

## New Mineral Names\*†

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This New Mineral Names has entries for 15 new minerals, including abuite, achalaite, arrojadite-(BaNa), burroite, ferri-obertiite, hermannjahnite, jörgellerite, leószilárdite, magnesiovesuvianite, mianningite, pharmazincite, riotintoite, wiklundite, zabińskiite, and zincobotryogen.

### ABUITE\*

S. Enju and S. Uehara (2017) Abuite,  $\text{CaAl}_2(\text{PO}_4)_2\text{F}_2$ , a new mineral from the Hinomaru–Nago mine, Yamaguchi Prefecture, Japan. *Journal of Mineralogical and Petrological Sciences*, 112, 109–115.

Abuite (IMA 2014-084), ideally  $\text{CaAl}_2(\text{PO}_4)_2\text{F}_2$ , is a new mineral discovered in the Hinomaru–Nago mine, Kiyo area, Abu, Abu County, Yamaguchi Prefecture, Japan (34°53'N 131°52'E). It was first mentioned as “gatumbaite-like mineral” (Matsubara and Kato 1998). However, it appeared to be different from gatumbaite  $\text{CaAl}_2(\text{PO}_4)_2(\text{OH})_2$  structurally and chemically. Abuite occurs in hydrothermally altered upper Cretaceous acidic pyroclastic rocks mainly composed of quartz, andalusite, some clay minerals and aluminum phosphates. The alteration related to the biotite adamellite intrusion. Abuite is often included in aluminum-phosphate-rich samples, embedded with quartz, augelite, and/or trolleite, and is often accompanied by other phosphates especially apatite and crandallite. It forms grains of 100–500  $\mu\text{m}$  in size or sometimes aggregates with other minerals, up to 2 mm. The mineral is transparent and colorless with a white streak and a vitreous luster. No fluorescence was observed. The cleavage was not observed. It is hardly recognizable visually from other minerals in association. Density was not measured due to small amount of the material;  $D_{\text{calc}} = 3.214 \text{ g/cm}^3$ . Hardness and optical properties not reported without explanation. No vibrational spectroscopy data provided. The average of 21 electron WDS probe analysis [wt% (range)] is  $\text{P}_2\text{O}_5$  45.04 (41.87–45.38),  $\text{Al}_2\text{O}_3$  31.26 (30.26–31.67),  $\text{CaO}$  17.29 (13.60–17.42),  $\text{SrO}$  0.22 (0–5.39),  $\text{F}$  11.24 (10.17–11.80),  $\text{H}_2\text{O}$  (by stoichiometry) 0.31,  $-\text{O}=\text{F}_2$  4.73, total 100.63. The empirical formula (based on 10 anions pfu,  $\text{O} = 8$ ,  $\text{F}+\text{OH} = 2$ ) is  $(\text{Ca}_{0.99}\text{Sr}_{0.01})_{1.00}\text{Al}_{1.96}\text{P}_{2.03}\text{O}_8(\text{F}_{1.89}\text{OH}_{0.11})$ . The empirical formula for most Sr-rich analyses is  $(\text{Ca}_{0.81}\text{Sr}_{0.17})_{0.99}\text{Al}_{1.99}\text{P}_{2.01}\text{O}_8\text{F}_{2.00}$ . Abuite is the calcium analogue of  $\text{SrAl}_2(\text{PO}_4)_2\text{F}_2$ , which was synthesized by hydrothermal methods. The strongest lines of the powder X-ray diffraction pattern are [ $d$  Å ( $h^2k^2l^2$ ): 4.362 (25; 101), 4.099 (16; 111), 3.683 (32; 021, 201), 3.529 (43; 121), 3.139 (86; 221), 3.001 (20; 301,040), 2.951 (100; 400,131), 2.928 (80; 311), 2.183 (24; 022)]. By analogy with synthetic  $\text{SrAl}_2(\text{PO}_4)_2\text{F}_2$ , the orthorhombic unit cell parameters refined from powder XRD data are  $a = 11.818(2)$ ,  $b = 11.993(3)$ ,  $c = 4.6872(8)$  Å,  $V = 664.3$  Å<sup>3</sup>,  $Z = 4$ , space group  $P2_12_12_1$ . Abuite has atomic coordinates similar to  $\text{SrAl}_2(\text{PO}_4)_2\text{F}_2$ , estimated from the resemblance of the calculated XRD pattern to the observed XRD pattern of abuite. The crystal structure of synthetic

$\text{SrAl}_2(\text{PO}_4)_2\text{F}_2$  (Le Meins and Courbion 1998) consists of infinite chains of Al octahedra along [001] *cis*-linked by sharing two fluorine atoms. Two different chains are linked by  $\text{PO}_4$  tetrahedra, giving rise to channels along [001] delimited by a helical distribution of oxygen anions in which the Sr cations are found. The mineral is named for the type locality. The type specimens are deposited in Kitakyushu Museum of Natural History and Human History, Kitakyushu, Japan. **D.B.**

**Comment:** The structural data based only on analogy with synthetic  $\text{SrAl}_2(\text{PO}_4)_2\text{F}_2$ . No explanation given why single crystal XRD data for abuite was not obtained.

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- Matsubara, S., and Kato, A. (1998) Phosphates from the Hinomaru–Nago mine, Abu-cho, Yamaguchi Prefecture, Western Japan. *Memoirs of the National Science Museum, Tokyo*, 30, 167–183.

### ACHALAIT\*

M.A. Galliski, M.F. Márquez-Zavalía, P. Černý, R. Lira, F. Colombo, A.C. Roberts, and H.-J. Bernhardt (2016) Achalaite,  $\text{Fe}^{2+}\text{TiNb}_2\text{O}_8$ , a new member of the wodginite group from the La Calandria granitic pegmatite, Córdoba, Argentina. *Canadian Mineralogist*, 54(4), 1043–1052.

Achalaite, (IMA 2016-009), ideally  $\text{Fe}^{2+}\text{TiNb}_2\text{O}_8$ , is a new mineral of the wodginite group from the La Calandria granitic pegmatite, Cañada del Puerto, Córdoba province, Argentina (31°25'S, 64°55'W). Many aplite and pegmatite dikes are particularly concentrated along the central-western margin of the Devonian composite Achala batholith. La Calandria mine is located at topaz- and columbite-tantalite bearing pegmatites, which are concordant with the schistosity of the regional metasedimentary units. Achalaite occurs in the intermediate zone of the pegmatite (variable thickness of 0.15 to 1.3 m), composed of K-feldspar, quartz, and albite, and accessory minerals in centimeter-size crystals, nodules or aggregates (topaz, triplite, microlite-group minerals, and dark Nb-Ta oxides). The mineral forms black equidimensional polygranular masses up to 1.5 cm across, included in quartz-albite-muscovite aggregates, in association with Ta-rich rutile, pyrochlore-superficial minerals, cassiterite, columbite-(Mn), ixiolite, and traces of bismuth. The crystallization of achalaite is possibly due to subsolidus rearrangement of cations of a primary phase, likely an ixiolite-type structure, produced in an  $\text{F}$ - $\text{H}_2\text{O}$ -bearing environment during the cooling of the host pegmatite. Achalaite is opaque, with black color and streak, metallic luster, brittle

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

† For a complete listing of all IMA-validated unnamed minerals and their codes, see <http://pubsites.uws.edu.au/ima-cnmmc/>.

tenacity, and irregular fracture. Mohs hardness is 5½.  $D_{\text{calc}} = 6.285 \text{ g/cm}^3$ . It is not fluorescent. In reflected plane-polarized light it is light gray with a slightly violet tint in air, and light gray with an olive tint in oil. It is not pleochroic. Reflectance values were measured in air between 400 and 700 nm in 20 nm intervals. The values for COM wavelengths [ $R_{\text{max}}$ ,  $R_{\text{min}}$  % air/oil ( $\lambda$  in nm)] are: 16.89, 17.72/5.26, 5.76 (470); 16.49, 17.26/4.98, 5.32 (546); 16.34, 17.04/4.97, 5.26 (589); 16.23, 16.94/4.86, 5.19 (650). The electron probe WDS analysis average (8 spots) [wt% (range)] is:  $\text{WO}_3$  2.41 (2.27–2.65),  $\text{Nb}_2\text{O}_5$  30.18 (36.98–38.22),  $\text{Ta}_2\text{O}_5$  37.56 (27.83–31.91),  $\text{TiO}_2$  6.90 (6.25–7.84),  $\text{ZrO}_2$  0.88 (0.77–0.96),  $\text{SnO}_2$  3.82 (2.99–4.64),  $\text{Fe}_2\text{O}_3$  (by electroneutrality) 4.35 (4.27–4.47),  $\text{FeO}$  7.54 (7.09–7.91),  $\text{MnO}$  5.14 (4.65–5.70),  $\text{CaO}$  0.02 (0.01–0.04),  $\text{UO}_2$  0.38 (0.31–0.53), total 99.18 wt%. The empirical formulae calculated on the basis of 32 O pfu and 16 cations is  $(\text{Fe}_{2.21}^{2+}\text{Mn}_{1.52}\text{Fe}_{0.23}^{3+}\text{U}_{0.03}\text{Ca}_{0.01})_{\Sigma 4.00}$   $(\text{Ti}_{1.82}\text{Fe}_{0.92}^{3+}\text{Ta}_{0.58}\text{Sn}_{0.53}\text{Zr}_{0.15})_{\Sigma 4.00}$   $(\text{Nb}_{4.78}\text{Ta}_{3.00}\text{W}_{0.22})_{\Sigma 8.00}\text{O}_{32}$ . The strongest lines in the X-ray powder diffraction pattern are [ $d \text{ \AA}$  (%;  $hkl$ )]: 3.630 (40; 220), 2.964 (100; 221, 221), 2.493 (40; 041), 1.735 (40; 402), 1.711 (50; 441, 441). The unit-cell parameters refined from the powder data are:  $a = 9.422(4)$ ,  $b = 11.427(3)$ ,  $c = 5.120(1) \text{ \AA}$ ,  $\beta = 90.12(4)^\circ$ ,  $V = 551.2 \text{ \AA}^3$ . X-ray diffraction intensity collection was hampered by the powdered nature of the sample. Achalaite is named for the type locality, the Achala granite batholith. The holotype is deposited in the Museo de Geología y Mineralogía “Dr. Alfred Stelzner” of the Universidad Nacional de Córdoba, Argentina. **F.C.**

### ARROJADITE-(BaNa)\*

P. Vignola, F. Hatert, M. Baijot, F. Dal Bo, S. Andò, D. Bersani, A. Pavese, A. Risplendente, and F. Vanini (2016) Arrojadite-(BaNa),  $\text{BaNa}_3(\text{Na,Ca})\text{Fe}_{15}^{2+}\text{Al}(\text{PO}_4)_{11}(\text{PO}_3\text{OH})(\text{OH})_2$ , a new phosphate mineral from the Luna albite pegmatite, Dorio commune, Lecco province, Italy. *Canadian Mineralogist*, 54(4), 1021–1032.

