_{0.22}K_{0.05})_{\Sigma1.00}{}^{B}(Ca_{1.79}Fe^{2+}_{0.10}Na_{0.01})_{\Sigma2.00}{}^{C}(Mg_{3.48}Fe^{2+}_{0.97}Al_{0.28}Fe^{3+}_{0.23}Cr^{3+}_{0.01}Ti^{4+}_{0.01})_{\Sigma5.00}{}^{T}(Si_{7.18}Al_{0.82})_{\Sigma8.00}O_{22}{}^{W}(OH_{1.93}F_{0.05}Cl_{0.02})_{\Sigma2.00}$ based on 24 (O+F+Cl) apfu with (OH+F+Cl) = 2. The strongest lines in the powder X-ray diffraction pattern obtained from projection of 3D single crystal data are [d_{calc} Å (I_{calc}%; *hkl*)]: 2.709 (100; 151), 8.412 (74; 110), 3.121 (73; 310), 2.541 (58; $\bar{2}$02), 3.386 (49; 131), 2.596 (45; 061), 2.338 (41; $\bar{3}$51), 2.164 (39; 261). The cell parameters obtained from single-crystal X-ray diffraction data collected on a 0.60 × 0.45 × 0.10 mm crystal are a = 9.8308(7), b = 18.0659(11), c = 5.2968(4) Å, β = 104.771(6)°, V = 909.64 Å^3, monoclinic, *C*2/*m*, Z = 2. The crystal structure was refined to R = 2.72% on 1244 reflections with $I > 3\sigma(I)$ and R_{all} = 3.15% on 1380 reflections. The refined and analyzed crystal was assigned code 1325 in the amphibole database of the CNR-IGG in Pavia, Italy. In magnesio-hornblende ^{T}Al is ordered at the *T*(1) site, smaller *B* cations (Mn,Fe,Mg) are ordered at the *M*(4′) site and $^{C}R^{3+}$ cations are almost ordered at the *M*(2) site but for a small amount of Al occurring at *M*(3). The *A* cations order among the *A*(*m*), *A*(2), and *A* subsites. The holotype material is deposited in the Museo di Mineralogia, Sistema Museale di Ateneo, University of Pavia, Italy. **F.C.**

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Merelaniite*

J.A. Jaszczak, M.S. Rumsey, L. Bindi, S.A. Hackney, M.A. Wise, C.J. Stanley, and J. Spratt (2016) Merelaniite, $Mo_4Pb_4VSbS_{15}$, a new molybdenum-essential member of the cylindrite group, from the Merelani Tanzanite Deposit, Lelatema Mountains, Manyara Region, Tanzania. Minerals, 6(4), 115.

Merelaniite (IMA 2016-042), ideally $Mo_4Pb_4VSbS_{15}$, is a new mineral species, the first Mo-essential member of the cylindrite homologous series discovered at the tanzanite gem mines in the Merelani hills near the town of Arusha, Lelatema Mountains, Manyara Region, Tanzania (~ 3°35′0 S, 37°0′30 E). It is named after the township of Merelani, in honor of the local miners, past and present, living and working in the region. Merelaniite might be identical to the mineral from Kayrakty, Kazakhstan (Yanulova and Kosyak 1971) and to "unnamed Pb-Mo sulfide" from the Sätra mine in Sweden (Zakrzewski et al. 1982) later listed as valid unknowns "UM1971-18-S:MoPbSb" and "UM1982-13-S:MoPb" respectively (Smith and Nickel, 2007). At Merelani it was originally noticed as "molybdenite" wires piercing chabazite crystals from (Simonoff and Wise, 2012, 2014). Organic and vanadium rich sedimentary "black shales" of Merelani region undergone ultrahigh temperature (granulitic facies) metamorphism at ~1000 °C with pressures up to 10–12 kbar. The formation of large sulfide crystals associating with well crystallized "flake" graphite would suggest a high temperature. The partial coating of the sulfides and later infilling of cracks and voids by lower-grade metamorphic phases such as the zeolites and prehnite indicates these multiple phases of reworking and deformation. Merelaniite growth potentially took place between initial deformation and one or more of the retrograde events. All the specimens with identified merelaniite have been obtained at the secondary mineral markets and has not been recorded in situ. Most of specimens appeared since the sulfide-rich "zone" with big wurtzite and alabandine crystals was mined at ~2011–2013. Merelaniite was formed after alabandite and wurtzite, yet prior to quartz, calcite, prehnite, fluorapatite, zoisite (tanzanite), chabazite, and other zeolites, which have all been observed to fully or partially encapsulate fully formed merelaniite whiskers. Other associated minerals include diopside, graphite, tremolite, titanite, clausthalite, and pyrite. Merelaniite whiskers also occur in crevices attached to the surfaces of large alabandite crystals, intimately associated with masses of loosely aggregated yet well-formed graphite crystals. Merelaniite metallic dark gray cylindrical whiskers are typically tens (up to 100) of micrometers in diameter and up to a millimeter, rarely up to 12 mm long. SEM study shows it consisting of tightly coiled layers and can be described as "scrolls" terminated in a conical shape. The mineral is opaque, non-fluorescent in UV light. It has dark gray to black streak. Whiskers are malleable, flexible with a splintery fracture. Cleavage is perfect on {001}. Hardness and density were not determined; D_{calc} = 4.895 g/cm^3 (for an ideal formula). In reflected light, merelaniite is weakly pleochroic gray to white, strongly bireflectant and strongly anisotropic with pale blue and orange-brown rotation tints. The reflectance values in air [R_1/R_2 (nm)] (interpolated **COM** wavelengths bolded) are: 37.6/47.6

(400), 37.4/47.2 (420), 37.2/46.8 (440), 36.9/46.5 (460), **36.8/46.3 (470)**, 36.6/46.1 (480), 36.3/45.7 (500), 36.0/45.1 (520), 35.7/44.4 (540), **35.6/44.1 (546)**, 35.4/43.5 (560), 35.0/42.7 (580), **34.8/42.3 (589)**, 34.6/41.8 (600), 34.4/41.0 (620), 34.3/40.2 (640), **34.3/39.9 (650)**, 34.2/39.6 (660), 34.1/39.2 (680), 34.0/39.0 (700). Raman spectra (collected using unpolarized incident laser radiation at 633 and 785 nm) show prominent peaks (cm^{-1}) at 324, 350 (weak), 379, 390, and 401 (strongest). An intense broad band are between 133 and 245 cm^{-1}, and less intense broad bands are centered near ~450, 570, and 780 cm^{-1}. Raman shifts at 916, 1176, 1374, and 1619 cm^{-1} can be seen only in the spectrum of a polished whisker excited with 633 nm radiation. The average of 13 selected electron probe WDS analyses [wt% (range)] is Cu 0.01 (0–0.05), Pb 42.40 (40.00–44.41), Mn 0.05 (0–0.23), Sb 2.59 (2.44–2.80), Bi 3.56 (3.05–4.12), As 0.39 (0.23–0.87), V 2.26 (2.16–2.41), Mo 21.10 (20.05–22.48), W 0.55 (0.39–0.62), S 24.05 (23.60–24.42), Se 1.25 (1.09–1.56), total 98.20. The empirical formula based on 15 anions pfu is $Mo_{4.33}Pb_{4.00}As_{0.10}V_{0.86}Sb_{0.43}Bi_{0.33}Mn_{0.05}W_{0.05}Cu_{0.03}(S_{14.70}Se_{0.30})$. An arsenic-rich variety up to As 0.29 apfu has been noted. The X-ray diffraction pattern was indexed according to the two centered pseudo-tetragonal and pseudo-hexagonal sublattices (Q and H pseudo-layers). The strongest X-ray powder diffraction lines [d Å (I%; hkl)] are 6.14 (30; 002), 2.965 (100; 200), 1.852 (20; 311) of Q sub cell and 5.94 (60; 002), 2.968 (25; 004), 2.673 (20; 111), 2.272 (40; 003); 1.829 (30; 301) of H sub cell. Single-crystal X-ray diffraction, electron diffraction, and high-resolution TEM confirm merelaniite belongs to the cylindrite homologous series with alternating centered pseudo-tetragonal (Q) and pseudo-hexagonal (H) layers with respective PbS and MoS_2 structure types. Both layers are triclinic with space group $C1$ or $C\bar{1}$. The unit cell parameters for the Q layer refined from single-crystal/powder X-ray data are a = 5.929(8)/5.9249(8) Å; b = 5.961(5)/5.987(3) Å; c = 12.03(1)/12.077(6) Å; α = 91.33(9)/90.61(3); β = 90.88(5)/90.04(2); γ = 91.79(4)/89.95(3); V = 425/428.4 $Å^3$, Z = 4. For the H layer, a = 5.547(9)/5.5503(6), b = 3.156(4)/3.1536(8), c = 11.91(1)/11.877(6) Å; α = 89.52(9)/90.00(1); β = 92.13(5)/90.05(1); γ = 90.18(4)/89.92(2); V = 208/207.9 $Å^3$, Z = 2. Among minerals of the cylindrite homologous series merelaniite is the first member with Mo essential H layers and the first case of triangular-prismatic coordination of cations in these layers. The **a** and **b** directions are parallel to the layers, and **c** is the layer-stacking direction; $\mathbf{a}_H$ is parallel to $\mathbf{b}_Q$. The orientation of the **a** and **b** directions relative to the whisker axis is currently unknown. The commensurability ratio between $\mathbf{a}_H$ and $\mathbf{b}_Q$ in merelaniite leads to 13Q/14H (77.58 Å with a δ 0.165 Å) being the first case of $n_Q < n_H$ owing to small H pseudo-layer due to Mo presence. The structural formula of merelaniite can be written as $[^{Q}(Pb_{0.80}Sb_{0.09}Bi_{0.07}As_{0.02}V^{3+}_{0.02})_{\Sigma 1.00}][^{H}(Mo^{4+}_{0.85}V^{3+}_{0.15}W^{4+}_{0.01}Cu^{+}_{0.01})_{\Sigma 1.02}]S_{2.92}Se_{0.06}$ yielding a metal to sulfur ratio 2:3 consistent with structural and chemical data. Merelaniite is related to cylindrite and franckeite by the substitutions $2Sn^{2+} + Fe + 2Sb \rightarrow 2Mo^{4+} + V + Sb + S$ and to abramovite by the mechanisms $2Bi \rightarrow V^{3+} + Sb$ and $2SnIn \rightarrow 4Mo + S$. Samples from the holotype specimen, all of which were extracted from a single 11 cm alabandite crystal have been deposited in the collections of the: Natural History Museum, London, Great Britain; the A.E. Seaman Mineral Museum, Houghton, Michigan, U.S.A.; the Smithsonian Institution's National Museum of Natural History, Washington, D.C., U.S.A. The crystals used for the X-ray crystallographic investigations are kept at the Department of Earth Sciences, University of Firenze, Italy. **D.B.**

