

New Mineral Names*†

DMITRIY I. BELAKOVSKIY¹ AND OLIVIER C. GAGNE²

¹Fersman Mineralogical Museum, Russian Academy of Sciences, Leninskiy Prospekt 18 korp. 2, Moscow 119071, Russia

²Department of Geological Sciences, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada

IN THIS ISSUE

This New Mineral Names has entries for 10 new minerals, including debattistiite, evdokimovite, ferdowsiite, karpovite, kolskyite, markhininite, protochabournéite, raberite, shulamitite, and vendidaite.

DEBATTISTIITE*

A. Guastoni, L. Bindi, and F. Nestola (2012) Debattistiite, $\text{Ag}_9\text{Hg}_{0.5}\text{As}_6\text{S}_{12}\text{Te}_2$, a new Te-bearing sulfosalt from Lengenbach quarry, Binn valley, Switzerland: description and crystal structure. *Mineralogical Magazine*, 76(3), 743–750.

Debattistiite (IMA 2011-098), ideally $\text{Ag}_9\text{Hg}_{0.5}\text{As}_6\text{S}_{12}\text{Te}_2$, is a new mineral discovered in the famous for Pb-Cu-Ag-As-Tl bearing sulfosalts Lengenbach quarry in the Binn Valley, Valais, Switzerland. Debattistiite has been identified in two specimens from zone 1 of the quarry in cavities in dolomitic marble with realgar, rutile, trechmannite, and hutchinsonite. The mineral occurs as very rare tabular euhedral black, opaque crystals up to 150 μm with a metallic luster and a gray streak. It is brittle with uneven fracture and no cleavage. The Vickers hardness $\text{VHN}_{25} = 80$ (65–94) kg/mm^2 , corresponding to a Mohs hardness of 2–2½. Density was not measured due to small size of grains; $D_{\text{calc}} = 5.647$ g/cm^3 . In reflected light debattistiite is dark gray, highly birefractant and weakly pleochroic from dark gray to a slightly greenish gray. It is highly anisotropic with brownish to blue rotation tints. No internal reflections were observed. The reflectance values in air for the COM wavelengths [R_{min} , R_{max} , (nm)] are 27.2, 34.5 (471.1), 25.5, 31.0 (548.3), 22.9, 28.4 (586.6), 20.1, 25.2 (652.3). The average of 9 electron probe WDS analyses [wt% (range)] is: Ag 44.88 (44.43–45.26), Hg 4.49 (4.11–4.68), As 20.77 (20.21–21.30), S 17.72 (17.19–18.01), Te 11.82 (11.44–12.09), total 99.68. Other detectable elements were at or below detection limits. The empirical formula based on 29.5 apfu is $\text{Ag}_{9.01}\text{Hg}_{0.49}\text{As}_{6.01}\text{S}_{11.98}\text{Te}_{2.01}$. The strongest lines of the calculated X-ray powder diffraction pattern [d Å (I ; hkl)] are: 10.56 (62; 001), 3.301 (47; $\bar{2}12$), 2.991 (40; $2\bar{1}2$), 2.742 (95; $\bar{2}\bar{1}1$), 2.733 (100; $\bar{2}30$). X-ray single-crystal diffraction study on a crystal fragment $70 \times 50 \times 40$ μm shows the mineral is triclinic, space group $P\bar{1}$; $a = 7.832(5)$, $b = 8.606(4)$, $c = 10.755(5)$ Å, $\alpha = 95.563(9)$, $\beta = 95.880(5)$, $\gamma = 116.79(4)^\circ$, $V = 635.3$ Å³; $Z = 1$. In the crystal structure of debattistiite [refined to $R_1 = 0.0826$

for 795 unique $I > 2\sigma(I)$ reflections] corner-sharing As(S,Te)₃ pyramids form three-membered distorted rings linked by Ag atoms in triangular or distorted tetrahedral coordination. Certain features of that linkage are similar to those in the structures of trechmannite and minerals of pearceite–polybasite group. Of the seven anion positions, one is almost fully occupied by Te ($\text{Te}_{0.93}\text{S}_{0.07}$). The Hg atom is in a nearly perfect linear coordination with two Te/S atoms. One of five Ag sites and Hg site, which are very close (separation 1.137 Å), are partially occupied (50%). Thus there is a statistical distribution (50:50) between $\text{Hg}(\text{Te,S})_2$ and $\text{AgS}_2(\text{Te,S})_2$ polyhedra in the structure. The conditions of sulfotellurides formation in hydrothermal systems are discussed. It is suggested that debattistiite formed from hydrothermal solutions at temperatures >330 °C similar to those reported for the other Lengenbach sulfosalts. The mineral was named for Luca De Battisti (b.1958), a systematic mineralogist and expert on the minerals of Lengenbach quarry who collected the specimens of debattistiite. Holotype material is deposited in the Museum of Mineralogy, Department of Geosciences, University of Padova, Italy. **D.B.**

EVDOKIMOVITE*

O.L. Siidra, L.P. Vergasova, Y.L. Kretser, Y.S. Polekhovskiy, S.K. Filatov, and S.V. Krivovichev (2014) Unique thallium mineralization in the fumaroles of the Tolbachik volcano, Kamchatka Peninsula, Russia. II. Evdokimovite, $\text{Tl}_4\text{VO}_3(\text{SO}_4)_5(\text{H}_2\text{O})_5$. *Mineralogical Magazine*, 78(7), 1711–1724.

Evdokimovite (IMA 2013-041), ideally $\text{Tl}_4\text{VO}_3(\text{SO}_4)_5(\text{H}_2\text{O})_5$ was discovered in a sample from a fumarole at the First scoria cone, North Breach of the Great Fissure Tolbachik volcano eruption, Kamchatka Peninsula, Russia. Evdokimovite occurs as thin colorless needles up to 0.09 mm long with no twinning in association with markhininite and karpovite. Other associated minerals are pauflerite bobjonesite and shcherbinaite. The mineral has a white streak and adamantine luster. It is brittle with no cleavage or parting and has conchoidal fracture. The average microhardness is $\text{VHN}_{100} = 92$ kg/mm^2 ; Mohs hardness is ~2½. The density was not measured; $D_{\text{calc}} = 4.20$ g/cm^3 for the ideal formula. In reflected light the mineral is light gray with beige tints, weak birefractance and no pleochroism. Anisotropy is masked by abundant greenish-gray internal reflections. Reflectance values were measured in air

* 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-cnmmc/>.

