New Mineral Names*†

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This New Mineral Names has entries for 23 new minerals, including alpeite, ammoniozippeite, batagay-ite, centennialite, dagenaisite, davidsmithite, epifanovite, ferro-thermakhite, greenilizarite, grotfontenite, janchevite, javorite, kampelite, roymillerite, tredouxite, vanadio-pargasite, and wilancookite. Included also is a series of pyrochlore supergroup minerals: fluorcalciopyrochlore, hydroyxycalciomicrolite, hydroyxferroméite, hydroxynatropyrochlore, oxynatromicrolite along with a new data on hydrokenoelsmoreite-3C and hydrokenoelsmoreite-6R.

ALPEITE*


Alpeite (IMA 2016-072), ideally Ca₅Mn⁴⁺[Al₃(Mn⁵⁺Mg)Si₂O₆](V²⁺O₄)(OH)₆, orthorhombic, is a new member of the ardennite group from the Monte Alpe mine (44°18′24″N, 9°32′00″E), Liguria, Italy. It crystallized from V- and Mn-rich hydrothermal fluids in an oxidizing environment. Alpeite is associated with braunite, dolomite, quartz, tozorokite, and ganophyllite. Alpeite occurs as intergrowths of plates up to ~0.3 mm in diameter, which are flattened on {100} and exhibit the forms {101}, {001}, {012}, and {102}. No twinning was observed. Crystals are brownish-red and transparent with a vitreous lustre and beigey streak. Crystals are brittle with a curved and stepped fracture. The cleavage is perfect on {100} and good on {010} and {001}. The mineral is non-fluorescent. Optically it is biaxial (–), α = 1.747(3), β = 1.785(3), γ = 1.808(3) (white light); 2V⁰ = 73(2)° (spindle stage); 2V⁰calc = 74.3°; dispersion of optical axes is r > v, strong; X = a, Y = b, Z = c. The pleochroism in shades of reddish brown is Y > Z > X. The Mohs hardness is 5½–6. The density was not measured because fragment are nearly invisible in Clerici solution. Dcalc = 3.374 g/cm³. The mineral is inert in concentrated HCl at room temperature. The average of 14 electron probe WDS analyses in 8 crystals is [w% (range)]: CaO 20.45 (19.99–20.67), MgO 2.49 (2.41–2.82), CoO 1.43 (0.91–1.98), MnO, 20.90 (20.17–21.84) (MnO 1.08 and Mn₃O₇ 19.70 according to site occupancies), Al₂O₃, 11.52 (10.56–12.02), SiO₂, 29.22 (28.63–30.74), V₂O₅, 7.36 (6.50–8.51), H₂O, 5.13 (on the basis of charge balance), total 99.08. The empirical formula (Ca₅₋₉Mn⁴⁺₁₋₁₋₉Al₃Mn⁵⁺Mg,Mn₂₋₃₋₉Si₃₋₄₋₉O₁₀₋₁₋₉(OH)₆₋₉) are: 3.022 (93; 115), 2.673 (100; 116), 2.572 (69; 206), 1.5112 (83; 040,27). The unit-cell parameters refined from powder-diffraction data: a = 8.9394(12), b = 6.0488(8), c = 18.954(3) Å, V = 1024.9 Å³. The single-crystal X-ray data obtained from the crystal of 0.07 × 0.04 × 0.005 mm in size shows that alpeite is orthorhombic, Pnma, a = 8.9421(11), b = 6.0534(6), c = 18.978(6) Å, V = 1027.29 Å³, Z = 2. The crystal structure of alpeite, refined to R = 4.4 % for 834 unique observed reflections with Fₙ > 4σ(Fₙ) and 5.39% for all 1022 reflections, is same as that of other members of the ardenite group. It contains chains of edge-sharing Mn³⁺ and Al octahedra extending along the b axis, which are linked into a framework by sharing corners with SiO₄ tetrahedra and with SiO₄ tetrahedral groups. Within the cavities in this framework are sevenfold-coordinated Ca sites. In the structure of alpeite, Mn⁵⁺ is the dominant cation in the M₁ sites, while in all other members of the ardenite group [ardenite-(As), ardenite-(V), and kannanite], Al is the dominant cation in both these sites. Alpeite is named for its type locality. The holotype specimen deposited in the Natural History Museum of Los Angeles County, California, U.S.A.

AMMONIOZIPPEITE*


Ammoniozippeite (IMA 2017-017), ideally (NH₄)₂[(UO₂)₂(SO₄)₃]O₇·H₂O, orthorhombic, is a new mineral discovered in the Blue Lizard Mine, San Juan County, Utah (37°33′26″N 110°17′44″W), and the Burro Mine, San Miguel County, Colorado, USA. (38°24′2″N 108°53′23″W). It was also found at Green Lizard, and showing-Givimint-Spitmout mines (near the Blue Lizard mine). At all locations it occurs as a low-temperature, secondary phase resulted from postmining oxidation of primary U ore in the humid underground environment. Ore minerals were deposited as replacements of wood and other organic material and as disseminations in the enclosing sandstone. At the Blue Lizard ammoniozippeite associated with a wide variety of other secondary phases including blödite, bobcoekite, brochantite, chalcanthite, devilline, dickite, ferrinatrite, gerhardtite, gyypsium, johannite, kröndite, magnesiozippeite, natrozippeite, pentahydrate, pickeringite, pläšilite, posnjakite, redcanyonite, wetherillite, and other potentially new uranyl sulfates (under study). At the Burro mine ammoniozippeite is rare and occurs on a matrix consisting of asphaltum, quartz, and calcite, associating with gypsum, natrojarosite, and natrozippeite. Ammoniozippeite crystals are acicular to bladed, usually tapering to a point up to 0.2 mm (Blue Lizard), or with rectangular (square) terminations up to ~2 mm (Burro mine). Crystals from the Blue Lizard mine are elongated on {010}; those from the Burro mine are flattened on {011} and have simple rectangular morphology with the forms {010} and {100}. Those from the Blue Lizard mine are flattened on {010}, often have a lozenge-shape with spear-like terminations and exhibit forms {001} and various combinations of {011}, {102}, {103}, and {102}. Ammoniozippeite is yellow to yellowish orange, transparent, with a pale-yellow streak and vitreous luster. It fluoresces dull green-yellow under 405 nm laser light. The cleavage is

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

**BATAGAYITE**


Batagayite (IMA 2017-002), CaZn_(2)(Zn,Cu)(PO_4)_3(OH), 12H_2O, monoclinic, is a new mineral discovered at the greisen-type Sn–Ta deposit of Késéter, Kyzyl-Yamykh-Khai massif, NE Yakutia, Russia. It was found in a quartz–phosphate nest of ~5 m in diameter within greisenized cassiterite-bearing granodiorite. The nest consists of pale-gray botryoidal aggregates of fluorapatite (up to 30 cm) and porous milky-white aggregates of quartz (up to 10 cm). The numerous voids and fractures in these aggregates are incrusted by dark-green crystals and spheneulites (up to 5 mm) of pseudomalachite and light blue sampleite, druses of pale-green long-prismatic crystals of libethenite (up to 7 mm), and separated clusters of native copper (up to 3 mm). Radial aggregates of colorless flattened-prismatic crystals of batagayite (up to 2 mm) grow on the surface of copper clusters closely associating with colorless cubo-octahedral arsenolite (up to 1 mm), colorless tetragonal plates of tobermorite (up to 1 mm), turquoise-blue crusts (up to 50 μm thick) of recently discovered here epifanovite NaCaCu_2(PO_4)_3[AsO_4](OH), 7H_2O (monoclinic) (Yakovenchuk et al. 2017) and radial fibrous aggregates (up to 3 mm) of unknown mineral. Other associated minerals are Na-analogue of batagayite and Mg-analogue of hopeite. Batagayite is a secondary low-temperature mineral formed as a result of alteration of primary minerals such as native copper and fluorapatite. Batagayite blades are flattened on {001} and elongated on {100} and often form radial aggregates. The streak is white, and the luster is vitreous. The mineral has a perfect cleavage on {001} with no parting observed. It is brittle with Mohs hardness of 3; D_{calc} = 3.02 g/cm^3. The mineral easily dissolves in 10% room-temperature HCl. Batagayite is non-pleochroic, optically biaxial (+), α = 1.566(2), β = 1.572(2), γ = 1.573(2) (589 nm), 2V = 40°(S), 2V = 44°(Z); Z ꞌ ꞌ ꞌ ꞌ 90°(001), further details unclear. No dispersion (unspecified kind) was observed.