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OYONITE*

L. Bindi, C. Biagioni, and F.N. Keutsch (2018) Oyonite, $Ag_3Mn_2Pb_4Sb_7As_4S_{24}$, a New Member of the Lillianite Homologous Series from the Uchucchacua Base-Metal Deposit, Oyon District, Peru. Minerals, 8(5), 192.

Oyonite (IMA 2018-002), ideally $Ag_3Mn_2Pb_4Sb_7As_4S_{24}$, monoclinic, is new mineral species discovered in the specimen obtained at the mineral market, which was collected in 2010 from Nivel 890, Uchucchacua deposit, Oyon district, Catajambo, Lima Department, Peru. The mineral was named for its type locality. Uchucchacua deposit is the type locality for other four Mn-bearing sulfosalts: uchucchacuaite, benavidesite, manganoquadratite, and menchettiite. Oyonite found in association with orpiment, tennantite-tetrahedrite, menchettiite, and other minerals of the system Pb-Ag-Sb-Mn-As-S, in calcite matrix. The new mineral occurs as very rare black metallic subhedral to anhedral crystals, up to 100 μm with a black streak. It is brittle with a micro-indentation hardness VHN_{100} = is 137 (132–147) kg/mm^2 corresponding to 3–3½ of Mohs scale. Density was not measured; D_{calc} = 5.237 g/cm^3 (5.275 for ideal formula). In reflected light, oyonite is weakly to moderately bireflectant and weakly pleochroic from dark gray to a dark green. Internal reflections are absent. Reflectance values are provided only for the COM wavelengths [R_{min}/R_{max} % (nm)] are: 33.9/40.2 (471.1), 32.5/38.9 (548.3), 31.6/38.0 (586.6), 29.8/36.5 (652.3). The average of five electron probe WDS analysis [wt% (range)]: Cu 0.76 (0.50–1.05), Ag 8.39 (8.08–8.91), Mn 3.02 (2.89–3.22), Pb 24.70 (24.55–25.81), As 9.54 (9.11–9.82), Sb 28.87 (28.24–29.61), S 24.30 (23.63–24.71), total 99.58 with other elements below detection limits. The empirical formula based on 20 cations pfu is $Cu_{0.38}Ag_{2.48}Mn_{1.75}Pb_{3.79}Sb_{7.55}As_{4.05}S_{24.12}$. The main X-ray powder diffraction lines are [d Å (I%; hkl)]: 3.34 (40; $\bar{3}12$), 3.29 (100; $\bar{5}20$), 2.920 (40; $\bar{1}32$), 2.860 (30; 620), 2.821 (70; $\bar{2}32$), 2.678 (35; $\bar{3}32$), 2.045 (50; 004). The unit-cell parameters refined from the powder data are: a = 19.175(1), b = 12.7775(9), c = 8.1817(8) Å, β = 90.26(11)°, V = 2004.6 $Å^3$. The single crystal X-ray data collected on a crystal 0.045 × 0.055 × 0.070 mm shows oyonite to be monoclinic, space group $P2_1/n$, a = 19.1806(18), b = 12.7755(14), c = 8.1789(10) Å, β = 90.471(11)°, V = 2004.1 $Å^3$, Z = 2. The crystal structure was refined to a final R_1 = 0.0317 for 6272 independent reflections. Oyonite is one of the $^{4,4}L$ homologous of the lillianite homologous series. Its crystal structure is formed by the alternation of $(311)_{PbS}$ slabs, four octahedra thick along $(100)_{PbS}$ and unit-cell twinned by reflection on $(311)_{PbS}$ planes. There are 10 metal sites and 12 S sites in the unit cell. One of two independent sites with a bicapped trigonal prismatic coordination on the composition planes (100) is fully occupied by Pb and the second has a mixed (Pb,Sb) occupancy leading to the chemical formula of the (100) composition plane $(Pb_{1.91}Sb_{0.09})S_2$. There is only one kind of $(311)_{PbS}$ slab formed by one kind of diagonal $(100)_{PbS}$ plane. On the border of the plane, mixed (Ag,Cu)- and (Mn,Ag)-centered octahedra on one side, and Sb and (Sb,Mn)-centered sites alternate. In the center of the plane, a pure Sb site alternates with a pure As site along **c** in one column and mixed (Sb,As) and (As,Sb) sites in the other column. The composition of the diagonal $(100)_{PbS}$ plane is $(Cu_{0.20}Ag_{1.25}Mn_{0.86}Sb_{3.65}As_{2.04}S_{10})$. The chemical formula obtained through the structural data for Z = 2 is $Cu_{0.40}Ag_{2.48}Mn_{1.74}Pb_{3.82}Sb_{7.48}As_{4.08}S_{24}$. The homologue order from chemical analysis is N = 3.58. The $Ag^+ + Me^{3+} = 2Pb^{2+}$ substitution percentage, considering minor cations, is 83% (75 for an idealized formula). Oyonite belongs to the Sb-rich members of the andorite homeotypic sub-series within the lillianite homologous series. Having an andorite component And_{75}, it corresponds to a new member in the sequence with m = 4. The holotype specimen is deposited in the Museo di Storia Naturale, Università degli Studi di Firenze, Florence, Italy. **D.B.**

PARARAISAITE*

A.R. Kampf, R.M. Housley, and G.R. Rossman (2018) Pararaisaite, the dimorph of raisaite, from the North Star Mine, Tintic, Utah, USA. Canadian Mineralogist, 56 (5), 811–820.