between 400 and 700 nm with 20 nm intervals. The values for the COM wavelengths [R_{\min} , R_{\max} , (nm)] are 7, 7.2 (470); 6.7, 6.9 (546); 6.6, 6.8 (589); 6.4, 6.6 (650). The average of 30 electron probe EDS analysis [wt% (range)] is Ti_2O 55.40 (54.2–56.01), VO_2 14.92 (12.09–15.62), SO_3 25.83 (24.39–27.03), H_2O 5.75 (calculated by stoichiometry and structural data), total 101.90. The empirical formula calculated on the basis of (Ti + V + S) = 12 apfu is $\text{Ti}_{4.10}\text{V}_{2.83}\text{S}_{5.07}\text{H}_{10.00}\text{O}_{27.94}$. A needle of evdokimovite $0.05 \times 0.01 \times 0.008$ mm was used for a single crystal study. The crystal structure was solved by direct methods and refined to $R_1 = 0.11$ on the basis of 3660 independent [$F \geq 4\sigma(F)$] reflections. It contains six symmetrically independent Ti^+ sites, three V^{4+} sites, and five S^{6+} sites. The V^{4+}O_6 octahedra and SO_4 tetrahedra share corners to form two types of vanadyl-sulfate chains, $[(\text{VO})(\text{H}_2\text{O})_2(\text{SO}_4)_2]^{2-}$ and $[(\text{VO})_2(\text{H}_2\text{O})_3(\text{SO}_4)_3]^{2-}$ linked by Ti atoms and H bonds. The structure can be described as a stacking of layers of A and B types. The A layer contains $[(\text{VO})_2(\text{H}_2\text{O})_3(\text{SO}_4)_3]^{2-}$ chains, Ti(2) and Ti(3) atoms. The B layer contains $[(\text{VO})(\text{H}_2\text{O})_2(\text{SO}_4)_2]^{2-}$ chains and Ti(1) atoms. The layers stacked as ...A*BAA'B*A*..., where A and A' differ by opposite orientations of the $[(\text{VO})_2(\text{H}_2\text{O})_3(\text{SO}_4)_3]^{2-}$ chains, and the A* and B* layers are rotated by 180° relative to the A and B layers, respectively. The chains $[(\text{VO})_2(\text{H}_2\text{O})_3(\text{SO}_4)_3]^{2-}$ are modulated and are arranged to form elliptical tunnels hosting disordered Ti(4), Ti(4A), and Ti(4B) sites. Evdokimovite is monoclinic, $P2_1/n$, $a = 6.2958(14)$, $b = 10.110(2)$, $c = 39.426(11)$ Å, $\beta = 90.347(6)^\circ$, $V = 2509.4$ Å³, $Z = 4$. The powder X-ray diffraction data were obtained from the crushed crystal used for the single crystal analysis. Unit-cell parameters refined from the powder data are $a = 6.292(9)$, $b = 10.103(9)$, $c = 39.43(2)$ Å, $\beta = 90.4(1)^\circ$. The strongest lines of the XRD powder pattern [d_{obs} Å ($I_{\text{obs}}\%$, hkl)] are: 9.793 (57, 011); 8.014 (100, 013); 6.580 (26, 006); 4.011 (19, 026); 3.621 (29, 118); 3.522 (44, 125); 3.010 (19, 036); 2.974 (21, 212). The new mineral is named in honor of Mikhail Dmitrievich Evdokimov (1940–2010), of the Department of Mineralogy, St. Petersburg State University, for his contributions to mineralogy and petrology, and teaching mineralogy to several generations of students. Type material is deposited in the Mineralogical Museum of St. Petersburg State University, St. Petersburg, Russia. **D.B.**

FERDOWSIITE*

E. Makovicky, D. Topa, H. Tajeddin, H. Putz, and G. Zagler (2013) Ferdowsiite: a new mineral from the Barika Ore Deposit, Iran. *Canadian Mineralogist*, 51(5), 727–734.

Ferdowsiite (IMA 2012-062), ideally $\text{Ag}_8(\text{Sb}_5\text{As}_3)_{28}\text{S}_{16}$, is a new mineral from the Barika gold deposit, located in NW Iran, 17 km East of Sardasht (West Azerbaijan province). This is a gold-rich volcanogenic massive sulfide deposit of Cretaceous age, where greenschist metamorphism and deformation in shear zones overprint the original synvolcanic stratiform mineralization. Ferdowsiite occurs as elongated crystals in barite, as worm-like symplectites with ferroan tetrahedrite-tennantite, and is sometimes found enveloping arsenquatrandorite, in turn surrounded by guettardite. Other associated minerals include smithite, sterryite, bournonite, boulangerite, geocronite, galena, as well as a plumbian variety of ferdowsiite. The maximum grain size of ferdowsiite is ~400 μm. The mineral is grayish

black with a dark gray streak, is opaque, metallic, brittle with irregular fracture and shows no cleavage or parting. The estimated Mohs hardness is 2½–3. Density could not be measured due to the paucity of the material; $D_{\text{calc}} = 5.3$ g/cm³. Ferdowsiite is grayish-white in reflected light and shows no internal reflections. Pleochroism is distinct, white to gray. Reflectance values were measured between 400 and 700 nm in 20 nm intervals. The values for (COM) wavelengths [R_{\min} , R_{\max} , % (λ nm)] in air are: 34.9, 37.3 (470); 33.4, 35.9 (546); 32.4, 35.1 (589); 30.7, 33.5 (650). Anisotropism is distinct in air and enhanced in oil; rotation tints vary between dark brown and bluish gray. The average of 10 electron probe WDS analyses on the holotype sample gave [wt% (range)]: Ag 38.81 (37.99–39.33), Pb 0.76 (0.51–1.19), Sb 26.06 (25.23–27.84), As 10.64 (9.23–11.56), Bi 0.11 (0.00–0.22), S 23.21 (22.68–23.75), total 99.59 wt%. The empirical formula based on 32 apfu is $\text{Ag}_{7.97}\text{Pb}_{0.08}\text{Sb}_{4.75}\text{As}_{3.15}\text{Bi}_{0.01}\text{S}_{16.04}$. The strongest lines in the calculated X-ray powder-diffraction pattern [d_{calc} Å ($I_{\text{calc}}\%$, hkl)] are: 3.225 (96, 113), 3.205 (100, $\bar{2}12$); 2.8995 (78, 020); 2.7559 (90, 301); 2.7073 (79, $\bar{1}05$); 1.9401 (22, 206); 1.9226 (22, $\bar{4}04$). Single-crystal X-ray diffraction data refined to $R_1 = 0.0282$ for 626 unique reflections with $I \geq 4\sigma(I)$ shows the mineral is monoclinic, space group $P2_1/n$, $a = 8.677(2)$, $b = 5.799(1)$, $c = 13.839(3)$ Å, $\beta = 96.175(4)^\circ$, $V = 692.28$ Å³, and $Z = 1$. Ferdowsiite belongs to ABX_2 -type silver sulfosalts, combining Sb and As, although its crystal structure is different from other members of this group. The structure of ferdowsiite has four independent cation and four anion sites, where two are occupied by Ag, one by Sb, and the remaining site shows mixed occupancy. The structure contains zigzag chains of Sb connected via short Sb–S bonds and flanked by (Sb,As)₃ groups and Ag polyhedra. The crystal structure can be interpreted as a complex superstructure of the cubic PbS archetype, with structural affinity to the ternary sulfosalts diaphorite. Ferdowsiite is named after Ferdowsi Tousi (935–1020), a great Persian personality and poet in honor of his life-long endeavor to preserve the national identity, language and heritage of his homeland. The holotype specimen of ferdowsiite is deposited in the mineral collection of the Natural History Museum in Vienna, Austria. **O.C.G.**

