

## New Mineral Names\*†

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## IN THIS ISSUE

This New Mineral Names has entries for 10 new minerals, including calciomurmanite, czochralskiite, ezazoite, honeaita, lobanovite, magnesiovoltaite, odigitriaite, romanorlovite, tatarinovite, zincomenite, and a new data on boscardinite and partzite (discredited).

## CALCIOMURMANITE\*

I.S. Lykova, I.V. Pekov, N.V. Chukanov, D.I. Belakovskiy, V.O. Yapaskurt, N.V. Zubkova, S.N. Britvin and G. Giester (2016) Calciomurmanite,  $(\text{Na}, \square)_2\text{Ca}(\text{Ti}, \text{Mg}, \text{Nb})_4[\text{Si}_2\text{O}_7]_2\text{O}_2(\text{OH}, \text{O})_2(\text{H}_2\text{O})_4$ , a new mineral from the Lovozero and Khibiny alkaline complexes, Kola Peninsula, Russia. *European Journal of Mineralogy*, 28, 835–845.

Calciomurmanite, (IMA 2014-103), with general formula  $(\text{Na}, \square)_2\text{Ca}(\text{Ti}, \text{Mg}, \text{Nb})_4[\text{Si}_2\text{O}_7]_2\text{O}_2(\text{OH}, \text{O})_2(\text{H}_2\text{O})_4$ , is a new murmanite-group mineral, the product of hydrothermal or supergene alteration of high-temperature, anhydrous phosphate-bearing titanosilicates lomonosovite and/or betalomonosovite. It was discovered in the specimen ST4994 (V.I. Spepanov collection at Fersman Mineralogical Museum, Moscow, Russia) originally catalogued as betalomonosovite from Mt. Flora, Lovozero alkaline complex, Kola peninsula, Russia. In this specimen (considered as the holotype) calciomurmanite forms irregular lamellae up to  $0.1 \times 0.4 \times 0.6$  cm sometimes combined in up to 3 cm aggregates are embedded in a rock mainly consisting of dark-green acicular aegirine and white microcline and containing lorenzenite, fluorapatite and minor calcite. In the cotype specimen (from hydrothermally altered peralkaline pegmatite at Mt. Eveslogchorr, Khibiny alkaline complex, Kola peninsula, Russia) the mineral forms  $2 \times 3.5$  cm fan-shaped aggregate of lamellae and is associated with microcline, aegirine, lamprophyllite, tsepinite-Ca, and tsepinite-K. The mineral has also been found in the outer zone of the Shcherbakovitoev pegmatite at the Koashva open pit of the Vostochniy apatite mine, Khibiny, with aegirine, microcline, lamprophyllite, pectolite, and relics of yellow betalomonosovite. Calciomurmanite is brownish (holotype) or purple (cotype), with a nacreous luster on cleavage surfaces and greasy on broken surfaces. The streak is white. Mica-like cleavage on {001} is perfect, and two distinct nearly perpendicular cleavages, both almost perpendicular to (001) are observed under the microscope. Mohs hardness is  $2\frac{1}{2}$ –3.  $D_{\text{meas.}} = 2.70(3)$  (by flotation in heavy liquids),  $D_{\text{calc.}} = 2.85 \text{ g/cm}^3$ . Calciomurmanite does not fluoresce under ultraviolet light or an electron beam. It is colorless, non-pleochroic in transmitted light, optically biaxial (–) with  $\alpha = 1.680(4)$ ,  $\beta = 1.728(4)$ ,  $\gamma = 1.743(4)$ ,  $2V_{\text{meas.}} = 58(5)^\circ$ ,  $2V_{\text{calc.}} = 57^\circ$  (589 nm). Y and Z lie in the ab plane. Dispersion of optical axes was not observed. The FTIR spectra of calciomurmanite show absorption bands ( $\text{cm}^{-1}$ , s = strong, sh = shoulder) at 3395, 3250sh (stretching vibrations of OH groups), 1644 (H-O-H bending vibrations of  $\text{H}_2\text{O}$  molecules), 1324 (Si–O···H bending vibrations), 1040sh, 975sh (Si–O stretching vibrations of Si–O–Si bridges in  $\text{Si}_2\text{O}_7$  groups), 926s

(Si–O stretching vibrations involving apical O atoms of  $\text{Si}_2\text{O}_7$  groups), 800sh (bending vibrations of M···O–H, where M is a cation), 682 (O–Si–O bending vibrations), 523 (Ti···O stretching vibrations), 450, 410, 378 (lattice modes involving Si–O–Si bending vibrations). The average of 7 electron probe EDS analyses [wt% (range)]: Na<sub>2</sub>O 5.39 (4.79–6.54), K<sub>2</sub>O 0.30 (0.22–0.43), CaO 7.61 (7.34–8.03), MgO 2.54 (1.79–3.05), MnO 2.65 (2.27–2.97), FeO 1.93 (1.58–2.09), Al<sub>2</sub>O<sub>3</sub> 0.85 (0.49–1.04), SiO<sub>2</sub> 30.27 (28.82–32.13), TiO<sub>2</sub> 29.69 (27.60–31.32), Nb<sub>2</sub>O<sub>5</sub> 6.14 (5.53–7.14), P<sub>2</sub>O<sub>5</sub> 0.27 (0.17–0.63), H<sub>2</sub>O (by the Alimarin method) 11.59, total 99.23. The empirical formula based on (Si+Al) = 4, pfu, is  $\text{Na}_{1.34}\text{Ca}_{1.04}\text{K}_{0.05}\text{Mg}_{0.49}\text{Mn}_{0.29}\text{Fe}_{0.21}\text{Nb}_{0.36}\text{Ti}_{2.85}(\text{Si}_{13.87}\text{Al}_{0.13})_2\text{O}_{16.40}(\text{OH})_{1.60}(\text{PO}_4)_{0.03}(\text{H}_2\text{O})_{4.94}$ . Measured H<sub>2</sub>O is higher than the value observed by structure refinement. Authors claim that it is related to absorbed H<sub>2</sub>O by partial amorphization. The strongest lines in the X-ray powder diffraction pattern are [*d* Å (%; *hkl*)]: 11.69 (100; 001), 5.87 (68; 011,002), 4.25 (89;  $\bar{1}\bar{1}\bar{1}, \bar{1}\bar{1}\bar{1}$ ), 3.825 (44;  $\bar{1}\bar{1}\bar{2}, 003, \bar{1}\bar{1}\bar{2}$ ), 2.940 (100;  $\bar{1}\bar{2}\bar{1}, \bar{1}\bar{2}\bar{1}$ ), 2.900 (79; 004, 120). The unit-cell parameters refined from the powder data are:  $a = 5.349(9)$ ,  $b = 7.08(1)$ ,  $c = 12.15(2)$  Å,  $\alpha = 91.85(3)$ ,  $\beta = 107.72(3)$ ,  $\gamma = 90.17(3)^\circ$ ,  $V = 438.1$  Å<sup>3</sup>. The single-crystal unit-cell parameters are:  $a = 5.3470(6)$ ,  $b = 7.0774(7)$ ,  $c = 12.1456(13)$  Å,  $\alpha = 91.827(4)$ ,  $\beta = 107.527(4)$ ,  $\gamma = 90.155(4)^\circ$ ,  $V = 438.03$  Å<sup>3</sup>, triclinic,  $P\bar{1}$ ,  $Z = 1$ . The crystal structure of calciomurmanite was refined to  $R_1 = 0.0656$  for 1895 observed [ $I_o > 2\sigma(I_o)$ ] reflections. Calciomurmanite is isostructural with murmanite. The structure is based on alternating HOH sheet of three polyhedral layers (two heteropolyhedral built up of tetrahedra disilicate groups and Ti-centered octahedra, and one central built up of NaO<sub>6</sub> and TiO<sub>6</sub> octahedra) and intermediate layers (built up of Ca-centered polyhedra and two H<sub>2</sub>O groups bonded to the apexes of Ti octahedra of the H layers and to the Ca-centered polyhedra). A continuous solid solution between calciomurmanite and murmanite is reported. Calciomurmanite is chemically related to another Ca-bearing member of the group is kolskyite  $(\text{Ca}\square)\text{Ti}_2\text{Na}_2\text{Ti}_2(\text{Si}_2\text{O}_7)_2\text{O}_4(\text{H}_2\text{O})_7$ , although the latter has a different structure of the intermediate layer bearing more H<sub>2</sub>O groups. The mineral is named as the Ca analog of murmanite. The holotype and cotype specimens are deposited in the Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow, Russia. **F.C.**

