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New Mineral Names*,†

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This New Mineral Names has entries for nine new minerals, including andychristyite, crimsonite, ferro-ferri-hornblende, kummerite, kuratite, oscarkempffite, oxo-mangani-leakeite, pauladamsite, and penberthycroftite.

ANDYCHRISTYITE*

A.R. Kampf, M.A. Cooper, S.J. Mills, R.M. Housley and G.R. Rossman (2016) Lead-tellurium oxysalts from Otto Mountain near Baker, California, USA: XII. Andychristyite, $PbCu^{2+}Te^{6+}O_5(H_2O)$, a new mineral with *hcp* stair-step layers. Mineralogical Magazine, 80(6), 1055–1065.

Andychristyite (IMA 2015-024), ideally $PbCu^{2+}Te^{6+}O_5(H_2O)$, is a new mineral found on the small dump outside the entrance to the Aga mine Otto Mountain near Baker, San Bernardino County, California, U.S.A. The new mineral was found as a few crystals in a small vug in quartz in association with timroseite. Andychristyite is a secondary oxidation-zone mineral presumed to have formed by oxidation of primary sulfides and tellurides during or following brecciation of quartz veins. It occurs as tablets flattened on {001}, up to ~50 μm in size, in sub-parallel aggregates. Crystals are bluish-green with very pale bluish-green streak, are transparent with adamantine luster, are brittle with irregular fracture, show perfect cleavage on {001}, and no twinning. Mohs hardness was not measured, but is estimated to be 2–3. The density was not measured; D_{calc} = 6.304 g/cm³. Andychristyite does not fluoresce under UV light. It decomposes rapidly in dilute HCl at room temperature. The mineral is optically biaxial with undetermined sign, large $2V$, and moderate very pale blue-green to medium blue-green pleochroism. One of the optical axis is oriented almost perpendicular to {001}. Neither refractive indexes nor the reflectance data were obtained. The Raman spectrum shows dominant bands at 708, 665, 625 cm^{-1} (typically υ_1 components of tellurates) and 3306 cm^{-1} (OH stretching). The absence of peaks in the 2500–1200 cm^{-1} region, specifically H_2O bending mode around 1600 cm^{-1}, is assumed to be either too weak to be observed or is not Raman active in andychristyite. The average of 5 electron probe WDS analyses is [wt% (range)]: PbO 43.21 (42.92–43.80), CuO 15.38 (14.98–15.64), TeO_3 35.29 (34.95–35.64), H_2O (calc.) 3.49, total 97.37. H_2O was calculated on the basis of 2 (Cu+Te) and 6 O apfu. This gives the empirical formula $Pb_{0.98}Cu^{2+}_{0.98}Te^{6+}_{1.02}O_6H_{1.96}$ based on 6 O apfu. The strongest lines in the X-ray powder-diffraction pattern [d Å (I%; hkl)] are: 6.71 (16; 010), 4.76 (17; 110), 3.274 (100; 120,102,012), 2.641 (27; 102,211,112), 2.434 (23; 200,$\bar{1}$20,003,0$\bar{2}$2), 1.6736 (17; 040,241,1$\bar{3}$2,142), 1.5882 (21; multiple). The unit-cell parameters refined from powder-diffraction data are: a = 5.323(2), b = 7.099(2), c = 7.521(2) Å, α = 83.611(6), β = 76.262(7), γ = 70.669(8)°, and V = 260.34 Å³. Single-crystal X-ray diffraction data collected on a crystal of size 15 × 10 × 5 μm refined to R_1 = 0.0165 for 1511 unique reflections with $I \geq 4\sigma(I)$ shows andychristyite is triclinic, space group $P\bar{1}$, with unit-cell dimensions a = 5.322(3), b = 7.098(4), c = 7.511(4) Å, α = 83.486(7), β = 76.279(5), γ = 70.742(5)°, V = 260.0 Å³, and Z = 2. The structure consists of stair-step-like *hcp* layers of $Te^{6+}O_6$ and $Cu^{2+}O_6$ octahedra parallel to {001} and linked in the [001] direction to interlayer Pb atoms. A split H_2O site in the interlayer region coordinates to Pb atoms and forms hydrogen bonds to O atoms. Andychristyite is named after Andrew (Andy) Gregor Christy (b. 1963), a Welsh-Australian mineralogist, petrologist, geochemist and solid-state chemist, for his contributions to mineralogy and, in particular, for the descriptions of new minerals. The holotype specimen is deposited in the Natural History Museum of Los Angeles County, CA, U.S.A. **O.C.G.**

CRIMSONITE*

A.R. Kampf, P.M. Adams, S.J. Mills and B.P. Nash (2016) Crimsonite, $PbFe^{3+}_2(PO_4)_2(OH)_2$, the phosphate analogue of carminite from the Silver Coin mine, Valmy, Nevada, USA. Mineralogical Magazine, 80(6), 925–935.

Crimsonite, (IMA 2014-095), ideally $PbFe^{3+}_2(PO_4)_2(OH)_2$, the phosphate analogue of carminite, is a new mineral from the Silver Coin mine, Valmy, Iron Point district, Humboldt County, Nevada, U.S.A. (40°55′44″N, 117°19′26″W), where it occurs as a low-temperature secondary mineral growing on plumbogummite that, in turn, is coating quartz. Crimsonite is found associated with fluorwavellite, goethite, hematite, hentschelite, plumbogummite, and variscite on quartz. Crimsonite occurs in subparallel aggregates of blades or plates up to 0.1 mm in maximum dimension. The blades are flattened on {100}, somewhat elongated on [010] and exhibit the forms {100}, {101}, and {011}. No twinning was observed. Crystals are transparent, with an adamantine luster. The color is deep red with a slight purplish cast and it has a light purplish-orange streak. Mohs hardness is 3½ by analogy with carminite. Tenacity is brittle, with irregular to splintery fracture and an imperfect cleavage (likely on {101}). The density was not measured; D_{calc} = 5.180 g/cm³. Crimsonite is insoluble at room temperature in concentrated HCl and 70% HNO_3. It is optically biaxial (+), $2V$ ≈ 85.5(5)°, (λ not reported). The birefringence measured using a Berek compensator is 0.011. The calculated refractive indexes are α = 2.021, β = 2.026, and γ = 2.032. The optical orientation is X = **b**; Y = **a**; Z = **c** and the pleochroism is X light orange, Y light yellow, Z red brown; $Y < X < Z$. The average of 22 points (on 9 crystals) electron probe WDS analyses [wt% (range)] is: PbO 40.69 (37.56–44.56), CaO 0.60 (0.21–0.83), ZnO 0.72 (0.51–1.01), CuO 0.13 (0–0.27), Fe_2O_3 23.36 (20.29–25.37), Al_2O_3 0.34 (0.22–0.76), V_2O_5 0.70 (0.21–1.20), As_2O_5 12.05 (8.31–17.03), P_2O_5 16.03 (11.56–19.09), SO_3 0.33 (0.17–0.65), H_2O (based on struc-

