

New Mineral Names*†

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This New Mineral Names has entries for 11 new minerals, including ammoniovoltaite, belousovite, chlorellestadite, clino-suenoite, marcobaldite, markeyite, martinandresite, parisite-(La), plumbopharmacosiderite, somersetite, and ziminaite.

AMMONIOVOLTAITE*

E.S. Zhitova, O.I. Siidra, D.I. Belakovskiy, V.V. Shilovskikh, A.A. Nuzhdaev, and R.M. Ismagilova (2018) Ammoniovoltaite, $(\text{NH}_4)_2\text{Fe}_5^{2+}\text{Fe}_3^{3+}\text{Al}(\text{SO}_4)_{12}(\text{H}_2\text{O})_{18}$, a new mineral from the Severo-Kambalny geothermal field, Kamchatka, Russia. *Mineralogical Magazine*, 82(5), 1057–1077.

Ammoniovoltaite (IMA 2017-022), ideally $(\text{NH}_4)_2\text{Fe}_5^{2+}\text{Fe}_3^{3+}\text{Al}(\text{SO}_4)_{12}(\text{H}_2\text{O})_{18}$, cubic, is a new voltaite-group mineral. It was discovered at the Severo-Kambalny (North-Kambalny) geothermal field, Kambalny volcanic ridge, Southern Kamchatka, Russia (51.42854°N, 156.87341°E). Ammoniovoltaite forms at ~100 °C around geothermal gas/steam vents in association with alunogen, tschermigite, and pyrite. Ammoniovoltaite occurs in aggregates or microscopic euhedral, usually distorted, crystals growing on alunogen plates. Forms exhibited are octahedral, cubo-octahedral and cubic. Ammoniovoltaite is black (greenish gray in thin fragments), opaque to translucent and has a vitreous luster. The mineral is brittle. Neither cleavage nor parting is observed, and the fracture is conchoidal. The Mohs hardness is ~3–3.5 (by analogy with other group members). The mineral is water-soluble and decomposes with formation of acid solution and solid residual. $D_{\text{calc}} = 2.529\text{--}2.549$ g/cm³. In plane-polarized light, it is pale greenish-gray, non-pleochroic. Grains and their fragments have an equant shape and no cleavage was observed. The mineral is isotropic, $n = 1.602(2)$ (589 nm). The FTIR spectra show bands (cm⁻¹; s = strong, w = weak, sh = shoulder) at: a broad ~3400s, 3300sh (O–H stretching of OH groups and NH₄), 1691, 1641 (H–O–H bending of H₂O), 1433 (related to ammonium), 1124s, 1053sh, 1003sh [asymmetric and symmetric stretching vibrations of SO₄²⁻ anions], 893w and 727w (Fe···O–H bending vibrations combined with overtones of Fe···O stretching vibrations), 660 and 590 (SO₄²⁻ anions bending vibrations), 483w [Fe³⁺···O bending vibrations and/or $\nu_2(E)$ bending vibrations of SO₄²⁻ anion]. The average of six electron microprobe WDS analyses is [wt% (range)]: FeO_{total} 23.68 (22.53–24.19), FeO (by Mössbauer) 13.26, Fe₂O₃ (by Mössbauer) 11.58, MgO 2.33 (1.65–3.26), ZnO 0.04 (0.02–0.14), Al₂O₃ 2.74 (2.68–2.83), SO₃ 47.46 (47.08–47.66), K₂O 0.19 (0.07–0.30), CaO 0.11 (0.11–0.13), (NH₄)₂O (by EDS) 2.96 (2.11–3.75), H₂O (from crystal structure) 16.03, total 96.70. The empirical formula based of 12 S pfu is $[(\text{NH}_4)_{1.88}\text{K}_{0.08}\text{C}_{0.04}]_{\Sigma 2.00}(\text{Fe}_{3.74}^{2+}\text{Mg}_{1.17}\text{Fe}_{0.05}^{3+}\text{Zn}_{0.01})_{\Sigma 4.97}(\text{Fe}_{2.89}^{3+}\text{Al}_{1.09})_{\Sigma 2.98}\text{Al}_{1.00}(\text{SO}_4)_{12.00}(\text{H}_2\text{O})_{18.00}$. The strongest X-ray powder diffraction lines are [d Å (I %; hkl)]: 9.67 (74; 022), 7.90 (56; 222), 5.58 (84; 422), 3.560 (100; 731), 3.418 (100; 008) and 2.8660 (37; 931). Unit-cell parameters refined from the powder data with whole-pattern fitting are $a = 27.352(1)$ Å, $V = 20.462$ Å³. The single crystal X-ray data ($R_1 = 0.031$ for 1217 $I > 2\sigma(I)$ reflections; $R_{\text{all}} = 0.0414$ for 1509 reflections) shows ammoniovoltaite is cubic, $Fd\bar{3}c$,

$a = 27.250(1)$ Å, $V = 20.234$ Å³, $Z = 16$. Ammoniovoltaite is isotypic with voltaite and other cubic members of the group. The crystal structure of ammoniovoltaite consists of kröhnkite-like chains running along the diagonal between two crystallographic axes. These chains are built by alternating $M2X_6$ [$X_6 = \text{O}_6^{2-}$, (H₂O)₂] and $M1O_6$ octahedra linked via SO₄ tetrahedra. The M2 site is occupied mainly by divalent cations, whereas the M1 site is preferable for trivalent cations. The three-dimensional arrangement of kröhnkite-like chains produces the framework, which contains two types of interstitial cavities: (1) those formed by $M2X_6$ octahedra and SO₄ tetrahedra and occupied by (NH₄)⁺ molecules; and (2) those formed by $M1X_6$ octahedra and SO₄ tetrahedra and occupied by large $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ complexes. The name highlights the composition of the mineral, i.e., ammonium analogue of voltaite. The type specimen is deposited in the Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow, Russia. **F.C.**

BELOUSOVITE*

O.I. Siidra, E.V. Nazarchuk, E.A. Lukina, A.N. Zaitsev, and V.V. Shilovskikh (2018) Belousovite, $\text{KZn}(\text{SO}_4)\text{Cl}$, a new sulfate mineral from the Tolbachik volcano with apophyllite sheet-topology. *Mineralogical Magazine*, 82(5), 1079–1088.

Belousovite (IMA 2016-047), ideally $\text{KZn}(\text{SO}_4)\text{Cl}$, monoclinic, is a new mineral discovered among sublimates of Yadovitaya fumarole at the Second scoria cone Tolbachik volcano, Kamchatka Peninsula, Russia. Gas temperature at the sampling location was ~250 °C. Belousovite occurs in close intergrowths with langbeinite associating with kamchatkite, euchlorine, anglesite, and zincite. It forms transparent colorless irregularly shaped grains with a vitreous luster and white streak and white translucent microcrystalline masses up to 0.1 cm. The mineral is brittle with an uneven fracture and perfect cleavage on {100}. Hardness and density were not measured due to the small size of individual grains and the porosity of the aggregates; $D_{\text{calc}} = 2.89$ g/cm³. Belousovite is easily soluble in water at room temperature and transforms slowly into hydrate in humid air. In transmitted plane-polarized light belousovite is colorless, non-pleochroic. It is optically biaxial (+), $\alpha = 1.532(2)$, $\beta = 1.544(2)$, $\gamma = 1.570(2)$ (589 nm); $2V_{\text{calc}} = 69.4^\circ$. The average of six EDS (WDS for Na and Zn) electron probe analysis is (wt%): K₂O 19.55 (19.46–19.76), Rb₂O 0.58 (0.48–0.64), ZnO 34.85 (34.53–35.59), SO₃ 34.65 (34.33–34.80), Cl 14.77 (14.50–14.85), –O=Cl₂ 3.34, total 101.06. Sodium was below WDS detection level. The empirical formula based on O+Cl = 5 pfu is $\text{K}_{0.97}\text{Rb}_{0.01}\text{Zn}_{1.00}\text{S}_{1.01}\text{O}_{4.03}\text{Cl}_{0.97}$. The strongest lines in the powder X-ray diffraction pattern are [d Å (I %; hkl)]: 6.845 (100; 100), 3.640 (71; 121), 3.159 (84; 112), 3.122 (41; 211), 3.114 (52; 022), 2.981 (41; 031), 2.912 (44; 130), 2.048 (19; 312). Unit-cell parameters refined from the powder data are $a = 6.90(1)$, $b = 9.65(2)$, $c = 8.18(2)$ Å, $\beta = 96.5(2)^\circ$, $V = 541$ Å³. Single-crystal X-ray data shows belousovite is monoclinic, space group $P2_1/c$, $a = 6.8904(5)$, $b = 9.6115(7)$, $c = 8.2144(6)$ Å, $\beta = 96.582(2)^\circ$, $V = 540.43$ Å³, $Z = 4$. The crystal structure was solved by