**Comment:** According to the new classification of the seidozerite-supergroup [approved by IMA-CNMMC (memorandum 56-SM/16) and later published by Sokolova and Cámara (2017)] calciomurmanite belongs to the murmanite group of the seidozerite-supergroup.

## Reference cited

Sokolova, E., and Cámara, F. (2017) The seidozerite supergroup of TS-block minerals: Nomenclature and classification, with change of the following names: rinkite to rinkite-(Ce), mosandrite to mosandrite-(Ce), hainite to hainite-(Y) and innelite-17 to innelite-1A. *Mineralogical Magazine*, <https://doi.org/10.1180/minmag.2017.081.010>.

\* 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/>.

## CZOCHRALSKIITE\*

L. Karwowski, R. Kryza, A. Muszyński, J. Kusz, K. Helios, P. Drożdżewski and E. V. Galuskin (2017) Czochralskiite,  $\text{Na}_4\text{Ca}_3\text{Mg}(\text{PO}_4)_4$ , a second new mineral from the Morasko IAB-MG iron meteorite (Poland). *European Journal of Mineralogy*, 28(6), 969–977.

Czochralskiite (IMA 2015-11) ideally  $\text{Na}_4\text{Ca}_3\text{Mg}(\text{PO}_4)_4$ , is the second new phosphate discovered in the Morasko IAB-MG iron meteorite, found in 1914 at the northern edge of the city of Poznań (Poland, 52°29'25.2"N; 16°53'25.9"E). The matrix of the Morasko iron is composed of kamacite (6.0–6.5 wt% Ni) and taenite (17–38 wt% Ni), associated with subordinate tetrataenite (~50 wt% Ni), phosphides (schreibersite and nickelporphide), carbide (cohenite), occasional sulfides (sphalerite and troilite), and rare altaite. Morasko contains also nodules (up to few centimeters in size) dominated by graphite and troilite. Czochralskiite was found in three of these graphite-bearing nodules, 1–3 mm in size, enclosed in the metal matrix. The nodules also contain schreibersite, cohenite, and a mutually intergrown phosphates: merrillite, brianite, and fluorapatite. Czochralskiite forms xenomorphic, usually oval and amoeboid aggregates, with individual grains ranging from 0.05 to 0.15 mm. No cleavage is observed. The mineral is brittle, with irregular, conchoidal fracture. The indentation hardness VHN = 403(18) kg/mm<sup>2</sup>, corresponding to a Mohs hardness of 4–5.  $D_{\text{calc}} = 3.14 \text{ g/cm}^3$ . Czochralskiite is colorless and non-pleochroic, transparent, with vitreous luster and white streak. It is optically biaxial (+),  $\alpha = 1.608(2)$ ,  $\beta = 1.611(2)$ ,  $\gamma = 1.616(2)$  (589 nm),  $2V_{\text{meas}} = 70(10)^\circ$ ,  $2V_{\text{calc}} = 76^\circ$ , dispersion (type not specified) is very weak. The orientation is  $X = \mathbf{a}$ ,  $Y = \mathbf{b}$ ,  $Z = \mathbf{c}$ . The Raman spectrum of czochralskiite shows bands related to four vibrational modes in an ideal  $(\text{PO}_4)^{3-}$  ion. The most intense bands (966, 974, and 986  $\text{cm}^{-1}$ ) correspond to the symmetrical stretching vibrations, resulting from three independent phosphate ions in the unit cell. The antisymmetrical stretching vibrations appear as six less intense bands at 1011, 1022, 1039, 1053, 1067, and 1119  $\text{cm}^{-1}$ , demonstrating the lowering of  $\text{PO}_4^{3-}$  symmetry. Antisymmetrical O-P-O bending modes are observed as five weak bands at 578, 585, 599, 606, and 616  $\text{cm}^{-1}$ , whereas the symmetrical analogs generate a band with a maximum at 441  $\text{cm}^{-1}$ , having shoulders at 415, 431, and 450  $\text{cm}^{-1}$ . The Raman study shows that  $\text{CO}_2$  is absent in the mineral. The average of 12 electron probe WDS analysis [wt% (range)] is:  $\text{P}_2\text{O}_5$  46.28 (44.68–46.86),  $\text{FeO}$  0.32 (0.08–1.55),  $\text{MnO}$  0.16 (0.00–0.31),  $\text{CaO}$  27.59 (26.8–28.04),  $\text{MgO}$  6.21 (6.12–6.30),  $\text{K}_2\text{O}$  0.09 (0.00–0.17),  $\text{Na}_2\text{O}$  20.04 (19.63–20.34), total 100.69. The empirical formula based on 16 O pfu, is  $\text{Na}_{3.97}\text{Ca}_{3.02}\text{Mg}_{0.95}\text{Mn}_{0.01}^{2+}\text{K}_{0.01}\text{Fe}_{0.03}^{2+}(\text{P}_{4.00}\text{O}_{16})$ . The strongest lines in the calculated X-ray powder diffraction pattern are [ $d_{\text{calc}}$ ,  $\text{Å}$  ( $J_{\text{calc}}\%$ ;  $hkl$ )]: 3.802 (48; 221), 3.728 (31; 401), 2.726 (100; 222), 2.679 (63; 040), 2.602 (83; 620), 1.901 (44; 442). X-ray diffraction intensity data was collected in one single crystal of  $0.10 \times 0.06 \times 0.04$  mm. The single crystal unit-cell parameters are:  $a = 17.9230(2)$ ,  $b = 10.7280(2)$ ,  $c = 6.7794(1)$   $\text{Å}$ ,  $V = 1303.53$   $\text{Å}^3$ , orthorhombic,  $Pnma$ ,  $Z = 4$ . The crystal structure of czochralskiite was refined to  $R_1 = 0.021$  for 3922 observed [ $I_0 > 2\sigma(I_0)$ ] reflections. The structure of czochralskiite is related to the structures of buchwaldite and brianite, where double layers of tetrahedra pseudo-hexagonally arranged hosting cation sites between them; divalent cations are arranged in columns of edge sharing polyhedra (CaCaCaCaCa... for buchwaldite and CaMgCaMg... in brianite). In czochralskiite both type of cations chains exist. These differences are related to the doubling or tripling  $c$  parameter in brianite and buchwaldite, respectively, with respect the  $c$  parameter of czochralskiite. The mineral is named in honor of Jan Czochralski (1885–1953), a noted Polish chemist, crystallographer and metallurgist, the inventor of the method of production of synthetic silicon crystals (known as Czochralski's method). The type material of czochralskiite is deposited in the Mineralogical Museum of the University of Wrocław, Poland, catalogue number MM UW r IV7870. F.C.