Pararaisaite (IMA 2017-110), ideally $Cu^{2+}Mg[Te^{6+}O(OH)_2]{\cdot}6H_2O$, monoclinic, was discovered in the dumps of North Star mine (exploited polymetallic Au-Ag-Cu-Pb vein deposit), Mammoth, Tintic district, Juab Co., Utah, U.S.A. Pararaisaite is an oxidation-zone mineral, as bodieite abstracted in this issue. It occurs in vugs in a massive quartz with embedded crystals of baryte and goldfieldite, with a secondary malachite. The main minerals of the ore zone include galena, cerussite, and enargite. The new mineral forms blue, striated, prismatic crystals up to 0.4 mm elongated on [010]. The forms are: {100}, {001}, {102}, {102}, {114}. Pararaisaite is transparent, has a white streak and vitreous luster. No twinning was observed. It is nonfluorescent under long- and short-wave UV light. The Mohs hardness is 2½. The mineral is brittle with a splintery fracture, has the perfect cleavage on {001} and good on {100}. D_{meas} = 2.85(2) and D_{calc} = 2.812 g/cm^3 (2.851 for the ideal formula). The crystals lose color immediately and birefringence slowly, but do not dissolve, in dilute or concentrated HCl at room temperature. The mineral is pleochroic: X very pale purple << Y purple < Z blue green. It is optically biaxial (+), $\alpha = 1.600(2)$, $\beta = 1.616(2)$, $\gamma = 1.713(3)$ (white light); $2V_{meas} = 47(1)°$; $2V_{calc} = 46.4$; $Z = \mathbf{b}$, $X \approx \mathbf{a}$, $Y \approx \mathbf{c}$. The dispersion of optical axes is $r > v$, weak. The bands of Raman spectrum in the range from 3600 to 3000 cm^{-1} correspond to O-H stretching of OH and H_2O groups. Strong bands at 708, 682 and at 573, 526 cm^{-1} correspond to tellurate stretching and tellurate bending modes, respectively. Weak features occur at 1117, 1049, 405, 389, 337, 246, 225, and 183 cm^{-1}. The averaged 4 point WDS electron probe analyses is [wt% (range/standard deviation)]: MgO 11.14 (10.78–11.50/0.33), CuO 18.59 (18.35–18.80/0.21), Sb_2O_5 0.26 (0.20–0.32/0.05), TeO_3 42.55 (42.20–43.21/0.46), H_2O 31.97 (by structure), total 104.51. The water loss under vacuum and/or during analyses accounts for high total. The empirical formula is $(Mg_{1.01}Cu^{2+}_{0.93}Te^{6+}_{0.96}Sb^{5+}_{0.01})_{\Sigma 3}O_{12}H_{14.12}$ based on 12 O atoms pfu. The strongest lines of the powder X-ray diffraction pattern are [d Å (I%; hkl)]: 8.77 (100; 002); 4.824 (71; 200,111); 4.392 (43; 004), 4.248 (85; $\bar{2}02$,202); 2.733 (39; 022), 2.419 (50; 400,024); 1.893 (48; $\bar{2}26$,226). The crystal structure of pararaisaite was solved by charge-flipping method and refined to R_1 = 2.59%. The mineral is monoclinic, $P2_1/c$, a = 9.6838(5), b = 5.75175(19), c = 17.6339(12) Å, β = 90.553(6)°, V = 982.14 Å^3, and Z = 4. The structure is based on $[Cu^{2+}Te^{6+}O_4(OH)_2]^{2-}$ sheets. These sheets are based on the straight edge-sharing chains of alternating $Cu^{2+}O_4(OH)_2$ and $Te^{6+}O_4(OH)_2$ octahedra, and the chains link to one another via shared octahedral corners. Adjacent $[Cu^{2+}Te^{6+}O_4(OH)_2]^{2-}$ sheets are linked by $Mg(H_2O)_6$ octahedra via hydrogen bonds. The mineral is named for the relation to its $C2/c$ dimorph raisaite, the crystal structure of which contains the same general types of octahedra linked in quite different ways. The holotype specimen is deposited in the Natural History Museum of Los Angeles County, Los Angeles, California, U.S.A. **Yu.U.**

PETŘÍČEKITE*

L. Bindi, H.-J. Förster, G. Grundmann, F.N. Keutsch, and C.J. Stanley (2016) Petříčekite, $CuSe_2$, a new member of the marcasite group from the Předbořice Deposit, Central Bohemia Region, Czech Republic. Minerals, 6(2), 33.

