New Mineral Names*,†

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This New Mineral Names has entries for 23 new minerals, including alpeite, ammoniozippeite, batagayite, centennialite, dagenaisite, davidsmithite, epifanovite, ferro-tschermakite, greenlizardite, grootfonteinite, janchevite, javorieite, kampelite, roymillerite, tredouxite, vanadio-pargasite, and wilancookite. Included also is a series of pyrochlore supergroup minerals: fluorcalciopyrochlore, hydroxycalciomicrolite, hydroxyferroroméite, hydroxykenoelsmoreite, hydroxynatropyrochlore, oxynatromicrolite along with a new data on hydrokenoelsmoreite-3C and hydrokenoelsmoreite-6R.

Alpeite*

A.R. Kampf, C. Carbone, D. Belmonte, B.P. Nash, L. Chiappino, and F. Castellaro (2017) Alpeite, $Ca_4Mn^{3+}_2Al_2(Mn^{3+}Mg)(SiO_4)_2(Si_3O_{10})(V^{5+}O_4)$ $(OH)_6$, a new ardennite-group mineral from Italy. European Journal of Mineralogy, 29(5), 907–914.

Alpeite (IMA 2016-072), ideally $Ca_4Mn^{3+}_2Al_2(Mn^{3+}Mg)(SiO_4)_2(Si_3O_{10})$ $(V^{5+}O_4)(OH)_6$, 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, todorokite, and ganophyllite. Alpeite occurs as intergrowths of plates up to ~0.3 mm in diameter, which are flattened on {100} and exhibit the forms {100}, {001}, {012}, and {102}. No twinning was observed. Crystals are brownish-red and transparent with a vitreous luster and beige 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); $2V_{meas}$ = 73(2)° (spindle stage); $2V_{calc}$ = 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 fragments are nearly invisible in Clerici solution. D_{calc} = 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 [wt% (range)]: CaO 20.45 (19.99–20.67), MgO 2.49 (2.41–2.82), CoO 1.43 (0.91–1.98), Mn_2O_3 20.90 (20.17–21.84) (MnO 1.08 and Mn_2O_3 19.70 according to site occupancies), Al_2O_3 11.52 (10.56–12.02), SiO_2 29.92 (28.63–30.74), V_2O_5 7.36 (6.50–8.51), H_2O 5.13 (on the basis of charge balance), total 99.08. The empirical formula $(Ca_{3.84}Mn^{3+}_{0.16})_{\Sigma4.00}(Mn^{3+}_{1.33}Al_{0.67})_{\Sigma2.00}(Al_{1.29}Mn^{3+}_{0.60}V^{5+}_{0.10})_{\Sigma1.99}$ $(Mn^{3+}_{0.70}Mg_{0.65}Al_{0.42}Co^{2+}_{0.20})_{\Sigma1.97}(SiO_4)_2(Si_3O_{10})[(V^{5+}_{0.75}Si_{0.25})O_4](OH)_6$, based on 28 O pfu. The strongest lines in the X-ray powder-diffraction pattern [d Å (I%; hkl)] are: 3.022 (93; 115), 2.673 (100; 116), 2.572 (69; 206), 1.5112 (83; 040,427). The unit-cell parameters refined from powder-diffraction data are: 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, $Pnmm$, a = 8.9421(11), b = 6.0534(6), c = 18.9781(6) Å, V = 1027.29 Å³, Z = 2. The crystal structure of alpeite, refined to R_1 = 4.4 % for 834 unique observed reflections with $F_o > 4σ(F_o)$ and 5.39% for all 1022 reflections, is the same as that of other members of the ardennite group. It contains chains of edge-sharing Mn^{3+} and Al octahedra extending along the **b** axis, which are linked into a framework by sharing corners with SiO_4 tetrahedra and with Si_3O_{10} tetrahedral groups. Within the cavities in this framework are sevenfold-coordinated Ca sites. In the structure of alpeite, Mn^{3+} is the dominant cation in the M1 sites, while in all other members of the ardennite group [ardennite-(As), ardennite-(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. **F.C.**

Ammoniozippeite*

A.R. Kampf, J. Plášil, T.A. Olds, B.P. Nash, and J. Marty (2018) Ammoniozippeite, a new uranyl sulfate mineral from the Blue Lizard Mine, San Juan County, Utah, and the Burro Mine, San Miguel County, Colorado, USA. Canadian Mineralogist, 56(3), 235–245.

Ammoniozippeite (IMA 2017-017), ideally $(NH_4)_2[(UO_2)_2(SO_4)$ $O_2]·H_2O$, 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, U.S.A. (38°2′42″N 108°53′23″W). It was also found at Green Lizard, Markey, and Giveaway-Simplot 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, bobcookite, brochantite, chalcanthite, devilline, dickite, ferrinatrite, gerhardtite, gypsum, johannite, krönkite, magnesiozippeite, natrozippeite, pentahydrate, pickeringite, plášilite, 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 [100]; those from the Burro mine are flattened on {001} 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 {101}, {102}, {103}, and {104}. 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

perfect on {010} and {001} and good on {100}. It is brittle, with a splintery fracture and Mohs hardness ~ 2½. Density was not measured; $D_{calc} = 4.427$ (Burro), 4.470 (Blue Lizard), and 4.433 g/cm³ for an ideal formula. The mineral is insoluble in room-temperature H_2O but very rapidly dissolves in room-temperature dilute HCl. In transmitted plane-polarized light ammoniozippeite is pleochroic X – colorless $<< Y$ – orange yellow $< Z$ – yellow orange. It is optically biaxial (+), $\alpha = 1.678(2)$, $\beta = 1.724(3)$, $\gamma = 1.779(3)$ (white light), $2V = 87.1(5)°$, $2V_{calc} = 87.4°$; $X = \mathbf{b}$, $Y = \mathbf{c}$, $Z = \mathbf{a}$. Dispersion of an optical axes is weak $r < v$. The FTIR spectra (measured from 4000 to 650 cm⁻¹) show (b = broad, w = weak, ms = medium-strong) bands at: ~3500b and ~2800b (O–H stretching of H_2O and N–H stretching vibrations from interlayer NH_4^+ groups), 1626w [v_2 (δ)-bending vibration of H_2O], 1408ms (N–H bending vibration of NH_4^+), 1120 (shoulder at 1138), 1065 (split triply degenerate v_3 SO_4^{2-} antisymmetric stretching), 1008w, 993w (v_1 SO_4^{2-} symmetric stretching), 933sb (antisymmetric v_3 UO_2^{2+} stretching), 846, 832 (v_1 UO_2^{2+} symmetric stretch, may coincide with the libration mode of H_2O). Raman spectrum (1600–100 cm⁻¹) bands are: ~1390wb [v_2 (δ) H–N–H bending vibration of NH_4^+], 1098, 1120sh (split triply degenerate v_3 SO_4^{2-} antisymmetric stretching), 1013w (v_1 SO_4^{2-} symmetric stretching), 848sh, 826s, 806sh (v_1 UO_2^{2+} symmetric stretching), 664w, 608w [split triply degenerate v_4 (δ) SO_4^{2-} bending], 508w, 461m, 406s [split doubly degenerate v_2 (δ) SO_4^{2-} bending], 368, 327 [v (U–O$_{equatorial}$) stretching, may coincide with the $v_{rotational}$ of interlayer NH_4^+ as those at 283, 268sh, 213m, 203m [v_2 (δ) U–O–U bending or U–O$_{eq}$–ligand stretching], 148s (external lattice modes and UO_2^{2+} translations and rotations). The averages of electron microprobe WDS analyses (five on four crystals from Burro mine / *four on three crystals from Blue Lizard*) are [wt% (range)]: $(NH_4)_2O$ 7.29 (6.96–7.76)/*7.36 (6.88–7.64)*, Na_2O 0.13 (0.04–0.14)/*0.19 (0.05–0.33)*, K_2O –/*0.43 (0.36–0.51)*, SO_3 11.45 (10.80–12.44)/*11.00 (10.61–11.37)*, UO_3 81.10 (79.24–84.24)/*81.90 (79.69–85.04)*, H_2O 2.56/*2.56* (by structure), total 102.53/*103.44*. The samples exhibited visible beam damage. The high totals are assigned to water loss under the beam and in vacuum. The empirical formulas based on 11 O are $[(NH_4)_{1.97}Na_{0.03}]_{\Sigma2.00}(U_{1.00}O_2)_2(S_{1.01}O_4)O_2 \cdot H_2O$ and $[(NH_4)_{1.99}K_{0.06}Na_{0.04}]_{\Sigma2.09}(U_{1.01}O_2)_2(S_{0.97}O_4)O_2 \cdot H_2O$ for crystals from the Burro and Blue Lizard mines, respectively. The strongest X-ray powder diffraction lines for Burro mine material are [d Å (I%; hkl)]: 7.17 (100; 020), 3.580 (21; 040), 3.489 (42; 203), 3.138 (63; 223), 1.6966 (18; 229,426). Unit-cell parameters refined from the powder data with whole-pattern fitting are $a = 8.812(3)$, $b = 14.351(5)$, $c = 17.204(5)$ Å, $V = 2175.6$ Å³. The single-crystal X-ray data shows ammoniozippeite is orthorhombic, $Ccmb$, $a = 8.7944(3)$, $b = 14.3296(7)$, $c = 17.1718(12)$ Å, $V = 2164.0$ Å³, $Z = 8$. The structure of ammoniozippeite ($R_1 = 0.0396$ for 932 $I > 2\sigma I$ reflections) contains edge-sharing zigzag chains of pentagonal UO_7 bipyramids linked by sharing corners with SO_4 groups to a $[(UO_2)_2(SO_4)O_2]^{2-}$ sheet of the zippeite-type topology. The interlayer space contains two NH_4^+ 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 $(NH_4)_2[(UO_2)_2(SO_4)O_2]$ refined in the space group $Cmca$. The non-standard space group $Ccmb$ chosen for ammoniozippeite to be consistent with the cells of the monoclinic zippeite-group minerals. However, zippeite group has not yet been formally approved by the CNMNC. The name reflects the fact that this mineral is the ammonium analog of zippeite, where NH_4^+ replaces K^+. One holotype (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.**

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Batagayite*

V.N. Yakovenchuk, Ya.A. Pakhomovsky, N.G. Konopleva, T.L. Panikorovskii, A. Bazai, J.A. Mikhailova, V.N. Bocharov, G.Yu. Ivanyuk, and S.V. Krivovichev (2018) Batagayite, $CaZn_2(Zn,Cu)_6(PO_4)_4(PO_3OH)_3 \cdot 12H_2O$,

a new phosphate mineral from Kёster tin deposit (Yakutia, Russia): occurrence and crystal structure. Mineralogy and Petrology, 112(4), 591–601.

Batagayite (IMA 2017-002), $CaZn_2(Zn,Cu)_6(PO_4)_4(PO_3OH)_3 \cdot 12H_2O$, monoclinic, is a new mineral discovered at the greisen-type Sn–Ta deposit of Kёster, Arga-Ynnykh-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 spherulites (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 $NaCaCu_5(PO_4)_4[AsO_2(OH)_2] \cdot 7H_2O$ (monoclinic) (Yakovenchuk et al. 2017) and radial fibrous aggregates (up to 3 mm) of unknown mineral. Other associated minerals are Na-analog of batagayite and Mg-analog 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; $D_{meas} = 2.90(3)$, $D_{calc} = 3.02$ g/cm³. The mineral easily dissolves in 10% room-temperature HCl. Batagayite is non-pleochroic, optically biaxial (–), $\alpha = 1.566(2)$, $\beta = 1.572(2)$, $\gamma = 1.573(2)$ (589 nm), $2V = 40(5)°$, $2V_{calc} = 44.3°$; $Z \perp(001)$, further details unclear. No dispersion (unspecified kind) were observed. The most intensive bands of the Raman spectrum (cm⁻¹) are: 1009, 983, 959, 942, and 926 (with shoulder at 912) correspond to the symmetric and antisymmetric stretching modes of the PO_4^{3-}; 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 v_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 [wt% (range)] is: Na_2O 0.31 (0–0.61), 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 (3.77–7.83), ZnO 35.62 (35.48–35.75), CdO 0.24 (0–0.48), H_2O 16.83 (from structure refinement), total 99.55. The empirical formula based on P+Si = 7 is $(Zn_{6.22}Cu_{1.04}Ca_{0.70}Mg_{0.49}Mn_{0.21}Al_{0.15}Na_{0.14}K_{0.05}Cd_{0.03})_{\Sigma9.03}(P_{6.89}Si_{0.11})_{\Sigma7.00}O_{24.91}(OH)_{3.09} \cdot 12.10H_2O$. The strongest lines in the X-ray powder-diffraction pattern are [d Å (I%; hkl)]: 14.59 (100; 001), 6.34 (25; 012), 6.02 (11; 111), 4.864 (37; 003), 4.766 (13; 112), 3.102 (20; 1$\overline{2}$4), 2.678 (11; 2$\overline{3}$3), 2.411 (16; 044). The unit-cell parameters refined from the powder data are $a = 8.460(1)$, $b = 12.852(1)$, $c = 14.774(3)$ Å, $\beta = 98.67(1)°$, $V = 1588.6$ Å³. The crystal structure was solved by direct methods and refined to $R_1 = 0.069$ for 3847 $F_o > 4\sigma(F_o)$ independent reflections. The mineral is monoclinic, $P2_1$, $a = 8.4264(4)$, $b = 12.8309(6)$, $c = 14.6928(9)$ Å, $\beta = 98.514(6)°$, $V = 1571.05$ Å³, $Z = 2$. Batagayite represents a new structure type based upon a complex hetero-polyhedral $[M_8(PO_4)_4(PO_3OH)_3(H_2O)_9]^{2-}$ layers (M = Zn, Cu, Mg) parallel to the (001) plane. Each layer consists of three sublayers. The central A sublayer with composition $[M_4(PO_4)_4(H_2O)_4]^{4-}$ consists of the zigzag chains of edge-sharing MO_6 octahedra running parallel to **a** and linked by sharing peripheral O atoms. The PO_4 tetrahedra are attached above and below the holes created by the linkage of zigzag octahedral chains. The two **B** sublayers consist of chains of ZnO_4 and (PO_3OH) tetrahedra,

which share corners to form 4-membered rings further linked via (PO_3OH) tetrahedra into chains parallel to **a**. The CuO_6 octahedra are located between the chains. The interlayer space is occupied by the Ca^{2+} cations and H_2O molecules. High hydration state and the modular character of the batagayite 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.**

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CENTENNIALITE*

W.A. Crichton and H. Müller (2017) Centennialite, $CaCu_3(OH)_6Cl_2\cdot nH_2O$, $n \approx 0.7$, a new kapellasite-like species, and a reassessment of calumetite. Mineralogical Magazine, 81(5), 1105–1124.