## ERAZOITE\*

J. Schlüter, T. Malcherek, C. Stanley, M. Dini, and A. Molina Donoso (2017) Erazoite, a new copper tin sulfide from the El Guanaco gold deposit, Antofagasta Province, Chile. *Neues Jahrbuch für Mineralogie–Abhandlungen*, 194/1, 91–96.

Erazoite (IMA 2014-061), ideally  $\text{Cu}_4\text{SnS}_6$ , a new hexagonal copper tin sulfide structurally related to covellite, was discovered at in the Chilena mine at the El Guanaco Au deposit (25°06'22"S 69°32'10"W), in the Atacama desert ~100 km ENE of Taltal, Antofagasta Province, Chile. The El Guanaco is an epithermal deposit rich in gold, copper, and arsenic, with a strong influence of meteoric waters. It is hosted by volcanic rocks composed of subalkaline dacites, andesites, basalts, and ignimbrites. The mineralization occurs in steeply dipping vuggy quartz veins with disseminated sulfides along vein borders. Ore minerals mostly represented by pyrite, chalcopyrite, enargite, and gold. Erazoite is enclosed in colorless euhedral baryte crystals up to 1.5 cm associated with alunite, jarosite, olivenite, and scorodite. El Guanaco is famous by secondary Cu-Al arsenates and sulfate mineralization. It is the type locality for ceruleite, guanacoite, lemanskiite, pharmacalumite, and schlossmacherite. In the holotype specimen, erazoite forms roundish black opaque aggregates up to 0.4 mm of fibrous, frequently radiating crystallites up to ~10  $\mu\text{m}$  wide closely intergrown with chalcopyrite, Sb- and Se-rich bismuthinite, goldfieldite, and enargite. Other minerals in the baryte crystals are covellite, tennantite, and a dull yellow earthy unknown (Sn-Fe-Cu-As) mineral (under investigation). Erazoite has a black streak and submetallic to metallic luster. The hardness estimated by the Kalb line method corresponds to ~3 of Mohs scale. The density was not measured due to small size of crystals;  $D_{\text{calc}} = 4.53 \text{ g/cm}^3$ . In reflected light erazoite is gray with no internal reflections observed. The reflectance data were measured in air from 400 to 700 nm with 20 nm intervals. The values for COM wavelengths ( $R_{\infty}$ ,  $R'_2$ , nm) are: 21.9, 27.8, **470**; 20.4, 26.8, **546**; 19.7, 27.2, **589**; 20.3, 30.3, **650**. The mineral is strongly birefractant and distinctly pleochroic from pinkish to gray (directions not specified). It is strongly anisotropic with characteristic orange-buff to deep red-brown to muddy green rotation tints. The average of 36 electron probe WDS analyses [wt% (range)] is: Cu 42.46 (41.87–43.47), Sn 20.99 (19.47–22.14), Fe 0.01 (0–0.29), In 0.26 (0.05–0.54), S 34.42 (33.96–34.90), total 98.14. The empirical formula based on 6 S pfu is  $\text{Cu}_{3.74}\text{Sn}_{0.99}\text{In}_{0.01}\text{S}_6$ . The strongest lines in the X-ray powder diffraction pattern [ $d$   $\text{Å}$  ( $P\%$ ;  $hkl$ )] are: 3.664 (8; 009), 3.265 (8; 101), 3.022 (100; 104), 1.999 (10; 1.0.13), 1.877 (47; 110), 1.667 (13; 119), 1.592 (12; 024). The unit-cell parameters refined from powder diffraction data are  $a = 3.756(8)$ ,  $c = 32.91(4)$   $\text{Å}$ ,  $V = 402.1$   $\text{Å}^3$ ,  $Z = 2$ . Erazoite is hexagonal, space group  $R\bar{3}m$ , by analogy with synthetic  $\text{Cu}_4\text{SnS}_6$  (ICSD 088972). No suitable crystals were found for single-crystal X-ray study. The crystal structure of the synthetic  $\text{Cu}_4\text{SnS}_6$  is composed of slabs of edge-sharing  $\text{SnS}_6$  octahedra sandwiched sharing corners between the sheets of  $\text{CuS}_4$ -tetrahedra. Those slabs are stacked along [001] and connected via S-S bonds. Some Cu occupies sites close to the center of opposite triangular faces of the  $\text{SnS}_6$  octahedra, which requires the center of that octahedron to be vacant. The resulting nearly planar  $\text{CuS}_3$  coordination with adjacent  $\text{CuS}_4$ -tetrahedra is similar to the covellite ( $\text{CuS}$ ) structure. The structure model suggests the substitution of one third of Sn atoms by pairs of Cu atoms. However, the EMPA results show that Cu-Sn substitution in erazoite is within of about 1 atom% and is equimolar. This might indicate that Sn/Cu substitution also affects the tetrahedrally coordinated Cu-sites. The only two other known natural ternaries in the system Cu–Sn–S, mohite  $\text{Cu}_2\text{SnS}_3$  and kuramite  $\text{Cu}_3\text{SnS}_4$  both have Sn in tetrahedral coordination. Erazoite is named for Gabriel Erazo Fernández (b. 1943) a mining engineer and mineralogist. He was professor of geology, crystallography, and metallurgy at Copiapo University and was the first director of the Mineralogical Museum of

Copiapó University from its opening in 1966 until 1991. The holotype specimen of erazoite has been deposited in the Mineralogical Museum of the University of Hamburg, Germany. **D.B.**

### HONEAITE\*

C.M. Rice, M.D. Welch, J.W. Still, A.J. Criddle, and C.J. Stanley (2017) Honeaite, a new gold-thallium-telluride from the Eastern Goldfields, Yilgarn Craton, Western Australia. *European Journal of Mineralogy*, 28(6), 979–990.

