

## New Mineral Names\*†

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This New Mineral Names has entries for 12 new minerals, including adranosite-(Fe), calciodelrioite, d'ansite-(Mn), d'ansite-(Fe), ferrochiavennite, jasrouxite, kokinosite, peatite-(Y), piemontite-(Pb), rhabdophane-(Y), ramikite-(Y), and steedite. It also includes 3 entries of new data for cannonite, magbasite, and sinnerite.

#### ADRANOSITE-(Fe)\*

D. Mitolo, F. Demartin, A. Garavelli, I. Campostrini, D. Pinto, C.M. Gramaccioli, P. Acquafredda, and U. Kolitsch (2013) Adranosite-(Fe),  $(\text{NH}_4)_4\text{NaFe}_2(\text{SO}_4)_4\text{Cl}(\text{OH})_2$ , a new ammonium sulfate chloride from La Fossa Crater, Vulcano, Aeolian Islands, Italy. Canadian Mineralogist, 51, 57–66.

Adranosite-(Fe) (IMA 2011-006), ideally  $(\text{NH}_4)_4\text{NaFe}_2(\text{SO}_4)_4\text{Cl}(\text{OH})_2$ , is a new mineral found on a pyroclastic breccia in two different fumaroles at “La Fossa” crater of Vulcano, Aeolian Islands, Italy, previously observed as an anthropogenic product from a burning coal dump at the Anna mine near Aachen, North Rhine-Westphalia, Germany. It was named as the  $\text{Fe}^{3+}$  analog of adranosite,  $(\text{NH}_4)_4\text{NaAl}_2(\text{SO}_4)_4\text{Cl}(\text{OH})_2$  (the ancient god of fire Adranos, Ἀδρανοῦς), which was also discovered at Vulcano (Demartin et al. 2010). It is associated with thermessaite, pseudocotunnite, and bismuthinite in a holotype specimen and with barberite, salammoniac, anhydrite, sassolite, and sulfur in a cotype. Adranosite-(Fe) forms aggregates of acicular crystals up to 1 mm in length with a tetrahedral habit and no apparent twinning. The mineral is pale-yellow with a white streak, is vitreous and has perfect cleavage on {001}. Mohs hardness was not measured;  $D_{\text{meas}} = 2.18(1)$  g/cm<sup>3</sup> and  $D_{\text{calc}} = 2.195$  g/cm<sup>3</sup>. Adranosite-(Fe) is not fluorescent in LW and SW ultraviolet radiation and is uniaxial (–) with  $\omega = 1.58(1)$ ,  $\epsilon = 1.57(1)$  (589 nm). Single-crystal laser-Raman spectra (not given) and microchemical tests using the Nessler reaction, suggest the presence of a considerable amount of  $\text{NH}_4^+$ . The average of 12 electron probe EDS analyses on the holotype gives [wt% (range)]: Na<sub>2</sub>O 5.01 (4.42–5.48), K<sub>2</sub>O 0.82 (0.75–0.91), Fe<sub>2</sub>O<sub>3</sub> 15.77 (15.01–16.45), Al<sub>2</sub>O<sub>3</sub> 5.11 (4.93–5.44), SO<sub>3</sub> 50.96 (50.38–51.69), Cl 3.71 (3.67–4.09), (NH<sub>4</sub>)<sub>2</sub>O 15.76 (deduced

from the difference between the theoretical value of the site and the K content), H<sub>2</sub>O 2.75 (by stoichiometry from the results of the crystal structure analysis), –O=Cl 0.84, total 99.05 wt%. The empirical formula is  $[(\text{NH}_4)_{3.89}\text{K}_{0.11}]_{\Sigma 4.00}\text{Na}_{1.04}(\text{Fe}_{1.27}\text{Al}_{0.64})_{\Sigma 1.91}(\text{SO}_4)_{4.10}\text{Cl}_{0.67}(\text{OH})_{1.96}$  on the basis of 19 anions pfu. The ranges of 5 electron probe EDS analysis on the cotype are: Na<sub>2</sub>O 3.06–5.78, Fe<sub>2</sub>O<sub>3</sub> 20.98–24.76, Al<sub>2</sub>O<sub>3</sub> 0.52–4.41, SO<sub>3</sub> 38.07–52.31, and Cl 3.89–5.18 wt%. The strongest lines in the X-ray powder-diffraction pattern [ $d_{\text{obs}}$  Å ( $I_{\text{obs}}\%$ ;  $hkl$ )] are: 9.134 (100; 020), 4.569 (83; 040), 3.047 (79; 152), 6.462 (36; 220), 3.232 (29; 251), and 2.891 (11; 004). The unit-cell parameters refined from powder-diffraction data are:  $a = 18.272(1)$ ,  $c = 11.558(1)$  Å,  $V = 3859.0$  Å<sup>3</sup> for the holotype and  $a = 18.259(2)$ ,  $c = 11.571(1)$  Å,  $V = 3857.7$  Å<sup>3</sup> for the cotype. Single-crystal X-ray diffraction data collected on a crystal  $0.18 \times 0.03 \times 0.03$  mm refined to  $R_1 = 0.0415$  for 670 unique reflections with  $I \geq 2\sigma(I)$ , shows adranosite-(Fe) is tetragonal, space group  $I4_1/acd$ , with  $a = 18.261(2)$ ,  $c = 11.562(1)$  Å,  $V = 3855.5$  Å<sup>3</sup>, and  $Z = 8$ . The structure consists of NaO<sub>4</sub>Cl<sub>2</sub> square tetragonal bipyramids linked through their opposite Cl corners and helicoidal chains with composition  $[\text{FeO}_4(\text{OH})_2\text{SO}_4]_n$ , both of which extend along [001]. The sharing of the sulfate ions between the different chains result in cages that host the nine-coordinated hydrogen-bonded NH<sub>4</sub><sup>+</sup>. The holotype specimen is deposited in the Reference Collection of the Dipartimento di Chimica, Università degli Studi di Milano. The cotype specimen is deposited at the Museum “C.L. Garavelli,” Dipartimento di Scienze Della Terra e Geoambientali, Università di Bari, Italy. **O.C.G.**

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Demartin, F., Gramaccioli, C.M., and Campostrini, I. (2010) Adranosite,  $(\text{NH}_4)_4\text{NaAl}_2(\text{SO}_4)_4\text{Cl}(\text{OH})_2$ , a new ammonium sulfate chloride from La Fossa crater, Vulcano, Aeolian Islands, Italy. Canadian Mineralogist, 48, 315–321.

#### CALCIODELRIOITE\*

A.R. Kampf, J. Marty, B.P. Nash, J. Plášil, A.V. Kasatkin, and R. Škoda (2012) Calciodelrioite,  $\text{Ca}(\text{VO}_3)_2(\text{H}_2\text{O})_4$ , the Ca analog of delrioite,  $\text{Sr}(\text{VO}_3)_2(\text{H}_2\text{O})_4$ . Mineralogical Magazine, 76(7), 2803–2817.

\* 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-cnmmc/>.

Calciodelrioite (IMA 2012-031), ideally  $\text{Ca}(\text{VO}_3)_2(\text{H}_2\text{O})_4$ , is a new mineral form the uranium-vanadium deposits of the eastern Colorado Plateau in the U.S.A. It was first found as a moderately rare mineral at the West Sunday mine, Slick Rock district, San Miguel County, Colorado. It was subsequently found at the adjacent St. Jude mine in the Slick Rock district, at the Blue Streak mine, Bull Canyon, Montrose County, Colorado, and at the Little Eva mine, Yellow Cat district, Grand County, Utah, U.S.A. Calciodelrioite occurs as crystalline crust on fracture surfaces on corvusite- and montroseite-impregnated sandstone as the result of the oxidative alteration of both vanadium minerals. It is associated with gypsum, rossite, metarossite, and also with celestine, huemulite, and pascoite (West Sunday mine); delrioite, hendersonite, pascoite, powellite, and schindlerite (St. Jude mine); delrioite, huemulite, hummerite, magnesiopascoite, powellite, and a K- and Mg-bearing decavanadate under study (Blue Streak mine); huemulite (Little Eva mine). In almost all specimens from these localities Ca was dominant over Sr (delrioite). The mineral occurs as three different appearances: (1) transparent colorless needles typically forming parallel-to-subparallel intergrowths or divergent sprays up to about 1 mm in length; (2) tan to brown to reddish brown needles forming bundles of parallel crystals up to about 2 mm in length; (3) brownish needles intergrown very tightly to create apparently black broad blades in flat-lying "star bursts" up to about 2 mm across. Needles are elongated parallel to [100] with common steps or striations parallel to their length. Prismatic forms are {001} and {011} terminated in a number of indistinct forms approximated as {100} and {61 $\bar{1}$ }. No twinning has been observed. Calciodelrioite has a white streak, and individual crystals are transparent with subadamantine luster. It has perfect cleavage on {001} and other possible cleavages parallel to [100]. It is brittle with irregular to splintery fracture. The estimated Mohs hardness is 2½. Calciodelrioite does not fluoresce in LW or SW ultraviolet light. It dissolves in water and in the density liquids available; therefore, the density was not measured. Calculated density is 2.451 and 2.503 g/cm<sup>3</sup>, for cotype specimens 63837 and 63838, respectively. The mineral is optically biaxial (+), with  $\alpha = 1.733(3)$ ,  $\beta = 1.775(3)$ , and  $\gamma = 1.825(3)$  (white light),  $X = \mathbf{b}$ ,  $Z \approx \mathbf{a}$ , and  $2V = 87.3(9)^\circ$  (from extinction data),  $2V_{\text{calc}} = 87^\circ$ . No dispersion and no pleochroism were observed. Electron microprobe WDS analyses gave the average composition [wt% (range)]: 63837, mean of 11 analyses, Na<sub>2</sub>O 0.40 (0.15–0.66), K<sub>2</sub>O 0.25 (0.00–0.48), CaO 18.30 (15.38–20.39), SrO 2.66 (0.43–7.02), V<sub>2</sub>O<sub>5</sub> 67.19 (67.42–71.62), H<sub>2</sub>O (calculated on the basis of structure data) 26.77, total 115.57. Normalization to 100% (authors justify high totals due to dehydration under the beam) gives Na<sub>2</sub>O 0.34, K<sub>2</sub>O 0.22, CaO 15.83, SrO 2.31, V<sub>2</sub>O<sub>5</sub> 58.13, H<sub>2</sub>O 23.1; 63838, mean of 10 analyses is Na<sub>2</sub>O 0.09 (0.0–0.25), K<sub>2</sub>O 0.04 (0.0–0.07), CaO 15.87 (13.65–17.66), SrO 8.15 (6.26–11.77), V<sub>2</sub>O<sub>5</sub> 67.50 (62.67–70.49), H<sub>2</sub>O (calculated on the basis of structure data) 26.86, total 118.51. Normalization to 100% gives Na<sub>2</sub>O 0.08, K<sub>2</sub>O 0.02, CaO 13.39, SrO 8.87, V<sub>2</sub>O<sub>5</sub> 56.96, H<sub>2</sub>O 22.66. Empirical formulas on the basis of 10 oxygen apfu are as follows:  $(\text{Ca}_{0.88}\text{Sr}_{0.07}\text{Na}_{0.04}\text{K}_{0.01})_{\Sigma 1.00}(\text{V}_{1.00}\text{O}_3)_2(\text{H}_{2.01}\text{O})_4$  for 63837 and  $(\text{Ca}_{0.76}\text{Sr}_{0.21}\text{Na}_{0.01})_{\Sigma 0.98}(\text{V}_{1.00}\text{O}_3)_2(\text{H}_{2.01}\text{O})_4$  for 63838. Powder and single-crystal X-ray studies were carried out using a Rigaku R-Axis Rapid II curved imaging plate microdiffrac-