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

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ture) 3.64, total 98.59. The empirical formula (based on 10 O apfu) is $(Pb_{1.06}Ca_{0.06})_{\Sigma 1.12}(Fe_{1.71}Zn_{0.05}Al_{0.04}Cu_{0.01})_{\Sigma 1.81}(P_{1.32}As_{0.61}V_{0.05}S_{0.02})_{\Sigma 2.00}O_8[(OH)_{1.64}(H_2O)_{0.36}]_{\Sigma 2.00}$. The eight strongest lines in the X-ray powder diffraction pattern are [*d* Å (*I*%; *hkl*)]: 5.86 (42; 111), 4.53 (45; 112), 3.485 (64; 113); 3.190 (100; 022), 3.026 (40; 004), 2.902 (54; 511), 2.502 (77; 422), 2.268 (54; 224). The unit-cell parameters refined from the powder data are: a = 16.2573(16), b = 7.4692(7), c = 12.1406(12) Å, V = 1474.2 Å^3. After a difficult selection, due to intimate intergrowth, a small crystal (0.040 × 0.030 × 0.010 mm^3) was used for collecting X-ray diffraction intensity data. The single-crystal unit-cell parameters are: a = 16.2535(13), b = 7.4724(4), c = 12.1533(9) Å, V = 1476.04(17) Å^3, orthorhombic, space group *Cccm*, Z = 8. The crystal structure of crimsonite was refined to R_1 = 0.0357 for 740 observed [$F_o > 4\sigma F_o$] reflections. It contains FeO_6 octahedra that share edges to form dimers, which are then linked to other dimers by corner sharing to form chains along [010]. These chains are linked by PO_4 tetrahedra yielding sheets parallel to {001}. The sheets are linked to one another via bonds to eightfold-coordinated Pb^{2+} atoms with non-stereoactive $6s^2$ lone-electron pairs. The mineral is named based upon the mineral's deep red (crimson) color and the fact that it is the phosphate analogue of carminite, a mineral with a very similar deep red color and whose name is also based upon its color (carmine). The holotype specimen is housed in the Mineral Sciences Department, Natural History Museum of Los Angeles County, CA, U.S.A., catalogue number 65558. **F.C.**

FERRO-FERRI-HORNBLENDE*

R. Oberti, M. Boiocchi, F.C. Hawthorne, N.A. Ball, F. Cámara, R. Pagano and A. Pagano (2016) Ferro-ferri-hornblende from the Traversella mine (Ivrea, Italy): occurrence, mineral description and crystal-chemistry. Mineralogical Magazine, 80(7), 1233–1242.

Ferro-ferri-hornblende (IMA 2015-054), a new member of the amphibole supergroup with end-member formula $^{A}\square^{B}Ca_2{}^{C}(Fe^{2+}_4Fe^{3+}){}^{T}(Si_7Al)O_{22}{}^{W}(OH)_2$, was discovered in a specimen from the historical collection of Leandro De Magistris, which was collected at the skarns of the Traversella iron mine (exploited since the XI century up to 1971), Val Chiusella, Ivrea, Piemonte, Italy. This specimen considered as holotype (code 1260 in the amphibole database of the CNR-IGG Pavia) and is currently deposited in the Museo di Mineralogia, Dipartimento di Scienze della Terra e dell'Ambiente, Università di Pavia. Another examined specimen (M/U15285 from the Museo Regionale di Scienze Naturali di Torino, Sezione di Mineralogia, Petrografia e Geologia, Torino) was originally catalogued as "speziaite," a mineral first described in 1914 by L. Colomba and later discredited (under its incorrect spelling "speziatite") and redefined as hornblende in 1978 by B.E. Leake. The examination of type specimen of "speziaite" (confirmed the presence of ferro-ferri-hornblende hence former "speziaite" is replaced definitively by ferro-ferri-hornblende, and the specimen is considered as cotype. Another cotype specimen (code 1258 in the amphibole database of the CNR-IGG Pavia) belongs to Pagano's collection. The holotype specimen consists of aggregates of ferro-ferri-hornblende crystals embedded in a matrix of fibrous to acicular tremolite with minor quartz and calcite. It contains a wide range of amphibole compositions from tremolite/actinolite to magnesio-hastingsite. Ferro-ferri-hornblende forms acicular or lamellar dark greenish transparent non-fluorescent crystals with a vitreous luster. It is brittle and shows perfect cleavage on {110}. The measured density of amphibole in cotype (Colomba 1914) is 3.362 g/cm^3; D_{calc} = 3.35 g/cm^3. In transmitted light, ferro-ferri-hornblende is pleochroic, X = medium gold/brown (weakest), Y = dark brown/black (strongest), Z = dark gray (medium). The mineral is optically biaxial (–), α = 1.697(2), β = 1.722(5), γ = 1.726(5) (λ = 590 nm), $2V_{meas}$ = 35.7°, $2V_{calc}$ = 43°. The optical orientation was determined by transferring the crystal from the spindle stage to a single-crystal diffractometer and is: $X \wedge \mathbf{a}$ = 26.2° (β obtuse), $Y // \mathbf{b}$, $Z \wedge \mathbf{c}$ = 11.5° (β acute). The averages of 10 electron probe WDS analyses of the holotype (1260) and a cotype (1258) [wt% (range) for 1260/**wt% (range) for 1258**] is: SiO_2 46.63 (44.59–49.09)/**42.87 (41.0–45.03)**, TiO_2 0.05 (0.03–0.08)/**0.14 (0.11–0.21)**, Al_2O_3 4.67 (2.88–5.74)/**9.14 (8.56–10.17)**, FeO_{total} 28.08 (26.50–29.06)/**28.54 (27.94–28.99)** [FeO 24.65, Fe_2O_3 3.81/**FeO 25.21, Fe_2O_3 3.70** by structure refinement], MnO 0.48 (0.40–0.58)/**0.40 (0.37–0.46)**, MgO 4.99 (4.30–6.03)/**3.53 (2.55–4.38)**, ZnO 0.03 (0–0.08)/**0.02 (0–0.05)**, CaO 11.59 (11.40–11.73)/**11.26 (not given)**, Na_2O 0.56 (0.33–0.70)/**1.07 (1.93–1.21)**, K_2O 0.63 (0.34–0.96)/**1.13 (1.05–1.27)**, F 0.02 (0–0.1)/**0.02 (0–0.05)**, Cl 0.38 (0.12–0.64)/**0.38 (0.35–0.46)**, –O=(F,Cl) 0.09/**0.10**, H_2O 1.82/**1.81** [calculated based on 24 (O,OH,F,Cl) with (OH+F+Cl) = 2 apfu]. The empirical formulas considering single-crystal structure refinement are $^{A}(Na_{0.10}K_{0.13})_{\Sigma 0.23}{}^{B}(Ca_{1.93}Na_{0.07})_{\Sigma 2.00}{}^{C}(Fe^{2+}_{3.21}Mg_{1.16}Mn_{0.06}Fe^{3+}_{0.45}Al_{0.12}Ti_{0.01})_{\Sigma 5.01}{}^{T}(Si_{7.26}Al_{0.74})_{\Sigma 8.00}O_{22}{}^{W}(OH_{1.89}F_{0.01}Cl_{0.10})_{\Sigma 2.00}$/$\mathbf{^{A}(Na_{0.23}K_{0.25})_{\Sigma 0.48}{}^{B}(Ca_{1.89}Na_{0.07}Mn_{0.04})_{\Sigma 2.00}{}^{C}(Fe^{2+}_{3.30}Mg_{0.82}Fe^{3+}_{0.44}Al_{0.40}Mn_{0.02}Ti_{0.02})_{\Sigma 5.00}{}^{T}(Si_{6.72}Al_{1.28})_{\Sigma 8.00}O_{22}{}^{W}(OH_{1.89}F_{0.01}Cl_{0.10})_{\Sigma 2.00}}$. The strongest lines in the powder X-ray diffraction pattern for holotype [*d* Å (*I*%; *hkl*)] are: 8.493 (100; 110), 2.728 (69; 151), 3.151 (47; 310), 2.555 (37; $\bar{2}02$), 2.615 (32; 061), 2.359 (28; $\bar{3}51$), 3.406 (26; 131), 2.180 (25; 261). The crystal structure refined to R_{obs} = 0.025 (for $I_o > 3\sigma_I$). The unit-cell parameters for holotype are a = 9.9307(5), b = 18.2232(10), c = 5.3190(3) Å, β = 104.857(1)°, V = 930.40 Å^3, and for specimen M/U15285: a = 9.9386(6), b = 18.2207(12), c = 5.3177(3) Å, β = 104.874(7)°, V = 930.70 Å^3, Z = 2, space group *C*2/*m*. The mineral was named according to the rules for an amphibole classification and nomenclature (Hawthorne et al. 2012). **D.B.**