* 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/>.

direct methods and refined to $R_1 = 0.029$ for 1965 independent reflections. The structure of belousovite contains one K^+ , one Zn^{2+} , and one S^{6+} site. It consists of infinite $[ZnSO_4Cl]^-$ layers formed by corner-sharing mixed-ligand ZnO_3Cl tetrahedra and SO_4 tetrahedra. K^+ ions are between these layers. The topology of $[ZnSO_4Cl]^-$ layers in belousovite is identical to $[Si_4O_{10}]^{4-}$ layers in the minerals of the apophyllite group. A review of mixed-ligand ZnO_mCl_n coordination polyhedra in minerals and inorganic compounds is given. The mineral name honors Alexander Borisovich Belousov (b. 1962), Institute of Volcanology, Russian Academy of Sciences, Petropavlovsk-Kamchatskiy, for his contributions to volcanology. Type material is deposited at the Mineralogical Museum of St. Petersburg State University, St. Petersburg, Russia. **D.B.**

CHLORELLESTADITE*

D. Środek, I.O. Galuskina, E. Galuskin, M. Dulski, M. Książek, J. Kusz, and V. Gazeev (2018) Chlorellestadite, $Ca_5(SiO_4)_{1.5}(SO_4)_{1.5}Cl$, a new ellestadite-group mineral from the Shadil-Khokh volcano, South Ossetia. *Mineralogy and Petrology*, 112(5), 743–752.

Chlorellestadite (IMA 2017-013), ideally $Ca_5(SiO_4)_{1.5}(SO_4)_{1.5}Cl$, hexagonal, is the Cl-end member of the ellestadite group. It was discovered in a calcium-silicate xenolith in rhyodacite lava from the Shadil Khokh volcano, Greater Caucasus, South Ossetia ($42^{\circ}32'32.5''N$, $44^{\circ}17'50.7''E$). The altered xenolith is a pyrometamorphic rock formed under sanidine facies (Iarnite sub-facies) conditions at temperature above $750^{\circ}C$ and low, near-ambient pressure. Chlorellestadite formed by metasomatic alteration of primary silicate-carbonate xenolith affected by fluid and gas of volcanic origin and enriched with chlorine. In addition, this is also the second known location of eltyubuyite, $Ca_{12}Fe_{10}Si_4O_{32}Cl_6$, the rare Cahumites kumtubyte, $Ca_5(SiO_4)_2F_2$, and fluorochegemite, $Ca_7(SiO_4)_3F_2$, as well as of dargaite, $BaCa_{12}(SiO_4)_4(SO_4)_2O_3$. Chlorellestadite is extensively replaced by ettringite and a fine-grained mixture of minerals such as tobermorite, jennite, afwillite, and unidentified hydrosilicates. Srebrodolskite, baryte, magnesioferrite-spinel series and periclase replaced by brucite are accessory minerals. Chlorellestadite forms inhomogeneous, porous, elongate grains up to 0.2–0.3 mm, partially replaced by secondary minerals, commonly represented by spherulitic aggregates. The mineral appears off-white with a bluish-greenish hue in hand sample and has a white streak and vitreous luster. Cleavage is indistinct parallel to elongation. No parting was observed. The mineral is brittle and shows an irregular fracture. The nano-indentation hardness averages to $VHN = 443$ kg/mm², i.e., about 4–4.5 on the Mohs scale. $D_{calc} = 3.091$ g/cm³. It shows no fluorescence in UV light. In thin section, chlorellestadite is colorless, transparent, and not pleochroic. It is optically uniaxial (–), $\omega = 1.664(3)$, $\epsilon = 1.659(3)$ (λ not reported). The main bands of the Raman spectrum correspond to the Si–O and S–O vibrations in tetrahedral sites: relatively intense bands at 649 and 630 cm^{–1} correspond to the ν_4 bending vibrations connected with the SO_4^{2-} group; two lower intense bands at 536 and 572 cm^{–1} are related to the ν_4 vibrations caused by SiO_4^{4-} groups. A variety of small bands can be observed between 500 and 350 cm^{–1} (mainly ν_2 bending vibrations of SO_4^{2-} and SiO_4^{4-} groups). Three relatively intense bands occurring at 311, 267 and 230 cm^{–1} may be caused by translation moves of O–Ca–O. Few more intense bands are present at 1008 and 857 cm^{–1} (ν_1 symmetric vibrations of the of SO_4^{2-} and SiO_4^{4-} groups, respectively). A band at 1078 cm^{–1} can be an overlaying of $\nu_3(SO_4)$ and $\nu_1(CO_3)$. Therefore, negligible amounts of CO_3 cannot be excluded. No bands are observed in the 3500–3600 cm^{–1} range, reflecting the low (OH) content. The average of 11 WDS electron probe analyses is [wt% (range)]: CaO 54.43 (54.71–57.51), Na₂O 0.07 (0–0.18), SO₃ 22.72 (22.90–23.70), SiO₂ 17.67 (17.64–18.95), P₂O₅ 0.44 (0.10–0.99), Cl 4.23 (4.03–4.89), F 0.40 (0.10–0.70), OH (by charge balance) 0.49 (0.38–0.74), –O=(F, Cl)₂ 1.12, total 99.33. The empirical formula based on 8 cations is $Ca_{4.99}Na_{0.01}(SiO_4)_{1.51}(SO_4)_{1.46}(PO_4)_{0.03}(Cl_{0.61}OH_{0.21}F_{0.11})_{\Sigma 0.93}$. The strongest lines of

the powder X-ray diffraction pattern [$d \text{ \AA}$ (%); (hkl) not reported] are: 2.858 (100), 2.771 (99), 2.793 (90), 2.858 (41), 3.435 (38), 1.851 (23). Single-crystal X-ray diffraction data obtained from a crystal of $20 \mu m \times 20 \mu m \times 20 \mu m$, shows the mineral is hexagonal, space group $P6_3/m$, $a = 9.6002(2)$, $c = 6.8692(2) \text{ \AA}$, and $V = 548.27 \text{ \AA}^3$, $Z = 2$. The structure was refined to $R = 0.0356$ for $I > 2\sigma(I)$ 372 reflections and $R = 0.0388$ for all 406 unique reflections. The crystal structure of natural chlorellestadite consists of a $Ca_4[(S, Si)O_4]_6$ framework with channels along the c axis, containing columns of $Ca_6[Cl, F, (OH)]_2$, and is nearly identical to that of its synthetic analogs. Differences are observed only in anion channel sites. The name “chlorellestadite” was first described from Crestmore, California, U.S.A. (McConnell 1937), although further studies revealed that hydroxyl dominates over chlorine and this mineral is hydroxyllell-estadite. The type material is deposited in the Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow, Russia. **F.C.**

References cited

McConnell, D. (1937) The substitution of SiO_4^- and SO_4^- groups for PO_4^- groups in the apatite structure; ellestadite, the end-member. *American Mineralogist*, 22, 977–986.

