

## New Mineral Names\*

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### BYKOVAITE\*

A.P. Khomyakov, Yu.P. Menshikov, G. Ferraris, P. Nemet, G.H. Nechelyustov (2005) Bykovaite, BaNa{(Na,Ti)<sub>4</sub>[(Ti,Nb)<sub>2</sub>(OH,O)<sub>3</sub>Si<sub>4</sub>O<sub>14</sub>](OH,F)<sub>2</sub>}·3H<sub>2</sub>O, a new heterophyllosilicate from the Lovozero Alkaline Massif, Kola Peninsula, Russia. Zap. Ross. Mineral. Obshch., 134(5), 40–48 (in Russian, English abstract).

Bykovaite is a new mineral species from the Shkatulka pegmatite vein at Mt. Alluaiv, Lovozero alkaline massif, Kola Peninsula, Russia. The vein consists of a central ussingitic core surrounded by a zone of mostly microcline and aegirine at the margins, and lies in poikilitic nepheline-sodalite syenite of the central part of the Lovozero complex. Bykovaite occurs in the ussingitic core, mostly as “chains” of spherulites that nucleated on plates of vuonnemite now in contact with ussingite. The spherulites are cream colored (sometimes with weak pinkish or yellowish tones), which would seem to be the only visual characteristic distinguishing bykovaite from bornemanite, which is nearly identical except for the characteristically pale yellow color of its spherulites. This is made all the more difficult by the fact that bykovaite and bornemanite occur in the same zone of the Shkatulka vein and are commonly intermixed due to incomplete pseudomorphism of bykovaite after bornemanite. Individual fibers within the spherulites range from 0.005 to 0.05 mm in thickness. Bykovaite has a white streak and silky luster and is brittle. Perfect {001} cleavage, imperfect {100}; fibrous fracture. Individual fibers (elongated along *b*) show (001) faces. Mohs' hardness 3.  $D_{\text{meas}} = 2.98(3)$ ,  $D_{\text{calc}} = 2.72 \text{ g/cm}^3$ , the discrepancy being due to minor contamination by relict bornemanite and a lemmleinite-Ba-like mineral. The mineral is stable in water, but decomposes slowly in solutions of 10% HCl or HNO<sub>3</sub>. Light gray to colorless in thin section. Biaxial (+), non-pleochroic,  $\alpha = 1.668(2)$ ,  $\beta = 1.679(2)$ ,  $\gamma = 1.710(3)$ ;  $2V_{\text{meas}} = 63(5)$ ,  $2V_{\text{calc}} = 63^\circ$ ; straight extinction and positive elongation with respect to fiber length; orientation matrix  $a \approx Y$ ,  $b \approx Z$ ,  $c \approx X$ . Thermal analysis indicates 10.0% H<sub>2</sub>O. Absorption maxima at 3420 and 1655 cm<sup>-1</sup> in the IR spectrum indicate that the water is present both as molecular H<sub>2</sub>O and OH. Electron microprobe analysis (average

of five grains) gives Na<sub>2</sub>O 13.34, K<sub>2</sub>O 0.67, CaO 0.20, SrO 0.66, BaO 13.22, FeO 0.28, MnO 2.22, Al<sub>2</sub>O<sub>3</sub> 0.15, SiO<sub>2</sub> 29.05, TiO<sub>2</sub> 18.93, Nb<sub>2</sub>O<sub>5</sub> 10.75, F 1.40, O ≡ F -0.59, which with the 10.0 H<sub>2</sub>O, above, gives a total of 100.28%. The empirical formula on a basis of 4(Si,Al) is: (Ba<sub>0.71</sub>Na<sub>0.47</sub>K<sub>0.12</sub>Sr<sub>0.05</sub>)<sub>Σ1.35</sub>(Na<sub>3.07</sub>Ti<sub>0.61</sub>Mn<sub>0.26</sub>Ca<sub>0.03</sub>Fe<sub>0.03</sub>)<sub>Σ4.00</sub>(Ti<sub>1.34</sub>Nb<sub>0.66</sub>)<sub>Σ1.00</sub>(Si<sub>3.98</sub>Al<sub>0.02</sub>)O<sub>14</sub>[(OH)<sub>3.13</sub>F<sub>0.61</sub>O<sub>0.58</sub>]<sub>Σ4.32</sub>·3H<sub>2</sub>O, which from structural considerations leads to a simplified formula of (Ba,Na,K,Sr)<sub>2</sub>{(Na,Ti,Mn)<sub>4</sub>[(Ti,Nb)<sub>2</sub>(OH, O)<sub>3</sub>Si<sub>4</sub>O<sub>14</sub>]}(OH,F)<sub>2</sub>·3H<sub>2</sub>O. Powder X-ray diffraction studies, supported by SAED, give  $a = 5.552(1)$ ,  $b = 7.179(1)$ ,  $c = 50.94(1)$  Å,  $\gamma = 91.10(1)^\circ$ ,  $Z = 4$ , space group *I11b*. These cell parameters are very similar to those of bornemanite, except for a nearly 3 Å increase in *c* due to the presence of interlayer H<sub>2</sub>O in bykovaite instead of PO<sub>4</sub> groups in bornemanite. The strongest lines in the powder diffraction pattern of bykovaite are [*d* Å (%; *hkl*): 25.5(100; 002), 12.74(14; 004), 8.48(72; 006), 3.44(14; 0.1.13), 3.17(74; 0.0.16), 2.763(20; 127, 202, 0.2.12), 2.110(14; 0.0.24, 0.1.23, 1.2.17, 136, 226)]. By analogy with other members of the lomonosovite-murmanite-vuonnemite-epistolite-bornemanite structural family, bykovaite is expected to have (1) bafertisite-like packets consisting of a central layer of closely packed NaO<sub>6</sub> and TiO<sub>6</sub> octahedra sandwiched between layers composed of Si<sub>2</sub>O<sub>7</sub> groups interconnected by (Ti,Nb)O<sub>6</sub> octahedra and Na atoms, supplemented by (2) lomonosovite-like interlayers hosting Na and Ba cations and H<sub>2</sub>O molecules, and (3) seidozerite-like interlayers that host only Na. Bykovaite is expected to inherit these structural features from the bornemanite it replaces, except that H<sub>2</sub>O molecules in the lomonosovite-like interlayers of bykovaite displace PO<sub>4</sub> molecules of this interlayer in bornemanite. As a consequence of these structural relationships, the authors propose the ideal structural formula for bykovaite given in the title of the paper. Bykovaite is named to honor analytical chemist Alexandra Vasilyevna Bykova (1917–2001), who first discovered that bornemanite could be transformed to a synthetic form of bykovaite upon treatment with water. Type material is stored at the museum of the St. Petersburg Mining Institute, Russia, catalog number 2869/2. **T.S.E.**

### CHALLACOLLOITE\*

J. Schlüter, D. Pohl, S. Britvin (2005) The new mineral chalcocolloite, KPb<sub>2</sub>Cl<sub>5</sub>, the natural occurrence of a technically known laser material. N. Jb. Miner. Abh., 182, 95–101.

