New Mineral Names*†

DMITRIY I. BELAKOVSKY† AND OLIVIER C. GAGNE‡

†Fersman Mineralogical Museum, Russian Academy of Sciences, Leninskiy Prospekt 18 korp. 2, Moscow 119071, Russia
‡Department 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) Debatstitite, Ag₉.₅Hg₀.₅As₆S₁₂Te₂, a new Te-bearing sulfosalt from Lengenbach quarry, Binn valley, Switzerland: description and crystal structure. Mineralogical Magazine, 76(3), 743–750.

Debatstitite (IMA 2011-098), ideally Ag₉Hg₀.₅As₆S₁₂Te₂, is a new mineral discovered in the famous for Pb-Cu-Ag-As-Tl bearing sulfosalts Lengenbach quarry in the Binn Valley, Valais, Switzerland. Debatstitite 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 VHN₂₅ = 80 (65–94) kg/mm², corresponding to a Mohs hardness of 2–2½. Density was not measured due to small size of grains; Dcalc = 5.647 g/cm³. In reflected light debattistiite is dark gray, highly bireflectant 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 [d Å (I; kkl)] are: 10.56 (62; 001), 3.301 (47; 2Y12), 2.091 (40; 2T2), 2.742 (95; 2Σ1), 2.733 (100; 2Σ3). X-ray single-crystal diffraction study on a crystal fragment 70 × 50 × 40 μm shows the mineral is triclinic, space group P̅T; a = 7.832(5), b = 8.606(4), c = 10.755(5) Å, α = 95.563(9), β = 95.880(5), γ = 116.79(4)°, V = 635.3 Å³; Z = 1. In the crystal structure of debattistiite [refined to R₁ = 0.0826 for 795 unique I > 2σ(I) reflections] corner-sharing As(S,Te₃) 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 (Te₉Ag₉S₀.₀₇). 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 Hg(Te,S)₂ and Ag₉(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*


Evdokimovite (IMA 2013-041), ideally Tl₆VO₃(SO₄)₅(H₂O)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 VHN₁₀₀ = 92 kg/mm²; Mohs hardness is ~ 2½. The density was not measured; Dcalc = 4.20 g/cm³ for the ideal formula. In reflected light the mineral is light gray with beige tints, 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 \([R_{\min}, R_{\max}] (\text{nm})\) 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 \([\text{wt}\% \text{ range}]\) is TiO$_2$ 55.40 (54.2–56.01), VO$_2$ 14.92 (12.09–15.62), SO$_2$ 25.83 (24.39–27.03), H$_2$O 5.75 (calculated by stoichiometry and structural data), total 101.90. The empirical formula calculated on the basis of \((\text{Ti} + \text{V} + \text{S}) = 12\) apfu is \(\text{Ti}_2\text{V}_2\text{O}_{26}\text{S}_{36}\text{H}_{10,0\text{z74}}\). A needle of evdokimovite 0.05 × 0.01 × 0.008 mm was used for a single crystal study. The crystal structure was solved by direct methods and refined to \(R = 0.11\) on the basis of 3660 independent \([F \geq 4\sigma(F)]\) reflections. It contains six symmetrically independent Ti$^4+$ sites, three V$^4+$ sites, and five S$^2+$ sites. The V$^4+$O$_6$ octahedra and SO$_4$ tetrahedra share corners to form two types of vanadyl-sulfate chains, \([\text{VO}(\text{H}_2\text{O})_2\text{SO}_4]_2^–\) and \([\text{VO}_2(\text{H}_2\text{O})_2\text{SO}_4]_2^–\) 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 \([\text{VO}_2(\text{H}_2\text{O})_2\text{SO}_4]_2^–\) chains, Ti(2) and Ti(3) atoms. The B layer contains \([\text{VO}_2(\text{H}_2\text{O})_2\text{SO}_4]_2^–\) chains and Ti(1) atoms. The layers stacked as ...A*BAA*BAA*..., where A and A’ differ by opposite orientations of the \([\text{VO}_2(\text{H}_2\text{O})_2\text{SO}_4]_2^–\) chains, and the A* and B* layers are rotated by 180° relative to the A and B layers, respectively. The chains \([\text{VO}_2(\text{H}_2\text{O})_2\text{SO}_4]_2^–\) are modulated and are arranged to form elliptical tunnels hosting disordered Ti(4), Ti(4A), and Ti(4B) sites. Evdokimovite is monoclinic, \(P2_1/n\), \(a = 6.2958(14), b = 10.10(10), c = 39.426(11)\ Å, β = 90.347(6)°, V = 2509.4 Å$^3$, Z = 4.\) 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 \(a = 6.292(9), b = 10.103(9), c = 39.43(2)\ Å, β = 90.4(1)°\). The strongest lines of the XRD powder pattern \([d_{\text{calc}}, \lambda, (hkl)]\) 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, 042); 2.7559 (90, 301); 2.7073 (79, 105); 1.9490 (22, 206); 1.9226 (22, 042). The new mineral is named in honor of Mikhail Dmitrievich Evdokimov (1940–2010), of the Department of Mineralogy, St. Petersburg State University, St. Petersburg, Russia. Type material is deposited in the Mineralogical Museum and petrology, and teaching mineralogy to several generations of students. Evdokimov is a poet in honor of his life-long endeavor to preserve the national poetical tradition.