Centennialite (IMA 2013-110), $CaCu_3(OH)_6Cl_2\cdot0.7H_2O$, 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 named for its type location. It occurs as a secondary product resulted from acid water reaction with unspecified supergene Cu mineralization (mineralogy and geological setting are given in Heinrich and Robinson 2004) and intimately mixed with the minerals of calumetite $Cu(OH,Cl)_2\cdot2H_2O$ and atacamite $Cu_2(OH)_3Cl$ families which are essentially indivisible from centennialite. Its chemistry and association are identical to that of the "Unidentified Cu–Ca–Cl Mineral," which has been noted at various mines in the district; e.g., Ahmeek, Quincy, White Pine, Mohawk, Franklin Jr., and Centennial mines (Brandes and Robinson 2002; Heinrich and Robinson 2004). The study is based on three specimens further considered as cotypes. Original cotype 1 specimen, purchased as calumetite, represented by single agglomerations up to 0.5 mm of detached botryoidal greenish blue crusts consisted of a mixture of centennialite and minor paratacamite with no calumetite. The retained part of this sample shared with Musée de Minéralogie, Paris, France, and the Mineral Museum of the University of Arizona, Tucson, U.S.A., where given catalogues numbers are 83080 and 19588, respectively. Cotype 2 is the specimen 8789 from University of Arizona Museum labeled as "Calumetite," from 800′ level of Centennial Mine (S. Williams specimen received by the Museum in 1964). It is $50 \times 25 \times 20$ mm specimen represented by chalky pale-blue encrustations in and on wall-rock consisted of centennialite, calumetite and clinoatacamite Cotype 3 is the specimen 14073 of the Musée de Minéralogie, Paris (type specimen for calumetite) from the same specific location labeled as "Calumetite" (exchanged with S. Williams in 1963). It consists of several millimeter-sized irregular encrusted pieces with pale and powder blue regions of centennialite-bearing calumetite. Pale blue parts tend to be centennialite richer. It also contains some paratacamite and pseudoboleite. No other macroscopic characterization provided as well as density and optical properties due to the nature of the material. The portion of calumetite from cotype 2 heated to 165 °C appeared to be converted to one of a near-clean centennialite-like compound. Due to the size and heterogeneity of the natural specimens, presence of absorbed water, etc. IR and thermogravimetric study seemed not to be useful and only qualitative and comparative EDS electron probe analyses were performed on natural materials using an area scans to minimize a beam damage. The results for three scan areas on each of three cotypes (wt% ranges for cotypes 1/*2*/**3**) are Al 0.0/*0–0.04*/**0–0.5**; Si 0.0/*0.0*/**0–0.3**; Ca 9.8–10.6/*9.9–10.2*/**3.4–8.9**; Cu 28.8–29.0/*29.1–29.2*/**30.4–30.6**; Cl 21.2–21.3/*21.6–21.9*/**19.1–23.0**; O 39.4–39.5/*39.1–39.2*/**38.5–40.7**. The atomic ratio Ca:Cu:Cl ~ 1:3:2 for all

three cotypes. As more accurate data pertaining specifically to centennialite was not obtained on the natural samples, analyses were also performed on synthetic material with X-ray control to ensure the phase analyzed is identical to both centennialite and its synthetic analog (Erdös et al. 1981). A combination of combustion analysis, ion chromatography, inductively coupled plasma mass spectrometry and inductively coupled plasma atomic emission spectroscopy analyses resulted as (wt%): Ca 10.1, Cu 44.3, Cl 16.9, O 24.2, H 1.91, total 97.41. The empirical formula based on 2 Cl pfu, with OH and H_2O partitioned according to H content and charge balance is $Ca_{1.05}Cu_{2.92}(OH)_{5.94}Cl_2H_{1.98}O$. Based on water content obtained here, and the structural studies of cotype 1 and cotype 3, the formula for centennialite is $CaCu_3(OH)_6Cl_2\cdot nH_2O$, where $n \approx 0.7$. The strongest lines in the X-ray powder diffraction pattern are [d Å $(I\%; hkl)$]: 5.799 (100; 001), 2.583 (75; 201), 2.886 (51; 111), 1.665 (20; 220), 1.605 (17; 023), 1.600 (15; 221), 1.444 (11; 222). The unit-cell parameters are $a = 6.6606(9)$, $c = 5.8004(8)$ Å, $V = 222.85$ Å^3. The crystal structure refinement by Rietveld ($R = 5.99\%$) with additional H location by repulsion methods shows the mineral is trigonal, $a = 6.6615(1)$, $c = 5.8022(2)$ Å, $V = 222.98$ Å^3; $P\bar{3}m1$, $Z = 1$; $D_{calc} = 3.100$ g/cm^3. The structure has a kapellasite-like topology. The layers consisting of triangular network of edge-sharing CaO_6 octahedra alternating with edge-sharing planar $CuO(H)_4$ units such way that each CaO_6 octahedron is surrounded by 6 rectangular $CuO(H)_4$ units. All O sites are protonated and bridge Ca and Cu sites. These Ca–Cu–polyhedral layers are stacked, along [001], with two hydrogen-bonded Cl sites between them. These extend the coordination to form the long apices of Jahn-Teller distorted $Cu(OH)_4Cl_2$ octahedra. The main difference from kapellasite-type structures is an extra site with non-integer and variable water content. This extends the coordination of the Ca-site to eightfold-fold, akin to the body-diagonal Pb–Cu sheet in murdochite $PbCu_6O_8$. The relationship between calumetite and centennialite is discussed and a substructure model is proposed for a synthetic calumetite-like phase directly related to centennialite. **D.B.**

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DAGENAISITE*

A.R. Kampf, R.M. Housley, and J. Marty (2017) Dagenaisite, a new zinc tellurate from the Gold Chain Mine, Tintic, Utah, U.S.A. Canadian Mineralogist, 55(5), 867–873.

Dagenaisite (IMA 2017-017), ideally $Zn_3Te^{6+}O_6$, monoclinic, is a new mineral from the 300 foot level of the Opohonga stope at Gold Chain mine, Tintic district, Juab County, Utah, U.S.A. (39°55′44″N; 112°6′50″W). The mine exploited a polymetallic (Au–Ag–Cu–Pb–Zn) vein deposit in dolomite. The upper portion of the deposit is almost completely oxidized. Dagenaisite was found with cinnabar, dugganite, eurekadumpite, and gold in vugs in a quartz–dolomite matrix. Other minerals of the general assemblage include adamite, arseniosiderite, atelestite, baryte, beudantite, conichalcite, hemimorphite, kettnerite, 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 sphalerite. 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_{calc} = 6.00 g/cm^3. At room temperature, the mineral is slowly soluble in diluted 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}, $Z \approx$ **a**. The refractive indexes were not determined; n_{calc} = 1.99. The Raman spectra recorded between 4000 and 100 cm^{-1} show poorly resolved broad main band centered at 721 cm^{-1} with indistinct shoulders at ~822, 634, 597, and 565 cm^{-1} assigned to Te^{6+}O$_6$ 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$_5$ 0.85 (0.25–1.57), TeO$_3$ 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 (Zn$_{2.39}$Cu$_{0.36}$Ca$_{0.06}$Mn$_{0.03}$As$_{0.03}$Si$_{0.02}$)$_{\Sigma2.89}$Te$_{1.02}$O$_6$. The strongest lines in the X-ray powder diffraction patterns are [d Å (I%; hkl)]: 4.311 (30; 310), 3.085 (22; $\overline{4}$02), 3.029 (44; 222), 2.744 (68; $\overline{3}$13,421); 2.539 (100; $\overline{1}$32,$\overline{4}$22); 1.657 (48; $\overline{7}$32,350,$\overline{2}$44). 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) Å, β = 93.33(2)°, V = 1367 Å^3, 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 Zn$_3$TeO$_6$ 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 Zn$_3$TeO$_6$ (Weil 2006) contains two distinct Te atom positions with relatively regular octahedral coordination and five different 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 species three of which are already approved. Four cotype specimens are housed in the Mineral Sciences Department, Natural History Museum of Los Angeles County, Los Angeles, U.S.A. **D.B.**

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DAVIDSMITHITE*

S.-A. Kechid, G.C. Parodi, S. Pont, and R. Oberti (2017) Davidsmithite, (Ca,☐)$_2$Na$_6$Al$_8$Si$_8$O$_{32}$: a new, Ca-bearing nepheline-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 Ca-rich silicate with the nepheline framework and crystal-chemical relationships in the compositional space (K,Na,Ca,☐)$_8$(Al,Si)$_{16}$O$_{32}$. European Journal of Mineralogy, 1(1), 59–70.

Davidsmithite (IMA 2016-070), ideally (Ca,☐)$_2$Na$_6$Al$_8$Si$_8$O$_{32}$, hexagonal, is a new feldspathoid mineral of the nepheline group that occurs it the retrogressed jadeite-rich layers of Liset eclogite pod, Liset, Selje, Western Gneiss Region (WGR), Vestlandet, Norway (62°4′ N, 5°20′ E). The new mineral discovered in the thin section G201b7 originated from eclogite sample G201 of rock collection COSEM of the Muséum National d'Histoire Naturelle (MNHN) in Paris, France. This thin section considered as holotype and is also a holotype for closely associated compositionally similar but structurally different mineral lisetite CaNa$_2$Al$_4$Si$_4$O$_{16}$. Other closely associated minerals are albite and taramite. Sometimes davidsmithite replacing a cluster of lisetite at its edges in an irregular corona style.

Relict jadeite and quartz, armored by coronas of clinoamphibole, occur nearby. Davidsmithite generally forms anhedral, and rarely skeletal or lath-like, crystals up to 80–100 μm long and about 30 μm wide in polycrystalline aggregates. The small size of the crystals, the frequent intergrown textures with lisetite, and/or the presence of micro-inclusions prevented the measurement density and some other physical properties. Davidsmithite is colorless to pale yellowish in thin section. Twinning was not observed in thin section, although is present in diffraction, probably polysynthetic on (100). Davidsmithite has white streak and vitreous to greasy luster. The Mohs hardness is 5½. D_{calc} = 2.597 g/cm^3. The mineral is non-fluorescent. Optically it is uniaxial (–), ω = 1.538(2), ε = 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), NiO 0.01 (0–0.01), TiO$_2$ 0.04 (0–0.08), total 100.12. The empirical formula ([Ca$_{0.636}$☐$_{0.636}$]☐$_{0.414}$K$_{0.165}$Na$_{0.149}$)$_{\Sigma2.000}$Na$_{6.000}$(Al$_{7.863}$Fe$^{3+}_{0.019}$)$_{\Sigma7.882}$Si$_{8.192}$O$_{32}$ based on 32 O pfu. The strongest lines in the X-ray powder-diffraction pattern [d Å (I%; hkl)] are: 4.322 (27.4; 020), 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 × 0.2 × 0.1 mm shows davidsmithite is hexagonal, $P6_3$, a = 9.982(1), c = 8.364(1) Å, V = 721.7 Å^3, Z = 1. The crystal structure of davidsmithite, refined to R_1 = 3.66% for 364 unique observed reflections with $F_o^2 > 3\sigma(F_o^2)$ and 10.41% for all 748 reflections, is the same tetrahedral framework as that of nepheline, but the with distribution of the Ca, Na, and K cations quite unusual: the large A cavity is statistically occupied by (Ca+Na+K+☐), with one position at the K position of ordinary nephelines but occupied by (Ca+Na+minor K+☐), and a second position labelled Ca′ and occupied by (Ca+Na+☐) displaced along the z axis at approximately 1.25 Å from the K position. The name honors David Christopher Smith (b. 1946), Emeritus Professor at the Muséum National d'Histoire Naturelle (MNHN) in Paris, France. As a mineralogist, he participated in discovery of the new minerals nyböite, lisetite, 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.**

EPIFANOVITE*

V.N. Yakovenchuk, Ya.A. Pakhomovsky, N.G. Konoplyova, T.L. Panikorovskii, Yu.A. Mikhailova, V.N. Bocharov, S.V. Krivovichev, and G.Yu. Ivanyuk (2017) Epifanovite, NaCaCu$_5$(PO$_4$)$_4$[AsO$_2$(OH)$_2$]·7H$_2$O, a new mineral from Kester deposit (Sakha-Yakutia, Russia). Zapiski Rossiyskogo Mineralogicheskogo Obshchestva (Proceedings of Russian Mineralogical Society), 146(3), 30–39 (in Russian).