The most intensive bands of the Raman spectrum (cm^-1) are: 1009, 983, 954, 942, and 926 (with shoulder at 912) correspond to the symmetric and antisymmetric stretching modes of the PO_4^2-; 440, 462 (bending vibrations of the same bonds), the high-frequency bands can be related to PO_4^3- groups coordinated by H_2O. Other bands in the range 1100–1150 can be attributed to the antisymmetric stretching vibrations ν_3 of the PO_4^3- Bands at 90, 110, 131, 157, 238, 271, 375 (weak), 525, and 570 are assigned to the different vibration modes of the Zn–O and Cu–O bonds. The broad bands in the range 3200–3600 are attributed to stretching vibrations of the O–H bonds of H_2O and hydroxyl groups. The average of 12 electron probe WDS analyses on 2 crystals [w% (range): Na_2O 0.31 (0.06–0.61), MgO 1.39 (1.38–1.41), Al_2O_3 0.55 (0.07–1.04), SiO_2 0.48 (0.14–0.82), P_2O_5 34.37 (33.60–35.14), K_2O 0.17 (0.17–0.17), CaO 2.76 (1.59–3.93), MnO 1.03 (0.49–1.56), CuO 5.80 (3.77–8.83), ZnO 35.62 (35.48–35.75), CdO 0.24 (0–0.48), H_2O 1.683 (from structure refinement), total 99.55. The empirical formula based on P + Si = 7 is (Zn_{0.26}Cu_{0.06}Ca_{0.66}Mg_{0.06}Mn_{0.16}Al_{0.15}Na_{0.05}K_{0.05}Ca_{0.03}Cu_{0.03}P_{0.82}Si_{0.18}O_{22}(OH)_{1.97}2H_2O, 12H_2O. The strongest X-ray lines powder diffraction patterns for Batagayite (Burns et al. 2003) are: d ( Å (Pd, %hkl)): 7.17 (100, 020), 3.580 (21, 040), 3.489 (20, 203), 3.138 (63, 223), 1.6966 (18, 229,426). Unit-cell parameters refined from the powder data with whole-pattern fitting are: a = 8.7944 (3), b = 14.351(5), c = 17.181(7) Å, V = 2164.0 Å^3, Z = 8. The structure of ammoniozippeite (Rig = 0.0396 for 392 3 > 2σ reflections) contains edge-sharing zigzag chains of pentagonal UO_2 bipyramids linked by sharing corners with SO_4 groups to a [(UO_2)(SO_4)O_2]_2 sheet of the zippeite-type topology. The interlayer space contains two NH_2 groups and one H_2O group pfu, statistically distributed over three sites. The synthetic analog of ammoniozippeite contains two fully occupied N sites and no H_2O in the interlayer (Burns et al. 2003). The structure of that phase (NH_2)CaZn_{2}(Zn,Cu)(PO_4)_3(OH) refined in the space group Cmca. The non-standard space group Cmcm chosen for ammoniozippeite to be consistent with the cells of the monoclinic zippeite-group minerals. However, zippeite group has not been yet been formally approved by the CNMNC. The name reflects the fact that this mineral is the ammonium analog of zippeite, where NH_3 replaces K^+. One holotyope (Burro mine) and one cotype (Blue Lizard mine) are deposited in the Natural History Museum of Los Angeles County, Los Angeles, California, U.S.A. D.B.
which share corners to form 4-membered rings further linked via (PO₃OH) tetrahedra into chains parallel to a. The CuO₆ octahedra are located between the chains. The interlayer space is occupied by the Ca²⁺ cations and H₂O molecules. High hydration state and the modular character of the batagatey structure resulted in a high structural complexity (1058:257 bits/cell). The mineral is named for a small town of Batagay (administrative center of the Verhoyansk ulus of the Sakha Republic) located in ~50 km from the deposit. The holotype specimen is deposited in the Mineralogical Museum of St. Petersburg University, Russia. D.B.

References cited

**CENTENNIALITE**


Centennialite (IMA 2013-110), CaCu₄(OH)₂Cl₃·0.7H₂O, trigonal, is a new mineral discovered at the Centennial Mine of the Lake Superior copper district, Houghton Co., Michigan, U.S.A. (47°15′30″ N, 88°25′43″ W) and atacamite Cu₃O₄Cl families which are essentially indivisible from each other. The mineral occurs as tiny light greenish-gray platelets with hexagonal outlines (up to 0.05 mm) and a streak which ranges from pale yellow to white. The crystals are transparent to translucent with a white streak, having a perfect crystal and showing a vitreous luster. The metallic color is due to the presence of a small amount of copper. The mineral is named for its type location. It occurs as a secondary product resulted from acid water reaction with unspecified supergene Cu mineralization (mining and processing waste). The mineral is identified by its trigonal crystallographic system, a chemical composition with high Cu content, and by the presence of a pronounced pleochroism.

The structure consists of two types of layers, each consisting of a CaO₆ octahedron and a CuO₄ tetrahedron. The CaO₆ octahedron is surrounded by 6 rectangular CuO(H)₄ tetrahedra, forming a triclinic layer. The layers are stacked along the [001] direction, with two hydrogen-bonded Cl sites between them. These extend the coordination to form the long apices of the triclinic layers. The structure has a kapellasite-like topology. The layers consisting of triangular network of edge-sharing CaO₆ octahedra alternating with edge-sharing planar CuO(H)₄ units such way that each CaO₆ octahedron is surrounded by 6 rectangular CuO(H)₄ units. All O sites are protonated and bridge Ca and Cu sites. The structure is stabilized by hydrogen bonds between the layers, resulting in a rigid framework. The mineral is monoclinic, space group P2₁/n, with unit cell parameters a = 16.6615(1), c = 5.8004(8) Å, V = 222.98 Å³.

**References cited**


**DAGENAISET**


Dagenaisite (IMA 2017-017), ideally Zn₆Te₆O₁₆, monoclinic, is a new mineral from the 300 foot level of the Ophohonga stope at Gold Chain mine, Tintic district, Juab County, Utah, U.S.A. (39°55′54″N; 112°56′0″W). The mine exploited a polymetallic (Te–Zn–Pb–Cu–Ag) vein deposit in dolomite. The upper portion of the deposit is almost completely oxidized.

Dagenaisite was found with cinnabar, dugganite, eurekdampite, and gold in vugs in a quartz-dolomite matrix. Other minerals of the general assemblage include adamiite, arseniosiderite, atelestite, baryte, beudantite, conichalcite, hemimorphite, kettermite, malachite, mimetite, mixite, olivenite, and rosasite. Dagenaisite formed at a late stage of oxidation and occurs as tiny light greenish-gray platelets with hexagonal outlines (up to 100 μm but generally smaller and less than 1 μm thick), usually intermixed with amorphous material, forming porous masses that are apparently replacements of earlier Te- and Zn-bearing minerals, probably hessite and sphaerelite. The crystals are transparent to translucent with a white streak, pearly luster irregular fracture and no cleavage. The tenacity is flexible. No fluorescence under UV radiation was observed. The Mohs hardness...
estimated to be ~2. The density was not measured; \( D_{\text{calc}} = 6.00 \, \text{g/cm}^3 \). At room temperature, the mineral is slowly soluble in dilute HCl and rapidly soluble in concentrated HCl. The mineral is non-pleochroic. Its crystals are isotropic viewed perpendicular to the plate and show parallel extinction viewed on-edge. The mineral is optically biaxial (+) with a relatively small 2V. Assuming the plate direction as \{100\}, \( Z \cong a \). The refractive indexes were not determined; \( n_{\text{ext}} = 1.99 \). The Raman spectra recorded between 4000 and 100 cm\(^{-1}\) show poorly resolved broad main band at 721 cm\(^{-1}\) with indistinct shoulders at ~822, 634, 597, and 65 cm\(^{-1}\) assigned to Te\(_6\)O\(_{16}\) groups. No features indicative of OH or H\(_2\)O were observed.