Arrojadite-(BaNa) (IMA 2014-071)  $\text{BaNa}_3(\text{Na,Ca})\text{Fe}_{15}^{2+}\text{Al}(\text{PO}_4)_{11}(\text{PO}_3\text{OH})(\text{OH})_2$ , is the Na-, Ba-rich member of the arrojadite group. It was found at the Luna albite pegmatite, Dorio, Lecco province, Italy (46°06'36"N; 9°19'59"E), where it occurs associated with fluorapatite in the blocky-albite unit of the pegmatite, which consists of three different albite pegmatite dikes belonging to the Late Triassic Piona pegmatite swarm. The mineral occurs as rounded masses or roughly crystallized individuals up to 4–5 cm in diameter. Color is pale grayish-green, translucent or pale yellowish brown when altered, and the luster is greasy. The mineral is brittle with an irregular fracture. Mohs hardness is ~4–5.  $D_{\text{meas}} = 3.54(2) \text{ g/cm}^3$  (by hydrostatic weighting using a Mettler Toledo balance),  $D_{\text{calc}} = 3.76 \text{ g/cm}^3$ . The mineral is optically biaxial (+),  $\alpha = 1.656(2)$ ,  $\beta = 1.660(2)$ ,  $\gamma = 1.664(2)$  (589 nm),  $2V_{\text{meas}} = 44(1)^\circ$ ,  $2V_{\text{calc}} = 45^\circ$ . Dispersion (sense not given) is intermediate. Optical axial plane is perpendicular to {110} (cleavage);  $Z \wedge c = 17\text{--}18^\circ$ . Raman spectrum of arrojadite-(BaNa) shows vibrational modes ( $\text{cm}^{-1}$ ) at 162 (lattice modes), 409 (bending modes  $\nu_2$  of  $\text{PO}_4$  and  $\text{H}_2\text{PO}_4$  units), 530 (out-of-plane bending modes  $\nu_4$  of  $\text{PO}_4$  and  $\text{H}_2\text{PO}_4$  units), 917 ( $\text{PO}_4^{3-}$   $\nu_1$  symmetric stretching modes), 1055 ( $\text{PO}_4^{3-}$   $\nu_3$  antisymmetric stretching modes), 1595 (OH bending), 3522 (OH stretching). The average of 20 electron probe WDS analyses [wt% (range)] is:  $\text{P}_2\text{O}_5$  39.73 (38.88–40.67),  $\text{Al}_2\text{O}_3$  2.40 (2.33–2.52),  $\text{FeO}$  32.91 (32.34–33.35),  $\text{MnO}$  5.41 (5.23–5.65),  $\text{MgO}$  3.60 (3.26–3.76),  $\text{PbO}$  1.35 (1.15–1.50),  $\text{BaO}$  4.43 (3.73–4.90),  $\text{SrO}$  0.35 (0.21–0.53),  $\text{CaO}$  2.22 (1.84–2.40),  $\text{Na}_2\text{O}$  6.06 (5.82–6.32),  $\text{K}_2\text{O}$  0.59 (0.52–0.65),  $\text{H}_2\text{O}^+$  (by stoichiometry) 0.42,  $\text{H}_2\text{O}^-$  (by 2 OH+F+Cl apfu) 0.70, F 0.22 (0.15–0.30),  $-\text{O}=(\text{F,Cl})$  0.09, total 100.30. The empirical formula on the basis of 12 P apfu is  $(\text{Ba}_{0.62}\text{K}_{0.27}\text{Pb}_{0.13}\text{Sr}_{0.07})_{\Sigma 1.09}\text{Na}_3(\text{Na}_{1.19}\text{Ca}_{0.85})_{\Sigma 2.04}$   $(\text{Fe}_{9.82}^{2+}\text{Mg}_{1.92}\text{Mn}_{1.64}^{2+}\text{Al}_{1.01}(\text{PO}_4)_{11}(\text{PO}_3\text{OH})(\text{OH})_{1.75}\text{F}_{0.25})_{\Sigma 2}$ . The strongest lines in the X-ray powder diffraction pattern are [ $d \text{ \AA}$  (%;  $hkl$ )]: 3.137 (100; 510), 2.818 (61; 316), 3.303 (46; 132), 2.667 (35; 208), 2.878 (32; 331), 3.488 (28; 116), 4.621 (22; 313), 2.936 (22; 330). The monoclinic unit-cell parameters refined from the powder data are:  $a = 15.551(4)$ ,  $b =$

10.058(2),  $c = 24.648(7) \text{ \AA}$ ,  $\beta = 106.51(2)^\circ$ ,  $V = 3933 \text{ \AA}^3$ . X-ray diffraction intensity data was collected in one single crystal of  $0.170 \times 0.150 \times 0.080 \text{ mm}$ . The single-crystal unit-cell parameters are:  $a = 16.4984(6)$ ,  $b = 10.0228(3)$ ,  $c = 24.648(1) \text{ \AA}$ ,  $\beta = 105.850(4)^\circ$ ,  $V = 3920.8 \text{ \AA}^3$ , space group  $C2/c$ ,  $Z = 4$ . The crystal structure of arrojadite-(BaNa) was refined starting from the model by Demartin et al. (1996), and yielded  $R_1 = 0.0688$  for 4608 unique reflections. It is similar to that of arrojadite-(BaFe) (Demartin et al. 1996), with the X2 to X4 sites occupied by Na, the X5 site occupied by Ba, and the M2 to M7 sites occupied mainly by  $\text{Fe}^{2+}$ . The X4 site is split in arrojadite-(BaFe), while this splitting does not occur in arrojadite-(BaNa). The P1 site is split in arrojadite-(BaNa), as previously observed in arrojadite-(BaFe) (Demartin et al. 1996). In arrojadite-(BaNa), the X1 site is occupied by Na and the M1 site by Ca. The name is in accordance with the nomenclature of the arrojadite group (Chopin et al. 2006). The co-type samples used for density measurement, Raman spectroscopy, electron-microprobe analyses, and X-ray powder diffraction are stored in the Museo Civico di Storia Naturale, Milano, Italy. The grains used for the crystal structure determination and for the optical measurements are in the Laboratory of Mineralogy, University of Liège. Other fragments from the co-type are stored by one of the authors (P.V.), and at the Department of Mineral Sciences of the National Museum of Natural History (Smithsonian Institution, Washington, D.C.) and at the Department of Geology and Petrography of the Moravian Museum (Brno, Czech Republic). **F.C.**

**Comment:** Following the arrojadite-group nomenclature approved by the Commission on New Minerals, Nomenclature and Classification (CNMNC) of the International Mineralogical Association (IMA) (Chopin et al. 2006), the dominance of Na at the X1 site (Ca in the cited nomenclature scheme) has never been observed and would probably imply a new name, not foreseen by the classification scheme. That would mean that the denomination of this new species as arrojadite-(BaNa) is questionable. In the same sense, the presence of Ca at the M1 site is also rather unique and not covered by the classification scheme. However, a careful analysis of published data yields that these problems could be due to the difficulty to discern both sites in a  $C2/c$  model, as both sites are split in the model of Demartin et al. (1996), which was used as starting model. It is also worthwhile to note that is rather improbable that Ca can order at the M1 site as that site shows up to four distances  $< 2.07 \text{ \AA}$  (one is even  $< 1.95 \text{ \AA}$ ). In addition the sum of cations at the M sites (13 sites pfu including M1), is  $(\text{Fe}+\text{Mn}+\text{Mg}) 13.38 \text{ apfu}$ , thus implying that if Ca is dominant at the M1 site, excess of  $(\text{Fe}+\text{Mn}+\text{Mg})$  over 13 would be  $> 0.5 \text{ apfu}$  and this would imply a second suffix Fe, and consequently this would not be a new mineral. Therefore, the proposed species name can be correct, but the formula probably must be revised. Also, the reported cell parameters from powder probably are mistaken as these values yield a cell volume of  $3696 \text{ \AA}^3$ , not  $3933 \text{ \AA}^3$ . It is plausible that the correct a lattice parameter is  $16.551 \text{ \AA}$  instead of  $15.551 \text{ \AA}$ . The reported value of  $\beta$  by single crystal data [ $105.850(4)^\circ$ ] is in agreement with the relation provided by Chopin et al. (1996) (their Fig. 1), that would assign (Na+K) ca. 4.3 apfu vs. the chemical analysis that gives 4.46 (Na+K) apfu. The angle by powder data would imply ca. 6 apfu (Na+K), which is clearly in disagreement with the analysis.

### Reference cited

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Demartin, F., Gramaccioli, C.M., Pilati, T., and Sciesa, E. (1996) Sigismundite,  $(\text{Ba,K,Pb})\text{Na}_3(\text{Ca,Sr})(\text{Fe,Mg,Mn})_{14}(\text{OH})_2(\text{PO}_4)_{12}$ , a new Ba-rich member of the arrojadite group from Spluga Valley, Italy. *Canadian Mineralogist* 34, 827–834.

### BURROITE\*

- A.R. Kampf, B.P. Nash, J.M. Hughes, and J. Marty (2017) Burroite,  $\text{Ca}_2(\text{NH}_4)_2(\text{V}_{10}\text{O}_{28}) \cdot 15\text{H}_2\text{O}$ , a new decavanadate mineral from the Burro Mine, San Miguel County, Colorado. *Canadian Mineralogist*, 55(3), 473–481.

Burroite, (IMA 2016-079), ideally  $\text{Ca}_2(\text{NH}_4)_2(\text{V}_{10}\text{O}_{28}) \cdot 15\text{H}_2\text{O}$ , is a new mineral species discovered in the Burro mine, Slick Rock district, San Miguel County, Colorado, U.S.A. ( $38^\circ 2' 42''\text{N}$ ,  $108^\circ 53' 23''\text{W}$ ), which is near the southern end of the Uravan Mineral Belt, where uranium and vanadium minerals occur together in bedded or roll-front deposits in the sandstone of the Salt Wash member of the Jurassic Morrison Formation. Burroite is very rare; it has thus far been found on only two specimens. It occurs on montroseite- and corvusite-bearing sandstone in an apparently  $\text{NH}_4$ -rich secondary assemblage that also contains the  $\text{NH}_4$ -bearing decavanadates schindlerite and wernerbaurite. The new mineral forms from the oxidation of montroseite-corvusite assemblages in a moist environment. The  $\text{NH}_4^+$  presumably derives from organic matter in the deposit. Burroite is orange-yellow and occurs as flattened prisms to 2 mm in length, with typically rounded faces, with craterlike depressions. Crystals are transparent to translucent with a vitreous luster and a yellow streak. Cleavage is good on  $\{001\}$ , tenacity is brittle, and fracture is irregular. Mohs hardness is  $1\frac{1}{2}$ –2.  $D_{\text{meas}} = 2.43(2)$  g/cm<sup>3</sup> (by flotation in a mixture of methylene iodide and toluene),  $D_{\text{calc}} = 2.442$  g/cm<sup>3</sup>. It is very slowly soluble in water and quickly soluble in dilute HCl at room temperature. It is not fluorescent. Optical data are incomplete due to the decomposition of crystals in liquids with refraction index  $> 1.8$ :  $\alpha = 1.764(3)$ ,  $\beta = \text{n.d.}$ ,  $\gamma > 1.81$  (white light); average  $n$  (calculated using the Gladstone-Dale relationship) is 1.816. Orientation was determined as  $X \approx \mathbf{a}$ ;  $Y$  probably  $\approx \mathbf{c}^*$ . Dispersion and  $2V$  could not be observed or calculated. No pleochroism observed. The average of 8 electron probe WDS analyses in four crystals [wt% (range)] is:  $(\text{NH}_4)_2\text{O}$  4.11 (3.82–4.37),  $\text{Na}_2\text{O}$  0.49 (0.36–0.70),  $\text{CaO}$  9.14 (9.02–9.29),  $\text{V}_2\text{O}_5$  78.74 (77.56–80.59),  $\text{H}_2\text{O}$  (by difference) 7.52, total 100.00. Normalized analyses to account for devolatilization under the electron beam are  $(\text{NH}_4)_2\text{O}$  3.54,  $\text{Na}_2\text{O}$  0.42,  $\text{CaO}$  7.88,  $\text{V}_2\text{O}_5$  67.84,  $\text{H}_2\text{O}$  (by crystal structure with  $V = 10$  and  $O$  43 apfu) 20.32, total 100.00. For those data, the empirical formula (based on 43 O apfu) is  $[\text{Ca}_{1.88}(\text{NH}_4)_{1.82}\text{Na}_{0.18}\text{V}_{10}^{5+}\text{O}_{28}]^{6-} \cdot 15\text{H}_2\text{O}$ . The strongest lines in the X-ray powder diffraction pattern are [ $d$  Å ( $I$ %;  $hkl$ )]: 11.06 (100; 001), 9.02 (46; 010), 8.10 (21; 011), and 7.71 (94;  $\bar{1}10$ ,  $\bar{1}01$ ). X-ray diffraction intensity data was collected in one single crystal of  $0.15 \times 0.10 \times 0.03$  mm with unit-cell parameters are:  $a = 8.779(2)$ ,  $b = 10.311(2)$ ,  $c = 12.060(2)$  Å,  $\alpha = 96.740(4)$ ,  $\beta = 107.388(5)$ ,  $\gamma = 114.439(6)^\circ$ ,  $V = 911.2$  Å<sup>3</sup>, triclinic,  $P\bar{1}$ ,  $Z = 1$ . The crystal structure of burroite was refined to  $R_1 = 0.0946$  for 2711 independent  $F_o > 4\sigma(F_o)$  reflections. The atomic arrangement of burroite consists of two distinct parts, a structural unit and an interstitial unit: the structural unit is the  $[\text{V}_{10}\text{O}_{28}]^{6-}$  decavanadate cluster; the interstitial unit has the ideal formula  $[\text{Ca}_2(\text{NH}_4)_2 \cdot 15\text{H}_2\text{O}]^{6+}$ , which balances the charge on the structural unit. Each Ca atom in the interstitial unit is bonded to eight oxygen atoms, seven of which are  $\text{H}_2\text{O}$  groups and one belongs to the structural unit. It was not possible to discern unambiguously  $\text{H}_2\text{O}$  from  $\text{NH}_4$  groups. Burroite, is the second known calcium-ammonium hydrate decavanadate, joining wernerbaurite,  $[\text{Ca}_2(\text{NH}_4)_2(\text{H}_2\text{O})_{16}][\text{V}_{10}\text{O}_{28}]$ . The mineral named for its type locality at Burro mine. One holotype and one cotype specimen of burroite, both micromounts split from the single specimen that contains the new phase, are deposited in the collections of the Natural History Museum of Los Angeles County, Los Angeles, California, U.S.A. **F.C.**