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KUMMERITE*

I.E. Grey, E. Keck, W.G. Mumme, A. Pring, C.M. MacRae, A.M. Glenn, C.J. Davidson, F.L. Shanks and S.J. Mills (2016) Kummerite, $Mn^{2+}Fe^{3+}Al(PO_4)_2(OH)_2 \cdot 8H_2O$, a new laueite group mineral from the Hagendorf Süd pegmatite, Bavaria, with ordering of Al and Fe^{3+}. Mineralogical Magazine, 80(7), 1243–1254.

Kummerite (IMA 2015-036), ideally $Mn^{2+}Fe^{3+}Al(PO_4)_2(OH)_2 \cdot 8H_2O$, is a new secondary phosphate mineral of the laueite group. It was discovered in a few specimens at 57 ± 2 m level of the Cornelia Mine Open Cut of the Hagendorf-Süd pegmatite, Hagendorf, Oberpfalz, Bavaria, Germany (49°39′1″N, 12°27′35″E). Kummerite occurs in small cavities in altered zwieselite closely associating with green needles of Zn- and Al-bearing beraunite, and with Al-bearing frondelite and jahnsite-(CaMnMn). Aggregates of kummerite laths are generally surrounding a core of laueite composition. The new mineral formation is related to reaction of laueite with hydrothermal Al-bearing fluids. Kummerite forms sprays or rounded aggregates up to 100–500 μm of very thin, typically deformed, amber yellow laths of a few micrometers thick. The morphology and color of kummerite is very similar to other laueite-related polymorphs and jahnsite. The mineral is translucent with a vitreous luster and white streak. It has a good cleavage on {010} and an uneven fracture. The density was not measured due to intimate intergrowths with beraunite; D_{calc} = 2.34 g/cm^3. Kummerite is weakly pleochroic in amber yellow tones. It is optically biaxial (–), α = 1.565(5), β = 1.600(5), and γ = 1.630(5) (white light), with a weak optical axes dispersion. Orientation and 2V were not determined; $2V_{calc}$ = 84°. The dominant feature in the IR spectrum is a strong broad envelope in the OH-stretching region, with peaks at 3235 and 3530 and shoulders at 2655, 2800, and 3375 cm^{-1}.

