New Mineral Names*†

DIMITRI Y. BELAKOVSKY†, FERNANDO CÁMARA2, and OLIVIER C. GAGNE3

1Fersman Mineralogical Museum, Russian Academy of Sciences, Leninskiy Prospekt 18 korp. 2, Moscow 119071, Russia
2Dipartimento di Scienze della Terra, Università di degli Studi di Torino, Via Valperga Caluso, 35-10125 Torino, Italy
3Department of Geological Sciences, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada

IN THIS ISSUE

This New Mineral Names has entries for 11 new minerals, including alfredopetrovite, bussyite-(Y), colinowensite, esquireite, ferromerrillite, fluorantropyrochlore, fluor-schorl, hogarthite, shilovite, tapiate, waimirite-(Y).

ALFREDOPETROVITE*


Alfredopetrovite (IMA 2015-026), ideally Al(SeO3)2·6H2O, is a new selenite mineral from the El Dragón mine, Antonio Quijarro Province, Potosi Department, Bolivia. The mine exploited a teluride deposit consisting of a single selenide vein hosted by sandstones and shales. The main primary mineral is a Co-rich kruťaite–penroseite. Clauschalite, petrovicite, waimirite, eldragόnite, and grundmannite were crystallized from later solutions. Alfredopetrovite is a secondary mineral and occurs in vugs in a kruťaite-penroseite-dolomite-goethite matrix. Other closely associated secondary minerals are: aihfeldite, allophane, calcite, chalcomenite, favreauite, felsóbányaiite, malachite, and molybdenite. Alfredopetrovite forms colorless to blue (transmit chalcomenite color) drusy/scaly coatings and compact balls up to 0.5 mm. Individual crystals are up to ~0.1 mm. Crystals are transparent with a white streak and a vitreous luster. The mineral is brittle with a smooth curved fracture and no cleavages. The mineral is optically uniaxial (+), ω = 1.554(2), ε = 1.566(2) (white light); non-pleochroic. The average of 3 electron probe WDS analyses [wt% (range)/wt% normalized to 100%] is: CuO 1.27 (1.04–1.46)/1.09, CoO 0.12 (0.10–0.15)/0.10, NiO 0.51 (0.35–0.68)/0.44, Al2O3 20.99 (20.41–22.04)/18.12, SeO3 69.63 (68.83–70.36)/60.12, H2O (by structure analysis) 23.30/20.12, total 115.82/99.99. The high total is due to dehydration in vacuum and under electron beam. The empirical formula based on 15 O apfu is: Al1.04Cu0.06Na0.08Co0.01Ca0.03Se0.97O2.98H2.94. IR data was not obtained. The strongest lines in the X-ray powder diffraction pattern are [d Å (I; hkl)]: 7.63 (55; 100), 6.22 (55; 101), 5.37 (26; 002), 4.398 (40; 110,102), 3.404 (100; 112), 2.783 (50; 211), 2.606 (22; 203), 1.661 (26; 410,322,314,116). The unit-cell parameters refined from the powder data are: a = 8.819(3), c = 10.721(2) Å, V = 722.0 Å3, and Z = 2. The crystal structure was refined to R1 = 0.0268 for 240 observed [F0 > 4σ(F0)] reflections. The structure is comprised of fairly regular AlO6 and SeO3 tetrahedral pyramids. Three SeO3 pyramids link two adjacent AlO6 octahedra forming a [Al(H2O)2]2[(Se2O4)1] unit. These units are bonded only via hydrogen bonds yielding a structure with relatively large channels along [010]. The configuration of the cluster is similar to that of the distinctive unit in the NASICON (sodium super-ionic conductor) structure, commonly referred to as a lantern unit. The mineral is named in honor of Alfredo Petrov (b. 1955), geologist/mineralogist and an avid mineral collector for his contributions to mineralogy and geology of Bolivia and as well for his contributions to mineral collector’s community as an author of a numerous publications and an active manager of http://www.mindat.org. Four cotypes (one of those is also cotype for favreauite) are deposited in the Natural History Museum of Los Angeles County, Los Angeles, U.S.A. One cotype specimen (it is also a cotype of favreauite) is housed in the Museum Victoria, Australia. D.B.