### FERRI-OBERTIITE\*

R. Oberti, M. Boiocchi, F.C. Hawthorne, N.A. Ball, and G. Blass (2017) Ferri-obertiite from the Rothenberg quarry, Eifel volcanic complex, Germany: Mineral data and crystal chemistry of a new amphibole end-member. *Mineralogical Magazine*, 81(3), 641–651.

Ferri-obertiite (IMA 2015-079), ideally  $^{\text{A}}\text{Na}^{\text{B}}\text{Na}_2^{\text{C}}(\text{Mg}_3\text{Fe}^{3+}\text{Ti})^{\text{T}}\text{Si}_8\text{O}_{22}\text{W}_2\text{O}_2$ , is a new amphibole-group mineral discovered at the Mount Rothenberg, Eifel volcanic complex, Germany. Ferri-obertiite was found in vesicles in silicate veins within a scoria of a basalt quarry at Rothen-

berg volcano. Associated minerals include potassic feldspar,  $\alpha$ -quartz paramorphic after  $\beta$ -quartz, epidote, tridymite, rutile, roedderite, and other amphiboles. Crystals of ferri-obertiite are acicular and  $\sim 40 \mu\text{m} \times 40 \mu\text{m} \times 300 \mu\text{m}$  in size. They are pink orange with vitreous luster, are transparent, brittle, show perfect cleavage on  $\{110\}$  and do not fluoresce.  $D_{\text{calc}} = 3.145$  g/cm<sup>3</sup>. The new mineral is optically biaxial (+),  $\alpha = 1.664(2)$ ,  $\beta = 1.680(2)$ ,  $\gamma = 1.722(2)$  ( $\lambda = 589.9$  nm),  $2V = 66.4(3)$ , and  $2V_{\text{calc}} = 64.7^\circ$ . In the plane-polarized transmitted light ferri-obertiite is pleochroic:  $X =$  pale pink  $< Y =$  pinkish orange  $< Z =$  orange brown,  $X \parallel \mathbf{b}$ ,  $Y \wedge \mathbf{c} = 17.8^\circ$  ( $\beta$  obtuse),  $Z \wedge \mathbf{a} = 3.5^\circ$  ( $\beta$  acute). The average of 10 electron probe WDS analyses is [wt% (range)]:  $\text{SiO}_2$  55.32 (55.04–55.54)  $\text{TiO}_2$  7.31 (6.76–7.96),  $\text{Al}_2\text{O}_3$  0.34 (0.27–0.39),  $\text{Cr}_2\text{O}_3$  0.12 (0.05–0.26),  $\text{Fe}_2\text{O}_3$  5.81,  $\text{FeO}$  0.04,  $\text{MnO}$  1.32 (1.07–1.49),  $\text{MgO}$  17.00 (15.96–17.59),  $\text{ZnO}$  0.05 (0.01–0.07),  $\text{NiO}$  0.04 (0.00–0.05),  $\text{CaO}$  2.31 (1.98–2.48),  $\text{Na}_2\text{O}$  8.62 (8.53–8.81),  $\text{K}_2\text{O}$  1.24 (1.22–1.29),  $\text{H}_2\text{O}$  0.20,  $\text{F}$  1.22 (0.84–1.70),  $\text{Cl}$  0.01 (0.00–0.02),  $-\text{O}=\text{F}_2$  0.52, total 100.43.  $\text{H}_2\text{O}$  and  $\text{Fe}^{2+}$  were calculated based on the minimum amount required to allow non-negative values of  $\text{Fe}^{2+}$  and  $(\text{F}+\text{OH}+\text{Cl}+\text{O}) = 2$  apfu. This gives the empirical formula  $^{\text{A}}(\text{Na}_{0.76}\text{K}_{0.22}\text{Ca}_{0.35}\text{Mn}_{0.04})_{22.00}^{\text{B}}(\text{Na}_{1.61}\text{Ca}_{0.35}\text{Mn}_{0.04})_{22.00}^{\text{C}}(\text{Mg}_{3.58}\text{Mn}_{0.11}\text{Fe}_{0.62}\text{Ti}_{0.66}\text{Cr}_{0.01}\text{Zn}_{0.01}\text{Ni}_{0.01})_{25.00}^{\text{T}}(\text{Si}_{7.82}\text{Ti}_{0.12}\text{Al}_{0.06}\text{O}_{22}\text{W})_{22.00}^{\text{W}}[\text{O}_{1.26}\text{F}_{0.55}(\text{OH})_{0.19}]_{22.00}$  based on 24 (O, OH, F) apfu. The strongest lines in the X-ray powder diffraction pattern [ $d$  Å ( $I$ %;  $hkl$ )] are: 2.704 (100; 151), 3.116, (76; 310), 3.388 (72; 131), 8.931, (72; 110), 2.5299 (67; 202), 2.583 (39; 061), 2.160 (38; 261), 3.260 (37; 240). Single-crystal X-ray diffraction data collected on a crystal of size  $0.25 \times 0.04 \times 0.03$  mm refined to  $R_1 = 0.03$  for 1138 unique reflections with  $I \geq 3\sigma(I)$  shows ferri-obertiite is monoclinic, space group is  $C2/m$ , with  $a = 9.7901(7)$ ,  $b = 17.9354(13)$ ,  $c = 5.2892(4)$  Å,  $\beta = 104.142(2)^\circ$ ,  $V = 900.58$  Å<sup>3</sup>.  $\text{Fe}^{3+}$  and  $\text{Ti}^{4+}$  are found in approximately equal amounts at the  $M(1)$  and  $M(2)$  sites (dominated by Mg), while  $M(3)$  is fully occupied by Mg. Ferri-obertiite is named according to the nomenclature system for the amphibole supergroup of minerals. The holotype is deposited at the Museo di Mineralogia of the Dipartimento di Scienze della Terra e dell'Ambiente of the Università degli Studi di Pavia, Italy. **O.C.G.**

### HERMANNJAHNITE\*

O.I. Siidra, E.V. Nazarchuk, A.A. Agakhanov, E.A. Lukina, A.N. Zaitsev, R. Turner, S.K. Filatov, I.V. Pekov, G.A. Karpov, and V.O. Yapaskurt (2017) Hermannjahnite,  $\text{CuZn}(\text{SO}_4)_2$ , a new mineral with chalcocyanite derivative structure from the Naboko scoria cone of the 2012–2013 fissure eruption at Tolbachik volcano, Kamchatka, Russia. *Mineralogy and Petrology*, doi: 10.1007/s00710-017-0520-4.

Hermannjahnite (IMA 2015-050), ideally  $\text{CuZn}(\text{SO}_4)_2$ , was discovered in the sublimes of Saranchinaitovaya fumarole, Naboko scoria cone, where the recent Fissure Tolbachik Eruption (FTE) occurred in 2012–2013. The cotype specimen was found in the Arsenatnaya fumarole, on the Second scoria cone of the Great Tolbachik Fissure Eruption (GTFE 1975–1976). The new mineral is named after Hermann Arthur Jahn, who with Edward Teller identified the Jahn-Teller effect, which strongly influences  $\text{CuO}_6$  octahedra geometry in Cu minerals. This effect is pronounced in the structure of hermannjahnite. In the Saranchinaitovaya fumarole, the mineral is closely associated and forms intergrowths with anhydrite and recently approved (IMA 2015-047) itelmenite  $\text{Na}_4\text{Mg}_3\text{Cu}_3(\text{SO}_4)_8$ . Other associated minerals are saranchinaitite (IMA 2015-019)  $\text{Na}_2\text{Cu}(\text{SO}_4)_2$ , chalcocyanite, euchlorine, thénardite, apthitalite, and hematite. In the Arsenatnaya fumarole hermannjahnite is intimately associated with dolerophanite, tenorite, euchlorine, fedotovite, chalcocyanite, langbeinite, apthitalite, anhydrite, hematite, and, in some cases, with dravertite. At both localities hermannjahnite occurs as isometric anhedral grains up to 0.05 mm across with massive aggregates or crusts up to  $2 \times 2$  mm on basaltic scoria. The new mineral is white to colorless, and sometimes displays light grayish, yellowish, greenish, or

bluish tints. It is transparent in individual grains and translucent in aggregates. The mineral has a white streak and vitreous luster. It is brittle, with an uneven fracture and no cleavage or parting. Hardness and density were not measured due to very small size of individual grains and the porosity of the aggregates.  $D_{\text{calc}} = 3.74 \text{ g/cm}^3$ . The new mineral is optically biaxial (+),  $\alpha = 1.642(2)$ ,  $\beta = 1.652(2)$ , and  $\gamma = 1.675(2)$  (589 nm),  $2V_{\text{calc}} = 67.6^\circ$ . Hermannjahnite is non-pleochroic. The averaged 10 point (for holotype) and 6 point (for cotype) EDS electron probe analyses [wt%, (range)] are: MgO 3.25 (3.02–3.48)/5.23 (3.87–6.19), MnO b.d.l./0.10 (b.d.l.–0.15), CuO 33.64 (32.65–34.70)/23.77 (23.44–26.24), ZnO 11.26 (10.23–11.62)/16.69 (12.95–19.06), Fe<sub>2</sub>O<sub>3</sub> b.d.l./0.10 (b.d.l.–0.17), SO<sub>3</sub> 51.71 (50.78–52.48)/52.59 (50.97–53.50), total 99.86/99.81 (98.86–101.19) wt%. The empirical formula of cotype hermannjahnite is  $\text{Cu}_{1.00}(\text{Zn}_{0.43}\text{Cu}_{0.31}\text{Mg}_{0.25})_{20.99}\text{S}_{2.00}\text{O}_8$  based on 8 O apfu and taking into account the structure refinement data. The strongest lines of the powder X-ray diffraction pattern are [ $d \text{ \AA}$  ( $P\%$ ;  $hkl$ ): 4.231 (31; 020), 4.177 (100; 110), 3.630 (72; 111), 3.486 (25; 111), 2.681 (29; 112), 2.648 (69; 022), 2.561 (29; 112), 2.428 (63; 130)]. The crystal structure of hermannjahnite was solved by direct methods and refined to  $R = 4.7\%$ . The new mineral is monoclinic,  $P2_1/n$ ,  $a = 4.8076(2) \text{ \AA}$ ,  $b = 8.4785(3) \text{ \AA}$ ,  $c = 6.7648(3) \text{ \AA}$ ,  $\beta = 93.041(3)^\circ$ ,  $V = 275.35(2) \text{ \AA}^3$ , and  $Z = 2$ . The crystal structure of hermannjahnite contains two symmetrically inequivalent cationic sites coordinated by six O<sup>2-</sup> anions. The of Zn<sup>2+</sup> and Cu<sup>2+</sup> cations occupy individual symmetrically independent crystallographic sites due to the Jahn-Teller effect on Cu<sup>2+</sup>. The [CuO<sub>6</sub>] polyhedra share common edges with ZnO<sub>6</sub> octahedra forming chains along the *c* axis. The [SO<sub>4</sub>] tetrahedra provide interconnection of these chains into a 3D framework. The crystal structure of hermannjahnite can be considered as consisting of pseudolayers formed by [SO<sub>4</sub>] tetrahedra and octahedral chains, and represents a monoclinically distorted chalcocyanite CuSO<sub>4</sub> structure and is also isotopic to that of dravertite, CuMg(SO<sub>4</sub>)<sub>2</sub>. The holotype specimen is deposited in the Mineralogical Museum of St. Petersburg State University, St. Petersburg, Russia. **Yu.U.**