tometer (MoK $\alpha$  radiation). The strongest lines in the X-ray powder-diffraction pattern [ $d_{\text{obs}}$  Å ( $I_{\text{obs}}$ ;  $hkl$ )] are: 6.450 (100; 011), 4.350 (16; 013), 3.489 (18; 020), 3.215 (17; 022), 3.027 (50;  $\bar{4}04$ , 402, 222,  $\bar{4}13$ , 411, 015), 2.560 (28;  $\bar{4}15$ , 413), 1.786 (18; 028). Refined unit-cell parameters were  $a = 14.609(7)$ ,  $b = 6.953(7)$ ,  $c = 17.052(7)$  Å,  $\beta = 102.59(2)^\circ$ , and  $V = 1690$  Å<sup>3</sup> ( $Z = 8$ ). Structure determination was done on a crystal of sample 63837. The single crystal parameters of the monoclinic unit cell are:  $a = 14.6389(10)$ ,  $b = 6.9591(4)$ ,  $c = 17.052(2)$  Å,  $\beta = 102.568(9)^\circ$ ,  $V = 1695.5$  Å<sup>3</sup>, space group  $I2/a$ . Model refined to an agreement factor of  $R_1 = 3.14\%$  for 1216  $F_o > 4\sigma F$ . In the structure of calciodelrioite V<sup>5+</sup>O<sub>5</sub> polyhedra link by sharing edges to form a zigzag divanadate [VO<sub>3</sub>] chain along **a**, similar to that found in the structure of rossite. The chains are linked via bonds to Ca atoms, which also bond to H<sub>2</sub>O groups, yielding CaO<sub>3</sub>(H<sub>2</sub>O)<sub>6</sub> polyhedra, which form chains along **b**. Each of the two symmetrically independent VO<sub>5</sub> polyhedra has two short vanadyl bonds and three long equatorial bonds. Calciodelrioite is isostructural with delrioite and form a continuous series Ca(VO<sub>3</sub>)<sub>2</sub>(H<sub>2</sub>O)<sub>4</sub>–Sr(VO<sub>3</sub>)<sub>2</sub>(H<sub>2</sub>O)<sub>4</sub>. Calciodelrioite is dimorphous with rossite. The new mineral is named calciodelrioite, as it is the Ca analog of delrioite. The cotypes are deposited in the collections of the Natural History Museum of Los Angeles County under catalog numbers 63837, 63838, and 63839. **F.C.**

#### D'ANSITE-(Mn)\* AND D'ANSITE-(Fe)\*

F. Demartin, I. Campostrini, C. Castellano, C.M. Gramaccioli, and M. Russo (2012) D'ansite-(Mn), Na<sub>21</sub>Mn<sup>2+</sup>(SO<sub>4</sub>)<sub>10</sub>Cl<sub>3</sub> and d'ansite-(Fe), Na<sub>21</sub>Fe<sup>2+</sup>(SO<sub>4</sub>)<sub>10</sub>Cl<sub>3</sub>, two new minerals from volcanic fumaroles. *Mineralogical Magazine*, 76(7), 2773–2783.

D'ansite-(Mn) (IMA 2011-064) ideally Na<sub>21</sub>Mn<sup>2+</sup>(SO<sub>4</sub>)<sub>10</sub>Cl<sub>3</sub> and d'ansite-(Fe) (IMA 2011-065) ideally Na<sub>21</sub>Fe<sup>2+</sup>(SO<sub>4</sub>)<sub>10</sub>Cl<sub>3</sub>, are two new minerals found at Vesuvius, Naples, Italy, and La Fossa crater, Vulcano, Aeolian Islands, Italy, respectively. They occur as encrustations on a pyroclastic breccia in fumaroles. D'ansite-(Fe) was collected in 2008 in an intracrater fumarole with a temperature of about 300 °C at La Fossa Crater and was previously described (Campostrini et al. 2011) as unknown species UK1-fo29. D'ansite-(Mn) was collected in May 1927 by A. Malladra in a 1926 eruption fumarole at Vesuvius, Naples, with a temperature of about 350 °C. The minerals were named as Mn- and Fe-dominant analogs of d'ansite Na<sub>21</sub>Mg(SO<sub>4</sub>)<sub>10</sub>Cl<sub>3</sub>. D'ansite-(Mn) forms colorless translucent tristetrahedral crystals up to 0.2 mm on edge associated to halite and apthitalite. D'ansite-(Fe) forms aggregates of colorless to white complex isometric crystals up to 0.2 mm, associated with sassolite, adranosite, and sulfate-chlorides under investigation. Both minerals have a white streak and a vitreous luster, and neither is fluorescent when exposed to either LW or SW ultraviolet radiation. Their hardness was not determined, their tenacity is brittle and no cleavage is evident. D'ansite-(Mn) is optically isotropic with  $n = 1.50(1)$  and d'ansite-(Fe) is optically isotropic with  $n = 1.51(1)$  (589 nm).  $D_{\text{calc}} = 2.610$  for d'ansite-(Mn) while for d'ansite-(Fe)  $D_{\text{meas}} = 2.62(1)$  and  $D_{\text{calc}} = 2.644$  g/cm<sup>3</sup>. The chemical composition was obtained by electron probe WDS analyses and gave the average composition [wt% (range)]: d'ansite-(Mn) (mean of 6 analyses) Na<sub>2</sub>O 39.37 (38.47–40.20), MnO 3.46

(3.38–3.62), MgO 0.13 (0.06–0.18), SO<sub>3</sub> 49.99 (49.22–50.68), Cl 6.36 (6.20–6.63), –O=Cl 1.14, total 97.87; d'ansite-(Fe) (mean of 8 analyses) Na<sub>20</sub>O 39.12 (38.49–41.05), MnO 4.18 (3.91–4.35), MgO 0.12 (0.07–0.18), SO<sub>3</sub> 49.91 (49.56–61.68), Cl 6.81 (6.28–7.42), –O=Cl 1.54, total 98.60. The empirical formula derived from chemical analysis on the basis of 43 anions pfu is for d'ansite-(Mn) Na<sub>20.61</sub>(Mn<sub>0.79</sub>Mg<sub>0.05</sub>)<sub>Σ0.84</sub>S<sub>10.13</sub>O<sub>40.09</sub>Cl<sub>2.91</sub> and for d'ansite-(Fe) Na<sub>20.42</sub>(Fe<sub>0.94</sub>Mg<sub>0.05</sub>)<sub>Σ0.99</sub>S<sub>10.08</sub>O<sub>39.89</sub>Cl<sub>3.11</sub>. The simplified formula of d'ansite-(Mn) is Na<sub>21</sub>Mn<sup>2+</sup>(SO<sub>4</sub>)<sub>10</sub>Cl<sub>3</sub> and of d'ansite-(Fe) is Na<sub>21</sub>Fe<sup>2+</sup>(SO<sub>4</sub>)<sub>10</sub>Cl<sub>3</sub>. The X-ray powder diffraction data for d'ansite-(Fe) were collected using a Rigaku D-MAXII diffractometer with CuK $\alpha$  radiation and the refined unit-cell parameter is  $a = 15.8842(7)$  Å; the powder pattern of d'ansite-(Mn) could not be measured due to the extreme scarcity of material and the pattern calculated from single crystal X-ray data. The strongest lines in the X-ray powder-diffraction pattern for d'ansite-(Fe) [ $d_{\text{obs}}$  Å ( $I_{\text{obs}}$ ;  $hkl$ )] are: 2.816 (100; 044), 2.570 (37; 235), 1.714 (29; 129), 3.384 (27; 233), 3.113 (26; 134), 2.108 (15; 237). The strongest lines calculated for d'ansite-(Mn) [ $d_{\text{calc}}$  Å ( $I_{\text{calc}}$ ;  $hkl$ )] are: 2.816 (100; 044), 3.396 (95; 233), 3.124 (45; 134), 2.584 (38; 235), 3.982 (35; 004), 4.257 (30; 123). Single crystal diffraction intensities were collected using a Bruker Apex II diffractometer equipped with a 2K CCD detector and MoK $\alpha$  radiation. As no violations of the extinction rules for the  $\bar{1}43d$  space group were present, the crystal structure of both minerals was solved by direct methods and refined to  $R_1 = 3.09\%$  based on 1287 reflections for d'ansite-(Mn) and to  $R_1 = 3.36\%$  based on 407 reflections for d'ansite-(Fe). Lattice parameters obtained from single crystal diffraction data are  $a = 15.9291(9)$  Å,  $V = 4041.8$  Å<sup>3</sup>,  $Z = 4$  and  $a = 15.882(3)$  Å,  $V = 4006$  Å<sup>3</sup>, for d'ansite-(Mn) and d'ansite-(Fe), respectively. The structure contains three independent Na sites, one of which is partially occupied by Mn<sup>2+</sup> or Fe<sup>2+</sup>, two independent sulfate anions, and one chlorine site. The holotype specimen of d'ansite-(Mn) is deposited in the mineral collections of the Osservatorio Vesuviano, Naples (under catalog number OV128). The crystal fragment used for the structure determination is housed in the reference collection of the Dipartimento di Chimica at the Università degli Studi di Milano (catalog no. 2011-03) together with the type specimen of d'ansite-(Fe) (catalog no. 2011-02). F.C.