Honeaite, (IMA 2015-60), ideally  $\text{Au}_3\text{TlTe}_2$ , is a new mineral from the late Archaean Karonie gold deposit, Eastern Goldfields province, Western Australia. The gold deposits are predominantly hosted by quartz amphibolite and, in the northern part of the deposit, minor quartz–biotite-rich metasediments. The largest deposit, where honeaite was discovered, is the Main Zone orebody, which has a strike length of ~600 m and is ~40 m wide. Specimens containing honeaite came from borehole KD41 at 78 m, where the sequence is dominated by quartz amphibolite. The rock hosting honeaite consisting predominantly of randomly orientated sheaves of ferrohornblende and mosaic textured calcic plagioclase ( $\text{An}_{31}$ ) with small amounts of orientated ilmenite and pyrite and traces of zircon, and are widely albitized. Honeaite and other ore minerals form clouds of small (largest ~300  $\mu\text{m}$ , most <100  $\mu\text{m}$ ) inclusions roughly following the metamorphic banding, mainly within areas of prehnite alteration of amphibolite. Inclusions consist mainly of gold (low Ag) and tellurobismuthite with small amounts of molybdenite, petzite, hessite, calaverite, melonite, mattagamite, frobergite, altaite, pyrrhotite and honeaite. Honeaite is black with a metallic luster and no observed cleavage.  $D_{\text{calc}} = 11.18 \text{ g/cm}^3$ . In reflected light, honeaite is slightly bluish gray, very weakly bireflectant and very weakly pleochroic from gray to slightly bluish gray. The mineral does not show any internal reflections. Honeaite is weakly anisotropic with dark brown to dark blue rotation tints. Reflectance values were measured between 400 and 700 nm in 20 nm intervals. The values for (COM) wavelengths [ $R_{\text{min}}$ ,  $R_{\text{max}}$  % ( $\lambda$  in nm)] in air / oil are: 51.7, 50.9 / **37.6, 37.4** (470); 51.1, 51.3 / **36.7, 37.6** (546); 50.7, 51.8 / **36.3, 38.0** (589); 50.2, 51.2 / **35.5, 37.5** (650). The average of 17 electron probe WDS analyses is [wt% (range)]: Au 56.33 (55.75–56.88), Tl 19.68 (19.11–20.10), Te 24.30 (24.09–24.59), total 100.31. The empirical formula based on 2 Te pfu is  $\text{Au}_{3.00}\text{Tl}_{1.01}\text{Te}_{2.00}$ . The strongest reflections of the calculated powder X-ray diffraction pattern are [ $d_{\text{calc}}$  Å ( $I_{\text{calc}}$ %;  $hkl$ )]: 2.938 (100; 022), 2.905 (39.8; 322,411), 2.989 (31; 300), 2.833 (23; 310), 1.853 (17; 332). X-ray diffraction data yielded unit-cell parameters:  $a = 8.9671(4)$ ,  $b = 8.8758(4)$ ,  $c = 7.8419(5)$  Å,  $V = 624.14$  Å<sup>3</sup>, orthorhombic,  $Pbcm$ ,  $Z = 4$ . The crystal structure of honeaite was refined to  $R_1 = 0.033$ . The structure topology is completely novel and is composed of two components: corrugated double-sheets of six-membered rings of corner-linked  $\text{TeAu}_3$  pyramids, with Te and Au atoms located at apices, and Te having the one-sided threefold coordination that is characteristic of a stereoactive lone-pair; there is additional intrasheet connectivity via Au–Au bonds. The second component are rows of octahedrally coordinated Tl atoms lying in the grooves of the corrugated sheets. Connections between adjacent  $\text{TeAu}_3$  double-sheets involve only Tl–Au bonds. The mineral is named in honor of the late Russell M. Honea (1929–2002) who was a well-known mineralogist in the western U.S.A. and, indeed, globally. Honeaite appears to be identical to Unnamed Mineral 1993–27 Te:AuTl (Smith and Nickel, 2007). Holotype material is deposited in the Natural History Museum, London, catalogue number BM 2015, 36. **F.C.**

### Reference cited

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### LOBANOVITE\*

E. Sokolova, F. Cámara, F.C. Hawthorne, E.I. Semenov and M.E. Ciriotti (2017) Lobanovite,  $\text{K}_2\text{Na}(\text{Fe}_3^{2+}\text{Mg}_2\text{Na})\text{Ti}_2(\text{Si}_4\text{O}_{12})_2\text{O}_2(\text{OH})_4$ , a new mineral of the astrophyllite supergroup and its relation to magnesioastrophyllite. *Mineralogical Magazine*, 81(1), 175–181.

Lobanovite, ideally  $\text{K}_2\text{Na}(\text{Fe}_3^{2+}\text{Mg}_2\text{Na})\text{Ti}_2(\text{Si}_4\text{O}_{12})_2\text{O}_2(\text{OH})_4$  is a redefined mineral of the astrophyllite group. It was first noted as magnesium astrophyllite with 6.39 wt% MgO (Semenov 1959) with no other data. Later it was reported under the names monoclinic astrophyllite, magnesiumastrophyllite or magnesioastrophyllite (Peng and Ma 1963; Shi et al. 1998; Piilonen et al. 2003 and other papers), but has not been formally approved by the CNMNC, IMA. Based on this study the mineral has been revalidated, approved (CNMNC-IMA: Nomenclature voting proposal 15-B), and named after Konstantin V. Lobanov, a prominent Russian ore geologist who has worked in the Kola Peninsula for more than 40 years. Lobanovite was found in alkaline pegmatites at Mt. Yukspor, Khibiny massif, Kola Peninsula, Russia, in association with shcherbakovite, lamprophyllite, delindeite, wadeite, umbite, kostylevite, and others. It forms straw yellow to orange, elongated bladed crystals up to 0.04 mm wide and 0.2 mm long with a vitreous luster and a yellowish-white streak. The new mineral does not fluoresce. Mohs hardness is 3. Lobanovite has a perfect cleavage on {001}, moderate on {010}, and no parting. The density was not measured;  $D_{\text{calc}} = 3.161 \text{ g/cm}^3$ . The optical and DTA data were obtained on different specimen (X-ray Laboratory, Hubei Geological College 1974) shows lobanovite is optically biaxial (–),  $\alpha = 1.658$ ,  $\beta = 1.687$ ,  $\gamma = 1.710$  (589 nm).  $2V = 81.5$ – $83^\circ$ ;  $Y = \mathbf{b}$ ;  $Z \wedge \mathbf{a} = -5$  to  $-6^\circ$ . The pleochroism is  $X$  (bright yellow) >  $Y$  (pale yellowish gray) >  $Z$  (gray). The DTA curve shows endothermic peaks at 835 °C (strong, escape of OH) and at 900 °C (weak). The average of 10 point WDS electron probe analyses is [wt%, (range)]: Nb<sub>2</sub>O<sub>5</sub> 0.64 (0.29–1.22), TiO<sub>2</sub> 13.11 (12.47–13.48), SiO<sub>2</sub> 39.72 (39.43–39.92), Al<sub>2</sub>O<sub>3</sub> 0.24 (0.08–0.42), BaO 0.13 (0.04–0.19), FeO 18.86 (17.98–21.05), MnO 4.21 (3.10–4.59), CaO 0.65 (0.59–0.82), MgO 6.72 (6.05–6.93), K<sub>2</sub>O 7.66 (7.54–7.78), Na<sub>2</sub>O 4.22 (4.10–4.29), F 0.29 (0.17–0.43), H<sub>2</sub>O (by structure refinement) 3.00, –O=F<sub>2</sub> 0.12, total 99.33. The empirical formula based on 30 (O+OH) plus 0.2 F apfu is  $(\text{K}_{1.97}\text{Ba}_{0.01})_{\Sigma 1.98}(\text{Na}_{0.65}\text{Ca}_{0.14})_{\Sigma 0.79}(\text{Fe}_{3.18}^{2+}\text{Mg}_{2.02}\text{Nb}_{1.00}\text{Mn}_{0.72})_{\Sigma 6.92}(\text{Ti}_{1.99}\text{Nb}_{0.06})_{\Sigma 2.05}[(\text{Si}_{8.01}\text{Al}_{0.06})_{\Sigma 8.07}\text{O}_{24}]\text{O}_2(\text{OH})_{4.03}\text{F}_{0.19}$ . The strongest lines of the powder X-ray diffraction pattern are [ $d$  Å (%;  $hkl$ )]: 3.38 (100; 003), 2.548 (90; 063), 10.1 (80; 001), 3.80 (60; 042,131), 3.079 (50; 132,062), 2.763 (90;  $\bar{1}71$ ). The crystal structure was refined to  $R = 3.2\%$  based on 1861 unique  $F_o > 4\sigma F$  reflections. The mineral is monoclinic,  $C2/m$ ,  $a = 5.3327(2)$ ,  $b = 23.1535(9)$ ,  $c = 10.3775(4)$  Å,  $\beta = 99.615(1)^\circ$ ,  $V = 1263.3$  Å<sup>3</sup>, and  $Z = 2$ . The general topology of the structure is in accord with Shi et al. (1998). The main structural unit is the HOH block, consisting of one close-packed octahedral (O) and two heteropolyhedral (H) sheets. The  $M(1-4)$  octahedra form the O sheet and the T<sub>4</sub>O<sub>12</sub> astrophyllite ribbons and [5]-coordinated Ti-dominant D polyhedra link through common vertices to form the H sheet. The HOH blocks repeat along [001], and K and Na atoms occur at the interstitial A and B sites. The topology of the HOH block in lobanovite differs from all other structures of the astrophyllite supergroup minerals due to the composition of the O sheet,  $\text{Fe}_3^{2+}\text{Mg}_2\text{Na}$ , where Na<sup>+</sup> is dominant at the  $M(1)$  site. Hence the Na octahedron is too large to share edges with Si<sub>2</sub>O<sub>7</sub> groups of astrophyllite ribbons resulting in a different linkage of H and O sheets. The crystal structure and the chemical data were obtained on the same crystal taken from the specimen of delindeite #6270 in the collection of Adriana and Renato Pagano, Milan, Italy. This crystal is considered as holotype and is deposited in the Fersman Mineralogical Museum Russian Academy of Sciences, Moscow, Russia. **Yu.U. and D.B.**