BUSSYITE-(Y)*


Bussyite-(Y) (IMA 2014-060), (Y,REE,Ca4)(Na,Ca)3MnSi2O7F, is a new mineral species from the Poudrette quarry (level 7), Mont Saint-Hilaire, Quebec, Canada. It occurs in a small alkaline pegmatite as embedded brown prismatic crystals inside massive white anatase. It differs from associated aegirine prisms by rectangular cross sections. Other associated minerals include microcline, sérandite, calcite, cappellenite-(Y), cataplate, charmate-2H and -3F, fluoride, helvine, kupletskite, perraultite, and tainiolite. The bussyite-(Y) crystals are prismatic to bladed, blocky, sometimes radiating, and reach up to 3 mm. The mineral is transparent to translucent, with a white streak and vitreous luster. It is brittle with a perfect {101} cleavage and splinterly fracture; Mohs hardness is ~4. The density was not measured due to the small grain size; Dcalc = 3.11 g/cm3. Bussyite-(Y) is non-pleochroic, optically biaxial (−) with α = 1.583(2), β = 1.593(2), γ = 1.600(2), 2Vαmax = 68°(Y), 2Vβcalc = 79°; Z = 33° (β obtuse), Y = b, and X = {101}. Dispersion was not observed. Fine lamellar twinning, parallel to the elongation, was noted in some crystals. On the IR spectrum of bussyite-(Y) a low broad peak at 3500–2500 cm−1 and 4 minor peaks in the 2500–2000 cm−1 range are assigned to OH stretching vibrations. The large broad peak centered at 967 cm−1 is assigned to [SiO4] and [BeO4] stretching modes with shoulders at 1008 and 1036 cm−1 likely due to the shorter bonds between Be and Si and OH and F. The moderate sharper peaks at 859, 705, and 647 cm−1 are assigned to the [SiO4] and [BeO4] bending modes. The average of 3 electron probe WDS analysis [wt% (ranges)] is: Na2O 8.21 (8.07–8.43), K2O 0.08 (0.50–0.10), BeO 0.97 (by structure refinement), CaO 5.25 (5.16–5.36), MnO 2.93 (2.57–3.20), BaO 0.03 (0.06), FeO 0.40 (0.25–0.60), Al2O3 0.29 (0.21–0.34), Y2O3 7.58 (7.37–7.79), La2O3 0.48 (0.40–0.60), Ce2O3 2.66 (2.37–3.09), Pr2O3