Chalcocolloite was described from the Chalcocollo silver mine, south east of Iquique, Atacama desert, northern Chile. The mineral was also subsequently found in samples from Vesuvius

\* Before publication, minerals marked with an asterisk were approved by the Commission on New Minerals and Mineral Names, International Mineralogical Association.

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(Italy) and many analyses for both samples are discussed in the publication. At the Challacollo mine, it occurs intergrown with cotunnite ( $\text{PbCl}_2$ ) and a mixture of boleite and pseudoboleite in aggregates up to 4 mm in size. It is also associated with hemimorphite, caracoite, anglesite, nitratine, anhydrite, and fluorite in quartz vugs. At Vesuvius, it is also found associated with cotunnite as a crust, and as botryoidal aggregates in a leucotephritic lava. The aggregates are comprised of subparallel intergrowths of bent lamellae, 2–5  $\mu\text{m}$  in width, 50  $\mu\text{m}$  in length and probably elongated along [100]. The mineral is colorless to white, with a white streak. It is brittle with subconchoidal fracture and a Mohs hardness of approximately 2 to 3. It has an adamantine luster on fresh surfaces to a greasy luster when exposed to the atmosphere and shows no fluorescence. Challacolloite dissolves in  $\text{H}_2\text{O}$  and  $\text{HCl}$ . Electron microprobe analyses of challacolloite from Challacollo (average of 8 analyses) gave K 5.45, Pb 66.30, Cl 28.69, sum 100.44 wt%, corresponding to  $\text{K}_{0.88}\text{Pb}_{2.02}\text{Cl}_{5.00}$  based on 5 anions. Analyses of material from Vesuvius (average of 7 analyses) gave K 6.4, Pb 66.1, Cl 28.2, sum 100.7 wt%, corresponding to  $\text{K}_{1.02}\text{Pb}_2\text{Cl}_{4.98}$  based on 8 atoms. The simplified formula is  $\text{KPb}_2\text{Cl}_5$ . No absorption bands were observed in the IR spectrum between 400 and 3800  $\text{cm}^{-1}$ . Challacolloite is biaxial positive,  $\alpha = 2.004(2)$ ,  $\beta = 2.010(2)$ ,  $\gamma = 2.024(3)$ ,  $2V_{\text{calc}} = 67^\circ$ . Many physical and optical properties could not be assessed due to the minute grain size and the curvature of the lamellae.

Challacolloite is monoclinic, space group  $P2_1/c$ , with unit-cell parameters refined from powder X-ray diffraction data for the Challacollo sample:  $a = 8.864(8)$ ,  $b = 7.932(8)$ ,  $c = 12.491(11)$  Å,  $\beta = 90.153(5)^\circ$ ,  $V = 878.2(1)$  Å<sup>3</sup>,  $D_{\text{calc}} = 4.77$  g/cm<sup>3</sup>. Rietveld refinement was performed using starting positional coordinates of the  $\text{NH}_4\text{PbCl}_5$  structure (Ras et al. 1977, *Acta Crystallogr.*, B33, 259–260), which converged to  $R_{\text{wp}} = 9.48$ . For the Vesuvius sample,  $a = 8.887(2)$ ,  $b = 7.939(1)$ ,  $c = 12.489(2)$  Å,  $\beta = 90^\circ$ ,  $V = 881.1(5)$  Å<sup>3</sup>,  $D_{\text{calc}} = 4.76$  g/cm<sup>3</sup>. The strongest lines on the powder X-ray diffraction pattern for the Challacollo mine sample (Philips X'pert powder diffractometer,  $\text{CuK}\alpha$  radiation, 47 lines given) include 8.855(39,100), 6.681(12,011), 5.335(14,11 $\bar{1}$ ,111), 5.097(10,102), 3.961(31,020), 3.686(100,211,013), 3.609(49,20 $\bar{2}$ ,202), 3.400(13,11 $\bar{3}$ ,113), 2.873(10,22 $\bar{1}$ ,221), 2.669(42,22 $\bar{2}$ ,30 $\bar{2}$ ,222), 2.548(18,204,420), 2.346(13,132,213), 2.231(13,033), 2.215(13,400,322), and 2.095(16,215). The strongest lines on the powder X-ray diffraction pattern for the Vesuvius sample (DRON-2 diffractometer,  $\text{CoK}\alpha$  radiation, 50 lines given) include 8.88(100,100), 5.92(19,110), 3.970(44,020), 3.699(99,211,211,013), 3.621(71,120,202,202), 2.676(57,302,302,222,222), 2.554(24,204,204), 2.350(20,132,132), 2.233(23,231,231,033), 2.220(45,400,322,322), and 2.100(20,215,215). A single crystal X-ray structural analysis was not possible due to the small crystal size and curvature of the lamellae. The unit cell parameters of challacolloite are pseudo-orthorhombic. The loss of a mirror plane reducing the symmetry differentiates it from orthorhombic  $\text{KPb}_2\text{Cl}_5$ . Challacolloite has an isotopic structure to the  $\text{NH}_4\text{PbCl}_5$  and  $\text{PbU}_2\text{Se}_5$  compounds and is homeotopic with  $\text{U}_3\text{Se}_5$ , an orthorhombic compound. The mineral is named after the type locality (IMA no. 2004-028). Type material has been deposited at the Mineralogical Museum of the University of Hamburg, Germany. **R.R.**

### CLINOHYDROXYLAPATITE\*

A.R. Chakhmouradian, L. Medici (2006) Clinohydroxylapatite: a new apatite-group mineral from northwestern Ontario (Canada), and new data on the extent of Na-S substitution in natural apatites. *Eur. J. Mineral.*, 18, 105–112.