KARPOVITE*

O.L. Siidra, L.P. Vergasova, Y.L. Kretser, Y.S. Polekhovsky, S.K. Filatov, and S.V. Krivovichev (2014) Unique thallium mineralization in the fumaroles of the Tolbachik volcano, Kamchatka Peninsula, Russia. II. Karpovite, $\text{Ti}_2\text{VO}(\text{SO}_4)_2(\text{H}_2\text{O})$. *Mineralogical Magazine*, 78(7), 1699–1709.

Karpovite (IMA 2013-040), ideally $\text{Ti}_2\text{VO}(\text{SO}_4)_2(\text{H}_2\text{O})$ was discovered in a sample from a fumarole at the First scoria cone, North Breach of the Great Fissure Tolbachik volcano eruption, Kamchatka Peninsula, Russia. The mineral occurs as sheaf-like aggregates up to $0.4 \times 0.2 \times 0.2$ mm or bundles of needle like prismatic crystals with no twinning in direct association with markhininite, evdokimovite and bobjonesite. Other associated minerals are paufferite and shcherbinaite. Karpovite is white with a bluish tint, white streak and adamantine luster. It is brittle with no cleavage or parting and has conchoidal fracture. The average microhardness is $\text{VHN}_{100} = 53$ kg/mm²; Mohs hardness is ~2. The density was not measured due to the paucity of material;

$D_{\text{calc}} = 4.743 \text{ g/cm}^3$. In reflected light, the mineral is light gray with beige tints. It has weak bireflectance and no pleochroism. Anisotropy is masked by abundant greenish-gray internal reflections. Reflectance values were measured in air between 400 and 700 nm with 20 nm intervals. The values for the COM wavelengths [R_{min} , R_{max} , (nm)] are 6.4, 6.7 (470); 6.5, 6.9 (546); 6.6, 7.1 (589); 6.8, 7.3 (650). The average of 20 electron probe EDS analysis [wt% (range)] is Ti_2O 61.43 (60.12–62.08), VO_2 11.53 (11.42–11.70), SO_3 23.55 (23.01–24.29), H_2O 2.61 (calculated from structural data), total 99.12. The empirical formula calculated on the basis of 10 O pfu is $\text{Ti}_{2.00}\text{V}_{0.96}\text{S}_{2.03}\text{O}_9(\text{H}_2\text{O})$. The crystal structure was solved by direct methods on a crystal fragment $0.08 \times 0.08 \times 0.10 \text{ mm}$ in size and refined to $R_1 = 0.026$ for 3425 independent [$F \geq 4\sigma(F)$] reflections. Karpovite structure contains two symmetrically independent Ti^{4+} sites, one V^{4+} site and two S^{6+} sites. Octahedra $\text{VO}_5\text{H}_2\text{O}$ and SO_4 tetrahedra are sharing corners to form $[\text{VO}(\text{H}_2\text{O})(\text{SO}_4)_2]^{2-}$ kröhnkite-type chains parallel to the **a** axis with their planes oriented parallel to (021) and (02 $\bar{1}$). Ti^{4+} cations are located between the chains, providing linkage into a three-dimensional structure. The chains $[\text{VO}(\text{H}_2\text{O})(\text{SO}_4)_2]^{2-}$ were not previously known while topologically similar chains based on VO_6 octahedra and PO_4 tetrahedra or SeO_3 trigonal pyramids have been found in the structures of synthetic $\text{Ba}_2\text{VO}(\text{PO}_4)_2 \cdot \text{H}_2\text{O}$, $\text{Ba}_2\text{VO}(\text{PO}_4)_2$, and $\text{K}(\text{VO})\text{H}(\text{SeO}_3)_2$. Karpovite has no direct synthetic analogs. Single-crystal study shows karpovite is monoclinic, space group $P2_1$, $a = 4.6524(4)$, $b = 11.0757(9)$, $c = 9.3876(7) \text{ \AA}$, $\beta = 98.353(2)^\circ$, $V = 478.60 \text{ \AA}^3$, $Z = 2$. The powder X-ray diffraction data were obtained from the crushed crystal used for the single crystal analysis. Unit-cell parameters refined from the powder data are $a = 4.648(4)$, $b = 11.099(8)$, $c = 9.390(7) \text{ \AA}$, $\beta = 98.31(8)^\circ$. The strongest lines of the XRD powder pattern [$d \text{ \AA}$ ($I\%$, hkl)] are: 4.289 (64, 012); 4.253 (81, 110); 3.683 (38, 111); 3.557 (47, 022); 3.438 (100, $\bar{1}21$); 2.982 (52, 013); 2.945 (59, 112); 2.354 (54, 132). The new mineral is named in honor of Gennadiy Alexandrovich Karpov (b. 1938), volcanologist at the Institute of Volcanology, Russian Academy of Sciences, Petropavlovsk-Kamchatskiy, Russia, in recognition of his contributions to volcanology. Type material is deposited in the Mineralogical Museum of St. Petersburg State University, St. Petersburg, Russia. **D.B.**

KOLSKYITE*

F. Cámara, E. Sokolova, Y. Abdu, F.C. Hawthorne, and A.P. Khomyakov (2013) Kolskyite, $(\text{Ca}\square)\text{Na}_2\text{Ti}_4(\text{Si}_2\text{O}_7)_2\text{O}_4(\text{H}_2\text{O})_7$, a group-IV Ti-disilicate mineral from the Khibiny Alkaline Massif, Kola Peninsula, Russia: Description and crystal structure. *Canadian Mineralogist*, 51(6), 921–936.

