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New Mineral Names*

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BRUMADOITE*

D. Atencio, A.C. Roberts, P.A. Matioli, J.A.R. Stirling, K.E. Venance, W. Doherty, C.J. Stanley, R. Rowe, G.J.C. Carpenter, and J.M.V. Coutinho (2008) Brumadoite, a new copper tellurate hydrate, from Brumado, Bahia, Brazil. Mineral. Mag., 72, 1201–1205.

Brumadoite occurs as a late fracture-filling mineral in coarse-grained magnesite at the Pedra Preta mine, Serra das Éguas, Brumado, Bahia, Brazil. It occurs as microcrystalline aggregates on, and as psuedomorphs after magnesite. It is platy, subhedral, with individual crystals 1–2 μm in size, or in crusts up to 100 μm thick. The mineral is blue, with a pale blue streak, is vitreous, transparent to translucent, not fluorescent, brittle with uneven fracture, and does not display a cleavage or parting. The Mohs hardness could not be determined. The pinacoid {100} was confirmed via a convergent beam electron diffraction study. Brumadoite has a calculated density of 4.768 g/cm^3. In transmitted light, brumadoite is pleochroic with a mean refractive index of ~1.79. In reflected light, it is gray with blue internal reflections and no bireflectance. Reflectance data were obtained in air [%(wavelength in nm)]: 10.2(470), 8.9(546), 8.3(589), and 8.3(650). The FTIR spectrum of brumadoite shows both OH and H_2O, with strong bands at 2965, 3323, and 3466 cm^{-1} (O-H stretching) and a weak peak at 1629 cm^{-1} (H-O-H bending).

The chemical composition of brumadoite was determined by electron microprobe analyses in WDS mode. The average (range) of 16 analyses gave: TeO_3 30.58(29.74–31.01), SiO_2 0.55(0.42–0.63), CaO 0.07(0.04–0.12), CuO 43.05(41.62–44.24), PbO 1.70(1.44–2.08), H_2O_{diff} 24.05, sum 100.00 wt%, corresponding to the empirical formula (based on 13 oxygen atoms): $(Cu_{2.90}Pb_{0.04}Ca_{0.01})_{\Sigma 2.95}(Te^{6+}_{0.93}Si_{0.05})_{\Sigma 0.98}O_{3.92}(OH)_{3.84}\cdot 5.24H_2O$. The ideal end-member formula is $Cu_3Te^{6+}O_4(OH)_4\cdot 5H_2O$, which requires CuO 44.16, TeO_3 32.50, H_2O 23.34, sum 100.00 wt%. The oxidation state of Te was determined by a microchemical spot test employing a KI solution.

Brumadoite is monoclinic, space group $P2_1/m$ or $P2_1$, a = 8.629(2), b = 5.805(2), c = 7.654(2) Å, β = 103.17°, V = 373.3(2) Å^3. The strongest lines on the powder X-ray diffraction pattern are [d_{obs} Å(I_{obs}%,hkl)]: 8.432(100,100), 3.162(66,$\bar{2}02$), 2.385(27,220), 2.291(12,$\bar{1}22$), 1.916(11,312), 1.666(14,$\bar{4}22$,114), 1.452(10,323), and 1.450(10,422,403).

The mineral is named for the type locality, Brumado, Bahia, Brazil, and has been approved by the IMA CNMNC (IMA 2008-028). Holotype material is deposited in the Museu de Geociências, Instituto de Geociências, Universidade de São Paulo, São Paulo, SP, Brazil; in the Museu José Bonifácio de Andrada e Silva, Santos, SP, Brazil (no. M5528); in the Systematic Reference Series of the National Mineral Collection, Geological Survey of Canada, Ottawa (no. NMC 068161), and at the Natural History Museum, London, U.K. (no. BM 2008,32). **P.C.P.**

BURGESSITE*

J. Sejkora, F.C. Hawthorne, M.A. Cooper, J.D. Grice, J. Vadak, and J.L. Jambor (2009) Burgessite, $Co_2(H_2O)_4[AsO_3(OH)]_2(H_2O)$, a new arsenate mineral species from the Keeley mine, South Lorrain Township, Ontario, Canada. Can. Mineral., 47, 159–164.

M.A. Cooper and F.C. Hawthorne (2009) The crystal structure of burgessite, $Co_2(H_2O)_4[AsO_3(OH)]_2(H_2O)$, and its relation to erythrite. Can. Mineral., 47, 165–172.

Burgessite was discovered on a mineral sample labeled erythrite that was collected from the Keeley mine, South Lorraine Township, Timiskaming District, Ontario Canada. Burgessite occurs as rosettes (up to 0.8 mm across) randomly distributed across a surface of primary skutterudite, cobaltite, and bismuth with associated supergene arsenolite, bismuthoferrite, and erythrite. Individual crystals are prismatic and untwinned, elongated along a (up to 0.1 mm long) with {011} >> {$h0l$}. It is transparent with a colorless to pale pink streak and a vitreous luster. No ultraviolet fluorescence was observed. The Mohs hardness is 3; there is one good cleavage {010} and one fair cleavage {001}. Crystals are brittle with a hackly fracture. D_{meas} and D_{calc} are 2.93(2) and 2.94 g/cm^3 respectively. Burgessite is biaxial positive with $\alpha = 1.596$, $\beta = 1.604$, $\gamma = 1.628$, all ±0.002, with a $2V_{obs} = 70(2)°$ and $2V_{calc} = 61°$. It is nonpleochroic, with an optic orientation X = b, $Y \wedge c = 29°$ (in β obtuse), $Z \wedge a = 20°$ (in β acute).

The composition of burgessite was determined by WDS. The average composition (range in parentheses) is As_2O_5 47.91 (46.62–49.11), P_2O_5 0.03 (0.00–0.06), CoO 27.31 (25.46–28.76), NiO 3.52 (2.67–4.93), ZnO 0.04 (0.00–0.10), CaO 0.18 (0.05–0.28), SO_3 0.13 (0.06–0.23), H_2O (calc.) 22.65, for a sum of 101.77 wt%. The authors suggest that the high total is the result of minor dehydration during analysis. The empirical formula of burgessite [on the basis (O,OH,H_2O) = 13] is $(Co_{1.75}Ni_{0.23}Ca_{0.02})_{\Sigma 2.00}(AsO_3OH)_{\Sigma 2.00}(H_2O)_5$.