CLINO-SUENOITE*

R. Oberti, M. Boiocchi, F.C. Hawthorne, M.E. Ciriotti, O. Revheim, and R. Bracco (2018) Clino-suenoite, a newly approved magnesium-iron-manganese amphibole from Valmalenco, Sondrio, Italy. *Mineralogical Magazine*, 82(1), 189–198.

Clino-suenoite (IMA 2016-111), ideally $A^{\square}B^{\square}Mn_2^{2+}Mg_5^{\square}Si_8O_{22}^W(OH)_2$, monoclinic, is a new amphibole of the magnesio-iron-manganese group found at the Lower Scerscen Glacier, Lanzada, Valmalenco, Sondrio, Italy ($46^{\circ}16'9''N$, $9^{\circ}54'8''E$), where it occurs in Mn-rich quartzite erratics containing braunite, rhodonite, pyroxmangite, rhodochrosite, Mn-bearing calcite, kutnohorite, pyrophanite, tiragalloyite, magnesio-riebeckite, manganberzeliite, aegirine–augite, tephroite, albite, Mn-rich muscovite, hausmannite, bixbyite, friedelite, hematite, clinocllore, romanèchite, rancièite, Mn-bearing tremolite, jacsobite, anatase, and johannsenite. The geological setting of the Scerscen manganese orebody belongs to the typical seafloor sequences of the Tethys Ocean and is dated mid to late Jurassic. The mineralization formed in shallow radiolaritic sediments of the Margna nappe sedimentary sequence, which were converted into quartzites by Alpine metamorphism. Clino-suenoite is yellow or yellow-brown to brown with a vitreous luster and occurs as fibrous aggregates and as flattened elongated crystals, often in tufts up to 2 cm long, included in rhodonite or in small carbonate veins associated with tiragalloyite and pyrophanite. Hardness, fracture, and density not reported; $D_{calc} = 3.175$ g/cm³. It does not fluoresce under UV radiation. In transmitted plane-polarized light, the mineral is pleochroic ($X =$ pale yellow to yellow, $Y =$ yellow to pale orange, and $Z =$ orange brown). It is optically biaxial (+), $\alpha = 1.632(2)$, $\beta = 1.644(2)$, $\gamma = 1.664(2)$ (λ not specified). Dispersion of an optical axes is $\nu < r$ weak. Orientation is: $X \wedge a = 15^{\circ}$ (in β obtuse), $Y \parallel b$, and $Z \wedge c = 2^{\circ}$ (in β acute) $2V_{meas} = 78(2)^{\circ}$ (spindle stage) and $2V_{calc} = 76.3^{\circ}$. The average of 10 WDS electron probe analyses is (wt%): Na₂O 0.70(5), K₂O 0.01(1), CaO 1.65(3), MgO 19.40(16), ZnO 0.10(8), NiO 0.12(5), MnO 17.81(41), FeO_{total} 1.00(7) [FeO 0.32, Fe₂O₃ 0.75 apportioned by electro neutrality], Al₂O₃ 0.22(2), SiO₂ 54.95(26), F 0.14(32), Cl 0.01(1), H₂O 1.80 [calculated based on 15.04 cations and 24 (O, OH, F, Cl)], O=F, Cl –0.06, total 97.93. The empirical formula based on 24 anions and 15.04 cations, is $A^{\square}Na_{0.04}^B(Mn_{1.58}^{2+}Ca_{0.26}Na_{0.16})_{\Sigma 2.00}^C(Mg_{4.21}Mn_{0.61}Zn_{0.01}Ni_{0.01}Fe_{0.08}Al_{0.04})_{\Sigma 5.00}^T Si_{8.00}O_{22}^W[(OH)_{1.94}F_{0.06}]_{\Sigma 2.00}$. The strongest lines of the powder X-ray diffraction pattern [$d \text{ \AA}$ (%); (hkl)] are: 2.728 (100, 151), 2.513 (77, $\bar{2}02$), 3.079 (62, 310), 8.321 (60, 110), 3.421 (54, 131), 2.603 (42, 061), 2.175 (42, 261), 3.253 (41, 240), 2.969 (40, 221), 9.036 (40, 020). Single-crystal X-ray diffraction data of a lamellar single crystal $350 \times 100 \times 40 \mu m$ in size, shows the mineral is monoclinic,

space group $C2/m$, $a = 9.6128(11)$, $b = 18.073(2)$, $c = 5.3073(6)$ Å, $\beta = 102.825(2)^\circ$ and $V = 899.1$ Å³, $Z = 2$. The structure was refined to $R = 0.043$ for $I > 3\sigma(I)$ 971 reflections and $R = 0.064$ for all 1355 unique reflections. The Mn site preference is $M(4) \gg M(1) > M(2) \gg M(3)$. The residual electron density at the A site is very low, in agreement with the presence of 0.04 Na atoms per formula unit (apfu) in the chemical analysis. The $\langle T-O \rangle$ distances are very short, confirming that no ¹Al is present. The name is given for following the classification scheme for amphiboles (Hawthorne et al. 2012) and the subsequent Commission on New Minerals, Nomenclature and Classification (CNMNC) of the International Mineralogical Association (IMA) decision (vote 13-A, Williams et al. 2013; proponents: Oberti, Hawthorne, and Kurosawa). The holotype material is deposited in the Museo di Mineralogia of the Università di Pavia, Italy. F.C.

References cited

Hawthorne, F.C., Oberti, R., Harlow, G.E., Maresch, W.V., Martin, R.F., Schumacher, J.C., and Welch, M.D. (2012) Nomenclature of the amphibole supergroup. *American Mineralogist*, 97, 2031–2048.

MARCOBALDIITE*

C. Biagioni, M. Pasero, Y. Moëlo, F. Zaccarini, and W.H. Paar (2018) Lead-antimony sulfosalts from Tuscany (Italy). XXII. Marcobaldiite, $\sim \text{Pb}_{12}(\text{Sb}_3\text{As}_2\text{Bi})_{26}\text{S}_{21}$, a new member of the jordanite homologous series from the Pollone mine, Valdicastello Carducci. *European Journal of Mineralogy* 30(3), 581–592.