The average of six electron probe WDS analyses [wt% (range)] is: CaO 0.70 (0.57–0.84), CuO 6.22 (4.60–7.77), MnO 0.42 (0.29–0.52), ZnO 42.78 (40.11–45.15), SiO\(_2\) 0.23 (0.12–0.38), As\(_2\)O\(_3\) 0.85 (0.25–1.57), TeO\(_2\) 39.15 (37.38–41.73), total 90.35. No other elements were detected by EDS. No beam damage observed, and low total assumed to be due to small crystal size, porous aggregates, and admixture of the amorphous material of similar composition and other surrounding phases, which might be responsible for the small amounts of Ca, Mn, Si, and As. The empirical formula based on 6 O pfu is \((\text{Zn}_{9.0}\text{Cu}_{2.6}\text{Ca}_{0.3}\text{Mg}_{0.05}\text{As}_{0.30}\text{Si}_{3.30}\text{C}_{0.25})_{\text{Te}_{6.0}\text{O}_{16}}\). The strongest lines in the X-ray powder-diffraction patterns are \([d \,(\text{Å}; \, hkl)]\): 4.311 (30; 310), 3.085 (22; 402), 3.029 (44; 222), 2.744 (68; 313,421), 2.539 (100; 322,322), 1.657 (48; 732,350,344). The parameters of the monoclinic unit-cell refined from the powder data with whole-pattern fitting are: \( a = 14.87(2), b = 8.88(2), c = 10.37(2) \), \( \beta = 93.33(2) \), \( \gamma = 1367 \, \text{Å} \), space group \( C2/c \), \( Z = 12 \). No suitable crystal for the X-ray single-crystal study was obtained, but the close match between the powder diffraction pattern of dagenaisite and the pattern calculated from the structure data for synthetic \( \text{Zn}_6\text{TeO}_{16} \) indicates that dagenaisite has the same structure based on an approximate close packing of O atoms in an \( hhchhc \) sequence along \{100\}. The structure of synthetic \( \text{Zn}_6\text{TeO}_{16} \) (Weil 2006) contains two distinct Te atoms with positions relatively regular octahedral coordination and five different \( \text{Zn} \) sites three of those with regular or distorted octahedral coordination, one has square pyramidal and one tetrahedral coordination. The name honors John Dagenais (b. 1945), prominent mineral field collector of Vancouver, British Columbia, Canada. He provided for scientific research a number of potentially new mineral from Kester deposit (Sakha-Yakutia, Russia). Zapiski Ros. Geol. Geokhim. Inst. (Transactions of Russian Geological and Geophysical Institute), 54(4), 71–82 (in Russian).

Davidsmithite (IMA 2016-070), ideally \((\text{Ca}\text{,\,Na})_2\text{Al}_6\text{Si}_2\text{O}_{16}\cdot xH_2O\), a new, Ca-bearing nesophile-group mineral from the Western Gneiss Region, Norway. European Journal of Mineralogy, 29(6), 1005–1013.

G. Rossi, R. Oberti, and D.C. Smith (1989) The crystal structure of a K-poor regular or distorted octahedral coordination, one has square pyramidal and some other physical properties. Davidsmithite is colorless to pale yellowish in thin section. Twinning was not observed in thin section, although it is present in diffraction, probably polysynthetic on (100). Davidsmithite has white streak and vitreous to greasy luster. The Mohs hardness is 5/5, \( D_{\text{calc}} = 2.597 \, \text{g/cm}^3 \). The mineral is non-fluorescent. Optically it is uniaxial (–), \( \epsilon = 1.538(2), \, \alpha = 1.535(2) \) (white light). The Raman spectrum shows the most intense band at 425 cm\(^{-1}\) and a weaker shoulder at 475 cm\(^{-1}\). No proofs of the presence of O–H stretching bands was obtained (in agreement with closure of EMP analyses). The average of 10 electron probe WDS analyses is [wt% (range)]: CaO 3.16 (3.10–3.22), K\(_2\)O 0.69 (0.56–0.81), Na\(_2\)O 16.89 (16.85–16.92), Al\(_2\)O\(_3\) 35.52 (35.42–35.61), Fe\(_2\)O\(_3\) 0.13 (0.07–0.19), SiO\(_2\) 43.63 (43.06–44.21), MgO 0.02 (0–0.05), MnO 0.04 (0–0.07), Ni 0.01 (0–0.01), TiO\(_2\) 0.04 (0–0.08), total 100.12. The empirical formula \((\text{Ca}\text{,\,Na})_6\text{Al}_2\text{Si}_2\text{O}_{16}\cdot xH_2O\), based on 32 O pfu. The strongest lines in the X-ray powder-diffraction pattern \([d \,(\text{Å}; \, hkl)]\): 4.322 (27.4; 0402), 4.182 (65.7; 002), 3.840 (92.9; 021), 3.267 (71; 230), 3.006 (100; 022), 2.882 (41.3; 030), 2.575 (23.2; 232), 2.343 (53.6; 023), 2.305 (31.3; 341), 1.561 (27.4; 453,153,025). The single-crystal X-ray data obtained from the crystal of \( 0.3 \times 0.2 \times 0.1 \) mm shows davidsmithite is hexagonal, \( P6_3, \, a = 9.982(1), \, c = 8.36(1) \), \( V = 721.7 \, \text{Å}^3, \, Z = 1 \). The crystal structure of davidsmithite, refined to \( R_1 = 3.66\% \) for 364 unique observed reflections with \( F^2 > 3\sigma(F^2) \) and 10.41\% for all 748 reflections, is the same tetrahedral framework as that of nepheline, but with the distribution of the Ca, Na, K cations quite unusual: the large A cation is statistically occupied by \((\text{Ca}+\text{Na}+\text{K}+\text{Na})\), with one position at the K position of ordinary nephelines but occupied by \((\text{Ca}+\text{Na}+\text{K})\), and a second position labelled Ca’ and occupied by \((\text{Ca}+\text{Na})\) displaced along the \( z \) axis at approximately 1.25 \( \text{Å} \) from the K position. The name honors David Christopher Smith (b. 1946), Emeritus Professor at the Museum National d’Histoire Naturelle (MNHN) in Paris, France. As a mineralogist, he participated in discovery of the new minerals nybőite, lisëtite, taramite, and ferro-taramite in Norway. As a petrologist, he pioneered the recognition of the new sub-discipline of ultrahigh-pressure metamorphism (UHPM) well before coesite was found in Italy and in Norway. The above-mentioned holotype thin section G201b7 is now deposited in the Mineral Collection of MNHN under the number MNHN215-001. F.C.
NEW MINERAL NAMES


Ferro-tschermakite (IMA 2016-116), ideally $^{4+}[\text{Cu}^2\text{Mg}(\text{Al})_3](\text{Si}2\text{Al}2\text{O}8)(\text{OH})_2$, monoclinic, is a newly characterized member of the calcium amphibole group (Hawthorne et al. 2012), coming from the dump of the Bâtiment et Granit de Ploumane’ch northern granite quarry, La Clarté, Perros-Guirec, Ploumane’ch granite complex, Brittany, France (−48°48′50″ N, −3°28′50″ W). The Perros-Guirec granite is a coarse-grained, porphyroid granite, where pronounced pink color due to the presence of large feldspar crystals, emplaced in the Icartian basement (lower Brioverian 615 Ma), and intruded by veins of the pink Ploumane’ch granite.

Ferro-tschermakite occurs as −3 cm long aggregate of dark green bladed-to-acicular crystals associated with white plagioclase and in mioraitolitic texture in a granite pegmatite. Ferro-tschermakite is nonfluorescent and has a dark green streak and a vitreous luster. Cleavage, fracture, and hardness not reported. The density was not measured; $D_{calc} = 3.260$ g/cm$^3$. In transmitted plane-polarized light, ferro-tschermakite is pleochroic (X = pale yellow-green, Y = olive green, Z = blue green). It is biaxial (−), α = 1.666(2), β = 1.680(2), γ = 1.690(2) (l. not reported), $2V_{meas} = 84(1)$, $2V_{calcd} = 79.8°$. The dispersion of an optical axis is medium ($r > v$), and the orientation is: X $^a = 9.5°$ (in β acute), Y'b', Z'c' $= 24.3°$ (in β obtuse). The average of 10 electron probe WDS analyses [wt% range] is: SiO$_2$ 41.32 (40.61–42.55), TiO$_2$ 0.35 (0.35–0.39), Al$_2$O$_3$ 18.13 (17.72–18.41), Cr$_2$O$_3$ 0.02 (0–0.03), V$_2$O$_3$ 0.05 (0.01–0.08), FeO$_{total}$ 17.55 (17.18–18.72), Fe$_2$O$_3$ 15.66 and FeO 2.09, MgO 6.94 (6.73–7.15), MnO 0.20 (0.15–0.22), NiO 0.01 (0–0.03), ZnO 0.02 (0–0.04), CaO 10.58 (18.48–16.64), Na$_2$O 1.61 (1.30–1.74), K$_2$O 0.45 (0.42–0.46), H$_2$O [on the basis of 2 (OH,FO) pfu] F 0.12 (0–0.24), O−F 0.05, total 99.47. The empirical formula based on 24 (O,OH,F) pfu is $^{\text{[Ca}_2\text{Fe}^{2+}3\text{Al}^{3+}\text{Si}_2\text{Al}^{2+}2\text{O}_{8}(\text{OH})_2]}$ $^{\text{[Ca}_2\text{Fe}^{2+}3\text{Al}^{3+}\text{Si}_2\text{Al}^{2+}2\text{O}_{8}(\text{OH})_2]}$. The strongest X-ray powder diffraction patterns are [d (A; Pห โดย (V, $^a$)): 8.359 (100; 110), 2.708 (84; 151), 3.095 (55; 310), 2.552 (43; 202), 2.595 (41; 061), 2.330 (33; 351), 2.159 (27; 261), 2.936 (27; 221), 3.328 (27; 131), 2.012 (24; 302), 3215]. The single-crystal X-ray data obtained from a crystal of 0.14 × 0.13 × 0.05 mm shows that ferro-tschermakite is monoclinic, $C_{2h}$ $^{2/m}$. The crystal structure was determined by direct methods and refined to R = 0.087 on the basis $^{2147}$ of independent observed reflections. It contains four CuO pymonds, linked to form [CuO$_4$] tetramers. The tetramers are linked via phosphate groups to the complex incrustated by dispersed $^{[\text{AsO}_4]^{3-}}$ group to form fundamental building blocks in the structure. The blocks are linked through phosphate groups to form layers [CuO$_4$]$_2$ layers (T = As, P) parallel to the (001) plane. The layers are joined into a three-dimensional framework by sharing of the apical atoms of the CuO pymonds and O atoms of disordered arsenate groups. Epifanovite is related to lavendulan-group minerals and related species: andyrobertsite, calcioandrobertsite, mahnerite, and richeltsdorfite. The most closely related are the structures of the monoclinic polytypes of the andyrobertsite–calcioandrobertsite KMeCu$_2$As$_2$O$_7$[As(OH)$_2$O$_2$]$^2$H$_2$O (Me = Cd, Ca). The name honors Porphyrik Prokopievich Epifanov, Russian geologist, the discoverer of the Kester, Ege-Khayva, and others tin deposits in 1936–1938. The holotype is deposited to the Mineral Museum of Sankt Petersburg University, Russia. D.B.
NEW MINERAL NAMES