Clinohydroxylapatite occurs as spherulites less than 30  $\mu\text{m}$  in size made of acicular crystals. Single crystals are elongated in their [001] axis and only a few microns in thickness. The mineral is white with a chalky luster, and has a Mohs hardness of 5. It has no discernible cleavage, and is brittle with a splintery fracture. In thin section, under plane-polarized light, it is colorless and transparent. Quantitative EDS analyses by electron microprobe (average of 28 analyses) gave  $\text{Na}_2\text{O}$  3.29,  $\text{CaO}$  50.07,  $\text{SrO}$  0.30,  $\text{La}_2\text{O}_3$  0.07,  $\text{Ce}_2\text{O}_3$  0.17,  $\text{SiO}_2$  0.19,  $\text{P}_2\text{O}_5$  33.20,  $\text{SO}_3$  10.01, Cl 1.64,  $\text{H}_2\text{O}$  1.38,  $-\text{O} = \text{Cl}_2$  0.37, sum 99.95 wt%, corresponding to  $(\text{Ca}_{4.466}\text{Na}_{0.531}\text{Sr}_{0.015}\text{La}_{0.002}\text{Ce}_{0.005})_{\Sigma 5.019}(\text{P}_{2.340}\text{S}_{0.625}\text{Si}_{0.016})_{\Sigma 2.981}\text{O}_{12}(\text{OH}_{0.769}\text{Cl}_{0.231})_{\Sigma 1.000}$ , based on [12O + (OH + Cl)]. The simplified, ideal formula is  $(\text{Ca},\text{Na})_5[(\text{P},\text{S})\text{O}_4]_3(\text{OH},\text{Cl})$  based on 20 atoms. Raman spectroscopy indicates bands at 590, 650, 960, and 1005  $\text{cm}^{-1}$  [ $(\text{PO}_4)^{3-}$  and  $(\text{SO}_4)^{2-}$  bending and stretching modes], and bands at 3200–3250  $\text{cm}^{-1}$  [(OH) stretching modes]. There is no evidence for the presence of  $(\text{CO}_3)^{2-}$  groups.

Clinohydroxylapatite was identified by its distinctive X-ray diffraction pattern. The investigation of the pattern led to the identification of reflections that indicated a deviation from hexagonal apatite  $P6_3/m$  and monoclinic apatite group minerals like hydroxyllestadite,  $P2_1/m$ . These different reflections are observed in monoclinic apatite-like compounds  $\text{Ca}_5(\text{PO}_4)_3\text{OH}$  with lowered symmetry  $P2_1/b$  (Elliott et al. 1973, *Science* 180, 1055–1057).  $P2_1/b$  is inferred to be the accurate space group for clinohydroxylapatite and that the monoclinic distortion would be caused by the ordering of anions in structural tunnels. The unit cell parameters were refined from the powder X-ray diffraction data and indexed on a  $P2_1/b$  cell giving  $a = 9.445(2)$ ,  $b = 18.853(4)$ ,  $c = 6.8783(6)$  Å,  $\gamma = 120.00(2)^\circ$ ,  $Z = 4$ ,  $D_{\text{meas}} = 3.07$  g/cm<sup>3</sup>,  $D_{\text{calc}} = 3.13$  g/cm<sup>3</sup>. The strongest lines on the powder X-ray diffraction pattern (Rigaku D-max Rapid micro-diffractometer,  $\text{CuK}\alpha$ , 64 lines given) include 3.440(20,002), 2.817(66,161), 2.781(41,142), 2.724(79,060), 2.630(24,242), 2.499(18,271), 2.267(100,320), 1.945(39,242), 1.892(15,162), 1.841(58,223), 1.784(70,420), 1.454(19,064). Clinohydroxylapatite is a member of the apatite group. It is the monoclinic equivalent of hydroxylapatite and structurally, the analog of synthetic  $\text{Ca}_5(\text{PO}_4)_3\text{OH}$  (Elliott et al. 1973, *Science*, 180, 1055–1057).

Clinohydroxylapatite occurs in altered leucogabbro in a unit of the Seagull ultramafic intrusion located 7.5 km SSW of the Wolf Mountain and 50 km W of the town of Nipigon, Thunder Bay district, northwestern Ontario, Canada. It is part of a mineral assemblage replacing metasomatized plagioclase, associated with plagioclase, clinopyroxene, prehnite, hibschite, a Ca silicate (tobermorite?), montmorillonite-type clay, ilmenite, titanite, rutile, and sphalerite. The mineral name is given based on its structure and relation to other apatite-group minerals (IMA 2004-006). Type material has been deposited

at the R.B. Ferguson Museum of Mineralogy, University of Manitoba, Canada. **R.R.**

### FARNESEITE\*

F. Cámara, F. Bellatreccia, G. Della Ventura, A. Mottana (2005) Farneseite, a new mineral of the cancrinite-sodalite group with a 14-layer stacking sequence: occurrence and crystal structure. *Eur. J. Mineral.*, 17, 839–846.