Marcobaldiite (IMA 2015-109), $\sim \text{Pb}_{12}(\text{Sb}_3\text{As}_2\text{Bi})_{26}\text{S}_{21}$, triclinic, is a new homologue of the jordanite series $\text{Pb}_{4N-2}(\text{Sb}, \text{As}, \text{Bi})_{26}^{\text{Sb}}\text{S}_{4N+7}$ with the homologue number $N = 3.5$. It has been discovered in a single specimen collected in a quartz vein embedded in tourmaline-bearing schist at the baryte-pyrite-Pb-Zn-Ag deposit of Pollone mine, Valdicastello Carducci, Pietrasanta, Apuan Alps, Tuscany, Italy (43°57'47"N; 10°16'19"E). The mineral is associated with Sb-rich tennantite. Its crystallization is related to the circulation of hydrothermal fluids during the Tertiary Alpine tectono-metamorphic events, favoring the remobilization of elements from the country rocks and the ore bodies. Marcobaldiite forms black opaque blocky prismatic striated crystal $10 \times 3 \times 3$ mm with black streak and a metallic luster. It is brittle, with an irregular fracture. Micro-indentation hardness $\text{VHN}_{15} = 182$ (170–195) kg/mm² corresponding to $\sim 3\text{--}3\frac{1}{2}$ of the Mohs scale. Density was not measured; $D_{\text{calc}} = 6.56$ g/cm³. In plane-polarized incident light, marcobaldiite is white, distinctly birefractant. In crossed polars, it is anisotropic, with gray to bluish-gray rotation tints. Internal reflections were not observed. Polysynthetic twinning is characteristic. The reflectance values in air were measured between 400 and 700 nm with a 20 nm interval. The values for the COM wavelengths are [R_{min} , R_{max} (%), (nm)]: 31.6, 40.1 (470), 30.9, 39.6 (546), 30.4, 38.5 (589), 30.0, 37.6 (650). The average of 10 electron probe WDS analyses [wt% (range)] is: Pb 64.05 (63.52–64.46), As 4.51 (4.35–4.62), Sb 9.10 (8.89–9.38), Bi 4.24 (4.16–4.35), S 17.24 (16.89–17.42), total 99.14. The empirical formula based on $\Sigma \text{Me} = 18$ apfu, is $\text{Pb}_{11.98}\text{Sb}_{2.90}\text{As}_{2.33}\text{Bi}_{0.79}\text{S}_{20.80}$. The main lines in the X-ray powder diffraction pattern [d Å (I_{rel} ; hkl)] (vs = very strong, s = strong, ms = medium strong) are: 3.568 (ms; 012), 3.202 (ms; 090), 3.016 (ms; 072), 2.885 (ms; 260), 2.233 (vs; 1.10.2), 2.125 (s; 370, 204), 1.848 (s; multiple), 1.775 (s; multiple). The single-crystal X-ray study shows the mineral is triclinic, space group $P1$, $a = 8.9248(9)$, $b = 29.414(3)$, $c = 8.5301(8)$ Å, $\alpha = 98.336(5)$, $\beta = 118.175(5)$, $\gamma = 90.856(5)^\circ$, $V = 1944.1$ Å³, $Z = 2$. The crystal structure has been solved and refined to $R_1 = 0.067$ for 6193 $F_o > 4\sigma(F_o)$ reflections. Marcobaldiite structure ($N = 3.5$ homologue of the jordanite homologous series) characterized by the 1:1 alternation along [010] of two kinds layers of distorted octahedra, three- and four-octahedra thick, i.e. of the kirkiite ($N = 3$) and jordanite ($N = 4$) types, respectively. Layers are connected by one parallel to {010}

atomic layer of three bicapped trigonal prismatic Pb atoms and one triangular pyramidal As atom in split position. The crystal-chemical formula of marcobaldiite can be obtained by the sum of the chemical compositions of the $N = 3$, $N = 4$ layers and the trigonal prismatic atomic layer: $[\text{Pb}_3(\text{Pb}_{0.85}\text{Bi}_{0.15})(\text{Sb}_{1.37}\text{As}_{0.63})_2\text{S}_8]^{-1.85} + [\text{Pb}_4(\text{Pb}_{0.85}\text{Bi}_{0.15})(\text{Pb}_{0.61}\text{Sb}_{0.39})(\text{Sb}_{1.07}\text{As}_{0.93})_2\text{S}_{10}]^{-1.46} + [\text{Pb}(\text{Pb}_{0.85}\text{Bi}_{0.15})_2\text{AsS}_3]^{+3.30} = \text{Pb}_8(\text{Pb}_{0.85}\text{Bi}_{0.15})_4(\text{Pb}_{0.61}\text{Sb}_{0.39})(\text{As}_{2.56}\text{Sb}_{2.44})_{5.00}\text{S}_{21}$, or $\text{Pb}_{12.01}(\text{Sb}_{2.83}\text{As}_{2.44}\text{Bi}_{0.60})_{5.99}\text{S}_{21}$, in good agreement with the formula obtained through chemical analysis. The mineral name honors the mineral collector Marco Baldi (b. 1944), for his contribution to the knowledge of the mineralogy of the ore deposits from southern Apuan Alps. The holotype material is deposited in the Museo di Storia Naturale, Università di Pisa, Italy. D.B.

MARKEYITE*

A.R. Kampf, J. Plášil, A.V. Kasatkin, and J. Marty (2018) Markeyite, a new calcium uranyl carbonate mineral from the Markey mine, San Juan County, Utah, USA. *Mineralogical Magazine*, 82(5), 1089–1100.

Markeyite (IMA 2016-090), ideally $\text{Ca}_9(\text{UO}_2)_4(\text{CO}_3)_{13} \cdot 28\text{H}_2\text{O}$, orthorhombic, is a new mineral discovered at the abandoned underground Markey mine, Red Canyon, White Canyon District, San Juan County, Utah, U.S.A. (37°32'57"N, 110°18'08"W). It is located ~ 1 km southwest of the Blue Lizard mine, where a number of new mineral species, most of which are secondary postmining Na uranyl sulfates were described recently. The uranium deposits in Red Canyon occur within the Shinarump member of the Upper Triassic Chinle Formation, in channels incised into the reddish-brown siltstones of the underlying Lower Triassic Moenkopi Formation. The Shinarump member consists of medium- to coarse-grained sandstone, conglomeratic sandstone beds and thick siltstone lenses. Ore minerals were deposited as replacements of wood and other organic material and as disseminations in the enclosing sandstone. Since the mine closed in 1982, oxidation of primary ores in the humid underground environment has produced a variety of secondary minerals, mainly carbonates and sulfates, as efflorescent crusts on the surfaces of mine walls. Markeyite occurs on asphaltum with calcite, gypsum, and natrozippeite. Other secondary minerals in the general assemblage are: ammoniozippeite, andersonite, anglesite, aragonite, arsenuranospathite, atacamaite, bayleyite, bluiezardite, bobcookite, brochantite, čejkaite, chalcantite, chalconatronite, chinleite-(Y), covellite, cuprosklodowskite, cyanotrichite, deliensite, devilline, erythrite, eugsterite, ferriite, jarosite, johannite, klaprothite, leószilárdite, leydetite, magnesioleydetite, mahnertite, malachite, marécottite, melanterite, metakahlerite, metasideronatriite, natrojarosite, plášilite, posnjakite, pseudojohannite, redcanyonite, römerite, sabugalite, schróckingerite, sideronatriite, sulfur, thénardite, thérèsemagnanite, uramarsite, uranospathite, wetherillite, zippeite, and other potentially new minerals (under investigation). Markeyite forms pale yellowish-green, vitreous to pearly bladed crystals and tablets up to ~ 1 mm, flattened on {001} and elongate on [010]. Observed forms are: {100}, {010}, {001}, {110}, {101}, {011}, and {111}. No twinning was observed. The mineral has a white streak. It fluoresces bright bluish white under a 405 nm laser. Cleavage is perfect on {001}; good on {100} and {010}. Markeyite is brittle, with irregular fracture, Mohs hardness $1\frac{1}{2}$ to 2. $D_{\text{meas}} = 2.68$ g/cm³; $D_{\text{calc}} = 2.699$. At room temperature, the mineral dissolves very slowly (minutes) in water and dissolves immediately with effervescence in dilute HCl. In plane-polarized light markeyite is pleochroic $X =$ light greenish yellow $> Y \approx Z =$ light yellow. It is optically biaxial (–), $\alpha = 1.538(2)$, $\beta = 1.542(2)$, $\gamma = 1.545(2)$ (white light); $2V = 81(2)^\circ$; the dispersion of an optical axes is weak, $r < v$. The Raman spectrum shows following bands (cm^{–1}): broad multiple features at 3700–3300 and 2800–2300 (ν O–H stretching of structurally nonequivalent/symmetrically distinct hydrogen-bonded OH and H₂O groups); weak broad band at ~ 1600 (ν_2 (δ))