The H–O–H bending vibration of H_2O peak is at 1640 cm^{-1} and a single strong $(PO_4)^{3-}$ stretching vibration peak is resolved, at 985 cm^{-1}. Under a high vacuum the crystals of kummerite undergo severe fracturing, cracking into small grains and dehydration. The yellow color becomes bleached, leaving silvery white crystals. The average of 13 electron probe WDS analyses [wt% (range)] is: Fe_2O_3 25.1 (21.7–30.5) (Fe_2O_3 19.1 and FeO 5.3 calculated on the structure basis), MnO 5.9 (4.4–8.5), MgO 2.2 (1.5–3.5), ZnO 0.5 (0–0.9), Al_2O_3 10.7 (8.2–14.4), P_2O_5 30.2 (25.5–33.6), H_2O 32.5 (calculated on the basis of $2OH^-+8H_2O$), total 106.6. The high total is due to severe dehydration in vacuum and under the beam. The analysis normalized to 100% is (wt%:) Fe_2O_3 17.2, FeO 4.8, MnO 5.4, MgO 2.2, ZnO 0.5, Al_2O_3 9.8, P_2O_5 27.6, H_2O 32.5. The empirical formula, based on 3 metal apfu is $(Mn^{2+}_{0.37}Mg_{0.27}Zn_{0.03}Fe^{2+}_{0.33})_{\Sigma 1.00}(Fe^{3+}_{1.06}Al_{0.94})_{\Sigma 2.00}(PO_4)_{1.91}(OH)_{2.27}(H_2O)_{7.73}$. The strongest lines in the powder X-ray diffraction pattern are [*d* Å (*I*%; *hkl*)]: 9.885 (100; 010); 6.476 (20; 001); 4.942 (30; 20); 3.988 (9; $\bar{1}10$); 3.116 (18; $1\bar{2}0$); 2.873 (11; $\bar{1}21$). The powder X-ray data refined in triclinic space group $P\bar{1}$ with $a = 5.323(1)$ Å, $b = 10.660(1)$ Å, $c = 7.141(1)$ Å, $\alpha = 107.82(1)°$, $\beta = 111.65(2)°$, $\gamma = 71.76(1)°$, $V = 349.3(9)$ Å^3, $Z = 1$. The crystal structure refined to $R_1 = 0.0325$ for all 4231 reflections. The single-crystal unit-cell parameters are $a = 5.316(1)$ Å, $b = 10.620(3)$ Å, $c = 7.118(1)$ Å, $\alpha = 107.33(3)°$, $\beta = 111.22(3)°$, $\gamma = 72.22(2)°$, $V = 348.45(16)$ Å^3. Kummerite is isostructural with laueite $^{M1}Mn^{2+}\,{}^{M2}Fe^{3+}\,{}^{M3}Fe^{3+}(PO_4)_2(OH)_2{\cdot}8H_2O$, but differs in having Al and Fe^{3+} ordered into alternate octahedral sites M2 and M3 in the 7.1 Å *trans*-connected octahedral chains. The mineral is named in honor of Rudolf Kummer (1924–1982), mining director of the Cornelia mine at Hagendorf Süd from 1964–1982 who had a great knowledge of the mineral occurrences at the mine and great support for researchers and collectors that came to study and collect samples from the mine. The type specimen is deposited in the mineralogical collections of Museum Victoria, Melbourne, Victoria, Australia. **D.B.**

KURATITE*

S.-L. Hwang, P. Shen, H.-T. Chu, T.-F. Yui, M.-E. Varela and Y. Iizuka (2016) Kuratite, $Ca_4(Fe^{2+}_{10}Ti_2)O_4[Si_8Al_4O_{36}]$, the Fe^{2+}-analogue of rhönite, a new mineral from the D'Orbigny angrite meteorite. Mineralogical Magazine, 80(6), 1067–1076.

Kuratite (IMA 2013-109), $Ca_4(Fe^{2+}_{10}Ti_2)O_4[Si_8Al_4O_{36}]$, the Fe^{2+}-analogue of rhönite, is a new mineral of the sapphirine supergroup identified in D'Orbigny, a 16.5 kg angrite meteorite found in July 1979 in Argentina. Previously Fe^{2+}-dominant rhönite was mentioned or partially described in a number of terrestrial and extraterrestrial occurrences under the names rhönite, Fe-rich rhönite, Fe-Al-Ti-silicate, etc.: in melaphonolite of Puy de Saint-Sandoux, Auvergne, France (Grünhagen and Seck 1972), in the unusual fassaite-melilite-rhönite paragenesis from an alkaline basalt contaminated by Ca from coral, Saint-Leu, Réunion Island (Havette et al. 1982), in the Mesozoic basanites from Scania, Sweden (Olsson 1983), in glass from kaersutite-bearing spinel-wehrlite xenoliths from Foster Crater (Gamble and Kyle 1987), in D'Orbigny meteorite (Mittlefehldt et al. 2002; Kurat et al. 2004), in the plutonic igneous angrite NWA 4590 (Kuehner and Irving 2007), in magmatic inclusions in augite grains of the Luna 24 regolith (Treiman 2008), in tephrite glass and limburgite of basaltic rocks from the Kaiserstuhl volcanic complex, Germany (Grapes and Keller 2010), in volcanic angrite SAHARA 99555 (Jambon and Boudouma 2011). D'Orbigny meteorite consists of the following silicate phase assemblage: tabular crystals of nearly pure anorthite, euhedral to anhedral augite crystals with Mg-free and Al,Ti-bearing hedenbergite rims, euhedral to anhedral olivine crystals with Mg-rich cores (Mg ~64 mol%) and complex Ca-rich fayalite + kirschsteinite overgrowths toward the rims. Kuratite occurs in multiple phase pockets, which sit mainly at olivine-augite triple junctions. Kuratite crystals are typically euhedral to anhedral, <20 μm in size, and occur, together with whitlockite, Fe sulfide, and ulvöspinel, within a rim of olivine of Ca-rich fayalite composition (Ca ≈ 20 mol%) + kirschsteinite (Ca ≈ 40 mol%) intergrowths at the contact between Fe-sulfide spherules and Al,Ti-bearing hedenbergite filling vesicles. Whitlockite inclusions in kuratite are common. Polysynthetic $(0\bar{1}1)$ twinning is common. $D_{calc} = 3.906$ g/cm^3. Other physical properties were not obtained due to the minute size of the kuratite crystals. Optical data for Fe-rich rhönite ($X_{Mg} = 0.49$) from Puy de St.-Sandoux are $\alpha = 1.805(7)$, $\beta = 1.815(7)$, $\gamma = 1.845(7)$, $2V = 50(3)°$; $Z \wedge \mathbf{c} = 38–43°$ for Kaiserstuhl rhönite ($X_{Mg} = 0.41$); $Z \wedge \mathbf{c} = 58°$ ($X_{Mg} = 0.02$) for Luna 24 rhönite (Grapes and Keller, 2010; Grünhagen and Seck 1972; Olsson 1983; Treiman 2008). HR confocal micro-Raman spectrometry (Ar^+ laser with 514.5 nm) shows four main scattering peaks near 563–571, 697–699 (strongest), 852–856, and 986–996 cm^{-1}. The weak shoulder on the strongest peak at 720 cm^{-1} recognized in lunar rhönite was not present in kuratite. The average of 8 electron probe WDS analysis [wt% (ranges)] is: SiO_2 25.55 (25.06–26.39), TiO_2 8.7 (8.15–9.78), Al_2O_3 9.8 (8.86–10.32), Cr_2O_3 0.01 (0–0.11), Y_2O_3 (0.03 0–0.08), La_2O_3 (0.04 0–0.23), Pr_2O_3 (0.09 0–0.22), Nd_2O_3 (0.07 0–0.21), FeO 41.6 (40.98–42.01), MnO 0.11 (0.02–0.24), NiO 0.07 (0–0.19), SrO 0.05 (0–0.08), ZnO 0.04 (0–0.22), MgO 0.01 (0–0.06), CaO 11.86 (11.56–12.1), Na_2O 0.04 (0–0.13), K_2O 0 (0–0.01), P_2O_5 0.2 (0.08–0.27), F 0.01 (0–0.03), Cl 0.02 (0–0.04), SO_3 0.08 (0.05–0.13), Total 98.38. The empirical formula based on 28 cations and 40 O atoms is: $(Ca_{3.88}Na_{0.02}REE^{3+}_{0.03}Mn_{0.03}Mg_{0.01}Ni_{0.02}Zn_{0.01}Sr_{0.01})_{\Sigma 4.01}(Fe^{2+}_{9.98}Ti_{2.00})_{\Sigma 11.98}(Si_{7.80}Al_{3.52}Fe^{3+}_{0.64}P_{0.05}S_{0.02})_{\Sigma 12.03}O_{39.98}F_{0.01}Cl_{0.01}$. The strongest reflections of the TEM SAED pattern obtained in two crystals prepared by the focused ion beam (FIB) technique [*d* Å (*hkl*)] are: 2.97 $(03\bar{1})$, 2.72 $(2\bar{4}1)$, 2.58 $(4\bar{2}0)$, 2.44 $(22\bar{1})$, 2.13 $(\bar{2}51)$, 2.12 $(\bar{4}1\bar{1})$. The refined triclinic unit-cell parameters are $a = 10.513(7)$, $b = 10.887(7)$, $c = 9.004(18)$ Å, $\alpha = 105.97(13)$, $\beta = 96.00(12)$, $\gamma = 124.82(04)°$, $V = 767$ Å^3, $Z = 1$, space group $P\bar{1}$ (by analogy to rhönite). Kuratite is a member of the sapphirine group. It existence was anticipated in the paper reporting the nomenclature of the sapphirine supergroup (Grew et al. 2008) as the Fe^{2+}-analogue of rhönite. The mineral name honors Gero Kurat (1938–2009), former Head of the Mineralogical-Petrographical Department and Curator of the Meteorite Collection at the Natural History Museum in Vienna, Austria. Type material is deposited in the collections of the Naturhistorisches Museum Wien, Vienna, Austria, inventory number Section D'Orbigny C-N1172-NH Wien. **F.C.**