### JÖRGKELLERITE\*

A.N. Zaitsev, S.N. Britvin, A. Kearsley, T. Wenzel, and C. Kirk (2017) Jörgkellerite, Na<sub>3</sub>Mn<sub>3</sub><sup>3+</sup>(PO<sub>4</sub>)<sub>2</sub>(CO<sub>3</sub>)O<sub>2</sub>·5H<sub>2</sub>O, a new layered phosphate-carbonate mineral from the Oldoinyo Lengai volcano, Gregory rift, northern Tanzania. *Mineralogy and Petrology*, 111(3), 373–381.

Jörgkellerite (IMA 2015-020), ideally Na<sub>3</sub>Mn<sub>3</sub><sup>3+</sup>(PO<sub>4</sub>)<sub>2</sub>(CO<sub>3</sub>)O<sub>2</sub>·5H<sub>2</sub>O, is a new phosphate-carbonate discovered in the famous gregoryite-nyerereite carbonatitic lavas of the Oldoinyo Lengai volcano (in the Gregory Rift, northern Tanzania) as a product of its low-temperature oxidative alteration. Jörgkellerite was found at older, pre-1917, carbonatite platform in a highly altered carbonatite rock consisting of two mineral assemblages. The first is composed of relics of the primary carbonatite minerals fluorite, khanneshite, baryte, magnetite, and rare nyerereite, and the second is composed of secondary minerals formed during low-temperature carbonatite alteration, such as calcite, shortite, nahcolite, trona, jacobsonite, and barytoalcite. The mineral was found in only two specimens and occurs as spherulites, up to 200 μm in diameter, consisting of plates up to 10 μm in thickness in shortite-calcite and calcite carbonatites. Spherulites contain relics of fluorite, magnetite, and khanneshite. Jörgkellerite is brown with a white streak and a vitreous luster. It has a perfect micaceous cleavage on {001}, Mohs hardness is 3. Density was not measured due to the lack of sufficient material,  $D_{\text{calc}} = 2.56 \text{ g/cm}^3$ . The mineral is non-fluorescent. Jörgkellerite is optically uniaxial (–),  $\omega = 1.700(2)$ ,  $\epsilon = 1.625(2)$  (589 nm). In plane-polarized light it is distinctly pleochroic:  $O = \text{dark brown} < E = \text{light brown}$ . In cross polars the mineral is yellow to red-brown light with undulose extinction. The IR spectrum obtained in the range 4000–700 cm<sup>-1</sup> has an absorption bands (cm<sup>-1</sup>) at: 821 (water libration); 861 [ $\nu_2$  (CO<sub>3</sub>)<sup>2-</sup> out-of-plane bending];

939, 1035, and 1075 [ $\nu_3$  (PO<sub>4</sub>)<sup>3-</sup> antisymmetric stretching and  $\nu_1$  (CO<sub>3</sub>)<sup>2-</sup> symmetric stretching]; 1404 and 1443 [ $\nu_3$  (CO<sub>3</sub>)<sup>2-</sup> antisymmetric stretching]; 1629 (water HOH bending) and 3260–3300 (hydroxyl stretching vibrations). The average of 10 electron probe WDS and EDS analysis is [wt% (range)]: Na<sub>2</sub>O 12.71 (11.15–13.90), SiO<sub>2</sub> 0.51 (0.35–0.74), P<sub>2</sub>O<sub>5</sub> 23.07 (21.18–23.95), K<sub>2</sub>O 2.17 (1.67–2.83), CaO 0.76 (0.40–1.35), Mn<sub>2</sub>O<sub>3</sub> 32.46 (28.61–33.11) (trivalent state confirmed by XANES), Fe<sub>2</sub>O<sub>3</sub> 7.52 (6.52–9.00) (assumed all trivalent), SrO (0.40–1.04), BaO 0.47 (0.37–0.75), CO<sub>2</sub> 7.34 (calculated assuming one CO<sub>3</sub> group pfu), H<sub>2</sub>O 15.22 [calculated assuming 5 H<sub>2</sub>O groups pfu and 2 (O,OH positions)], total 102.03. Despite the defocused beam was used the high total can be explained by partial loss of hydrate water under the beam or insignificant amount of Mn<sup>2+</sup>. The empirical formula calculated on the basis of (P+Si) = 2 and O = 18 is (Na<sub>2.46</sub>K<sub>0.28</sub>Ca<sub>0.08</sub>Sr<sub>0.04</sub>Ba<sub>0.02</sub>)<sub>Σ2.88</sub>(Mn<sub>3.39</sub>Fe<sub>0.56</sub><sup>3+</sup>)<sub>Σ2.95</sub>[(PO<sub>4</sub>)<sub>1.95</sub>(SiO<sub>4</sub>)<sub>0.05</sub>]<sub>Σ2.00</sub>(CO<sub>3</sub>)[O<sub>1.84</sub>(OH)<sub>0.16</sub>]<sub>Σ2.00</sub>·5H<sub>2</sub>O. The strongest X-ray powder-diffraction lines [ $d \text{ \AA}$ , ( $P\%$ ;  $hkl$ )] are: 10.97 (100; 001), 5.597 (15; 002), 4.993 (8; 111), 3.234 (6; 030), 2.796 (14; 220), 2.724 (20; 004). Jörgkellerite is trigonal, space group  $P\bar{3}$ ,  $a = 11.201(2) \text{ \AA}$ ,  $c = 10.969(2) \text{ \AA}$ ,  $V = 1191.9(7) \text{ \AA}^3$ ,  $Z = 3$ . The crystal structure was refined to  $R_1 = 0.088$  for 846 unique observed  $F_o \geq 4\sigma F$  reflections. The relatively high values of  $R_1$  is accounted to the imperfection of the even best available crystal. Jörgkellerite represents the only known example of a phosphate-carbonate having layered architecture. The basic unit of its structure is an infinite [Mn<sub>3</sub>O<sub>8</sub>(CO<sub>3</sub>)] layer: a two-dimensional lattice composed of triplets of disordered edge-sharing [MnO<sub>6</sub>] octahedra slightly compressed along *Z* axis due to Jahn-Teller effect. Each fourth Mn site in octahedral layer is vacant that results in appearance of ordered system of hexagonal “holes” occupied by (CO<sub>3</sub>) groups. The manganese-carbonate layers are linked in the third dimension by (PO<sub>4</sub>) tetrahedra and partially occupied Na-polyhedra. The mineral named in honor of Jörg Keller (b. 1938), Emeritus Professor of Institut für Geo- und Umweltnaturwissenschaften, Albert-Ludwigs-Universität, Freiburg, Germany, for his valuable contributions to the study of the origin and evolution of alkaline rocks and carbonatites, and particularly the Oldoinyo Lengai volcano. A polished mount with jörgkellerite spherulites extracted from the holotype sample OL 124 is deposited at the Mineralogical museum of the St. Petersburg State University, St. Petersburg, Russia. **D.B.**

### LEÓSZILÁRDITE\*

T.A. Olds, L.R. Saderegaski, J. Plášil, A.R. Kampf, P.C. Burns, I.M. Steele, J. Marty, S.M. Carlson, and O.P. Mills (2017) Leószilárdite, the first Na, Mg-containing uranyl carbonate from the Markey Mine, San Juan County, Utah, USA. *Mineralogical Magazine*, 81(5), 1039–1050.

Leószilárdite (IMA 2015-128), ideally Na<sub>6</sub>Mg(UO<sub>2</sub>)<sub>2</sub>(CO<sub>3</sub>)<sub>6</sub>·6H<sub>2</sub>O, is a new uranyl carbonate mineral discovered in the Markey Mine, Red Canyon, White Canyon District, San Juan County, Utah, U.S.A. Markey mine is one of the uranium deposits in the area characterized as channel-type sediments from streams that deposited the Triassic Shinarump conglomerate, and commonly cut into the underlying reddish-brown silty sandstones and mudstones of the Moenkopi Formation. The geology is quite similar to that of the nearby Blue Lizard mine where a number of new secondary uranium sulfates were discovered recently although the mineralogy of the Markey mine is notably richer in carbonate phases. The difference may be related to the considerably higher CO<sub>2</sub> level compare to the Blue Lizard. Leószilárdite is the product of post-mining oxidation of primary minerals in the humid underground environment. It occurs in areas with abundant andersonite, natrozippite, gypsum, anhydrite, and probable hydromagnesite along with other secondary uranium minerals bayleyite, čekkaite, johannite, and chalcantite coating veins of uraninite in sulfide-laden carbonaceous wood fragments. Leószilárdite forms aggregates of pale yellow bladed crystals flattened