T.L. Panikorovskii, S.V. Krivovichev, V.N. Yakovenchuk, and G.Yu. Ivanyuk (2017) The crystal structure of epifanovite. Zapiski Rossiyskogo Mineralogicheskogo Obshchestva (Proceedings of Russian Mineralogical Society), 146(3), 39–50 (in Russian).

Epifanovite (IMA 2016-063), ideally NaCaCu$_5$(PO$_4$)$_4$[AsO$_2$(OH)$_2$]·7H$_2$O, monoclinic, is a new phosphate–arsenate discovered in a quartz–apatite nest within greizenized cassiterite-rich granodiorite of the Kester tin deposit, Sakha-Yakutia, Russia. This nest is about 5 m in diameter and consists mostly of light gray botryoidal aggregates of fluorapatite ("staffelite") up to 30 cm and porous milky quartz up to 10 cm. The fractures encrusted with dark green crystals or spherulites of As-rich pseudomalachite (up to 5 mm), light green libethenite crystals

(up to 7 mm), and segregations of native copper (up to 3 mm). All those covered with the radial aggregates of hair-like slavkovite crystals, colorless cuboctahedral crystals of arsenolite, colorless plates of tobermorite, and mate crusts of turquoise blue vitreous tabular pseudotetragonal crystals of epifanovite (up to 50 × 10 μm) along with tabular-prismatic crystals of potentially new Mg–Zn phosphate. The origin of epifanovite is related to low-temperature hypergenic alteration of primary minerals (chalcopyrite, bornite, chalcocite, covellite, cubanite, stanine, sphalerite, tetrahedrite, löllingite, realgar, currite, and others) by oxidizing hydrothermal solutions reacting with "staffelite." The main crystal forms of epifanovite are {100}, {010}, and {001}. Cleavage is perfect on (001) and good on (100) and (010) with no parting observed. The mineral is brittle with a step fracture, has a pale blue streak, and Mohs hardness of 3. $D_{meas} = 3.65(3)$ and $D_{meas} = 3.73$ g/cm³. No fluorescence under UV light was observed. In transmitted light epifanovite is green, non-pleochroic, "without dispersion" (what kind is not specified). It is optically biaxial (–), α = 1.708(5), β = 1.730(5), γ = 1.735(5), $2V = 40$–45° (λ = 589 nm); $2V_{calc} = 50°$. $X = \mathbf{a}$, $Y = \mathbf{b}$. Epifanovite easy dissolves in cold diluted (10%) HCl. The Raman spectrum is close to that of sampleite. The main bands (cm⁻¹) are: 3410, 3200, 2900 (O–H stretching); 1153, 1086, 1002, 962, 921 (vibrations in PO_4 tetraheda); 828 and 858 (stretching vibrations in AsO_4 tetrahedra). The bands below 700 cm⁻¹ are related to bending P–O and As^{5+}–O vibration, stretching vibrations of Cu^{2+}–O and to lattice modes. The thermogravimetry and differential scanning calorimetry studies show weight loss ~5% in vacuum before heating (absorbed water). The mineral is quickly dehisces in vacuum. Gradual weight loss of 7.3% during heating to 400 °C related to molecular water release. The weight loss of 2.3% between 400 and 600 °C corresponding to endothermic peak at 486 °C related to dehydroxylisation. Further weight loss of 2.7% (600–1000 °C) and corresponding endothermic feature at 849 °C are assigned to disintegration of epifanovite crystal structure onto CuO and amorphous residue. The average of unreported number of electron probe WDS analyses is [wt% (range)]: Na_2O 3.04 (0.83–5.67), K_2O 0.31 (0–0.64), CaO 4.42 (3.77–5.21), CuO 38.66 (37.10–41.77), ZnO 0.49 (0–1.20), P_2O_5 28.72 (25.79–33.56), As_2O_5 8.95 (7.48–10.14), H_2O 9.60 + 5.00 (by TGA), Cl 0.05 (0–0.14), –O=Cl₂ 0.01, total 99.23. The empirical formula is $(Na_{0.94}K_{0.06})_{\Sigma1.00}(Ca_{0.82}Na_{0.08})_{\Sigma0.90}$ $(Cu_{5.04}Zn_{0.06})_{\Sigma5.10}(PO_4)_4[(As_{0.81}P_{0.19})_{\Sigma1.00}(O_{1.92}OH_{2.06}Cl_{0.02})_{\Sigma4.00}]\cdot7.37H_2O$ based on P+As = 5. The strongest lines in the X-ray powder-diffraction pattern [d Å (I%; hkl)] are: 9.73 (100; 001), 6.79 (35, 110), 4.355 (12, 021), 3.072 (43, 130), 3.061 (24, 221), 3.003 (24, $\overline{2}2\overline{2}$); 2.698 (11, 023), 1.6775 (10, $\overline{5}04$). The cell parameters refined from the powder X-ray data are a = 9.6912(9), b = 9.7440(9), c = 9.9561(9) Å, β = 102.23 (1)°, V = 918.7 Å³. The single-crystal unit-cell parameters are a = 9.6911(8), b = 9.7547(9), c = 9.9632(14) Å, β = 102.237(10)°, V = 920.46 Å³, Z = 2. The mineral is monoclinic, space group $P2_1/m$. The crystal structure was determined by direct methods and refined to $R_1 = 0.087$ on the basis 2147 independent observed reflections. It contains four CuO_5 pyramids linked to form $[Cu_4O_{13}]$ tetramers. The tetramers are linked via phosphate groups into the complex incrusted by disordered $[AsO_2(OH)_2]^-$ group to form fundamental building blocks in the structure. The blocks are linked through phosphate groups to form layers $[Cu_4O(TO_4)_4]$ 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_5 pyramids and O atoms of disordered arsenate groups. Epifanovite is related to lavendulan-group minerals and related species: andyrobertsite, calcioandyrobertsite, mahnertite, and richelsdorfite. The most closely related are the structures of the monoclinic polytypes of the andyrobertsite–calcioandyrobertsite $KMeCu_5(AsO_4)_4[As(OH)_2O_2]\cdot2H_2O$ (Me = Cd, Ca). The name honors Porphiriy Prokopievich Epifanov, Russian geologist, the discoverer of the Kester, Ege-Khaya, and others tin deposits in 1936–1938. The holotype is deposited to the Mineral Museum of Sankt Petersburg University, Russia. **D.B.**

FERRO-TSCHERMAKITE*

R. Oberti, M. Boiocchi, F.C. Hawthorne, and M.E. Ciriotti (2018) Ferro-tschermakite from the Ploumanac'h granitic complex, Brittany, France: mineral description. European Journal of Mineralogy, 30(1), 171–176.

Ferro-tschermakite (IMA 2016-116), ideally $^A\square$ $^B Ca_2$ $^C(Mg_3Al_2)$ $^T(Si_6Al_2)O_{22}$ $^W(OH)_2$, 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 Ploumanac'h northern granite quarry, La Clarté, Perros-Guirec, Ploumanac'h granitic 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 Ploumanac'h granite. Ferro-tschermakite occurs as ~3 cm long aggregate of dark green bladed-to-acicular crystals associated with white plagioclase and in miarolitic 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/cm³. 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) (λ not reported), $2V_{(meas)} = 84(1)$, $2V_{(calc)} = 79.8°$. The dispersion of an optical axes is medium (r > v), and the orientation is: $X \wedge \mathbf{a} = 9.5°$ (in β acute), $Y \parallel \mathbf{b}$, $Z \wedge \mathbf{c} = 24.3°$ (in β obtuse). The average of 10 electron probe WDS analyses [wt% (range)] is: SiO_2 41.32 (40.61–42.55), TiO_2 0.37 (0.35–0.39), Al_2O_3 18.13 (17.72–18.41), Cr_2O_3 0.02 (0–0.03), V_2O_3 0.05 (0.01–0.08), FeO_{tot} 17.55 (17.18–17.82), FeO 15.66 and Fe_2O_3 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 (18.48–10.64), Na_2O 1.61 (1.30–1.74), K_2O 0.45 (0.42–0.46), H_2O [on the basis of 2 (OH,F) pfu] F 0.12 (0–0.24), –O=F₂ 0.05, total 99.47. The empirical formula based on 24 (O,OH,F) pfu is $^A(Na_{0.29}K_{0.08})_{\Sigma0.37}$ $^B(Ca_{1.69}$ $Fe^{2+}_{0.11}Mn^{2+}_{0.02}Na_{0.18})_{\Sigma2.00}$ $^C(Fe^{2+}_{1.84}Mg_{1.54}Al_{1.33}$ $Fe^{3+}_{0.24}V^{3+}_{0.01}Ti_{0.04})_{\Sigma5.00}$ $^T(Si_{6.15}Al_{1.85})_{\Sigma8.00}O_{22}$ $^W(OH_{1.94}F_{0.06})_{\Sigma2.00}$. The strongest lines in the X-ray powder diffraction patterns are [d Å (I%; hkl)]: 8.359 (100; 110), 2.708 (84; 151), 3.098 (55; 310), 2.552 (43; $\overline{2}02$), 2.595 (41, 061), 2.330 (33; $\overline{3}51$), 2.159 (27; 261), 2.936 (27; 221), 3.338 (27; 131), 2.012 (24; $\overline{4}02,351$). The single-crystal X-ray data obtained from a crystal of 0.14 × 0.13 × 0.05 mm shows that ferro-tschermakite is monoclinic, $C2/m$, a = 9.7598(6), b = 18.0220(11), c = 5.3299(3) Å, β = 104.826(1)°, V = 906.27(9) Å³, Z = 2. The crystal structure refined to $R_{obs} = 2.5\%$ for 1249 unique observed reflections with $F_o^2 > 3\sigma(F_o^2)$, and $R_{all} = 2.7$ % for 1377 unique reflections. Calculated <M(1)–O> and <M(3)–O> distances are significantly shorter than the measured values, which excludes the presence of trivalent cations at the M(1) and M(3) sites, and hence any deprotonation, so that the assumption of 24 (O,OH,F) atoms per formula unit (apfu) in the calculation of the formula unit is further supported. Ferro-tschermakite forms a series with tschermakite, $^A\square$ $^B Ca_2$ $^C(Mg_3Al_2)$ $^T(Si_6Al_2)$ O_{22} $^W(OH)_2$, the only composition related to the rootname "tschermakite" so far recognized as a valid mineral species by IMA-CNMNC (Winchell 1945; Abdu and Hawthorne 2009). However, according to the classification rules in force, that amphibole now falls in the compositional field of magnesiohornblende (although with a significant pargasite component) and must be considered as named amphibole (Burke and Leake 2004) and a potential new mineral. The holotype ferro-tschermakite is deposited in the mineralogical collections of the Museo di Mineralogia dell'Università di Pavia, Italy. **F.C.**

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GREENLIZARDITE*

A.R. Kampf, J. Plášil, B.P. Nash, and J. Marty (2018) Greenlizardite, (NH_4) $Na(UO_2)_2(SO_4)_2(OH)_2 \cdot 4H_2O$, a new mineral with phosphuranylite-type uranyl sulfate sheets from Red Canyon, San Juan County, Utah, USA. Mineralogical Magazine, 82(2), 401–411.