Infrared spectroscopy of burgessite (KBr disk) shows bands

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* All minerals marked with an asterisk have been approved by the IMA CNMMC.

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at 3392 and 1600–1750 cm^{-1} that are associated with (OH) stretching and H-O-H bending, respectively. A series of bands (3000–2700, 1500–1100, and 700–600 cm^{-1}) were assigned to various stretching modes of (OH) and (As-OH) in the (AsO_3OH) group. Strong bands at 868, 837, and 806 cm^{-1} were assigned to (As-O) antisymmetric and symmetric stretching vibrations respectively. Bands at 493 and 432 cm^{-1} are associated with (As-O) bending vibrations.

Powder X-ray diffraction data were collected using graphite monochromated Cu$K\alpha$ radiation and a Philips X'Pert powder diffractometer. The strongest lines in the powder diffraction pattern [d_{obs} Å(I_{obs}%,*hkl*)] are: 7.446(100,011), 6.267(44,002), 3.725(29,022), 3.260(25,12$\bar{1}$), 2.998(31,031), 2.970(21,014), and 2.596(23,024).

The crystal structure of burgessite was determined by direct methods using data collected with a graphite monochromated Mo$K\alpha$ radiation and a CCD equipped Bruker P4 diffractometer. There were 711 unique reflections with 494 where $|F_o > 5\sigma(|F_o|)$, $R1$ = 4.3%. Burgessite is monoclinic, space group $P2_1/n$, a = 4.7058(12), b = 9.299(3), c = 12.738(4) Å, β = 98.933(8)°, V = 550.6(5) $Å^3$, Z = 2, a:b:c = 0.5061:1:1.3698.

The structure of burgessite consists of two cation sites. The As site is tetrahedrally coordinated by O and OH and completely occupied by As. The Co site is coordinated octahedrally by four oxygen atoms and two H_2O groups. It is predominantly occupied by Co. The structure contains seven distinct anion sites. Three of these sites contain oxygen, three contain (H_2O) groups, and one contains (OH) that is bonded to arsenic to form an acid arsenate group (As_3OH). Pairs of Co octahedra share an edge to form a $Co_2\Phi_{10}$ dimer and $As\Phi_4$ tetrahedra link pairs of vertices in adjacent octahedra to create a $[Co_2(As\Phi4)_2\Phi_6]$ cluster. These clusters polymerize to form a chain of $[Co_2(H_2O)_4[As^{5+}O_3(OH)]_2]$ in the [100] direction. These chains are linked by hydrogen bonds [between (OH) bonded to As^{5+}, H_2O bonded to Co, and (H_2O) held in place only by hydrogen bonds] to form a three-dimensional structure.

The mineral is named for David Burgess, who brought the sample to the author's attention. The holotype sample is held in the collection of the Canadian Museum of Nature (CNMMC 86051). **G.P.**

BUSSYITE-(CE)*

J.D. Grice, R. Rowe, G. Poirier, A. Pratt, and J. Francis (2009) Bussyite-(Ce), a new beryllium silicate mineral species from Mont Saint-Hilaire, Quebec, Can. Mineral., 47, 193–204.

Bussyite-(Ce), ideally $(Ce,REE,Ca)_3(Na,H_2O)_6MnSi_9Be_5(O,OH)_{30}(F,OH)_4$, was found in a 15 × 30 cm pocket in a nepheline syenite-hosted pegmatite in the Poudrette Quarry, Mont Saint Hilaire, Rouville County, Quebec. The pocket was serandite-bearing, with aegirine, albite, analcime, ancylite-(Ce), calcite, catapleiite, gonnardite, kupletskite, leucophanite, microcline, nenadkevichite, polylithionite, and sphalerite.

Bussyite-(Ce) occurs as prismatic crystals elongate on {101} and bound by the {111} prism and the {10$\bar{1}$} pinacoid. They range from 5 to 10 mm in length with rough terminations. Crystals are pale pinkish orange, transparent to translucent with a vitreous luster and a white streak. Fluorescence was not observed in long or short wavelength UV light. Bussyite-(Ce) is brittle with a splintery fracture and a perfect {10$\bar{1}$} cleavage. The Mohs hardness is 4. Measured and calculated densities are 3.00 and 3.11 g/cm^3, respectively. Optically bussyite-(Ce) is biaxial (–) with α = 1.574(2), b = 1.591(2), γ = 1.597(2), $2V_{meas}$ = 63(2)°, $2V_{calc}$ = 61°. No dispersion or pleochroism was observed. The optical orientation is X $\wedge$ c = 39° (β acute), Y = b, and Z $\wedge$ a = 44.5° (β obtuse). In some crystals, fine, lamellar twinning was observed parallel to the elongation.

The composition of bussyite-(Ce) was determined by WDS and time-of-flight SIMS. Backscattered electron imaging and WDS analyses revealed the presence of a rare, anhydrous, Na-rich phase. The average composition for the hydrous phase (n = 23, range in parentheses) is Na_2O 7.63 (9.40–6.62), K_2O 0.05 (0.13–0.0), BeO 8.33 (SIMS), CaO 5.35 (5.95–4.17), MgO 0.03 (0.11–0.00), MnO 2.49 (3.00–1.71), Al_2O_3 0.82 (1.54–0.39), Y_2O_3 1.97 (2.68–1.51), La_2O_3 2.65 (3.11–2.16), Ce_2O_3 9.77 (11.22–8.15), Pr_2O_3 1.23 (1.49–0.74), Nd_2O_3 4.54 (5.13–3.91), Sm_2O_3 0.99 (1.25–0.68), Eu_2O_3 0.010 (0.25–0.0), Gd_2O_3 1.03 (1.23–0.81), SiO_2 38.66 (39.94–37.66), ThO_2 3.31 (4.59–2.12), F 3.67 (6.39–2.54), S 0.03 (0.00–0.08), H_2O 4.12 (determined from crystal-structure analysis), for a total of 95.21 wt%. This gives an empirical formula (on the basis of 34 anions) of $4\{(Ce_{0.823}Nd_{0.373}Y_{0.242}Th_{0.173}Pr_{0.103}Sm_{0.079}Gd_{0.078}Eu_{0.008})_{\Sigma 1.89}(Ca_{0.775}La_{0.225})_{\Sigma 1}[Na_{3.000}(H_2O)_{\Sigma 2.500}Ca_{0.544}K_{0.015}]_{\Sigma 6.055}(Mn_{0.485}Na_{0.402}Mg_{0.012})_{\Sigma 0.899}(Si_{8.897}Be_{4.605}Al_{0.222})_{\Sigma 13.724}O_{30}[F_{2.67}(OH)_{1.33}]_{\Sigma 4}\}$. The average of three analyses of the Na-rich phase gives Na_2O 14.37, K_2O 0.0, BeO 8.33 (SIMS), CaO 2.74, MgO 0.0, MnO 0.0, Al_2O_3 0.0, Y_2O_3 2.41, La_2O_3 3.67, Ce_2O_3 12.00, Pr_2O_3 1.51, Nd_2O_3 5.48, Sm_2O_3 1.24, Eu_2O_3 0.11, Gd_2O_3 1.06, SiO_2 39.93, ThO_2 0.77, F 6.30, S 0.0, for a total of 97.27 wt%. This leads to an empirical formula of $4[(Ce_{1.047}Nd_{0.466}La_{0.323}Y_{0.306}Pr_{0.131}Sm_{0.102}Gd_{0.084}Eu_{0.009}Th_{0.042})_{\Sigma 2.510}(Na_{6.645}Ca_{0.701})_{\Sigma 7.346}(Si_{9.521}Be_{4.772})_{\Sigma 14.293}(O_{29.251}F_{4.749})_{\Sigma 34}]$.