Petříčekite (IMA 2015-111), ideally $CuSe_2$, orthorhombic, is a new member of marcasite group discovered at the Předbořice uranium deposit, Central Bohemia Region, Czech Republic. It was also found at El Dragón mine, Potosi, Bolivia and in Sierra de Cacheuta, Mendoza, Argentina. Mineralized fissures Předbořice are complicated low-temperature hydrothermal veins up to 25–100 m long, 25–50 m high, and up to 30 cm (max. 1 m) thick, cutting through the metamorphic rocks close to its contact with granitoids of central bohemian pluton. The main ore mineral is uraninite. The main gangue minerals are quartz, hematite-bearing calcite, and barite. Mineralization also includes among others a number of rare selenides: aguilarite, athabascaite, berzelianite, bukovite, chaméanite, chrisstanleyite, clausthalite, eskebornite, eucairite, ferroselite, giraudite, jolliffeite, krut'aite-trogtalite series, klockmannite, merenskyite, naumannite, telargpalite, tiemannite, tyrrellite, umangite, fischesserite, hakite, milotaite, permingeatite, and native gold. In El Dragón mine selenides dominating over sulfides in small hydrothermal veins (to 4 cm thick) cutting black shale and silt stone. Petříčekite formed as a late-stage mineral in the Se mineralization. At the Sierra de Cacheuta deposit selenium mineralization occurs in calcitic veinlets in porphyry forming a fine-grained mixture of clausthalite, naumannite, klockmannite, umangite, berzelianite, eucairite, tyrrellite, and eskebornite. Petříčekite identified here based on optical and chemical data. This deposit is the type locality for achávalite and molybdomenite. Petříčekite, has been found in two specimens from Předbořice bought at a mineral fair and in old specimen from Sierra de Cacheuta obtained same way. The origin of material from El Dragón was not specified. In the specimens from Předbořice petříčekite occurs either as rare fractured inclusions up to 150 μm in large eucairite grains closely associated with athabascaite/klockmannite and unknown (under investigation) selenides, or as fractured inclusions in tiemannite closely associated with eskebornite. At El Dragón petříčekite forms euhedral to subhedral crystals up to 25 μm (often intergrown with krut'aite of an ideal composition and the phase with composition close to Cu_3Se_4) and skeletal and/or myrmekitic aggregates up to 200 μm filling cracks, pores and interstices in brecciated krut'aite-penroseite. Homogeneous grains are exceptional and usually partly or completely replaced by krut'aite. Klockmannite, watkinsonite, and native selenium found in grain-boundary contacts. Other associated minerals include quartz, calcite, barite, covellite, goethite, lepidocrocite, chalcomenite, molybdomenite, olsacherite, schmiederite, ahlfeldite, favreauite, felsőbányaite, and allophane. In the sample from Sierra de Cacheuta clausthalite partly replaced by krut'aite, petříčekite, molybdomenite, and native selenium. Petříčekite is black, opaque with a black streak and metallic luster. It is brittle, has uneven fracture. No cleavage was observed. Micro-indentation hardness VHN_{15} = 33 (28–40) kg/mm^2 corresponding to ~ 2–2½ of a Mohs scale. Density was not measured due to small grain size; D_{calc} = 6.673 g/cm^3. In reflected light, petříčekite from Předbořice is weakly pleochroic from pale blue gray to pale pinkish, and weakly bireflectant. It is anisotropic with light gray-blue to light pink rotation tints. Internal reflections were not observed. Pleochroism (from violet to blue) and anisotropy (with copper-red to light gray rotations tints) increase significantly for near endmember petříčekite from El Dragón. The reflectance values in air for Předbořice sample $(Cu_{0.53}Fe_{0.48})(Se_{1.98}S_{0.01})$ vary in 400–700 nm interval from 41.9 to 42.8% for R_1 and from 41.5 to 44.6% for R_2. For the **COM** wavelengths [R_1/R_2 % (nm)] are: 42.35/41.8 (470), 42.0/42.2 (546), 41.9/42.35 (589), 42.05/42.85 (650). The reflectance values for El Dragón sample $(Cu_{0.99}Se_{2.00})$ differ significantly [R_1/R_2 % (nm)], **COM** wavelengths are bolded: 26.9/50.7 (400), 25.7/44.0 (420), 24.9/40.2 (440), 24.2/37.5 (460), **24.0/36.3 (470)**, 23.7/35.1 (480), 23.1/32.8 (500), 22.3/30.6 (520), 21.5/28.6 (540), **21.4/28.2 (546)**, 21.1/27.1 (560), 21.4/25.7 (580), **21.9/25.1 (589)**, 22.5/24.4 (600), 24.6/23.3 (620), 27.9/22.8 (640), **29.8/22.9 (650)**, 31.7/23.0 (660), 35.8/24.3 (680), 39.4/27.1 (700). The averaged electron probe WDS analyses for **holotype** (9 points)/ all samples from Předbořice (66 points)/ El Dragón specimens (5 points) are [wt% (ranges)]: Ag **0.22 (0.09–0.46)**/ 0.37 (0–1.46)/ 0.04 (0.04–0.05), Cu **15.39 (15.10–15.56)**/ 16.81 (13.81–21.45)/ 28.42 (28.21–28.58)/ Hg **0.01 (0–0.07)**/ 0.33 (0–3.61)/ –, Pb **0.03 (0–0.07)**/ 0.01 (0–0.07)/ –, Fe **12.18 (12.02–12.34)**/ 9.47 (5.34–12.64)/ –, Pd 0.11 (0.02–0.17)/ 1.26 (0–9.64)/ –, Sb **0.00**/ 0.01 (0–0.10)/ –, **S 0.09 (0.08–0.10)**/ 0.08 (0–0.19)/ 0.03 (0.02–0.03), Se **71.61 (71.10–71.90)**/ 71.19 (68.83–71.97), total **99.64**/ 99.78/ 99.88. The empirical formulae based on 3 apfu are: $\mathbf{(Cu_{0.53}Fe_{0.48})_{\Sigma 1.01}(Se_{1.98}S_{0.01})_{\Sigma 1.99}}$/ $(Cu_{0.58}Fe_{0.38}Pd_{0.03}Ag_{0.01}Ni_{0.01})_{\Sigma 1.01}(Se_{1.99}S_{0.01})_{\Sigma 2.00}$/ $Cu_{0.99}Se_{2.00}$ (same as for sample from Sierra de Cacheuta for which wt% data for is not provided). The Cu-richest additionally structurally studied composition from Předbořice is $(Cu_{0.70}Fe_{0.30})_{\Sigma 1.00}Se_{2.00}$. The composition most close to end-member from that deposit is $(Cu_{0.74}Fe_{0.27}Ag_{0.01})_{\Sigma 1.02}Se_{1.98}$. The composition of the Pd-richest grain is $(Cu_{0.49}Fe_{0.22}Pd_{0.21}Ni_{0.05}Ag_{0.03})_{\Sigma 1.00}Se_{2.00}$. The strongest powder-diffraction lines [*d* Å (*I*%; *hkl*)] are: 2.938 (70; 101), 2.639 (100; 111), 2.563 (85; 120), 1.935 (70; 211), 1.834 (30; 002), 1.760 (25; 031), 1.492 (25; 122). The unit-cell parameters refined from the powder X-ray data are: $a = 4.9072(3)$, $b = 6.0116(4)$, $c = 3.6671(5)$ Å, $V = 108.18$ Å^3. The single-crystal X-ray data collected on the crystal 0.035 × 0.045 × 0.05 mm shows petříčekite is orthorhombic, space group *Pnnm*, $a = 4.918(2)$, $b = 6.001(2)$, $c = 3.670(1)$ Å; $V = 108.31$ Å^3; $Z = 2$. The crystal structure refined to $R_1 = 0.0336$ for 159 $F_o > 4\sigma(F_o)$ reflections. It is a marcasite-type structure consisting of edge-sharing chains of $CuSe_6$ octahedra parallel to [001] linked by sharing Se_2 dimers. The Se–Se bonds are all parallel to (001). The mineral name honors Václav Petříček (b. 1948), Czech crystallographer (Institute of Physics of the Czech Academy of Sciences, Prague), for his outstanding contributions to crystallography. The holotype is deposited in the Mineralogical and Geological Museum at Harvard, U.S.A. **D.B.**

QUIJARROITE*

H.-J. Förster, L. Bindi, G. Grundmann, and C.J. Stanley (2016) Quijarroite, $Cu_6HgPb_2Bi_4Se_{12}$, a new selenide from the El Dragón Mine, Bolivia. Minerals, 6(4), 123.

Quijarroite (IMA 2016-052), ideally $Cu_6HgPb_2Bi_4Se_{12}$, orthorhombic, is a new species discovered at the El Dragón mine, Antonio Quijarro Province, Department of Potosí, Bolivia and named for its type locality. The almost vertical ore vein is in the center of a 1.5 m wide shear zone thinly stratified, pyrite-rich black shales and reddish-gray, hematite-bearing siltstones of probably Devonian age. Selenium mineralization consisted of a single vein ~15 m long and mostly 0.5 to 2 cm thick and represents a multi-phase assemblage of primary and secondary minerals enriched with Se-bearing species. It is the type locality of eldragónite, favreauite, grundmannite, hansblockite, alfredopetrovite, and petříčekite. Quijarroite is a primary mineral, deposited from an oxidizing low-*T* hydrothermal fluid. The new mineral resembles phase "A" (Paar et al. 2012), $Cu_5HgPb_2Bi_3Se_{10}$ for which no structural data was provided and might be a polymorph of "Bi-rich petrovicite" $Cu_{6.50}Hg_{0.96}Pb_{2.04}Bi_{3.72}Se_{12}$ (Dymkov et al. 1990). Quijarroite mostly forms lath-shaped thin plates up to 150 × 20 μm intimately (subparallel) intergrown with hansblockite. Occasionally it occurs as sub- to anhedral grains up to 200 × 50 μm either alone in the matrix or intergrown with watkinsonite, clausthalite, eldragónite, krut'aite-penroseite, eskebornite, klockmannite, umangite and rarely, in grain-boundary contact, petrovicite, grundmannite, and native gold. The mineral is black, opaque, non-fluorescent, with a metallic luster and black streak. It is brittle, with an irregular fracture and no obvious cleavage and parting. The density and Mohs hardness were not measured due to the small grain size; $D_{calc} = 5.771$ g/cm^3. In reflected light, quijarroite is weakly pleochroic from cream to very slightly more brownish cream, displaying no internal reflections. It is moderately anisotropic with pale orange brown to blue rotation tints. Lamellar twinning on {110} is common; parquet twinning occurs rarely. The reflectance values in air [R_1/R_2 (nm)] (**COM** wavelengths bolded) are: 45.1/45.6 (400), 45.3/45.8 (420), 45.7/46.1 (440), 46.4/46.6 (460), **46.7/46.8 (470)**, 46.9/47.0 (480), 47.3/47.5 (500), 47.7/47.8 (520), 47.4/48.1 (540), **47.4/ 48.2 (546)**, 47.3/48.4 (560), 47.2/48.5 (580), **47.1/ 48.5 (589)**, 47.0/48.6 (600), 46.8/48.7 (620), 46.6/48.7 (640), **46.6/ 48.7 (650)**, 46.5/48.7 (660), 46.4/48.7 (680), 46.3/48.8 (700). The average of 24 electron probe WDS analyses [wt% (range)] is: Cu 13.34 (12.50–13.86), Ag 1.02 (0.42–1.76), Hg 7.67 (7.31–8.16), Pb 16.87 (16.55–17.11), Co 0.03 (0–0.11), Ni 0.15 (0–0.45), Bi 27.65 (27.37–28.05), Se 33.52 (33.19–34.00), total 100.24. The empirical formula, based on 25 apfu, is $(Cu_{5.84}Ag_{0.26})_{\Sigma 6.10}(Hg_{1.06}Ni_{0.07}Co_{0.01})_{\Sigma 1.14}Pb_{2.27}Bi_{3.68}Se_{11.81}$. The strongest X-ray powder-diffraction lines [*d* Å (*I*%; *hkl*)] are: 5.36 (55; 111), 3.785 (60; 211), 3.331 (40; 202), 3.291 (90; 022), 3.125 (100; 212), 2.312 (50; 400), 2.078 (35, 214). Unit-cell parameters refined from the powder X-ray data are $a = 9.2376(8)$, $b = 9.0176(7)$, $c = 9.6198(8)$ Å, $V = 801.34$ Å^3. Single crystal X-ray data obtained from a crystal fragment 0.03 × 0.035 × 0.05 mm shows quijarroite is orthorhombic, space group $Pmn2_1$, $a = 9.2413(8)$, $b = 9.0206(7)$, $c = 9.6219(8)$ Å, $V = 802.1$ Å^3, $Z = 1$. The crystal structure refined to $R = 0.0276$ for 1523 $[F_o > 4\sigma(F_o)]$ reflections. It is a galena derivative and its structure can be derived from that of bournonite. Polyhedra centered by Pb, Bi trigonal pyramids, and Cu tetrahedra share corners and edges to form a three-dimensional network. $CuSe_4$ tetrahedra share corners to form chains parallel to [001]. In quijarroite only one of the two Pb positions of bournonite (2*b* Wyckoff position) is occupied by Pb, whereas the second is vacant and replaced by a general position occupied by Cu and Hg (with site population: $Cu_{0.75}Hg_{0.25}$), showing almost perfect linear coordination. Comparing with bournonite, the structural formula of quijarroite can be written as $[Cu_{0.75}\square_{0.25}][Cu_{0.75}Hg_{0.25}]Pb_{0.5}BiSe_3$ ($Z = 4$), which for $Z = 1$ equals to $Cu_6HgPb_2Bi_4Se_{12}$. The X-rayed crystal fragment is deposited in the Florence Museum, Italy. The polished section, from which the holotype crystal fragment was extracted, is housed in the Natural History Museum, London. The cotype is deposited within the Mineralogische Staatssammlung München, Museum "Reich der Kristalle," Germany. **D.B.**