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### FERROCHIAVENNITE\*

J.D. Grice, R. Kristiansen, H. Friis, R. Rowe, G.G. Poirier, R.S. Selbekk, M.A. Cooper, and A.O. Larsen (2013) Ferrochiavennite, a new beryllium silicate zeolite from syenite pegmatites in the Larvik Plutonic Complex, Oslo region, Southern Norway. *Canadian Mineralogist*, 51, 285–296.

Ferrochiavennite (IMA 2012-039), ideally Ca<sub>1–2</sub>Fe Si<sub>5</sub>Be<sub>2</sub>O<sub>13</sub>(OH)<sub>2</sub>·2H<sub>2</sub>O, is a new mineral found at two syenite pegmatite localities in Norway: (1) Blåfjell, Langangen, Telemark, and (2) the AS Granit larvikite quarry, Tvedalen, Vestfold. In locality 1, ferrochiavennite is associated with albite, magnetite, and fayalite, with minor amounts of zircon,

nepheline, analcime, pyrite, and hambergite. It occurs in small vugs in masses of analcime associated with hambergite at locality 2, with other late-stage minerals including tvedalite, apophyllite-(KF), natrolite, gonnardite, pale yellowish white chiavennite, epididymite, behoite, calcite, chlorite, aegirine, catapleiite, gaidonnayite, neotocite, fluorite, and molybdenite. Crystal aggregates of ferrochiavennite form spherules up to ~2 mm in diameter (locality 1). Individual crystals reach 0.2 × 0.2 × 0.02 mm in size, are platy on {001} and spear-shaped along [100]. In locality 2, spherules are up to 1 mm across, but the individual crystals are significantly smaller than at locality 1. Ferrochiavennite is beige to pale-yellow in locality 1, pale-green in locality 2, has a white streak and is vitreous to translucent. It is brittle with uneven fracture and shows no cleavage. The Mohs hardness is ~3;  $D_{\text{meas}} = 2.67(2)$  and  $D_{\text{calc}} = 2.709$  g/cm<sup>3</sup> for locality 1. Ferrochiavennite is non-fluorescent in long- and short-wave ultraviolet radiation. It is biaxial (+) with  $\alpha = 1.583(1)$ ,  $\beta = 1.589(1)$ ,  $\gamma = 1.602(1)$ ,  $2V_{\text{meas}} = 62(4)^\circ$ ,  $2V_{\text{calc}} = 69^\circ$ . The optical orientation is  $X \sim a$ ,  $Y \sim c$ , and  $Z \sim b$ . Ferrochiavennite is nonpleochroic and dispersion could not be measured. The average of 10 electron-microprobe WDS analysis for a specimen of locality 1 gives [wt% (range)]: SiO<sub>2</sub> 46.00 (44.06–49.12), Al<sub>2</sub>O<sub>3</sub> 4.64 (3.97–6.28), FeO 5.29 (3.64–6.99), MnO 4.04 (2.60–5.06), MgO 0.13 (0.09–0.17), CaO 17.62 (10.50–24.32), Na<sub>2</sub>O 0.73 (0.50–0.86), K<sub>2</sub>O 0.02 (0.01–0.03), BeO 10.37, H<sub>2</sub>O 9.81, total 98.65 wt%. Fluorine was below detection limits and H<sub>2</sub>O and BeO were calculated by stoichiometry from the results of the crystal structure analysis. The empirical formula calculated on the basis of 17 anions and 7 cations in tetrahedral sites pfu, is (Ca<sub>1.73</sub>Na<sub>0.13</sub>)<sub>Σ1.86</sub>(Fe<sub>0.41</sub>Mn<sub>0.31</sub>Mg<sub>0.02</sub>)<sub>Σ0.74</sub>(Si<sub>4.22</sub>Al<sub>0.50</sub>Be<sub>2.28</sub>)<sub>Σ7.00</sub>O<sub>13</sub>(OH)<sub>2</sub>·2H<sub>2</sub>O. The average of 7 electron microprobe WDS analysis for a specimen of locality 2 gives [wt% (range)]: SiO<sub>2</sub> 46.41 (42.82–48.76), Al<sub>2</sub>O<sub>3</sub> 2.76 (1.83–3.78), FeO 9.94 (8.25–10.83), MnO 3.53 (2.33–4.93), CaO 12.23 (10.94–14.56), Na<sub>2</sub>O 1.00 (0.58–1.68), K<sub>2</sub>O 0.02 (0.01–0.04), BeO 9.91, H<sub>2</sub>O 9.44, total 95.24 wt%. The empirical formula calculated on the same basis is (Ca<sub>1.25</sub>Na<sub>0.19</sub>Mn<sub>0.08</sub>)<sub>Σ1.52</sub>(Fe<sub>0.79</sub>Mn<sub>0.21</sub>)<sub>Σ1.00</sub>(Si<sub>4.42</sub>Al<sub>0.31</sub>Be<sub>2.27</sub>)<sub>Σ7.00</sub>O<sub>13</sub>(OH)<sub>2</sub>·2H<sub>2</sub>O. The strongest reflections of the X-ray powder-diffraction pattern [ $d_{\text{obs}}$  Å ( $I_{\text{obs}}$ ;  $hkl$ )] are: 15.555 (100; 002), 4.104 (29;  $\bar{1}12$ , 112), 3.938 (36;  $\bar{1}13$ , 113), 3.909 (60; 008), 3.820 (30;  $\bar{2}04$ , 204), 3.251 (66; 017, 210,  $\bar{2}11$ ), 3.186 (27;  $\bar{2}12$ , 212), 2.884 (64;  $\bar{2}15$ , 215). The unit-cell parameters refined from powder-diffraction data are:  $a = 8.759(5)$ ,  $b = 4.864(2)$ ,  $c = 31.258(6)$  Å,  $\beta = 90.31(6)^\circ$ ,  $V = 1331.7$  Å<sup>3</sup>, and  $Z = 4$ , space group  $P2_1/c$ . Single-crystal X-ray diffraction data collected on a crystal of size 0.01 × 0.03 × 0.04 mm refined to  $R_1 = 0.048$  for 3651 unique reflections with  $I \geq 4\sigma(I)$  shows ferrochiavennite is monoclinic, space group  $P2_1/c$ , with  $a = 8.7499(5)$ ,  $b = 4.9160(3)$ ,  $c = 31.431(2)$  Å,  $\beta = 90.1574(9)^\circ$ ,  $V = 1352.0$  Å<sup>3</sup>, and  $Z = 4$ . Ferrochiavennite is essentially isostructural with chiavennite, hence the name. The uninterrupted zeolite structure consists of intersecting channels of nine-, six-, five-, and four-fold rings, where the tetrahedral framework consists of seven tetrahedrally coordinated sites that are dominantly occupied by Si and Be. The holotype material is preserved in the Canadian Museum of Nature, Ottawa, Canada, and the Department of Geology, Natural History Museum, University of Oslo. O.C.G.



**JASROUXITE\***

- D. Topa, E. Makovicky, G. Favreau, V. Bourgoïn, J.-C. Boulliard, G. Zagler, and H. Putz (2013) Jasrouxite, a new Pb-Ag-As-Sb member of the lillianite homologous series from Jas Roux, Hautes-Alpes, France. *European Journal of Mineralogy*, 25, 1031–1038.
- E. Makovicky and D. Topa (2014) The crystal structure of jasrouxite, a Pb-Ag-As-Sb member of the lillianite homologous series. *European Journal of Mineralogy*, 26, 145–155.