Greenlizardite (IMA 2017-001), $(NH_4)Na(UO_2)_2(SO_4)_2(OH)_2 \cdot 4H_2O$, 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′37.10″N, 110°17′52.80″W) and named for its type locality. It is a secondary alteration 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. Greenlizardite is associated with ammoniozippeite, boussingaultite, dickite, and an unknown Mg uranyl sulfate (under study). Other secondary minerals of the assemblage include beshtauite, calcite, gypsum, fermiite, johannite, natrozippeite, oppenheimerite, plášilite, rozenite, shumwayite, sulfur and wetherillite. The general geology and 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 ~0.3 mm long with a white streak and vitreous luster. Blades are flattened on {001}, elongated by [100] and exhibit the forms {$\bar{1}$00}, {010}, {0$\bar{1}$0}, {001}, {00$\bar{1}$}, {$\bar{1}$10}, {$\bar{1}$$\bar{1}$0}, {$\bar{1}$20}, and {2$\bar{1}$0}. The mineral fluoresces greenish blue in 405 nm light. It is brittle with irregular fracture cleavage perfect on {001} and good on {2$\bar{1}$0}. Mohs hardness is ~2. Density was not measured due to solubility of the mineral in Clerici solution; D_{calc} = 3.469 g/cm³. Greenlizardite is easily soluble in room-temperature H_2O. It is pleochroic in pale yellow–green tones in transmitted plane-polarized light $X < Y < Z$. The mineral is optically biaxial (+), α = 1.559, β = 1.582, γ = 1.608 (white light), $2V$ = 88(1)°; $2V_{calc}$ = 87.8°; $X \approx $ **c**, $Y \approx $ **a**, $Z \approx $ **b***; dispersion of an optical axes is moderate, $r < v$. Twinning, probably by reflection on {001}, is observed under crossed polars. The Raman spectrum recorded from 3000 to 50 cm⁻¹ shows bands at (cm⁻¹; s = strong, w = weak, sh = shoulder): 1225, 1097, 1086sh, 1068 (ν₃ antisymmetric stretching vibrations of the SO_4 tetrahedra); 1031, 1027sh (ν₁ symmetric SO_4 stretching modes); 938w, 933w (ν₃ antisymmetric stretching vibration of the UO_2^{2+}; 837vs (ν₁ symmetric U–O stretching of the UO_2^{2+}; 635w, 618w [ν₄ (δ) triply degenerated antisymmetric stretching vibrations of SO_4 tetrahedra]; 469w, 450w, 435sh [ν₂ (δ) doubly degenerate bending vibrations of the SO_4]; 355, 297 (Na–O stretching); 234, 194, 258sh, 177 [ν₂ (δ) doubly degenerate bending vibration of the UO_2^{2+} and U–O$_{eq-ligand}$ stretching modes]. Weak bands at the lowest energies can be assigned to unclassified lattice modes, probably skeletal vibrations of the whole sheets of polyhedra. The average of 6 electron probe WDS analyses on 4 grains [wt% (range)] is: $(NH_4)_2O$ 2.75 (1.82–4.02), Na_2O 2.34 (1.80–3.05), UO_3 60.45 (58.14–63.60), SO_3 17.70 (16.85–18.87), H_2O (by structure) 9.76, total 93.00. The low total and lower than expected Na are attributed to the irregular surfaces of mounted grains. The semi-quantitative EDS analyses are consistent with Na stoichiometry of 1 apfu (i.e Na_2O 3.34 wt%) so the resulting empirical formula based on 18 O pfu is $(NH_4)_{0.98}$ $Na_{1.00}U_{1.96}S_{2.04}O_{18.00}H_{10.02}$. The strongest lines of the X-ray diffraction pattern [d Å (I%; hkl)] are: 13.59 (24; 001), 6.80 (100; 002), 6.06 (36; $\bar{1}$01), 5.75 (62; 1$\bar{1}$1), 5.52 (24; 101), 4.41 (32; 0$\bar{2}$1,020), 3.481 (25; 0$\bar{2}$3), 3.404 (56; 022,$\bar{2}$10,004), 3.126 (60; $\bar{2}$12,$\bar{1}$30), 3.073 (26; $\bar{1}$$\bar{2}$2), 2.988 (34; 1$\bar{1}$4,1$\bar{3}$2,2$\bar{1}$2), 1.9097 (26; multiple). The crystal structure was refined to R_1 = 0.0239 using 2542 $I>2σI$ reflections. Greenlizardite is triclinic, $P\bar{1}$, a =

6.8362(2), b = 9.5127(3), c = 13.898(1) Å, α = 98.636(7), β = 93.713(7), γ = 110.102(8)°, V = 832.49 Å³, Z = 2. In the structure edge-sharing dimers of UO_7 pentagonal bipyramids link by sharing corners with SO_4 groups to form a $[(UO_2)_2(SO_4)_2(OH)_2]^{2-}$ sheet based on the phosphuranylite anion topology. Zigzag edge-sharing chains of NaO_6 octahedra link adjacent $[(UO_2)_2(SO_4)_2(OH)_2]^{2-}$ sheets, forming thick slabs. NH_4 bonds to O atoms in adjacent slabs linking them together. H_2O groups occupy channels in the slabs and space between the slabs. One holotype and one cotype specimens are deposited in the Natural History Museum of Los Angeles County, California, U.S.A. **D.B.**

GROOTFONTEINITE*

O.I. Siidra, E. Jonsson, N.V. Chukanov, D.O. Nekrasova, I.V. Pekov, W. Depmeier, Y.S. Polekhovsky, and V.O. Yapaskurt (2018) Grootfonteinite, $Pb_3O(CO_3)_2$, a new mineral species from the Kombat Mine, Namibia, merotypically related to hydrocerussite. European Journal of Mineralogy, 30(2), 383–391.

Grootfonteinite (IMA 2015-051), ideally $Pb_3O(CO_3)_2$, hexagonal, is a new Pb oxycarbonate found in a mineralogically complex, banded assemblage from the Mn(–Fe) oxide ore unit of the Kombat mine, Grootfontein district, Otjozondjupa region, northern Namibia (WGS 84 coordinates 19°46′60″ S, 18°1′0″ E). Grootfonteinite occurs in association with jacobsite, cerussite, dolomite, clinochlore, hausmannite, melanotekite, sahlinite, rhodochrosite, and baryte. Textural and paragenetic observations suggest that the mineral may have formed as a consequence of regional metamorphism. 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 {001} and no parting. The fracture is uneven across the cleavage planes. The microindentation hardness VHN₂₀ = 55.3 (48.7–66.1) kg/mm², corresponding to a Mohs hardness of ~2. The lack of material and high density prevented its measurement; D_{calc} = 6.856 g/cm³. In reflected light, grootfonteinite is gray. It is non-pleochroic, with abundant white internal reflections and a very weak bireflectance masked by the internal reflections. The reflectance measurements made in air in the range 400–700 nm with 20 nm interval. The values [R_{max}/R_{min}% (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 those of the related minerals hydrocerussite and plumbonacrite, 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 CO_3^{2-}); 1418 s, 1380 sh (asymmetric C–O stretching vibrations of CO_3^{2-}); 1200 (combination mode involving Pb–O-stretching and O–C–O bending vibrations); 1046 (symmetric C–O stretching vibrations of CO_3^{2-}); 837 (out-of-plane bending vibrations of CO_3^{2-}); 685sh, 680s (in-plane bending vibrations of CO_3^{2-}); 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 $H_{0.345}Na_{0.275}Ca_{0.045}Pb_{2.645}C_2O_7$ based on 7 O and 2 C apfu. The strongest lines in the X-ray powder-diffraction pattern [d Å (I%; 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 = 5.300(2), c = 13.761(2) Å, V = 334.88 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, $P6_3/mmc$, a = 5.303(1), c = 13.770(3) Å, V = 335.3 Å³, Z = 2. The crystal structure of grootfonteinite was refined to R_1 = 5.16 % for 178 unique observed $F_o>4σ(F_o)$ reflections and to R_1 = 15.17% for all 185 reflections. Grootfonteinite is structurally related to hydrocerussite, abellaite, and plumbonacrite. The characteristic structural feature of all these minerals is the presence of $[PbCO_3]^0$ sheets

perpendicular to the **c** axis (*C*-type sheets), in the upper and lower parts of invariably electroneutral 2D blocks, the middle part being variable. The topology of these intermediate 2D blocks in the structure of grootfonteinite 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 $\{(Pb_{0.7}Na_{0.3})[O_{0.7}(OH)_{0.3}]\}^0$, 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). **F.C.**

Janchevite*

N.V. Chukanov, D.O. Nekrasova, O.I. Siidra, Y.S. Polekhovsky, and I.V. Pekov (2018) Janchevite, $Pb_7V^{5+}(O_{8.5}\square_{0.5})Cl_2$, a new mineral from the Kombat Mine, Namibia. Canadian Mineralogist, 56(2), 159–165.

Janchevite (IMA 2017-079), ideally $Pb_7V^{5+}(O_{8.5}\square_{0.5})Cl_2$, 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 kombatite. Janchevite occurs as thick tabular anhedral to subhedral grains up to $0.4 \times 0.8 \times 0.8$ mm in size and it is translucent, orange–red with orange streak; the luster is adamantine. The mineral is brittle with distinct cleavage on {001}. The indentation hardness VHN_{20} = 85.8 (73.4–100.8) kg/mm^2 corresponding to 2½ of a Mohs scale. The density was not measured; D_{calc} = 8.160 g/cm^3. 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 nm interval. The values for COM wavelengths [$R_{max}/R_{min}\%$ (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 V^{5+}–O stretching and Mo^{6+}–O stretching vibrations (at 736–870 and 595 cm^{-1}, respectively), O–(V,Mo)–O bending vibrations (at 462 and 405 cm^{-1}), and Pb–O stretching vibrations (at 366 cm^{-1}). No bands corresponding to CO_3^{2-} anions and H-bearing groups are observed in the range 1000–3800 cm^{-1}. The absence of IR bands in the range 890–990 cm^{-1} indicates the absence of vanadyl VO^{2+} and molybdenyl MoO^{3+} cations in the structure of janchevite. The average of 7 electron probe WDS analyses is [wt% (range)]: SiO_2 0.45 (0.15–0.71), V_2O_5 1.95 (1.73–2.32), MoO_3 2.41 (2.19–2.58), PbO 91.64 (90.51–92.30), Cl 4.16 (3.92–4.34), total 99.67. The empirical formula is $Pb_{7.20}V_{0.38}^{5+}Mo_{0.29}^{6+}Si_{0.13}Cl_{2.06}O_{8.25}$, based on (Pb+V+Mo+Si) = 8 apfu. The strongest lines in the X-ray powder-diffraction pattern [d Å (*I*%; *hkl*)] are: 3.889 (24; 011), 3.501 (31; 013), 2.979 (86; 015), 2.833 (25; 008), 2.794 (100; 110), 1.992 (26; 118), 1.988 (49; 020), 1.649 (46; 215). The unit-cell parameters refined from powder-diffraction data are: a = 3.955(2), c = 22.626(7) Å, V = 355.9 Å^3, space group $I4/mmm$, Z = 1. In spite of the low quality of crystals due to their mosaicity, the single-crystal X-ray data confirmed the unit cell [a = 3.9591(5), c = 22.6897(3) Å, V = 355.65 Å^3] and allow one to consider that janchevite has the crystal structure of parkinsonite and asisite. Janchevite belongs to the family of lead oxychlorides with layered Pb–O blocks. Structural architectures of these minerals consist of Pb–O blocks alternating with tetragonal sheets of Cl$^-$ ions. In parkinsonite and asisite the stacking sequence of the sheets is ...Cl|Pb–O|Pb–O|Cl|Pb–O|Pb–O|..., i.e., the (Pb–O):Cl ratio is 2:1. Janchevite is a vanadium-dominant structural analog of parkinsonite $Pb_7MoO_9Cl_2$. Janchevite is chemically related to kombatite $Pb_{14}O_9(VO_4)_2Cl$, although the crystal structure and powder X-ray diffraction pattern of kombatite are 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 metasomatic 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.**

Javorieite*

P. Koděra, Á. Takács, M. Racek, F. Šimko, J. Luptáková, T. Váczi, and P. Antal (2017) Javorieite, $KFeCl_3$: a new mineral hosted by salt melt inclusions in porphyry gold systems. European Journal of Mineralogy, 29(1), 1–10.

Javorieite (IMA 2016-020), $KFeCl_3$, orthorhombic, is a new mineral, discovered in salt melt inclusions enclosed in vein quartz in the Biely Vrch porphyry gold deposit (3.5 km southeast of the town Detva) located in the central zone of the Javorie andesitic stratovolcano, which is part of the Middle Miocenic Central Slovakia Volcanic Field in the Western Carpathians. Porphyry gold mineralization hosted by stocks of diorite porphyries emplaced in andesites and prevolcanic basement rocks. The vapor inclusions are dominant at Biely Vrch in all generations of vein quartz. The coeval salt melt inclusions mostly hosted by granular vein quartz but rarely found in pyroxene veinlets. Javorieite was also found in three other localities in this volcanic field. Javorieite occurs as the major solid phase in every salt melt inclusion. Other associated minerals within most of inclusions are halite, chlorocalcite, rinneite, and the phase close to $Fe_2(OH)_3Cl$ (probably hibbingite). Some inclusions contain fluorite, scheelite/powellite, unidentified Ba-, Zn-, Pb-bearing chlorides with a very rare presence of some salt hydrates (e.g. $FeCl_2 \cdot 2H_2O$), magnetite, K-feldspar, pyroxene, scheelite, and chalcopyrite. Javorieite forms green anhedral crystals up to 15 μm differ by high relief compare to other phases and melting in the range 320–338 °C when heated. The experimental data in the NaCl–KCl–$FeCl_2$ system agree with the microthermometric behavior of javorieite. This phase has never been described as a mineral due to an extremely strong liability to hydration and oxidation when the host inclusions are opened to air. Due to that nature most of physical properties were not obtained. The Raman spectra acquired in the 65–4000 cm^{-1} interval show the main bands at 66–69, 108–109, 119–120, 134–135, and 235–237 cm^{-1} and are (after quartz subtraction) nearly identical to those of synthetic $KFeCl_3$ with minor differences probably related to admixtures in the natural sample. Further identification of the mineral done using the FIB-SEM-EBSD analytical technique. The standardless electron probe EDS analyses of the grains exposed to the surface, obtained at the same spots where the EBSD pattern and Raman spectra were, successfully matched to those of synthetic $KFeCl_3$. Since the size of inclusions was smaller than the excitation volume, all analyses were affected by the neighboring solid phases and the host quartz. The ranges for 8 analyses of three samples from the various depths of the Biely Vrch deposit are (wt% normalized to 100%): Si 1.0–18.4, Al 0–0.4, O 1.7–16.9, Fe 15.6–21.5, Mn 1.3–4.2, Ca 0–0.6, Na 0.5–2.3, K 11.5–18.5, Cl 35.5–53.5. Variations of the number of atoms per formula unit in empirical formula based on 5 apfu (after subtracting Si, Al, and O) are: K 0.84–1.06, Na 0.05–0.28, Ca 0–0.04, Fe 0.72–1.03, Mn 0.06–0.16, Cl 2.78–3.14. X-ray powder and single-crystal studies of javorieite were not performed due to the small crystal size. The strongest lines in the X-ray powder-diffraction pattern obtained for synthetic $KFeCl_3$ [d Å (*I*%; *hkl*)] are: 7.07 (36; 002), 2.88 (31; 210), 2.83 (100; 005,211), 2.75 (32; 204), 2.69 (52; 105), 2.67 (94; 212), 2.28 (25; 311,015,106), 1.92 (46; 020). The identity of javorieite to synthetic $KFeCl_3$ for which crystal structure is known is based on very good match of EBSD pattern for those. Thus, javorieite was considered as an orthorhombic with space group *Pnma*, and unit-cell parameters a = 8.715(6), b = 3.845(8), c = 14.15(3) Å, V = 474.16 Å^3, Z = 4. The genesis of salt melt inclusions is discussed in relation phase diagram of the NaCl–KCl–$FeCl_2$ system and in relation to the genesis of shallow porphyry systems that can be potentially enriched in gold. The name given for Javorie stratovolcano, which hosts

most porphyry gold systems in this volcanic field. No data on location of any kind type material provided. **D.B.**