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STAROČESKÉITE*

R. Pažout and J. Sejkora (2018) Staročeskéite, $Ag_{0.70}Pb_{1.60}(Bi_{1.35}Sb_{1.35})_{\Sigma 2.70}S_6$, from Kutná Hora, Czech Republic, a new member of the lillianite homologous series. Mineralogical Magazine, 82(4), 993–1005.

Staročeskéite (IMA 2016-101), ideally $Ag_{0.70}Pb_{1.60}(Bi_{1.35}Sb_{1.35})_{\Sigma 2.70}S_6$, orthorhombic is a new member of lillianite homologous series of sulfosalts with $N = 4$. It has been discovered at the medieval mine dumps of Staročeské pásmo Lode of the Kutná Hora ore district, 60 km east of Prague, Central Bohemia, Czech Republic. Originally compositions corresponding to staročeskéite were detected in 2005. Then it was considered as an intermediate member between gustavite and andorite-group minerals. Later the structure was solved (Pažout and Dušek 2010) but the phase was only recognized as a new mineral species after the description of the another new Bi–Sb member of the lillianite homologous series: terrywallaceite from Huancavelica, Peru (Yang et al., 2013). The Kutná Hora Ag–Pb–Zn ore district contains a hydrothermal vein type mineralization of Variscan age. It was one of the main European producers of silver in the 14th to 16th centuries, with hundreds of mines on twelve major lodes each of those represents a hydrothermally altered zone of several hundred meters to about 3 km long and dozens of meters wide, with the depth range between several hundred meters to 1 km, each consisting of several, usually parallel veins. The new mineral was found in quartz gangue in the rich Ag–Pb–Bi–Sb sulfosalt association and was formed in the late-stage Bi-mineralization associating with other lillianite homologues (gustavite, terrywallaceite, vikingite, treasurite, eskimoite, erzwiesite, Bi-rich fizélyite, and Bi-rich ramdohrite) along with Ag- and Bi-bearing galena and Pb–Bi–Sb sulfosalts (izoklakeite, cosalite, and Bi-rich jamesonite). The origin of this mineralization is related to the penetration of low-temperature fluids (~100–250 °C) into tectonically opened fractures in older ore vein fillings (pyrite, arsenopyrite and stannite). Staročeskéite forms lath shaped crystals or anhedral grains up to 80 μm × 70 μm, growing together in aggregates up to 200 μm × 150 μm across. It is steel-gray with a metallic luster. No other data on physical properties is provided; D_{calc} = 6.185 g/cm^3. In reflected light staročeskéite is grayish white; bireflectance and pleochroism are weak with grayish tints. Anisotropy is weak to medium with gray to bluish gray rotation tints. Internal reflections were not observed. The reflectance values in air [R_{max}/R_{min} (nm)] (COM wavelengths bolded) are: 41.6/39.3 (400), 41.7/39.7 (420), 41.6/39.6 (440), 41.0/39.2 (460), **40.8/39.0 (470)**, 40.5/38.7 (480), 40.2/38.4 (500), 39.8/38.0 (520), 39.5/37.7 (540), **39.4/37.6 (546)**, 39.2/37.4 (560), 38.9/37.1 (580), **38.8/37.1 (589)**, 38.7/37.0 (600), 38.5/36.8 (620), 38.4/36.8 (640), **38.3/36.7 (650)**, 38.4/36.7 (660), 38.3/36.6 (680), 38.1/36.5 (700). The average of five WDS electron probe analyses [wt% (range)] is: Ag 7.02 (6.61 – 7.51), Cu 0.05 (0.04–0.07), Fe 0.05 (0.04–0.05), Pb 31.09 (29.67–31.82), Cd 0.10 (0.07–0.12), Bi 26.62 (25.36–27.94), Sb 16.01 (14.74–16.69), Se 0.07 (0.03–0.09), S 18.66 (18.29–18.82), total 99.67. The empirical formula based on 11 apfu is: $(Ag_{0.68}Cu_{0.01})_{\Sigma 0.69}(Pb_{1.56}Fe_{0.01}Cd_{0.01})_{\Sigma 1.58}(Bi_{1.32}Sb_{1.37})_{\Sigma 2.69}(S_{6.04}Se_{0.01})_{\Sigma 6.05}$, corresponding to N_{chem} = 3.94, Bi/(Bi+Sb) = 0.49 and L% = 70.5. An ideal formula, corresponding to L% = 70% [$Ag^+ + (Bi^{3+}, Sb^{3+}) \leftrightarrow 2\ Pb^{2+}$ substitution relative to the Ag-free ideal composition of lillianite $Pb_3Bi_2S_6$] and the Bi:Sb ratio 1:1 [Bi/(Bi+Sb) = 0.50], can be written as $Ag_{0.70}Pb_{1.60}(Bi_{1.35}Sb_{1.35})_{\Sigma 2.70}S_6$, which requires Ag 7.22, Pb 31.70, Bi 26.97, Sb 15.72, S 18.39, total 100.00 wt%. Powder X-ray data were not collected. The strongest lines of the calculated powder X-ray diffraction pattern are [d_{calc} Å (I_{calc}%; hkl)]: 3.746 (33; 112), 3.446 (62; 113), 3.382 (100; 025), 3.035 (45; 131), 2.932 (81; 132), 2.779 (34; 133), 2.127 (29; 200), 1.800 (23; 225). Single-crystal X-ray data obtained on a fragment 0.04 × 0.03 × 0.02 mm shows the mineral is orthorhombic, space group $Cmcm$, a = 4.2539(8), b = 13.3094(8), c = 19.625(1) Å, V = 1111.1 Å^3 and Z = 4. The structure of staročeskéite, a member of the lillianite homologous series with N = 4, was refined to final R_w = 5.08% for observed reflections. It consists of one Pb site (M3) in trigonal prismatic coordination and two octahedral mixed sites M1 and M2 each consisting of three elements. Based on obtained site occupancies, the empirical formula is ${}^{M3}Pb{}^{M2}(Sb_{0.60}Pb_{0.26}Bi_{0.14})_{\Sigma 2}{}^{M1}(Bi_{0.52}Ag_{0.36}Sb_{0.12})_{\Sigma 2}S_6$, which is in a good agreement with chemical data. It can be simplified to ${}^{M3}Pb{}^{M2}Sb_2{}^{M1}(AgBi)_{\Sigma 2}S_6$. The mineral lies between two series of the lillianite structures with N = 4: lillianite–gustavite series and the andorite series. Thus the name staročeskéite would be valid for a lillianite structure with composition $Ag_xPb_{3-2x}Bi_ySb_{2+x-y}S_6$ with $½ \le x \le 0.8$ and $1–½x \le y \le 2$, where x = Ag content = L% expressed as a fraction and y = total Bi content. For x = 1 the phase would correspond to Bi-rich andorite-VI [L%= 100 and Bi/(Bi + Sb) = 0.19] or terrywallaceite [L%= 100 and Bi/(Bi+Sb) = 0.66], and for x = 0.9 the phase would correspond to Bi-rich andorite-IV [L% = 90 and Bi/(Bi+Sb) = 0.19] or terrywallaceite [with L% = 90 and Bi/(Bi+Sb) = 0.69]. The holotype specimen has been deposited in the Department of Mineralogy and Petrology of National Museum in Prague, Czech Republic. **D.B.**

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Yang, H., Downs, R.T., Evans, S.H., and Pinch, W.W. (2013) Terrywallaceite, $AgPb(Sb,Bi)_3S_6$, isotypic with gustavite, a new mineral from Mina Herminia, Julcani Mining District, Huancavelica, Peru. American Mineralogist, 98, 1310–1314.