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OSCARKEMPFFITE*

D. Topa, W.H. Paar, E. Makovicky, C.J. Stanley and A.C. Roberts (2016) Oscarkempffite, $Ag_{10}Pb_4(Sb_{17}Bi_9)_{\Sigma 26}S_{48}$, a new Sb-Bi member of the lillianite homologous series. Mineralogical Magazine, 80(5), 809–817.

Oscarkempffite (IMA 2011-029), ideally $Ag_{10}Pb_4(Sb_{17}Bi_9)_{\Sigma 26}S_{48}$, is a new mineral found in two specimens collected in 1929–1930 from the Colorada vein, Animas mine, Chocaya Province, Department of Potosi, Bolivia (66°33′W; 21°S). The specimens were originally part of the famous Philadelphia Academy of Natural Science collection which contained a lot of historically important materials and which was sold to a mineral dealer. The specimens were provided for study by R. Lavinsky (Arkenstone). The deposit is a typical one of the vein type Ag-Sn formation of Bolivia and located in strongly altered volcanic rocks. In the vein cassiterite associated with freibergite and members of the stannite–kësterite family. Textures indicated an open space filling with very distinct banding, crustification and cockades. Oscarkempffite is associated with aramayoite, stannite, miargyrite, pyrargyrite and tetrahedrite. It forms anhedral grains up to several millimeters in size and grain aggregates up to 10 mm in size. Oscarkempffite is grayish black, opaque with metallic luster and dark gray streak. The mineral is brittle with irregular fracture and shows no cleavage, parting or twinning. Mohs hardness is 3–3½. The indentation hardness, VHN_{50}, = 200 (189–208) kg/mm². Density was not measured because of paucity of material; D_{calc} = 5.8 g/cm³. Oscarkempffite is grayish white in reflected light, has distinct pleochroism, white to dark gray. Bireflectance is weak to distinct (in oil) and no internal reflections were observed. Reflectance values were measured between 400 and 700 nm in 20 nm intervals. The values for (COM) wavelengths [R_{min}, R_{max} % (λ in nm)] in air/**oil** are: 39.93, 42.6/**24.1, 39.9** (470); 38.6, 41.7/**22.6, 38.6** (546); 38.1, 41.2/**22.1, 38.1** (589); 37.3, 40.6/**21.4, 37.3** (650). The average of 4 electron probe WDS analyses is [wt% (St.dev.)]: Cu 0.24(7), Ag 14.50(8), Pb 11.16(14), Sb 28.72(16), Bi 24.56(17), S 20.87(5), total 100.05. This gives the empirical formula $Cu_{0.24}Ag_{9.92}Pb_{4.00}Sb_{17.36}Bi_{8.64}S_{47.84}$ based on Me + S = 88 apfu. The strongest lines in the X-ray powder-diffraction pattern [*d* Å (*I*%; *hkl*)] are: 3.66 (35; 122), 3.37 (70; 132), 3.34 (100; 250), 2.982 (55; 312), 2.881 (86; 322), 2.733 (29; 332), 2.073 (27; 004), 2.062 (31; 182). The unit-cell parameters refined from powder-diffraction data are: a = 13.240(5), b = 19.339(7), c = 8.320(4) Å, and V = 2130(2) Å³. Single-crystal X-ray diffraction data collected on a crystal of size 0.15 × 0.05 × 0.05 mm refined to R_1 = 0.037 shows oscarkempffite is orthorhombic, space group *Pnca*, with a = 13.199(2), b = 19.332(3), c = 8.249(1) Å, V = 2116.3(5) Å³, Z = 1. The structure of oscarkempffite contains five distinct coordination polyhedra of cations and seven of anions. It contains a mixed (Pb,Bi) site with a trigonal prismatic coordination, a silver site with a distorted tetrahedral coordination in an octahedral arrangement of ligands, which alternates along the 8 Å direction with a mixed Sb1 site, and a string of alternating Sb2 and a mixed Sb3 ($Sb_{0.59}Bi_{0.41}$) sites, in the central parts of PbS-like slabs. Oscarkempffite is the member of lillianite homologous series with N = 4. The mineral is named in honor of Oscar Kempff Bacigalupo (b.1948), eminent Bolivian mineralogist and economic geologist, who discovered several large mineral deposits in Bolivia (e.g., the deposit of Don Mario). The holotype specimen of oscarkempffite is deposited in the Naturhistorisches Museum Wien, Wien, Austria; cotype material is deposited in the Natural History Museum, London, U.K. **O.C.G.**

OXO-MANGANI-LEAKEITE*

R. Oberti, M. Boiocchi, F.C. Hawthorne, N.A. Ball and P.M. Ashley (2016) Oxo-mangani-leakeite from the Hoskins mine, New South Wales, Australia: occurrence and mineral description. Mineralogical Magazine, 80(6), 1013–1021.