Farneseite, a new member of the cancrinite-sodalite group, occurs as transparent, colorless, prismatic crystals in vugs between interlocking feldspars within a pyroclastic rock. Crystals are elongated along [001], 0.5 mm in length, and show complex hexagonal morphologies with streaked faces. Farneseite has a vitreous luster, is not fluorescent, has a poor cleavage on {001}, no parting, and is brittle with a conchoidal fracture. The mineral is uniaxial positive,  $\omega = 1.499(1)$  and  $\epsilon = 1.503(1)$ , colorless and non-pleochroic in thin section. Chemical analyses by electron microprobe (WDS) gave SiO<sub>2</sub> 33.00, Al<sub>2</sub>O<sub>3</sub> 27.34, CaO 6.34, Na<sub>2</sub>O 14.59, K<sub>2</sub>O 5.59, SO<sub>3</sub> 11.82, F 0.04, Cl 0.22, H<sub>2</sub>O<sub>calc</sub> 0.71, –O = (F,Cl) 0.07, total 99.58 wt%, corresponding to (Na<sub>36.43</sub>K<sub>9.18</sub>Ca<sub>8.75</sub>)<sub>Σ54.36</sub>(Si<sub>42.50</sub>Al<sub>41.50</sub>)<sub>Σ84.00</sub>O<sub>168</sub>(SO<sub>4</sub>)<sub>11.43</sub>F<sub>0.16</sub>Cl<sub>0.48</sub>·3.03H<sub>2</sub>O based on 84 Si + Al atoms pfu. The H<sub>2</sub>O content was calculated and confirmed by structural methods. The FTIR spectrum indicates only H<sub>2</sub>O and no OH. The ideal formula of farneseite is [(Na,K)<sub>46</sub>Ca<sub>10</sub>]<sub>Σ56</sub>(Si<sub>42</sub>Al<sub>42</sub>O<sub>168</sub>)(SO<sub>4</sub>)<sub>12</sub>·6H<sub>2</sub>O. The FTIR spectrum of farneseite contains bands at 7050, 5236, 3518, 3285, and 1635 cm<sup>-1</sup> (H<sub>2</sub>O), 2352 cm<sup>-1</sup> (CO<sub>2</sub>), 1420 cm<sup>-1</sup> (CO<sub>3</sub>), 1120 cm<sup>-1</sup> (SO<sub>4</sub>), 1004 cm<sup>-1</sup> (T-O framework stretching), and 551 cm<sup>-1</sup> (not assigned).

The structure of farneseite was solved by direct methods and refined using a 0.3 × 0.23 × 0.23 mm crystal,  $R_1 = 0.0765$  for 7884 reflections with  $I > 2\sigma(I)$ . It is hexagonal,  $P6_3/m$ ,  $a = 12.8784(2)$ ,  $c = 37.0078(12)$  Å,  $V = 5315.5(2)$  Å<sup>3</sup>,  $Z = 1$ ,  $D_{\text{calc}} = 2.425$  g/cm<sup>3</sup>. The strongest lines in the powder X-ray diffraction pattern (Scintag X1 diffractometer, CuK $\alpha$  radiation, 37 lines given) include: 6.448(15,110), 5.404(20,106), 4.278(18,108), 3.994(15,213), 3.862(23,109), 3.842(17,207,214), 3.722(100,300), 3.668(26,215), 3.485(65,216), 3.119(36,218,223), 2.857(18,315,1.1.12), 2.648(32,0.0.14, 228), 2.613(17,405,1.0.14), 2.156(17,3.0.14,418), and 2.149(34,4.0.11,330). The structure of farneseite consists of a stacking sequence of 14 layers of six-membered rings of tetrahedra along the  $c$  axis. SO<sub>4</sub> occurs in the liottite cages surrounded by Na, K, and Ca, highly disordered SO<sub>4</sub> occurs in the sodalite cages, and H<sub>2</sub>O occurs in the cancrinite cages. The stacking sequence is ABCABABACBACAC where A, B, and C represent the positions of rings in the layers, giving rise to liottite, sodalite, and cancrinite cages. Farneseite is part of the complex sequence of cancrinite-sodalite minerals (N = number of layers): bystryte N = 4, liottite N = 6, afghanite N = 8, franzinite N = 10, tounkite and marinellite N = 12, farneseite N = 14, giuseppettite N = 16, and sacrofanite N = 28.

Farneseite was collected within a pyroclastic sequence from Farnese, Viterbo Province (north of Rome), associated with the Latera caldera collapse in the Latium volcanic area, Italy. The pyroclastic sample consisted of a 3 × 3 cm fragment of fine-grained, syenitic-looking rock composed of sanidine with minor

andradite, augite, biotite, Fe-oxides, and feldspathoids. The name is for the type locality. Type material (IMA 2004-043) has been deposited at the Museum of Mineralogy, University of Rome, La Sapienza (catalog no. 33000/1). **P.C.P.**

### KALUNGAITE\*

N.F. Botelho, M.A. Moura, R.C. Peterson, C.J. Stanley, D.V.G. Silva (2006) Kalungaite, PdAsSe, a new platinum-group mineral from the Buraco do Ouro gold mine, Cavalcante, Goiás State, Brazil. *Mineral. Mag.*, 70, 123–130.

Kalungaite is a new mineral from the Buraco do Ouro gold mine, Cavalcante town, Goiás State, central Brazil. The gold deposit is hosted by a muscovite mylonite related to a E-W trending shear zone in a peraluminous granite of the Aurumina Suite (2.15 Ga), which intrudes graphite-bearing metasedimentary rocks of the Ticunzal Formation. The mineral occurs as anhedral crystals up to 0.3 mm in composite grains with gold and other platinum-group minerals (bohdanowiczite, guanajuatite, clausenthalite, stibiopalladinite, sperrylite, and padmaite) in platy, anhedral aggregates within grayish-green muscovite-rich zones of the mylonite. Other associated minerals include chalcopyrite, muscovite, quartz, tourmaline, and magnetite. Kalungaite is lead gray, has a metallic luster, black streak, is brittle, has an uneven fracture, and does not have cleavage. The mineral has a microindentation hardness of VHN<sub>25</sub> = 438, which corresponds to a Mohs' hardness of 4 to 5. In plane-polarized light, kalungaite is cream to creamy-gray, has no internal reflections, and is isotropic. Reflectance measurements in air/oil gave 47.5/33.3 (470 nm), 46.9/32.6 (546 nm), 46.8/32.6 (589 nm), and 48.0/34.0 (650 nm).

Electron microprobe analyses of kalungaite (WDS, average of 8 analyses) gave Pd 41.32 (41.07–41.58), As 27.49 (27.15–27.77), Bi 0.35 (0.27–0.43), Sb 1.59 (1.43–1.80), Se 27.67 (26.73–28.33), S 1.22 (1.00–1.64), total 99.64 wt%, corresponding to Pd<sub>1.006</sub>(As<sub>0.950</sub>Sb<sub>0.034</sub>Bi<sub>0.004</sub>)<sub>Σ0.988</sub>(Se<sub>0.908</sub>S<sub>0.099</sub>)<sub>Σ1.007</sub> based on three atoms pfu. The ideal formula is PdAsSe.