on {001} and elongated along [010], individually reaching up to 0.2 mm. Crystals exhibit the forms {110}, {001}, {100}, {101}, {101}, no twinning was observed. More commonly it occurs as pale yellow pearly masses to 2 mm consisting of very small plates. It is translucent with a vitreous to pearly luster and a white streak. Leószilárdite shows weak green fluorescents under both long-wave and short-wave UV light. It is brittle with uneven fracture, perfect cleavage on {001} and Mohs hardness of ~2. The density was not measured due to limited amount of the material;  $D_{\text{calc}} = 3.256 \text{ g/cm}^3$ . The new mineral is readily soluble in room temperature  $\text{H}_2\text{O}$ . In plane-polarized transmitted light leószilárdite is pleochroic  $X$  (colorless)  $< Y \approx Z$  (light yellow). It is optically biaxial (-),  $\alpha = 1.504$ ,  $\beta = 1.597$ ,  $\gamma = 1.628$  (white light);  $2V = 57^\circ$ ,  $2V = 57.1^\circ$ ; dispersion of an optical axes is weak,  $r > v$ ;  $X = \mathbf{b}$ ,  $Y \approx \mathbf{a}$ ,  $Z \approx \mathbf{c}$ . The Raman spectrum shows the bands ( $\text{cm}^{-1}$ ) at: 1535, 1396, and 1328 [ $\nu_3$  ( $\text{CO}_3$ )<sup>2-</sup> antisymmetric stretching vibrations], 1078, 1062, 1052 [split  $\nu_1$  ( $\text{CO}_3$ )<sup>2-</sup> symmetric stretching], 824 very strong [ $\nu_1$  ( $\text{UO}_2$ )<sup>2+</sup> symmetric stretching], 742, 729, 705, 695 [split doubly degenerate  $\nu_4$  ( $\delta$ ) ( $\text{CO}_3$ )<sup>2-</sup> in-plane bending], 345 weak [ $\nu$  ( $\text{U}-\text{O}_{\text{ligand}}$ ) stretching], 290, 254 [doubly degenerate  $\nu_2$  ( $\delta$ ) ( $\text{UO}_2$ )<sup>2+</sup> bending], 193, 172, 161, 144 and 125 [ $\nu_2$  ( $\delta$ ) ( $\text{UO}_2$ )<sup>2+</sup> bending modes,  $\text{U}-\text{O}_{\text{ligand}}$  stretches, or external lattice vibration modes]. No bands related to the  $\nu_2$  ( $\delta$ )-bending vibration of water were observed. The average of six electron probe WDS analyses [wt% (range)] is:  $\text{Na}_2\text{O}$  14.54 (14.15–15.06),  $\text{MgO}$  3.05 (2.71–3.35),  $\text{UO}_3$  47.95 (47.35–48.74),  $\text{CO}_2$  22.13 (calculated as 6 C apfu),  $\text{H}_2\text{O}$  9.51 (by charge balance), total 97.18. The empirical formula based on 28 O apfu is  $\text{Na}_{5.60}\text{Mg}_{0.90}\text{U}_2\text{O}_{28}\text{C}_6\text{H}_{12.60}$ . The strongest X-ray powder diffraction lines [ $d$  Å ( $P\%$ ;  $hkl$ )] are: 7.59 (36; 002), 5.46 (100;  $\bar{1}11, \bar{2}01, 111$ ), 4.64 (28;  $\bar{1}12, 202$ ), 3.82 (30;  $\bar{1}13, 113$ ), 3.383 (33; 020, 310), 3.105 (25; 204, 022), 2.864 (31;  $\bar{2}21, 401, 401$ ), 2.028 (28; multiple). Single-crystal data shows leószilárdite is monoclinic,  $C2/m$ ,  $a = 11.6093(21)$ ,  $b = 6.7843(13)$ ,  $c = 15.1058(28)$  Å,  $\beta = 91.378(3)^\circ$ ,  $V = 1189.4$  Å<sup>3</sup>, and  $Z = 2$ . The crystal structure was refined to  $R_1 = 0.0387$  for 1394  $I_{\text{obs}} > 4\sigma I$  reflections. It consists of uranyl tricarbonate anion clusters  $[(\text{UO}_2)(\text{CO}_3)_3]^{4-}$  held together in part by irregular chains of  $\text{NaO}_3(\text{H}_2\text{O})$  polyhedra sub parallel to [010]. Individual uranyl tricarbonate clusters are also linked together by three-octahedron units consisting of two Na-centered octahedra that share the opposite faces of a Mg-centered octahedron at the center (Na–Mg–Na), and have the composition  $\text{Na}_2\text{MgO}_{12}(\text{H}_2\text{O})_4$ . The mineral is named in honor the Hungarian-American physicist and biologist Leó Szilárd (1898–1964). The holotype specimen is deposited in the Natural History Museum of Los Angeles County, Los Angeles, California, U.S.A. **D.B.**

### MAGNESIOVESUVIANITE\*

T.L. Panikirovskii, V.V. Shilovskikh, E.Yu. Avdontseva, A.A. Zolotarev, V.Yu. Karpenko, A.S. Mazur, V.N. Yakovenchuk, A.V. Bazai, S.V. Krivovichev, and I.V. Pekov (2017) Magnesiovesuvianite,  $\text{Ca}_{19}\text{Mg}(\text{Al}, \text{Mg})_{12}\text{Si}_{18}\text{O}_{69}(\text{OH})_9$ , a new vesuvianite-group mineral. *Journal of Geosciences*, 62(1), 25–36.

Magnesiovesuvianite (IMA 2015-104), ideally  $\text{Ca}_{19}\text{Mg}(\text{Al}, \text{Mg})_{12}\text{Si}_{18}\text{O}_{69}(\text{OH})_9$ , was discovered in an old museum specimen from the Tuydo combe, near Lojane, Republic of Macedonia, deposited in the systematic collection (#59783) of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. In this specimen, now considered as the holotype, magnesiovesuvianite is associated with calcite, grossular-andradite, and clinocllore. It occurs in cavities of a garnet-bearing rodingite and has hydrothermal origin. Magnesiovesuvianite forms radiating aggregates up to 2 cm across consisting of acicular tetragonal crystals (up to 7 mm long and 5–40  $\mu\text{m}$  thick) with a distinct fiber-optic effect. It is transparent, light pink with a silky luster and a white streak. No cleavage was observed. The Mohs hardness is 6.  $D_{\text{meas}} = 3.30(1) \text{ g/cm}^3$ ,  $D_{\text{calc}} = 3.35 \text{ g/cm}^3$ . Magnesiovesuvianite is optically uniaxial (-),  $\omega = 1.725(2)$ ,  $\varepsilon = 1.721(2)$  (white light), and is non-pleo-

chroic. Solid-state magic-angle nuclear magnetic resonance study was completed for magnesiovesuvianite for <sup>27</sup>Al and <sup>1</sup>H. The NMR spectrum showed that the new mineral contains both [5]- and [6]-coordinated Al study. The <sup>1</sup>H MAS NMR spectrum of magnesiovesuvianite contains two peaks centred at 6.52 and -0.95 ppm. Absence of the peak at 3.38 ppm indicates the insignificant role of  $\text{SiO}_4^{4-} \leftrightarrow [\text{H}_4\text{O}_4]^{4+}$  substitution in magnesiovesuvianite. The O–H $\cdots$ O distances calculated using the formula  $\delta_{\text{iso}}$  (ppm) =  $79.05 - 0.255d(\text{O}-\text{H}\cdots\text{O})$  (pm) are 2.84 and 3.13 Å. The most intense peak at 6.74 ppm corresponds to the chemical shifts of the O(11)–H(1a) $\cdots$ O(7) and the O(10)–H(2) $\cdots$ O(10) bonds, and the peak at -0.95 ppm can be attributed to the O(11)–H(1b) $\cdots$ O(11) bond. The absorption bands in IR spectrum ( $\text{cm}^{-1}$ ) are: 393 412, 492, [(Al–O)<sub>6</sub> stretching vibrations], 443 ( $\nu_2$  Si–O symmetric bending), 576, 606 ( $\nu_4$  Si–O asymmetric bending), 713 (potentially vibrations of OH groups), 802, 906 (doublet), 968, 1024 (asymmetric stretching vibrations of Si–O and Si–O–Si), 3200, 3450, 3630 (O–H stretching). The TGA and DSC curves have one major step of weight loss (3.10%) corresponding to an endothermic effect at 1024 °C. The average of electron probe WDS analyses (number not given) is [wt%, (range)]:  $\text{Na}_2\text{O}$  0.01 (0–0.15),  $\text{FeO}$  0.04 (0–0.23),  $\text{MnO}$  0.18 (0.10–0.36),  $\text{MgO}$  1.80 (1.62–1.99),  $\text{CaO}$  36.50 (35.80–37.17),  $\text{Al}_2\text{O}_3$  20.01 (19.52–20.67),  $\text{SiO}_2$  36.73 (36.27–37.35),  $\text{H}_2\text{O}$  (by thermogravimetry) 3.10, total 98.37. The empirical formula based on  $(\text{Ca}+\text{Na}) = 19$  apfu is:  $(\text{Ca}_{18.99}\text{Na}_{0.01})_{219.00}(\text{Mg}_{0.60}\text{Al}_{0.40})_{21.00}(\text{Al}_{11.05}\text{Mg}_{0.70}\text{Mn}_{0.07}\text{Fe}_{0.02})_{211.84}\text{Si}_{17.84}\text{O}_{68.72}(\text{OH})_9$ . The strongest lines in the powder X-ray diffraction pattern are [ $d$  Å ( $P\%$ ;  $hkl$ )]: 10.96 (23; 110), 3.46 (22; 240), 3.038 (33; 510), 2.740 (100; 432), 2.583 (21; 522), 2.365 (94; 620), 2.192 (19; 710), 1.6165 (25; 672). The crystal structure of magnesiovesuvianite was refined to  $R = 2.7\%$  using a merohedral twin model with the twin ratio 0.485/0.515. The new mineral is tetragonal,  $P4/n$ ,  $a = 15.5362(2)$ ,  $c = 11.7960(3)$  Å,  $V = 2847.26$  Å<sup>3</sup>,  $Z = 2$ . The name reflects the predominance of  $\text{Mg}^{2+}$  at the Y1 site. **Yu.U.**

### MIANNINGITE\*

X. Ge, G. Fan, G. Li, G. Shen, Z. Chen, and Y. Ai (2017) Mianningite,  $(\square, \text{Pb}, \text{Ce}, \text{Na})(\text{U}^{4+}, \text{Mn}, \text{U}^{6+})\text{Fe}_3^{2+}(\text{Ti}, \text{Fe}^{3+})_{18}\text{O}_{38}$ , a new member of the crichtonite group from Maoniuping REE deposit, Mianning county, southwest Sichuan, China. *European Journal of Mineralogy*, 29(2), 331–338.

Mianningite (IMA 2014-072),  $(\square, \text{Pb}, \text{Ce}, \text{Na})(\text{U}^{4+}, \text{Mn}, \text{U}^{6+})\text{Fe}_3^{2+}(\text{Ti}, \text{Fe}^{3+})_{18}\text{O}_{38}$ , was discovered in Baozi Hill near well-known Maoniuping REE mine, Mianning county, Sichuan province, China and named for its type locality. Mianningite was found in fractures within lamprophyre veins and their contacts with a later quartz-alkali feldspar syenite dike with REE, U, and Th mineralization. The associated minerals are microcline, albite, quartz, iron-rich phlogopite, augite, muscovite, calcite, barite, fluorite, epidote, magnetite, hematite, galena, hydroxylapatite, titanite, ilmenite, rutile, garnet-group minerals, zircon, allanite-(Ce), monazite-(Ce), bastnasite-(Ce), parasite-(Ce), maoniupingite-(Ce), thorite, pyrochlore-group minerals, and chlorite. The new mineral forms black (with a black streak) submetallic opaque subhedral to euhedral tabular crystals generally 1–2 mm in size, and occasionally up to 2 cm (Zhang et al. 1995). Mianningite is brittle and exhibits a conchoidal fracture. No cleavage or parting were observed. Mohs hardness is ~6.  $D_{\text{meas}} = 4.62(8) \text{ g/cm}^3$ ,  $D_{\text{calc}} = 4.77 \text{ g/cm}^3$ . In reflected light mianningite is grayish white with no internal reflections. The new mineral is partially metamict, and due to this it is only weakly anisotropic and does not exhibit birefractance or pleochroism. The reflectance values (in air) [ $R_{\text{max}}$ ,  $R_{\text{min}}$  (nm)] are: 18.6, 16.4 (400); 19.9, 18.9 (420); 19.8, 18.9 (440); 19.2, 18.5 (460); 18.8, 18.1 (480); 18.5, 17.9 (500); 18.2, 17.6 (520); 18.0, 17.4 (540); 17.7, 17.1 (560); 17.5, 16.9 (580); 17.3–16.7 (600); 17.1–16.5 (620); 17.0, 16.3 (640); 16.8, 16.1 (660); 16.8–16.1 (680); 16.5–15.7 (700). The averaged 22 point WDS electron probe analyses