Kolskyite (IMA 2013-005), ideally $(\text{Ca}\square)\text{Na}_2\text{Ti}_4(\text{Si}_2\text{O}_7)_2\text{O}_4(\text{H}_2\text{O})_7$, is a new mineral from the Kirovskii mine (+252 m level), Mount Kukisvumchorr, Khibiny alkaline massif, Kola Peninsula, Russia. The mineral formed in a pegmatite as a result of hydrothermal activity and is associated with natrolite, nechelyustovite, kazanskyite, barytolamprophyllite, hydroxylapatite, belovite-(La), belovite-(Ce), gaidonnayite, nenadkevichite, epididymite, apophyllite-(KF), and sphalerite. The mineral occurs as single platy crystals 2–40 μm thick and up to 500 μm across. Kolskyite is pinkish yellow with a white streak, vitreous luster,

perfect cleavage on {001}, splintery fracture, and Mohs hardness of 3. The density of the mineral could not be measured owing to the very small thickness of the flakes; $D_{\text{calc}} = 2.509 \text{ g/cm}^3$. The mineral is biaxial negative with $\alpha = 1.669$, $\beta = 1.701$, $\gamma = 1.720^\circ$ ($\lambda = 590 \text{ nm}$), $2V_{\text{meas}} = 73.6(5)^\circ$, and $2V_{\text{calc}} = 74.0^\circ$. It shows no discernible dispersion, is nonpleochroic and does not fluoresce under 240–400 nm ultraviolet radiation. The FTIR spectrum shows absorption bands at $\sim 3300 \text{ cm}^{-1}$ (very broad) and $\sim 1600 \text{ cm}^{-1}$ (sharp) associated with H_2O stretches and H–O–H bends. An envelope centered at $\sim 1430 \text{ cm}^{-1}$ is probably due to combination bands involving metal-oxygen deformations, or may result from intergrown alteration phase(s). Absorption bands in the 1100–650 cm^{-1} region, with an intense band at $\sim 945 \text{ cm}^{-1}$ and a sharp peak at 1038 cm^{-1} , attributed to Si–O stretching vibrations of the Si_2O_7 groups. The Raman spectrum shows absorption bands at peaks at 925 (strong), 800 (weak), and 685 (strong) cm^{-1} attributed to Si–O stretching, 586, 435, and 420 cm^{-1} attributed to bending vibrations of Si_2O_7 groups, while peaks below $\sim 400 \text{ cm}^{-1}$ are mainly due to lattice modes. The average of 4 electron probe WDS analyses gave [wt% (range)]: Nb_2O_5 6.96 (6.49–7.81), ZrO_2 0.12 (0.06–0.18), TiO_2 26.38 (23.95–28.84), SiO_2 27.08 (22.13–32.60), FeO 0.83 (0.60–1.04), MnO 2.95 (2.42–3.44), MgO 0.76 (0.60–1.10), BaO 3.20 (2.51–3.78), SrO 5.21 (4.06–6.16), CaO 4.41 (3.37–5.00), K_2O 0.79 (0.48–1.29), Na_2O 6.75 (6.23–7.40), H_2O 13.81 (determined from structure solution), F 0.70 (0.54–0.82), $-\text{O}=\text{F}$ 0.29, sum 99.66 wt%. The empirical formula based on 25 (O + F) apfu is $(\text{Na}_{1.93}\text{Mn}_{0.04}\text{Ca}_{0.03})_{\Sigma 2}(\text{Ca}_{0.67}\text{Sr}_{0.45}\text{Ba}_{0.19}\text{K}_{0.15})_{\Sigma 1.46}(\text{Ti}_{2.93}\text{Nb}_{0.46}\text{Mn}_{0.33}\text{Mg}_{0.17}\text{Fe}_{0.10}^{2+}\text{Zr}_{0.01})_{\Sigma 4}\text{Si}_{4.00}\text{O}_{24.67}\text{H}_{13.60}\text{F}_{0.33}$. The strongest lines in the X-ray powder-diffraction pattern [$d_{\text{obs}} \text{ \AA}$ ($I_{\text{obs}}\%$, hkl)] are: 15.161 (100, 001); 2.810 (19, 121, $\bar{1}22$); 3.069 (12, 005); 2.938 (10, $\bar{1}21$, 120, $\bar{1}21$); 2.680 (9, $\bar{1}23$, 200, 114, $\bar{2}01$); 1.771 (9, 04 $\bar{1}$, 040); 2.618 (8, $\bar{1}23$, 122); 2.062 (7, 221, $\bar{2}22$, $\bar{2}23$, $\bar{2}22$); 1.600 (7, $\bar{3}2\bar{1}$, 320, 320). The unit-cell parameters refined from powder-diffraction data are: $a = 5.386(4)$, $b = 7.082(5)$, $c = 15.486(14) \text{ \AA}$, $\alpha = 96.61(8)$, $\beta = 94.10(10)$, $\gamma = 89.97(6)^\circ$, $V = 585.2 \text{ \AA}^3$. Single-crystal X-ray diffraction data collected on a crystal of size $0.30 \times 0.14 \times 0.02 \text{ mm}$ refined to $R_1 = 0.088$ for 2424 unique reflections with $I \geq 4\sigma(I)$ shows kolskyite is triclinic, space group $P\bar{1}$, $a = 5.387(1)$, $b = 7.091(1)$, $c = 15.473(3) \text{ \AA}$, $\alpha = 96.580(4)$, $\beta = 93.948(4)$, $\gamma = 89.818(3)^\circ$, $V = 585.8 \text{ \AA}^3$, and $Z = 1$. Kolskyite is a group-IV TS-block mineral, i.e., it consists of the combination of a TS (titanium-silicate) block and an I (intermediate) block. The TS block consists of HOH sheets (H-heteropolyhedral, O-octahedral). In the H sheet, Si_2O_7 groups link to [6]-coordinated Ti octahedra. In the O sheet, Ti-dominant and Na octahedra each form brookite-like chains. The I block consists of H_2O groups and a partially occupied (68%) peripheral site populated by Ca, Sr, Ba and K. The I block is topologically identical to those in the kazanskyite and nechelyustovite structures. Kolskyite is named after the Kola Peninsula (*Kolsky Poluostrov* in Russian) and to commemorate the outstanding achievements of Alexander Petrovich Khomyakov, a prominent mineralogist who described more than 100 new minerals (primarily from Kola) and who passed away (October 12, 2012) during work on this new mineral. The holotype specimen of kolskyite is deposited at the Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow, Russia. **O.C.G.**

MARKHININITE*

O.L. Siidra, L.P. Vergasova, S.V. Krivovichev, Y.L. Kretser, A.N. Zaitsev, and S.K. Filatov (2014) Unique thallium mineralization in the fumaroles of Tolbachik volcano, Kamchatka Peninsula, Russia. I. Markhininite, $\text{TlBi}(\text{SO}_4)_2$. Mineralogical Magazine, 78(7), 1687–1698.