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

Colinowensite


Colinowensite (IMA 2012-060), ideally BaCuSi$_2$O$_6$, is a new mineral species from the central-eastern ore body of the Wessels mine, Kalahari Manganese Field, Northern Cape Province, South Africa. It was found in 2 specimens which both contain a subset of typical paragenesis of Ba-, Sr-, and Cu-bearing silicates effenbergerite-wesselsite, lavinskyite, scottite, and diegogattaite, in close association with pectolite, quartz, aegirine, and richsterite, minerals of the garnet group and a number of manganese and iron oxides with a dominance of hausmannite and hematite. Sugilite, which is generally found in the same paragenesis, is almost completely absent on these specimens. Colinowensite forms purple to dark blue (when thicker) vitreous subhedral crystals up to 100 × 100 × 50 μm with a purplish streak. The crystal forms (100) and (110) are observed while (001) is always present as a cleavage planes. No fluorescence is observed under UV radiation. The mineral is brittle, with uneven fracture, and the estimated Mohs hardness is 4–5. Density by micropycnometry is 4.28(3); $D_{\text{calc}} = 4.236$ g/cm$^3$. Colinowensite is not soluble in acids except HF. It shows very intense absorption in the range 450–620 nm, rendering the mineral almost opaque. Optical measurements in this range lack any confidence. They are feasible below and above this range, albeit with a relatively large estimated error. Colinowensite is uniaxial (−), with $\alpha = 1.740(20)$, $\epsilon = 1.735(20)$ (420 nm) and $\alpha = 1.745(20)$, $\epsilon = 1.730(20)$ (650 nm). It is very strongly pleochroic from purple along the e axis to blue in a perpendicular direction. The average of electron probe WDS analysis of 5 fragments (4 spots each) [wt% (range)] is: CuO 22.53 (22.09–22.98), BaO 43.43 (42.58–44.29), SiO$_2$ 34.04 (33.71–34.37), total 100.00. No other elements detectable by electron probe were found. The empirical formulae based on 6 O apfu is Ba$_{0.9+}$Cu$_{0.1-}$Si$_{2+}$O$_6$. No IR data was obtained. The strongest lines of the powder X-ray diffraction pattern [d Å (P( hkl)]) are: 8.049 (T00; 111), 6.924 (210; 020), 3.529 (38; 311), 3.435 (21; T33), 3.155 (23; T15), 2.940 (35; T31), 2.840 (50; 331), 2.736 (30; 006), 2.651 (38; T35), 2.629 (30; 402). The unit-cell parameters of the monoclinic cell (space group C2) refined from X-ray powder-diffraction data are: $a = 11.545(2)$, $b = 13.840(2)$, $c = 16.504(4)$ Å, $\beta = 95.87(2)^\circ$, $V = 2623.1$ Å$^3$; $Z = 4$. The single crystal unit-cell parameters are: $a = 11.600(3)$, $b = 13.856(3)$, $c = 16.516(4)$ Å, $\beta = 95.84(1)^\circ$, $V = 2641$ Å$^3$. The structure was refined to $R_I = 0.035$ for 6531 unique, observed reflections. Bussyite-Y (Y) has a layered structure consisting of two chemically distinct layers parallel to (201): (1) a layer of [Si(Be)$_2$O$_4$] tetrahedra and (2) a large cation Y-Ca-Mn-Na-OF$^-$ polyhedral layer. Layers are cross-linked through shared O and F atoms. The polyhedra of the layer (2) are in two chains: higher bond-valence cations Y, Ca, and Mn form one polyhedral chain that is cross-linked to the chain of Na polyhedra. There are a number of holes that contain the H atoms. The tetrahedral layer is made up of a series of cross-linked 4-, 5-, and 8-connected rings. The 8 Na sites of the layer (2) ideally hold 6 cations. The discrepancy with electron probe data [Na$_{0.96+}$Ca$_{0.04+}$K$_{0.02+}$(H$_2$O)$_{0.01+}$] is explained by possible loss of Na under the electron beam which also could be a reason for a low wt% total. The structure of bussyite-Y is topologically similar to that of bussyite-Ce but differs in details. The H atoms are much more abundant in bussyite-Ce as [H$_2$O] groups at Na vacant sites while there are no [H$_2$O] groups in bussyite-Y and OH groups are at O and F sites coordinated to Be. The amount of H in both minerals is approximately equal in weight percent. The mineral named as Y analog of bussyite-(Ce). The root name honors the French chemist and pharmacist Antoine Alexandre Brutus Bussy (1784–1802) who researched the preparation of magnesium and isolating the element beryllium. The presence of magnesium and isolating the element beryllium. The holotype specimen is housed in the Canadian Museum of Nature, Ottawa, Ontario, Canada. D.B.