**Comment:** The mineral is widely distributed in Khibiny alkaline massif, mostly in rischorrite pegmatites related to the ijolite-urtite arc with apatite deposits. Sometimes it forms pseudomorphs after



aegirine-diopside but most commonly occurs as scaly aggregates up to 15 cm with the very specific bronze-green color. Its physical, including optical properties, chemical composition, density, IR spectra, etc., were described in detail (under the name magnesioastrophyllite) for the different morphological varieties and associations (Kostyleva et al. 1978).

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## MAGNESIOVOLTAITE\*

- N.V. Chukanov, S.M. Aksenov, R.K. Rastsvetaeva, G. Möhn, V.S. Rusakov, I.V. Pekov, R. Scholz, T.A. Eremina, D.I. Belakovskiy and J.A. Lorenz (2017) Magnesiovoltaite,  $K_2Mg_3Fe_3^{3+}Al(SO_4)_{12} \cdot 18H_2O$ , a new mineral from the Alcaparrosa mine, Antofagasta region, Chile. *European Journal of Mineralogy*, 28, 1005–1017.

Magnesiovoltaite, (IMA 2015-95), ideally  $K_2Mg_3Fe_3^{3+}Al(SO_4)_{12} \cdot 18H_2O$ , is a new voltaite-group mineral, discovered in the Alcaparrosa mine, Cerro Alcaparrosa, El Loa province, Antofagasta region, Chile. The Alcaparrosa polymetallic sulfide deposit consists of a series of iron sulfate veins and lenses of varying strikes and dips, hosted in volcanic rocks of the Punta del Cobre Formation composed mainly of massive andesitic and dacitic rocks. Magnesiovoltaite occurs in two mineral assemblages: as crystals growing on coquimbite, associated with tamarugite, alum-(Na), rhombochalcite, yavapaiite, voltaite, and opal; as yellow crystals overgrowing a matrix mainly consisting of botryogen and opal with tamarugite, alum-(K), pickeringite, magnesiocopiapite, and jarosite or natrojarosite. Magnesiovoltaite forms transparent amber-yellow to brownish-yellow or pale yellow to pale yellowish-greenish, sometimes almost colorless isometric crystals up to 2 mm across in cavities of aggregates of other sulfate minerals. The main crystal forms are {111}, {100}, and {110}. Magnesiovoltaite is brittle, with subconchoidal fracture. Neither cleavage nor parting is observed. Mohs hardness is  $2\frac{1}{2}$ .  $D_{meas} = 2.51(2)$  g/cm<sup>3</sup> (by heavy liquids),  $D_{calc} = 2.506$  g/cm<sup>3</sup>. The new mineral is non-fluorescent under short- and long-wave UV light. In transmitted light magnesiovoltaite is colorless, non-pleochroic and, despite the cubic symmetry, show quite noticeable anisotropy: largest grains often show conoscopic figures of a negative uniaxial crystal with  $\epsilon = 1.584(2)$  and  $\omega = 1.588(2)$  (589 nm); some smallest fragments show biaxial (–)  $\alpha = 1.584(2)$ ,  $\beta = 1.587(2)$ , and  $\gamma = 1.588(2)$  (with weak to medium dispersion of optical axes,  $r > v$ ) and  $2V_{calc} = 60^\circ$ . The FTIR spectrum of magnesiovoltaite is similar to the one of voltaite: (cm<sup>-1</sup>): s = strong band, w = weak band, sh = shoulder) 3565sh, 3480sh, 3441, 3134 (3070sh) (O–H stretching of H<sub>2</sub>O), 2496w (O–H stretching of HSO<sub>4</sub> groups), 1684w, 1640sh, 1624 (bending of H<sub>2</sub>O), 1168s, 1133s, 1067s [ $\nu_3(F_2) =$  asymmetric stretching vibrations of SO<sub>4</sub><sup>2-</sup> anions], 1011s, 995sh [ $\nu_1(A_1) =$  symmetric stretching of SO<sub>4</sub><sup>2-</sup>], 876w, 718sh (possibly, M···O–H bending combined with overtones of M···O stretching), 660sh, 629, 596 [ $\nu_4(F_2) =$  bending of SO<sub>4</sub><sup>2-</sup>], 440 [Fe<sup>3+</sup>···O stretching and/or  $\nu_2(E)$  bending mode of SO<sub>4</sub><sup>2-</sup>]. The average of an unreported number of electron probe EDS analyses is [wt% (range)]: Na<sub>2</sub>O 0.13