Jasrouxite (IMA 2012-058), ideally  $\text{Ag}_{16}\text{Pb}_4(\text{Sb}_{25}\text{As}_{15})_{\Sigma 40}\text{S}_{72}$ , is a new mineral from the thallium-rich sulfosalt deposit of Jas Roux, in Pelvoux Massif, France, and was named after the locality where it was discovered. Jasrouxite formed at the early Pb-containing stage of the Tl-As-Sb mineralisation. Grains of jasrouxite are covered by a three-phase myrmekite aggregate composed of stibnite, boscardinite, and smithite in intergrowth, and are also associated with pyrite, sphalerite, and other lead sulfosalts. Jasrouxite is gray, opaque, has metallic luster and gray streak. It forms anhedral crystals up to a few millimeters in size or aggregates of crystals up to 10 mm in diameter. Jasrouxite is brittle, has irregular fracture, and no cleavage or parting. The density could not be measured as the material is scarce.  $D_{\text{calc}} = 4.87 \text{ g/cm}^3$ . In reflected light, jasrouxite is white and has weak pleochroism between white and whitish creamy. It is anisotropic with rotation tints vary between pale bluish green and pale greenish blue. No internal reflections observed. The reflectance decreases from 400 to 700 nm with a 5% difference. The interpolated reflectance values (in air) for COM wavelengths [ $R_{\text{min}}$ ,  $R_{\text{max}}$  (nm)] are: 30.4, 35.1 (470); 29.8, 34.7 (546); 29.1, 34.1 (589); 28.2, 33.1 (650). The average of 12 electron microprobe analyses (wt%) collected on two grains of jasrouxite gave: Cu 0.55, Ag 17.52, Pb 9.44, Tl 0.10, As 12.77, Sb 33.61, S 25.77, total 99.67. The empirical formula calculated on the basis of 132 apfu is  $\text{Cu}_{0.79}\text{Ag}_{14.64}\text{Pb}_{4.10}\text{Tl}_{0.05}\text{As}_{15.37}\text{Sb}_{24.87}\text{S}_{72.18}$ . The strongest lines of the calculated powder diffraction pattern [ $d_{\text{calc}}$  Å ( $I_{\text{calc}}$ ;  $hkl$ )] are: 3.847 (33;  $0\bar{4}\bar{3}$ ), 3.294 (80;  $0\bar{5}\bar{3}$ ), 3.281 (100;  $0\bar{5}\bar{3}$ ), 2.8602 (33;  $0\bar{6}\bar{3}$ ), 2.8498 (26;  $0\bar{6}\bar{3}$ ). The crystal structure of jasrouxite determined on the basis of 14 000 reflections refined to  $R_1 = 6.0\%$ . The mineral is triclinic,  $P\bar{1}$ ,  $a = 8.2917(5)$ ,  $b = 19.101(1)$ ,  $c = 19.487(1)$  Å,  $\alpha = 89.731(1)$ ,  $\beta = 83.446(1)$ ,  $\gamma = 89.944(1)^\circ$ ,  $V = 3066.1 \text{ \AA}^3$ , and  $Z = 1$ . Jasrouxite is a member of the lillianite homologous series, with a supercell based on a lillianite subcell. There are 30 independent cation sites and 36 independent sulphur sites. The c parameter is identical to that of lillianite, **a** is doubled, and **b** is about 3/2 of a diagonal to (001) of lillianite. Lone-pair-electron-pair micelles in jasrouxite slabs are of a large type, rich in Sb and As. In the lillianite homologous series, jasrouxite has the order number of 4, and degree of Ag + (Sb, As)  $\leftrightarrow$  2 Pb substitution for the new mineral is 36.5 % above the theoretical 100% substitution expressed as  $\text{PbAg}(\text{Sb}, \text{As})_3\text{S}_6$ . Jasrouxite is also distinguished by considerable replacement of Pb by Sb in trigonal prismatic sites, and high contents of Ag and (Sb, As). Holotype material is deposited in the collections of the Department of Materials Engineering and Physics, University of Salzburg, Austria. Cotype specimens are deposited in the Collection des Minéraux de Jussieu, IMPMC, Université Pierre

et Marie Curie, France, and in the collections of Museum of Mineralogy, Mines Paris Tech, France. **Yu.U.**

**KOKINOSITE\***

- A.R. Kampf, J.M. Hughes, B. Nash, and J. Marty (2014) Kokinosite  $\text{Na}_2\text{Ca}_2(\text{V}_{10}\text{O}_{28}) \cdot 24\text{H}_2\text{O}$ , a new decavanadate mineral species from the St. Jude mine, Colorado: crystal structure and descriptive mineralogy. *Canadian Mineralogist*, 52, 15–25.

Kokinosite (IMA 2013-099), ideally  $\text{Na}_2\text{Ca}_2(\text{V}_{10}\text{O}_{28}) \cdot 24\text{H}_2\text{O}$ , is a new mineral found in the St. Jude mine, Gypsum Valley, Slick Rock district, San Miguel County, Colorado, U.S.A. The mineral was found growing on a corvusite-montroseite-bearing sandstone block closely associated with gypsum, huemulite, metarossite, pascoite, rossite, and wernerbaurite. Other minerals found in the same area include calciodelrioite, delrioite, hendersonite, hughesite, nashite, powellite, postite, and schindlerite. Kokinosite forms from the oxidation of montroseite-corvusite assemblages in a moist environment. It typically occurs as tablets or blades up to 0.05 mm in thickness, with stepped faces, up to 1 mm in the longest dimension, but also as larger irregularly stepped crystal masses up to several millimeters across. Kokinosite is yellow orange, sometimes has an orange-brown tint, has a yellow streak, a subadamantine luster, is transparent, brittle, has good cleavage on  $\{01\bar{1}\}$ , an irregular fracture and shows no parting. Mohs hardness is approximately  $1\frac{1}{2}$ . The density of kokinosite could not be measured due to its dissolution in density liquids;  $D_{\text{calc}} = 2.35 \text{ g/cm}^3$ . It is non-fluorescent in long- and short-wave ultraviolet radiation, is biaxial (–) with  $\alpha = 1.725(3)$ ,  $\beta = 1.770(5)$ , and  $\gamma = 1.785(3)$ ,  $2V_{\text{meas}} = 56.6(3)$ , and  $2V_{\text{calc}} = 58.7^\circ$ . Dispersion is  $r < v$ , moderate,  $X \wedge \mathbf{a} = 15^\circ$ ,  $Y \approx \mathbf{b}$ . The mineral is pleochroic:  $X, Z =$  orange-yellow,  $Y =$  orange, and  $X = Z < Y$ . The average of 10 electron-microprobe WDS analysis on 3 crystals gives [wt% (range)]:  $\text{Na}_2\text{O}$  4.64 (3.78–5.95),  $\text{K}_2\text{O}$  0.04 (0.02–0.07),  $\text{CaO}$  8.08 (6.39–9.91),  $\text{SrO}$  1.01 (0.52–2.54),  $\text{V}_2\text{O}_5$  72.43 (70.66–74.08), total 86.20 wt%. The low wt% is due to partial dehydration under the vacuum of the microprobe chamber. The loss of  $\text{H}_2\text{O}$  results in higher concentrations for the remaining constituents than are expected for the fully hydrated phase; as not enough material was available for a direct measurement of  $\text{H}_2\text{O}$ , its content was calculated by stoichiometry and the analyzed constituents (above) were subsequently normalized. The resulting empirical formula, calculated on the basis of  $V = 10$  and  $O = 52$  apfu, is  $(\text{Na}_{1.88}\text{K}_{0.01})_{\Sigma 1.89}(\text{Ca}_{1.81}\text{Sr}_{0.12})_{\Sigma 1.93}(\text{V}_{10}\text{O}_{28}) \cdot 24\text{H}_2\text{O}$ . The strongest lines in the diffraction pattern [ $d_{\text{obs}}$  Å ( $I_{\text{obs}}\%$ ;  $hkl$ )] are: 9.88 (100;  $010, 0\bar{1}1$ ), 7.92 (36;  $\bar{1}01$ ), 8.42 (33; 100) and 6.01(31;  $1\bar{1}1, 110$ ). Single-crystal X-ray diffraction data collected on a crystal of size  $0.12 \times 0.08 \times 0.03$  mm refined to  $R_1 = 0.0379$  for 3806 unique reflections with  $I \geq 4\sigma(I)$  shows kokinosite is triclinic, space group  $P\bar{1}$ , with  $a = 8.74899(19)$ ,  $b = 10.9746(3)$ ,  $c = 12.8216(9)$  Å,  $\alpha = 114.492(8)$ ,  $\beta = 105.093(7)$ ,  $\gamma = 91.111(6)^\circ$ ,  $V = 1070.25 \text{ \AA}^3$ , and  $Z = 1$ . The structural unit of kokinosite is the decavanadate polyanion,  $(\text{V}_{10}\text{O}_{28})^{6-}$ , consisting of ten distorted  $\text{VO}_6$  octahedra, making it a member of the pascoite family. The interstitial unit  $[\text{Na}_2\text{Ca}_2(\text{H}_2\text{O})_{24}]^{6+}$  keeps charge balance in the structure and consists of  $\text{Na}(\text{H}_2\text{O})_6$  octahedra and  $\text{Ca}(\text{H}_2\text{O})_8$  polyhedra that link into chains by edge- and corner-sharing. The structural and interstitial units are solely linked by

hydrogen bonding. Kokinosite is named in honor of Michael (Mike) Kokinos (b. 1927) of Shingle Springs, California, U.S.A., member of the Micromounters' Hall of Fame, for his collecting work and his role as a mentor in the collecting community. Six cotype specimens of kokinosite are deposited in the collections of the Natural History Museum of Los Angeles County, Los Angeles, California, U.S.A. **O.C.G.**

### PEATITE-(Y)\* AND RAMIKITE-(Y)\*

A.M. McDonald, M.E. Black, R.A. Gault, and L. Horváth (2013) Peatite-(Y) and ramikite-(Y), two new Na-Li-Y±Zr phosphate-carbonate minerals from the Poudrette pegmatite, Mont Saint-Hilaire, Quebec. *Canadian Mineralogist*, 51, 569–596.