quartz, and titanotaramellite. Esquireite occurs as colorless transparent rectangular blades, elongated and striated parallel to [010] and flattened on [001]. Twinning is common on [001]. The streak is white, the luster is vitreous to pearly. The mineral shows no fluorescence under UV radiation. It is brittle with irregular fracture and Mohs hardness is ~2. Two cleavages are observed: perfect on [001] and fair on [100]. The density (by flotation in an aqueous solution of sodium polytungstate) is $D_{\text{pol}} = 2.18(2) \text{g/cm}^3$; $D_{\text{m}} = 2.237 \text{g/cm}^3$. The mineral is insoluble and unlikeable in concentrated HCl, H$_2$SO$_4$, HNO$_3$, and NaOH. Esquireite is optically biaxial (+), with $\alpha = 1.477$, $\beta = 1.481$, $\gamma = 1.492$ (white light); 2$V_{\text{meas}} = 63.8(6)^\circ$; $\gamma = b$, $Z^\circ = c = 22^\circ$. No dispersion or pleochroism was observed. The average of the WDS electron probe analyses (wt% for 4 points from Esquireite #1 claim and from Trumbull Peak crystals) along with the ranges (in parentheses) are: BaO 25.65 (25.06–26.20); SiO$_2$ 63.60 (62.88–64.53); $H_2$O (based upon the crystal structure) 22.41, total 111.66 (due to dehydration under vacuum). The data normalized to a total of 100% are BaO 22.97; SiO$_2$ 56.96; $H_2$O 20.07. The empirical formula (based on 20 O apfu) is $\text{Ba}_{0.65}\text{Si}_{3.88}\text{O}_{8.63}\text{H}_{1.16}$. The strongest lines in the X-ray powder diffraction pattern obtained in powdered sample by Gandolfi-type motion [d Å (P%; hkl)] are: 7.02 (38; 002), 5.11 (33; 201), 4.649 (66; 003,203), 4.191 (100; 111), 3.339 (65; 302,31,312), 2.967 (32; 205,314,311), 2.343 (33; multiple), and 2.261(35; multiple). The unit-cell parameters refined from X-ray powder diffraction pattern are $a = 13.552(6), b = 4.909(6), c = 15.091(6)$ Å, $\beta = 111.50(1)^\circ$, and $V = 934.3$ Å$^3$. A crystal of 80 × 10 × 50 μm from the Trumbull Peak specimen was used for the collection of structure data. The structure, solved by direct methods, refined to $R_1 = 0.108$ on the basis of 323 unique $F_0 > 4o(F_0)$ reflections, with $a = 13.601(4), b = 4.9222(10), c = 16.092(5)$ Å, $\beta = 111.578(19)^\circ$, $V = 939.6$ Å$^3$, space group $C2, Z = 2$. The crystal structure of esquireite contains four-tetrahedra-silicate layers parallel to {001} with Ba(H$_2$O)$_2$O (based upon the crystal structure) 22.41, total 111.66%; 2.741 (21; 218); 2.747 (20; 218); 2.594 (73; 220); 2.594 (50; 220), 1.710 (21; 20.20)/1.713 (20; 20.20). The trigonal unit-cell parameters refined from the powder data are [for Shergotty and Los Angeles, respectively]: $a = 10.370(9)$ and 10.379(2) Å; $c = 37.17(9)$ and 37.06(2) Å, $V = 3462$ Å$^3$. The single-crystal X-ray study shows ferromerrillite is trigonal, R3c, $a = 10.372(2), c = 37.217(13)$ Å, $V = 3467$ Å$^3$, $Z = 6$. A crystal 0.02 × 0.02 × 0.03 mm of ferromerrillite from Los Angeles sample was used for crystal structure determination. The crystal showed extremely high angular mosaicism owing to impact shock experienced by the host meteorite, a phenomenon, which is inherently typical for impact shocked crystals from shergottite meteorites. Data has been refined to $R = 0.066$ on the basis of 1420 unique $F > 4o(F)$ reflections. Ferromerrillite is isosstructural with merrillite and is named as the Fe$^{2+}$-dominant analog of merrillite. The holotype specimen of ferromerrillite from Shergotty is deposited in the Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow. F.C.