Infrared spectroscopy of bussyite-(Ce) shows peaks centered at 3421 cm^{-1} for O-H or H-O-H stretching, and at 1645 cm^{-1} for H-O-H bending. Other peaks are at 993 cm^{-1} ([SiO_4] and [BeO_4] stretching), 705 cm^{-1} ([SiO_4] and [BeO_4] bending) and 503 cm^{-1} ([SiO_4] bending).

A powder diffraction pattern of bussyite-(Ce) was collected using Cu$K\alpha$ radiation and a two-dimensional area detector. The six strongest lines in the diffraction pattern [d_{obs} Å(I_{obs}%,*hkl*)] are 8.120 (100,$\bar{1}$11), 2.863 (48,331), 3.543 (39,024), 2.668 (33,$\bar{1}$35), 6.959 (26,020), 2.959 (24,$\bar{3}$31). Bussyite-(Ce) is monoclinic, space group $C2/c$, with unit-cell parameters refined from powder-diffraction data: a = 11.654(3), b = 13.916(3), c = 16.583(4) Å, β = 95.86(2)°, V = 2675.4(8) $Å^3$, and Z = 4.

Single-crystal data were collected from a 40 × 60 × 200 μm cleavage fragment using graphite monochromated Mo$K\alpha$ radiation, a four circle goniometer and a CCD detector. The $R1$ index for 1134 reflections > $4\sigma(F)$ was 4.0%. The structure of bussyite-(Ce) consists of two distinct layers parallel to (10$\bar{1}$). One layer consists of [$(Si,Be)O_4$] tetrahedra and the other is made up of Ce–, Ca–, Mn–, Na–(O,F) polyhedra. These layers are cross linked through shared O and F atoms. The topology of the tetrahedral layers resembles that of semenovite-(Ce) and harstigite.

The name is for Antoine Alexandre Brutus Bussy, co-discoverer of beryllium. The holotype specimen is held in the collection of the Canadian Museum of Nature (CMNMC 85929). **G.P.**

FRIEDRICHBECKEITE*

C.L. Lengauer, N. Hrauda, U. Kolitsch, R. Krickl, and E. Tillmans (2009) Friedrichbeckeite, $K(\square_{0.5}Na_{0.5})_2(Mg_{0.8}Mn_{0.1}Fe_{0.1})_2(Be_{0.6}Mg_{0.4})_3[Si_{12}O_{30}]$, a new milarite-type mineral from the Bellerberg volcano, Eifel area, Germany. Mineral. Petrol., 96, 221–232, DOI: 10.1007/s00710-009-0050-9.

Friedrichbeckeite is a new member of the milarite-osumilite group found in a xenolith from the Bellerberg volcano, southeast of Ettringen, East Eifel volcanic area, Germany. The locality is famous for rare and new mineral species formed as a result of the interaction between silicate- and calcium-rich xenoliths with a leucite-tephrite magma, followed by metasomatic alterations. Friedrichbeckeite occurs in vesicles in the pyrometamorphically modified silicate-rich xenoliths, having crystallized from Mg- and Si-rich gas phases during the reaction process. The xenolith itself is comprised dominantly of quartz and sanidine. Associated minerals include tridymite, augite, magnesiohornblende, enstatite, almandine-spessartine garnet, fluorapatite, biotite, braunite, hematite, and roedderite. Friedrichbeckeite occurs as euhedral, thin tabular crystals flattened on {0001}, up to 0.6 × 0.1 mm in size. Forms include the dominant {0001} pinacoids, and less common $\{10\bar{1}0\}$ and $\{11\bar{2}0\}$ faces. The mineral is colorless to light yellow, has a light cream streak, vitreous luster, no cleavage, is brittle with an irregular fracture, and a Mohs hardness of 6. The calculated density is 2.686 g/cm^3. It is uniaxial positive with $\omega = 1.552(2)$, $\varepsilon = 1.561(2)$. Anomalous extinction, slight biaxiality, and zoning are sometimes observed. The mineral is pleochroic from yellow $\parallel \omega$ to light blue $\parallel \varepsilon$.