Ferdowsiite*


Ferdowsiite (IMA 2012-062), ideally Ag$_7$(Sb$_5$As$_3$)$_{27}$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 sympolites with ferroan tetrahedrite-tennantite, and is sometimes found enveloping arsenquatrandorite, in turn surrounded by guettardite. Other associated minerals include smithite, sterryite, bournonite, boulangerite, geoconrite, 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/cm$^3$. 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 \([R_{\min}, R_{\max}, \% (\lambda \text{ nm})]\) 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 \([\text{wt}\% (\text{range})]\): 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 Ag$_7$(Sb$_5$As$_3$)$_{27}$S$_{16}$O$_{31}$, which is 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)S$_3$ 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.
NEW MINERAL NAMES

KOLSKYITE*

F. Cámara, E. Sokolova, Y. Abdu, F.C. Hawthorne, and A.P. Khomyakov (2013) Kolskyite, (Ca□Na1)2Ti2(Si2O7)2O4(H2O), 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 (Ca□Na1)2Ti2(Si2O7)2O4(H2O), 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, kanzaksyite, barytalaomonophyllyte, hydroxylapatite, belovite-(La), belovite-(Ce), gaidonnayite, nenadkevichite, epididymite, apophyllite-(KF), and spherelite. 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 \( \alpha = 1.541, \beta = 1.579, \gamma = 1.607 \) (\( 2 = 590 \text{ nm} \)), \( 2V_{\text{meas}} = 73.6(5) \), 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 ~3300 cm\(^{-1}\) (very broad) and ~1600 cm\(^{-1}\) (sharp) associated with H\(_2\)O stretches and H–O–H bends. An envelope centered at ~1430 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 ~945 cm\(^{-1}\) and a sharp peak at 1038 cm\(^{-1}\) attributed to Si–O stretching vibrations of the Si\(_2\)O\(_7\) groups. The Raman spectrum shows absorption bands at peaks at 925 (strong), 800 (weak), and 685 (strong) cm\(^{-1}\) attributed to Si–O stretching vibrations of the Si\(_2\)O\(_7\) groups, while peaks below ~400 cm\(^{-1}\) are mainly due to lattice modes. The average of 4 electron probe WDS analyses gave \( \text{wt%} \) (range): Nb\(_2\)O\(_5\) 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 (2.42–3.34), MgO 0.76 (0.60–1.00), BaO 3.20 (2.51–3.78), SrO 5.21 (4.06–6.16), CaO 4.41 (3.37–5.00), K\(_2\)O 0.79 (0.48–1.29), Na\(_2\)O 6.75 (6.23–7.40), H\(_2\)O 13.81 (determined from structure solution), \( F(0.54–0.82) \), \( -O=F \) 0.29, sum 99.66 wt%.
**MARKHININITE**


Markhininite (IMA 2012-040), ideally TlBi(SO₄)₂, is 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 ~500 °C in association with scherbinaite, pafaite, bobjonesite, karpovite, evdokimovite, and microcrystalline Mg, Al, Fe, and Na sulfates. The specimen with Tl-rich sulfate mineralization about ~8 × 8 × 3 cm in size was when recovered packed to isolate from the air. Markhininite occurs as white transparent platy crystals grow on scherbinaite needles and intergrown with bobjonesite. It was when recovered packed to isolate from the air. Markhininite 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_{calc} = 5.91 g/cm³ 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 Tl₂O₃ 35.41 (35.38–35.44), Bi₂O₃ 38.91 (38.87–38.93), SO₄ 25.19 (25.17–25.21), total 99.51. The empirical formulas based on 8 O pfu is Tl₁.04 Bi₁.05 S₁.97 O₈. The crystal structure was refined from the powder data are: 3.60 Å (avg. of 3 samples). The density was not determined due to the paucity and small size of the material; D_{calc} = 5.008 and 5.137 g/cm³ 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.