bending of H₂O] partly overlaps with a very weak broad band which is along with a more distinct weak band at 1412 assigned to the split doubly degenerate ν_3 (CO₃)²⁻ antisymmetric stretching vibrations; medium to strong bands at 1095, 1086, 1078, 1067 [ν_1 (CO₃)²⁻ symmetric stretching]; weak band at 882 [ν_2 (δ) (CO₃)²⁻ bending vibrations or ν_3 (UO₂)²⁺ antisymmetric stretching or both; very strong band at 825 [ν_1 (UO₂)²⁺ symmetric stretching]; weak to strong bands at 772, 751, 733, and 694 [doubly degenerate ν_4 (δ) (CO₃)²⁻ bending]; medium broad band at 238 [split doubly degenerate ν_2 (δ) (UO₂)²⁺ bending; weak to medium bands at 170, 155, and 128 (lattice modes). The average of nine electron probe EDS analyses [wt% (range)] is CaO 18.60 (17.87–19.34), UO₃ 42.90 (41.10–44.60), CO₂ 21.30, H₂O 18.78, total 101.58. Attempts to use WDS mode with a higher beam current resulted in partial dehydration. No other elements with Z > 8 were observed. The contents of H₂O and CO₂ were not determined directly because of extreme paucity of material but were calculated by stoichiometry based on 75 O pfu and confirmed by the crystal-structure refinement and Raman spectroscopy. The empirical formula Ca_{8.91}(U_{1.01}O₂)₄(CO₃)₁₃·28H₂O. The strongest powder X-ray diffraction lines are [d Å (P%; hkl): 10.12 (69; 001), 6.41 (91; 220, 121), 5.43 (100; 221), 5.07 (33; 301, 002, 131), 4.618 (25; 040), 4.104 (37; 401, 141), 3.984 (34; 222). Unit-cell parameters refined from the powder data using with whole pattern fitting are: $a = 17.9688(13)$, $b = 18.4705(6)$, $c = 10.1136(4)$ Å, $V = 3356.6$ Å³, $Z = 2$. Markeyite is orthorhombic, $Pm\bar{m}n$. The crystal structure was solved by direct methods and refined to $R_1 = 0.0435$ for 3427 $F_o > 4\sigma(F)$ reflections. Two U sites in the structure of markeyite are each surrounded by eight O atoms forming a squat UO₈ hexagonal bipyramids which are each chelated by three CO₃ groups, forming uranyl tricarbonate clusters (UTC) with formula [(UO₂)(CO₃)₃]⁴⁻. UTC are linked by Ca–O polyhedra forming thick corrugated heteropolyhedral layers parallel to (010). The Ca–O polyhedra within the layers are linked by an additional disordered CO₃ groups. The layers are linked to one another and to interlayer H₂O groups only via hydrogen bonds. The formula based upon the refined structure is Ca₉(UO₂)₄(CO₃)_{12.71}(OH)_{0.50}·28.25H₂O. The ideal formula assumes full occupancy of the O15 site and half occupancy of the C5 and O16 sites. The structure has some similarities to that of liebigite. The mineral is named for its type locality. The holotype and four cotypes are deposited in the Natural History Museum of Los Angeles County, Los Angeles, California, U.S.A. One cotype specimen is housed in the Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow, Russia. **D.B.**

MARTINANDRESITE*

N.V. Chukanov, N.V. Zubkova, N. Meisser, S. Ansermet, S. Weiss, I.V. Pekov, D.I. Belakovskiy, S.A. Vozhikova, S.N. Britvin, and D.Yu. Pushcharovky (2018) Martinandresite, Ba₂(Al₄Si₁₂O₃₂)·10H₂O, a new zeolite from Wasenalp, Switzerland. *Physics and Chemistry of Minerals*, 45(6), 511–521.

Martinandresite (IMA 2017-038), ideally Ba₂(Al₄Si₁₂O₃₂)·10H₂O, is a new mineral discovered in the armenite locality of Wasenalp near the Isenwegg peak, Ganter valley, Simplon region, Switzerland. It was found in zoisite-, celsian-, and armenite-bearing gneisses that contain up to 15 wt% Ba and are cut by steep open veins. Late-stage hydrothermal fluids formed a series of free-grown clear quartz, calcite, dravite, clinzoisite, armenite, and martinandresite in these rocks. The new mineral occurs in close association with armenite, quartz, dickite, and chlorite. It forms aggregates up to 6 cm across and consisting of 6–8 mm long blocky and rounded tan crystals, autoepitaxially covered by milk-white, cross-twinned plates up to 3.5 mm long. The blocky crystals can be up to 8×5×3.5 mm in size, and the platy crystals visually resembling baryte are overgrowing blocky crystals and may form scaly to lamellar aggregates up to 7 mm. More perfect platy crystals reach a maximum of 5×3×0.7 mm in size. Three pinacoids forms are observed: {010} (habit), {100} and

{001}, as well as non-indexed faces of the crystals. The new mineral is white or tan, transparent to translucent, locally light green due to microscopic chlorite inclusions. Martinandresite has a white streak and vitreous to porcelainous luster. No fluorescence under UV radiation was observed. It has two directions of indistinct cleavage, presumably on {010} and in a direction across (010), and no parting. No cleavage was observed. The fracture is uneven, and the Mohs hardness is 4½. $D_{\text{meas}} = 2.482(5)$ g/cm³; $D_{\text{calc}} = 2.495$ g/cm³. In transmitted plane-polarized light martinandresite is colorless, non-pleochroic. It is biaxial (–), $\alpha = 1.500(2)$, $\beta = 1.512(2)$, $\gamma = 1.515(2)$ ($\lambda = 589$ nm). $2V_{\text{meas}} = 55(10)^\circ$, $2V_{\text{calc}} = 53^\circ$. Dispersion of an optical axes is $r < v$, weak. The IR spectrum shows the following bands (cm⁻¹; w = weak band, s = strong band, sh = shoulder): 3625, 3570sh, 3260sh (O–H stretching vibrations of H₂O), 1638 (H₂O bending), 1167, 1028s (stretching vibrations of the tetrahedral framework), 774w, 728w, 700w (mixed vibrations of the tetrahedral framework), 616, 551, 432s (lattice modes involving predominantly bending vibrations of the tetrahedral framework and librational vibrations of H₂O molecules). The average of five WDS electron probe analyses is [wt%, (range)]: Na₂O 0.37 (0.29–0.47), K₂O 0.12 (0.00–0.22), BaO 21.55 (21.13–22.08), Al₂O₃ 15.03 (14.72–15.34), SO₃ 49.86 (49.53–50.18), H₂O (by the Alimarin method) 12.57±0.15, total 99.50. The empirical formula based on 16 Si+Al atoms pfu is Na_{0.17}K_{0.04}Ba_{2.00}(Al_{4.19}Si_{11.81}O₃₂)H_{19.85}O_{9.95}. The strongest lines of the powder X-ray diffraction pattern are [d Å (P%; hkl): 6.98 (74; 001), 6.26 (83; 011), 5.61 (100; 101), 3.933 (60; 220, 031), 3.191 (50; 112), 3.170 (62; 041), 3.005 (79; 231, 141). The crystal structure was solved by direct methods and refined to $R_1 = 5.27\%$. The new mineral is orthorhombic, $Pm\bar{m}n$, $a = 9.4640(5)$, $b = 14.2288(6)$, $c = 6.9940(4)$ Å, $V = 941.82(8)$ Å³, $Z = 1$. The crystal structure of the new zeolite is unique and is based on the framework of [(Al,Si)O₄] tetrahedra that form four-, six-, and eight-membered rings. Four-membered tetrahedral rings are linked to form double crankshaft chains along the a axis. The chains are connected via common vertices of tetrahedral rings to form six- and eight-membered tetrahedral rings. Na, K, and Ba atoms as well as H₂O groups are located in the channels of the framework. The new mineral is named after Martin Andres (b. 1965), the Swiss mineral collector and amateur mineralogist, who discovered the armenite vein locality of Wasenalp. Part of the holotype specimen is deposited in the collections of the Geological Museum of Lausanne, Switzerland. **Yu.U.**

PARISITE-(LA)*

L.A.D. Menezes Filho, M.S.C. Chaves, N.V. Chukanov, D. Atencio, R. Scholz, I. Pekov, G. Magela da Costa, S.M. Morrison, M.B. Andrade, E.T.F. Freitas, R.T. Downs, and D.I. Belakovskiy (2018) Parisite-(La), ideally CaLa₂(CO₃)₃F₂, a new mineral from Novo Horizonte, Bahia, Brazil. *Mineralogical Magazine*, 82(1), 133–144.