The chemical composition of friedrichbeckeite was determined by WDS electron microprobe analysis, with the Be content determined by laser-ablation ICP-MS. The average (range) composition (15 WDS and 5 LA-ICP-MS analyses) is Na_2O 2.73 (2.43–3.04), K_2O 4.16 (4.10–4.25), BeO 4.67 (4.26–5.72), MgO 11.24 (9.19–12.71), CaO 0.04 (0.01–0.10), MnO 2.05 (1.70–2.55), FeO 1.76 (1.20–2.24), Al_2O_3 0.15 (0.08–0.19), SiO_2 73.51 (72.96–74.43), TiO_2 0.02 (0.00–0.04), sum 100.33 wt%, corresponding to an empirical formula based on Si = 12 of $K_{0.87}Na_{0.86}(Mg_{1.57}Mn_{0.28}Fe_{0.24})_{\Sigma 2.09}(Be_{1.83}Mg_{1.17})_{\Sigma 3.00}[Si_{12}O_{30}]$, which can be simplified to $K(\square_{0.5}Na_{0.5})_2(Mg_{0.8}Mn_{0.1}Fe_{0.1})_2(Be_{0.6}Mg_{0.4})_3[Si_{12}O_{30}]$. The end-member formula can be written as $K(\square_{0.5}Na_{0.5})_2Mg_2Be_3[Si_{12}O_{30}]$. Micro-Raman spectroscopy (Renishaw RM1000 spectrometer, 633 nm emission of He-Ne laser, 17 mW) of friedrichbeckeite shows a spectrum similar to other members of the milarite-osumulite group, the most pronounced difference the increased splitting of the bands around 550 cm^{-1} in the series milarite-almarudite-friedrichbeckeite, with a clear splitting with maxima of 577 and 543 cm^{-1} in friedrichbeckeite. This splitting, a reflection of short-range order, is thought to be the result of increased distortion of the *T*2 tetrahedron in the series. No evidence for OH, H_2O or other molecular species was noted.

Single-crystal X-ray intensity data for a 0.05 × 0.07 × 0.08 mm crystal of friedrichbeckeite were collected on a Nonius Kappa goniometer with a CCD detector using Mo$K\alpha$ radiation. The structure was refined using starting parameters of almarudite, 644 unique reflections, 586 unique reflections with $F_o^2 > 2\sigma(F_o^2)$, $R1 = 3.62\%$, $R1 > 2\sigma(F_o^2) = 3.12\%$. The mineral is hexagonal, space group $P6/mcc$, $a = 9.970(1)$, $c = 14.130(3)$ Å, $V = 1216.4(3)$ Å^3, $Z = 2$. The powder X-ray diffraction pattern of friedrichbeckeite was obtained using a 114.59 mm Debye-Scherrer camera equipped with a Gandolfi attachment, with Ni-filtered Cu$K\alpha$ radiation and an exposure time of 16 hours. Intensity values were estimated visually, and the film was corrected for shrinkage. The following are the most important diffraction peaks [d_{obs} Å(I_{obs}%,hkl)]: 7.057(10,002), 4.993(30,110), 4.321(25,020), 4.081(30,112), 3.690(30,022), 3.525(25,004), 3.180(100,121), 2.885(70,114,030), 2.737(25,024), and 1.828(15,135,036).

Friedrichbeckeite is isotypic with other members of the milarite-osumilite group with the general structural formula $^{[12]}C^{[9]}B_2{}^{[6]}A_2{}^{[4]}T2_3[^{[4]}T2_{12}O_{30}]$. The wide variation in chemistry in the group results in a range of unit-cell parameters, with unit-cell volumes varying by ~12% between berezanskite and armenite. A bi-modal population is observed when comparing *a*:*c* ratios vs. unit-cell volumes, a function of the size of the cation in the *A* site. Friedrichbeckeite fits into the subgroup with a mean *a*:*c* ratio of 1.41(1), which is dominated by Li-bearing members of the milarite-osumilite group. Friedrichbeckeite is the Mg-analogue of almarudite, milarite, and oftedalite, and the Be-analogue of merrihueite and roedderite.

The mineral is named for Austrian mineralogist and petrographer Friedrich Johann Karl Becke (1855–1931), who was the Head of the Mineralogisch-Petrographisches Institut at the Universität Wien from 1898 to 1927, and who is best known for developing the Becke-line method. Holotype and cotype material has been deposited in the mineral collection at the Naturhistorisches Museum Wien (NHMW), Austria (catalog no. 2009-IV-a).

Discussion: The name "beckelite" was originally for Friedrich Becke, but was discredited in 1980 as being identical to britholite-(Ce). **P.C.P.**

LALONDEITE*

A.M. McDonald and G.Y. Chao (2009) Lalondeite, a new hydrated Na–Ca fluorosilicate species from Mont Saint-Hilaire, Quebec: description and crystal structure. Can. Mineral., 47, 181–191.

Lalondeite is the eighth member of reyerite-gyrolite group. It was discovered in a hand sized sample of altered breccia from the Poudrette Quarry, Mont St. Hilaire, Quebec. It makes up to 2% of the sample in which it occurs as subhedral roundish plates up to 3 mm across and 0.5 mm thick. Associated minerals are microcline, clinoamphibole, and narsarssukite. Crystals of lalondeite are dominated by the {001} pinacoid, with no observed twinning. They are colorless and transparent, with a pearly luster and a white streak. There is medium to strong violet-blue fluorescence under medium-wave ultraviolet light and a weak violet to violet-blue fluorescence under short-wave radiation. Lalondeite is brittle with a splintery fracture, a Mohs hardness of 3 and a perfect {001} cleavage. Cleavage fragments are inelastic. Measured and calculated densities are 2.50(1) and 2.51 g/cm^3, respectively. It does not effervesce in 1:1 HCl at room temperature. Optically it is non-pleochroic, biaxial (–) with $\alpha = 1.522(1)$, $\beta = 1.528(1)$, $\gamma = 1.529(1)$ (for $\lambda = 589$ nm), $2V_{meas} = 48(1)°$, $2V_{calc} = 44(1)°$; no dispersion was observed. The optical orientation is X ≈ *c*.

The composition of lalondeite was determined using combined WDS-EDS with precautions taken to avoid beam damage to the samples. Aluminum, Ti, Fe, Mg, Rb, and Cs were sought but not detected. Eighteen analyses of three grains gave an average composition (ranges in parentheses) of Na_2O 11.28 (10.06–11.99), K_2O 0.70 (0.49–0.77), CaO 15.00 (14.82–15.20), SiO_2 66.36 (65.64–67.38), F 1.28 (1.10–1.51), Cl 0.18 (0.14–0.21), and H_2O (calc.) 4.27, O = F+Cl –0.58, total 98.49 wt%. This leads to an empirical formula (on the basis of 43 anions) of $(Na_{5.33}Ca_{0.91}K_{0.22})_{\Sigma 6.46}Ca_3Si_{16.16}O_{38}(F_{0.99}OH_{0.94}Cl_{0.07})_{\Sigma 2}{\cdot}3H_2O$ and an ideal formula of $(Na,Ca)_6Ca_3Si_{16}O_{38}(F,OH)_2{\cdot}3H_2O$.