**Comment:** No direct determination of Fe$^{2+}$ content has been provided by the authors in their description. The authors discuss the iron oxidation state on the basis of statistical analysis of correlation of lattice parameters and composition of M sites of known whitlockite-type compounds with available chemical analyses of merrillite samples and of the calculated bond valence values obtained from refined structure data. They conclude that all iron is divalent in the studied samples of ferromerrillite. However, the authors report Fe$^{3+}$ in the formulas reported at Tables 2 and 3. These are probably an uncorrected error left from a previous version of the draft manuscript and these Fe$^{3+}$ should not be taken into account nor mentioned in future work. Oxidation state in martian minerals is a debated item and therefore particular attention should be paid to avoid propagation of erroneous data unsupported by strong evidences.

**References cited**


**FLUOR NATROPYROCHLOR**


The description of fluor natropyrochlore (IMA 2013-056), with a general formula $[\text{Na,Ph,Ca,REE, U},]_n\text{Nb}_2\text{O}_5\text{F}$ changes status of this mineral from possible new species (Christy and Atencio 2013) to an officially approved species according current nomenclature of the pyrochlore supergroup (Atencio et al. 2010). The mineral was found in the alkali granite intruded into Silurian marble at the Boziguoer REE deposit, Baicheng County, Akesu, Xinjiang Autonomous Region, China (42°13′14″N; 81°54′29″E). It is closely associated with microcline, albite, aegirine, sodium amphibole, biotite, zircon, rutile, thorite, fluorite, fluorocerite-(Ce), columbite-(Fe), xenotime-(Y), astrophyllite, chevkinite-(Ce), and fergusonite-(Y). Fluor natropyrochlore forms translucent to transparent brownish yellow to red-
dish orange, anhedral, rarely subhedral grains from 0.02 to 0.25 mm with an adamantine luster and light yellow streak. The mineral does not fluoresce in UV light. No cleavage or parting was observed. It is brittle with Mohs hardness 4–4½. The density was measured; \( \rho = 5.375 \text{ g/cm}^3 \). Fluor-natropyrochlore is optically isotropic, \( n_r = 2.01(5) \) (589.9 nm). FTIR spectrum shows the absence of bands of \( \text{OH} \) or \( \text{H}_2\text{O} \) groups with only single peak at 931 cm\(^{-1}\). The average of 10 electron probe WDS analysis on 2 grains [wt\% (range)] is: Na\(_2\)O 6.80 (3.33–9.30), K\(_2\)O 0.01 (0–0.04), CaO 2.01 (1.69–2.22), MgO 0.01 (0–0.05), FeO 0.05 (0–0.15), SrO 0.03 (0–0.11), Pbo 16.17 (14.75–18.77), CeO\(_2\) 4.29 (3.76–5.41), La\(_2\)O\(_3\) 1.65 (1.37–1.93), Nb\(_2\)O\(_5\) 0.41 (0–0.62), Y\(_2\)O\(_3\) 0.42 (0.17–0.67), SiO\(_2\) 0.03 (0–0.09), TiO\(_2\) 1.36 (0.72–1.91), UO\(_2\) 5.81 (4.21–7.36), Ta\(_2\)O\(_5\) 3.00 (1.33–4.00), NbO\(_2\) 53.42 (51.71–56.16), F 3.19 (2.33–4.12), Cl 0.02 (0–0.06), ThO\(_2\) 0.48 (0.13–1.41), SrO 0.01 (0–0.07), ZrO\(_2\) 0.01 (0–0.13), MnO 0.04 (0–0.11), SnO\(_2\) 0.34 (0.23–0.41), –O=(Fe\(_{0.5}\)), total 98.21. Ba, Al, and P were found below detection limit of 0.01 wt\%. The empirical formula based on 7 anions pfu is: \( (\text{Na}_{0.50}\text{K}_{0.38}\text{Ca}_{0.05}\text{Th}_{0.01}\text{Ce}_{0.01}\text{La}_{0.04}\text{Y}_{0.01}\text{Nb}_{0.13}\text{Ta}_{0.33})\text{O}_{26}F_{176} \). The strongest lines in the powder XRD pattern are \( d (\AA) \): 6.074 (3; 111), 6.051 (3; 111), 3.042 (100; 222), 2.628 (38; 004), 1.971 (12; 200), 1.707 (1; 448). The mineral is cubic with \( a = 10.505(3) \) \( \AA \), \( \beta = 1159.4 \) \( \AA^2 \), \( \gamma = 8 \), space group \text{Fd\text{3}m}. The crystal structure was refined to \( R = 0.053(1) \). Site-sorting refinement analysis shows that fluor-natropyrochlore is characterized by F dominance at the Y site, Na dominance at the A site, and Nb dominance at the B site of the pyrochlore supergroup general formula \( A_{x-y}B_{x-y}X_{y}Y_{z} \), where \( m = 0–1.7 \), \( w = 0–0.7 \), \( n = 0–1 \). The mineral name is given according to the pyrochlore supergroup nomenclature rules. Type materials, including the polished thin section used for microprobe analyses, the single crystal used for crystal structure analysis, and a macro-crystal of natropyrochlore, have been deposited in the Geological Museum of China, Beijing, China. D.B.