Peatite-(Y) (IMA 2009-020), ideally  $\text{Li}_4\text{Na}_{12}(\text{Y}, \text{Na}, \text{Ca}, \text{HREE})_{12}(\text{PO}_4)_{12}(\text{CO}_3)_4(\text{F}, \text{OH})_8$ , and ramikite-(Y) (IMA 2009-021), ideally  $\text{Li}_4\text{Na}_{12}(\text{Y}, \text{Ca}, \text{HREE})_6\text{Zr}_6(\text{PO}_4)_{12}(\text{CO}_3)_4\text{O}_4(\text{F}, \text{OH})_4$ , are two new Na-Li-Y±Zr phosphate-carbonate minerals from the Poudrette pegmatite, Mont Saint-Hilaire, Québec. They are named after Cynthia Peat, a former X-ray technician at the Royal Ontario Museum, Toronto, Canada, an avid mineralogist who spent a lot of decades studying the mineralogy of Mont Saint-Hilaire, and Robert Ramik, a thermoanalytical technician and mineralogist at the Royal Ontario Museum. Both minerals occur as epitaxial intergrowths with peatite-(Y) forming rims and ramikite-(Y) being in the core of these intergrowths. Peatite-(Y) occurs as thin, colorless, pale pink to purple overgrowths on ramikite-(Y) crystals, which are yellowish and translucent. Peatite-(Y) and ramikite-(Y) occur as free-standing crystals overgrowing albite and Mn-Fe carbonates and, less commonly, chabazite-Na, synchysite-(Ce), and sabinaitite. Rarely, they were observed as inclusions in chabazite-(Na). Peatite-(Y) has very good {100}, {010}, and {001} cleavages, and ramikite-(Y) has no distinct cleavage. Peatite-(Y) has a brittle fracture, while ramikite-(Y) cores exhibit splintery fracture. Peatite-(Y) has a vitreous luster and ramikite-(Y) has luster between vitreous and dull. Mohs hardness for both minerals is 3.  $D_{\text{calc}} = 3.62(1) \text{ g/cm}^3$  for peatite-(Y) and  $D_{\text{calc}} = 3.60(1) \text{ g/cm}^3$  for ramikite-(Y). Both minerals are non-pleochroic, with no discernible dispersion. The optic sign and  $2V$  could not be obtained due to the poor quality of samples. One refractive index was measured;  $\beta = 1.601(1)$  in peatite-(Y) and  $\beta = 1.636(1)$  in ramikite-(Y) ( $\lambda = 589 \text{ nm}$ ). The average of 4 electron probe analyses on peatite-(Y) gives [wt% (range)]:  $\text{Na}_2\text{O}$  12.95 (12.50–13.30),  $\text{CaO}$  1.15 (0.98–1.51),  $\text{Y}_2\text{O}_3$  37.32 (37.01–37.52),  $\text{Gd}_2\text{O}_3$  0.61 (0.54–0.74),  $\text{Dy}_2\text{O}_3$  3.08 (2.91–3.44),  $\text{Ho}_2\text{O}_3$  0.67 (0–1.02),  $\text{Er}_2\text{O}_3$  2.88 (2.59–3.15),  $\text{Tm}_2\text{O}_3$  0.28 (0–0.40),  $\text{Yb}_2\text{O}_3$  1.78 (1.67–1.92),  $\text{ZrO}_2$  0.67 (0.63–0.70),  $\text{ThO}_2$  0.37 (0–0.56),  $\text{P}_2\text{O}_5$  27.29 (27.09–27.64),  $\text{F}$  4.35 (4.03–4.62),  $-\text{O}=\text{F}_2$  1.83; with calculated amounts for  $\text{CO}_2$  5.79,  $\text{H}_2\text{O}$  0.31, and  $\text{Li}_2\text{O}$  1.96, the total is 99.75 wt%. The empirical formula of peatite-(Y) calculated on the basis of 68 anions is  $\text{Li}_4\text{Na}_{12}(\text{Y}_{10.06}\text{Na}_{0.72}\text{Ca}_{0.62}\text{Dy}_{0.50}\text{Er}_{0.46}\text{Yb}_{0.28}\text{Zr}_{0.17}\text{Ho}_{0.11}\text{Gd}_{0.10}\text{Tm}_{0.04}\text{Th}_{0.04}\text{Tb}_{0.02})_{12}(\text{PO}_4)_{11.70}(\text{CO}_3)_4[\text{F}_{6.97}(\text{OH})_{1.03}]_{28}$ . The average of 22 electron probe analyses on ramikite-(Y) gives [wt% (range)]:  $\text{Na}_2\text{O}$  11.25 (10.32–13.34),  $\text{CaO}$  4.15 (4.01–4.27),  $\text{Y}_2\text{O}_3$  16.48 (14.88–18.25),  $\text{La}_2\text{O}_3$  0.11 (0–0.48),  $\text{Ce}_2\text{O}_3$  0.10 (0–0.40),  $\text{Nd}_2\text{O}_3$  0.08 (0–0.31),  $\text{Dy}_2\text{O}_3$  1.11 (0.96–1.23),  $\text{Er}_2\text{O}_3$  1.18 (1.01–1.36),  $\text{Yb}_2\text{O}_3$  0.57 (0.46–0.68),  $\text{ZrO}_2$  23.40 (22.66–24.70),  $\text{ThO}_2$  0.49 (0–0.70),

$\text{HfO}_2$  0.69 (0.48–0.92),  $\text{Al}_2\text{O}_3$  0.14 (0.09–0.22),  $\text{P}_2\text{O}_5$  28.10 (27.47–28.58),  $\text{F}$  0.62 (0.24–0.90),  $-\text{O}=\text{F}_2$  0.26; with calculated amounts for  $\text{CO}_2$  5.92,  $\text{H}_2\text{O}$  0.92, and  $\text{Li}_2\text{O}$  2.01 the total is 97.06 wt%. For both species the presence of Li was confirmed by LA-ICP-MS and crystal structure refinement, and the presence of  $\text{H}_2\text{O}$  and  $\text{CO}_2$  was confirmed by crystal-structure refinement and Raman spectroscopy. The empirical formula of ramikite-(Y) calculated on the basis of 68 anions is  $\text{Li}_4(\text{Na}_{10.79}\text{Ca}_{1.21})_{12}(\text{Y}_{4.34}\text{Ca}_{0.99}\text{Dy}_{0.18}\text{Er}_{0.18}\text{Yb}_{0.09}\text{La}_{0.02}\text{Ce}_{0.02}\text{Nd}_{0.01})_{12}(\text{Zr}_{5.83}\text{Hf}_{0.10}\text{Th}_{0.06})_{12}[(\text{P}_{0.98}\text{Al}_{0.01})_{12}(\text{O}_4)_{12}(\text{CO}_3)_4\text{O}_4][(\text{OH})_{3.03}\text{F}_{0.97}]_{24}$ . The strongest lines on the X-ray powder-diffraction pattern [ $d_{\text{obs}} \text{ \AA}$  ( $I_{\text{obs}}\%$ ;  $hkl$ )] for peatite-(Y) are: 4.56 (57; 211,121,112), 3.95 (57; 220,202,022), 3.54 (46; 310,301,130), 2.99 (83; 321,312,231), 2.63 (100; 330,303,033), 2.149 (42; 333), and for ramikite-(Y) are: 11.04 (76; 010,100,001), 7.80 (79; 011,110,101), 6.36 (75; 111,111,111,111), 3.89 (100; 022,220,202), 2.94 (98; 132,123,231), 2.59 (98; 033,330,303). The crystal structures of both minerals were solved by direct methods and refined to  $R_1 = 3.60\%$  for peatite-(Y) and  $R_1 = 5.13\%$  for ramikite-(Y). Peatite-(Y) is orthorhombic,  $P222$ ,  $a = 11.167(2)$ ,  $b = 11.164(2)$ ,  $c = 11.162(2) \text{ \AA}$ ,  $V = 1391.7 \text{ \AA}^3$ , and  $Z = 1$ ; while ramikite-(Y) is triclinic,  $P1$ ,  $a = 10.9977(6)$ ,  $b = 10.9985(6)$ ,  $c = 12.387(1) \text{ \AA}$ ,  $\alpha = 90.075(4)$ ,  $\beta = 89.984(4)$ ,  $\gamma = 89.969(4)^\circ$ ,  $V = 1330.1 \text{ \AA}^3$ , and  $Z = 1$ . The minerals are not isostructural but their structures are very similar and are governed by  $M\phi 8$  polyhedra, where  $M = \text{Y}$ ,  $\text{Zr}$  and  $\phi =$  unspecified ligand. These polyhedra are linked into six-membered, edge- or corner-sharing clusters, which are joined together by  $\text{PO}_4$  tetrahedra. Both  $\text{LiO}_6$  octahedra and  $\text{CO}_3$  groups are located within the corner-sharing clusters. Linked polyhedra form an open framework structure, and Na atoms occupy the resulting cavities. Peatite-(Y) and ramikite-(Y) are paragenetically late-stage products, and are possibly related to the in situ alteration of the pre-existing mineral assemblage present in the core of the Poudrette pegmatite. Holotypes are deposited in the Royal Ontario Museum, Toronto, Canada, with a specimen numbers of M53894 for peatite-(Y), and M53893 for ramikite-(Y). **Yu.U.**

### PIEMONTITE-(PB)\*

N.V. Chukanov, D.A. Varlamov, F. Nestola, D.I. Belakovskiy, J. Goettlicher, S.N. Britvin, A. Lanza, and S. Jančev (2012) Piemontite-(Pb),  $\text{CaPbAl}_2\text{Mn}^{3+}[\text{Si}_2\text{O}_7][\text{SiO}_4]\text{O}(\text{OH})$ , a new mineral species of the epidote supergroup. *Neues Jahrbuch für Mineralogie, Abhandlungen*, 189/3, 275–286.