TANTALOWODGINITE*

S.L. Hanson, A.U. Falster, W.B. Simmons, R. Sprague, P. Vignola, N. Rotiroti, S. Andó, and F. Hatert (2018) Tantalowodginite, $(Mn_{0.5}\square_{0.5})TaTa_2O_8$, a new mineral species from the Emmons pegmatite, Uncle Tom Mountain, Main, U.S.A. Canadian Mineralogist, 56(4), 543–553.

Tantalowodginite (IMA 2017-095), $(Mn_{0.5}\square_{0.5})TaTa_2O_8$, monoclinic, is a new mineral discovered at the Emmons pegmatite dike, Uncle Tom Mountain near the town of Greenwood, Oxford Co., Maine, U.S.A (44°19′24.37″ N, 70°41′45.02″ W). The name "tantalowodginite" was earlier introduced (Ercit et al. 1984, 1992) but then retracted recognizing the type samples to be Ta-rich wodginite and lithiowodginite. Later "tantalowodginite" was identified at the Emmons pegmatite and submitted for approval (IMA 2000-26) but was not approved pending a complete structural analysis. Tantalowodginite in the quartz–K-feldspar core of complexly zoned pegmatite up to ~8 m thick intruded a high-grade metasedimentary migmatites. The wall zone comprised of K-feldspar, quartz, almandine, and schorl, and the intermediate zones are composed of K-feldspar, quartz, muscovite, and altered spodumene. The core-intermediate zone boundary has undergone almost total alteration and replacement with secondary minerals including cleavelandite, and a dense and fibrous muscovite as a fracture filling and as a secondary mineral replacing schorl and garnet. Pollucite pods several meters in size, large phosphate nodules (up to 15 cm), löllingite with minor arsenopyrite, and beryl (aquamarine, morganite, and goshenite in crystals up to 30 cm) are present. Tantalowodginite found in primary anhedral masses or clusters (0.5–12 cm) sometimes occurring rims on tantalite-(Mn) and in its term rimmed by wodginite. Rarely, in miarolitic cavities, it forms crystals (0.2–1 cm) rimmed by columbite-(Mn) and associated with muscovite and fluorapatite. The mineral is orange red to deep red, semi-transparent with a vitreous to sub-adamantine luster, and a yellowish-tan streak. Tantalowodginite is non-fluorescent in UV light. It is brittle with a conchoidal fracture, and a distinct {100} cleavage. The Mohs hardness is 5.5; D_{meas} = 7.61(1); D_{calc} = 7.87 g/cm^3. The mineral is weakly to moderately pleochroic from orangish-yellow parallel to cleavage to greenish-yellow perpendicular to cleavage on (010). It is biaxial (+) with strong to extreme birefringence and the refractive index over 2.0 (n_{calc} = 2.24); $2V \approx 70°$; Z ^ **c** = 5–12°. Due to strong dispersion it shows anomalously sky-blue interference colors, which appears only close to the extinction point. The average of six electron probe WDS analyses (wt%) is: Li_2O 0.54 (DCP spectrometry), MnO 6.23, FeO 0.23, TiO_2 0.01, SnO_2 8.14, Nb_2O_5 3.97, Ta_2O_5 80.75, total 99.87. No ranges or deviations are given. The empirical formula based on 8 O pfu is $(Mn_{0.58}Li_{0.24}Fe_{0.02}\square_{0.16})_{\Sigma 1.00}(Ta_{0.62}Sn_{0.36}Ti_{<0.01})_{\Sigma 0.98}(Ta_{1.80}Nb_{0.20})_{\Sigma 2.00}O_8$. The strongest X-ray powder diffraction lines are [d Å (I%; hkl)]: 7.332 (20; 110), 4.741 (20; 200), 3.838 (30; 021), 3.667 (100; 220), 3.000 (100; 221), 2.957 (100; $\bar{2}21$), 2.883 (30; 040), 1.778 (30; 260). The unit cell parameters refined from the X-ray powder data are: a = 9.510(6), b = 11.520(6), c = 5.118(3) Å, β = 91.22(5)°, V = 560.6 Å^3. Single crystal X-ray diffraction data obtained on a crystal fragment 0.05 × 0.075 × 0.115 mm shows tantalowodginite is monoclinic, space group $C2/c$, a = 9.542(1), b = 11.488(2), c = 5.128(1) Å, β = 91.13(1)°, V = 562.1 Å^3, Z = 4. The crystal structure was refined to R_1 = 2.73% for 762 unique $I > 3\sigma(I)$ reflections. Tantalowodginite is ^{A}Mn and ^{B}Ta member of wodginite group: ABC_2O_8 where A = Mn^{2+}, Fe^{2+}, Li, $\square$; B = Sn^{4+}, Ti, Fe^{3+}, Ta; C = Ta, Nb (Ercit et al. 1992). The wodginite structure has three octahedrally coordinated sites. The A- and B sites form zigzag chains along **z** via edge sharing. Within these chains, the A- and B-sites alternate within the same plane. The C-sites form chains via edge sharing that lie in a different plane and connect the A-B chains by sharing apexes alternately with the A and B polyhedra. In tantalowodginite the C-site is almost completely ordered and occupied mainly by Ta. The coupled substitution mechanism between tantalowodginite and wodginite is ${}^A\square + 2[{}^BTa^{5+}]_2 \leftrightarrow {}^AMn^{2+} + 2[{}^BSn^{4+}]$. The electron distributions at A- and B-sites obtained from structural data are different from those indicated by the chemical analyses. That may be caused by strong cation disorder. The name is given for its composition according wodginite group classification scheme. The type specimen is deposited in the Maine Mineral and Gem Museum, Maine, U.S.A. **D.B.**

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TOPSØEITE*

T. Balić-Žunić, A. Garavelli, and D. Mitolo (2018) Topsøeite, $FeF_3(H_2O)_3$, a new fumarolic mineral from the Hekla Volcano, Iceland. European Journal of Mineralogy, 30 (4), 841–848.