The crystal structure of kalungaite could not be determined by single-crystal methods due to the lack of a suitable inclusion-free single crystal. Powder X-ray diffraction data were collected using a 114.6 mm Gandolfi camera (CoK $\alpha$  radiation). Refinement of the powder data suggests that kalungaite is cubic,  $Pa\bar{3}$ ,  $a = 6.089(5)$  Å,  $V = 225.78$  Å<sup>3</sup>,  $Z = 4$ ,  $D_{\text{calc}} = 7.59$  g/cm<sup>3</sup>. The calculated X-ray diffraction pattern utilized  $x$  coordinate data for As and Se based on the structure of PtAs<sub>2</sub> (Brese and Von Schnering, 1994, *Zeit. Anorganische Allgemeine Chem.*, 620, 393–404). The strongest lines in the powder X-ray diffraction pattern [26 lines given,  $d(I_{\text{obs}}, hkl)$ ] include 3.027(75,002), 2.725(65,021), 2.478(65,112), 2.152(40,022), 1.838(100,113), 1.761(20,222), 1.685(30,023), 1.625(55,123), 1.361(20,024), 1.329(20,142), 1.241(30,224), 1.172(95,115), 1.131(60,025), 1.112(40,125), 1.077(80,044), 1.015(006), 0.988(70,116), 0.963(50,026), 0.929(90,335), and 0.918(70,226).

Kalungaite is thought to have formed during syn-emplacment deformation and hydrothermal alteration of the peraluminous granite. The source of the metals is unknown, but is possibly the graphite-rich host rocks. Deposition of the Au, Pd, Se, and As in the Buraco do Ouro deposit could be the result

of saline and acidic fluids from the granite interacting with the host rocks. The name is for the Kalunga people, a community of descendants of African slaves living in Cavalcante and nearby towns (IMA no. 2004-047). Co-type material in the form of a polished thin section has been deposited at the Natural History Museum, London (catalog no. BM2004,35).

**Discussion:** the observed and calculated intensities for the powder X-ray diffraction pattern are not in good agreement. No explanation is given for these large discrepancies. **P.C.P.**

#### LAFOSSAITE\*

A.C. Roberts, K.E. Venance, T.M. Seward, J.D. Grice, W.H. Paar (2006) Lafossaite, a new mineral from the La Fossa Crater, Vulcano, Italy. *Mineral. Rec.*, 37, 165–168.

Lafossaite was found as a drusy coating on one surface of a single specimen collected from an active fumarole of the La Fossa crater, Vulcano, Italy. Single crystals are subhedral (predominant) to euhedral cubes, cuboctahedra and octahedra, and are up to 0.2 mm in size. Forms observed include {100} major (lustrous), {111} minor (non-lustrous), and {110} very minor (non-lustrous). The mineral is malleable, estimated Mohs' hardness 3–4, translucent with resinous to greasy luster, gray-brown (close to Royal Horticultural Society color chart number 199D), has an off-white to cream streak that appears resinous, has a subconchoidal fracture, and no observable cleavage or parting. It is non-fluorescent, with measured index of refraction much greater than 1.80. In plane-polarized reflected-light, lafossaite is grayish-white with distinct white internal reflections. The mineral shows no birefractance, no pleochroism, and no anisotropy. Reflectance values of lafossaite (in air, Zeiss 314 WTiC standard) are (R) 16.0 (470 nm), 15.2 (546 nm), 15.0 (589 nm), and 14.7 (650 nm). For 589 nm, the calculated index of refraction is 2.264. The average of fourteen electron microprobe analyses gave Ti 81.74, Cl 10.79, Br 5.99, sum 98.52 wt%, corresponding to  $Ti_{1.027}Cl_{0.781}Br_{0.192}$  for two atoms, ideally TiCl. The mineral is soluble in dilute HCl. Single-crystal precession study with Zr-filtered Mo X-radiation showed the mineral to be cubic,  $a = 3.901 \text{ \AA}$ , with space group assumed to be  $Pm\bar{3}m$ , by analogy with the synthetic equivalent (PDF 78-625). Powder diffraction data were collected with a Debye-Scherrer camera (114.6 mm,  $\lambda = 1.54178 \text{ \AA}$ ) and yielded refined unit cell parameter  $a = 3.8756(3) \text{ \AA}$ ,  $V = 58.212(8) \text{ \AA}^3$ , and the strongest lines [ $d_{\text{meas}}$  in  $\text{Å}$  ( $I, hkl$ ): 3.887 (80,100), 2.745 (100,110), 2.237 (55,111), 1.937 (50,200), 1.733 (45,210), 1.583 (70,211), 1.370 (25,220), 1.291 (20,221/300), 1.226 (25,310), 1.119 (15,222)].  $D_{\text{calc}} = 7.21$  for the empirical formula and the cell refined from powder data, 6.84 g/cm<sup>3</sup> for the ideal formula and  $Z = 1$ . Lafossaite is isostructural with sal ammoniac,  $NH_4Cl$ . Both minerals have the well-known CsCl structure; KCl and RbCl adopt this structure-type only under conditions of elevated pressure or cryogenic temperature. Lafossaite is only the second mineral to contain both essential Ti and Cl, along with thalferite,  $Tl_6(Fe, Ni, Cu)_{25}S_{26}Cl$ .

Lafossaite occurs as a drusy coating of tiny crystals formed by sublimation directly from fumarolic gas and is associated with other sublimate minerals including cannizzarite, galenobismutite, pyrite and an undefined Fe-K silicate. Despite an extensive search for further material, only a single specimen was

recovered from an active fumarole on the rim of the La Fossa crater on the island of Vulcano, Aeolian archipelago, Sicily, Italy (38° 23' N, 14° 58' E). The lafossaite condensed at about 400 °C from fumarolic gas that contained appreciable HF, HCl and HBr, and up to 2.25 mg/kg of thallium. The authors note the close similarity of the powder diffraction patterns of lafossaite and sal ammoniac ( $a = 3.868\text{--}3.878 \text{ \AA}$ ), which has also been identified from the fumaroles of Vulcano, and recommend that chemical data be used to assist in distinguishing the two minerals. Lafossaite is named after the type locality and corresponds to IMA mineral No. 2003-032. The holotype is housed in the research collection of T.M. Seward at the Institut für Mineralogie und Petrographie of Eidgenössische Technische Hochschule Zürich, Switzerland, a portion of which has been deposited in the Systematic Reference Series of the National Mineral Collection of Canada, Geological Survey of Canada, Ottawa, catalog number 68098. The polished section used for reflectance measurements and electron microprobe analysis has been deposited with the Natural History Museum, London, U.K. under catalog number BM2004,55. **A.J.L.**

#### PARATOOITE-(La)\*

A. Pring, K. Wallwork, J. Brugger, U. Kolitsch (2006) Paratooite-(La), a new lanthanum-dominant rare-earth copper carbonate from Paratoo, South Australia. *Mineral. Mag.*, 70, 131–138.