References cited

Fluor-Schorl*

Fluor-Schorl (IMA 2010-067), ideally NaFe\(_2\)Al\(_2\)Si\(_2\)O\(_8\)(BO\(_4\))\(_2\)(OH)\(_2\), F, is a new species of the tourmaline supergroup from alluvial tin deposits near Steinberg, Zschoklau, Erzgebirge (Saxonian Ore Mountains), Saxony, Germany, and from pegmatites near Grasstein (area from Mittelwall to Sachsenklemme), Trentino, South Tyrol, Italy. Fluor-schorl was formed as a pneumatolytic phase associated to tin mineralization (Zschoklau) and in high-temperature hydrothermal veins in granitic pegmatites (Grasstein). Fluor-schorl is closely associated with quartz, biotite, albite, orthoclase, schorl, apatite, beryl, cassiterite, and “wollframate” (Zschoklau) and occurs as striated black prismatic crystals, up to 1 × 10 mm, that are often radi-

Fluor-Schorl (IMA 2010-067), ideally NaFe\(_2\)Al\(_2\)Si\(_2\)O\(_8\)(BO\(_4\))\(_2\)(OH)\(_2\), F, is a new species of the tourmaline supergroup from alluvial tin deposits near Steinberg, Zschoklau, Erzgebirge (Saxonian Ore Mountains), Saxony, Germany, and from pegmatites near Grasstein (area from Mittelwall to Sachsenklemme), Trentino, South Tyrol, Italy. Fluor-schorl was formed as a pneumatolytic phase associated to tin mineralization (Zschoklau) and in high-temperature hydrothermal veins in granitic pegmatites (Grasstein). Fluor-schorl is closely associated with quartz, biotite, albite, orthoclase, schorl, apatite, beryl, cassiterite, and “wollframate” (Zschoklau) and occurs as striated black prismatic crystals, up to 1 × 10 mm, that are often rad-

References cited
Henry, D.J., Novák, M., Hawthorne, F.C., Ertl, A., Dutrow, B.L., Uher, P., and Pez-