The infrared spectrum of lalondeite shows broad O-H stretching centered at 3443 cm^{-1} and a weak band at 1631 cm^{-1} assigned to H-O-H bending. A strong band at 1025 and a shoulder at 1121 cm^{-1} are assigned to asymmetric O-Si-O stretching. Four sharp bands in the region 787–388 cm^{-1} are attributed to Si-O-Si stretching.

X-ray powder diffraction data were collected with a Debye-Scherrer camera and Ni-filtered Cu*K*α radiation The strongest seven lines in the X-ray powder-diffraction pattern [d_{obs} Å(I_{obs}%,*hkl*)] are: 11.938(90,001), 4.142(30,$2\bar{2}0$), 4.106(30,020,$0\bar{2}1$), 3.972(40,003,$1\bar{2}2$), 2.981(35,$2\bar{1}3$,004), 2.967(50,$\bar{1}22$,$3\bar{1}1$,$\bar{1}04$,$\bar{2}31$) and 2.888(100,$\bar{1}23$,121,$2\bar{3}2$,$\bar{3}12$). Single-crystal intensity data were collected using graphite monochromated Mo*K*α radiation. The crystal structure was solved with direct methods. 761 reflections with $F_o > 4\sigma(F_o)$ were observed with R_F of 3.29%. Lalondeite is triclinic, space group *P*1, with *a* = 9.589(2), *b* = 9.613(2), *c* = 12.115(2) Å, α = 96.62(2), β = 92.95(2), γ = 119.81(2)°, *V* = 954.8(1) $Å^3$, Z = 2.

The structure of consists of layers of tetrahedra (T) and octahedra (O) layered along [001]. The T layers are composed of six membered rings of silicon tetrahedra (SiO_4) cross-linked by SiO_4 tetrahedra. The octahedral sheets consist of edge sharing octahedra and polyhedra. These O sheets are sandwiched between symmetrically equivalent T sheets forming a T-O-T unit. Interlayers between these units contain disordered Na^+ and H_2O molecules.

The name is for Professor Andre E. Lalonde, Department of Earth Sciences, University of Ottawa, Canada. The holotype sample is held in the collection of the Canadian Museum of Nature, Aylmer, Quebec, Canada (CMNMC 83720). **G.P.**

LISIGUANGITE*

Z. Yu, F. Cheng, and H. Ma (2009) Lisiguangite, $CuPtBiS_2$, a new platinum-group mineral from the Yanshan Mountains, Hebei, China. Acta Geol. Sinica, 83, 238–244.

Lisiguangite is a new platinum-group mineral from PGE-bearing Co-Cu sulfide veins near Sandao Village, 250 km northeast of Beijing, China. The deposit is contact metamorphic in origin, with the PGM and sulfide minerals occurring in an exoskarn associated with mafic igneous rocks (garnet pyroxenite). Lisiguangite was obtained from heavy mineral concentrates. It is associated with chalcopyrite, bornite, galena, carrolite, molybdenite, pyrite, and tenorite. Other PGMs include daomanite, Co-bearing malanite, sperrylite, moncheite, cooperate, damiaoite, yixunite, and malyshevite. The mineral occurs as idiomorphic, tabular or lamellar [on (010)] crystals elongated along [100] up to 2 mm long and 0.5 mm wide. The pinacoid is the dominant form. The mineral is brittle, has perfect {010}, distinct {001}, and visible {100} cleavage, a stepped fracture, Mohs hardness of 2.5 (VHN_{25} = 46.7–49.8 kg/mm^2), and a D_{calc} = 7.42 g/cm^3. In plane polarized reflected light, lisiguangite is bright white with a yellowish tint. It does not show internal reflection, bireflectance, or pleochroism, has weak to moderate anisotropy with blue-green to brown colors, and parallel extinction. Reflectance data for standard wavelengths (nm) include ($R_1/R_2;R_3/R_4;{}^{oil}R_3/{}^{oil}R_4$): 470 nm = (39.2/36.7;37.5/35.7;23.4/22.3), 546 nm = (40.3/37.3;38.6/36.5;23.6/22.6), 589 nm = (40.7/37.9;39.4/37.5;23.6/22.7), and 650 nm = (40.8/37.9;40.3/38.2;23.7/22.9).

The chemical composition of lisiguangite was determined by electron microprobe (WDS). The average (range) of 8 analyses is: S 17.55 (17.25–18.19), Cu 12.98 (12.70–13.27), Pd 2.69 (2.30–3.30), Pt 30.04 (29.12–30.69), Bi 37.65 (36.69–38.05), sum 100.91 wt%. The empirical formula, based on 6 apfu, is $Cu_{1.10}(Pt_{0.83}Pd_{0.14})_{\Sigma 0.97}Bi_{0.97}S_{2.96}$. The ideal formula is $CuPtBiS_3$, which requires Cu 11.27, Pt 34.60, Bi 37.70, S 17.06, sum 100.00 wt%.

Intensity data for lisiguangite were collected on a 60 × 40 × 30 μm crystal employing a Rigaku R-axis Rapid IPI diffractometer (Mo*K*α radiation). The structure was solved and refined in space group $P2_12_12_1$, *R*1 = 0.2204 and w*R*2 = 0.5179 for $I > 2\sigma(I)$, and *R*1 = 0.2338, w*R*2 = 0.5426 for all observed reflections. Lisiguangite is orthorhombic, $P2_12_12_1$, *a* = 7.7152(15), *b* = 12.838(3), *c* = 4.9248(10) Å, *V* = 487.79(17) $Å^3$, *Z* = 4. Powder X-ray diffraction data were collected on a 57.3 mm Debye-Scherrer camera (Cu$K\alpha_1$ radiation), with refined unit-cell parameters *a* = 7.685(3), *b* = 12.882(5), *c* = 4.9243(10) Å, *V* = 487.54(11) $Å^3$, *Z* = 4. The strongest lines on the powder diffraction pattern include [d_{obs} Å(I_{obs}%,*hkl*)]: 6.40(30,020), 5.93(20,120), 3.24(80,031), 3.03(100,201), 2.87(20,230), 2.73(20,221), 2.27(40,051), 2.14(50,250), 2.05(25,132), 1.920(20,400), 1.865(60,232), 1.463(20,501,143), and 1.423(30,233).