(0–0.25), K<sub>2</sub>O 4.64 (4.43–4.77), MgO 9.13 (8.52–9.73), MnO 1.73 (1.64–1.94), ZnO 0.84 (0.53–1.22), Al<sub>2</sub>O<sub>3</sub> 2.47 (2.23–2.84), Fe<sub>2</sub>O<sub>3</sub> (by Mossbauer) 13.36 (12.96–13.68), SO<sub>3</sub> 50.83 (50.34–51.38), H<sub>2</sub>O 17.6 ± 0.5 (by gas chromatography), total 100.73. The empirical formula based on 66 O pfu is (K<sub>1.85</sub>Na<sub>0.08</sub>)(Mg<sub>4.25</sub>Mn<sub>0.46</sub>Zn<sub>0.14</sub>)Fe<sub>3.14</sub>Al<sub>0.91</sub>(SO<sub>4</sub>)<sub>11.91</sub>(H<sub>2</sub>O)<sub>18.325</sub>O<sub>0.03</sub>. The strongest reflections of the calculated powder X-ray diffraction pattern are [*d* Å (%; *hkl*)]: 9.56 (29; 022), 6.77 (37; 004), 5.53 (61; 224), 3.532 (68; 137), 3.392 (100; 008), 3.034 (45; 048), 2.845 (30; 139). The unit cell parameter refined from powder data is  $a = 27.17(1)$  Å,  $V = 20057$  Å<sup>3</sup>. X-ray diffraction data on an anhedronal crystal of 0.13 × 0.13 × 0.17 mm yielded unit-cell parameter:  $a = 27.161(1)$  Å,  $V = 20037$  Å<sup>3</sup>, cubic,  $F\bar{4}3c$ ,  $Z = 16$ . The crystal structure was refined to  $R_1 = 0.0321$  for 1147 independent reflections with  $I > 2\sigma(I)$ . The magnesiovoltaite is isostructural with other members of the voltaite group. Based on the refined site-scattering factors, the crystal-chemical formula of magnesiovoltaite can be written as follows ( $Z = 16$ ):  $A(K_{1.85}Na_{0.1})[(Al_{0.95}Fe_{0.1}^{3+})(H_2O)_6]\{[M^{(1)}(Mg_{4.3}(Fe^{3+}, Mn, Zn)_{1.7}(H_2O)_{12}]^{M(2)}Fe_3^{3+}(SO_4)_{12}]\}$ , where the composition of the heteropolyhedral framework is put in figure brackets. The mineral is named as an analog of voltaite and zincvoltaite with Mg dominant at the M1. The holotype and cotype specimens are deposited in the collections of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. F.C.

## ODIGITRIAITE\*

- A.A. Agakhanov, L.A. Pautov, E. Sokolova, F.C. Hawthorne, V.Yu. Karpenko, O.I. Siidra and V.A. Muftakhov (2017) Odigitriaite, CsNa<sub>5</sub>Ca<sub>5</sub>[Si<sub>14</sub>B<sub>2</sub>O<sub>38</sub>]F<sub>2</sub>, a new caesium borosilicate mineral from the Darai-Pioz alkaline massif, Tajikistan: Description and crystal structure. *Mineralogical Magazine*, 81(1), 113–122.

Odigitriaite (IMA 2015-028), ideally CsNa<sub>5</sub>Ca<sub>5</sub>[Si<sub>14</sub>B<sub>2</sub>O<sub>38</sub>]F<sub>2</sub>, was discovered in the moraine adjacent to the Darai-Pioz alkaline massif in the upper reaches of the Darai-Pioz river at the joint of Turkestan, Zeravshan and Alay mountain ridges, Tajikistan. The name originates from the Greek Οδηγήτρια, meaning “she who shows the way,” it was named odigitriaite to emphasize the role of Cs as a major indicator of extreme fractionation. Odigitriaite was discovered in cobbles and boulders of anhedronal quartz range in size from 5 to 80 cm, which contain inclusions of slightly deformed stacks of polythionite, crystals of pale-green to white microcline, patches of pale-pink reedmergerite, randomly distributed black idiomorphic crystals of aegirine, rare red-brown translucent crystals of stillwellite-(Ce), grass-green translucent to transparent crystals of leucosphenite, violet-pink plates of sogdianite, dark-green crystals of turkestanite and brown patches (up to 30 cm) of pectolite. Odigitriaite occurs in these pectolite brown patches associated with Sr-rich fluorite, pekovite, mendeleevite-(Ce), orlovite, kirchhoffite, neptunite, zeravshanite, senkevichite, nordite-(Ce), alamosite, hyalotekite, and khvorovite. It forms irregular elongated grains up to 100 μm. Odigitriaite is colorless, translucent, with a white streak and a vitreous luster. It does not fluoresce under the UV light. Odigitriaite has a perfect cleavage on {001} with no parting. It is brittle with an uneven fracture. Indentation hardness VHN<sub>50</sub> = 606 (560–65) kg/mm<sup>2</sup> corresponds to Mohs hardness of 5.  $D_{meas} = 2.80(2)$  and  $D_{calc} = 2.830$  g/cm<sup>3</sup>. In transmitted light the mineral is colorless, non-pleochroic. It is optically biaxial (–),  $\alpha = 1.502(2)$ ,  $\beta = 1.564(2)$ ,  $\gamma = 1.576(2)$  (589 nm);  $2V_{obs} = 46(2)^\circ$ , dispersion of optical axes is weak  $r > v$ . The average of 10 point EDS (WDS for B and F) electron probe analyses is [wt% (range)]: SiO<sub>2</sub> 55.30 (54.34–56.36), Y<sub>2</sub>O<sub>3</sub> 0.44 (0–1.21), Al<sub>2</sub>O<sub>3</sub> 0.09 (0–1.21), B<sub>2</sub>O<sub>3</sub> 4.75 (4.33–5.06), PbO 0.21 (0.08–0.42), FeO 0.10 (0–0.22), MnO 0.94 (0.48–1.34), CaO 17.37 (16.80–17.92), Cs<sub>2</sub>O 8.36 (7.85–9.00), K<sub>2</sub>O 0.01 (0–0.06), Na<sub>2</sub>O 10.49 (10.07–10.89), F 1.74 (1.64–1.79), H<sub>2</sub>O (by structure refinement) 0.37, –O=F<sub>2</sub> 0.74, total 99.43. The empirical formula based on total of 40

anions with  $(F+OH) = 2$  apfu is  $Ca_{0.90}Na_{5.12}Mn_{0.20}Y_{0.06}Fe_{0.02}Pb_{0.01}[Si_{13.92}Al_{0.03}B_{2.06}O_{38}]F_{1.39}(OH)_{0.62}$ . Powder X-ray diffraction data were not collected due to the paucity of the material but the three-dimensional diffraction data were collapsed into two directions to be representative of the chemical composition and crystal structure of the new mineral. The strongest lines of the diffraction pattern are [ $d \text{ \AA}$  ( $I\%$ ;  $hkl$ )]: 5.45 (25; 113), 4.66 (33; 311), 4.40 (26; 022), 4.10 (36;  $\bar{3}13$ ), 3.95 (25; 313), 2.85 (31; 222), 2.68 (40; 006), 3.62 (45; 024), 3.35 (100;  $\bar{2}24$ ), 3.31 (30;  $\bar{3}15$ ), 3.25 (35; 404), 3.04 (60;  $\bar{4}22$ ), 2.925 (22;  $\bar{4}23$ ), 1.813 (23; 910). The crystal structure of odigitriaite was solved by direct methods and refined to  $R = 2.75\%$ . The new mineral is monoclinic,  $C2/c$ ,  $a = 16.652(5)$ ,  $b = 9.598(3)$ ,  $c = 22.120(7)$  \AA,  $\beta = 92.875(14)^\circ$ ,  $V = 3530.9 \text{ \AA}^3$ , and  $Z = 4$ . The crystal structure of odigitriaite is based on a double-layer sheets of  $[SiO_4]$  and  $[(B,Si)O_4]$  tetrahedra. Cs and Na are intercalated within the double-layer sheet, and the double layers are linked by interstitial Ca and Na atoms. The holotype specimen was deposited in the Fersman Mineralogical Museum, Russian Academy of Science, Moscow, Russia. **Yu.U.**