GROUPT-2041

GREENLIZARDITE


Greenlizardite (IMA 2017-001), (NH₄)Na(UO₂)₃(SO₄)₂(OH)₄·4H₂O, triclinic, is a new mineral discovered at the Green Lizard mine, Red Canyon, White canyon district, San Juan County, Utah, U.S.A. (37°34'30.70"N, 110°17'52.80"W) and named for its type locality. It is a secondary alteration mineralogy are similar to that of nearby located Blue Lizard, Giveaway-Simplot, and Markey mines which recently appeared to be a prolific source for new minerals (mostly U sulphates), having already yielded more than 16 species. Greenlizardite forms light green–yellow transparent blades up to several millimeters. Grootfonteinite forms platy grains up to 1 mm across and up to 0.2 mm thick included in, and intergrown with, massive cerussite. In one portion of the studied material it occurs as platy aggregates up to several millimeters. Grootfonteinite is colorless, with white streak and adamantine luster. It is brittle with a perfect cleavage on {011} and no parting. The fracture is uneven across the cleavage planes. The microindentation hardness VHN₁₀₀ = 68.56 g/cm². In reflected light, grootfonteinite is gray. It is non-pleochroic, with abundant white internal reflections and a very weak birefringence masked by the internal reflections. The reflectance measurements made in air in the range 400–700 nm with 20 nm interval. The values [R₉₋₋/R₉₋% (nm)] for COM wavelengths are 13.0/10.8 (470), 12.6/10.5 (546), 12.5/10.3 (589), 12.3/10.2 (650). The IR spectrum is rather similar to that of the related minerals hydrocerussite and plombacite, and shows (cm⁻¹; s = strong band, w = weak band, sh = shoulder): 3470w, 3386w (O–H stretching vibrations); 1738 (overtone of in-plane bending vibrations of CO₂⁻); 1418 s, 1380 sh (asymmetric C–O stretching vibrations of CO₂⁻); 1200 (combination mode involving Pb–O–stretching) and C–O bending vibrations); 1046 (symmetric C–O stretching vibrations of CO₂⁻); 837 (out-of-plane bending vibrations of CO₂⁻); 685sh, 680s (in-plane bending vibrations of CO₂⁻); 480 (Pb–O stretching vibrations). The average of 10 electron probe WDS analyses is [wt% (range)]; Na 0.92 (0.88–0.95), Ca 0.26 (0.23–0.29), Pb 79.66 (79.40–80.09), O 16.28 (15.70–17.02), C (by stoichiometry) 3.49, H (by charge balance) 0.05, total 100.66. The empirical formula is Hₙ₋₈Naₓ₋₈Caₓ₋₈Pbₓ₋₈CO₃₋₈·HₓO (based on 7 O and 2 C apfu). The strongest lines in the X-ray powder-diffraction pattern [d Å (P/P₀); hkl] are: 4.586 (25; 010), 3.244 (100; 013), 2.652 (30; 110), 2.294 (21; 020), 2.053 (39; 023). The lattice parameters refined with powder data in the hexagonal unit-cell, are: a = 3.500(2), c = 13.833 Å, V = 3323.8 Å³, Z = 2. The single-crystal X-ray data obtained from the crystal of 0.12 × 0.12 × 0.005 mm shows grootfonteinite is hexagonal, P6₃/mmc, a = 5.3031(1), c = 13.770(3) Å, V = 3353.3 Å³, Z = 2. The crystal structure of grootfonteinite was refined to R₁ = 5.16 % for 178 unique observed F₂=4(Fe) reflections and to R₁ = 15.17 % for all 185 reflections. Grootfonteinite is structurally related to hydrocerussite, abellate, and plombacite. The characteristic structural feature of all these minerals is the presence of [PbCO₃]₆ sheets.
perpendicular to the ε axis (C-type sheets), in the upper and lower parts of invariably electronuele 2D blocks, the middle part being variable. The topology of these intermediate 2D blocks in the structure of grootfon-teinite can be considered as intermediate between those of abellaite and hydrocerussite. In the structure of grootfonteinite Pb1- and Pb2-centered polyhedra share common O atoms to form two-dimensional blocks. Additionally, sheets of composition [(Pb6Na6)(OH)(OH2)n]4+, formed by the Pb2 and O2 sites (LO sheets) are sandwiched between every other pair of C-type sheets. Grootfonteinite is named after the locality in the Grootfontein district. The type material is deposited in the collections of the Swedish Museum of Natural History (Stockholm, Sweden).

**JANCHEVITE**


Janchevite (IMA 2017-079), ideally PbV45(O2,Cl),2Cl, tetragonal, is a new mineral species from the abandoned Kombat copper mine located in the Grootfontein district, Otjozondjupa region, northern Namibia. Janchevite is the 14th new mineral discovered in the Kombat mine. It formed as a consequence of regional metamorphism of a primary, Pb–Mn–(As–Ba)-rich, chemically heterogeneous, volcanic hydrothermal assemblage. Associated minerals are baryte, hausmannite, calcite, magnesite, and kambite. Janchevite occurs as thick tabular anhedral to subhedral grains up to 0.4 × 0.8 × 0.8 mm in size and it is translucent, orange-red with orange streak; the luster is adamantine. The mineral is brittle with distinct cleavage on {010}. The induration hardness VHN10 = 85.8 (73.4–100.8) kg/mm2 corresponding to 2/3 of a Mohs scale. The density was not measured; Dmeas = 8.160 g/cm3. The color in reflected light is light gray, with deep red internal reflections. Janchevite is weakly anisotropic. The reflectance spectrum was measured between 400 and 700 nm with 20 mm interval. The values for COM wavelengths [Rmin/Rmax (%) (nm)] are: 20.56/20.06 (470 nm), 19.20/18.81 (546), 19.06/18.59 (589), 19.31/18.85 (650). The IR spectrum of janchevite contains bands of V5+–O stretching and Mo5+–O stretching vibrations (at 366 cm−1), respectively, O(VMoO3)–O bending vibrations (at 462 and 405 cm−1), and Pb–O stretching vibrations (at 366 cm−1). No bands corresponding to CO2− ions and H-bearing groups are observed in the range 1000–3800 cm−1. The IR spectrum of janchevite is similar to those of abellaite and grootfonteinite. The index of refraction n = 1.92 (49; 020), 1.90 (41; 020, br), 1.87 (10; 101, br), 1.87 (25; 100), 1.86 (25; 100), 1.85 (41; 020, br), 1.85 (41; 020). The refractive indices of janchevite are lower than those of abellaite and grootfonteinite.

Janchevite is chemically related to kombatite Pb4–Pb6Cl2(F,OH)2Cl, although the crystal structure and powder X-ray diffraction pattern of kombatite is quite different from those of janchevite. Janchevite is named in honor of the prominent Macedonian mineralogist Simeon Janchev, a specialist in the mineralogy and petrology of igneous rocks and metamorphic ore deposits. The holotype specimen of janchevite is deposited in the collections of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. F.C.
most porphyritic gold systems in this volcanic field. No data on location of any kind type material provided. D.B.