The new epidote-supergroup mineral piemontite-(Pb) (IMA 2011-078), the Pb-dominant analog of piemontite, ideally  $\text{CaPbAl}_2\text{Mn}^{3+}[\text{Si}_2\text{O}_7][\text{SiO}_4]\text{O}(\text{OH})$  was described in the pre-Cambrian dolomitic marbles and baryte shists of “Mixed Series” formation, near Nežilovo village, Jacupica Mountains, Macedonia. Its potential presence in metamorphic rocks of Nežilovo was mentioned based on electron probe analysis (Jančev 1997). Piemontite-(Pb) was considered as a theoretical member in the recommended nomenclature of the epidote group (Armbruster et al. 2006). The new mineral is associated with barite, dolomite, calcite, hematite, cymrite, Zn- and Mn-bearing phlogopite, intermediate members of epidote-(Pb)–epidote–piemontite series, hedyphane, nežilovite, rinmanite, gahnite, tilasite, rutile, Zn-rich

aegirine-augite, eckermannite-ferroglaucophane, senaite, roméite, As-fluorapatite, bindheimite, mimetite, chromite, and braunite. Piemontite-(Pb) forms purplish-red (with a pink streak and vitreous luster) blocky crystals up to  $0.5 \times 2$  mm or random aggregates up to 2 mm across. It is brittle with Mohs hardness of 6. Cleavage is perfect on  $\{001\}$ , and distinct on  $\{010\}$ . Density could not be measured because of paucity of material;  $D_{\text{calc}} = 4.282 \text{ g/cm}^3$ . The mineral is optically biaxial (-),  $\alpha = 1.835(10)$ ,  $\beta = 1.885(10)$ ,  $\gamma = 1.895(10)$ ,  $2V = 35(10)^\circ$ ,  $2V_{\text{calc}} = 47^\circ$ . Dispersion of optical axes is very strong  $r > v$ . It is moderately pleochroic:  $Z$  (red-brown)  $>$   $Y$  (light red-brown)  $>$   $X$  (light lilac);  $Y = \mathbf{b}$ ,  $X \wedge c = 23^\circ$ , optical axes plane is (010). The main absorption bands in the IR spectrum are ( $\text{cm}^{-1}$ ; s = strong, sh = shoulder): 3340 (O–H stretching vibrations), 1177, 1105s, 1060sh (Si–O stretching vibrations of Si–O–Si links), 934s, 880s, 840sh (Si–O stretching vibrations of apical Si–O bonds), 840sh ( $\text{Al} \cdots \text{O–H}$  bending vibrations), 698, 654, 635, 610 (O–Si–O bending vibrations of  $\text{Si}_2\text{O}_7$  groups), 557, 501s (Al–O stretching vibrations), 443, 384s, 370sh (combination of Si–O–Si bending vibrations and stretching vibrations of  $\text{Fe}^{3+}\text{O}_6$  and  $\text{Mn}^{3+}\text{O}_6$  octahedra). No bands corresponding to the presence of  $\text{H}_2\text{O}$  molecules, B- or C-bearing groups have been detected. The average (range) of 32 electron probe WDS analyses [wt% (range)] is: CaO 11.86 (9.07–14.81), PbO 26.34 (20.32–32.62),  $\text{Al}_2\text{O}_3$  14.04 (12.14–16.13),  $\text{Mn}_2\text{O}_3$  8.61 (7.17–9.87),  $\text{Fe}_2\text{O}_3$  8.75 (7.53–11.21),  $\text{SiO}_2$  28.90 (27.27–28.90);  $\text{H}_2\text{O}$  (calculated from structural data as 1 OH pfu) 1.47; total 99.97. The empirical formula based on 13 O atoms and with the regard for the data on the crystal structure is  $\text{Ca}(\text{Pb}_{0.73}\text{Ca}_{0.30})(\text{Al}_{0.65}\text{Fe}_{0.34})\text{Al}(\text{Mn}_{0.77}\text{Fe}_{0.33})(\text{Si}_{2.96}\text{Al}_{0.04})\text{O}_{12}(\text{OH})$ . The trivalent state of Mn was confirmed by Mn *K*-edge XANES spectroscopy. The strongest lines of the X-ray powder diffraction pattern [ $d$  (Å) ( $I\%$ ;  $hkl$ )] are: 9.44 (44; 001), 8.12 (68; 100), 4.67 (53; 110, 11 $\bar{1}$ ), 3.518 (77; 21 $\bar{1}$ ), 2.931 (100; 11 $\bar{3}$ , 30 $\bar{2}$ , 020), 2.843 (51; 211), 2.736 (57; 013), 2.610 (66; 31 $\bar{1}$ ). The crystal structure was refined from single-crystal X-ray diffraction data to  $R_1 = 0.0354$  for 842 unique reflections with  $F > 4\sigma(F)$ . Piemontite-(Pb) is isostructural with other epidote supergroup minerals and is monoclinic, space group  $P2_1/m$ ;  $a = 8.938(1)$ ,  $b = 5.6810(6)$ ,  $c = 10.289(1)$  Å,  $\beta = 114.17(1)^\circ$ ,  $V = 476.66$  Å<sup>3</sup>,  $Z = 2$ . Type material is deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **D.B.**

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## RHABDOPHANE-(Y)\*

Y. Takai and S. Uehara (2012) Rhabdophane-(Y),  $\text{YPO}_4 \cdot \text{H}_2\text{O}$ , a new mineral in alkali olivine basalt from Hinodematsu, Genkai-cho, Saga Prefecture. *Journal of Mineralogical and Petrological Sciences*, 107(2), 110–113.

Rhabdophane-(Y) (IMA 2011-031), ideally  $\text{YPO}_4 \cdot \text{H}_2\text{O}$ , is a new mineral found at the Higashimatsuura alkaline olivine basalt at Hinodematsu, Genkai-cho, Saga Prefecture, Japan.

Rhabdophane-(Y) occurs in a druse of crystals within the basalt. It covers the surface of the basalt or the druse minerals. It forms radial aggregates of short rod-like crystals  $1 \times 2\text{--}3$  μm in size and is associated with plagioclase, forsterite, augite, enstatite, magnetite, and ilmenite. Lanthanite-(Nd) is also present at the Higashimatsuura basalt, but it is not associated to rhabdophane-(Y) in the same druse. Rhabdophane-(Y) is yellowish white to yellowish brown and translucent, with yellowish white streak. It has silky to dull luster.  $D_{\text{calc}} = 4.54 \text{ g/cm}^3$ . Because of the small amount of mineral available no other physical and optical properties could be measured. The average of 9 electron probe WDS analyses gives [wt% (range)]:  $\text{Y}_2\text{O}_3$  15.25 (14.35–16.37),  $\text{La}_2\text{O}_3$  20.76 (18.29–23.76),  $\text{Ce}_2\text{O}_3$  1.10 (0.44–2.34),  $\text{Pr}_2\text{O}_3$  5.28 (4.36–6.33),  $\text{Nd}_2\text{O}_3$  14.73 (13.43–15.98),  $\text{Sm}_2\text{O}_3$  0.33 (0.00–0.86),  $\text{Gd}_2\text{O}_3$  4.02 (3.72–4.45), CaO 2.03 (1.78–2.45),  $\text{P}_2\text{O}_5$  27.98 (25.56–30.43),  $\text{H}_2\text{O}$  8.52 (by difference); total 100 wt%. On the basis of 4 anions pfu, the empirical chemical formula is  $(\text{Y}_{0.33}\text{La}_{0.31}\text{Nd}_{0.21}\text{Pr}_{0.08}\text{Gd}_{0.05}\text{Ce}_{0.02}\text{Sm}_{0.00})_{\Sigma 1.01}\text{Ca}_{0.09}\text{P}_{0.96}\text{O}_4 \cdot 1.15 \text{H}_2\text{O}$ . The strongest lines in the X-ray powder-diffraction pattern [ $d_{\text{obs}}$  Å ( $I_{\text{obs}}$ ;  $hkl$ )] are: 2.821 (100; 102), 3.013 (77; 200), 6.026 (76; 100), 4.385 (47; 101), 3.480 (44; 110), 2.127 (28; 003), 1.854 (24; 212). The unit-cell parameters obtained from the powder-diffraction experiment are  $a = 6.959(2)$ ,  $c = 6.384(2)$  Å,  $V = 267.7$  Å<sup>3</sup>. Rhabdophane-(Y) is hexagonal and crystallizes in space group  $P6_22$ . Rhabdophane-(Y) belongs to the rhabdophane-group minerals, which includes rhabdophane-(La), rhabdophane-(Ce), rhabdophane-(Nd), grayite (hydrated Th phosphate), tristramite (hydrated U–Ca phosphate), and brockite (hydrated Ca–Th phosphate). The lattice parameters of rhabdophane-(Y) are slightly larger than those of its synthetic equivalent  $(\text{Y}_{0.7}\text{La}_{0.3})\text{PO}_4 \cdot 0.7\text{H}_2\text{O}$  ( $a = 6.917$ ,  $c = 6.366$  Å), due its lower Y content. Rhabdophane-(Y) is named according to the Levinson rule as the Y-dominant species of rhabdophane-(Ce). The holotype specimen of is deposited at the Kitakyushu Museum of Natural History and Human History, Kitakyushu, Japan under the registered number KMNHM000002. **F.C.**

## STEEDITE\*

M.M.M. Haring and A.M. McDonald (2014) Steedeite,  $\text{NaMn}_2[\text{Si}_3\text{BO}_9](\text{OH})_2$ : Characterization, crystal-structure determination, and origin. *Canadian Mineralogist*, 52, 47–60.