Parisite-(La) (IMA 2016-031), ideally CaLa₂(CO₃)₃F₂, monoclinic, was discovered in a hydrothermal vein crosscutting a metarhyolite of the Rio dos Remédios Group, at the Mula mine, Tapera village, Novo Horizonte county, Bahia, Brazil. The pit of the Mula mine is composed of brecciated quartz veins cemented by chalcedony. Parisite-(La) was found in association with almedaite, hematite, rutile, fluocerite-(Ce), brockite, monazite-(La), rhabdophane-(La), and bastnasite-(La). The chemical composition match the parisite-(La) have been reported earlier from Třebíč durbachite massif, SW Moravia, Czech Republic (Sulovský 2001); at a metabauxite/marble interface in the eastern part of Samos island, Greece (Theye et al. 2003); alkaline rocks in Romania (Hirtopanu 2006; Hirtopanu et al. 2015); Cerro Boggiani massif, Alto Paraguay Province, Paraguay (Enrich et al. 2010); Bear Lodge carbonatite, Wyoming, U.S.A. (Moore et al. 2015). Parisite-(La) occurs as nuclei up to 5 mm in doubly terminated pseudo-hexagonal crystals with corrugated faces up to 8.2 cm. The crystals formed by acute pseudodipyramids with horizontally striated faces, terminated by a pinacoid. These crystals were partially replaced

by bastnäsite-(La), monazite-(La), and rhabdophane-(La). Parisite-(La) is yellow-green to white, transparent, with a white streak and vitreous to dull luster. It does not fluoresce under UV light. Parisite-(La) is brittle, has a distinct cleavage on {001}, and no parting, but laminated, conchoidal, or uneven fracture. The Mohs hardness is between 4 and 5. The density was not measured; $D_{\text{calc}} = 4.273 \text{ g/cm}^3$. In transmitted light, parisite-(La) is colorless, non-pleochroic. It is pseudo-uniaxial (+), $\omega = 1.670(2)$, and $\varepsilon = 1.782(5)$ (589 nm). The IR spectrum of parisite-(La) is close to that of parisite-(Ce), with the following bands (cm^{-1} ; w = weak band, s = strong band, sh = shoulder): 1700–3000w (overtone and combination modes); 1454s, 1430sh (degenerate asymmetric C–O stretching vibrations), 1089w, 1081w (non-degenerate symmetric C–O stretching vibrations), 871s, 850sh (out-of-plane bending vibrations of the carbonate ion triangles), 746w, 734w (in-plane bending vibrations of the carbonate ion triangles), 679w, 602w (presumably, overtones and/or combination modes) and 368 (lattice mode involving Ca–O- or REE–O-stretching vibrations). Bands in the range 3000–3800 cm^{-1} are not observed, indicating the absence of OH groups. The Raman spectrum of parisite-(La) contains the following bands (cm^{-1}): 1428 (ν_3 asymmetric stretching mode of CO_3^{2-} anions; 1081, 1091, and 1098 (symmetric C–O stretching modes); 737 and 871 (in-plane and out-of-plane vibrations of CO_3^{2-} groups, respectively); 600 and 970 (vibrations involving F^- anions); bands below 500 (lattice modes, and all peaks above 1500 cm^{-1} are due to fluorescence. The averages of 25 WDS electron probe analyses (at University of Arizona) / 7 WDS analyses (at Universidade Federal de Minas Gerais, Brazil) [wt%, (range)] are: CaO 10.10 (10.05–10.15) / 9.45 (9.28–9.73), Y_2O_3 0.52 (0.47–0.55) / 0.51 (0.48–0.54), La_2O_3 24.77 (24.54–24.96) / 24.82 (24.31–25.32), Ce_2O_3 11.16 (11.03–11.32) / 12.99 (12.86–13.24), Pr_2O_3 4.73 (4.63–4.91) / 7.95 (7.27–8.83), Nd_2O_3 15.82 (not given) / 14.77 (14.23–15.26), Sm_2O_3 1.25 (not given) / 1.24 (1.22–1.27), Eu_2O_3 0.07 (not given) / 0.07 (0.02–0.09), F 7.30 (not given) / 6.71 (6.01–7.58), CO_2 (calculated for charge neutrality) 24.50 / 24.70, $-\text{O}=\text{F}_2$ 3.07 / 2.82, total 97.15 / 100.39. The content of CO_2 from TG data is 23.68 wt%. The empirical formulae based on 11 (O+F) pfu are accordingly $\text{Ca}_{0.89}(\text{La}_{0.83}\text{Nd}_{0.51}\text{Ce}_{0.37}\text{Pr}_{0.16}\text{Sm}_{0.04}\text{Y}_{0.03})_{\Sigma 1.94}\text{C}_{3.03}\text{O}_{8.91}\text{F}_{2.09} / \text{Ca}_{0.91}(\text{La}_{0.82}\text{Nd}_{0.47}\text{Ce}_{0.43}\text{Pr}_{0.26}\text{Sm}_{0.04}\text{Y}_{0.02})_{\Sigma 2.04}(\text{CO}_3)_3\text{F}_{1.91}$. The strongest lines in the powder X-ray diffraction pattern are [$d \text{ \AA}$ (hkl)]: 13.95 (55; 002), 6.98 (20; 004), 4.655 (37; 006), 3.555 (88; 020,311), 2.827 (100; 026,315,317), 2.055 (58; 331,602), 1.950 (38; 0.2.12,3.1.11,3.1.13), 1.880 (36; 335,337,604,608), 1.663 (23; 046,624,628). Single-crystal X-ray diffraction and convergent-beam electron diffraction performed under transmission electron microscopy indicated monoclinic symmetry (pseudo-trigonal) and systematic absences compatible with $C2$, Cm , and $C2/m$ space groups, $a = 12.356(1)$, $b = 7.1368(7)$, $c = 28.299(3)$ Å, $\beta = 98.342(4)^\circ$, $V = 2469.1 \text{ \AA}^3$, $Z = 12$. It was not possible to obtain single-crystal data suitable for crystal-structure refinement. Part of the holotype specimen is deposited in the collections of the Museu de Geociências, Instituto de Geociências, Universidade de São Paulo, São Paulo, Brazil, and at the University of Arizona Mineral Museum, Tucson, Arizona, U.S.A. **Yu.U.**

References cited

- Enrich, G.E.R., Gomes, C.B., and Ruberti, E. (2010) Química mineral de carbonatos de elementos terras raras em nefelina sienitos e fonólitos apáíticos do maciço de Cerro Boggiani, Província Alto Paraguai, Paraguai. X Congresso de Geoquímica dos Países de Língua Portuguesa, 2010, Porto. Actas, 2010. v. CDrom, pp. 223–227.
- Hirtopanu, P. (2006) One hundred minerals for one hundred years (dedicated to the Centennial of the Geological Institute of Romania), 3rd Conference on Mineral Sciences in the Carpathians, Miskolc Hungary. Acta Mineralogica–Petrographica, Abstract series, 5, 86.
- Hirtopanu, P., Fairhurst, R.J., and Jakab, G. (2015) Niobian rutile and its associations at Jolotca, Ditrău Alkaline Intrusive Massif, East Carpathians, Romania. Proceedings of the Romanian Academy, Series B, 17, 39–55.
- Moore, M., Chakhmouradian, A.R., Mariano, A.N., and Sidhu, R. (2015) Evolution of rare-earth mineralization in the Bear Lodge carbonatite, Wyoming:

Mineralogical and isotopic evidence. Ore Geology Reviews, 64, 499–521.

Sulovsky, P. (2001) Accessory minerals of the Trebič durbachite massif (SW Moravia). Mineralia Slovaca, Košice: SGS, 33(5), 467–472.