Topsøeite (IMA 2016-113), ideally $FeF_3(H_2O)_3$, tetragonal, was discovered in the fumaroles of the Hekla Volcano, Iceland, in the specimen collected in 1992 after the 1991 eruption. The temperature in the fumarole at the time of sampling was 170 °C. A preliminary description was given by Jakobsson et al. (2008) under the name HI (UM2008-30-F:FeHO). Topsøeite forms short, pseudocubic tetragonal prisms up to several tens of micrometers, crystal aggregates up to 100 μm, or fractured veins inside up to 3 mm thick yellow to brown crust on altered scoria, together with hematite, opal, mallardite, heklaite, ralstonite, and several other not fully characterized minerals. Topsøeite is yellow with irregular fracture and no prominent cleavage observed. Density and optical properties were not measured due to tiny size of crystals and intimate admixture with other minerals; $D_{calc} = 2.067$ g/cm^3. For an ideal formula $D_{calc} = 2.330$ and $n_{calc} = 1.63$. The averaged 11 point electron probe EDS analyses on unpolished surface is [wt%, (range/standard deviation)]: Fe 38.52 (33.50–42.92/3.34), F 38.23 (33.20–43.67/3.48), Cl 1.03 (0.41–1.64/0.42), O 21.10 (15.29–26.20/4.00), total 98.88. The empirical formula based on one atom of Fe pfu is $Fe(F_{2.94}Cl_{0.04})_{\Sigma 2.98}(H_2O)_{1.94}$. The strongest lines of the powder X-ray diffraction pattern are [*d* Å (*I*%; *hkl*)]: 5.55 (100; 110), 3.92 (43; 020), 3.47 (39; 011), 3.17 (22; 111), 2.77 (30; 220), 2.479 (31; 130,310), 1.877 (16; 012), 1.753 (24; 240,420). The crystal structure of topsøeite was solved and refined by the Rietveld method to $R_P = 3.98\%$. Topsøeite is tetragonal, *P*4/*n*, $a = 7.8381(3)$, $c = 3.8674(1)$ Å, $V = 237.60$ Å^3, $Z = 2$. The X-ray data matches well with that of synthetic β-$FeF_3(H_2O)_3$. The structure consists of straight infinite chains of $[FeF_4(H_2O)_2]$ octahedra extending along the **c** axis. The adjacent octahedra share apical F atoms. Four unshared, equatorially positioned atoms are disorder two F and two O atoms from H_2O groups. Additional H_2O groups occupy the spaces between chains and are tetrahedrally coordinated by four (F, H_2O) from four different chains. One third of the H_2O groups is not directly coordinated to Fe atoms but bonded only through hydrogen bonds. That might explain the deficit of the water obtained by the chemical analysis assuming that the crystal structure can be partially dehydrated. Topsøeite is isostructural with rosenbergite [β-$AlF_3(H_2O)_3$]. The name is after the Topsøe family of Danish scientists including Haldor Frederik Axel Topsøe (1842–1935), Haldor Topsøe (1913–2013), and Henrik Topsøe (b.1944) contributed significantly to the crystallography and chemistry. The holotype specimen is deposited in the Icelandic Institute of natural History, Gardabaer, Iceland. **Yu.U.**

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TSYGANKOITE*

A.V. Kasatkin, E. Makovicky, J. Plášil, R. Škoda, A.A. Agakhanov, V.Y. Karpenko, and F. Nestola (2018) Tsygankoite, $Mn_8Tl_8Hg_2(Sb_{21}Pb_2Tl)_{\Sigma 24}S_{48}$, a new sulfosalt from the Vorontsovskoe Gold Deposit, Northern Urals, Russia. Minerals, 2018 (8), 218.

Tsygankoite (IMA 2017-088), ideally $Mn_8Tl_8Hg_2(Sb_{21}Pb_2Tl)_{\Sigma 24}S_{48}$, monoclinic, is a new sulfosalt discovered at the Vorontsovskoe gold deposit, near the settlement of Vorontsovka, 13 km south of Krasnotur'insk city, North Urals, Russia. General data on the occurrence and mineral assemblages of the deposit are given in the abstract for other two new minerals recently discovered there: vorontsovite and ferrovorontsovite (see below). Along with these new species tsygankoite was found in the ores of the sulfide-carbonate type and was identified only in three polished sections. Tsygankoite occurs as lath-like elongated crystals up to 0.2 mm embedded in calcite–dolomite–clinochlore matrix. Occasionally it partly replaced with alabandine. The associated minerals also include aktashite, arsenopyrite, barite, cinnabar, fluorapatite, orpiment, pyrite, realgar, routhierite, sphalerite, tilasite, and titanite. The new mineral is black, opaque with a metallic luster and black streak. It is brittle with an uneven fracture and no obvious parting and cleavage. The micro indentation hardness $VHN_{10} = 144$ (131–167) kg/mm^2, corresponding to ~3 of Mohs scale. The density was not measured; $D_{calc} = 5.450$ g/cm^3. In reflected light, tsygankoite is white, non-pleochroic. It is weakly bireflectant and strongly anisotropic with rotation tints vary from light gray to dark gray to black. No internal reflections were observed. The reflectance values in air [R_1/R_2 (nm)] (COM wavelengths bolded) are: 33.85/30.53 (400), 33.64/30.94 (420), 32.39/30.72 (440), 32.88/31.56 (460), **33.16/31.67 (470)**, 33.44/31.78 (480), 33.22/31.71 (500), 32.84/31.49 (520), 32.53/31.26 (540), **32.41/31.11 (546)**, 32.26/31.00 (560), 31.89/30.54 (580), **31.58/30.18 (589)**, 31.51/30.14 (600), 30.95/29.83 (620), 30.27/29.10 (640), **29.83/28.73 (650)**, 29.37/28.39 (660), 28.29/27.58 (680), 27.41/26.74 (700). The average of seven electron probe WDS analyses [wt% (range)] is Mn 6.29 (6.15–6.40), Hg 5.42 (5.31–5.58), Tl 26.05 (25.52–26.53), Pb 5.84 (5.01–6.34), As 3.39 (3.15–3.72), Sb 30.89 (30.32–31.39), S 21.87 (21.40–22.40), total 99.75. The empirical formula, based on 90 apfu, is $Mn_{8.06}Tl_{8.97}Hg_{1.90}Sb_{17.86}As_{3.19}Pb_{1.98}S_{48.03}$. No X-ray powder diffraction data was obtained due to the lack of material. The strongest lines of the calculated powder X-ray diffraction pattern are [d_{calc} Å (I_{calc}%; *hkl*)]: 3.866 (38; $\bar{2}07$), 3.587 (100; 112), 3.559 (44; $\bar{6}02$), 3.391 (68; $\bar{2}08$), 3.353 (70; $\bar{1}14$), 3.204 (88; 405), 2.988 (45; 313), 2.786 (99; $\bar{5}14$). Single-crystal X-ray data obtained on crystal fragment 0.032 × 0.017 × 0.007 mm shows tsygankoite is monoclinic, space group *C*2/*m*, $a = 21.362(4)$, $b = 3.8579(10)$, $c = 27.135(4)$ Å, $\beta = 106.944(14)°$, $V = 2139.19$ Å^3, $Z = 1$. The crystal structure of tsygankoite was refined to $R = 0.0607$ for 957 unique [$I > 3\sigma(I)$] reflections. The structure is unique among minerals having partial similarity to that of rouxelite $Cu_2HgPb_{22}Sb_{28}S_{64}(O,S)_2$. It consists of an alternation of two thick layer-like arrays of PbS- and SnS- archetypes. The former contains a Hg site, Tl site, octahedrally coordinated Mn site, and two pure Sb sites. The latter contains four distinct Sb sites, all of which statistically mix with either heavier Pb or Tl cations or with arsenic. Embedded in this array is a Tl3 site, and a Mn^{2+} site, apical to the second array. The simplified formula based on structure refinement is $Mn_8Tl_8Hg_2(Sb_{9.85},As_{2.18})_{12.03}(Sb_{8.89}Pb_{1.44}Tl_{1.67})_{12}S_{48}$. Certain disagreement with chemical data is explained either by slightly distinct chemistry of the grains used for EMPA and SCXRD or by less perfect resolution of Sb/As and Sb/Pb + Sb/Tl distribution among the Sb sites. The mineral name honors Mikhail Vladimirovich Tsyganko (b. 1979), a mineral collector from city of Severouralsk, Northern Urals, Russia and founder of the mineralogical museum in that city. He collected the specimens where the new mineral was discovered along with other specimens where new species vorontsovite and ferrovorontsovite were found. The type specimen is deposited in the Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow, Russia. **D.B.**

VORONTSOVITE* AND FERROVORONTSOVITE*

A.V. Kasatkin, F. Nestola, A.A. Agakhanov, R. Škoda, V.Y. Karpenko, M.V. Tsyganko, and J. Plášil (2018) Vorontsovite, $(Hg_5Cu)_{\Sigma 6}TlAs_4S_{12}$, and ferrovorontsovite, $(Fe_5Cu)_{\Sigma 6}TlAs_4S_{12}$: The Tl- and Tl-Fe-analogues of galkhaite from the Vorontsovskoe Gold Deposit, Northern Urals, Russia. Minerals, 8(5), 185.