Paratooite-(La) occurs as pale turquoise-blue to light blue sheaves and radiating sprays of blade-like to tabular crystals up to  $200 \times 30 \times 5 \mu\text{m}$  in size. It is transparent, has a vitreous to pearly luster, is not fluorescent in long- or short-wave ultraviolet light, and has an estimated Mohs hardness of 4. No cleavage was observed, but the morphology and TEM imaging suggests that the cleavage should be {100}. Paratooite-(La) reacts quickly with dilute HCl with effervescence, dissolves slowly in cold 10%  $HNO_3$ , but rapidly with effervescence and discoloration when the acid solution is heated. The mineral is very pale blue in thin section, biaxial negative with  $\alpha = 1.605(3)$ ,  $\beta = 1.696(3)$ , and  $\gamma = 1.752(2)^\circ$ . It displays moderate pleochroism,  $X$  very pale blue  $\ll Y$  bluish  $\approx Z$  bluish,  $2V_{\text{calc}} = 72.6^\circ$ . The dispersion could not be measured.

Chemical analyses of paratooite-(La) (WDS and CHN) gave [wt%(range)]  $Y_2O_3$  0.72(0.58–0.75),  $La_2O_3$  26.47(25.4–27.3),  $Pr_2O_3$  7.74(7.5–7.9),  $Nd_2O_3$  8.15(7.5–8.4),  $Sm_2O_3$  0.66(0.5–1.0),  $Gd_2O_3$  0.85(0.7–1.0), CaO 7.57(6.9–8.1), SrO 3.15(2.6–3.7), CuO 5.77(5.6–6.2),  $Na_2O$  3.30(3.2–3.6), F 0.24(0.0–0.5),  $CO_2$  32.05,  $NO_2$  1.12,  $-H_2O$  2.34,  $-O=F$  0.10, total 100.03. The  $H_2O$  is thought to be due to absorbed water or contamination; neither the IR nor Raman spectra indicate the presence of structural water. Similarly, the authors are unsure as to the identity of the  $NO_2$ , whether it is truly part of the structure or an artifact. As such, two empirical formulae were calculated: (1) including  $NO_2$  -  $(La_{3.54}Ca_{2.94}Na_{2.32}Nd_{1.05}Pr_{1.03}Sr_{0.66}Y_{0.14}Gd_{0.10}Sm_{0.08})_{\Sigma 11.86}Cu_{1.58}(C_{15.84}N_{0.53})O_{47.76}F_{0.24}$ , and (2) excluding  $NO_2$  -  $(La_{3.62}Ca_{3.00}Na_{2.37}Nd_{1.08}Pr_{1.05}Sr_{0.68}Y_{0.14}Gd_{0.10}Sm_{0.08})_{\Sigma 12.12}Cu_{1.61}C_{16.20}O_{47.72}F_{0.28}$ . The simplified ideal formula is either  $(REE, Ca, Na, Sr)_6Cu(CO_3)_8$  or  $REE_3(Ca, Sr)_2NaCu(CO_3)_8$ ,  $Z = 2$ ,  $D_{\text{meas}} = 3.68(3) \text{ g/cm}^3$ ,  $D_{\text{calc}} = 3.78 \text{ g/cm}^3$ . The single-crystal Raman (785 nm red laser)

spectrum of paratooite-(La) is dominated by two strong, narrow bands at 1095 and 1075  $\text{cm}^{-1}$ , which are assigned to stretching vibrations of  $\text{CO}_3$  groups. Bands with frequencies  $<1000 \text{ cm}^{-1}$  are due to bending vibrations of  $\text{CO}_3$  groups, vibrations of metal-oxygen polyhedra, and lattice vibrations. The infrared spectrum of paratooite-(La) confirms the absence of  $\text{H}_2\text{O}$  and OH.

A full structural analysis is required to determine the correct ideal formula for paratooite-(La) and to clarify questions regarding  $\text{CO}_3$ ,  $\text{H}_2\text{O}$  and  $\text{NO}_2$ , as well as ordering of REE and Na in the large cation sites. Attempts to solve the crystal structure by *ab initio* methods from powder X-ray diffraction data were not successful, but a fitting of the X-ray pattern by the *Le Bail* profile method yielded the following primitive orthorhombic cell:  $a = 10.0862(5)$ ,  $b = 12.8088(6)$ ,  $c = 7.2360(4)$  Å,  $V = 934.8(1)$  Å<sup>3</sup>, with space group choices  $P222$ ,  $Pmmm$ ,  $P222_1$ , or  $Pmm2$ . Powder X-ray diffraction data (88 lines observed) were obtained using a 100 mm Guinier-Hgg camera (CrK $\alpha$  radiation) and synchrotron radiation ( $\lambda = 0.7012$  Å; Photon Factory, Tsukuba, Japan). The strongest lines on the powder pattern include [ $d_{hkl}$  synchrotron,  $d_{hkl}$  Guinier-Hagg( $I, hkl$ )]: 6.40, 6.405(25,020); 5.04, 5.043(53,200); 4.80, 4.796(49,021); 4.33, 4.331(16,121); 3.96, 3.962(43,220); 3.48, 3.482(43,012); 2.97, 2.971(16,231,311); 2.94, 2.940(100,202); 2.93, 2.928(52,041); 2.87, 2.865(36,212); 2.53, 2.532(52,241); 2.52, 2.522(37,400); 2.35, 2.346(22,420,103); 2.23, 2.232(20,421); 2.13, 2.135(32,060); 2.08, 2.080(17,431); 2.07, 2.069(18,402); 2.06, 2.060(27,223); 2.05, 2.048(28,061,152); 2.04, 2.042(15,412,350); 2.02, 2.017(16,500); 2.01, 2.007(25,161); 1.97, 1.969(56,422); 1.91, 1.911(42,441); 1.90, 1.897(22,261); 1.81, 1.809(23,162,360,170,243,450); 1.79, 1.791(28,014,053,442,153,262,413); 1.63, 1.629(15,532,620); 1.59, 1.590(18,461,621); 1.53, 1.525(19,602,263); 1.46, 1.464(25,082,154,414,641,073); and 1.26, 1.262(17,473,0.10.1,800,055). Paratooite-(La) is the second transition metal-bearing rare-earth carbonate to be described; the other is decrespignyite-(Y), also from the Paratoo Copper Mine. A comparison of refractive indices of other REE carbonates suggests that paratooite-(La) is most similar to those of the bastnssite-synchysite-parisite group with carbonate groups arranged either parallel or perpendicular to the optic axis, rather than in a corrugated sheet as is observed in kamphaugite-(Y).