is [wt% (range)]:  $\text{P}_2\text{O}_5$  0.03 (0.01–0.08),  $\text{V}_2\text{O}_5$  0.57 (0.36–0.88),  $\text{Nb}_2\text{O}_5$  0.59 (0.12–1.64),  $\text{SiO}_2$  0.02 (0.01–0.04),  $\text{TiO}_2$  53.12 (51.45–54.84),  $\text{ZrO}_2$  0.15 (0.02–0.33),  $\text{ThO}_2$  0.15 (0.01–0.39),  $\text{UO}_2$  total 8.05 (5.75–10.33) [ $\text{UO}_2$  6.44,  $\text{UO}_3$  1.71],  $\text{Al}_2\text{O}_3$  0.07 (0.01–0.16),  $\text{Cr}_2\text{O}_3$  0.07 (0.01–0.16),  $\text{Fe}_2\text{O}_3$  total 28.78 (27.42–29.64) [ $\text{FeO}$  0.93,  $\text{Fe}_2\text{O}_3$  27.75],  $\text{Y}_2\text{O}_3$  0.55 (0.08–1.02),  $\text{La}_2\text{O}_3$  0.67 (0.26–1.00),  $\text{Ce}_2\text{O}_3$  1.12 (0.52–1.50),  $\text{Nd}_2\text{O}_3$  0.11 (0.01–0.25),  $\text{MgO}$  0.05 (0.02–0.08),  $\text{CaO}$  0.03 (0.01–0.07),  $\text{MnO}$  1.11 (0.86–1.50),  $\text{SrO}$  0.20 (0.07–0.39),  $\text{BaO}$  0.30 (0.09–0.50),  $\text{PbO}$  2.56 (1.44–3.41),  $\text{Na}_2\text{O}$  0.21 (0.09–0.36),  $\text{K}_2\text{O}$  0.09 (0.03–0.23), total 98.60. The amount of  $\text{UO}_2$ ,  $\text{UO}_3$ ,  $\text{FeO}$ , and  $\text{Fe}_2\text{O}_3$  was re-calculated from  $\text{UO}_2$  total and  $\text{Fe}_2\text{O}_3$  total on the basis of XPS data. The empirical formula of mianningite is  $[\square_{0.322}(\text{Pb}_{0.215}\text{Ba}_{0.037}\text{Sr}_{0.036}\text{Ca}_{0.010})_{\Sigma 0.298}(\text{Ce}_{0.128}\text{La}_{0.077}\text{Nd}_{0.012})_{\Sigma 0.217}(\text{Na}_{0.127}\text{K}_{0.036})_{\Sigma 0.163}]_{\Sigma 1.000}(\text{U}_{0.447}^{4+}\text{Mn}_{0.293}\text{U}_{0.112}^{6+}\text{Y}_{0.091}\text{Zr}_{0.023}\text{Th}_{0.011})_{\Sigma 0.977}(\text{Fe}_{1.224}^{3+}\text{Fe}_{0.243}^{2+}\text{Mg}_{0.023}\text{P}_{0.008}\text{Si}_{0.006}\square_{0.496})_{\Sigma 2.000}(\text{Ti}_{12.464}\text{Fe}_{5.292}^{3+}\text{V}_{0.118}^{5+}\text{Nb}_{0.083}\text{Al}_{0.026}\text{Cr}_{0.017})_{\Sigma 18.000}\text{O}_{38}$  based on 38 atoms of O pfu. The strongest lines of the powder X-ray diffraction pattern are [ $d$  Å (%;  $hkl$ ): 2.627(100; 125); 2.144(100; 135); 3.065(75; 025); 2.254(70; 028); 1.545(60; 336); 2.883(55; 116); 2.476(55; 027); 1.705(55; 146)]. The unheated crystals of mianningite were partially metamict, and produce a poor X-ray powder diffraction pattern. The single-crystal X-ray diffraction data collected on the annealed grain shows it is trigonal,  $R\bar{3}$ ,  $a = 10.3462(5)$ ,  $c = 20.837(2)$  Å,  $V = 1931.65$  Å<sup>3</sup>,  $Z = 3$ . The crystal structure of mianningite was refined to  $R = 7.0\%$ . It is isostructural with other members of the crichtonite group, comprising nine layers of close-packed octahedra  $M(1)$  and  $M(3-5)$  and tetrahedra  $M(2)$ . There is also a large 12-fold-coordinated  $M(0)$  site per each nine polyhedral layers. Small cations occupy the voids of 19 octahedra and 2 tetrahedra, and large cations such as Pb, Ce, La, Na partially occupy the 12-fold-coordinated  $M(0)$  site, leaving it 32.2% vacant. The U, Mn, and Y ions are located in the octahedral  $M(1)$  site. The tetrahedral  $M(2)$  site is occupied by  $\text{Fe}^{3+}$ , while the  $M(3)$ ,  $M(4)$ , and  $M(5)$  sites host Ti and  $\text{Fe}^{3+}$ . The holotype specimen is deposited in the collections of the Geological Museum of China, China. **Yu.U.**

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### PHARMAZINCITE\*

I.V. Pekov, V.O. Yapaskurt, D.I. Belakovskiy, M.F. Vigasina, N.V. Zubkova, and E.G. Sidorov (2017) New arsenate minerals from the Arsenatnaya fumarole, Tolbachik volcano, Kamchatka, Russia. VII. Pharmazincite,  $\text{KZnAsO}_4$ . Mineralogical Magazine, 81(4), 1001–1008.

Pharmazincite (IMA 2014-015), ideally  $\text{KZnAsO}_4$ , is a new mineral discovered at the Arsenatnaya fumarole at the Second scoria cone of the Northern Breakthrough of the Great Tolbachik Fissure Eruption Tolbachik volcano, Kamchatka, Russia. The new mineral was found in sublimates (360–380 °C) as a minor constituent of incrustations in association with shchurovskyite, dmisokolovite, bradaczekite, arsmirandite, tilasite, johillerite, tenorite, hematite, aphthalite, and As-bearing orthoclase. Pharmazincite was likely deposited directly from the gas phase temperatures higher than 360 °C. The new mineral occurs as short- to long-prismatic and acicular crystals elongated by [001], usually imperfect, with coarse striation along [001], typically skeletal, with a gear-like cross section. Terminations are crude, sometimes roundish and/or “fringed,” with epitactic overgrowths of tiny crystals of the same mineral. Prismatic crystals are up to 0.03 mm × 0.07 mm in size and acicular crystals are up to 1 × 0.01 mm in size. Crystals form near-parallel or chaotic clusters, open-work radial aggregates up to 1.5 mm in diameter usually overgrowing crusts or dense clusters (up to 2 mm across and up to 0.02 mm thick) of the same mineral belonging to its earlier generation. Major crystal forms are assumed to be {110} and {101}, whereas {100} and {001} are subordinate. Pharmazincite is colorless to white,

transparent with vitreous luster. It is brittle with a stepped fracture. The cleavage is perfect on {001}. Hardness and density were not measured because of small crystal size and open-work character of aggregates;  $D_{\text{calc}} = 4.748$  g/cm<sup>3</sup>. Pharmazincite is optically uniaxial (–),  $\omega = 1.649(2)$ ,  $\epsilon = 1.642(2)$ . It is non-fluorescent under ultraviolet rays or an electron beam. The Raman spectrum shows bands (cm<sup>–1</sup>) at 853 (strong;  $\text{As}^{5+}$ –O stretching vibrations of  $\text{AsO}_4^{3-}$  groups), 550–250 ( $\text{As}^{5+}$ –O bending vibrations and Zn–O stretching). The absence of bands with frequencies higher than 1000 cm<sup>–1</sup> indicates the absence of O–H, C–H, C–O, N–H, N–O, and B–O bonds. The average of 7 electron probe WDS analyses is [wt% (range)]:  $\text{K}_2\text{O}$  18.98 (18.51–19.94),  $\text{CaO}$  0.14 (0–0.35),  $\text{MgO}$  1.20 (0.56–1.67),  $\text{CuO}$  4.41 (3.05–5.73),  $\text{ZnO}$  27.58 (25.19–30.26),  $\text{Fe}_2\text{O}_3$  0.15 (0.00–0.54),  $\text{P}_2\text{O}_5$  0.50 (0.18–0.95),  $\text{As}_2\text{O}_5$  46.67 (45.74–47.57), total 99.63. This gives the empirical formula  $(\text{K}_{0.97}\text{Ca}_{0.01})_{\Sigma 0.98}(\text{Zn}_{0.82}\text{Cu}_{0.13}\text{Mg}_{0.07}\text{Fe}_{0.01}^{2+})_{\Sigma 1.03}(\text{As}_{0.98}\text{P}_{0.02})_{\Sigma 1.00}\text{O}_4$  based on 4 O pfu. The strongest lines in the X-ray powder-diffraction pattern [ $d$  Å (%;  $hkl$ )] are: 6.36 (28; 111), 4.64 (45; 220), 4.35 (48; 002), 3.260 (36; 411), 3.179 (100; 222), 2.770 (26; 113), 2.676 (77; 600), 2.278 (15; 602), 1.710 (15; 713,115). The unit-cell parameters refined from powder-diffraction data are:  $a = 18.653(7)$ ,  $c = 8.676(6)$  Å, and  $V = 2614$  Å<sup>3</sup>. Single-crystal X-ray diffraction data shows pharmazincite is hexagonal, space group  $P6_3$ ,  $a = 18.501(4)$ ,  $c = 8.7114(9)$  Å,  $V = 2582.4$  Å<sup>3</sup>,  $Z = 24$ . Pharmazincite is isostructural with megakalsilite  $\text{KAlSiO}_4$  and has a crystal structure based upon a tetrahedral tridymite-type  $\{\text{ZnAsO}_4\}^-$  framework. Pharmazincite is named for its chemical constituents. The type specimen is deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **O.C.G.**

### RIOTINTOITE\*

N.V. Chukanov, S.M. Aksenov, R.K. Rastsvetaeva, A.R. Kampf, G. Möhn, D.I. Belakovskiy, and J.A. Lorenz (2016) Riotintoite,  $\text{Al}(\text{SO}_4)(\text{OH}) \cdot 3\text{H}_2\text{O}$ , a new mineral from La Vendida copper mine, Antofagasta Region, Chile. Canadian Mineralogist, 54, 1293–1305.

Riotintoite (IMA 2015-079), ideally  $\text{Al}(\text{SO}_4)(\text{OH}) \cdot 3\text{H}_2\text{O}$ , is a new mineral species from the abandoned La Vendida mine (until 1990 known as the Rio Tinto mine) situated about 3 km WNW of the Sierra Gorda village, Antofagasta Region, Atacama desert, Chile. It occurs in association with intermediate members of the aubertite–magnesioaubertite solid-solution series, belloite, eriochalcite, alunite, kaolinite, and halloysite; riotintoite along with other two species discovered in the La Vendida mine—vendidaite and belloite are the latest minerals in this association. Crystals occur lining cavities and are intergrown in veins up to several millimeters thick and two or more cm in extent, along with massive accumulations of secondary sulfate, chloride, and clay minerals. Riotintoite forms colorless transparent vitreous tabular crystals up to 0.1 × 0.4 × 0.4 mm, flattened on (010). Cleavage is good on {010}, {001}, and {201}. Riotintoite is brittle, with a Mohs hardness of 2½.  $D_{\text{meas}} = 2.13(2)$  g/cm<sup>3</sup> (by flotation in heavy liquids),  $D_{\text{calc}} = 2.129$  g/cm<sup>3</sup>. Riotintoite is optically biaxial (–),  $\alpha = 1.513(2)$ ,  $\beta = 1.522(2)$ ,  $\gamma = 1.526(2)$  (589 nm),  $2V_{\text{meas}} = 62(1)^\circ$ ,  $2V_{\text{calc}} = 67^\circ$ ;  $X \wedge \mathbf{b} = 41^\circ$ ,  $Y \wedge \mathbf{c} = 45^\circ$ ,  $Z \wedge \mathbf{a} = 44^\circ$ . Dispersion of an optical axes is weak,  $r > v$ . Infrared absorption spectrum show the following bands (cm<sup>–1</sup>; s – strong band, w – weak band, sh – shoulder): 3540 (O–H stretching of OH–groups); 3335sh, 3270sh, 3145s, 3110sh, 3010sh, 2900sh, 2480 (O–H stretching vibrations of  $\text{H}_2\text{O}$  molecules); 2110w, 1933w (combination modes); 1690, 1647 (bending vibrations of  $\text{H}_2\text{O}$  molecules); 1186s, 1117s, 1095s [ $\nu_3(\text{F}_2)$  – asymmetric stretching of  $\text{SO}_4^{2-}$  anions]; 1021, 968 [in phase and out-of-phase modes involving  $\nu_1(\text{A}_1)$  – symmetric S–O stretching vibrations of neighboring  $\text{SO}_4^{2-}$  anions]; 882w, 843, 760sh, 700 ( $\text{Al} \cdots \text{O} \cdots \text{H}$  bending); 880sh, 850sh, 814 ( $\text{Al} \cdots \text{O} \cdots \text{H}$  bending vibrations); 745sh, 683, 607s [ $\nu_4(\text{F}_2)$  O–S–O bending vibrations of  $\text{SO}_4^{2-}$  anions]; 549, 485, 465, 455sh, 435w ( $\text{Al} \cdots \text{O}$  stretching, possibly combined with librational vibrations of  $\text{H}_2\text{O}$