Lisiguangite is a member of the lapieite group and the Pt-dominant analogue of mückeite. The M1 sites are occupied by Cu tetrahedrally coordinated by S. The M2 sites are occupied by Pt, which is octahedrally coordinated by four S and two Bi. The Bi atoms are coordinated by four S atoms to form a trigonal pyramid.

The mineral is named for renowned Chinese geologist, Li Siguang (J.S. Lee) in honor of his birthday (1889–1971). He was minister of geology of China (1952–1971), Vice President of the Chinese Academy of Sciences, and Chairman of the China National Association of the Sciences. The mineral and name have been approved by the IMA CNMNC (no. 2007-003). Holotype material (polished thin sections) is deposited at the Geological Museum of China, Beijing (cat. no. M-11031). **P.C.P.**

MONTETRISAITE*

P. Orlandi and E. Bonaccorsi (2009) Montetrisaite, a new hydroxy-hydrated copper sulfate species from Monte Trisa, Vicenza, Italy. Can. Mineral., 47, 143–151.

Montetrisaite was discovered associated with kaolinite in a porous, altered, basic volcanic unit in old drifts near the Veneziana mine, Monte Trisa, Torrebelvicino, Vicenza, Italy. Other associated minerals are galena, sphalerite, chalcopyrite, cerussite, anglesite, goethite, langite, posnjakite, linarite, and redgillite. Montetrisaite is believed to be an alteration product of sulfide minerals. Montetrisaite forms small vertically striated crystals with a tabular [001] and elongate [100] faces. The crystals are blue and transparent with a vitreous luster. The crystals are brittle with a conchoidal fracture and a Mohs hardness of 2–3. Density was not determined. Montetrisaite is optically biaxial, with $\alpha = 1.584 \parallel a$, $\gamma = 1.65 \parallel b$ and the axial plane $\perp$ to *c*. Pleochroism is very pale blue $\parallel b$ and blue $\parallel a$.

Chemical composition (WDS, with H_2O on the basis of structure) is ($n = 5$, range in parentheses) CuO 71.66 (76.41–67.69), ZnO 0.33 (0.20–0.50), PbO 0.11 (0.0–0.18), SO_3 11.17 (9.65–12.29) H_2O 19.00. This leads to an empirical formula (on the basis of 6 (Cu+Zn) of $Cu_{5.97}Zn_{0.03}(SO_4)_{0.93}(OH)_{10.00}\cdot 2H_2O$.

Powder X-ray diffraction data were collected using a Gandolfi camera and Cu*K*α radiation. The strongest reflections [d_{obs} Å(I_{obs}%,*hkl*)] are: 7.45(100,002), 3.73(35,004), 2.788(18,061), 2.503(14,132) and 1.595(20,175). Montetrisaite is orthorhombic with $a = 2.989(2)$, $b = 16.970(5)$, $c = 14.812(4)$ Å, $V = 751.1$ Å^3, space group $Cmc2_1$, Z = 2 . Weaker reflections suggest a monoclinic unit cell with *a* doubled. Single-crystal X-ray intensity data were collected at the X-ray diffraction beamline of the Elettra Synchrotron facility (Trieste, Italy) on a $0.10 \times 0.02 \times 0.01$ mm crystal using an X-ray wavelength of 1.0 Å. The structure refinement was carried out using full-matrix least squares on F^2. There were 716 independent reflections with goodness of fit on $F^2 = 0.997$ and $R_1 = 0.0787$.

The structure of montetrisaite consists of edge-sharing layers of Cu-centered octahedra with SO_4 groups connected on one side. H_2O occurs between the layers that are linked by hydrogen bonds. Montetrisaite is structurally related to posnjakaite, wroewolfeite, and langite. Redgillite, which is chemically similar, has sulfate groups on both sides of the layers of Cu octahedra.

The mineral is named for the locality. The type material is held in the collection of the Museo di Storia Naturale e del Territorio of the University of Pisa at Calci, Pisa, Italy (catalog no. 18900). **G.P.**

NIELSBOHRITE*

K. Walenta, F. Hatert, T. Theye, F. Lissner, and K. Röller (2009) Nielsbohrite, a new potassium uranyl arsenate from the uranium deposit of Menzenschwand, southern Black Forest, Germany. Eur. J. Mineral., 21, 515–520.

Nielsbohrite, ideally $K(UO_2)_3(AsO_4)(OH)_4\cdot H_2O$, is a new mineral species found in a uranium deposit situated in the Krunkelbach valley, near the village of Menzenschwand, in the southern Black Forest, Baden-Württemberg, Germany. It is associated with hematite, pyrite, schoepite, metazeunerite, and the gangue minerals quartz and barite. Details of the discovery of the mineral are not known, but samples most likely were found on the mine dumps. This is the type locality for five other mineral species: arsenuranospathite, joliotite, uranosilite, uranotungstite, and arsenovanmeersscheite. The hydrous solutions in the oxidized zone of the Menzenschwand deposit contain sufficient uranium as $(UO_2)^{2+}$ for the formation of nielsbohrite, which was released by alteration of uraninite.

Nielsbohrite occurs mainly in euhedral rhombohedron-like crystals reaching 0.15 mm in size, often altered, and showing the forms {001}, {100}, or {010}, and {210} or {120}. The mineral is yellow with a vitreous to dull luster and with a yellowish streak. It is non-fluorescent in ultraviolet light, brittle, and shows an irregular fracture without any visible cleavage. The estimated Mohs hardness is about 2, and the calculated density is 5.45–5.65 g/cm^3. Nielsbohrite is biaxial negative, with $n_\alpha = 1.756(2)$, $n_\beta = 1.764(2)$, and $n_\gamma = 1.765(2)$. No pleochroism was observed. The measured 2*V* angle is 35(5)°, and the calculated 2*V* angle is 39°, orientation Y = *c*. A strong r > v dispersion has been observed, with anomalous blue-green and reddish brown interference colors.