Steedeite (IMA 2013-052), ideally  $\text{NaMn}_2[\text{Si}_3\text{BO}_9](\text{OH})_2$ , is a new mineral found at the Poudrette quarry, La Vallée-du-Richelieu, Montérégie (formerly Rouville County), Québec, Canada. Steedeite was found in radiating to loose, randomly oriented groupings (~1 cm in diameter) within vugs in a loose boulder (~1×1 m) of sodalite syenite, associated with microcline, analcime, nepheline, aegirine, pyrrhotite, sodalite, eudialyte-group minerals, natron, catapleite and two other unidentified minerals. Steedeite precipitated from late-stage aqueous fluids that are inferred to have been highly alkaline due to the presence of late-stage natrite. Crystals of steedeite are euhedral, acicular, and elongate along [001] with average dimensions of  $0.006 \times 0.01 \times 0.5$  mm. The dominant form is pinacoid  $\{100\}$ , and minor forms include pinacoids  $\{010\}$  and  $\{001\}$ . Steedeite is colorless to pale pink with a white streak, are vitreous, transparent to translucent, shows no parting or cleavage and exhibit an uneven fracture. The



Mohs hardness and density could not be measured due to small crystal size;  $D_{\text{calc}} = 3.106 \text{ g/cm}^3$ . Steedeite does not effervesce in 10% HCl at room temperature. The mineral shows a weak pale green to pale yellow fluorescence under medium-wave radiation. It is assumed to be a biaxial, based on its symmetry, but full optical characterization could not be done due to the small size of the crystals. Steedeite shows a positive elongation and refractive indices of  $n_{\text{min}} = 1.636(2)$  and  $n_{\text{max}} = 1.656(2)$ , and is nonpleochroic. The Raman spectrum shows wide bands at 3250–3500  $\text{cm}^{-1}$  (O–H stretching), strong and sharp bands at 575–750 and 825–1075  $\text{cm}^{-1}$  (Si–O bonds, also possibly B–O bonds), and weak to strong bands at 50–500  $\text{cm}^{-1}$  (Na–O/Mn–O bonds). The average of 14 electron-microprobe EDS analysis on 7 crystals gives [wt% (range)]: Na<sub>2</sub>O 7.51 (6.78–8.32), CaO 0.17 (0.08–0.22), MnO 31.02 (29.91–32.83), FeO 0.86 (0.76–1.01), SiO<sub>2</sub> 46.34 (40.39–49.29), S 0.39 (0–2.36), B<sub>2</sub>O<sub>3</sub> (calc) 8.73, and H<sub>2</sub>O (calc) 4.52, total 99.53 wt%. Values for B and H<sub>2</sub>O were determined by crystal-structure refinement and their presence confirmed by Raman spectroscopy. The empirical formula calculated on the basis of 11 anions is Na<sub>0.97</sub>(Mn<sub>1.75</sub>Fe<sub>0.05</sub>Ca<sub>0.01</sub>)<sub>Σ1.81</sub>(Si<sub>3.07</sub>S<sub>0.02</sub>)<sub>Σ3.09</sub>BO<sub>9</sub>(OH)<sub>2</sub>. The strongest reflections of the X-ray powder-diffraction pattern [ $d_{\text{obs}}$  Å ( $I_{\text{obs}}$ %;  $hkl$ )] are: 8.454 (100; 00 $\bar{1}$ ), 7.234 (39; 00 $\bar{1}$ ), 3.331 (83; 1 $\bar{2}$ 1, 0 $\bar{1}$ 2, 20 $\bar{1}$ , 1 $\bar{1}$ 2), 3.081 (38; 0 $\bar{2}$ 1), 2.859 (52; 0 $\bar{1}$ 3), and 2.823 (80; 21 $\bar{1}$ ). Single-crystal X-ray diffraction data refined to  $R_1 = 0.0168$  for 2409 unique reflections with  $I \geq 4\sigma(I)$  shows steedeite crystallizes in space group  $P\bar{1}$ , with  $a = 6.837(1)$ ,  $b = 7.575(2)$ ,  $c = 8.841(2)$  Å,  $\alpha = 99.91(3)$ ,  $\beta = 102.19$ ,  $\gamma = 102.78(3)^\circ$ ,  $V = 424.81 \text{ \AA}^3$ , and  $Z = 2$ . The structure of steedeite is based on corner-sharing silicate chains with a periodicity of three (i.e., dreier chain) in a C-shape, closed by BO<sub>2</sub>(OH)<sub>2</sub> tetrahedra to form four-membered borosilicate rings of composition [BSi<sub>3</sub>O<sub>9</sub>(OH)<sub>2</sub>]<sup>5-</sup>. The clusters are linked together through shared corners to bands of edge-sharing MnO<sub>5</sub>(OH) octahedra, where the resulting framework contains channels along {011} that are occupied by Na. Steedeite is the first mineral found to contain single loop-branched dreier silicate chains. The mineral is named after Anthony Hosford Steede (b. 1940) in recognition of his contributions to the understanding of the mineralogy of Mont Saint-Hilaire. The holotype material is deposited in the collections of the Department of Natural History, Royal Ontario Museum, Toronto, Ontario, Canada. **O.C.G.**

## NEW DATA

### CANNONITE

G.C. Capitani, T. Catelani, P. Gentile, A. Lucotti, and M. Zema (2013) Cannonite [Bi<sub>2</sub>O(SO<sub>4</sub>)(OH)<sub>2</sub>] from Alfenza (Crodo, Italy): crystal structure and morphology. *Mineralogical Magazine*, 77(8), 3067–3079.

First noted in Cu-Bi-S mineralization in the Ohio Mining District, Marysville, Utah, U.S.A., by Radtke et al. (1967), cannonite [Bi<sub>2</sub>O(SO<sub>4</sub>)(OH)<sub>2</sub>] was described as a new mineral well later (Stanley et al. 1992). Its structure was known from synthetic analogs only. Reported identification of cannonite in few other localities based on EDS analysis is uncertain since could be misidentified with riomarinaite [Bi(OH)SO<sub>4</sub>·H<sub>2</sub>O] and baličžuničite

[Bi<sub>2</sub>O(SO<sub>4</sub>)<sub>2</sub>]. Cannonite found in mineralized quartz dykes intruding garnet micaschist cropping out near Alfenza (Crodo, Italy) and grows as crowded, radiating, acicular aggregates of {010} “scalpel-like” habit crystals up to a few millimeters covering bismuthinite. Other associated minerals are pyrite, arsenopyrite, cosalite, bornite, anglesite, micas, and two other Bi oxysulfates under study. The average of 10 electron probe WDS analyses of cannonite gives [wt% (range)]: Bi<sub>2</sub>O<sub>3</sub> 77.87 (74.71–81.12), SO<sub>3</sub> 14.33 (12.40–15.47), F 0.28 (0.15–0.39), –O=F<sub>2</sub> 0.12, total 92.35 leading to empirical formula Bi<sub>1.95</sub>Si<sub>1.04</sub>O<sub>5</sub>(OH)<sub>1.91</sub>F<sub>0.09</sub> based on 7 anions pfu. No other elements detected by WDS. The sublimation due to beam damage is blamed for a low total. The most intense bands at Raman spectrum ( $\text{cm}^{-1}$ , s = strong, m = medium) are: 3439, 3376, 3190 (O–H-stretching vibrations), 1114, 1059, 984vs (SO<sub>4</sub> stretching), 562m, 467m, 452s, 438s (SO<sub>4</sub> bending), 337m, 318s, 222vs, 147vs, 121vs, 101vs (Bi–O lattice vibrations.). The IR spectrum shows SO<sub>4</sub> stretching modes in the 1000–1200  $\text{cm}^{-1}$  and the OH-stretching modes in the 3000–3600  $\text{cm}^{-1}$  with no significant bands around 1600  $\text{cm}^{-1}$  (expected region for the bending modes of molecular water). Both Raman and IR spectroscopy confirm the presence of OH groups and the absence of molecular water, and OH···O geometry comparable with the structural data. The crystal structure refined to  $R_1 = 4.24\%$  in the  $P2_1/c$  space group. The cell parameters:  $a = 7.7196(5)$ ,  $b = 13.8856(9)$ ,  $c = 5.6980(4)$  Å,  $\beta = 109.174(1)$ ,  $D_{\text{calc}} = 6.494 \text{ g/cm}^3$  with  $Z = 4$ . The crystal structure consists of anion-centered OBi<sub>4</sub> edge-sharing tetrahedra forming chains running parallel to [001] and strongly bonded along [100] by isolated SO<sub>4</sub> tetrahedra. Each OBi<sub>4</sub> tetrahedron is further connected along [010] by OH groups, making walls of composition Bi<sub>4</sub>O<sub>2</sub>(SO<sub>4</sub>)<sub>2</sub>(OH)<sub>4</sub> parallel to (010). These walls, that represent half of the cell content, are tied to each other along [010] by fewer Bi–O–S bridges and weaker OH···O bonds. **D.B.**

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 Stanley, C.J., Roberts, A.C., Harris, D.C., Criddle, A.J., and Szymański, J.T. (1992) Cannonite, Bi<sub>2</sub>O(OH)<sub>2</sub>SO<sub>4</sub>, a new mineral from Marysville, Utah, USA. *Mineralogical Magazine*, 56, 605–609.