Hogarthite*
A.M. Mcdonald, P. Tarassoff and G.Y. Chao (2015) Hogarthite, \( (\text{Na,K})_2\text{CaTi}_3\text{Si}_6\text{O}_{18}\) 8H\(_2\)O, a new member of the lemoynite group from Mont St-Hilaire, Quebec: Characterization, crystal structure determination, and origin. Canadian Mineralogist, 53(1), 13–30.
The new mineral hogarthite, (IMA 2009-043), (Na,K)CaTiSi$_2$O$_6$·8H$_2$O, was discovered in vugs within metasomatically altered marble xenoliths in the Poudrette quarry, Mont Saint-Hilaire, La-Vallée-du-Richelieu RCM, Montérégie, Quebec, Canada, where it formed from a late-stage alkaline fluid enriched in SiO$_2$ and TiO$_2$, under conditions of low $P$ at $T < 200$ °C, and possibly through crystallization of a gel. Hogarthite is optically biaxial (+), $\alpha = 1.527(2)$, $\beta = 1.545(5)$, $\gamma = 1.610(2)$, $2V = 40$–50°, but could not be determined accurately because the mineral decomposes rapidly in immersion liquids. $D_{\text{calc}} = 5.7$ °C. Hogarthite is non-fluorescent. The main absorption bands of the IR spectrum (cm$^{-1}$) are: 548, 448, 1645, 1394, 1329, 1235, 1036, 978, 902, 710, 679, 643, 584, 505, 475, 469, 420, 410, 367, 352, 311, 291, 235, 198, 184, 170, 160, 114, 110, 109, 98, and 77 cm$^{-1}$. The X-ray powder-diffraction pattern of hogarthite is dominated by reflections at (101), (101), and (111), and shows the presence of other minerals. The new mineral is deep violet blue with a violet blue streak that changes to light blue as a result of decomposition and loss of NH$_3$. Crystals of shilovite are translucent with a vitreous luster, are sectile and show no cleavage. Density was not measured, but the small grain size of crystals and the instability of the mineral in available heavy liquids. $D_{\text{calc}} = 1.92$ g/cm$^3$. Mohs hardness ≤ 2. Shilovite is optically biaxial (+), $\alpha = 1.527(2)$, $\beta = 1.545(5)$, $\gamma = 1.610(2)$, $2V = 40$–50°, but could not be determined accurately because the mineral decomposes rapidly in immersion liquids. $D_{\text{calc}} = 5.7$ °C. Shilovite is non-fluorescent. The main absorption bands of the IR spectrum (cm$^{-1}$) are: 548, 448, 1645, 1394, 1329, 1235, 1036, 978, 902, 710, 679, 643, 584, 505, 475, 469, 420, 410, 367, 352, 311, 291, 235, 198, 184, 170, 160, 114, 110, 109, 98, and 77 cm$^{-1}$. The X-ray powder-diffraction pattern of shilovite is dominated by reflections at (101), (101), and (111), and shows the presence of other minerals.
-2–3. Density was not measured due to the crystals being too difficult to see in Clerici solution. D_{calc} = 2.681 g/cm³. Tapiate is non-pleochroic, optically biaxial (+) with α = 1.579(1), β = 1.588(1), γ = 1.610(1), 2V_{meas} = 66°(2I), and 2V_{calc} = 66°. X = [10I]; Y = b, z = [10I]. The average of 5 electron probe WDS analyses on 5 crystals [wt% (range)] is: NaO = 0.09 (0.04–0.16), CaO 24.96 (24.13–25.89), CuO 0.73 (0.15–1.75), Al₂O₃ 10.08 (9.48–10.70), Fe₂O₃ 0.19 (0.04–0.41), As₂O₅ 40.98 (39.84–42.56), Sb₂O₅ 0.09 (0.07–0.13), H₂O 23.46 [calculated on the basis of 11 total cations (Ca⁵⁺ + Na⁺ + Cu²⁺ + Al³⁺ + Fe³⁺ + As⁺⁵⁺ + Sb⁺⁵⁺)] charge balance and 32 O], total 100.58.

Waimirite-(Y) is orthorhombic YF₃, a new mineral from the Pitinga mine, Presidente Figueiredo, Amazonas, Brazil and from Jabal Tawlah, Saudi Arabia: description and crystal structure. Mineralogical Magazine, 79(3), 767–780.

Waimirite-(Y) (IMA 2013-108), orthorhombic YF₃, is a new mineral found at the A-type Madere granite (~1820 Ma), at the Pitinga mine, Presidente Figueiredo Co., Amazonas State, Brazil, as well as at Jabal Tawlah (Mount Tawlah) in the Kingdom of Saudi Arabia. At the Pitinga mine, the crystal occurs in hydrothermal veins (up to 30 mm thick) cross-cutting the albite-enriched facies associated with halloysite. Minerals in the granite are K-feldspar, albite, quartz, riebeckite, biotite, muscovite, cryolite, zircon, polylithionite, cassiterite, pyrochlore-group minerals, columbite, thorite, native lead, hematite, galena, fluorite, xenotime-(Y), garnetite-(Y), fluoroctite-(Cc), genethelite-belvite, topaz, ilite, kaolinite, and clorite. At Jabal Tawlah, waimirite-(Y) occurs in hydrothermally altered quartz-rich microgranite, also as the main REE mineral. Associated minerals include biotite, albite, muscovite, microcline, columbite-(Fe), zircon, thorite, xenotime-(Y), samarskite-(Y), ilmenite, an undetermined Ca-Y mineral, euxenite-(Y), fergusonite-(Y), rutile, illicite, barite, calcite, and goethite.