For the single-crystal study, two tiny crystals of nielsbohrite were measured on an Oxford Diffraction Xcalibur 4-circle diffractometer (Mo*K*α radiation, $\lambda = 0.71073$ Å), equipped with a Sapphire2 CCD-area detector (Ruhr-Universität Bochum, Germany). The single-crystal unit-cell parameters are $a = 8.193(3)$, $b = 11.430(4)$, $c = 13.500(5)$ Å, and $V = 1264.1(8)$ Å^3, with $Z = 4$, space group *Cccm*. The strongest lines of the powder X-ray diffraction pattern [d_{obs} Å(I_{obs} %,*hkl*)] are: 6.71(80,110), 6.03(100,111), 3.78(70,113), 3.33(80,220), 2.96(60,024), 2.63(50,204), and 1.942(50,244).

Electron-microprobe analysis gives K_2O 1.90, UO_3 83.34, As_2O_5 10.64, H_2O_{calc} 5.07, total 100.95 wt%. The empirical formula, calculated on the basis of 10 O + 4 OH structural anions per formula unit (pfu), is $(K_{0.430}\square_{0.570})(AsO_4)_{0.987}(UO_2)_{3.106}(OH)_4 \cdot 1.00H_2O$. The infrared spectrum of nielsbohrite is characterized by a very large absorption band centered around 3500 cm^{-1} and corresponding to the OH stretching vibrations, as well as a large domain located around 1000 cm^{-1} and corresponding to UO_2 and AsO_4 vibrations.

The structure consists of a uranyl arsenate framework composed of AsO_4 tetrahedra, U_3O_8 elongated hexagonal bipyramids, and $U1O_7$ pentagonal bipyramids. Pairs of uranyl pentagonal bipyramids are connected via edge-sharing to two adjacent hexagonal bipyramids, producing a heteropolyhedral chain topologically identical to those observed in minerals of the phosphuranylite group. These uranyl chains, which extend parallel to (110), are connected by edge-sharing with arsenate tetrahedra to form a framework. Each arsenate tetrahedron is linked to two chains by sharing two tetrahedral edges with uranyl hexagonal bipyramids of adjacent chains.

Type material is deposited at the Staatliches Museum für Naturkunde in Stuttgart, Germany, and the single crystal used for the structural study at the Laboratory of Mineralogy, University of Liège, Belgium (no. 20355). **K.T.T.**

OMONGWAITE*

F. Mees, F. Hatert, and R. Rowe (2008) Omongwaite, $Na_2Ca_5(SO_4)_6\cdot 3H_2O$, a new mineral from recent salt lake deposits, Namibia. Mineral. Mag., 72, 1307–1318.

Omongwaite is a new mineral found as inclusions in gypsum crystals found in deposits of the Omongwa pan, near Aminuis, 140 km SSE of Gobabis, southwestern Kalahari, Namibia. Omongwaite occurs within gypsum in samples from the gypsiferous part of the pan deposits. Crystals can be up to 200 μm long and 20 μm in length, but are generally much smaller. They are elongate, with a sphenoid termination and a psuedohexagonal cross-section. The inclusions mainly occur as bands or smaller groups of parallel crystals with constant orientation between clusters within the gypsum grain. The crystals show small variations in orientation, with fan-like or random patterns. The inclusion bands are parallel to the sides of the gypsum crystals, with the euhedral terminations pointing toward the center. The base of the omongwaite crystals are never in contact with the side of the gypsum crystal. It does not show a cleavage, and has a calculated density of 2.720 g/cm^3. In thin section, omongwaite is transparent, colorless, and non-fluorescent with an average refractive index higher than that of the enclosing gypsum (>1.53; $n_{calc} = 1.540$). The birefringence is ~0.015, orientation Z ~ c, with slight inclined extinction (<10°).

The chemical composition of omongwaite was determined by electron microprobe analyses (WDS) at –192 °C to limit dehydration and alkali cation migration within the sample. The average (range) of 175 analyses is: SO_3 56.16 (51.49–59.65), CaO 30.82 (29.12–33.36), Na_2O 5.25 (4.14–6.26), K_2O 3.21 (2.46–4.40), H_2O_{calc} 6.25, sum 101.69 wt%, corresponding to the empirical formula (calculated on the basis of 24 anhydrous apfu and $3H_2O$) $(Na_{1.47}K_{0.59})_{\Sigma 2.06}Ca_{4.76}S_{6.07}O_{24}\cdot 3H_2O$. The ideal formula is $Na_2Ca_5(SO_4)_6\cdot 3H_2O$, which requires Na_2O 7.07, CaO 31.98, SO_3 54.78, 6.17 H_2O, sum 100.00 wt%. The presence of H_2O was confirmed by Raman spectrometry (3527 cm^{-1}). Additional bands in the Raman spectrum include 436 (ν_2SO_4), 476 (ν_2SO_4), 608 (ν_4SO_4), 637 (ν_4SO_4), 665 (ν_4SO_4), 1013 (ν_1SO_4), and 1143 cm^{-1} (ν_3SO_4).

Powder X-ray diffraction data were collected on both a Bruker AXS Discover 8 microdiffractometer (Cu$K\alpha_1$ radiation), as well as a Gandolfi camera (Fe$K\alpha$ radiation). Intensity data from the microdiffractometer were unreliable; d_{obs} values for both data sets are presented here, with intensities taken from the Gandolfi pattern, $d_{GADDS}/d_{Gandolfi}$ Å($I_{Gandolfi}$ %,*hkl*): 6.005/6.053(75,110), 3.481/3.503(50,310), 3.015/3.038(100,220), 2.819/2.815(100,$\bar{1}$12), and 2.139/2.146(25,$\bar{4}$21). The mineral is monoclinic, *C*2, with unit-cell parameters refined from the powder X-ray diffraction data, a = 12.08(3), b = 6.96(1), c = 6.39(2) Å, β = 90.2(3)°, V = 537(2) Å^3, Z = 1. The crystal structure of synthetic omongwaite indicates that it is similar to that of bassanite. Omongwaite represents the end-member in a solid-solution series with bassanite. It is the result of topotatic replacement during interaction of gypsum with brines. Omongwaite has a higher solubility than gypsum and is only preserved where gypsum further overgrew the omongwaite.