KAMPELSE


Kampellite (IMA 2016-086), ideally BaMg2Sc4(PO4)(OH), 4H2O, orthorhombic, is a new Ba–Sc phosphate mineral from the Kovdor phoscorite–carbonatite complex (Kola Peninsula, Russia, N 67°33’ E 30°31’). The Kovdor massif of peridotites, foidolites, melilitolites, phoscorites, carbonatites, and related metasomatic rocks is of a central-type, polyphase volcano-plutonic complex intruded through the Archean biotite and hornblende–biotite (granite–gneiss). The western contact of peridotite and foidolite intrusions is intruded by a vertical concentrically zoned pipe of phoscorites and phoscorite-related carbonatites, with later stockworks of vein calcite and dolomitic carbonatites. The type locality of kampellite is situated in the carbonate–magnetite-rich phoscorite of the ore-pipe axial zone.

Kampellite is biaxial (+) (pseudouniaxial), α ≈ β = 1.607(2), γ = 1.612(2). The unit-cell parameters are:

P cm

[0x0]a = 2654.6 Å, b = 111–121 Å, c = 7.12 Å, α = 90°, β = 109° 26', γ = 90° 30'. The strongest lines in the X-ray powder-diffraction pattern (hkl) are: 15.80 (100; 001), 13.86 (45; 002), 3.184 (18; 222), 3.129 (19; 026), 2.756 (16; 402), 2.688 (24; 101.0). The unit-cell parameters refined from powder-diffraction data are: a = 11.256(1), b = 8.512(1), c = 27.707(4), α = 90° 26', β = 90° 30', γ = 90° 30'. The development of technologies of mining and processing of the complex. The holotype specimen is deposited in the Mineralogical Museum of St. Petersburg State University, Russia. F.C.

ROYMILLERITE


Roymillerite (IMA 2015-093), ideally Pb2Mg2(AlO2)(SiO2)(BO3)(CO3)2(PO4)2(OH), triclinic, is a new mineral species from the Kombat Mine, Otavi Valley, 49 km south of Tsumeb, Grootfontein district, Otjozondjupa region, northern Namibia. Roymillerite occurs in a predominantly fine-grained groundmass of rhodochrosite, cersussite, and other associated minerals mainly within a rhodochrosite band, while grootfonteinite occurs in a groundmass dominated by cersussite, with disseminated crystals and subhedral grains of Mn–Fe oxides, and locally euhedral to subhedral melanotekite. Granular aggregate of sahlinitic platelets constitutes a separate band. Roymillerite forms platy single-crystal grains and aggregates up to 1.5 mm across and 0.3 mm thick. The only distinct feature is [001]. Crystals are transparent, colorless, with a white streak. The luster is strong, vitreous. Cleavage is perfect on [001]; thin platelets are flexible, non-elastic. Fracture is uneven. Parting has not been observed. The Mohs hardness is ~3. The density was not measured because of the absence of heavy liquids with D > 5 g/cm³. D calc = 5.973 g/cm³. The mineral is non-fluorescent under both long- and short-wave UV radiation. In transmitted light roymillerite is non-pleochroic, colorless. It is optically biaxial (+), α = 1.86(1), β = 1.94(1) (589 nm). 2V calc = 50° (V < c). Dispersion of optical axes was not observed. The IR spectrum is similar to that of the related mineral britvitine. Absorption bands are at c1 = cm⁻¹; s = strong band, w = weak band, sh = shoulder): 3700, 3583, 3513, 3352 (O–H stretching vibrations of OH⁻ groups), 2392w (possibly, acid Si–OH group), 1726w (combination mode), 1385s (asymmetric stretching vibrations of CO²⁻ groups), 1231, 1204 (asymmetric stretching vibrations of BO³⁻ groups), 1083, 1050s, 1042, 999s (Si–O stretching vibrations of the SiO4 tetrahedra), 915, 898, 875s (Si–O stretching vibrations of isolated SiO4 tetrahedra), 842w, 806w, 780w (out-of-plane vibrations of CO²⁻ groups, possibly combined with Mg–O–H and Pb–O–H bending vibrations), 725w, 688, 679 (in-plane vibrations of CO²⁻ groups, possibly combined with O–Si–O bending vibrations of the SiO4 tetrahedra), 635w, 605w, 580w, 548w, 467v, 420sh, 400s (combination of Si–O–Si bending and Mg–O– Si stretching vibrations). The average of 7 electron probe WDS analyses is (wt% [range]): SiO2, 7.90 (7.67–8.06); MgO, 4.93 (4.67–5.23); MnO, 0.24 (0.13–1.45); FeO, 0.95 (0.81–1.03); PbO, 75.78 (74.16–76.82); B2O3, 0.50 (from structural data); Al2O3, 0.74 (0.64–0.88); CaO, 5.83 ± 0.15 and H2O, 1.8 ± 0.2 (both by gas chromatography), total 99.27. The empirical formula is (Pb1.56Mg2.44Al2.02Si6.34O24·(BO3)2·(PO4)2·(OH)2·4H2O based on 83 O.pu. The strongest lines in the X-ray powder-diffraction pattern [d Å (Pb, k); Å (Pb, k); Å (Pb, k)] are: 15.80 (100; 001), 13.86 (45; 002), 3.184 (18; 222), 3.129 (19; 026), 2.756 (16; 402), 2.688 (24; 101.0). The unit-cell parameters refined from powder-diffraction data are: a = 11.256(1), b = 8.512(1), c = 27.707(4), V = 2654.6 Å³. The single-crystal X-ray data obtained from the crystal of 0.11 × 0.12 × 0.15 mm shows kampellite is orthorhombic, \( \text{Pnma, } a = 11.226(9), b = 8.5039(6), c = 27.699(2) \text{ Å, } V = 2644.3 \text{ Å³, } Z = 4. \) The crystal structure of kampellite, refined to \( R = 9.2% \) for 2620 unique observed reflections with \( F > 4 \sigma(F) \), is based on complex \( \text{[Mg}_2\text{Ba}_4\text{Sc}_4\text{PO}_{24}]_0 \) layers consisting of the Ba–PO4 zigzag sheet inserted between two Mg–Sc–PO4 sheets. Kampellite is named in honor of Russian mining engineer Felix Borisovich Kampel’ (b. 1935) for his contribution to...
26.463(4) Å, α = 83.295(3)°, β = 83.309(3)°, γ = 90.053(2)°, V = 1971.2 Å³, Z = 2 (Rint = 4.86%). This cell can be transformed via the matrix \[ \begin{pmatrix} T & 0 & 0 \\ 0 & T & 0 \\ 0 & 0 & 1 \end{pmatrix} \] to a pseudomonic C-centered pseudocell with \( a = 16.134, b = 9.319, c = 26.463, \beta = 97.74^\circ \), re-fined from powder-diffraction data are: \[ 2\overline{4}a, R_{int} = 45\% \]. The crystal structure of roymillerite, refined to \( R \approx 5.71 \% \) for 11 532 unique observed reflections with \( F^2 > 4\sigma(F^2) \), resulted in those of molybdo-phyllite and britivinite, and is based on a pyrophyllite-type TOT-module, which alternates with the lead-oxide-carbonate \( I \)-block. Therefore, the crystal-chemical formula of roymillerite can be written as follows (Z = 1): 
\[ \begin{pmatrix} \text{Pb}(\text{OH})\text{O}_2\text{CO}_3\text{Si}_2\text{O}_7 \end{pmatrix} \times \text{Pb}[\text{SiO}_4] \text{O}(\text{OH}) \text{O}(\text{OH}) \text{Si}(\text{Al})O_2 \text{O}_2 \text{O}_2 \].

The \( I \)-block in the structure of roymillerite contains 10 “lead” layers and 4 “carbonate” layers, whereas in the structures of britivinite and molybdo-phyllite there are 7 “lead” layers and 2 “carbonate” layers, and 4 “lead” layers and 1 “carbonate” layer, respectively. The \( I \)-blocks contains O atoms and OH groups coordinated by Pb atoms, which could be described as of anion-centered polyhedra. The O12 and O31 atoms are tetrahedrally coordinated forming \([\text{Pb}_2\text{Pb}]\text{O}_6\)-tetrahedra. Those form a heteropolyhedral \([\text{O}(\text{OH})\text{Pb}]\)-cluster previously revealed in the structure of synthetic plum-bonacite \([\text{Pb}(\text{OH})\text{O}_2\text{CO}_3]_{\text{Si}_2\text{O}_7} \text{O}(\text{OH}) \text{O}(\text{OH}) \text{Si}(\text{Al})O_2 \text{O}_2 \text{O}_2 \text{O}_2 \). 