Raberite*  
Raberite (IMA 2012-016), ideally Tl\textsubscript{5}Ag\textsubscript{4}As\textsubscript{6}SbS\textsubscript{15}, is a new mineral from Lengenbach quarry, Binn Valley, Valais, Switzerland, one of the world’s premiere localities for Tl-bearing sulfosalts, the type locality for Tl species in host phases, enargitite, edenharterite, stalderite, jentschite, sibirite, gabrielite, and dalnegroite. Raberite has been collected in 1992 from zone 1 of the quarry in cavities in saccharoidal dolomite 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, reargal, 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 Mohs hardness of 2½–3. The density was not measured; D\textsubscript{calc} = 5.649 g/cm\textsuperscript{3}. In reflected light rabbit is moderately bireflectant 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 Tl 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 Tl\textsubscript{5}Ag\textsubscript{4}As\textsubscript{6}Sb\textsubscript{14}S\textsubscript{5}O\textsubscript{2}S\textsubscript{2} based on 31 apfu. The strongest lines of the calculated X-ray powder diffraction pattern \([d (A, hkl)]\) are: 3.506 (58, 1 0 0); 2.591 (57, 3 3 0); 

\[
\begin{align*}
\text{Ca}_3 \text{TiFe}^{3+} \text{Al} \text{O}_8 & \quad \text{a new perovskite-related mineral from Hatrurim Basin, Israel. European Journal of Mineralogy, 25(1), 97–111.}
\end{align*}
\]

**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 Ca\textsubscript{3}TiFe\textsuperscript{3+}Al\textsubscript{2}O\textsubscript{8}—a new perovskite-related mineral from Hatrurim Basin, Israel. European Journal of Mineralogy, 25(1), 97–111.