molecules) 382 (lattice vibrations). Bands of stretching vibrations of  $\text{BO}_3^{3-}$ ,  $\text{CO}_3^{2-}$ , and  $\text{NO}_3^-$  (in the range from 1200 to 1600  $\text{cm}^{-1}$ ) are absent in the IR spectrum of riotintoite. The average of seven electron probe EDS analyses [wt% (range)] is:  $\text{Al}_2\text{O}_3$  24.36 (23.37–25.22),  $\text{SO}_3$  40.69 (39.82–41.54),  $\text{H}_2\text{O}$  (by gas chromatography) 34(2), total 99.05. The empirical formula based on 8 anions pfu and OH/ $\text{H}_2\text{O}$  ratio calculated from charge balance is  $\text{Al}_{0.93}(\text{SO}_{4.09}(\text{OH})_{0.81} \cdot 3.25\text{H}_2\text{O})$ . The strongest lines in the X-ray powder diffraction pattern are [ $d$  Å (I%;  $hkl$ )]: 6.975 (100; 010), 4.459 (40; 111), 4.391 (72; 101), 3.766 (31;  $\bar{1}\bar{1}1$ ), 3.695 (29; 002,012), 3.491 (24; 021,020), 2.552 (26; 201, $\bar{2}$ 01,013). Unit-cell parameters refined from the powder data are:  $a = 5.605(7)$ ,  $b = 7.453(8)$ ,  $c = 7.683(11)$  Å,  $\alpha = 74.61(11)$ ,  $\beta = 86.04(4)$ ,  $\gamma = 75.78(3)^\circ$ ,  $V = 299.9$  Å<sup>3</sup>. X-ray diffraction intensity data was collected in one single crystal of  $0.15 \times 0.12 \times 0.07$  mm shows the mineral is triclinic,  $P\bar{1}$ , with unit-cell parameters  $a = 5.600(2)$ ,  $b = 7.450(3)$ ,  $c = 7.671(3)$  Å,  $\alpha = 74.785(7)$ ,  $\beta = 86.042(7)$ ,  $\gamma = 75.810(7)^\circ$ ,  $V = 299.4$  Å<sup>3</sup>,  $Z = 1$ . The crystal structure of riotintoite was refined to  $R_1 = 0.0398$  for 1402 independent  $I > 2\sigma(I)$  reflections. It represents a new structure type based on isolated clusters that consist of a dimer of edge-sharing  $\text{AlO}_6$  octahedra decorated by two  $\text{SO}_4$  tetrahedra. The  $\text{AlO}_6$  octahedron is formed by two OH groups (along the shared octahedral edge), three  $\text{H}_2\text{O}$  groups (comprising the corners of one face), and one O atom. The octahedral dimer and connected sulfate groups form a neutral  $\{\text{Al}_2(\text{SO}_4)_2(\text{OH})_2(\text{H}_2\text{O})_6\}$  cluster. The clusters are linked in three dimensions via strong hydrogen bonds ( $d_{\text{H}\cdots\text{A}} < 1.8$  Å) between the hydrogen atoms of the  $\text{H}_2\text{O}$  groups and the non-bridging oxygen atoms of  $\text{SO}_4$  groups in adjacent clusters. Jurbante,  $\text{Al}(\text{SO}_4)(\text{OH}) \cdot 5\text{H}_2\text{O}$ , a mineral with similar composition, but higher water content, contains edge sharing dimers of  $\text{AlO}_6$  octahedra; however, its  $\text{SO}_4$  groups are unconnected. The name is for the old name of the mine. The holotype specimen of riotintoite is deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. A co-type specimen is deposited in the Natural History Museum of Los Angeles County, Los Angeles, U.S.A. **F.C.**

### WIKLUNDITE\*

M.A. Cooper, F.C. Hawthorne, J. Langhof, U. Hälenius, and D. Holtstam (2017) Wiklundite, ideally  $\text{Pb}_2^{4l}(\text{Mn}^{2+}, \text{Zn})_3(\text{Fe}^{3+}, \text{Mn}^{2+})_2(\text{Mn}^{2+}, \text{Mg})_9(\text{As}^{3+}\text{O}_3)_2[(\text{Si}, \text{As}^{5+})\text{O}_4]_6(\text{OH})_{18}\text{Cl}_6$ , a new mineral from Långban, Filipstad, Värmland, Sweden: Description and crystal structure. *Mineralogical Magazine*, 81(4), 841–855.

Wiklundite (IMA 2015-057),  $\text{Pb}_2^{4l}(\text{Mn}^{2+}, \text{Zn})_3(\text{Fe}^{3+}, \text{Mn}^{2+})_2(\text{Mn}^{2+}, \text{Mg})_9(\text{As}^{3+}\text{O}_3)_2[(\text{Si}, \text{As}^{5+})\text{O}_4]_6(\text{OH})_{18}\text{Cl}_6$ , is a new mineral from Långban, Filipstad, Värmland, Sweden. The new mineral occurs in a dolomite-rich skarn in association with tephroite, mimetite, turneaureite, johnbaumite, jacobsonite, barite, native lead, filipstadite, and parwelite. Wiklundite probably crystallized during skarn-forming processes shortly after peak metamorphism at temperatures above 600 °C and moderate pressures of <3.5 kbar. It forms radiating, sheaf-like aggregates (up to 1 mm) of thin brownish-red and slightly bent lath-shaped crystals, with the wiklundite-like mineral constituting the inner zone of each aggregate. Wiklundite is reddish brown to dark brown with pale yellowish-brown streak and resinous to sub-metallic luster. It is brittle with irregular fracture and perfect cleavage on  $\{001\}$ . No parting or twinning was observed. Mohs hardness and density were not measured due to small crystal size;  $D_{\text{calc}} = 4.072$  g/cm<sup>3</sup>. In plane-polarized transmitted light wiklundite is orange red, non-pleochroic. It is optically uniaxial (–). Other optical properties were not determined due to incomplete extinction and distorted interference figures;  $n_{\text{calc}} = 1.85$ . Wiklundite does not fluoresce under ultraviolet light. The main absorption bands of the IR spectrum ( $\text{cm}^{-1}$ ) are: 3128, 3316, 3404, 3441, 3496, and 3536 (OH-stretching modes), 681, 712, 795, 813, 848, 861, 875, 938, 959, and 1020 ( $\text{AsO}_4$  modes, and subordinate  $\text{SiO}_4$  and  $\text{AsO}_3$  modes), 1300–2100 (overtones). A room-temperature <sup>57</sup>Fe Möss-

bauer spectrum shows that  $\text{Fe}^{3+}$  forms one regular octahedron and shows no indication of  $\text{Fe}^{2+}$ . The average of 8 electron probe WDS analyses is [wt% (range)]:  $\text{SiO}_2$  11.17 (11.02–11.31),  $\text{Al}_2\text{O}_3$  0.06 (0.03–0.08),  $\text{Fe}_2\text{O}_3$  4.46 (4.23–4.78),  $\text{As}_2\text{O}_5$  0.75,  $\text{As}_2\text{O}_3$  6.81,  $\text{MnO}$  47.89 (47.34–48.37),  $\text{ZnO}$  0.78 (0.60–0.90),  $\text{CaO}$  0.09 (0.07–0.13),  $\text{PbO}$  14.48 (13.10–15.10),  $\text{Cl}$  6.65 (5.96–7.04),  $\text{H}_2\text{O}$  5.18,  $-\text{O}=\text{Cl}_2$  1.50, total 97.11.  $\text{H}_2\text{O}$  was calculated based on  $(\text{OH}+\text{Cl}) = 24$  apfu,  $\text{As}_2\text{O}_3/\text{As}_2\text{O}_5$  based on structure refinement, and  $\text{Fe}^{3+}/(\text{Fe}^{2+}+\text{Fe}^{3+})$  by Mössbauer spectroscopy. This gives the empirical formula  $\text{Pb}_{2.04}(\text{Mn}_{2.70}^{2+}\text{Zn}_{0.30})_{\Sigma 3.00}(\text{Fe}_{1.76}^{3+}\text{Al}_{0.04}\text{Mn}_{0.20}^{2+})_{\Sigma 2.00}(\text{Mn}_{18.33}^{2+}\text{Mg}_{0.23}\text{Ca}_{0.05})_{\Sigma 18.61}\text{As}_{2.16}^{3+}(\text{Si}_{5.85}\text{As}_{0.21}^{5+})_{\Sigma 6.06}\text{O}_{30}(\text{OH})_{18.10}\text{Cl}_{5.90}$  based on 54 anions  $[\text{O}_{30}(\text{OH}+\text{Cl})_{24}]$  apfu. The powder-diffraction data was not obtained due to very fine intimately intergrowths with at least one other phase of similar composition. The strongest lines in the simulated X-ray powder-diffraction pattern [ $d_{\text{calc}}$  Å ( $I_{\text{calc}}\%$ ;  $hkl$ )] are: 2.882 (100;  $\bar{2}$  2 26), 2.805 (90; 0 2 28), 4.128 (83;  $\bar{1}$  20), 3.098 (81;  $\bar{1}$  2 27), 2.384 (70;  $\bar{2}$  3 25,030) and 4.052 (58;  $\bar{1}$  26). Single-crystal X-ray diffraction data collected on a crystal of size  $3 \times 20 \times 30$   $\mu\text{m}$  refined to  $R_1 = 0.032$  for 1290 unique  $I \geq 4\sigma(I)$  reflections shows wiklundite is hexagonal, space group  $R\bar{3}c$ ,  $a = 8.257(2)$ ,  $c = 126.59(4)$  Å,  $V = 7474$  Å<sup>3</sup>,  $Z = 6$ . Its structure consists of a stacking of five layers of polyhedra. Three layers are trimers of edge-sharing  $\text{Mn}^{2+}$ -dominant octahedra linked by  $\text{SiO}_4$  tetrahedra,  $\text{Fe}^{3+}(\text{OH})_6$  dominant octahedra and  $\text{AsO}_3$  triangular pyramids, one layer is made of corner-sharing  $\text{SiO}_4$  and  $\text{Mn}^{2+}\text{O}_4$  tetrahedra, and the last layer is made of  $\text{Mn}^{2+}\text{Cl}_6$  octahedra and  $\text{Pb}^{2+}(\text{OH})_3\text{Cl}_6$  polyhedra. The name is after Markus Wiklund (b. 1969) and Stefan Wiklund (b. 1972), Swedish mineral collectors who jointly found the specimen containing the mineral. The holotype specimen is deposited in the Department of Geosciences, Swedish Museum of Natural History, Sweden. **O.C.G.**

### ŻABIŃSKIITE\*

A. Pieczka, F.C. Hawthorne, C. Ma, G.R. Rossman, E. Szełęg, A. Szuszkiewicz, K. Turniak, K. Nejbart, S.S. Ilnicki, P. Buffat, and B. Rutkowski (2017) Żabińskiite, ideally  $\text{Ca}(\text{Al}_{0.5}\text{Ta}_{0.5})(\text{SiO}_4)\text{O}$ , a new mineral of the titanite group from the Piława Górna pegmatite, the Góry Sowie Block, southwestern Poland. *Mineralogical Magazine*, 81(3), 591–610.