Oxo-mangani-leakeite (IMA 2015-035), ideally $^{A}Na^{B}Na_2{}^{C}(Mn^{3+}_4Li){}^{T}Si_8O_{22}{}^{W}O_2$, is a new mineral found in a rock containing manganese silicate and oxide at the Hoskins Mine, a Mn deposit located ~3 km west of Grenfell, New South Wales, Australia. Oxo-mangani-leakeite occurs in oxidized assemblages, commonly foliated and laminated, in association with clinopyroxenes ranging from namansilite to aegirine, manganoan pectolite–serandite, braunite, norrishite, calcium and barium carbonates, quartz, albite, potassium feldspar, Mn-bearing sugilite, and barite. The new mineral has a prismatic habit. Crystals are red-orange, transparent with vitreous luster, brittle, and show perfect cleavage on {110}. Mohs hardness and density were not measured; D_{calc} = 3.25 g/cm³. The mineral does not fluoresce in ultraviolet light. Oxo-mangani-leakeite is biaxial (–), α = 1.681(2), β = 1.712(2), γ = 1.738(2), $2V_{meas}$ = 81.0(4)°, $2V_{calc}$ = 83.5°. It is pleochroic with *X* - red brown > *Y* = *Z* = orange red; *X* ^ **c** = 51.5° (β acute), *Z* // **b**, *Y* ^ **a** = 66.3° (β obtuse). The average of an electron probe WDS analyses is [wt% (range)]: SiO_2 53.53 (52.88–53.96), TiO_2 0.28 (0.20–0.32), Al_2O_3 0.29 (0.21–0.35), Fe_2O_3 (calc.) 3.91, Mn_2O_3 (calc.) 20.46, MgO 7.20 (7.02–7.43), ZnO 0.13 (0.05–0.19), NiO 0.06 (0.00–0.11), Li_2O (measured by SIMS) 0.96, CaO 0.36 (0.22–0.46), Na_2O 8.96 (8.72–9.07), K_2O 1.90 (1.79–2.03), H_2O (calc.) 0.64, total 98.68. This gives the empirical formula $^{A}(Na_{0.65}K_{0.36})_{\Sigma 1.01}{}^{B}(Na_{1.94}Ca_{0.06})_{\Sigma 2.00}{}^{C}(Mg_{1.60}Zn_{0.01}Mn^{3+}_{2.32}Fe^{3+}_{0.44}Al_{0.03}Ti^{4+}_{0.03}Li_{0.58})_{\Sigma 5.01}{}^{T}(Si_{7.98}Al_{0.02})_{\Sigma 8.00}O_{22}{}^{W}(O_{1.34}OH_{0.66})_{\Sigma 2.00}$ based on 24 anions pfu and the single-crystal structural data. (FeO:Fe_2O_3 and MnO:Mn_2O_3 ratios were calculated from single-crystal structure refinement). H_2O was estimated by assuming complete oxidation of both Fe and Mn. The strongest lines in the calculated X-ray powder-diffraction pattern [d_{calc} Å (I_{calc} %; *hkl*)] are: 8.423 (100; 110), 3.377 (46; 131), 4.461 (40; 040), 4.451 (40; 021), 3.134 (37; 310), 2.694 (37; 151), 2.282 (27; $\bar{3}12$), 2.734 (25; $\bar{3}31$), 2.575 (24; 061), 2.331 (24; $\bar{3}51$,$\bar{4}21$). Single-crystal X-ray diffraction data collected on a crystal of size 200 × 50 × 50 μm refined to R_1 = 0.0201 for 769 unique reflections with $I \geq 3\sigma(I)$ shows oxo-mangani-leakeite is monoclinic, space group *C*2/*m*, with a = 9.875(5), b = 17.873(9), c = 5.295(2) Å, β = 104.74(3)°, V = 903.8(7) Å³, and Z = 2. Oxo-mangani-leakeite adopts the well-known monoclinic amphibole structure. The new mineral was named according to the new rules for amphibole classification and nomenclature (Hawthorne et al. 2012). The holotype specimen was deposited in the Canadian Museum of Nature, Ottawa, Canada. **O.C.G.**

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PAULADAMSITE*

A.R. Kampf, S.J. Mills and B.P. Nash (2016) Pauladamsite, $Cu_4(SeO_3)(SO_4)(OH)_4 \cdot 2H_2O$, a new mineral from the Santa Rosa mine, Darwin district, California, USA. Mineralogical Magazine, 80, 949–958.

Pauladamsite (IMA 2015-005), ideally $Cu_4(SeO_3)(SO_4)(OH)_4 \cdot 2H_2O$, is a new mineral from the Santa Rosa mine, Darwin district, Inyo County, California, U.S.A. (36°25′7″N, 117°43′26″W), where it occurs as a secondary oxidation-zone mineral in association with brochantite, chalcanthite, gypsum, ktenasite, mimetite, schulenbergite, and smithsonite on limonitic gossan. Other secondary minerals identified in the general assemblage are antlerite, boyleite, brianyoungite, devilline, hydrozincite, lahnsteinite, osakaite, and posnjakite. Pauladamsite forms green blades up to 0.5 mm long elongated on [100] and flattened on {001}, which are grouped in radial sprays. Multiple twinning is ubiquitous, probably by rotation on [100]. Crystals are transparent and have vitreous to silky luster with a pale green streak. The mineral does not fluoresce in long- or short-wave UV light. The Mohs hardness is ~2. It is brittle with irregular fracture and perfect {001} cleavage. D_{calc} = 3.535 g/cm³. The mineral is rapidly soluble in room-temperature, dilute HCl. Pauladamsite is optically biaxial (–), α_{calc} = 1.667, β = 1.723(2), γ = 1.743(2) (white light), $2V_{meas}$ = 60(2)°; *X* ≈ **c***, *Y* ≈ **b**, *Z* ≈ **a**. The dispersion of an optical axis is strong *r* > *v*. The pleochroism is *X* = light yellowish green, *Y* = bluish green, *Z* = nearly colorless;