Paratooite-(La) was discovered in the Paratoo Copper Mine, 30 km southwest of Yunta, on the western edge of the Olary Province, South Australia. The Paratoo mine is located within the Adelaide Geosyncline, a rift basin with a thick (15 km) Neoproterozoic sedimentary sequence overlain by Lower Cambrian carbonates. The copper mineralization is hosted by the Auburn dolomite, a lenticular silty carbonaceous dolomite in the upper Burra group (Torrensian). The primary mineralization consists of chalcopyrite and magnetite in thin ( $<10$  cm) quartz veins. Paratooite-(La) is a supergene mineral, which precipitated from neutral or slightly basic, carbonated groundwater under oxidizing conditions. It is found in narrow fissures of a fine-grained, inhomogeneous albitized dolomitic slatestone and is associated with kamphaugite-(Y), donnayite-(Y), bastnssite-(La) [all three of which formed before paratooite-(La)], malachite, nontronite, and limonite after pyrite. The mineral is named after the type locality, the Paratoo Copper Mine (IMA no. 2005-020). Type material has been deposited at the South Australian Museum, Adelaide (catalog no. G29614).

## REDGILLITE\*

J.J. Pluth, I.M. Steele, A.R. Kampf, D.I. Green (2005) Redgillite,  $\text{Cu}_6(\text{OH})_{10}(\text{SO}_4)\cdot\text{H}_2\text{O}$ , a new mineral from Caldbeck Fells, Cumbria, England: description and crystal structure. *Mineral. Mag.*, 69, 973–980.

Redgillite occurs as bladed, grass-green crystals with square or tapering terminations. Blades are 0.15 mm long and usually occur in radiating groups. Observed forms include {001} prominent, {010} visible only under high magnification, and {100} irregular. No twinning was observed. Crystals are transparent to translucent, have a white streak, a vitreous luster, are non-fluorescent, brittle, slightly flexible, non-elastic, exhibit perfect {001} cleavage and good {100} and {010} cleavage with uneven fracture. It has a Mohs' hardness of  $\sim 2$ , and dissolves slowly in dilute HCl. The mineral is biaxial negative,  $\alpha = 1.693(2)$ ,  $\beta = 1.721(2)$ ,  $\gamma = 1.723(2)$ ,  $2V_{\text{obs}} = 30(2)^\circ$ ,  $2V_{\text{calc}} = 30^\circ$ , dispersion  $r > v$ , medium,  $X \approx c$ ,  $Y = b$ ,  $Z \approx a$ . It has strong pleochroism with  $Y$  blue-green  $> X$  blue-green  $> Z$  yellow green.

Electron microprobe analyses of redgillite (WDS) gave (range) CuO 68.9 (66.8–70.7),  $\text{SO}_3$  11.6 (11.0–12.4), total 80.5 (77.8–82.5) wt%. No other elements were detected. Direct determination of  $\text{H}_2\text{O}$  was not possible due to the paucity of material available;  $\text{H}_2\text{O}$  was therefore determined from the structure analysis. The empirical formula based on 15 oxygen atoms is  $\text{Cu}_{5.995}(\text{OH})_{9.991}(\text{SO}_4)_{1.003}\cdot\text{H}_2\text{O}$ . The simplified formula is  $\text{Cu}_6(\text{OH})_{10}(\text{SO}_4)\cdot\text{H}_2\text{O}$ .

The crystal structure of redgillite was solved and refined using a  $70 \times 20 \times 6$   $\mu\text{m}$  crystal aggregate to  $R_1 = 0.0896$  for 1529 observed reflections with  $I > 2\sigma(I)$ . The mineral is monoclinic,  $P2_1/c$ ,  $a = 3.155(3)$ ,  $b = 10.441(8)$ ,  $c = 19.436(16)$  Å,  $\beta = 90.089(13)^\circ$ ,  $V = 640.2(9)$  Å<sup>3</sup>,  $Z = 2$ ,  $\mu = 10.03 \text{ mm}^{-1}$ ,  $D_{\text{meas}} = 3.45(5)$ ,  $D_{\text{calc}} = 3.450 \text{ g/cm}^3$ . The strongest lines on the powder X-ray diffraction pattern (114.6 mm Gandolfi camera, CuK $\alpha$  radiation, 24 lines given) include [ $d(I_{\text{obs}}, hkl)$ ]: 9.72(90,002), 7.11(100,012), 4.60(30,022), 4.068(20,023), 2.880(30,11 $\bar{2}$ ,112), 2.426(15,008), 2.318(50,13 $\bar{1}$ ,131), 2.000(15,14 $\bar{1}$ ,141), 1.941(15,0.0.10). The crystal structure of redgillite consists of Jahn-Teller distorted  $\text{CuO}_6$  octahedra and  $\text{SO}_4$  tetrahedra. The octahedra share edges to form zigzag sheets in cross-section down the  $a$  axis and are stacked perpendicular to the  $c$  axis. Each zig-zag is four octahedra long and repeats every six octahedra. The  $\text{SO}_4$  tetrahedra share an oxygen with the Cu layer and link layers via hydrogen bonds, forming columns parallel to the  $a$  axis. The S site is only half-occupied. The structure of redgillite is similar to that observed in wroewolfeite, langite, posnjakite, spangolite, and schulenbergite, which all contain edge-sharing  $\text{CuO}_6$  layers connected to  $\text{SO}_4$  tetrahedra bridged by hydrogen bonds.