Shulamitite (IMA 2011-016) ideally Ca\textsubscript{3}TiFe\textsuperscript{3+}Al\textsubscript{2}O\textsubscript{8}—the natural Al-rich analog of the orthorhombic synthetic phase Ca\textsubscript{3}TiFe\textsuperscript{3+}O\textsubscript{8}, an intermediate member between perovskite CaTiO\textsubscript{3} and brownmillerite Ca\textsubscript{2}(Fe,Al)\textsubscript{2}O\textsubscript{3} 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 Ca\textsubscript{x}Ti(Fe,Al)\textsubscript{2}O\textsubscript{3} was noted from Hatrurim Formation as an intermediate phase X (Sharygin et al. 2008). A phase close to Ca\textsubscript{3}TiFe\textsubscript{2}O\textsubscript{4} 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-dominated phases were also described in metacarbonate xenoliths in alkali basalts at Belleberg, Eifel, Germany; in olivine nepheline at Klöch, Styria, Austria, in parabasalt from burned dump of mine 42, Kopieisk, 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. Y’el’emite, magnesiosterrite, 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, hellebrandite, afwillite, foshagite, katoite, and a not fully described yet hydrated phase Ca\textsubscript{3}Ti(Fe,Al)\textsubscript{2}O\textsubscript{2}·3H\textsubscript{2}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 VHN\textsubscript{100} = 866 (683–977) kg/mm\textsuperscript{2}. Mohs hardness is ~6–7. Density was not measured due to small grain size and inclusions; D\textsubscript{calc} = 3.840–3.865 g/cm\textsuperscript{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. Bireflectance 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\textsuperscript{-1}): 1501 (overtone); 802, 746, 518 (stretching and bending vibrations of \([\text{Al(Fe}^{3+}\text{)O}_4]\) tetrahedra; 388, 290, 238, 145, 110 [vibrations of CaO\textsubscript{2} and (Fe\textsuperscript{3+},Ti)\textsubscript{O}\textsubscript{2} polyhedra]. The mean of 20 electron probe WDS analyses of the crystals used for structure study [wt\% (range)] is: SiO\textsubscript{2} 0.80 (0.65–0.97), TiO\textsubscript{2} 20.39 (19.93–20.76), ZrO\textsubscript{2} 0.49 (0.33–0.59), Cr\textsubscript{2}O\textsubscript{3} 0.30 (0.17–0.42), Al\textsubscript{2}O\textsubscript{3} 8.82 (7.93–9.13), Fe\textsubscript{2}O\textsubscript{3} 25.03 (23.94–27.40), FeO 0.11 (0–0.28), 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 \[\text{Ca}_3\text{Ti}_{(0.99\text{Zr}_{0.01})}\text{Fe}_{(0.10\text{Cr}_{0.02}\text{Fe}_{0.01})}\text{Mn}_{0.02}\text{Al}_{0.02}\text{Si}_{0.02}\text{O}_{30}\]. Shulamitite and its Fe-analog from Hatrurim and
other occurrences show the broad compositional variation showing the existence of the isomorphic series Ca3TiFeAlO8–Ca9TiFeFeO12. The mean of 19 electron probe WDS analyses of the sample closest to Fe end-member from Belleberg, Eifel, Germany, is (wt%): SiO2 0.71, TiO2 20.98, ZrO2 0.03, Nb2O5 0.18, V2O5 0.13, Al2O3 3.21, Fe2O3 30.74, FeO 0.51, MnO 0.38, MgO 0.30, CaO 41.64, SrO 0.55, total 99.36. The empirical formula is (Ca2+0.96Sr0.03)Σ3.00(Ti1.06Zr0.01)Σ1.07(Fe3+0.83Mg0.02Fe2+0.03Mn0.02)Σ0.93(Al0.62Si0.05O6)Σ3.00O4. 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 Pnma 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 R1 = 0.029 based on 533 independent I > 2σ(I) reflections. The structure is intermediate between perovskite and brownmillerite. Shulamitite has a threefold superstructure of cubic perovskite: a = v × v2, a0, a × v2. Cations Ti and Fe3+ are randomly distributed among all octahedra indicating an example of “valency-imposed double 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 the Institute of Geology and Mineralogy, Novosibirsk, Russia. D.B.

References cited


VENDIDAITE*


Vendidaite (IMA 2012-089), ideally Al16(SO4)8(OH)3Cl·6H2O, is a new mineral from La Vendida mine, near Sierra Gorda, Antofagasta Region, Atacama desert, Chile. Vendidaite was found on a 2 × 1 × 1 m2 block at the edge of the quarry and was later found on the dumps of the La Vendida mine. The mineral was found in association with aubertite, magnesioaubertite, belloite, eriochalcite, alunite, kaolinite, and halloysite. Vendidaite forms platy crystals up to 0.01 × 0.3 × 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 {110}, {011}, and {101}. Crystals of vendidaite are colorless, transparent, have a vitreous luster, perfect cleavage on {010}, are brittle with Mohs hardness ~ 2–2.5. Dmax = 1.971 g/cm3, Dcalc = 1.974 g/cm3. Vendidaite is insoluble in water and dissolves slowly in warm 20% hydrochloric acid. The mineral is optically biaxial (+), ω = 1.522(2), β = 1.524(2), γ = 1.527(2)°, 2V = 75(15)°, 2Vcalc = 79°. 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 1628, 1542, 1404 (s = strong, w = weak) cm–1, 1366, 1351 (C–O stretching vibrations of CO32− anions) and 800, 745, 697 (O–H bending vibrations). The unit-cell parameters refined from powder-diffraction data are: a = 11.91(4), b = 16.13(2), c = 7.46(3) Å, V = 1164 Å3. Single-crystal X-ray diffraction data collected on a crystal of size 0.12 × 0.10 × 0.11 mm refined to R1 = 0.044 for 2034 unique reflections with I ≥ 4σ(I) shows vendidaite is monoclinic, space group C2/c, a = 11.9246(16), b = 16.134(2), c = 7.4573(9) Å, β = 125.815(2)°, V = 1163.4 Å3, and Z = 4. The structure is based upon [Al16(OH)(H2O)16]16+ chains of edge- and corner-sharing [Al(OH2)6] octahedra running parallel to the a axis. The Cl– anions and (SO4)2− groups form pseudo-layers parallel to {010} that link to the chains via hydrogen bonding. Vendidaite is named after its type locality, “La Vendida 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.