KAMPELITE*

V.N. Yakovenchuk, G.Yu. Ivanyuk, Y.A. Pakhomovsky, T.L. Panikorovskii, S.N. Britvin, S.V. Krivovichev, V.V. Shilovskikh, and V.N. Bocharov (2018) Kampelite, $Ba_3Mg_{1.5}Sc_4(PO_4)_6(OH)_3 \cdot 4H_2O$, a new very complex Ba–Sc phosphate mineral from the Kovdor phoscorite–carbonatite complex (Kola Peninsula, Russia). Mineralogy and Petrology, 112(1), 111–121.

Kampelite (IMA 2016-086), ideally $Ba_3Mg_{1.5}Sc_4(PO_4)_6(OH)_3 \cdot 4H_2O$, orthorhombic, is a new Ba–Sc phosphate from the Kovdor phoscorite–carbonatite complex (Kola Peninsula, Russia, N67°33′, E30°31′). The Kovdor massif of peridotites, foidolites, melilitolites, phoscorites, carbonatites, and related metasomatic rocks is of a central-type, polyphaser 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 kampelite is situated in the carbonate–magnetite-rich phoscorite of the ore-pipe axial zone. Kampelite is associated with forsterite, hydroxylapatite, magnetite (with ilmenite, geikielite, and spinel exolutions), calcite, and minor quantities of ScNb-rich baddeleyite, microlite, zirconolite, strontianite, barytocalcite, ancylite-(Ce), pyrrhotite (with exsolution lamellae of cobaltpentlandite), pyrite, sphalerite, chalcopyrite, galena, valleriite, thorianite, monazite-(Ce), rhabdophane-(Ce), magnesite, quintinite, witherite, norsethite, burbankite, shortite, eitelite, nyerereite, and northupite. Kampelite forms spherulites up to 1.5 mm in diameter grown on the dark-orange pyramidal crystals of quintinite-2H in close association with cubic crystals of pyrite, gray spherulites of bobierrite (up to 2 cm in diameter) and yellow crystals of quintinite-3R. The radiated aggregates are built of split plates (up to 700 μm long and 30 μm thick) elongated by [010] and flattened on {010}, which are flexible and have a smooth fracture. The cleavage is perfect on {001}. Neither twinning nor parting was observed. Radiated aggregates of kampelite are silvery-white, translucent, and its separated plates are colorless, transparent with a pearly luster and a white streak. In transmitted light, the mineral is colorless, without pleochroism and dispersion. Kampelite is biaxial (+) (pseudouniaxial), $\alpha \approx \beta = 1.607(2)$, $\gamma = 1.612(2)$ (589 nm). The mineral is non-fluorescent. Mohs hardness is ~1. $D_{meas} = 3.07(3)$ (Clerici solution); $D_{calc} = 3.28$ g/cm³. The mineral easily dissolves in 10% cold HCl. The Raman spectrum shows the most intense band at 975 cm⁻¹ and a weaker shoulder at 932 cm⁻¹, attributed to symmetric stretching modes of PO_4^{3-} groups. Another intense band occurs at 1092 cm⁻¹ (antisymmetric ν_3 of PO_4^{3-} groups). Further weaker bands in the range 400–850 cm⁻¹ are related to the symmetric ν_1 and antisymmetric ν_4 bending of PO_4^{3-} groups. H_2O bending is observed at 1604 cm⁻¹. Bending modes of Sc–O and Sc–O–Sc angles are related to bands at 297 and 402 cm⁻¹, respectively, and Ba–O symmetric stretching and lattice vibrations are observed at 77 and 173 cm⁻¹. The average of 3 electron probe WDS analyses is [wt% (range)]: MgO 4.79 (4.22–5.63), Al_2O_3 0.45 (b.d.l.–1.36), P_2O_5 31.66 (30.18–33.91), K_2O 0.34 (0.30–0.39), CaO 0.25 (0.21–0.29), Sc_2O_3 16.17 (15.54–17.17), MnO 1.46 (1.41–150), FeO 1.24 (1.13–1.26), SrO 3.44 (2.764.17), BaO 29.81 (27.25–31.54), H_2O (from structural data) 7.12, total 97.03. The empirical formula $(Ba_{2.62}Sr_{0.45}K_{0.10}Ca_{0.06})_{\Sigma3.23}$ $Mg_{1.60}Mn_{0.28}(Sc_{3.15}Fe^{3+}_{0.23}Al_{0.12})_{\Sigma3.50}(PO_4)_6(OH)_{2.61} \cdot 4.01H_2O$ based on 6 P pfu. The strongest lines in the X-ray powder-diffraction pattern [d Å (I%; hkl)] are: 15.80 (100; 001), 13.86 (45; 002), 3.184 (18; 223), 3.129 (19; 026), 2.756 (16; 402), 2.688 (24; 1.0.10). The unit-cell parameters refined from powder-diffraction data are: $a = 11.256(1)$, $b = 8.512(1)$, $c = 27.707(4)$ Å, $V = 2654.6$ Å³. The single crystal X–ray data obtained from the crystal of 0.11 × 0.08 × 0.001 mm shows kampelite is orthorhombic,

$Pnma$, $a = 11.2261(9)$, $b = 8.5039(6)$, $c = 27.699(2)$ Å, $V = 2644.3$ Å³, $Z = 4$. The crystal structure of kampelite, refined to $R_1 = 9.2\%$ for 2620 unique observed reflections with $F_o > 4\sigma(F_o)$, is based upon complex $[MgBa_2Sc_4(PO_4)_6]$ layers consisting of the Ba–PO_4 zigzag sheet inserted between two Mg–Sc–PO_4 sheets. Kampelite is named in honor of Russian mining engineer Felix Borisovich Kampel' (b. 1935) for his contribution to 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*

N.V. Chukanov, E. Jonsson, S.M. Aksenov, S.N. Britvin, R.K. Rastsvetaeva, D.I. Belakovskiy, and K.V. Van (2017) Roymillerite, $Pb_{24}Mg_9(Si_9AlO_{28})(SiO_4)(BO_3)(CO_3)_{10}(OH)_{14}O_4$, a new mineral: mineralogical characterization and crystal chemistry. Physics and Chemistry of Minerals, 44(10), 685–699.

Roymillerite (IMA 2015-093), ideally $Pb_{24}Mg_9(Si_9AlO_{28})(SiO_4)(BO_3)$ $(CO_3)_{10}(OH)_{14}O_4$, 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, cerussite, and other associated minerals mainly within a rhodochrosite band, while grootfonteinite occurs in a groundmass dominated by cerussite, with disseminated crystals and subhedral grains of Mn–(Fe) oxides, and locally euhedral to subhedral melanotekite. Granular aggregate of sahlinite 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 form 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 (–), $\alpha = 1.86(1)$, $\beta \approx \gamma = 1.94(1)$ (589 nm). $2V_{meas} = 5°(5)$; $X \approx \mathbf{c}$. Dispersion of optical axes was not observed. The IR spectrum is similar to that of the related mineral britvinite. Absorption bands are (cm⁻¹; s = strong band, w = weak band, sh = shoulder): 3700, 3583, 3513, 3352 (O–H stretching vibrations of OH⁻ groups), 2396w (possibly, acid Si–OH group), 1726w (combination mode), 1385s (asymmetric stretching vibrations of CO_3^{2-} groups), 1231, 1204 (asymmetric stretching vibrations of BO_3^{3-} groups), 1083, 1050sh, 1042, 999s (Si–O stretching vibrations of the Si_5O_{14} sheets), 915, 898, 875sh (Si–O stretching vibrations of isolated SiO_4^{4-} groups), 842w, 806w, 780w (out-of-plane vibrations of CO_3^{2-} groups, possibly combined with Mg···O–H and Pb···O–H bending vibrations), 725w, 688, 679 (in-plane vibrations of CO_3^{2-} groups, possibly combined with O–Si–O bending vibrations of the Si_5O_{14} sheets), 635w, 605w, 580w, 548w, 467s, 420sh, 400sh (combination of Si–O–Si bending and Mg···O stretching vibrations). The average of 7 electron probe WDS analyses is [wt% (range)]: SiO_2 7.90 (7.67–8.06), MgO 4.93 (4.67–5.23), MnO 1.24 (1.03–1.45), FeO 0.95 (0.81–1.03), PbO 75.38 (74.14–76.82), B_2O_3 0.50 (from structural data), Al_2O_3 0.74 (0.64–0.88), CO_2 5.83 ± 0.15 and H_2O 1.8 ± 0.2 (both by gas chromatography), total 99.27. The empirical formula $Pb_{24.12}Mg_{8.74}Mn_{1.25}Fe_{0.94}B_{1.03}Al_{1.04}C_{9.46}Si_{9.39}H_{14.27}O_{83}$ based on 83 O pfu. The strongest lines in the X-ray powder-diffraction pattern [d Å (I%; hkl)] are: 25.9 (100; 001), 13.1 (11; 002), 3.480 (12; $017,107,\bar{1}15,1\bar{1}5$), 3.378 (14; $126,216$), 3.282 (16; $2\bar{1}5,\bar{1}25$), 3.185 (12; $\bar{1}16,1\bar{1}6$), 2.684 (16; $031,301,030,300,332,\bar{1}09,01\bar{9},1\bar{1}8$), 2.382 (11; $0.0.\bar{1}1$). The unit-cell parameters refined from powder-diffraction data are: $a = 9.309(9)$, $b = 9.331(9)$, $c = 26.44(3)$ Å, $\alpha = 83.31(3)°$, $\beta = 83.30(3)°$, $\gamma = 59.87(4)°$, $V = 1968(2)$ Å³. The single-crystal X-ray data obtained from the crystal of 0.11 × 0.12 × 0.15 mm shows roymillerite is triclinic, $P\bar{1}$, $a = 9.3152(15)$, $b = 9.3164(15)$, $c =$

26.463(4) Å, $\alpha = 83.295(3)°$, $\beta = 83.308(3)°$, $\gamma = 60.023(2)°$, $V = 1971.2$ Å^3, $Z = 2$ ($R_{int} = 4.86\%$). This cell can be transformed via the matrix [$\bar{1}$ $\bar{1}$ 0/1 $\bar{1}$ 0/0 0 1] to a pseudomonoclinic C-centered pseudocell with $a = 16.134$, $b = 9.319$, $c = 26.463$, $\beta = 97.74°$; $V = 3942.4$ Å^3, $R_{int} \approx 45\%$. The crystal structure of roymillerite, refined to $R_1 = 5.71 \%$ for 11 532 unique observed reflections with $F_o^2 > 4\sigma(F_o^2)$, is related to those of molybdophyllite and britvinite, and is based on a pyrophyllitetype TOT-module, which alternates with the lead-oxo-carbonate I-block. Therefore, the crystal-chemical formula of roymillerite can be written as follows ($Z = 1$): $^I\{Pb_{24}(OH)_6O_4(CO_3)_{10} [(BO_3)_{0.5}(SiO_4)_{0.5}]_2\}^{TOT}\{Mg_9(OH)_8[(Si,Al)_{10}O_{28}]\}$. The I-block in the structure of roymillerite contains 10 "lead" layers and 4 "carbonate" layers, whereas in the structures of britvinite and molybdophyllite 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 polyhedral. The O12 and O31 atoms are tetrahedrally coordinated forming [OPb$_4$]-tetrahedra. Those form a heteropolyhedral [O(OH)$_3$Pb$_7$]-cluster previously revealed in the structure of synthetic plumbonacrite Pb$_5$O(OH)$_2$(CO$_3$)$_3$. Roymillerite, molybdophyllite, and britvinite are related mineral species that have layered modular structures and form a merotypic series, based on the T-layer Si$_{10}$O$_{28}$, with large 12-membered rings. In roymillerite, "molybdophyllite" modules alternate with "plumbonacrite" modules [(O(OH)$_3$Pb$_7$)(TO$_3$)$_3$]. The mineral is named to honor Roy M. Miller (b. 1941) who has made important contributions to the knowledge of the geology of Namibia. The holotype specimen is deposited in the Swedish Museum of Natural History, Stockholm, Sweden. **F.C.**

TREDOUXITE*

L. Bindi, F. Zaccarini, D.E. Miller, and G. Garuti (2018) Tredouxite, NiSb$_2$O$_6$: another new Ni–bearing mineral from the Bon Accord oxide body, South Africa. European Journal of Mineralogy, 30(2), 393–398.