The new mineral redgillite was collected on the Golden Hugh level of the Silver Gill vein, Caldbeck Fells, Cumbria, England (NY 2987 3405). The occurrence is a NE-SW trending normal fault, which contains lead-zinc-copper mineralization thought to be early Carboniferous in age. The major minerals include chalcopyrite, and galena with minor sphalerite, covellite, pyrite, quartz, barite, calcite, and dolomite. Redgillite was found in thin fractures of partly oxidized sulphides associated with langite, malachite, cuprite, connellite, and brochantite. In other

localities, redgillite occurs in dumps as a post-mining oxidation product (e.g., Penberthy Croft mine, St. Hilary, Cornwall; the Sheefry mine, Co. Mayo, Ireland; Frongoch mine, Devil's Bridge, Wales; the Bwlchrhennaid mine, Goginan, Wales; and the Nant y cagle (Eaglebrook) mine, Talybont, Wales). The name is for the Red Gill mine from which it is best known and originally described. Holotype material has been deposited in the Manchester Museum, The University of Manchester, U.K. (catalog no. MANCH:18024). **P.C.P.**

## NEW DATA

### MISERITE

I.V. Rozhdestvenskaya, M.D. Evdokimov (2006) Refinement of miserite crystal structure  $(K_{1.29-0.21})[Ca_{5.51}M_{0.49}^{3+}][Si_6(O,OH)_{15}(Si_2O_7)(F,OH) \cdot 0.25H_2O$  ( $M=Y, REE, Fe, Ti, Mn, Mg, Na$ ) from the Dara-i-Pioz occurrence, Pamir, Tajikistan. Dokl. Earth Science., 406, 74–78.

Electron microprobe analyses of miserite from Dara-i-Pioz, Pamir, Tajikistan gave  $SiO_2$  50.61,  $TiO_2$  0.16,  $Al_2O_3$  0.05,  $FeO$  0.32,  $MgO$  0.08,  $CaO$  32.66,  $MnO$  0.24,  $Na_2O$  0.06,  $K_2O$  6.59,  $Y_2O_3$  2.11,  $La_2O_3$  0.09,  $Ce_2O_3$  1.06,  $Pr_2O_3$  0.66,  $Nd_2O_3$ , 1.36,  $F$  1.10,  $LOI$  6.8,  $H_2O$  5.7,  $O = F - 0.46$ , total 102.85 wt%, corresponding to  $K_{1.33}[Ca_{5.52}Fe_{0.04}Ti_{0.01}Mg_{0.02}Mn_{0.03}Y_{0.18}TREE_{0.18}Na_{0.02}(Si_{7.99}Al_{0.01})(O,OH)_{22}(OH_{1.45}F_{0.55}) \cdot 0.15H_2O$  based on 8 (Si + Al). The crystal structure of miserite was refined on a crystal  $0.08 \times 0.1 \times 0.15$  mm,  $R_1 = 0.0426$ . The mineral is triclinic,  $P\bar{1}$ ,  $a = 10.120(3)$ ,  $b = 16.079(3)$ ,  $c = 7.378(3)$  Å,  $\alpha = 96.62(2)$ ,  $\beta = 111.15(2)$ ,  $\gamma = 76.33(2)^\circ$ ,  $V = 1087(1)$  Å<sup>3</sup>,  $Z = 2$ ,  $D_{meas} = 2.926$ ,  $D_{calc} = 2.87$  g/cm<sup>3</sup>. The miserite structure is characterized by the presence of (1) tube silicate radicals  $[Si_{12}O_{30}]^{12-}$  (four pyroxenoid chains of  $SiO_4$  tetrahedra) that extend along the  $c$

axis, (2) diorthosilicate groups  $[Si_2O_7]^{6-}$  that share edges with (Ca,REE) [7]-coordinated polyhedra, and (3)  $K^+$  and  $H_2O$  that are ordered in large cavities in the 8-membered  $SiO_4$  rings. The refined crystallochemical formula of miserite can be written  $(K_{1.29-0.21})[Ca_{5.51}M_{0.49}^{3+}][Si_6(O,OH)_{15}(Si_2O_7)(F,OH) \cdot 0.25H_2O$  where  $M = Y, REE, Fe, Ti, Mn, Mg, or Na$ .

**Discussion:** It is stated that the F and  $H_2O$  contents were determined analytically, but the method is not mentioned. **P.C.P.**

### NEIGHBORITE

V. Pischedda, G. Ferraris, G. Raade (2005) Single-crystal X-ray diffraction study on neighborite ( $NaMgF_3$ ) from Gjerdingsselva, Norway. Neus. Jb. Mineral. Abh., 182, 23–29.

Neighborite from the miarolitic cavities in the Gjerdingsselva peralkaline granite, Lunner, Oppland, Norway, occur as cube-like, colorless, pale yellow, or brownish crystals up to 1 mm. The crystals commonly display polysynthetic twinning striations. Associated minerals in the miarolitic cavities include quartz, aegirine, rhodochrosite, zircon, fluorite, gagarinite, monazite-(Ce), galena, sphalerite, molybdenite, and brookite. Neighborite is a late-stage, low-temperature (<300 °C) hydrothermal mineral. The average of 10 chemical analyses (EDS) confirmed the ideal stoichiometric composition,  $NaMgF_3$ ; no trace elements were detected. The crystal structure of natural neighborite has been determined for the first time; all other diffraction experiments have been performed on synthetic equivalents. The structure of neighborite was refined using a  $0.24 \times 0.14 \times 0.18$  mm crystal to  $R_1 = 0.0262$  for 474 reflections with  $F_o > 4\sigma(F_o)$ . Neighborite shares the  $ABX_3$  perovskite structure type, is orthorhombic,  $Pbnm$ ,  $a = 5.352(1)$ ,  $b = 5.485(1)$ ,  $c = 7.663(2)$  Å,  $V = 224.9(1)$  Å<sup>3</sup>,  $Z = 4$ ,  $D_{calc} = 3.08$  g/cm<sup>3</sup>. The departure from ideal cubic symmetry is the result of tilting and rotation of the  $MgF_6$  octahedra and the presence of  $Na^+$  in the A site, which lowers the site symmetry from the ideal cubo-octahedron to [8]-coordinated. **P.C.P.**