Two new mineral species, vorontsovite (IMA 2016-076), $(Hg_5Cu)_{\Sigma 6}TlAs_4S_{12}$, and ferrovorontsovite (IMA 2017-007), $(Fe_5Cu)_{\Sigma 6}TlAs_4S_{12}$, the Tl- and Tl–Fe-analogues of galkhaite, have been discovered at the

Vorontsovskoe gold deposit, near the settlement of Vorontsovka, 13 km south of Krasnotur'insk city, North Urals, Russia. The specimens were found in 2016 at the ore stockpile. Earlier, the composition with Tl slightly dominant over Cs pfu, thus corresponding to vorontsovite, was reported (Chen and Szymański 1981) in one spot in the core of zonal galkhaite crystal from the Getchel mine, Nevada, U.S.A. It was noted however that peak overlapping and the lack of suitable standards might affect the accuracy of the chemical data. Vorontsovskoe deposit is located in a volcanic-plutonic belt. Ore formation developed in several stages and represented by three main types of primary ores: sulfide-skarn ores, sulfide-silicate ores, and sulfide-carbonate ores. Both new minerals occur in the ores of the third type located in calcite-dolomite limestone breccias with subordinated quartz, feldspar, clinochlore, muscovite, accessory minerals (titanite, apatite, baryte, armenite, scheelite, gold), and sulfidic assemblage: abundant pyrite, realgar, stibnite, and cinnabar; less common orpiment, Hg-sphalerite, and Zn–Mn-bearing metacinnabar; rare wakabayashilite and coloradoite. Thallium mineralization is presented by relatively common routhierite, dalnegroite-chabournéite and parapierrotite-bernardite series. Other Tl-bearing species are extremely rare and include christite, boscardinite, enneasartorite and heptasartorite. The new minerals form black anhedral grains up to 0.5 mm (vorontsovite) and 0.2 mm (ferrovorontsovite) (usually much smaller with an average size ~0.05 mm) and their segregations up to 1 mm embedded in white calcite-dolomite matrix. Both species are opaque, have metallic luster and black streak, are brittle with uneven fracture. Cleavage and parting were not observed. Both are non-fluorescent in UV light, and both are insoluble in 10% HCl. The indentation hardness VHN_{10} = 172 (166–178) kg/mm^2 for vorontsovite and 170 (166–174) kg/mm^2 for ferrovorontsovite, corresponding to ~3½ of Mohs scale. Density was not measured; D_{calc} = 5.14 and 4.74 g/cm^3 respectively. In reflected light both are light gray, isotropic. No bireflectance, pleochroism, and internal reflections were observed. The reflectance values in air [$R_{vorontsovite}/R_{ferrovorontsovite}$ % (nm)] (**COM** wavelengths bolded) are: 25.62/24.90 (400); 25.82/25.02 (420); 25.97/25.21 (440); 26.20/25.43 (460); **26.31/25.54 (470)**; 26.42/25.64 (480); 26.54/25.87 (500); 26.95/26.11 (520); 27.21/26.41 (540); **27.30/26.49 (546)**; 27.55/26.71 (560); 27.87/27.06 (580); **28.11/27.26 (589)**; 28.30/27.47 (600); 28.70/27.52 (620); 29.06/27.83 (640); **29.28/27.90 (650)**; 29.47/27.98 (660); 29.98/28.39 (680); 30.44/28.83 (700). The averaged electron WDS probe analyses for vorontsovite/ferrovorontsovite (10 spots for each) [wt% (ranges)] are: Hg 35.70 (30.66–38.78)/ 25.13 (22.03–27.00), Fe 5.36 (3.99–8.46)/ 9.89 (9.08–10.88), Zn 1.26 (1.16–1.35)/ 1.16 (0.93–1.43), Cu 3.42 (3.28–3.75)/ 3.95 (3.84–4.07), Ag 0.64 (0.47–0.85)/ 0.45 (0.10–0.89), Tl 11.53 (10.93–12.27)/ 12.93 (12.22–13.55), Cs 0.35 (0–0.67)/ 0.44 (0.19–0.78), Pb 0.04 (0–0.11)/ 0.04 (0–0.09), As 15.98 (14.74–17.26)/ 17.83 (17.13–19.01), Sb 2.35 (1.58–2.79)/ 2.15 (1.59–2.85), Te 0.41 (0.36–0.49)/ 0.40 (0.38–0.50), S 22.70 (21.91–24.31)/ 24.91 (23.90–25.90), Se 0.02 (0–0.08)/ b.d.l., total 99.76/ 99.28. No other elements with $Z > 8$ were detected. The empirical formulae, based of 23 apfu, are: $[(Hg_{3.02}Fe_{1.63}Zn_{0.33})_{\Sigma 4.98}(Cu_{0.91}Ag_{0.10})_{\Sigma 1.01}](Tl_{0.96}Cs_{0.04})_{\Sigma 1.00}(As_{3.62}Sb_{0.33}Te_{0.05})_{\Sigma 4.00}S_{12.01}$/ $[(Fe_{2.74}Hg_{1.94}Zn_{0.27})_{\Sigma 4.95}(Cu_{0.96}Ag_{0.06})_{\Sigma 1.02}](Tl_{0.98}Cs_{0.05})_{\Sigma 1.03}(As_{3.68}Sb_{0.27}Te_{0.05})_{\Sigma 4.00}S_{12.00}$. The strongest lines of the powder X-ray diffraction pattern are [$d_{vorontsovite}$ Å (I%)/ $d_{ferrovorontsovite}$ Å (I%, hkl)]: 7.28 (16)/ 7.22 (10, 110); 4.198 (79)/ 4.175 (93, 211); 2.970 (100)/ 2.952 (100, 222); 2.749 (66) /2.735 (57, 321); 2.572 (22)/ 2.562 (18, 400); 1.879 (18)/ 1.869 (11, 521); 1.818 (49)/ 1.810 (40, 440); 1.550 (31)/ 1.543 (24, 622). The cubic unit-cell parameters refined from the powder data are a = 10.2921(2)/ 10.2486(2) Å. Single-crystal X-ray data obtained from the grains of 0.015 × 0.012 × 0.010/ 0.020 × 0.010 × 0.008 mm confirm the cubic symmetry, space group $I\bar{4}3m$, with a = 10.2956(6) Å, V = 1091.3 Å^3, Z = 2 (vorontsovite)/ 10.2390(7) Å, V = 1073.43 Å^3 , Z = 2 (ferrovorontsovite). The crystal structures of vorontsovite/ ferrovorontsovite were refined to R_1 [$F_o > 4\sigma(F_o)$] = 0.0376/ 0.0576 for 227/ 250 observed reflections. Both species are isostructural with galkhaite, being its Tl- and Tl–Fe analogues, respectively, and forming together the galkhaite group. Similarly to galkhaite, the crystal structures of vorontsovite and ferrovorontsovite are represented by three independent crystallographic sites: Tl and Cs share large 12-fold coordinated cavities; As with Sb and Se are at the top of a trigonal pyramids, the base of which is a triangle formed by S-anions; $(Hg,Fe,Zn)S_4$ tetrahedra form a three-dimensional framework through corner-sharing. The homovalent substitution $Hg^{2+} \leftrightarrow Fe^{2+}$, Zn^{2+} is typical for many sulfosalts thus making possible the existence of potential Zn member of the group. Vorontsovite was named for its type locality, which name consequently honors the mining engineer Vladimir Vasilyevich Vorontsov (1842 – later than 1908). Ferrovorontsovite named as its Fe-analogue. The type specimens of both new minerals are deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **D.B.**

Comments: A strong difference in accuracy of the electron probe data depend on the choice of emission lines, standards, beam focus, etc., was noted for galkhaite (Chen and Szymański 1981; Pekov and Bryzgalov 2006). Particular, a defocused beam was used to avoid a sample damage. The new species were analyzed at 25 kV and 20 nA with a beam size of 1 μm. No data on the samples behavior under the beam provided. The difference in optical properties between galkhaite and isostructural new minerals seems unusual. The reflectance value for galkhaite is gradually decreasing from ~ 27 to ~ 20% with the wavelength increasing from ~470 to ~700 nm and further (Gruzdev et al. 1972), while for vorontsovite/ ferrovorontsovite these values are increasing from ≈ 26/ 25 to ≈ 30/ 29 % at the same interval. The reason for that might be in Tl behavior in the structure and deserves a special discussion.

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