$Y > X > Z$. Raman spectroscopy (514 nm laser) shows a number of SO_4 bands at 1166 (ν_3 antisymmetric stretch), 1076 (ν_3 antisymmetric stretch), and 989 (ν_1 symmetric stretch) cm^{-1}, and SeO_3 bands at 839 (ν_1 symmetric stretch), 745 (ν_3 antisymmetric stretch), 487 (ν_2 bending mode), and 396 (ν_2 bending mode) cm^{-1}. FTIR spectroscopy of pauladamsite shows bands at 1633 and 3341 cm^{-1}, which confirm the presence of H_2O and OH within the structure. Additional bands in the region 1167–980 cm^{-1} are due to the SO_4, while bands between 873 and 690 are due to SeO_3. The average of 5 electron probe WDS analysis [wt% (range)] is: CuO 48.96 (46.51–51.30), ZnO 3.56 (1.86–5.07), SeO_2 18.82 (18.26–19.83), SO_3 13.90 (13.44–14.17), H_2O 13.29 (based upon S = 1, charge balance and 13 O), total 98.5. The empirical formulae based on 13 O apfu is: $(Cu_{3.55}Zn_{0.25})_{\Sigma 3.80}Se_{0.98}SO_{13}H_{8.50}$. The strongest lines of the powder X-ray diffraction pattern [d Å (I%; hkl)] are: 10.5 (46; 011), 3.245 (100; 001), 5.81 (50; 011), 2.743 (49; 112), 3.994 (67; 012), 3.431 (23; $\bar{1}12,\bar{1}\bar{2}1,\bar{1}20$), 2.692 (57; $0\bar{3}2,\bar{1}22,\bar{2}\bar{1}2$), and 2.485 (39; $\bar{2}12,\bar{1}\bar{3}2,0\bar{2}4$). The parameters of the triclinic unit-cell refined from the powder data are $a = 6.0895(16)$, $b = 8.4104(17)$, $c = 10.7828(16)$ Å, $\alpha = 103.641(6)$, $\beta = 95.299(7)$, $\gamma = 89.903(8)°$, and $V = 534.26(19)$ Å^3. The crystal structure of pauladamsite was refined with X-ray diffractions intensity data, collected on single crystals with dimensions of 0.13 × 0.20 × 0.21 to $R_1 = 0.106$ based on 2086 unique $F_o > 4\sigma(F)$ reflections. Unit-cell parameters obtained from a single crystal are $a = 6.0742(7)$, $b = 8.4147(11)$, $c = 10.7798(15)$ Å, $\alpha = 103.665(7)$, $\beta = 95.224(7)$, $\gamma = 90.004(6)°$, $V = 533.03(12)$ Å^3, space group $P\bar{1}$, $Z = 2$. The structure of pauladamsite contains $Cu^{2+}O_6$ octahedra, SO_4 tetrahedra, and $Se^{4+}O_3$ pyramids. There are four different Jahn-Teller distorted CuO_6 octahedra, which share edges to form wide bands extending along [100]. The bands are five octahedra-wide in the $[01\bar{1}]$ direction, and connect along $[01\bar{1}]$ by bridging SO_4 tetrahedra and in the [011] direction by bridging $Se^{4+}O_3$ pyramids, thereby forming a framework. An extensive network of hydrogen bonds further binds the framework together. Pauladamsite is a rare case of mineral containing both selenite and sulfate groups. The only other are olsacherite, $Pb_2(SeO_3)(SO_4)$ and munakataite, $Pb_2Cu_2(Se^{4+}O_3)(SO_4)(OH)_4$. The new mineral is named pauladamsite in honor of Paul M. Adams (b. 1954) who discovered/collected the mineral and is coauthor of seven other new mineral descriptions. Five cotype specimens are deposited in the collections of the Natural History Museum of Los Angeles County, U.S.A., catalogue numbers 65569, 65570, 65571, 65572, and 65573 **F.C.**

PENBERTHYCROFTITE*

I.E. Gray, J. Betterton, A.R. Kampf, C.M. MacRae, F.L. Shanks and J.R. Price (2016) Penberthycroftite, $[Al_6(AsO_4)_3(OH)_9(H_2O)_5]\cdot 8H_2O$, a second new hydrated aluminium arsenate mineral from the Penberthy Croft mine, St. Hilary, Cornwall, UK. Mineralogical Magazine, 80(7), 1149–1160.