Markhininite (IMA 2012-040), ideally $\text{TlBi}(\text{SO}_4)_2$, the first oxysalt mineral that contains both Tl and Bi, was discovered as a product of the fumarolic activity at the First scoria cone, North Breach of the Great Fissure Tolbachik volcano eruption, Kamchatka Peninsula, Russia. The mineral found in a fumarole with the gas temperature $\sim 500^\circ\text{C}$ in association with shcherbinaite, paufferite, bobjonesite, karpovite, evdokimovite, and microcrystalline Mg, Al, Fe, and Na sulfates. The specimen with Tl-rich sulfate mineralization about $\sim 8 \times 8 \times 3$ cm in size was when recovered packed to isolate from the air. Markhininite occurs as white transparent pseudo-hexagonal platy crystals grow on shcherbinaite needles and intergrown with bobjonesite. It has white streak, adamantine luster, perfect cleavage on {011} and conchoidal fracture. The mineral is brittle, no parting was observed. Hardness and density could not be measured due to the lack of suitable material; $D_{\text{calc}} = 5.91 \text{ g/cm}^3$ for the ideal formula. No data was provided on crystal size, optical properties and IR data. The average of 20 electron probe EDS analysis [wt% (range)] is Tl_2O 35.41 (35.38–35.44), Bi_2O_3 38.91 (38.87–38.93), SO_3 25.19 (25.17–25.21), total 99.51. The empirical formula based on 8 O pfu is $\text{Tl}_{1.04}\text{Bi}_{1.05}\text{S}_{1.97}\text{O}_8$. The crystal structure was solved by direct methods and refined to $R_1 = 0.055$ on the basis of 1425 independent [$F \geq 4\sigma(F)$] reflections. The structure of markhininite is unique. It contains 4 Tl^+ and 2 Bi^{3+} sites in holodirected symmetrical coordination. BiO_8 tetragonal antiprisms and SO_4 tetrahedra share corners to form $[\text{Bi}(\text{SO}_4)_2]^-$ layers, which are parallel to (111) and linked through interlayer Tl^+ cations. $[\text{M}(\text{TO}_4)_2]^-$ layers (M = Fe, Mg; T = S, P) topologically similar to that of markhininite are known in the structures of yavapaiite, eldfellite and brianite. Markhininite is triclinic, space group $P\bar{1}$, $a = 7.378(3)$, $b = 10.657(3)$, $c = 10.657(3) \text{ \AA}$, $\alpha = 61.31(3)$, $\beta = 70.964(7)$, $\gamma = 70.964(7)^\circ$, $V = 680.2 \text{ \AA}^3$, $Z = 4$. The powder X-ray diffraction data were obtained from the crushed crystal used for the single crystal analysis. Unit-cell parameters refined from the powder data are $a = 7.375(9)$, $b = 10.647(16)$, $c = 10.671(12) \text{ \AA}$, $\alpha = 61.24(9)$, $\beta = 70.77(13)$, $\gamma = 70.85(10)^\circ$. The strongest lines of the XRD powder pattern are [$d_{\text{obs}} \text{ \AA}$ ($I_{\text{obs}}\%$, hkl)]: 4.264 (68, 111); 3.441 (100, 113); 3.350 (35, 222); 3.125 (24, 122); 3.054 (23, 202); 2.717 (45, 022); 2.217 (20, 331); 2.114 (34, 204). The mineral is named in honor of Evgeniy Konstantinovich Markhinin (b. 1926), Institute of Volcanology, Russian Academy of Sciences at Petropavlovsk-Kamchatskiy, Russia, in recognition of his contributions to volcanology. Type material is deposited in the Mineralogical Museum of St. Petersburg State University, St. Petersburg, Russia. **D.B.**

PROTOCHABOURNÉITE*

P. Orlandi, C. Biagioni, Y. Moëlo, E. Bonaccorsi, and W.H. Paar (2013) Lead-antimony sulfosalts from Tuscany (Italy). XIII. Protochabournéite, $\sim \text{Tl}_2\text{Pb}(\text{Sb}_{9-8}\text{As}_{1-2})_{\Sigma 10}\text{S}_{17}$, from the Monte Arsiccio Mine: Occurrence, crystal structure and

relationship with chabournéite. Canadian Mineralogist, 51(3), 475–494.

Protochabournéite (IMA 2011-054), ideally $\text{Tl}_2\text{Pb}(\text{Sb}_{9-8}\text{As}_{1-2})_{\Sigma 10}\text{S}_{17}$, is a new mineral discovered in small ore deposits of the Monte Arsiccio mine, near Sant'Anna di Stazzema, Apuan Alps, Tuscany, Italy. The mineral occurs as black compact masses up to 1 cm wide associated with barite, boscardinite, calcite, cymrite, dolomite, pyrite, realgar, routhierite, sphalerite, and stibnite. Protochabournéite is black with a metallic luster, is brittle and shows conchoidal fracture and imperfect cleavage. The Vickers hardness $\text{VHN}_{15} = 168$ (146–195) kg/mm^2 (average of 5 measurements). The density was not determined due to the paucity and small size of the material; $D_{\text{calc}} = 5.008$ and 5.137 g/cm^3 for two different samples. The mineral is white in reflected light with scarce internal reflections and assumes a dark red color along fractures. Reflectance values were measured between 400 and 700 nm in 20 nm intervals. The values for (COM) wavelengths [R_{min} , R_{max} % (λ nm)] in air are: 36.4, 39.5 (470); 34.2, 36.7 (546); 33.0, 35.4 (589); 31.2, 33.4 (650). Pleochroism is very weak, from very pale yellow to very pale blue. The bireflectance is distinct. Anisotropism is distinct, with rotation tints from blue-green to brown. The average of eight electron probe analyses on each of two different grains of protochabournéite gave (wt%): Tl 16.81(27), Pb 10.65(17), Sb 41.75(17), As 6.59(4), S 23.43(11), total 99.24 and Tl 15.05(26), Pb 13.04(32), Sb 45.49(29), As 3.07(4), S 22.77(14), total 99.42 for the second sample. The empirical formulas based on $\Sigma \text{Me} = 13$ apfu are $\text{Tl}_{1.89}\text{Pb}_{1.18}\text{Sb}_{7.90}\text{As}_{2.03}\text{S}_{16.83}$ and $\text{Tl}_{1.74}\text{Pb}_{1.48}\text{Sb}_{8.81}\text{As}_{0.97}\text{S}_{16.75}$, respectively. The strongest lines in the X-ray powder-diffraction pattern [$d_{\text{obs}} \text{ \AA}$ (I_{obs})] are: 3.608 (strong), 2.824 (strong), 2.790 (medium), 2.170 (very strong). Single-crystal X-ray diffraction data collected on a crystal of size $0.25 \times 0.20 \times 0.15$ mm refined to $R_1 = 0.0437$ for 3392 unique reflections with $I \geq 4\sigma(I)$ shows protochabournéite is triclinic, space group $P\bar{1}$, $a = 8.150(2)$, $b = 8.716(2)$, $c = 21.579(4) \text{ \AA}$, $\alpha = 85.18(1)$, $\beta = 96.94(1)$, $\gamma = 88.60(1)^\circ$, $V = 1515.4 \text{ \AA}^3$, and $Z = 2$. The structure of protochabournéite is composed of two kinds of layers: the first one is derived from the SnS archetype and the second one from the PbS archetype. The structure has mixed (Tl,Pb), (Pb,Sb), and (Sb,As) sites, together with pure Tl, Pb, and Sb sites and agrees with the general features of chabournéite, with a primitive unit cell, without any visible superstructure. The high Sb:As atomic ratio of protochabournéite appears as the main factor precluding the $2a \times 2c$ superstructure visible in chabournéite. Protochabournéite is named in emphasis of its close similarity to chabournéite. The prefix “proto” (= primary) aims to indicate that this derivative of chabournéite has a primitive unit cell. The holotype specimen of protochabournéite is deposited in the mineralogical collection of the Museo di Storia Naturale, Università di Pisa, Pisa, Italy. **O.C.G.**