Tredouxite (IMA 2017-061), ideally NiSb$_2$O$_6$, tetragonal, is a new Ni-rich mineral species from the Bon Accord Ni-oxide deposit, located southeast of the town of Nelspruit at (~25°40′59″ S, 31°10′0″ E) in South Africa. The Bon Accord Ni-oxide deposit is hosted by altered ultramafic rocks of the 3.2 Ga Onverwacht Group that occur in tectonic contact with metamorphic rocks, such as schists and mylonites, and forms a dark-to-light green elliptical body, about 0.5 m thick and 20 m wide on its longest axis. Tredouxite occurs closely associated with trevorite in a Ni-rich hydroxysilicate (likely willemseite) matrix, and it probably formed at temperatures around 600 °C, by impregnation of pervasive H$_2$O-rich fluids, forming secondary hydrated minerals like bottinoite. It forms subhedral to anhedral grains varying in size from 10 to 500 μm, commonly intergrown with bottinoite. Tredouxite exhibits a submetallic luster and a gray streak. It is brittle with no cleavage. The micro-indentation hardness VHN$_{10}$ = 226 (218–240) kg/mm^2, which corresponds to a Mohs hardness of 3–3½. The density was not measured; D_{calc} = 6.650 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 brownish-gray to gray colors. The reflectance values [$R_{max}/R_{min}\%$ (nm)] 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 [wt% (range)]: NiO 17.21 (16.74–17.97), Fe$_2$O$_3$ 1.78 (0.50–2.72), Sb$_2$O$_5$ 79.88 (79.00–80.46), As$_2$O$_5$ 0.51 (0.31–0.70), total 99.38. The empirical formula is (Ni$_{0.92}^{2+}$Fe$_{0.08}^{3+}$)(Sb$_{1.97}^{5+}$As$_{0.02}^{5+}$Fe$_{0.01}^{3+}$)O$_{6.03}$, based on 3 cations pfu, and assuming Ni, Fe, Sb, and As in the valence states 2+, 3+, 5+, and 5+. The strongest lines in the X-ray powder-diffraction pattern [d Å (I%; hkl)] 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 Å^3. Most single crystals of tredouxite tested were an intergrowth of two phases: tredouxite and weakly diffractive bottinoite

[NiSb$_2$(OH)$_{12}$·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 = 9.2154(8) Å, V = 197.91(3) Å^3, tetragonal, $P4_2/mnm$, 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_1 = 0.0559 on the basis 65 independent observed reflections with $F_o > 4\sigma(F_o)$. 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^{5+}-M^{5+}... along the c-axis, which leads to a tripling of the c-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*

L.Z. Reznitsky, E.V. Sklyarov, G. Cametti, T. Armbruster, L.F. Suvorova, Z.F. Ushchapovskaya, and I.G. Barash (2017) Vanadio-pargasite NaCa$_2$Mg$_4$V[Si$_6$Al$_2$]O$_{22}$(OH)$_2$—new mineral of the amphibole group. Zapiski Rossiyskogo Mineralogicheskogo Obshchestva (Proceedings of Russian Mineralogical Society), 146(6), 62–74 (in Russian).

G. Cametti, T. Armbruster, L.Z. Reznitsky, E.V. Sklyarov, and G. Della Ventura (2018) Crystal structure and crystal-chemistry of vanadio-pargasite: a new amphibole from southern Lake Baikal, Siberia, Russia. European Journal of Mineralogy, https://doi.org/10.1127/ejm/2018/0030-2758.

Vanadio-pargasite (IMA 2017-019), ideally NaCa$_2$Mg$_4$V[Si$_6$Al$_2$]O$_{22}$(OH)$_2$, monoclinic is a new species of an amphibole group discovered at the Pereval marble quarry in Cr–V-bearing marbles, near the town of Sludyanka, Lake Baikal, Russia. The dolomite–calcite marbles contain bands or thin (0.5–3 cm) layers consisted mostly of black magnesiocoulsonite–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 0.10 × 0.8 mm. The habit forms are {010} and {110} with a typical amphibole striation. The streak is pale green. The cleavage is perfect on {110}; fracture is uneven. The indentation hardness VHS = 795 (752–824) kg/mm^2 corresponding to ~6 of Mohs scale. The mineral is slightly magnetic. D = 3.05(5) (Clerici solution), D_{calc} = 3.112 g/cm^3. Under plane-polarized transmitted light, the mineral is pale green, non-pleochroic. Vanadio-pargasite is optically biaxial (+) (–), α = 1.643(2), β = 1.651(2), γ = 1.659 (2) (white light) (dispersion was not mentioned), $2V = 86°(2)$, $2V_{calc} = -89.6°$ optical sign is unclear since $2V$ is very close to 90°, $Z\wedge\mathbf{c} = 23–25°$. The main bands of IR spectrum (cm^{-1}) are: 3435 (O–H stretching), 1633 (H$_2$O bending), wide band with maxima 1050, 980, 919 (Si–OSi stretching), 469 (–MeO and –SiO– bending vibrations in SiO$_4$ tetrahedra. The thermogravimetry and differential scanning calorimetry studies were performed between 42 and 1400 °C and combined with a gas composition control. Main water release at 654–1081 °C matched by endothermic effect. The main endothermic effect at 900–1183 °C related to structural changes, water (and probably F release) and melting the mineral at 1020 °C. The average of 528 electron probe WDS analysis on 166 grains is [wt% (range)]: SiO$_2$ 42,75 (41.3–44.32),

TiO$_2$ 0.14 (0–0.25), Al$_2$O$_3$ 12,75 (11.43–13.76), Cr$_2$O$_3$ 0.44 (0–0.82), V$_2$O$_3$ 5.92 (5.07–6.75), MgO 19.15 (18.42–20.47), FeO 0.03 (0–0.07), MnO 0.01 (0–0.05), CaO 12.52 (11.82–13.42), Na$_2$O 3.45 (3.08–3.81), K$_2$O 0.41 (0.27–0.6), F 0.61 (0.14–1.31) [0.74(5) by potentiometry], H$_2$O 1.75 (calculated based on F content thus –O=F$_2$ already counted), total 99.91. The empirical formula calculated on the basis of 22 O and (OH+F) = 2 is (Na$_{0.90}$K$_{0.07}$)(Ca$_{1.91}$Na$_{0.05}$Mg$_{0.04}$)(Mg$_{4.02}$V$_{0.68}$Al$_{0.23}$Cr$_{0.05}$Ti$_{0.02}$)(Si$_{6.09}$Al$_{1.91}$) O$_{22}$(OH$_{1.67}$F$_{0.33}$). The strongest lines of X-ray powder diffraction pattern [d Å (*I*%; *hkl*)] are 8.98 (15; 020); 8.43 (40; 110), 3.27 (30; 240), 3.14 (100; 310), 2.82 (35; 330), 2.70 (18; l51), 2,34 (15; 42$\bar{1}$), 1.898 (15; 510), 1.445 (25; 4.10.$\bar{1}$). The cell parameters refined from the powder data are a = 9.91(1), b = 18.00(1), c = 5.300(4) Å, β = 105.68(7)°, V = 910 Å^3. Single-crystal data shows vanadio-pargasite is monoclinic, space group $C2/m$, a = 9.8956(1), b = 17.9970(2), c = 5.2970(1) Å, β = 105.391(1)°, V = 909.52 Å^3. The crystal structure was refined to R_1 = 0.0181. Vanadio-pargasite is a new member of the calcium amphibole subgroup with V ordered at M(2) site together with minor [6]Al, while a low amount of [6]Al is present at M(3) (inferred from FTIR). The most closely related minerals are pargasite, magnesio-hastingsite, chromio-pargasite and Mn^{3+}-rich pargasite. It was named vanadio-pargasite as vanadium-bearing analogue of pargasite, according to classification of the amphibole supergroup (Hawthorne et al. 2012). The holotype is deposited in the Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow, Russia. **D.B.**

Reference cited

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WILANCOOKITE*

F. Hatert, S. Philippo, L. Ottolini, F. Dal Bo, R. Scholz, M.L.S.C. Chaves, H. Yang, R.T. Downs, and L.A.D. Menezes Filho (2017) Wilancookite, (Ba,K,Na)$_8$(Ba,Li,□)$_6$Be$_{24}$P$_{24}$O$_{96}$·32H$_2$O, a new beryllophosphate with a zeolite framework. European Journal of Mineralogy, 29(5), 923–930.

Wilancookite (IMA 2015-034), ideally (Ba,K,Na)$_8$(Ba,Li,□)$_6$Be$_{24}$P$_{24}$ O$_{96}$·32H$_2$O, cubic, is a new mineral species from the Lavra Ponte do Piauí complex granitic pegmatite, Itinga, 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, cassiterite, elbaite, and quartz. The secondary phosphate association contains fluorapatite, childrenite, eosphorite, zanazziite, greifenstenite, guimarãesite, ushkovite, saléeite, and moraesite. Wilancookite forms tiny dodecahedral {110} crystals, deposited on moraesite 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 either long- or 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 pahasapaite. The density could not be measured due to small grain size; D_{calc} = 3.05 g/cm^3. Wilancookite is isotropic, colorless, non-pleochroic, with n = 1.560(2) (λ = 590 nm). The Raman spectrum is characterized by peaks at 430 (Be–O), 580 (v_4 PO$_4$), 1000 (v_1 PO$_4$), 1050 (v_3 PO$_4$), 1600 (v_2 H$_2$O), 3430 and 3680 (v_3 H$_2$O) cm^{-1}. The average of an unreported number electron probe WDS analyses is [wt% (range)]: P$_2$O$_5$ 36.19 (33.39–37.29), SiO$_2$ 0.04 (0.01–0.07), Al$_2$O$_3$ 0.41 (0.27–0.61), BaO 34.65 (34.07–35.01), Na$_2$O 0.09 (0.06–0.13), K$_2$O 0.32 (0.26–0.43), BeO (SIMS) 12.86, Li$_2$O (SIMS) 0.50, H$_2$O (by crystal structure) 12.31, total 97.37. The empirical formula (Ba$_{7.54}$K$_{0.32}$Na$_{0.14}$)$_{Σ8.00}$ (Ba$_{3.04}$Li$_{1.57}$□$_{1.39}$)$_{Σ6.00}$ Be$_{24.08}$(P$_{23.88}$Al$_{0.38}$Si$_{0.03}$)$_{Σ24.29}$O$_{96}$·32H$_2$O based on 96 O pfu. The strongest lines in the X-ray powder-diffraction pattern [d Å (*I*%; *hkl*)] are: 6.90 (60; 200), 5.54 (80; 211), 3.630 (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) Å, V = 2504 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*23, with a = 3.5398(2) Å, V = 2482.21 Å^3, Z = 2. The crystal structure of wilancookite, refined to R_1 = 4.38% for 761 unique observed reflections with F_o > 4σ(F_o) and 4.58% for all 805 reflections, is a beryllophosphate framework similar to that occurring in pahasapaite, and is based on zeolite-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 cotypes 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.**

PYROCHLORE SUPERGROUP MINERALS: FLUORCALCIOPYROCHLORE*, HYDROXYCALCIOMICROLITE*, HYDROXYFERROROMÉITE*, HYDROXYKENOELSMOREITE*, HYDROXYNATROPYROCHLORE*, OXYNATROMICROLITE* AND NEW DATA ON HYDROKENOELSMOREITE-3C AND HYDROKENOELSMOREITE-6R

L. Guowu, Y. Guangming , L. Fude, X. Ming, G. Xiangkun, P. Baoming, and J. de Fourestier (2016) Fluorcalciopyrochlore, a new mineral species from Bayan Obo, Inner Mongolia, P.R. China. Canadian Mineralogist, 54(5), 1285–1291.

M.B. Andrade, H. Yang, D. Atencio, R.T. Downs, N.V. Chukanov, M. H. Lemée-Cailleau, A.I.C. Persiano, A.E. Goeta, and J. Ellena (2017) Hydroxycalciomicrolite, Ca$_{1.5}$Ta$_2$O$_6$(OH), a new member of the microlite group from Volta Grande pegmatite, Nazareno, Minas Gerais, Brazil. Mineralogical Magazine, 81(3), 555–564.

S.J. Mills, A.G. Christy, M.S. Rumsey, J. Spratt, E. Bittarello, G. Favreau, M.E. Ciriotti, and C. Berbain (2017) Hydroxyferroroméite, a new secondary weathering mineral from Oms, France. European Journal of Mineralogy, 29(2), 307–314.

S.J. Mills, A.G. Christy, A.R. Kampf, W.D. Birch, and A. Kasatkin (2017) Hydroxykenoelsmoreite, the first new mineral from the Republic of Burundi. European Journal of Mineralogy, 29(3), 491–497.