The mineral is named after the type locality, the Omongwa pan. Both the mineral and name have been approved by the IMA CNMNC (no. 2003-054b). Holotype material has been deposited at the Royal Museum for Central Africa, Tervuren, Belgium (catalog no. RGM 15.908). **P.C.P.**

PAŠAVAITE*

A. Vymazalová, F. Laufek, M. Drábek, J. Haloda, and T. Sidorinová, and J. Plá Il (2009) Pašavaite, $Pd_3Pb_2Te_2$, a new platinum-group mineral species from the Noril'sk-Talnakh Ni-Cu camp, Russia. Can. Mineral., 47, 53–62.

Pašavaite occurs as subhedral inclusions (<20 μm) in polarite from a massive Cu-Ni ore from the Talnakh deposit in the Noril'sk-Talnakh mining camp, Taimyr autonomous District, Russia. The grains of polarite are enclosed in chalcopyrite-pentlandite and rimmed by Au-Ag phases and galena. The mineral is believed to have formed from a Pd-Pb-Te residual liquid (at 400–500 °C) as the last phase of liquid segregation of the Ni-Cu ores. The paucity of type material required the production of a synthetic analogue of $Pd_3Pb_2Te_2$ prepared using an evacuated silicon tube method with pure elements at a temperature of 400 °C for five months. The correspondence of the natural and synthetic material was verified using electron back-scattering diffraction, which showed that there was a very good match between pašavaite and the synthetic analogue. All physical properties except chemistry were determined using this synthetic material.

Pašavaite is brittle with a weak {001} cleavage, and a VHN_{25} of 233 kg/mm^2 (Mohs hardness = 2). Measured and calculated densities are 9.9 and 10.18 g/cm^3, respectively. In plane polarized light pašavaite (and the synthetic analogue) are pleochroic from brownish to light pink, distinctly to strongly anisotropic with no internal reflections. Megascopically the analogue is gray with a metallic luster and a gray streak. Reflectance values of the synthetic material in air (R_{max}, R_{min}) are: 49.9, 42.4 (470 nm), 51.8, 44.6 (546 nm), 52.2, 45.7 (589 nm), and 52.8, 46.9 (650 nm).

Chemical composition of the natural material was determined using WDS. The average of four analyses of the natural material was (range in parentheses) Pd 31.51 (31.31–31.68), Pb 41.54 (40.76–42.16), Bi 0.019 (0.06–0.42), Te 25.75 (25.61–26.10), total 98.99 giving an empirical formula of $Pd_{2.96}(Pb_{2.01}Bi_{0.01})Te_{2.02}$. The average of seven analyses of the synthetic material was (range in parentheses) Pd 32.17 (31.77–32.42), Pb 41.78 (41.40–42.16), Te 25.93 (25.68–26.30), total 99.88 wt%, giving an empirical formula of $Pd_{2.99}Pb_{2.00}Te_{2.01}$.

Powder diffraction data were collected from the synthetic material using Cu$K\alpha$ radiation with Bragg-Brentano geometry. The strongest lines in the powder X-ray powder diffraction pattern of synthetic pašavaite [d_{obs} Å(I_{obs}%,*hkl*)] are: 6.3152(34,001), 3.1572(33,002), 3.0495(100,211), 2.5456(63,202), 2.4424(34,220), 2.2786(42,221), 2.1637(71,022), 2.1496(30,400), 1.8906(42,203), and 1.5248(31,422). Due to the unsuitability of the synthetic material for single-crystal analysis the crystal structure was solved from the diffraction pattern using Rietveld refinement. R_F was 0.032 for 537 reflections. Pašavaite is orthorhombic with space group *Pmmn*, with a =8.599(1), b = 5.9381(6), c = 6.3173(8) Å, V = 322.6(1) Å^3, and Z = 2. The structure of pašavaite is described as a layered structure formed by face-sharing $[PdPb_4Te_2]$ octahedra parallel to the *b* axis. Two-independent Pd atoms are surrounded by four Pb and two Te atoms. The structure is similar to those of shandite and parkerite

The name is for Jan Pašava a geologist with the Czech Geological Survey. The holotype material, a polished section, is held in the collection of the Department of Mineralogy in the National Museum, Prague, Czech Republic (catalog no. P1p 15/2007). **G.P.**

NEW DATA

ERCITITE*

M.A. Cooper, F.C. Hawthorne, and P. Černỳ (2009) The crystal structure of ercitite, $Na_2(H_2O)_4[Mn^{3+}_2(OH)_2(PO_4)_2]$, and its relation to bermanite, $Mn^{2+}(H_2O)_4[Mn^{3+}_2(OH)_2(PO_4)_2]$. Can. Mineral., 47, 173–180.

Initial work on ercitite suggested that its relationship to bermanite $\{Mn^{2+}(H_2O)_4[Mn^{3+}_2(OH)_2(PO_4)_2]\}$ was more complicated than a simple chemical substitution. Data for this study was collected on the same piece of ercitite used in the original study. Single-crystal data were collected using a SMART 1K diffractometer and graphite monochromated Mo*K*α radiation. There were 431 unique observed reflections $|F_o \geq 4\sigma F_o)$ with $R_1 = 4.0\%$. Ercitite is orthorhombic, space group *Cmca*, $a = 6.2499(6)$, $b = 8.7479(9)$, $c = 19.9554(17)$ Å, $V = 1091.0$ Å^3, Z = 4. The structure was refined by direct methods.

There is one *P* site tetrahedrally coordinated by oxygen atoms and entirely filled with P. There are two octahedrally coordinated M sites. M1 is filled by trivalent Mn, ferric iron, and aluminum in order of decreasing abundance. The M2 is mainly vacant, with 7% divalent manganese. There is one Na site, six coordinated and occupied by $(Na_{0.89}Ca_{0.04}\square_{0.07})$. There are six anion sites: O2 is occupied by (OH), O5 and O6 are occupied by H_2O, and the remaining sites occupied by O^{2-}.

The structural unit in ercitite and bermanite, $[Mn^{3+}_2(OH)_2(PO_4)_2]$, is topologically identical in both structures. In ercitite these units are linked by corner-sharing Na-polyhedra, which share edges with polyhedra of the structural units. In bermanite the sheets are linked by shared polyhedra with interstitial $[Mn^{2+}O_2(H_2O)_4]$ octahedra. The change from the monoclinic cell in the original description to the orthorhombic cell described here changes some optical and physical properties to the following. Crystals are elongated along [010] and flattened on {100}; there are two good cleavages on {100} and {001}. The optical orientation is X = *c*, Y = *b*, Z = *a*. **G.P.**