Roymillerite has the tapiolite, or the byströmite–ordoñezite structure, a cation-ordered \( M^+ \)-cell edge. Tredouxite is named in honor of Marian Tredoux, University of the Free State, Bloemfontein, South Africa, for her contribution to the knowledge of the mineralogical and geochemical aspects of ultramafic rocks and the origin of the enigmatic, hyper-nickeliferous Bon Accord body. The holotype is housed in the Museo di Storia Naturale, University of Florence, Italy. F.C.

**VANADIO-PARGASITE**


Vanadio-pargasite (IMA 2017-019), ideally NaCa$_2$Mg$_2$V$_2$Si$_5$O$_{13}$(OH)$_4$, monoclinic is a new species of an amphibole group discovered at the Perea mural marble quarry in Cr–V-bearing marbles, near the town of Studyanka, Lake Baikal, Russia. The dolomite–calcite marbles contain bands or thin (0.5–3 cm) layers consisted mostly of black magnesio-coulsonite–magnesochromite. The brightest green vanadio-pargasite with highest V$_2$O$_5$ content occurs at the contacts of layers with marble. The V-rich amphibole of less intensive color forms crystals and aggregates up to 2 mm in marble along with bright-red Cr–V-rich spinel. Other associated minerals are phlogopite, forsterite, Cr–V-bearing diopside and chlorite.

Vanadio-pargasite forms bright-green to emerald-green vitreous subhedral long- and short-prismatic crystals from 0.05 × 0.10 to 0.80 × 0.5 mm. The habits are found (101) and (110) with a typical amphibole striation. The streak is pale green. The cleavage is perfect on (110); fracture is uneven.

The induration hardness VHN$_{25}$ = 226 (218–240) kg/mm$^2$, which corresponds to a Mohs hardness of 3–3.5. The density was not measured; \( D_{\text{calc}} = 6.650 \text{ g/cm}^3 \). In reflected plane-polarized light tredouxite is light gray non-pleochroic with a weak bireflectance and weak red-brown internal reflections. Between crossed polars, it is very weakly anisotropic with light brown-gray to gray colors. The reflectance values \([R_{\text{max}};R_{\text{min}}] \text{ (mm)} \) measured for COM wavelengths are 15.6/15.8 (471.1), 14.6/14.4 (548.3), 14.5/14.3 (586.6), 14.6/14.4 (652.3). The average of 9 electron probe WDS analyses is \([\text{wt} \% \text{ (range)}] \): NiO @ 17.21 (16.74–17.97), Fe$_2$O$_3$ @ 1.78 (0.50–2.72), Sb$_2$O$_3$ @ 79.88 (79.00–80.46), As$_2$O$_3$ @ 0.51 (0.31–0.70), total 99.38. The empirical formula is 
\[ \text{Ni}_{0.51}\text{Fe}_{0.49}\text{Sb}_{0.51}\text{As}_{0.49}\text{Fe}_{0.51}\text{O}_{10.51} \text{Si}_{2.51} \text{Al}_{2.51} \text{O}_{13.51} \text{O}_2 \text{O}_2 \text{O}_2 \text{O}_2 \text{O}_2 \].

The strongest lines in the X-ray powder-diffraction pattern \([d\ \text{(Å), \%}] \) are: 3.28 (100); 110, 2.561 (65; 103), 1.716 (60; 213), and 1.379 (20; 303). The unit-cell parameters refined from powder-diffraction data are: \( a = 4.6376(1), c = 9.2067(4)\ Å, V = 198.01 \AA^3 \). Most single crystals of tredouxite tested were an intergrowth of two phases: tredouxite and weakly diffractive bottnoitite [NiSi$_2$(OH)$_2$·6H$_2$O]. A small (0.050 × 0.065 × 0.085) fragment with minor intergrowth was studied by single-crystal X-ray diffraction yielding the following unit-cell parameters: \( a = 4.6342(5), c = 9.3154(8)\ Å, V = 197.91(3)\ Å³, \) tetragonal, \( P4/mbm, Z = 2 \). Because of the similarity of the unit cell with minerals of the group of tapiolite, the crystal structure was refined starting from the atom coordinates of tapiolite-(Fe) to \( R = 0.0559 \) on the basis 65 independent observed reflections with \( F^2 > 4\sigma(F^2) \). Tredouxite has the tapiolite, or the byströmite–ordoñezite structure, a cation-ordered derivative of the rutile structure. It consists of a hexagonal closest-packing of oxygen atoms with cations occupying one half of the octahedral interstices, yielding chains of edge-sharing octahedra. Such chains are linked to adjacent chains by corner sharing. Unlike the rutile structure, Ni and Sb in tredouxite occupy two distinct sites, resulting in the intra-chain sequence ...-M$^2$-M$^3$-M$^4$-... along the c-axis, which leads to a tripling of the c-cell edge. Tredouxite is named in honor of Mariam Tredoux, University of the Free State, Bloemfontein, South Africa, for her contribution to the knowledge of the mineralogical and geochemical aspects of ultramafic rocks and the origin of the enigmatic, hyper-nickeliferous Bon Accord body. The holotype is housed in the Swedish Museum of Natural History, Stockholm, Sweden. E.C.
Wilancookite


Wilancookite (IMA 2015-034), ideally (Ba,K)Na(Ba,Li,Be)PO₄O₆·32H₂O, cubic, is a new mineral species from the Lavra Ponte do Piauí complex granitic pegmatite, Itunga, Jequitinhonha, Minas Gerais, Brazil (16°43′33″ S, 41°53′55″ W). Wilancookite is a secondary mineral occurring in phosphate nodules adjacent to the quartz core of the pegmatite. Primary associated minerals are albite, montebrasite, Li-bearing micas, cancrinite, laumontite, and quartz. Wilancookite forms tiny dodecahedral [110] crystals, deposited on micaepitaxial fibers. Crystals are transparent, colorless, and reach a diameter of 100 μm. The luster is vitreous, and the streak is white. The mineral is non-fluorescent under both long- and short-wavelength ultraviolet light. No cleavage has been observed. The mineral is brittle with an irregular fracture. Mohs hardness is 4–5, by analogy with related phasapataite. The density could not be measured due to small grain size; \( \rho_{\text{calc}} = 3.05 \text{ g/cm}^3 \). Wilancookite is isotopic, colorless, non-pleochroic, with \( n = 1.560(2) (\lambda = 590 \text{ nm}) \). The Raman spectrum is characterized by peaks at 430 (Be-O), 580 (v₁ PO₄), 1000 (v₂ PO₄), 1050 (v₃ PO₄), 1600 (v₁ H₂O), 3430 and 3680 (v₂ H₂O) cm⁻¹. The average of an unreported number electron probe WDS analyses with [wt% (range): P₂O₅ 36.19 (33.39–37.29), SiO₂ 0.04 (0.01–0.07), Al₂O₃ 0.41 (0.27–0.61), BaO 34.35 (34.07–35.01), Na₂O 0.09 (0.06–0.13), K₂O 0.32 (0.26–0.43), BeO (SIMS) 12.86, Li₂O (SIMS) 0.50, H₂O (by crystal structure) 12.31, total 97.37. The empirical formula (Ba₂.38K₁.7Na₂.5Li₀.6Be₂.0O₄.8)\(_{32}\)H₂O based on 96 O pfu. The strongest lines in the X-ray powder-diffraction pattern [\( d (\text{pattern}) \)] are: 6.90 (60; 200), 5.54 (80; 211), 3.63 (60; 321,312), 3.212 (70; 330,411), 3.043 (100; 420,402), 2.885 (70; 332), 2.774 (80; 422), 2.398 (60; 440). The unit-cell parameters refined from powder-diffraction data are: \( a = 13.579(9) \text{ Å}, V = 2504 \text{ Å}^3 \). The single-crystal X-ray data obtained from the crystal of 0.089 × 0.070 × 0.065 mm shows wilancookite is cubic, \( I\overline{2}3d \), with \( a = 3.5398(2) \text{ Å}, V = 2482.21 \text{ Å}^3, Z = 2 \). The crystal structure of wilancookite, refined to \( R_I = 4.38\% \) for 761 unique observed reflections with \( F > 4 \sigma (F) \) and 4.58% for all 805 reflections, is a beryllophosphate framework similar to that occurring in phasapataite, and is based on zoisite-RHO cages. The tetrahedral framework of wilancookite is however distorted and built by an array of truncated cubo-octahedral cages, linked together through octagonal prisms strongly distorted. The non-framework species in wilancookite are the Ba₁ and Ba₂ cations, as well as the W₁ and W₂ water molecules. Li is ordered in Ba₂ site. The mineral is named to honor mineralogist and crystallographer William R. Cook Jr. (1927–2006) and his wife Anne. Bill and Anne endowed the mineralogy chair at the Cleveland Museum of Natural History and were founding members of the Mineralogical Society of Cleveland. The type specimens are deposited in the Laboratory of Mineralogy, University of Liège (cotype used for optics, crystal structure, and Gandolfi measurements: catalogue number 20394), and in the Natural History Museum of Luxembourg (cotype used for chemical analyses: catalogue number 2011-33). F.C.
commonly V\(^{4+}\), Sn\(^{4+}\), Zr, Hf, Fe\(^{3+}\), Mg, Al, and Si. The X site is typically occupied by O, but can also contain minor OH and F. The Y is an anion (OH, F, O), but can also be a vacancy, H\(_2\)O, or a very large monovalent cation (e.g., K, Cs, Rb). According to the present pyrochlore supergroup nomenclature (Atencio et al. 2010) the dominance of Ta, Nb, Ti, Sn\(^{4+}\), or W in the B site defines the group name within the supergroup (microlite, pyrochlore, betafla, roméite, or elmoreite, respectively) and the root of a mineral species name. The first prefix in the mineral name refers to the dominant anion (or cation) of the dominant valence [or H\(_2\)O or Cl\(^-\) in the A site. All names of new pyrochlore-supergroup mineral species below are given according those rules. That nomenclature scheme bases names upon the preponderant species of preponderant valence group in each site of the structure. However, the variety of possible coupled substitutions is such that a valid species name can be associated with either one, several, or no end-members. Most of currently known pyrochlore-supergroup minerals have a cubic unit cell and space group \(F\bar{D}3m\), however lower symmetry in cubic system is known and several different non-cubic pyrochlore polytypes exist; the most common of these is \(3\bar{R}\) with the space group \(R\bar{3}m\). Descent in symmetry splits the A, B, and X sites in the structure.