### ROMANORLOVITE\*

- I.V. Pekov, V.O. Yapaskurt, S.N. Britvin, M.F. Viganina, I.S. Lykova, N.V. Zubkova, S.V. Krivovichev and E.G. Sidorov (2016) Romanorlovite, a new copper and potassium hydroxychloride from the Tolbachik volcano, Kamchatka, Russia. *Zapiski Rossiyskogo Mineralogicheskogo Obshchestva*, 145(2), 44–58.
- N.V. Zubkova, S.V. Krivovichev, I.V. Pekov, A.A. Zolotarev Jr., D.Yu. Pushcharovsky and E.G. Sidorov (2016) Crystal structure and comparative crystal chemistry of romanorlovite. *Zapiski Rossiyskogo Mineralogicheskogo Obshchestva*, 145(4), 36–46.

Romanorlovite (IMA 2014-011), is a new tetragonal K–Cu hydroxychloride with simplified chemical formula  $K_{11}Cu_9Cl_{25}(OH)_4 \cdot 2H_2O$ . It was discovered in upper, moderately hot zones of two fumaroles, Glavnaya Tenoritovaya and Arsenatnaya, at the Second scoria cone of the Northern Breakthrough of the Great Tolbachik Fissure Eruption, Tolbachik volcano, Kamchatka, Russia. The association in the Arsenatnaya fumarole includes avdoninite along with earlier crystallized hematite, pseudobrookite, clinooenstatite, diopside, anhydrite, powellite and baryte. In Glavnaya Tenoritovaya the mineral is associated with avdoninite, belloite, sylvite, carnallite, mitscherlichite, sanguite, chlorothionite, eriochalcite, chrysothallite and mellizinkalite. Romanorlovite forms yellow-brown to dark brown prismatic, equant or tabular tetragonal crystals up to 0.1 mm (tiny crystals are honey- or golden-yellow) with main forms  $\{100\}$ ,  $\{110\}$ , and  $\{001\}$ , crystal clusters up to 0.5 mm and crusts up to  $2 \times 2$  mm in area. The mineral is transparent, vitreous with a yellow streak. Cleavage was not observed. Romanorlovite is brittle with Mohs hardness of  $\sim 3$ .  $D_{\text{meas}} = 2.61(1)$ ;  $D_{\text{calc}} = 2.72\text{--}2.79 \text{ g/cm}^3$  depending on Pb content. Significantly lower value of measured density is due to the porous nature of the crystals. Placed into the water at room temperature romanorlovite hydrolyzes in a first few seconds (grains becoming dull) and then easily dissolves. In transmitted plane-polarized light the mineral is yellow-brown, non-pleochroic. It is optically uniaxial (–),  $\omega = 1.727(3)$ ,  $\epsilon = 1.694(2)$  (589 nm). The Raman spectrum shows maxima ( $\text{cm}^{-1}$ ) at 3512 (O–H stretching vibrations of OH groups), 3440 (O–H stretching of  $H_2O$  molecules), 931 and 879 (bending vibrations  $Cu^{2+} \cdots O-H$ , 548 and 477 (most likely libration vibration of  $H_2O$ ), 290 ( $Cu^{2+}$ –O stretching). Strong bands below  $280 \text{ cm}^{-1}$  are assigned to stretching vibrations of  $Cu^{2+}$ –Cl, K–Cl and to lattice modes. The absence of H–O–H bending vibration bands between 1500 and  $1700 \text{ cm}^{-1}$  is explained by symmetrical position of  $H_2O$ . The average of 9 electron probe WDS analyses on the holotype specimen is [(wt% (range)): K 21.52 (20.24–23.17), Pb 0.89 (0–1.69), Cu 28.79 (26.82–30.64), Zn 0.02 (0–0.12), Cl 44.74 (42.72–46.97),

$O_{\text{calc}} 4.85$ ,  $H_{\text{calc}} 0.41$  (both by structure refinement), total 101.22. The empirical formula calculated based on 25 Cl and  $(OH)_4(H_2O)_2$  pfu is:  $K_{10.90}Pb_{0.09}Cu_{8.97}Zn_{0.01}Cl_{25}(OH)_4 \cdot 2H_2O$ . The strongest reflections of the powder XRD pattern [ $d \text{ \AA}$  ( $I\%$ ;  $hkl$ )] are: 12.48 (56; 110), 11.74 (36; 101), 8.80 (100; 200), 7.97 (34; 002), 6.71 (40; 112), 3.165 (32; 512), 2.933 (80; 215,433), 2.607 (38; 514). Unit cell parameters refined from the powder XRD (holotype) are:  $a = 17.585(3)$ ,  $c = 15.912(3)$  \AA,  $V = 4920 \text{ \AA}^3$ , space group  $I4/mmm$ . Single-crystal unit-cell parameters are:  $a = 17.5804(7)$ ,  $c = 15.9075(6)$  \AA,  $Z = 4$ ,  $V = 4916.5 \text{ \AA}^3$ . The crystal chosen for single-crystal study is enriched with Pb and has unit-cell parameters  $a = 17.5538(19)$ ,  $c = 15.8620(17)$  \AA,  $V = 4887.7 \text{ \AA}^3$ . The crystal structure was refined to  $R = 5.49\%$  for 769 unique  $I > 2\sigma(I)$  reflections. The structure is based on two main blocks built by  $Cu^{2+}$ -centered polyhedra. The first one includes chains consisting of edge-sharing  $CuCl_4(OH)_2$  octahedra. In the chain a fragment built by four edge-sharing Cu(1)-centered octahedra could be distinguished whereas Cu(2)-centered octahedra are connected with this fragment from both upper and lower sides. The second structural block consists of isolated  $Cu_6Cl_{18}$  clusters built by Cu(3)-centered tetragonal pyramids and Cu(4)-centered distorted tetrahedra. In a core of the cluster  $Cu^{2+}$  and  $Pb^{2+}$  cations statistically replacing each other in the same site. These basic structural blocks are connected via distorted  $ACl_6$  octahedra ( $A = Cu, K$ ) forming pseudo-framework.  $K^+$  cations are located in the voids and channels of the pseudo-framework. Various defects in the structure are discussed. The crystal-chemical formula of romanorlovite is  $K_{22}(K,Pb)_{16}(K,Cu,\square)_8Cu_{28}(\square,Cu)_{16}(\square,Cu,Pb)_2Cl_{92}(Cl,\square)_8(Cl,\square)_8(OH)_{16} \cdot 8H_2O$  ( $Z = 1$ ). The mineral is named in honour of the Russian mineralogist and physicist Roman Yu. Orlov (1929–2005) who worked in Department of Mineralogy of Moscow State University. The holotype specimen has been deposited in the Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow, Russia. **D.B.**

### TATARINOVITE\*

- N.V. Chukanov, A.V. Kasatkin, N.V. Zubkova, S.N. Britvin, L.A. Pautov, I.V. Pekov, D.A. Varlamov, Ya.V. Bychkova, A.B. Loskutov and E.A. Novgorodova (2016) Tatarinovite  $Ca_3Al(SO_4)[B(OH)_4](OH)_6 \cdot 12H_2O$ , a new ettringite-group mineral from the Bazhenovskoe deposit (the Middle Urals, Russia) and its crystal structure. *Geology of Ore Deposits*, 58, 653–665.