RABERITE*

L. Bindi, F. Nestola, A. Guastoni, L. Peruzzo, M. Ecker, and R. Carampin (2012) Raberite, $\text{Tl}_5\text{Ag}_4\text{As}_6\text{SbS}_{15}$, a new Tl-bearing sulfosalts from Lengenbach quarry, Binn valley, Switzerland: description and crystal structure. Mineralogical Magazine, 76(5), 1153–1163.

Raberite (IMA 2012-016), ideally $\text{Ti}_5\text{Ag}_4\text{As}_6\text{SbS}_{15}$, is a new mineral from Lengenbach quarry, Binn Valley, Valais, Switzerland, one of the world's premiere localities for TI-bearing sulfosalts, the type locality for TI species imhofite, erniggliite, edenharterite, stalderite, jentschite, sicherite, gabrielite, and dalnegroite. Raberite has been collected in 1992 from zone 1 of the quarry in cavities in saccharoidal dolomitic marble. It occurs as euhedral elongated black opaque metallic crystals up to 0.15 mm without inclusions or intergrowths of other minerals on hatchite/wallisite in association with yellowish fibrous smithite, realgar, trechmannite, edenharterite, jentschite, and two unidentified sulfosalts. The mineral has a dark brown-red streak. It is brittle with uneven fracture and no cleavage observed. The microhardness $\text{VHN}_{10} = 52$ (50–55) kg/mm^2 corresponds to a Mohs hardness of 2½–3. The density was not measured; $D_{\text{calc}} = 5.649$ g/cm^3 . In reflected light raberite is moderately birefractant and very weakly pleochroic from light gray to a slightly greenish gray. It is very weakly anisotropic with grayish to light blue rotation tints. No internal reflections were observed. Reflectance values for the COM wavelengths [R_{min} , R_{max} , (nm)] are 30.6, 31.8 (471.1); 28.1, 29.3 (548.3); 27.1, 28.0 (586.6); 25.8, 26.9 (652.3). The average of 9 electron probe WDS analyses [wt% (range)] is Ti 39.55 (38.44–39.76), Ag 18.42 (18.30–20.30), Cu 0.06 (0–0.07), As 17.08 (16.34–17.21), Sb 5.61 (4.71–5.90), S 19.15 (18.43–19.20); total 99.87 wt%, corresponding to empirical formula $\text{Ti}_{4.85}\text{Ag}_{4.28}\text{Cu}_{0.02}\text{As}_{5.72}\text{Sb}_{1.16}\text{S}_{1.00}$ based on 31 apfu. The strongest lines of the calculated X-ray powder diffraction pattern [d Å (I , hkl)] are: 3.580 (100, $\bar{1}\bar{1}3$); 3.506 (58, $\bar{1}\bar{2}3$); 3.281 (73, 006); 3.017 (54, $\bar{1}23$); 3.001 (98, 133); 2.657 (51, 226); 2.636 (46, 300); 2.591 (57, 330). X-ray single-crystal diffraction study on a crystal fragment $60 \times 55 \times 60$ μm shows the mineral is triclinic, space group $P\bar{1}$, $a = 8.920(1)$, $b = 9.429(1)$, $c = 20.062(3)$ Å, $\alpha = 79.66(1)$, $\beta = 88.84(1)$, $\gamma = 62.72(1)^\circ$, $V = 1471.6(4)$ Å³, and $Z = 2$. In the raberite crystal structure [refined to $R_1 = 0.0827$ for 2110 reflections with $I > 2\sigma(I)$] columns of nine-coordinated TI irregular polyhedra extend along [001] and form sheets parallel to (010). The TI atoms in the columns are interrupted by Ag and As positions, i.e., every five TI positions there is the couple Ag–M (M = As, Sb) with a short distance of 2.68 Å. The columns are decorated by corner sharing MS_3 pyramids and linked by AgS_3 triangles. Of the seven M positions, one is dominated by Sb and the others by As. The new mineral has been named in honor of Thomas Raber (b. 1966), a well-known expert on Lengenbach minerals. Holotype is deposited in the Museum of Mineralogy of the Department of Geosciences at the University of Padova, Italy. **D.B.**

SHULAMITITE*

V.V. Sharygin, B. Lazic, T.M. Armbruster, M.N. Murashko, R. Wirth, I.O. Galuskina, E.V. Galuskin, Y. Vapnik, S.N. Britvin, and A.M. Logvinova (2013) Shulamitite $\text{Ca}_3\text{TiFe}^{3+}\text{AlO}_8$ —a new perovskite-related mineral from Hatrurim Basin, Israel. European Journal of Mineralogy, 25(1), 97–111.

Shulamitite (IMA 2011-016) ideally $\text{Ca}_3\text{TiFe}^{3+}\text{AlO}_8$ —the natural Al-rich analog of the orthorhombic synthetic phase $\text{Ca}_3\text{TiFe}_2^+\text{O}_8$, an intermediate member between perovskite