Penberthycroftite (IMA 2015-025), ideally $[Al_6(AsO_4)_3(OH)_9(H_2O)_5]\cdot 8H_2O$, is a new secondary aluminium arsenate mineral discovered at the Penberthy Croft mine located in the parish of St. Hilary, Cornwall, England, U.K. (50.1414°N, 5.4269°W). The mine was worked for Cu and Sn in the 18th and 19th centuries and was designated a Site of Special Scientific Interest in 1993 for its mineralization. The mine is well known for the diversity of secondary Cu-Pb-Fe arsenates resulted from prolonged oxidation of arsenopyrite and other sulfides in the upper parts of lodes and veins within the mine and on dumps. The acidic leaching alteration resulted in rich Fe-Mn oxides, hydroxides, and quartz assemblages that hosted the various arsenate suites. Penberthycroftite occurs in cavities in the quartz matrix and is associated with arsenopyrite, bettertonite, bulachite, cassiterite, chalcopyrite, chamosite, goethite, liskeardite, pharmacoalumite–pharmacosiderite, and scorodite. The mineral forms cavity fillings and thin white to pale cream crusts of tufted and sometimes interconnected crystalline aggregates, also in parts developing into protruding structures and clusters. It often grows on an ultra-thin layer of a reddish goethite. The mineral is generally found in an intimate and extremely complex mixtures with bettertonite, liskeardite, bulachite, and pharmacosiderite–pharmacoalumite in aggregates resembling a boxwork cellular network with regular to irregular-shaped cells after arsenopyrite. The aggregates of penberthycroftite consist of ultrathin (sub-micrometer) rectangular laths, with lateral dimensions generally <20 μm. Sometimes sprays of laths found. The laths are flattened on {010} and elongated on [100]. Penberthycroftite is translucent with a white streak and a vitreous to pearly luster. The mineral is non-fluorescent under both short- and long-wavelength ultraviolet radiation. The cleavage is perfect on {010}. The crystals are flexible, with irregular fracture. The density is not reported; $D_{calc} = 2.18$ g/cm^3. The mineral is non pleochroic. The laths have parallel extinction and negative elongation. Orientation was not determined. Only lower 1.520 and upper 1.532 refractive indices were measured based more upon relief than Becke line observations. Thermogravimetric analysis show two endotherms corresponding to water evolution at 94 and 180 °C, and an endotherm due to SO_3 evolution at 481 °C. No AsO_x gaseous species were detected. The total mass loss corrected for admixed quartz and for evolved SO_3 gave 32.1 wt% of H_2O. The IR spectrum of penberthycroftite is very similar to that of bettertonite and shows a broad band ~3600–2500 cm^{-1}, with a number of weak sharp peaks superimposed on the hump, corresponds to O–H stretching vibrations from strongly H-bonded water and hydroxyl. The band at 1630 cm^{-1} is due to H–O–H bending vibration. A peak at 1070 cm^{-1} assigned to the triply degenerate ν_3 asymmetric stretching vibration of $(SO_4)^{2-}$ while peak at 690 cm^{-1} is assigned to ν_4 bending vibration of $(SO_4)^{2-}$. Two doublets with main peaks at 855 and 795 and shoulders at 884 and 775 cm^{-1} are assigned to As–O ν_1 symmetric stretching and ν_3 antisymmetric stretching vibrations respectively. The average of 14 electron probe WDS analysis [wt% (range)] is: Al_2O_3 37.6 (35.9–41.1), Fe_2O_3 0.42 (0–0.82), As_2O_5 41.0 (38.3–43.9), SO_3 2.58 (1.83–3.32), H_2O (by TGA) 32.1, total 113.7. The high total is due to dehydration of the mineral during analysis. The element contents normalized to 100–32.1 wt% of H_2O are: Al_2O_3 31.3, Fe_2O_3 0.35, As_2O_5 34.1, SO_3 2.15. The empirical formula, based on 9 metal apfu and 26 framework anions is $[Al_{5.96}Fe_{0.04}(As_{0.97}Al_{0.03}O_4)_3(SO_4)_{0.26}(OH)_{8.30}(H_2O)_{5.44}](H_2O)_{7.8}$. The strongest lines in the powder X-ray diffraction pattern are [d Å (I%; hkl)] 13.264 (46; 011), 12.402 (16; 020); 9.732 (100; 021), 7.420 (28; 110), 5.670 (8; 130), 5.423 (6; $\bar{1}31$); 3.598 (6; $\bar{2}02$), 3.562 (6; $\bar{2}12$). The unit-cell parameters refined from the powder X-ray data are: $a = 7.789(2)$, $b = 24.777(4)$, $c = 15.737(3)$ Å, $\beta = 93.960(1)°$, $V = 3029.7(1.0)$ Å^3. The structure of penberthycroftite was solved on the rectangular lath ~0.03 mm × 0.01 mm × 0.001 mm in size using synchrotron single-crystal diffraction data and refined to $R = 0.068$ for 1639 observed $[I > 3\sigma(I)]$ reflections. Penberthycroftite is monoclinic, space group $P2_1/c$ with unit-cell dimensions measured at 100 K: $a = 7.753(2)$, $b = 24.679(5)$, $c = 15.679(3)$ Å, $\beta = 94.19(3)°$, $V = 2991.9(12)$ Å^3, $Z = 4$. Penberthycroftite has a heteropolyhedral layer structure, with the crankshaft-like stepped parallel to (010). The layers comprise hexagonal rings of edge-shared Al-centered octahedra that are interconnected by corner-sharing with AsO_4 tetrahedra. The layers are strongly undulating and their stacking produces large channels along [100] that are filled with water molecules. The layers are identical to those in bettertonite $[Al_6(AsO_4)_3(OH)_9(H_2O)_5]\cdot 11H_2O$, but they are displaced relative to one another along [001] and [010] such that the interlayer volume is decreased (by ~10%) relative to bettertonite, with a corresponding reduction of the interlayer water content to 8 H_2O pfu compare to 11 H_2O pfu in bettertonite. The interlayer region also contains a partially occupied SO_4 anion site that coordinates to a terminal anion of one of the Al-centered octahedral. Bettertonite has almost the same SO_3 content as penberthycroftite but in the refinement of bettertonite the sulfate molecules could not be located. The mineral is named for the location where it was found. Co-type specimens were deposited in the Museum Victoria, Melbourne, Victoria, Australia, and in the Natural History Museum, London, U.K. **D.B.**

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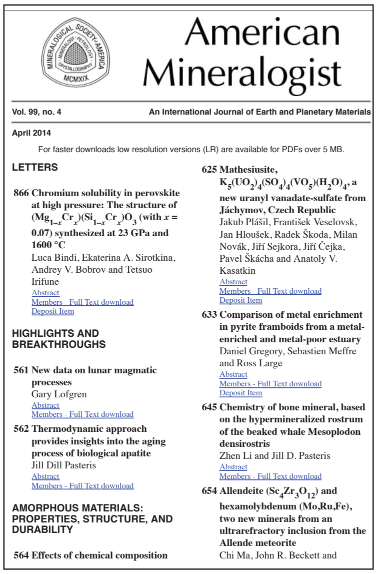

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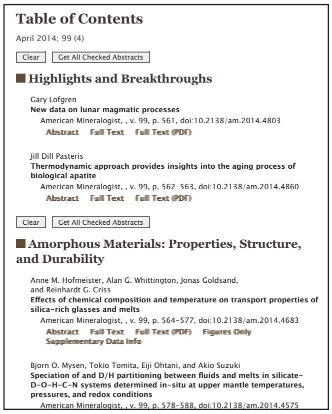

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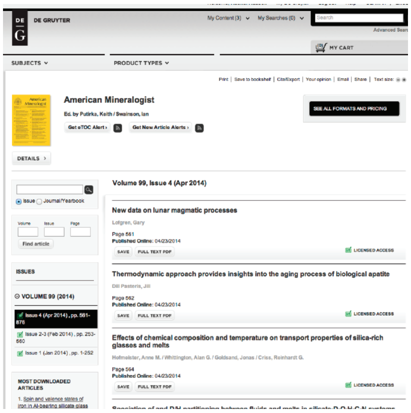

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