### MAGBASITE

M.D. Welch, R.H. Mitchell, A.R. Kampf, A.R. Chahmouradian, D. Smith, and M. Carter (2014) Crystal structure and topological affinities of magbasite, KBaFe<sup>3+</sup>Mg<sub>7</sub>Si<sub>8</sub>O<sub>22</sub>(OH)<sub>2</sub>F<sub>6</sub>: a trellis structure related to amphibole and carpholite. *Mineralogical Magazine*, 78(1), 29–45.

Magbasite was originally described by Semenov et al. (1965) based on wet chemical analysis of ~0.03 g of material, optical data and X-ray powder diffraction. The locality was not given but later found to be Bayan Obo, Inner Mongolia, China. The mineral was approved by IMA with a chemical formula KBa(Al,Sc)(Mg,Fe<sup>2+</sup>)<sub>6</sub>Si<sub>6</sub>O<sub>20</sub>F<sub>2</sub>. Yang et al. (2009) analyzed material from Semenov but reported a different chemical formula: KBa(Mg,Fe)<sub>8</sub>Si<sub>8</sub>O<sub>23</sub>F<sub>5</sub> (with no Sc) and an orthorhombic lattice:  $a = 22.70(4)$ ,  $b = 19.01(4)$ ,  $c = 5.28(2)$  Å. Lately, a mineral phase close to magbasite in composition was discovered at the Eldor

carbonatite complex, Québec, Canada. The mineral was found in thin veins cutting ferrodolomite- and siderite-carbonatites in association with phlogopite, quartz, siderite, Nb-rich rutile, bafertisite, monazite-(Ce), rare-earth fluoro-carbonates (bastnasite-parisite), and fluorite. Magbasite occurs as aggregates of lavender sub-parallel to acicular crystals. It is biaxial negative with  $\alpha = 1.597(1)$ ,  $\beta = 1.612(1)$ ,  $\gamma = 1.618(1)$ ,  $2V_{\text{meas}} = 65(5)^\circ$ , and  $2V_{\text{calc}} = 64.1^\circ$ ;  $X = \mathbf{a}$ ,  $Y = \mathbf{b}$ , and  $Z = \mathbf{c}$ ; dispersion of optical axes is moderate  $r > v$ . The mineral is pleochroic  $Z$  (lavender)  $> X$  (pale lavender)  $> Y$  (colorless). The averaged electron probe analyses (EDS, 12 points on several grains) gives [wt% (range)]:  $\text{K}_2\text{O}$  3.62 (3.51–3.90),  $\text{BaO}$  13.96 (13.70–14.13),  $\text{MgO}$  23.33 (22.96–23.85),  $\text{MnO}$  0.54 (0.46–0.64), total Fe as  $\text{Fe}_2\text{O}_3$  10.22 (8.13–11.92) ( $\text{FeO}$  3.42,  $\text{Fe}_2\text{O}_3$  6.42),  $\text{Al}_2\text{O}_3$  0.88 (0.30–1.61),  $\text{SiO}_2$  42.32 (42.01–42.58),  $\text{F}$  9.81 (9.54–10.07),  $\text{H}_2\text{O}$  1.74,  $-\text{O}=\text{F}_2$  4.13, total 101.91 wt% ( $\text{Fe}^{2+}/\text{Fe}^{3+}$  ratio and  $\text{H}_2\text{O}$  are calculated from crystal structure refinement). The empirical formula of magbasite calculated on the basis of 30 (O+F) anions is  $\text{K}_{0.86}\text{Ba}_{1.02}\text{Mg}_{6.50}\text{Fe}_{0.53}^{2+}\text{Fe}_{0.90}^{3+}\text{Al}_{0.19}\text{Si}_{7.90}\text{O}_{22.04}(\text{OH})_{2.17}\text{F}_{5.79}$ . Single-crystal Raman microspectroscopy at a room temperature identified a pair of strong peaks at  $3630/3636\text{ cm}^{-1}$  (OH-vibrations) and a pair of very weak peaks at  $3719/3735\text{ cm}^{-1}$  assigned to a small amount of OH in the amphibole-like chain of octahedra substituting for F. Powder infrared spectroscopy identified peaks at  $\sim 3620$ ,  $\sim 3630$ ,  $\sim 3640$ , and  $\sim 3653\text{ cm}^{-1}$ . The strongest lines of the X-ray powder diffraction pattern are [ $d_{\text{obs}}$  Å ( $I_{\text{obs}}$ %;  $hkl$ )]: 3.546 (47; 241,401), 2.991 (68; 441), 2.572 (100; 461,202), 2.416 (41; 312,606), 2.306 (38; 042,332,402,731). The crystal structure of magbasite was solved by direct methods and refined to  $R_1 = 2.6\%$ . The mineral is orthorhombic,  $Cmme$ ,  $a = 18.9506(3)$ ,  $b = 22.5045(3)$ ,  $c = 5.2780(1)$  Å,  $V = 2250.93$  Å<sup>3</sup>, and  $Z = 4$ . The crystal structure of magbasite is related to both carpholite and amphibole topologies. An amphibole-like chain (I-beam) parallel to [100] of edge-sharing  $M$  octahedra occupied by Mg is sandwiched in-between double-chains of  $\text{SiO}_4$  tetrahedra parallel to the  $\mathbf{c}$  axis. The I-beam is linked to the side ribbons of edge-sharing octahedra occupied by Mg,  $\text{Fe}^{2+}$ , and  $\text{Fe}^{3+}$ , and the linkage forms a tunnelled or trellis structure similar to that of carpholite. K occupies a tunnel site analogous to the A site of amphibole, while Ba occupies a cavity site at the intersection of the I-beam and side-ribbon, and corresponds to the A site of carpholite. **Yu.U.**

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### SINNERITE

- L. Bindi, E. Makovicky, F. Nestola, and L. De Battisti (2013) Sinnerite,  $\text{Cu}_6\text{As}_4\text{S}_9$ , from the Lengenbach quarry Binn Valley, Switzerland: description and re-investigation on the crystal structure. *Canadian Mineralogist*, 51(6), 851–860.

Sinnerite, a rare sulfosalt from the famous Lengenbach quarry, Binn Valley, Canton Valais, Switzerland, was originally described as mineral with complicated superlattice structure with a small subcell  $a = 3.72$ ,  $b = 3.70$ ,  $c = 5.24$  Å,  $\alpha = \beta = \gamma = 90^\circ$  (Marumo and Nowacki 1964). Later Makovicky and Skinner (1975) use a synthetic specimen to show the triclinic symmetry of sinnerite (despite of presence sphalerite-like substructure with  $a \sim 5.25$  Å) with cell parameters  $a = 9.064$ ,  $b = 9.830$ ,  $c = 9.078$  Å,  $\alpha = 90.00$ ,  $\beta = 109.30$ ,  $\gamma = 107.48^\circ$ ,  $Z = 2$ , space group  $P1$  and propose a structural model. Both natural and synthetic crystals were complexly twinned with twins containing 24 individuals and simulate a  $\bar{4}3m$  cubic symmetry. The twinning resulted in high  $R$  value (17.2%) and large errors in the atom coordinates and the bond distances. In this study the crystal structure was solved on a natural gem-quality, untwinned sinnerite crystal from the type locality.  $\text{Cu}_6\text{As}_4\text{S}_9$  stoichiometry was confirmed by semi-qualitative SEM-EDS analysis. The mineral is structurally identical to synthetic  $\text{Cu}_6\text{As}_4\text{S}_9$ . The triclinic symmetry with space group  $P1$  was confirmed with  $a = 9.103(2)$ ,  $b = 9.860(3)$ ,  $c = 9.111(2)$  Å,  $\alpha = 90.27(2)$ ,  $\beta = 109.53(2)$ ,  $\gamma = 107.58(2)^\circ$ ,  $V = 729.6$  Å<sup>3</sup>, and  $Z = 2$ . The crystal structure of sinnerite has been refined on a homogeneous crystal fragment ( $100 \times 115 \times 130$  μm) to  $R_1 = 5.45\%$  for 1028 unique reflections with  $I > 2\sigma(I)$ . The structure of sinnerite contains 8 different  $\text{AsS}_3$  coordination pyramids and 12 distinct  $\text{CuS}_4$  coordination tetrahedra. There are 18 distinct S positions in these polyhedra. It consists of a sphalerite substructure with 2/5 of the tetrahedra replaced by  $\text{AsS}_3$  pyramids; 4 pyramids form  $\text{As}_4\text{S}_{12}$  clusters. The true-cell reflections resulted mostly from the presence of sulfur vacancies in the centers of 2 crystallographically independent  $\text{As}_4\text{S}_{12}$  clusters and from the deviation of As sites from the regular tetrahedral arrangement. Alternatively the structure can be described in terms of  $\text{AsS}_3$  pyramids linked into twisted and branched chain-like structures with compositions  $\text{As}_3\text{S}_7$  and  $\text{As}_5\text{S}_{11}$ . The chains are linked by  $\text{CuS}_4$  tetrahedra. Packing of these chains results in the OD (order-disorder) character of the sinnerite structure. **D.B.**

### References cited

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 Marumo, F., and Nowacki, W. (1964) The crystal structure of lautite and of sinnerite, a new mineral from the Lengenbach Quarry. *Schweizer Mineralogische und Petrographische Mitteilungen*, 44, 440–454.