Żabińskiite (2015-033), ideally  $\text{Ca}(\text{Al}_{0.5}\text{Ta}_{0.5})(\text{SiO}_4)\text{O}$ , is a new mineral from Piława Górna, Lower Silesia, SW Poland. The new mineral was found in weakly fractionated parts of the Julianna system of anatectic pegmatites at Piława Górna, exposed in an amphibolite-migmatite quarry of the Kompania Górnicza (formerly Dolnośląskie Surowce Skalne S.A. Company). Żabińskiite was observed with (Al,Ta,Nb)-bearing titanites, a bismuth-rich pyrochlore-group mineral and single plates of a K-mica in aggregates healing fractures in zircon intergrowth with polycrase-(Y) and euxenite-(Y) in blocky feldspar. Żabińskiite is observed with titanite in aggregates reaching  $\sim 120 \mu\text{m} \times 70 \mu\text{m}$  in size, where individual grains not exceeding 25  $\mu\text{m}$  in length. The mineral is transparent brownish with a white streak and a vitreous luster. It is brittle, show now cleavage or parting and have uneven fracture. Density was not measured due to small crystal size and compositional heterogeneity;  $D_{\text{calc}} = 3.897$  g/cm<sup>3</sup>. Mohs hardness is  $\sim 5$ . The new mineral is non-pleochroic, optically biaxial (–), with mean refractive indices  $\geq 1.89$ ,  $2V_{\text{meas}} = 83.1(5)^\circ$ . It is non-fluorescent. The main absorption bands of Raman spectrum ( $\text{cm}^{-1}$ ) are 341, 431, 487, 581, 642, 835, and 997. The average of 10 electron probe WDS analyses is [wt% (range)]:  $\text{Nb}_2\text{O}_5$  4.68 (4.10–5.32),  $\text{Ta}_2\text{O}_5$  24.20 (23.42–24.85),  $\text{SiO}_2$  25.88 (25.65–26.42),  $\text{TiO}_2$  10.37 (9.77–10.85),  $\text{VO}_2$  0.04 (0–0.16),  $\text{ZrO}_2$  0.05 (0.00–0.11),  $\text{SnO}_2$  0.35 (0.13–0.54),  $\text{Al}_2\text{O}_3$  7.82 (7.42–8.45),  $\text{Fe}_2\text{O}_3$  0.99 (0.63–1.62),  $\text{CaO}$  23.97 (23.63–24.24),  $\text{Na}_2\text{O}$  0.20 (0.16–0.24),  $\text{F}_2$  0.39 (0.21–0.65),  $\text{H}_2\text{O}$  0.03 (0–0.17),  $-\text{O}=\text{F}_2$  0.16, total 98.80.  $\text{H}_2\text{O}$  in the form of OH<sup>–</sup> groups is calculated on the basis of 5 (O,F,OH) pfu, and Fe is assumed to be  $\text{Fe}^{3+}$ . This gives the empirical formula  $(\text{Ca}_{0.98}\text{Na}_{0.02})_{\Sigma 1.00}(\text{Al}_{0.34}\text{Fe}_{0.03}^{3+}\text{Ti}_{0.30}\text{Sn}_{0.01}\text{Ta}_{0.25}\text{Nb}_{0.08})_{\Sigma 1.01}(\text{Si}_{10.99}\text{Al}_{0.01})_{\Sigma 11.00}$

$[\text{O}_{4.94}\text{F}_{0.05}(\text{OH})_{0.01}]_{\Sigma 5.00}$  based on 3 cations pfu. The strongest lines in the calculated X-ray powder-diffraction pattern [ $d_{\text{calc}}$  Å ( $I_{\text{calc}}\%$ ;  $hkl$ )] are: 3.226 (100;  $\bar{2}\bar{1}1$ ), 3.001 (98; 002), 2.609 (89; 031,  $0\bar{3}1$ ), 4.939 (65; 011,  $0\bar{1}1$ ) and 1.704 (31;  $\bar{4}11, \bar{2}\bar{1}2, 222, \bar{4}\bar{1}1$ ). Single-crystal X-ray diffraction data collected on a crystal of size  $5 \times 7 \times 20 \mu\text{m}$  refined to  $R_1 = 0.0237$  for 1056 unique  $I \geq 4\sigma(I)$  reflections shows žabińskiite is triclinic, space group  $A\bar{1}$ , with  $a = 7.031(2)$ ,  $b = 8.692(2)$ ,  $c = 6.561(2)$  Å,  $\alpha = 89.712(11)$ ,  $\beta = 113.830(13)$ ,  $\gamma = 90.352(12)^\circ$ , and  $V = 366.77 \text{ \AA}^3$ . The new mineral is isostructural with triclinic titanite and topologically identical with titanite and other minerals of the titanite group. Žabińskiite is named in honor of the late Witold Žabiński (1929–2007), eminent Polish mineralogist. The holotype specimen is deposited at the Mineralogical Museum of the University of Wrocław, Wrocław, Poland. **O.C.G.**

### ZINCOTRYOGEN\*

Z. Yang, G. Giester, Q. Mao, Y. Ma, D. Zhang, and H. Li (2017) Zincobotryogen,  $\text{ZnFe}^{3+}(\text{SO}_4)_2(\text{OH}) \cdot 7\text{H}_2\text{O}$ : validation as a mineral species and new data. *Mineralogy and Petrology*, 111(3), 363–372.

Zincobotryogen (IMA 2015-107), ideally  $\text{ZnFe}^{3+}(\text{SO}_4)_2(\text{OH}) \cdot 7\text{H}_2\text{O}$  was validated as a mineral species. Originally botryogen with Zn prevailing over the Mg had been reported by (Zemann 1961) from Rammelsberg mine, Germany. The crystal structure of this mineral was determined with all non-H atoms positions in space group  $P2_1/n$  by Süsse (1967, 1968). The mineral with a similar composition was reported as a variety of botryogen from the Xitieshan Pb-Zn deposit, Qinghai Province, China (Tu et al. 1964) and more detailed study including crystal structure refinement on material from that mine was given by Yang and Fu (1988a, 1988b). The name of botryogen-Zn is used for the sample from Mina Quetena, Calama, Chile (Lane et al. 2015). However, the mineral was not officially recognized by IMA as a valid mineral species. Thus, the mineral was validated under the name zincobotryogen (according its composition) based on the study of the original sample from the Xitieshan Pb-Zn deposit located at the northern margin of the Qaidam Basin, Qinghai Province, China, and distributed in the Upper Ordovician Tanjianshan Group volcanic-sedimentary rocks. The Pb-Zn ore bodies are hosted in the marble and greenschists. The main minerals in the deposit are sphalerite, galena, pyrite, and calcite with minor quartz, dolomite, chlorite, pyrrhotite, chalcopyrite, marcasite, and arsenopyrite. Zincobotryogen is found in a well-developed oxidation zone in the jarosite subzone, associated with jarosite, copiapite, zincocopiapite, fibroferrite, and quartz. It forms transparent, light to dark orange red, vitreous prismatic crystals elongated by  $[001]$ , 0.05 to 2 mm in length commonly occurs in radial or globular aggregates. The observed forms are  $\{010\}$ ,  $\{\bar{1}01\}$ ,  $\{120\}$ , and  $\{110\}$ . The mineral is soluble in hot water similar to botryogen. No data on cleavage and hardness are provided. The density of crystal aggregates is 2.20(1) (by micro-torsion balance),  $D_{\text{calc}} = 2.266 \text{ g/cm}^3$ .

In plane-polarized transmitted light zincobotryogen is pleochroic  $X = \text{colorless} < Y = \text{light yellow} < Z = \text{yellow}$ . The crystals have negative elongation. It is optically biaxial (+),  $\alpha = 1.542(5)$ ,  $\beta = 1.551(5)$ ,  $\gamma = 1.587(5)$ ;  $2V_{\text{calc}} = 54.1^\circ$  (589.9 nm). The dispersion of an optical axes is strong  $r > v$ ;  $Z \parallel \mathbf{b}$  and  $X \wedge \mathbf{c} = 10^\circ$ . A Mössbauer spectrum (Yang and Fu 1988a) indicates that all iron belong to  $\text{Fe}^{3+}$  in two independent atomic sites. On the given IR spectrum sharp peak at  $3550 \text{ cm}^{-1}$  attributed to the OH-stretching mode, the wide peak at  $3420 \text{ cm}^{-1}$  and the sharp peak at  $1635 \text{ cm}^{-1}$  to  $\text{H}_2\text{O}$ . Peaks between  $\sim 1200\text{--}1000$  and  $\sim 650\text{--}450 \text{ cm}^{-1}$  are not attributed. TG and DTA data indicate the loss of 28.2 wt%  $\text{H}_2\text{O}$  at  $149^\circ\text{C}$ . The loss of OH (total of 2.0 wt%) occurs between 475 and  $578^\circ\text{C}$  (Yang and Fu 1988a). The average of 10 microprobe WDS analysis is [wt% (range)]  $\text{SO}_3$  38.04 (37.24–38.46),  $\text{Al}_2\text{O}_3$  0.04 (0–0.10),  $\text{Fe}_2\text{O}_3$  18.46 (18.22–18.82),  $\text{ZnO}$  13.75 (12.95–14.82),  $\text{MgO}$  1.52 (1.37–1.86),  $\text{MnO}$  1.23 (1.03–1.96),  $\text{H}_2\text{O} = 31.06$  (calculated by charge balance and  $\text{H}_2\text{O} = 7$  pfu), total 104.10. The empirical formula based on 16 O pfu is  $(\text{Zn}_{0.73}\text{Mg}_{0.16}\text{Mn}_{0.08})\text{Fe}^{3+}_{0.99}(\text{SO}_4)_{2.04}(\text{OH})_{0.82} \cdot 7\text{H}_2\text{O}$ . The strongest lines in the X-ray powder-diffraction pattern [ $d$  Å ( $I\%$ ;  $hkl$ )] are: 8.92 (100; 110), 6.32 (77;  $\bar{1}01$ ), 5.56 (23; 021), 5.14 (45; 111), 4.08 (22;  $\bar{2}21$ ), 3.21 (31; 231), 3.03 (34; 032), 2.77 (22; 042). The cell parameters refined from the powder data are:  $a = 10.49(1)$ ,  $b = 17.81(1)$ ,  $c = 7.187(9)$  Å,  $\beta = 100.8(2)^\circ$ ,  $V = 1318 \text{ \AA}^3$ . A single crystal study shows the mineral is monoclinic,  $P2_1/n$ ,  $a = 10.504(2)$ ,  $b = 17.801(4)$ ,  $c = 7.1263(14)$  Å,  $\beta = 100.08(3)^\circ$ ,  $V = 1311.9 \text{ \AA}^3$ ,  $Z = 4$ . The crystal structure was refined to  $R_1 = 0.0355$  for 2816 unique  $I > 2\sigma(I)$  reflections. It is characterized by chains of composition  $[\text{Fe}^{3+}(\text{SO}_4)_2(\text{OH})(\text{H}_2\text{O})]^{2-}$  and  $\sim 7 \text{ \AA}$  repeat distance running parallel to the  $c$ -axis. The chain links to  $[\text{MO}(\text{H}_2\text{O})_5]$  octahedra ( $M = \text{Zn, Mg}$ ) and an unshared  $\text{H}_2\text{O}$  molecule, and forms a larger chain building module with composition  $[\text{M}^{2+}\text{Fe}^{3+}(\text{SO}_4)_2(\text{OH})(\text{H}_2\text{O})_6(\text{H}_2\text{O})]$ . The inter-chain module linkage involves only hydrogen bonding. The type specimen has been deposited in the Museum at Institute of Geology and Geophysics, Chinese Academy of Sciences. **D.B.**

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