Theye, T., Ockenga, E., and Bertoldi, C. (2003) Davidite-(La), bastnaesite-(La), parisite-(La), monazite-(La): REE minerals at a metabauxite/marble interface in eastern Samos (Greece). Berichte der Deutschen Mineralogischen Gesellschaft, Beihefte zum European Journal of Mineralogy, Vol. 15 (1). ftp://ftp.gmg.rub.de/pub/geo2003/17%20Quantification%20and%20dating%20of%20metamorphic%20processes%20WILLNER/Theye.PDF.

PLUMBOPHARMACOSIDERITE*

P. Vignola, N. Rotiroli, F. Hatert, F. Dal Bo, P. Gentile, C. Albertini, M. Merlini, A. Risplendente, and A. Pavese (2018) Plumbopharmacosiderite, $\text{Pb}_{0.5}\text{Fe}_{0.5}^{2+}(\text{AsO}_4)_3(\text{OH})_4 \cdot 5\text{H}_2\text{O}$, a new mineral species from the Monte Falò Pb–Zn Mine Near the Village of Coiromonte in the Armeno Municipality, Novara Province, Italy. Canadian Mineralogist, 56(2), 143–150.

Plumbopharmacosiderite (IMA 2016-109), $\text{Pb}_{0.5}\text{Fe}_{0.5}^{2+}(\text{AsO}_4)_3(\text{OH})_4 \cdot 5\text{H}_2\text{O}$, cubic, is a new hydrated and hydroxylated arsenate of Fe^{2+} and Pb of the pharmacosiderite group, pharmacosiderite supergroup. It was discovered at the dumps of the Monte Falò Pb–Zn mine near the village of Coiromonte in the Armeno municipality, Novara province, Italy (45°50′52.37″N, 8°29′1.13″E). The mineral forms minute cubes up to 50 μm on the surfaces of brittle fissures in a mica schist cross-cut by arsenopyrite veins. Plumbopharmacosiderite is a product of oxidation of primary Pb-, Fe-sulfide minerals due to weathering of the primary ore and is found in close association with arsenopyrite, scorodite, beudantite, rare segnitite, marcasite, galena, sphalerite, and mimetite. The mineral is pale green to yellowish-green, transparent with a white streak and vitreous to resinous luster. It is brittle with an irregular fracture, and estimated Mohs hardness of 2.5–3. The density was not measured; $D_{\text{calc}} = 2.89 \text{ g/cm}^3$. No fluorescence was observed under 254–366 nm UV light. The mineral is optically isotropic, $n = 1.73(1)$. The average of eight electron probe WDS analyses [wt%, (range)] is: As_2O_5 38.41 (32.86–44.56), P_2O_5 0.07 (0–0.17), SO_3 0.03 (0–0.06), SiO_2 0.04 (0–0.09), Al_2O_3 1.30 (1.08–1.44), Fe_2O_3 33.37 (31.35–34.97), CaO 0.03 (0–0.09), BaO 2.61 (2.28–2.93), ZnO 0.05 (0–0.23), PbO 10.59 (9.63–11.62), Na_2O 0.12 (0.01–0.36), K_2O 1.08 (0.48–1.36), H_2O (calculated for total of 100%) 14.17, total 101.87. The empirical formula based on 14 anhydrous O pfu is: $(\text{Pb}_{0.42}\text{K}_{0.20}\text{Ba}_{0.15}\text{Na}_{0.03}\text{Ca}_{0.01})_{\Sigma 0.81}(\text{Fe}_{0.39}\text{Al}_{0.22})_{\Sigma 3.91}(\text{As}_{2.95}\text{Si}_{0.01})_{\Sigma 2.96}\text{O}_{12}(\text{OH})_{2.90} \cdot 5\text{H}_2\text{O}$. The strongest lines in the powder X-ray diffraction pattern are [$d \text{ \AA}$ (hkl)]: 8.024 (100; 001), 5.859 (15; 011), 4.558 (12; 111), 3.980 (18; 002), 3.252 (23; 112), 2.830 (18; 201), 2.535 (12; 103), 1.879 (29; 303). The unit-cell parameters refined from the powder X-ray data are $a = 7.972(25) \text{ \AA}$, $V = 507.00 \text{ \AA}^3$. The single-crystal X-ray data shows plumbopharmacosiderite is cubic, space group $P\bar{4}3m$, $a = 7.9791(2) \text{ \AA}$, $V = 508.00 \text{ \AA}^3$, $Z = 1$. The crystal structure was solved and refined to $R_1 = 10.07\%$ for observed reflections. The plumbopharmacosiderite structure is consistent with the pharmacosiderite structure-type. It is characterized by strongly distorted FeO_6 octahedra, which share corners with AsO_4 tetrahedra to form large zeolite-like channels located in the center of the unit-cell face. Lead with minor K and H_2O and further water are sited within these channels. Pb as Ba in biopharmacosiderite structure is placed exactly at the center of the unit-cell face, while the lighter ions are displaced from the center. The holotype is stored in the Mineralogical Collection of the Laboratoire de Minéralogie, University of Liège, Belgium. **D.B.**

SOMERSETITE*

O.I. Siidra, D.O. Nekrasova, R. Turner, A.N. Zaitsev, N.V. Chukanov, Y.S. Polekhovskiy, J. Spratt, and M.S. Rumsey (2018) Somersetite, $\text{Pb}_8\text{O}(\text{OH})_4(\text{CO}_3)_5$, a new complex hydrocerussite-related mineral from the Mendip Hills, England. Mineralogical Magazine, 82(5), 1211–1224.