**Fluorocalciopyrochlore** (IMA 2013-055), (Ca\(_3\)Na\(_2\)Sn\(_6\)O\(_{19}\)F\(_2\), cubic, was found in the dolomitic carbonatites of the Bayan Obo (the world’s largest REE and major iron and niobium deposit), Inner Mongolia, People’s Republic of China (41°47’8”N, 109°58’17”E). An F-rich pyrochlore was first mentioned by Hogarth (1961). The pyrochlores of composition similar to fluorocalciopyrochlore were mentioned in the different and associations but mostly in carbonatites (Ohnenstetter and Plantone 1992; Nasraoui and Bilal 2000; Seifert et al. 2000; Thompson et al. 2002; Bonazzi et al. 2006; Jung et al. 2006), however those minerals were not sufficiently characterized to grant them official status of a distinct species. Fluorocalciopyrochlore was listed as a possible new species by Christy and Atencio (2013). Fluorocalciopyrochlore from Bayan Obo disseminated as fine euhedral or subhedral grains or veinlets scattered in dolomite and calcite. All these minerals seemed to be crystallized at the same time. The mineral was perhaps a product of bimetasomatism among Ca–Mg-carbonate rock or carbonate and REE-, F-rich postmagmatic hydrothermal solutions. Other associated minerals are aragonite, reiebeckite, diopside, fluorate, baryte, phlogopite, britholite-(Ce), bastnaesite-(Ce), zircon, magnetite, pyrite, ferrsite, columbite-(Fe), monazite-(Ce), rutile, and others. Fluorocalciopyrochlore crystals (generally 0.01–0.3 mm) are brownish-yellow to reddish-orange, translucent to transparent with an adamantine luster and a light-yellow streak. When euhedral the main forms are \{111\}, \{110\}, \{100\}, or their combinations. No parting or cleavage was observed, and the fracture is conchoidal. The microinden hardness VHN = 424 kg/mm\(^2\) (load not specified). The Mohs hardness is 4.6. The density was not measured; \(D_{\text{calc}} = 4.34 \, \text{g/cm}^3\). The mineral does not dissolve in HCl or HNO\(_3\). In transmitted light the mineral is brown, isotropic with \(n = 1.9\); \(n_{\text{calc}} = 2.06\). In reflected light it is gray. The reflectance values for COM wavelengths (\(R \%\), nm) are: 19.06, 74.80, 496, 1971, 598, 2093, 650. The IR spectrum obtained in reflection mode on a single crystal shows (\(cm^{-1}\) ) a 1266 (Ca–O polyhedron vibrations, 1135 and 914 cm\(^{-1}\) (overtones and combination modes). Absence of peaks at 1500–1700 cm\(^{-1}\) suggests all hydrogen is present as OH groups. The Raman spectrum shows bands at 3586 and 3614 cm\(^{-1}\) (O–H stretching vibrations). The average of 13 electron probe WDS analyses is [wt\% (St.dev.):] Na\(_2\)O 0.36(8), CaO 15.64(13), SnO\(_2\) 0.26(3), Nb\(_2\)O\(_5\) 2.82(30), Ta\(_2\)O\(_5\) 1.98(30), MnO 0.12(2), F 0.72(12), H\(_2\)O 1.30 (by structural data), –O=F 0.30, total 99.31. This gives the empirical formula \((\text{Ca}_{0.36(8)}\text{Na}_{0.26(3)}\text{Sn}_{0.26(3)}\text{O}_{1.98(30)}(\text{OH})_{0.72(12)}\text{F}_{0.72(12)}\text{O}_{1.30})_{0.26(3)}\). The presence of weak reflections violating the \(P\bar{6}\) symmetry was confirmed by both X-ray and neutron diffraction. It caused by long-range ordering of Ca and vacancies on the A sites. Type material is deposited in the Museum of Geosciences, Instituto de Geociências, Universidade de São Paulo, São Paulo, Brazil. Part of the cotype sample has been deposited at the University of Arizona Mineral Museum, RRUFF Project.

**Hydroxyferroroméite** (IMA 2016-006), (Fe\(^{3+}\)\(_{0.4}\)\(_{0.6}\)Sn\(_{0.4}\)\(_{0.6}\)O\(_{10}\)(OH)\(_2\)), cubic, is a new Fe\(^{3+}\)-dominant member of the roméite group, and first species of the pyrochlore supergroup with Fe\(^{2+}\) dominant in the A site, was found at the Corrèze d’en Llinassos, Oms, Pyrénées-Orientales Department, France (42°32’16”N, 2°42’26”E) in the only two specimens. It is associated with hematite, goethite, chloropyrite, tetrahedrite, and native antimony and occurs as yellow to yellow-brown powdery boxwork replacements up to about 50 μm across after tetrahedrite in a siderite–quartz matrix in siderite-rich vein capped by impermeable shale. No distinct crystals were observed. The mineral formed from the decomposition of tetrahedrite under mildly acidic and oxidizing conditions. According to Ian Graham (personal communication) hydroxyferroroméite was also found in Australian Museum specimen D53310 and Museum Victoria specimen M50021 originated from the Consols Mine Broken Hill, New South Wales, Australia, where it associated with chlorargyrite and dysarsite. **Hydroxyferroroméite** It has a yellow streak and an earthy to vitreous luster. The Mohs hardness is ~3, but that of single crystals could be higher. A conchoidal fracture