Waimirite-(Y) formed from fluorine-rich hydrothermal fluids containing large amounts of REE. Waimirite-(Y) from Brazil occurs as aggregates of platy crystals up to ~1 mm. Forms observed (determined on synthetic YF₃ only) are pinacoids, prisms, and bipyramids. Crystals are pink with white streak, are transparent to translucent with non-metallic luster, show no cleavage (synthetic YF₃ shows perfect cleavage on [010]) or parting. The Mohs hardness and density was not measured due to the small crystal size; D_{calc} = 5.586 g/cm³. Waimirite-(Y) is biaxial, mean n = 1.54–1.56. It is non-fluorescent under UV radiation. Waimirite-(Y) from Saudi Arabia occurs as inclusions in an undetermined Ca-YF₃ mineral where anhezidral-to-subhedral crystals of several tens to several hundreds of micrometers in size are common. The mineral is colorless with white streak, is transparent with vitreous luster, shows no cleavage, has irregular to conchoidal fracture and is brittle. The density was not measured because of small grain size; D_{calc} = 5.678 g/cm³. The indentation hardness VHN₁₀₀₀₀ = 700 (667–786) kg/mm² corresponding to 5–6 of the Mohs scale. It is optically biaxial (+) with 2V = 70–80° and mean refractive index n = 1.60. At the IR spectrum of the material from Brazil polluted with a halloysite a strong band at 380 cm⁻¹ (with shoulders at 400 and 440 cm⁻¹) belongs to waimirite-(Y). IR spectrum demonstrates the absence of carbonate and borate groups. The average of 24 electron probe WDS analyses on the sample from Brazil [wt% (range)] is: F 29.27 (28.43–30.19), Y 37.25 (34.75–38.89), La 0.19 (0.01–0.28), Ce 0.30 (0.19–0.46), Pr 0.15 (0.03–0.25), Nd 0.65 (0.57–0.81), Sm 0.74 (0.66–0.87), Gd 1.86 (1.65–2.09), Tb 0.78 (0.60–0.95), Dy 8.06 (7.36–8.16), Ho 1.85 (1.47–2.35), Er 6.38 (5.80–7.24), Tm 1.00 (0.69–1.34), Yb 5.52 (4.99–6.16), Lu 0.65 (0.38–1.58), Ca 0.83 (0.71–0.97), O 2.05 (calculated by charge balance), total 97.53. This gives the empirical formula (Y₁.₃±₀.₀₁(Na₀.₉₋₁₁(Ca₀.₃₋₁₁(Alₒ.₇₋₁₃(Feₒ.₃₋₁₃(Asₒ.₃₋₁₃(Sbₒ.₃₋₁₃O)₆(OH)₆)))))₂(H₂O)₂. H₂O, total 100.58. The strongest lines in the X-ray powder-diffraction pattern [d (hkl)] are: 3.707 (26; 011), 3.623 (78; 101), 3.438 (99; 202), 3.205 (100; 111), 2.894 (59; 210), 2.937 (33; 131), 1.937 (24; 301), 1.862 (27; 230). The unit-cell parameters refined from powder-diffraction data are: a = 16.008(8), b = 5.767(9), c = 16.367(8) Å, β = 116.72(2), and V = 1350 Å³. Single-crystal X-ray diffraction data collected on a crystal of size 0.05 × 0.03 × 0.02 mm refined to R₁ = 0.0537 for 1733 unique reflections shows tapiate is monoclinic, P2₁/a, with unit-cell parameters a = 16.016(1), b = 5.778(1), c = 16.341(1) Å, β = 116.704(8)°, F = 1350.9 Å³, and Z = 2. The structure of tapiate consists of a backbone chain of trans-edges-sharing AlO₆ octahedra where adjacent octahedra are further linked to one another by AsO₄ tetrahedra in a staggered arrangement, forming Al(As₂O₄)(OH)₂ chains of octahedra and tetrahedra. These chains are topologically identical to the chain in the structure of linarite. CaO₆ polyhedra condense to these chains, forming columns, where CaO₆ polyhedra in adjacent columns link to one another by corner-sharing to form thick layers parallel to [101], further linked to AsO₄ tetrahedra. An extensive system of hydrogen bonds links the framework. The new mineral is named tapiate for Enrique Tapia (1955–2008), a well-known Chilean mineral collector. Four cotype specimens are deposited in the Natural History Museum of Los Angeles County, U.S.A. O.C.G.