CaTiO_3 and brownmillerite $\text{Ca}_2(\text{Fe,Al})_2\text{O}_5$ was discovered as a major mineral in a high-temperature larnite-mayenite rock from the pseudoconglomerates of the combustion-metamorphic complex of Hatrurim Formation (“Mottled Zone”) in Hatrurim Basin (~5 km southeast from Arad town), Israel. Previously the mineral of close composition $\text{Ca}_3\text{Ti}(\text{Fe,Al})_2\text{O}_8$ was noted from Hatrurim Formation as an intermediate phase X (Sharygin et al. 2008). A phase close to $\text{Ca}_3\text{TiFe}_2\text{O}_8$ was analyzed in carbonate-silicate rocks of xenoliths in ignimbrites of the Upper-Chegem volcanic structure, Kabardino-Balkaria, Northern Caucasus, Russia (Galuskin et al. 2008). Since that both Fe- and Al-dominant phases were also described in metacarbonate xenoliths in alkali basalts at Belleberg, Eifel, Germany; in olivine nephelinite at Klöch, Styria, Austria, in parabasalt from burned dump of mine 42, Kopeisk, South Urals, Russia and from burned dump of the Kalinin mine, Donetsk coal basin, Ukraine (Sharygin 2011, 2012; Niedermayr et al. 2011). The holotype sample is the pebble in which larnite, F-rich mayenite, shulamitite (~20%), Cr-spinel, and sulfate-bearing fluorapatite are the major phases. Ye’elimite, magnesioferrite, brownmillerite and unidentified K-Fe-Cu-Ni sulfides are the minor or accessory minerals. The temperature of that association formation estimated as 1170–1200 °C while the pressure was low. The later retrograde assemblage represented by portlandite, hematite, hillebrandite, afwillite, foshagite, katoite, and a not fully described yet hydrated phase $\text{CaTiFe}^{3+}\text{AlO}_8 \cdot 2\text{--}3\text{H}_2\text{O}$. Those minerals are located in small vugs between grains of primary minerals. The weathering crust of the pebble is up to 5 mm and represented by hydrated Ca-silicates and ettringite. In other larnite rocks of the Hatrurim Basin shulamitite is less enriched (1–3 vol%). The mineral forms reddish brown xenomorphic subhedral grains, platy crystals [$\{100\} + \{010\} + \{001\}$], star-like twins (in 90°, 45°, and 60°) up to 200 μm and intergrowths up to 500 μm . It has light brown streak, adamantine to submetallic luster, even to uneven fracture, good cleavage on $\{010\}$ and imperfect on $\{001\}$ and $\{100\}$. The microhardness $\text{VHN}_{100} = 866$ (683–977) kg/mm^2 ; Mohs hardness is ~6–7. Density was not measured due to small grain size and inclusions; $D_{\text{calc}} = 3.840\text{--}3.865$ g/cm^3 . In transmitted light the color varies from reddish-brown to yellow-brown. In reflected light shulamitite is distinctly pleochroic gray to light gray and has yellow-brown internal reflections. Birefractance and anisotropy are weak. Reflectance values were measured in air between 400 and 700 nm with 20 nm intervals. The values for the COM wavelengths [R_{min} , R_{max} , (nm)] are 11.7, 12.6 (470); 11.6, 12.4 (546); 11.6, 12.3 (589); 11.4, 12.3 (650). The main bands in the Raman spectrum of shulamitite are (cm^{-1}): 1501 (overtone); 802, 742, 561, 498 (stretching and bending vibrations of $[\text{Al,Fe}^{3+}\text{O}_4]$ tetrahedra; 388, 290, 238, 145, 110 [vibrations of CaO_8 and $(\text{Fe}^{3+},\text{Ti})\text{O}_6$ polyhedra]. The mean of 20 electron probe WDS analyses of the crystals used for structure study [wt% (range)] is: SiO₂ 0.80 (0.65–0.97), TiO₂ 20.39 (19.93–20.76), ZrO₂ 0.49 (0.33–0.59), Cr₂O₃ 0.30 (0.17–0.42), Al₂O₃ 8.82 (7.93–9.13), Fe₂O₃ 25.03 (23.94–27.40), FeO 0.11 (0–0.28) ($\text{Fe}^{3+}/\text{Fe}^{2+}$, by charge balance), MgO 0.22 (0.08–0.33), CaO 43.75 (43.39–44.14), total 99.02. The empirical formula based on 6 cations and 8 O pfu is $\text{Ca}_{3.02}(\text{Ti}_{0.99}\text{Zr}_{0.01})_{\Sigma 1.00}(\text{Fe}_{0.93}\text{Mg}_{0.02}\text{Cr}_{0.02}\text{Fe}_{0.01})_{\Sigma 0.98}(\text{Al}_{0.67}\text{Fe}_{0.28}\text{Si}_{0.05})_{\Sigma 1.00}\text{O}_8$. Shulamitite and its Fe-analog from Hatrurim and

other occurrences show the broad compositional variation showing the existence of the isomorphic series $\text{Ca}_3\text{TiFeAlO}_8$ – $\text{Ca}_3\text{TiFeFeO}_8$. The mean of 19 electron probe WDS analyses of the sample closest to Fe end-member from Belleberg, Eifel, Germany, is (wt%): SiO_2 0.71, TiO_2 20.98, ZrO_2 0.03, Nb_2O_5 0.18, V_2O_5 0.13, Al_2O_3 3.21, Fe_2O_3 30.74, FeO 0.51, MnO 0.38, MgO 0.30, CaO 41.64, SrO 0.55, total 99.36. The empirical formula is $(\text{Ca}_{2.99}\text{Sr}_{0.01})_{\Sigma 3.00}(\text{Ti}_{1.06}\text{Zr}_{0.01})_{\Sigma 1.07}(\text{Fe}_{0.85}^{3+}\text{Mg}_{0.03}\text{Fe}_{0.03}^{2+}\text{Mn}_{0.02})_{\Sigma 0.93}(\text{Fe}_{0.70}^{3+}\text{Al}_{0.25}\text{Si}_{0.05})_{\Sigma 1.00}\text{O}_8$. The strongest lines of the X-ray diffraction powder pattern [d Å (I %, hkl)] are: 11.12 (19, 010); 3.89 (13, 101); 2.755 (40, 200); 2.677 (100, 131); 1.940 (40, 202); 1.842 (16, 060); 1.585 (17, 133); 1.559 (16, 331); 1.527 (13, 260). The single-crystal X-ray study shows the orthorhombic $Pmma$ symmetry, $a = 5.4200(6)$, $b = 11.064(1)$, $c = 5.5383(7)$ Å, $V = 332.12$ Å³, $Z = 2$. The crystal structure of shulamitite has been refined to $R_1 = 0.029$ based on 533 independent $I > 2\sigma(I)$ reflections. The structure is intermediate between perovskite and brownmillerite. Shulamitite has a threefold superstructure of cubic perovskite: $a_c \times \sqrt{2}$, $3a_c$, $a_c \times \sqrt{2}$. Cations Ti and Fe^{3+} are randomly distributed among all octahedra indicating an example of “valency-imposed double site occupancy.” The mineral named in honor of Shulamit Gross (1923–2012), emeritus member of the Geological Survey of Israel and famous Miss “Mottled Zone.” The name of this reddish brown mineral is also related to biblical Shulamit, red-haired sweetheart of King Solomon. The type specimens are deposited in the Mineralogical Museum of St. Petersburg State University, Russia and in the Central Siberian Geological Museum of Institute of Geology and Mineralogy, Novosibirsk, Russia. **D.B.**