The unit cell is \(a = 10.4169(9) \, \text{Å}, V = 1130.20 \, \text{Å}^3\). The crystal structure was solved by direct methods and refined to \(R = 0.05\) for \(F^2 > [4\times F^2]\) in space group \(F\bar{D}3m\). The type material is deposited in the Geological Museum of China, Beijing, People’s Republic of China.
could be seen on the boxwork veins. No other physical and optical properties were determined due to the very fine-grained and porous nature of the material. The main absorption bands of Raman spectrum (cm⁻¹) are: 3634, 3074, 2936 (OH stretching), 1773, 1706, 1608 (H-O-H bending modes), 650 with a shoulder at 709 and a weak band at 568 (Sb-O bridging), 466, 436, 358 (Sb-O vibrations), 271, 180 (lattice modes). X-ray photoelectron spectroscopy showed the presence of only Fe⁺, Cu⁺, and Sb⁺ in the sample, with no Fe²⁺, Cu²⁺, or Sb²⁺. The average of 9 electron probe WDS analyses is [wt% (range)]: Sb₂O₅ 6.70 (64.72–70.43), As₂O₅ 0.15 (0.07–0.08), SiO₂ 1.17 (0.65–2.02), Al₂O₃ 0.28 (0.1–0.94), CaO 0.18 (0–1.40), SrO 0.58 (0.47–0.77), FeO 16.95 (15.60–17.66), CuO 8.69 (7.53–9.34), ZnO 0.54 (0.40–0.72), H₂O (calculated on the basis of 7 O+OH+H₂O) 1.72 (1.16–2.27), total 97.36. The gives the empirical formula (Fe⁺,Cu⁺⁺,Sb⁺⁺)₂(SiO₄)₂(OH)₆O₁₂(OH)₂ based on 7 (O+OH+H₂O) pfu. The strongest lines in the X-ray powder-diffraction pattern [d Å (PbF₆, hkI)] are: 2.983 (100; 202), 3.128 (64; 113), 1.8249 (57; 208; 202), 5.399 (51; 101), 1.5579 (47; 226), and 2.582 (32; 024). The unit-cell parameters refined from the X-ray powder-diffraction data are: a = 7.313(2), c = 17.863(7) Å, V = 827 Å³. Single-crystal X-ray diffraction data collected at 100 K refined to R₁ = 0.1388 for 192 unique IZE(0K) reflections shows hydroxykenoelsmoreite is trigonal, space group R₃̅₁, d = 7.2855(10), c = 17.8584(4) Å, V = 829.9 Å³, Z = 6. The refined structure corresponds to a charge-balanced formula (Fe⁺,Cu⁺⁺,Sb⁺⁺)₂(W₆O₁₆Fe₆O₁₆)₂(O₇(OH)₁₂(OH)₂)²⁺. The significant difference from EMPA data is explained by variable compositions in zoned crystals. Increasing Pb²⁺ in the A sites demonstrates solid solution towards a hypothetical “plumboelsmoreite” species. Among a number of different non-cubic pyrochlore polytypes the most common is 3R polytype with the space group R₃m. Descent in symmetry splits the A, B, and X sites making structural formula (A₁)(A₂)(B₁)(B₂)(X₁)(X₂)Y. For the hydroxykenoelsmoreite-3R, unlike hydroxynomelite-3R (Atencio, 2016), the symmetry is further lowered to R̅₃̅₃m due to very small rotations of coordination polyhedra that are not associated with further site splitting. The deviation from the cubic symmetry of hydroxykenoelsmoreite-3R is mostly due to the ordering of Fe⁺⁺ onto one of two BS sites. Type specimen is type specimen was deposited in the Museum Victoria, Melbourne, Victoria, Australia.

Hydroxynatropyrochlore (IMA 2017-074), (Na⁺,Ca⁺⁺,Ce⁺⁺,Nb⁴⁺)(OH), cubic, was described from Kovidor massif, Kola Peninsula, Russia. The pyrochlore-supergroup minerals are abundant in the Kovidor phoscorite-carbonatite pipe with the economic-level concentration in its axial zone. About one quarter of pyrochlore-supergroup minerals in Kovidor is the hydroxynatropyrochlore, and the rest includes mainly hydroxy-calciopyrochlore and a U–Th–REE-rich variety of a recently approved hydroxykenopyrochlore (see above), which was known at Kovidor previously as “hatchettolite.” Hydroxynatropyrochlore was noted before in Khibiny, Sebil’yar, and other alkaline and alkaline–ultrabasic massifs (Yakovchuk et al. 2005; Subbotin and Subbotina 2000), but it has not been fully characterized. Within the Kovidor phoscorite-carbonatite pipe, hydroxynatropyrochlore is the late hydrothermal mineral resulted mainly from the alteration of Nb-rich baddeleyite. It forms external rims around grains of amorphous U-rich hydroxykenopyrochlore and separated crystals in voids of dolomite carbonatite veins. The crystals are usually cubic or cubo-octahedral up to 0.7 mm, zonal, with irregularly shaped relics of U–Ta-rich hydroxykenopyrochlore inside. Other associated minerals are calcite, forsterite, hydroxylapatite, magnetite, and plagioclase, accessory baddeleyite, baryte, barytocalcite, chalcopyrite, chromite–clinochlore, galena, glauzite, zinnwaldite, ilmenite, magnetite, pyrite, pyrohitite, quintinite, spinel, strotanite, vallerite, and zincilomite. Hydroxynatropyrochlore is pale-brown, with an adamantine to greasy lustre and a white streak. It is brittle with distinct cleavage on {111} and conchoidal fracture. Mohs hardness is ~5. D₉₅₀ = 1.67 g/cm³. The main Raman spectrum (cm⁻¹) is: 2923, 1610 very weak (H–O–H bending) showing H₂O being almost absent which is confirmed by bond-valence calculations, 929s (W–O stretching), 853 and 691w and 476 and 402v (O–W–O stretching and O–W–O bending modes, respectively), 100–350 (lattice modes). The average of 4 electron probe WDS analyses is [wt% (range)]: NaO 0.03 (0–0.05), K₂O 0.03 (0–0.02), CaO 0.10 (0.03–0.18), BaO 0.03 (0–0.04), PbO 0.14 (14.42–15.71), Al₂O₃ 1.67 (12.6–13.89), FeO 0.59 (5.37–11.13), WO 72.39 (71.62–73.18), H₂O 5.45 (calculated from charge balance and structure refinement) total 100.46. This gives the empirical formula (Ca⁺⁺,Ba⁺⁺,Sb⁺⁺,Fe⁺⁺,Cu⁺⁺)₂(W₆O₁₆Fe₆O₁₆)²⁺(O₇(OH)₁₂(OH)₂)²⁺ based on 7 (O+OH+H₂O) pfu. The directly corresponded end-member composition would be W₆O₁₆(OH)²⁺(OH), but it is not electrically neutral and physically realizable compositions must always have heterovalent substitutions in one or more sites. There is no unique end-member which composition can be used as an ideal formula for this mineral. The closest charge-balanced end-members corresponding to the name “hydroxykenoelsmoreite” could be W₆O₁₆(OH)²⁺(OH) or (Ca⁺⁺,Ba⁺⁺,Sb⁺⁺,Fe⁺⁺,Cu⁺⁺)₂(W₆O₁₆Fe₆O₁₆)²⁺(O₇(OH)₁₂(OH)₂)²⁺ based on 7 (O+OH+H₂O) pfu. The strongest X-ray powder
diffraction lines [d Å (2θ; hkl)] are: 5.96 (47; 111), 3.110 (30; 311), 2.580 (100; 222), 2.368 (19; 400), 1.9875 (6; 333), 1.8257 (25; 440), 1.5561 (14; 622). The unit-cell parameters refined from the powder data are a = 10.3211(3) Å, V = 1099.46 Å³. The crystal structure of hydroxystyropychrochlore refined to R = 0.026 for 80 independent Fe²⁺-6t(F′) reflections shows the mineral is cubic, space group Fd3m, a = 10.3276(5) Å, V = 1101.5 Å³, Z = 8. The holotype specimen is deposited in the Mineralogical Museum of St. Petersburg State University, Russia.

Oxynatromicrolite (IMA 2013-063), (Na,Ca,U)₃₂O₇. Fe₂O₃, by guest (50°24′26″N, 4°0′35″W) has shown them to be two different polytypes (now known as Drakelands mine), Museum, London) labelled as “ferritungstite” from the Hemerdon mine in the cubic system. The type material is deposited in the Geological Museum of St. Petersburg State University, Russia.

This gives the empirical formula (Na₁.50 (calculated to correspond to 0.47 H₂O) · (W,Fe²⁺,Fe³⁺,Nb,Ta₂O₆)O₇. H₂O (by structure) 7.40 (7.14–7.60)/8.70 (8.25–9.54), total 96.08/90.85 (systematically low totals are due to dehydration under electron beam). The empirical formulas are [Na₈₋₁₀(WO₄)₂(Si₂O₆)₃]₀.₁₇₋₀.₃₂(H₂O) and [Na₆₋₁₀(WO₄)₂(Si₂O₆)₃]₀.₁₇₋₀.₃₂(H₂O) · (H₂O). Main substitutions can be expressed as, (A⁺ₓNa⁺ₓ⁻₅(WO₄)₂(PO₄)OH)·(H₂O) H₂O, where x = 0.17–0.29, y = 0.49–0.63, and z = 3–y. The structures of HKE-3C and HKE-6R were solved by direct methods respectively in space group Fd3m [R = 0.0130 for 121 Fc²⁺-4t(F) reflections], a = 10.3065(3) Å, Z = 16 and in space group R₃̂ [R = 0.0196 for 596 Fc²⁺-4t(F) reflections], a = 7.2882(2) Å, c = 35.7056(14) Å, Z = 9. The periodicity in Fc²⁺ relative to the unique threefold axis of the 3C cubic structure is doubled due to Na and (H₂O, H²O) ordering in the A site; no long-range ordering is observed between W and Fe/AI in the B site. In space group R₃̂, there is considerable splitting of the sites of the cubic pyroclore, the 6R structure can be represented as (A₁)₃₋₆(A₂)₅(B₁)₅(B₂)₅(B₃)₅(X₁)₁(X₂)₃(X₃)₄(X₄)₁(Y₁)₁(Y₂)₂. D.B., O.C.G.

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