Somersetite (IMA 2017-024), ideally $\text{Pb}_8\text{O}(\text{OH})_4(\text{CO}_3)_5$, is a new Pb basic carbonate mineral species from the Torr Works quarry, near the town of Cranmore in Somerset, England. The quarry works Carboniferous limestone strata, overlain disconformably by Jurassic Upper Oolites. The limestones have Mississippian Pb ore veins bearing galena, fluorite, calcite, and baryte, resulting in a large area being irregularly mineralized with sub-parallel ore veins. Regional uplift, erosion and subsequent marine transgression allowed the ingress of seawater into many of these Pb veins, causing deposition of manganate minerals. Later multiple hydrothermal events and hot hydrothermal fluids, hot enough to silicify the limestone wallrocks in places, caused irregular thermal alteration of existing Pb veins, as well as deposition of quartz and other minerals, leading to the remobilization of Pb into solution as hydrocerussite. This event formed crude crystals of hydrocerussite up to 50 mm in size and aggregates to 150 mm, which contains somersetite associated with symesite, calcite, aragonite, and quartz. Somersetite forms green or white plates and subhedral grains up to 5 mm across and up to 2 mm thick with a white streak and adamantine luster. Bi-colored crystals of sommersite are found in intergrowths with plumbonacrite. The mineral is brittle with an uneven fracture, perfect cleavage on $\{001\}$ and no parting. The micro-indentation hardness $\text{VHN}_{20} = 140.4 \text{ kg/mm}^2$, corresponding to ~ 3 of the Mohs scale. $D_{\text{calc}} = 7.01 \text{ g/cm}^3$. The mineral is optically biaxial (–), $n_{\text{calc}} = 2.0$. It is strongly pleochroic, from green throughout orange-brown, to deep red colors. In reflected light, somersetite is gray, non-pleochroic, with white internal reflections, very weak bireflectance ($\Delta R_{589} = 1\%$), and a relatively weak anisotropy masked by the abundant internal reflections. The reflectance values were measured in air between 400 and 700 nm with 20 nm interval. The values for COM wavelengths [$R\%$ (nm)] are: 46.3 (470), 47.6 (546), 48.5 (589), 49.5 (650). The FTIR spectra (powdered samples) is similar to that of plumbonacrite and, to a lesser degree, hydrocerussite. Bands and their assignments are (cm^{-1} ; s = strong band, w = weak band, sh = shoulder): 3549, 3280w (O–H stretching vibrations); 2524w (combination mode), 1734w (overtone of in-plane bending vibrations of CO_3^{2-} anions); 1403s (asymmetric C–O stretching vibrations of CO_3^{2-} anions); 1217 (possibly, combination mode involving Pb–O stretching and O–C–O bending vibrations); 1046w (symmetric C–O stretching vibrations of CO_3^{2-} anions); 849 (out-of-plane bending vibrations of CO_3^{2-} anions); 738w, 690sh, 683s (in-plane bending vibrations of CO_3^{2-} anions); 615w (Pb–O–H bending vibrations), 507w, 391 (Pb–O stretching vibrations). The averages of an unreported number of electron probe WDS analyses is [wt% (range)]: PbO 86.77 (86.54–87.12), CO_2 (by charge valance) 10.70, H_2O (by charge balance) 1.75, total 99.22. The empirical formula calculated on the basis of 20 O pfu is $\text{Pb}_{8.00}\text{C}_{5.00}\text{H}_{4.00}\text{O}_{20}$. The strongest X-ray powder diffraction lines are [$d \text{ \AA}$ ($I\%$; hkl)]: 4.308 (33; 103), 4.148 (25; 104), 3.581 (40; 107), 3.390 (100; 108), 3.206 (55; 109), 2.625 (78; 110), 2.544 (98; 0.0.16). Unit-cell parameters refined from the powder data with whole-pattern fitting are $a = 5.249(1)$, $c = 40.679(2) \text{ \AA}$, $V = 970.89 \text{ \AA}^3$. The crystal structure was refined to $R_1 = 0.031$ for 509 $F_o > 4\sigma(F_o)$ and 0.073 for 518 unique reflections. The mineral is hexagonal, $P6_3/mmc$, $a = 5.2427(7)$, $c = 40.624(6) \text{ \AA}$, $V = 967.0 \text{ \AA}^3$, $Z = 2$. The crystal structure somersetite consists of the alternation of the electroneutral plumbonacrite-type $[\text{Pb}_3\text{O}(\text{OH})_2(\text{CO}_3)_3]^0$ and hydrocerussite-type $[\text{Pb}_3(\text{OH})_2(\text{CO}_3)_2]^0$ blocks separated by stereochemically active lone electron pairs on Pb^{2+} . There are two blocks of each type per unit cell in the structure, which corresponds to the formula $[\text{Pb}_3\text{O}(\text{OH})_2(\text{CO}_3)_3][\text{Pb}_3(\text{OH})_2(\text{CO}_3)_2]$ or $\text{Pb}_8\text{O}(\text{OH})_4(\text{CO}_3)_5$ in a simplified representation. The 2D blocks are held together by weak Pb–O bonds and weak interactions between lone pairs. The presence of $[\text{Pb}_3\text{O}(\text{OH})_2(\text{CO}_3)_3]^0$ blocks in somersetite reveals structural relationships with the closely associated plumbonac-

rite. Somersetite (Cyrillic: сомeрсетит) is named for the locality in the county of Somerset in South West England. Type material is deposited in the museum of the Department of Mineralogy, Saint Petersburg State University, Saint Petersburg, Russia. F.C.

ZIMINAITE*

I.V. Pekov, O.I. Siidra, V.O. Yapaskurt, Y.S. Polekhovskiy, and P.M. Kartashov (2018) Ziminaite, $\text{Fe}^{3+}\text{VO}_4$, a new howardevansite-group mineral from the Bezmyannyi volcano, Kamchatka, Russia. Mineralogy and Petrology, 112(3), 371–379.

Ziminaite (IMA 2014-062), ideally $\text{Fe}^{3+}\text{VO}_4$, was discovered in fumarole sublimates on volcanic scoria at the Bezmyannyi volcano, Kamchatka, Russia. It was found in a single specimen collected in 1985, the same specimen where koksharovite was earlier discovered. It is associated with koksharovite, bannermanite and an insufficiently characterized Ca vanadate; as well as quartz, biotite and Ti- and V-bearing magnetite as earlier minerals. The new mineral forms lamellar, tabular, flattened prismatic or sometimes hoper crystals up to $10 \times 30 \times 50 \text{ \mu m}$ (usually from 5 to 20 \mu m) in size. These crystals epitaxially overgrow crystals of koksharovite located on the surface of volcanic scoria. Ziminaite is also observed as separate crystals (usually cavernous, with numerous inclusions of particles of scoria) and their groups or as spongy aggregates (up to 0.15 mm across) of irregularly shaped grains filling small cavities in porous volcanic scoria altered by fumarole gas. Ziminaite is yellowish-brown, translucent, with an adamantine luster, and a yellow streak. The micro-indentation hardness $\text{VHN}_{20} = 426$ (379–495) kg/mm^2 , corresponding to $\sim 4\frac{1}{2}$ of the Mohs scale. Ziminaite is brittle, has an uneven fracture and does not demonstrate cleavage or parting. Density was not measured because of the small crystal size and cavernous character of grains; $D_{\text{calc}} = 3.448 \text{ g/cm}^3$. In reflected light ziminaite is light gray, non-pleochroic, with intense deep yellow internal reflections. It is weakly bireflectant; anisotropism is weak. The reflectance values were measured in air between 400 and 700 nm with a 20 nm interval. The interpolated values for COM wavelengths [R_{min} , R_{max} (nm)] are: 16.3, 17.7 (470); 14.1, 15.7 (546); 13.8, 15.1 (589); 13.6, 14.7 (650). The average of five WDS electron probe analyses [wt%, (range)] is: MgO 2.20 (2.03–2.53), CaO 0.01 (0–0.04), Al_2O_3 7.81 (6.01–9.61), Fe_2O_3 27.18 (25.30–30.08) (trivalent state of all iron by structure refinement), TiO_2 4.50 (3.93–5.15), SiO_2 0.26 (0.19–0.38), P_2O_5 0.09 (0–0.16), V_2O_5 57.01 (56.58–57.79), total 99.06. The empirical formula based on 24 O pfu is $(\text{Fe}_{3.79}^{3+}\text{Al}_{1.48}\text{Ti}_{0.54}\text{Mg}_{0.53})_{\Sigma 5.84}(\text{V}_{6.05}\text{Si}_{0.04}\text{P}_{0.01})_{\Sigma 6.10}\text{O}_{24}$. The strongest lines of the powder X-ray diffraction pattern are [$d \text{ \AA}$ ($I\%$; hkl)]: 3.751 (17; $1\bar{2}1$, $12\bar{1}$); 3.539 (86; 120); 3.270 (67; $01\bar{2}$); 3.209 (100; $2\bar{2}0$); 3.090 (20; $2\bar{1}1$, 002); 3.041 (18; $03\bar{1}$, $02\bar{2}$); 2.934 (14; $12\bar{2}$, 030); 1.665 (24; 023 , $12\bar{4}$). Ziminaite is triclinic, $P\bar{1}$, $a = 8.012(4)$, $b = 9.345(5)$, $c = 6.678(3) \text{ \AA}$, $\alpha = 106.992(10)$, $\beta = 101.547(8)$, $\gamma = 96.594(11)^\circ$, $V = 460.4 \text{ \AA}^3$, $Z = 1$. The crystal structure of ziminaite was solved by direct methods and refined to $R_1 = 8.5\%$. It is based on the heteropolyhedral framework formed by $[\text{VO}_4]$ tetrahedra and Fe^{3+} -centered octahedra and fivefold polyhedra. Ziminaite is isostructural with other members of the howardevansite, which includes howardevansite, koksharovite, and grigorievite, and is the first member of this group without species-defining uni- or divalent cations and with all large cation sites vacant. The new mineral is also isostructural with synthetic FeVO_4 , AlVO_4 , and other members of the ZnMoO_4 structure type. The new mineral is named after the Zimina volcano, located 12 km south of the Bezmyannyi volcano. The type specimen is deposited in the collections of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. Yu.U.