References cited

- Galuskin, E.V., Gazeev, V.M., Armbruster, T., Zadov, A.E., Galuskina, I.O., Pertsev, N.N., Dzierzanowski, P., Kadiyski, M., Gurbanov, A.G., Wrzalik, R., and Winiarski, A. (2008) Lakargiite CaZrO_3 : A new mineral of the perovskite group from the North Caucasus, Kabardino-Balkaria, Russia. *American Mineralogist*, 93, 1903–1910.
- Niedermayr, G., Auer, C., Bernhard, F., Brandstätter, F., Gröbner, J., Hammer, V.M.F., Knobloch, G., Koch, G., Kolitsch, U., Konzett, J., Leikauf, B., Löffler, E., Postl, W., Prasník, H., Prayer, A., Pristacz, H., Sabor, M., Seemann, R., Stehlik, H., Thinschmidt, A., and Walter, F. (2011) Neue Mineralfunde aus Österreich LX. *Carinthia II*, 201/121, 135–186 (in German).
- Sharygin, V.V. (2011) Lakargiite and minerals of the perovskite-brownmillerite series in metacarbonate rocks from Donetsk burned dumps. *Proceedings of Donetsk National Technical University, Mining and Geological Series*, 15(192), 114–125 (in Russian).
- (2012) Minerals of the $\text{Ca}_3\text{TiFeAlO}_8$ – $\text{Ca}_3\text{TiFeFeO}_8$ series in natural and tectonogenic pyrometamorphic systems. *The Mineralogy of Technogenesis-2012*, Institute of Mineralogy, Ural Branch of RAS, Miass, 29–49 (in Russian).
- Sharygin, V.V., Sokol, E.V., and Vapnik, Y. (2008) Minerals of the pseudobinary perovskite-brownmillerite series from combustion metamorphic lamite rocks of the Hatrurim Formation (Israel). *Russian Geology and Geophysics*, 49, 709–726.
- Vendidaite (IMA 2012-089), ideally $\text{Al}_2(\text{SO}_4)(\text{OH})_3\text{Cl}\cdot 6\text{H}_2\text{O}$, is a new mineral from La Vendita mine, near Sierra Gorda, Antofagasta Region, Atacama desert, Chile. Vendidaite was found on a $2 \times 1 \times 1$ m³ block at the edge of the quarry and was later found on the dumps of the La Vendita mine. The mineral was found in association with aubertite, magnesioaubertite, belloite, eriochalcite, alunite, kaolinite, and halloysite. Vendidaite forms platy crystals up to $0.01 \times 0.3 \times 0.3$ mm, flattened on (010), and forming clusters up to 0.5 mm, as well as white, fine-grained aggregates. The major form observed is {010}; the subordinate forms are {100}, {001}, and {101}. Crystals of vendidaite are colorless, transparent, have a vitreous luster, perfect cleavage on {010}, are brittle with Mohs hardness ~ 2 – $2\frac{1}{2}$. $D_{\text{meas}} = 1.97(1)$ g/cm³, $D_{\text{calc}} = 1.974$ g/cm³. Vendidaite is insoluble in water and dissolves slowly in warm 20% hydrochloric acid. The mineral is optically biaxial (+), $\alpha = 1.522(2)$, $\beta = 1.524(2)$, $\gamma = 1.527(2)^\circ$, $2V = 75(15)^\circ$, $2V_{\text{calc}} = 79^\circ$. The FTIR spectrum shows absorption bands at (cm⁻¹; $s =$ strong, $w =$ weak, $sh =$ shoulder): 3640sh, 3585, 3490sh, 3421, 3293s, 3190sh, 3164s, 2989 (O–H stretching vibrations of OH⁻ anions and H₂O molecules), 2521w, 2445w, 2299w (combination modes and/or O–H stretching vibrations of acid OH groups), 1685sh, 1646 (bending vibrations of H₂O molecules), 1168, 1107s, 1040 (asymmetric stretching vibrations of SO₄²⁻ anions), 993w (symmetric S–O stretching vibrations of SO₄²⁻ anions), 882w, 843, 760sh, 700 (Al–O–H bending vibrations), 639, 620, 609 (O–S–O bending vibrations of SO₄²⁻ anions), 547, 497 (Al–O stretching vibrations, possibly combined with librational vibrations of H₂O molecules), 460, 379 (mixed lattice vibrations). Bands of B-, C-, and N-bearing groups are absent in the IR spectrum. Weak IR bands at 2299, 2445, and 2521 cm⁻¹ indicate the presence of trace amounts of HSO₄⁻ ion. The average of five electron probe EDS analyses gave [wt% (range)]: Al_2O_3 28.51 (27.71–29.24), Fe_2O_3 1.39 (1.21–1.68), SO_3 22.38 (21.86–22.73), Cl 9.87 (9.67–10.17), H_2O 38.8 (by gas chromatography), $-\text{O}=\text{Cl}$ 2.23, total 98.72. The empirical formula based on 14 O + Cl apfu with OH/H₂O ratio calculated by charge balance is $\text{Al}_{1.96}\text{Fe}_{0.06}^{3+}(\text{SO}_4)_{0.98}\text{Cl}_{0.98}(\text{OH})_{3.12}\cdot 5.98\text{H}_2\text{O}$. The strongest lines in the X-ray powder-diffraction pattern [d_{obs} Å (I_{obs} %, hkl)] are: 6.78 (59, 11 $\bar{1}$); 4.849 (94, 021); 4.366 (80, 13 $\bar{1}$); 4.030 (75, 040, 111); 3.855 (100, 31 $\bar{1}$); 3.285 (59, 131); 2.435 (52, 26 $\bar{1}$). The unit-cell parameters refined from powder-diffraction data are: $a = 11.91(4)$, $b = 16.13(2)$, $c = 7.46(3)$ Å, $\beta = 125.8(2)^\circ$, and $V = 1164$ Å³. Single-crystal X-ray diffraction data collected on a crystal of size $0.12 \times 0.10 \times 0.11$ mm refined to $R_1 = 0.044$ for 2034 unique reflections with $I \geq 4\sigma(I)$ shows vendidaite is monoclinic, space group $C2/c$, $a = 11.9246(16)$, $b = 16.134(2)$, $c = 7.4573(9)$ Å, $\beta = 125.815(2)^\circ$, $V = 1163.4$ Å³, and $Z = 4$. The structure is based upon $[\text{Al}_2(\text{OH})_3(\text{H}_2\text{O})_6]^{3+}$ chains of edge- and corner-sharing $[\text{Al}(\text{OH}, \text{H}_2\text{O})]$ octahedra running parallel to the a axis. The Cl anions and $(\text{SO}_4)^{2-}$ groups form pseudo-layers parallel to (010) that link to the chains via hydrogen bonding. Vendidaite is named after its type locality, “La Vendita mine.” The type material is deposited in the collection of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **O.C.G.**

VENDIDAITE*

N.V. Chukanov, S.V. Krivovichev, A.P. Chernyatieva, G. Möhn, I.V. Pekov, D.I. Belakovskiy, K.V. Van, and J.A. Lorenz (2013) Vendidaite, $\text{Al}_2(\text{SO}_4)(\text{OH})_3\text{Cl}\cdot 6\text{H}_2\text{O}$, a new mineral from La Vendita Copper Mine, Antofagasta Region, Chile. *Canadian Mineralogist*, 51(4), 559–568.