G.Yu. Ivanyuk, V.N. Yakovenchuk, T.L. Panikorovskii, N. Konoplyova, Ya.A. Pakhomovsky, A.V. Bazai, V.N. Bocharov, and S.V. Krivovichev. (2018) Hydroxynatropyrochlore, (Na,Ca,Ce)$_2$Nb$_2$O$_6$(OH), a new member of the pyrochlore group from the Kovdor phoscoritecarbonatite pipe (Kola Peninsula, Russia). Mineralogical Magazine, doi.org/10.1180/minmag.2017.081.102.

F. Guang, G. Xiangkun, L. Guowu, Yu. Apeng, and S. Ganfu (2017) Oxynatromicrolite, (Na,Ca,U)$_2$Ta$_2$O$_6$(O,F), a new member of the pyrochlore supergroup from Guanpo, Henan Province, China. Mineralogical Magazine, 81(4), 743–751.

S.J. Mills, A.G. Christy, M.S. Rumsey, and J. Spratt (2016) The crystal chemistry of elsmoreite from the Hemerdon (Drakelands) mine, UK: hydrokenoelsmoreite-3C and hydrokenoelsmoreite-6R. Mineralogical Magazine, 80(7), 1195–1203.

Six new pyrochlore-supergroup minerals were recently described. The general formula of the pyrochlore supergroup is $A_{2–m}B_2X_{6–w}Y_{1–n}$ (m = 0–1.7, w = 0–0.7, n = 0–1.0) where A represents large [8]-coordinated cations (Na, Ca, Ag, Mn, Sr, Ba, Fe^{2+}, Pb, Sn^{2+}, Sb^{3+}, Bi^{3+}, Y, REE, Sc, U, Th), a vacancy (□) or H$_2$O. The A atoms occupy cavities in the framework of edge-sharing BX_6 octahedra where B is mainly Ta, Nb, Ti, Sb^{5+}, W, or less

commonly V^{5+}, 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_2O, 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, Sb^{5+}, or W in the B site defines the group name within the supergroup (microlite, pyrochlore, betafite, roméite, or elsmoreite, 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_2O or $\square$] at the Y site. The second prefix refers to the dominant cation of the dominant valence [or H_2O or $\square$] 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 $Fd\bar{3}m$, however lower symmetry in cubic system is known and several different non-cubic pyrochlore polytypes exist; the most common of these is $3R$ with the space group $R\bar{3}m$. Descent in symmetry splits the A, B, and X sites in the structure.

Fluorcalciopyrochlore* (IMA 2013-055), $(Ca,Na)_2Nb_2O_6F$, cubic, was found in the dolomitic carbonatites of the Bayan Obo (the world's largest REE and a 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 fluorcalciopyrochlore were mentioned in the different and associations but mostly in carbonatites (Ohnenstetter and Piantone 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. Fluorcalciopyrochlore was listed as a possible new species by Christy and Atencio (2013). Fluorcalciopyrochlore 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 carbonatite and REE-, F-rich postmagmatic hydrothermal solutions. Other associated minerals are aegirine, riebeckite, diopside, fluorite, baryte, phlogopite, britholite-(Ce), bastnäsite-(Ce), zircon, magnetite, pyrite, fersmite, columbite-(Fe), monazite-(Ce), rutile, and others. Fluorcalciopyrochlore 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 microindentation hardness VHN = 424 kg/mm^2 (load not specified). The Mohs hardness is 5. The density was not measured; D_{calc} = 4.34 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_{calc} = 2.06. In reflected light it is gray. The reflectance values for COM wavelengths (R %, nm) are: 19.09, 470; 19.49, 546; 19.71, 589; 20.03, 650. The IR spectrum obtained in reflection mode on a single crystal shows bands (cm^{-1}) a 1266 (Ca–O polyhedron vibrations), 1135 and 914 (Nb–O octahedron vibrations). No absorption attributed to OH^- or H_2O was observed. The average of 10 electron probe WDS analyses on 5 grains [wt% (range)] is: Na_2O 6.30 (5.40–6.86), CaO 17.59 (17.16–18.26), FeO 0.10 (0–0.20), SrO 0.85 (0.54–1.11), PbO 0.24 (0.15–0.36), Ce_2O_3 2.51 (1.69–4.07), La_2O_3 0.50 (0.36–0.64), Nd_2O_3 0.57 (0.26–0.87), Y_2O_3 0.42 (0.28–0.66), TiO_2 6.31 (5.47–7.95), UO_2 0.26 (0–0.43), Nb_2O_5 61.36 (57.71–65.21), F 4.76 (4.54–5.17), ThO_2 0.76 (0.33–1.08), ZrO_2 0.51 (0–1.14), SnO_2 0.30 (0.24–0.47), –O=F_2 2.00, total 101.44. The empirical formula based on 7 anions pfu is $(Ca_{1.14}Na_{0.74}Ce_{0.06}Sr_{0.03}Th_{0.01}Fe_{0.01}Y_{0.01}La_{0.01}Nd_{0.01})_{\Sigma 2.02}(Nb_{1.68}Ti_{0.29}Zr_{0.02}Sn_{0.01})_{\Sigma 2.00}O_{6.00}(F_{0.92}O_{0.08})_{\Sigma 1.00}$. The strongest lines in the X-ray powder-diffraction pattern [d Å (I%; hkl)] are: 6.040 (9; 111), 3.017 (100; 222), 2.613 (17; 004), 1.843 (29; 044), 1.571 (15; 226).

The unit cell is a = 10.4164(9) Å, V = 1130.2 Å^3, Z = 8. The crystal structure was solved by direct methods and refined to R_1 = 0.05 for $F^2 > [4\delta(F^2)]$ in space group $Fd\bar{3}m$. The type material is deposited in the Geological Museum of China, Beijing, People's Republic of China.

Hydroxycalciomicrolite (IMA 2013-073), $(Ca_{1.5}\square_{0.5})Ta_2O_6(OH)$, cubic, was found at Nazareno, Minas Gerais, Brazil, in the Volta Grande LCT granitic pegmatites intruded into Archaean amphibolites (tholeiitic metabasalts), probably related to the Transamazonian-cycle age Ritápolis granite. The mineral was obtained from an old concentrate so no relationships with associated minerals given. Other minerals in the concentrates are albite, almandine, beryl, bityite, brookite, cassiterite, epidote, fluorite, fluorapatite, gahnite, goethite, hematite, ixiolite, "lepidolite," magnetite, microcline, monazite-(Ce), muscovite, quartz, rutile, samarskite-(Y), spodumene, tantalite-(Mn), "tourmaline," "varlamoffite," xenotime-(Y), and zircon along with other microlite-group minerals hydrokenomicrolite and fluorcalciomicrolite. The concentrate sample is from the Museu de Geociências, Universidade de São Paulo where it was labelled as "djalmaite" (donor unknown). Hydroxycalciomicrolite forms translucent yellow isolated octahedral crystals up to 1.5 mm often modified by {110}. The mineral has white streak and vitreous to resinous luster. It is brittle with conchoidal fracture and no cleavage. Mohs hardness is 5–6. Density was not measured, D_{calc} = 6.176 g/cm^3. Hydroxycalciomicrolite does not fluoresce under UV radiation, nor under electron beam. It is colorless under plane-polarized light; isotropic; n_{calc} = 2.010. The main absorption bands of the IR spectrum (cm^{-1}, w = weak) are: 3580, 3599w (O–H stretching vibrations), 856, 900, 1010, 1075w (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_2O 0.36(8), CaO 15.64(13), SnO_2 0.26(3), Nb_2O_5 2.82(30), Ta_2O_5 78.39(22), MnO 0.12(2), F 0.72(12), H_2O 1.30 (by structural data), –O=F_2 0.30, total 99.31. This gives the empirical formula $(Ca_{1.48}Na_{0.06}Mn_{0.01}\square_{0.45})_{\Sigma 2.00}(Ta_{1.88}Nb_{0.11}Sn_{0.01})_{\Sigma 2.00}O_{6.00}[(OH)_{0.76}F_{0.20}O_{0.04}]$ based on 2 cations pfu at B site. The strongest lines in the X-ray powder-diffraction pattern [d Å (I%; hkl)] are: 6.025 (100; 111), 3.010 (73; 222), 3.145 (15; 311), 1.843 (8; 440). The unit-cell parameters refined from powder-diffraction data are: a = 10.4280(8) Å, V = 1134.0 Å^3. Single-crystal X-ray diffraction data collected on a crystal of size 50 × 40 × 20 μm refined to R_1 = 0.03 for 497 unique $I \geq 2\sigma(I)$ reflections shows the space group $P4_332$, a = 10.4205(1) Å, V = 1131.53 Å^3, Z = 8. Hydroxycalciomicrolite is the first pyrochlore-supergroup mineral exhibiting $P4_332$, instead of $Fd\bar{3}m$. The presence of weak reflections violating the F-lattice 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 Museu de Geociências, 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), $(Fe^{2+}_{1.5}\square_{0.5})Sb^{5+}_2O_6(OH)$, cubic, a new Fe^{2+}-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 Correc 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, chalcopyrite, 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 dyscrasite. 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

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^{2+}, Cu^{2+} and Sb^{5+} in the sample, with no Fe^{3+}, Cu$^+$, or Sb^{3+}. The average of 9 electron probe WDS analyses is [wt% (range)]: Sb$_2$O$_5$ 67.10 (64.72–70.43), As$_2$O$_5$ 0.15 (0.07–0.28), SiO$_2$ 1.17 (0.65–2.02), Al$_2$O$_3$ 0.28 (0–1.94), 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), H$_2$O (calculated on the basis of 7 O+OH+H$_2$O) 1.72 (1.16–2.27), total 97.36. This gives the empirical formula (Fe$^{2+}_{1.07}$Cu$^{2+}_{0.50}$Zn$_{0.03}$Sr$_{0.03}$Ca$_{0.01}\square_{0.36}$)$_{\Sigma2.00}$(Sb$^{5+}_{1.88}$Si$_{0.09}$Al$_{0.02}$As$_{0.01}$)$_{\Sigma2.00}$O$_6$[(OH)$_{0.86}$O$_{0.14}$]$_{\Sigma2.00}$ based on 7 (O+OH) pfu. The strongest lines in the X-ray powder-diffraction pattern [d Å (I%; hkl)] are: 2.963 (100; 222), 5.920 (65; 111), 3.089 (63; 311), 1.815 (63; 440), 1.548 (43; 622), and 1.733 (25; 531). The unit-cell parameters refined from powder-diffraction data are: $a = 10.25(3)$ Å, $V = 1077$ Å^3, and $Z = 8$, space group $Fd\bar{3}m$. Although a single-crystal X-ray diffraction data was not obtained, the high symmetry, location of atoms on special positions allow to propose a model, based on bond-valence theory, for incorporation of the small Fe^{2+} cation into the A site, but with displacement of A and Y species from the ideal positions confirmed by observed and calculated X-ray powder diffraction intensities. The type specimen was deposited in the collections of Museum Victoria, Melbourne, Victoria, Australia, and probe mount used for chemical analyses is deposited in the Natural History Museum, London, U.K.

Hydroxykenoelsmoreite (IMA 2016-056), ($\square_{1.67}$Pb$_{0.33}$Na$_{0.01}$)$_{\Sigma2}$(W$_{1.49}$Fe$_{0.51}$)$_{\Sigma2}$[O$_{4.12}$(OH)$_{1.88}$]$_{\Sigma6}$(OH), trigonal (3R polytype), is a member of the elsmoreite group found at the Masaka gold mine, Muyinga Province, Burundi. The Masaka gold field consists of a 2.5 × 15 km zone of hydrothermal quartz veins hosted in a quartzite and quarztitic conglomerate horizon. Hydroxykenoelsmoreite found in a single specimen and is associated with only goethite and galena. A mineral of similar composition was described and approved as jixianite (Liu 1979), but by current criteria remains inadequately characterized for the exact species and hence has now "questionable" status (Christy and Atencio 2013). At Masaka mine hydroxykenoelsmoreite forms rosettes up to 150 μm across of platy crystals up to 50 μm × <2 μm (generally < 20 μm). The dominant form is {001} with either {100} or {110}. Crystals are canary yellow with pale yellow streak, are transparent with vitreous luster, are brittle with an irregular fracture and have perfect cleavage on {001}. Mohs hardness is ~3 by analogy with hydroxykenoelsmoreite. Density and indices of refraction were not measured; $D_{calc} = 5.806$ g/cm^3; $n_{calc} = 2.065$. Hydroxykenoelsmoreite is non-pleochroic, optically uniaxial (–). The Raman spectrum shows bands at (cm^{-1}, s = strong, w = weak, b = broad): 2923b, 3443b (O–H stretching), 1610 very weak (H–O–H bending) showing H$_2$O being almost absent which is confirmed by bond-valence calculations, 929s (W=O stretching), 853 and 691w and 476 and 402w (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)]: Na$_2$O 0.03 (0–0.05), K$_2$O 0.03 (0–0.02), CaO 0.10 (0.03–0.18), BaO 0.03 (0–0.04), PbO 14.77 (14.42–15.71), Al$_2$O$_3$ 1.67 (1.26–1.86), Fe$_2$O$_3$ 5.99 (5.37–7.13), WO$_3$ 72.39 (71.62–73.18), H$_2$O 5.45 (calculated from charge balance and structure refinement) total 100.46. This gives the empirical formula ($\square_{1.67}$Pb$_{0.32}$Ca$_{0.01}$Na$_{0.01}$K$_{<0.01}$Ba$_{<0.01}$)$_{\Sigma2}$(W$^{6+}_{1.49}$Fe$^{3+}_{0.36}$Al$_{0.16}$)$_{\Sigma2}$[O$_{4.12}$(OH)$_{1.88}$]$_{\Sigma6}$(OH) based on 7 O+OH pfu. The directly corresponded end-member composition would be $\square_2$W$_2$O$_6$(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 $\square_2$W$_2$[O$_5$(OH)](OH) or ($\square_{1.5}$Pb$_{0.5}$)$_2$W$_2$O$_6$(OH) with the first one dominant (>74% of the mineral studied) for the case. The strongest

lines in the X-ray powder-diffraction pattern [d Å (I%; hkl)] are: 2.983 (100; 202), 3.128 (64; 11$\bar{3}$), 1.8249 (57; 208,202), 5.99 (51; 101), 1.5579 (47; 22$\bar{6}$), 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, $V = 827$ Å^3. Single-crystal X-ray diffraction data collected at 100 K refined to $R_1 = 0.1388$ for 198 unique $I{\geq}4\sigma(I)$ reflections shows hydroxykenoelsmoreite is trigonal, space group $R\bar{3}$, $a = 7.2855(10)$, $c = 17.858(4)$ Å, $V = 820.9$ Å^3, $Z = 6$. The refined structure corresponds to a charge-balanced formula ($\square_{1.21}$Pb$_{0.79}$)$_{\Sigma2}$(W$_{1.56}$Fe$_{0.44}$)$_{\Sigma2}$[O$_{5.25}$(OH)$_{0.75}$]$_{\Sigma6}$(OH). The significant difference from EMPA data is explained by variable compositions in zoned crystals. Increasing Pb^{2+} 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 $R\bar{3}m$. Descent in symmetry splits the A, B, and X sites making structural formula ($A1$)$_3$($A2$)$_1$($B1$)$_3$($B2$)$_1$($X1$)$_6$($X2$)$_6$Y$_2$. For the hydroxykenoelsmoreite-3R, unlike hydrokenomicrolite-3R (Atencio, 2016), the symmetry is further lowered to $R\bar{3}$, 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^{3+} onto one of two B sites. Type specimen is type specimen was deposited in the Museum Victoria, Melbourne, Victoria, Australia.

Hydroxynatropyrochlore (IMA 2017-074), (Na,Ca,Ce)$_2$Nb$_2$O$_6$(OH), cubic, was described from Kovdor massif, Kola Peninsula, Russia. The pyrochlore-supergroup minerals are abundant in the Kovdor phoscorite-carbonatite pipe with the economic-level concentration in its axial zone. About one quarter of pyrochlore-supergroup minerals in Kovdor 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 Kovdor previously as "hatchettolite." Hydroxynatropyrochlore was noted before in Khibiny, Sebl'yavr, and other alkaline and alkaline–ultrabasic massifs (Yakovenchuk et al. 2005; Subbotin and Subbotina 2000), but it has not been fully characterized. Within the Kovdor 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 phlogopite, accessory baddeleyite, baryte, barytocalcite, chalcopyrite, chamosite–clinochlore, galena, gladiusite, juonniite, ilmenite, magnesite, pyrite, pyrrhotite, quintinite, spinel, strontianite, valleriite, and zirconolite. Hydroxynatropyrochlore is pale-brown, with an adamantine to greasy luster and a white streak. It is brittle with distinct cleavage on {111} and conchoidal fracture. Mohs hardness is ~5. $D_{meas} = 4.60(5)$; $D_{calc} = 4.77$ g/cm^3 (difference assigned to admixture of hydroxykenopyrochlore). No fluorescence in UV was observed. In transmitted light, the mineral is light brown, isotropic, $n = 2.10(5)$ ($\lambda = 589$ nm). The mineral slowly dissolves in hot HCl and this process is activated by its metamictization due to the high contents of U and Th. The Raman spectrum of hydroxynatropyrochlore shows the bands (cm^{-1}, sh = shoulder) at: 3540, 3460, 3250 (O–H stretching), 810, 624, 545sh (stretching vibrations in BO$_6$ octahedra), 265 (bending vibrations in BO$_6$ octahedra), 170, 128sh, 94, 75sh (lattice modes) with no characteristic bands of the H$_2$O vibrations. The average of unspecified number of electron microprobe WDS analysis [wt% (standard deviation)] is: Na$_2$O 7.97 (0.09), CaO 10.38 (0.47), TiO$_2$ 4.71 (1.24), FeO 0.42 (0.59), Nb$_2$O$_5$ 56.44 (0.40), Ce$_2$O$_3$ 3.56 (0.77), Ta$_2$O$_5$ 4.73 (3.90), ThO$_2$ 5.73 (1.51), UO$_2$ 3.66 (0.25) F 0.05 (0.06), –O=F$_2$ 0.02, total 97.63. The water content was not determined due to the intimate intergrowth with U–Ta-rich water-bearing hydroxykenopyrochlore and estimated as 2.37 wt% by difference considering IR data. The empirical formula based on Nb+Ta+Ti = 2 apfu is (Na$_{1.02}$Ca$_{0.73}$Ce$_{0.09}$Th$_{0.09}$U$_{0.05}$Fe$^{2+}_{0.02}$)$_{\Sigma2.00}$(Nb$_{1.68}$Ti$_{0.23}$Ta$_{0.09}$)$_{\Sigma2.00}$O$_{6.03}$(OH$_{1.04}$F$_{0.01}$)$_{\Sigma1.05}$. The strongest X-ray powder

diffraction lines [d Å (I%; 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 hydroxynatropyrochlore refined to R_1 = 0.026 for 80 independent $F_o > 4\sigma(F_o)$ reflections shows the mineral is cubic, space group $Fd\overline{3}m$, 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), $(Na,Ca,U)_2Ta_2O_6O$, was found at Guanpo (Lushi county, Henan Province, China) in the No. 309 rare-metal granitic pegmatite vein in association with quartz, albite, potassium feldspar, muscovite, kaolinite, tantalite-Mn, stibiotantalite, pollucite, spodumene, montebrasite, Hf-rich zircon, a red tourmaline, polylithionite, trilithionite, and luanshiweiite-$2M_1$. The new mineral is believed to have crystallized directly and primarily from a highly evolved acid magma or transitional magmatic-hydrothermal fluids enriched in volatile, flux, and lithophile elements. Oxynatromicrolite can be replaced secondarily by a more hydrated phase. Oxynatromicrolite crystals (0.05–0.20 mm) are mostly octahedral but also form rhombic dodecahedra, cubes, or their combinations. It is strongly metamict due to radiation damage. Crystals are brown or yellowish brown with ale yellowish brown streak, are opaque (translucent on thin edges) with greasy-to-waxy luster, are brittle, have conchoidal fracture and show no parting or cleavage. Mohs hardness is ~5. D_{meas} = 6.580 and D_{calc} = 6.506 g/cm³. Recrystallized oxynatromicrolite is isotropic; the unheated mineral has n = 1.999. Reflectance values were measured between 400 and 700 nm in 20 nm intervals. The values for COM wavelengths [R % (λ nm)] in air are: 11.88 (470); 11.42 (546); 11.05 (589); 10.69 (650). Differential thermal analysis shows oxynatromicrolite loses adsorbed water at 150 °C and recrystallizes at 505 °C. IR spectroscopy shows no hydroxyl-stretching bands (3500–3700 cm⁻¹) but stretches of molecular H_2O are observed as a broad band at 3310 cm⁻¹ and H_2O bending—at 1640 cm⁻¹. Similar conclusions are drawn from the Raman spectrum. The average of 18 electron probe WDS analyses on 8 crystals [wt% (range)] is: Na_2O 5.41 (4.42–5.89), CaO 4.56 (2.49–5.26), UO_2 14.60 (12.38–18.03), La_2O_3 0.16 (0.03–0.28), Ce_2O_3 0.11 (0.03–0.30), Nd_2O_3 0.13 (0.13–0.22), PbO 0.62 (0.47–0.95), Ta_2O_5 61.52 (59.46–65.70), Nb_2O_5 8.21 (7.22–10.13), Sb_2O_5 0.23 (0.08–0.66), TiO_2 0.05 (0.01–0.08), SiO_2 0.56 (0.52–0.63), SnO_2 0.29 (0.07–00.66), F 1.04 (0.52–1.31), H_2O 1.50 (calculated to correspond to 0.47 H_2O pfu), –O=F_2 0.44, total 98.53. This gives the empirical formula $(Na_{0.99}Ca_{0.46}U_{0.31}Pb_{0.02}La_{0.01}(H_2O)_{0.21})_{\Sigma2.00}$ $(Ta_{1.58}Nb_{0.35}Si_{0.05}Sn_{0.01}Sb_{0.01})_{\Sigma2.00}O_6(O_{0.43}F_{0.31}(H_2O)_{0.26})_{\Sigma1.00}$ based on 2 apfu at the B site. A single-crystal X-ray diffraction experiment was not performed. When heated to 1000 °C for 4 h in N_2, the mineral recrystallizes in the cubic system. The type material is deposited in the Geological Museum of China, Beijing, China.

New data: Hydrokenoelsmoreite-3C and hydrokenoelsmoreite-6R. The study of specimens BM 2006,118 and BM 2008,56 (Natural History Museum, London) labelled as "ferritungstite" from the Hemerdon mine (now known as Drakelands mine), ~10 km E of Plymouth, Devon, U.K. (50°24′26″N, 4°0′35″W) has shown them to be two different polytypes (3C and 6R) of hydrokenoelsmoreite (HKE) with simplified formula $(\square,Na,H_2O)_2(W,Fe^{3+},Al)_2(O,OH)_6 \cdot H_2O$. The upper part of the greisen type W–Sn deposit of the Hemerdon mine is heavily altered and has produced a number of secondary minerals, i.e., scorodite, pharmacosiderite, and minor amounts of the tungstates russellite and "elsmoreite" (often labelled as "ferri-" or "alumotungstite"). The platy habit of these specimens, despite their cubic (3C) or pseudocubic (6R) symmetry, suggests those are pseudomorphs after a non-cubic precursor phase (probably phyllotungstite or pittongite, which are considered as polymorphs of hydrokenoelsmoreite). The averages of 15/7 electron probe WDS analyses of HKE-3C / *HKE-6R* [wt% (range)] are: WO_3 77.49 (76.48–79.37)/ *70.15 (68.08–72.89)*, As_2O_5 0.15 (0–0.18)/*0.12 (0.08–0.18)*, TiO_2 n.d./ *0.06 (0–0.18)*, Fe_2O_3 5.83 (5.27–6.33)/*8.17 (6.89–8.75)*, Al_2O_3 2.41 (2.15–2.85)/*0.97 (0.36–1.74)*, CaO 0.49 (0.42–0.57)/*0.58 (0.27–0.84)*, BaO 0.10 (0.06–0.16)/*0.09 (0.06–0.15)*, K_2O 0.22 (0.17–0.25)/*0.31 (0.19–0.37)*, Na_2O 1.97 (1.24–2.67)/*1.57 (1.25–1.89)*, H_2O (by structure) 7.40 (7.14–7.60)/*8.82 (8.25–9.54)*, total 96.08/*90.85* (systematically low totals are due to dehydration under electron beam). The empirical formulas are $[\square_{1.46}Na_{0.28}(H_2O)_{0.20}Ca_{0.04}K_{0.02}]_{\Sigma2.00}(W_{1.47}Fe^{3+}_{0.32}Al_{0.21}As^{5+}_{0.01})_{\Sigma2.00}$ $[O_{4.79}(OH)_{1.21}]_{\Sigma6.00} \cdot (H_2O)$ and $[\square_{1.06}(H_2O)_{0.63}Na_{0.24}Ca_{0.04}K_{0.03}]_{\Sigma2.00}(W_{1.42}$ $Fe^{3+}_{0.49}Al_{0.08}As^{5+}_{0.01})_{\Sigma2.00}[O_{4.65}(OH)_{1.35}]_{\Sigma6.00} \cdot (H_2O)$. Main substitutions can be expressed, as $(A^0_{2-x}Na_x)(W_{2-y}B_{3+y})[O_{6-z}(OH)_z] \cdot H_2O$, where x = 0.17–0.29, y = 0.49–0.63, and z = 3y – x. The structures of HKE-3C and HKE-6R were solved by direct methods respectively in space group $Fd\overline{3}m$ [R_1 = 0.0130 for 121 $F_o > 4\sigma(F)$ reflections], a = 10.3065(3) Å, Z = 16 and in space group $R\overline{3}$ [R_1 = 0.0196 for 596 $F_o > 4\sigma(F)$ reflections], a = 7.2882(2) Å, c = 35.7056(14) Å, Z = 9. The periodicity in 6R relative to the unique threefold axis of the 3C cubic structure is doubled due to Na and ($\square$, H_2O) ordering in the A site; no long-range ordering is observed between W and Fe/Al in the B site. In space group $R\overline{3}$, there is considerable splitting of the sites of the cubic pyrochlore, the 6R structure can be represented as $(A1)_3$ $(A2)_2(A3)_3(B1)_1(B2)_1(B3)_6(X1)_6(X2)_6(X3)_6(X4)_6(Y1)_2(Y2)_2$. **D.B., O.C.G.**

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