Tatarinovite (IMA 2015-055), is a new hexagonal member of the ettringite group with an ideal chemical formula  $Ca_3Al(SO_4)[B(OH)_4](OH)_6 \cdot 12H_2O$ . It has been discovered at the Bazhenovskoe chrysotile asbestos deposit (near the town of Asbest, Middle Urals, Russia) in the cavities of rodingite body  $\sim 1.5$  m thick and a few hundred meters long at the contact between the dike of partly rodingitized gabbroic rock and hosting serpentinite. Rodingite consist mostly of grossular, diopside, and clinocllore with some vesuvianite, clinzoisite, prehnite, tremolite, serpentine, and calcite. In peripheral part of rodingite body tatarinovite forms colorless, vitreous, dipyrmidal  $\{104\}$  crystals up to 1 mm (0.5 mm in average) in cavities within massive diopside, in association with xonotlite, clinocllore, pectolite, and calcite. Both in periphery and in central part of rodingite body tatarinovite also found as white granular sugary aggregates up to 5 mm on grossular with pectolite, diopside, calcite, and xonotlite. The mineral has a white streak, perfect cleavage on  $\{100\}$  and Mohs hardness  $\sim 3$ ;  $D_{\text{meas}} = 1.79(1)$  and  $D_{\text{calc}} = 1.777 \text{ g/cm}^3$ . The fluorescence in UV light was not observed. In transmitted light tatarinovite is colorless, non-pleochroic. It is optically uniaxial (+),  $\omega = 1.475(2)$ ,  $\epsilon = 1.496(2)$  (589 nm). The IR spectrum contains the ( $\text{cm}^{-1}$ , s = strong, w = weak, sh = shoulder): 3614s, 3495sh, 3460sh, 3425s, 3240sh (O–H stretching vibrations of  $H_2O$  and OH groups), 2420w, 2252w (O–H stretching of  $HSO_4^-$  groups), 1686 ( $H_2O$  bending), 1403s (asymmetric stretching of  $CO_3^{2-}$ ), 1227w,

1195sh (B–O bending of B(OH)<sub>3</sub> and B(OH)<sub>4</sub>), 1114s (asymmetric bending of SO<sub>4</sub><sup>2-</sup>), 991, 953 (B–O stretching and B–O–H bending vibrations of B(OH)<sub>4</sub>), 879 (out of plane bending vibrations of CO<sub>3</sub><sup>2-</sup>), 720sh [Si–O stretching in Si(OH)<sub>6</sub> octahedra], 675s, 645sh, 595 (SO<sub>4</sub><sup>2-</sup> bending), 555 [Al–O stretching in Al(OH)<sub>6</sub> octahedra], 501 [O–Si–O bending of Si(OH)<sub>6</sub>], 417 [O–Al–O bending of Al(OH)<sub>6</sub>]. Quantitative electron probe analysis was not performed due to instability of the mineral under the beam. Semiquantitative analysis show the presence only B, Ca, Al, Si, S, and minor Fe in detectable amounts. The chemical composition (ICP-AES) of tatarinovite [wt% (range)] is: CaO 27.40 (27.12–27.67), B<sub>2</sub>O<sub>3</sub> 4.06 (4.04–4.07), Al<sub>2</sub>O<sub>3</sub> 6.34 (6.23–6.44), Fe<sub>2</sub>O<sub>3</sub> 0.03 (0.03–0.03), SiO<sub>2</sub> 2.43 (2.34–2.52), SO<sub>3</sub> 8.48 (8.46–8.49), CO<sub>2</sub> 4.2 (3.9–4.5)\*, H<sub>2</sub>O 46.1(2)\*, total 99.04 (\* = determined by selective sorption of gaseous products of annealing). The empirical formula based on 3 Ca pfu is: H<sub>31.41</sub>Ca<sub>3.00</sub>(Al<sub>0.76</sub>Si<sub>0.25</sub>)<sub>Σ1.01</sub>(B<sub>0.72</sub>S<sub>0.65</sub>C<sub>0.59</sub>)<sub>Σ1.96</sub>O<sub>24.55</sub>. The strongest reflections of the powder X-ray diffraction pattern [*d* Å (*I*%; *hkl*)] are: 9.63 (100; 100), 5.556 (30; 110), 4.654 (14; 102), 3.841 (21; 112), 3.441 (12; 211), 2.746 (10; 302), 2.538 (12; 213). The unit-cell parameters refined from the powder XRD data are: *a* = 11.116(1) Å, *c* = 10.626(5) Å, *V* = 1137.1 Å<sup>3</sup>. The single-crystal unit-cell parameters are: *a* = 11.1110(4) Å, *c* = 10.6294(6) Å, *V* = 1136.44 Å<sup>3</sup>, *Z* = 2, space group *P*6<sub>3</sub>. The crystal structure solved by direct methods and refined to *R*<sub>1</sub> = 0.0252 for 9846 *I* > 2σ(*I*) reflections. Tatarinovite is the structural analog of thaumasite with Al dominating over Si in octahedral position. Its structure is based on infinite columns along *c* axis with composition of [Ca<sub>3</sub>(Al,Si)(OH,O)<sub>6</sub>(H<sub>2</sub>O)<sub>12</sub>] consisting of octahedra [(Al,Si)(OH,O)<sub>6</sub>] and polyhedra Ca(OH)<sub>4</sub>(H<sub>2</sub>O)<sub>4</sub>. In thaumasite those columns are connected by a hydrogen bonds with groups (SO<sub>4</sub>)<sup>2-</sup> and (CO<sub>3</sub>)<sup>2-</sup> which are alternating along *c* axes and are completely ordered. In tatarinovite anions (SO<sub>4</sub>)<sup>2-</sup>, [B(OH)<sub>4</sub>]<sup>-</sup>, (CO<sub>3</sub>)<sup>2-</sup> and, in one position, B(OH)<sub>3</sub> are also between columns but strongly disordered. The sites occupied by S and C atoms in thaumasite in tatarinovite occupied by S, B, and C with statistical distribution leading to the crystal-chemical formula: Ca<sub>3</sub>(Al<sub>0.70</sub>Si<sub>0.30</sub>)<sub>Σ1.00</sub>{[SO<sub>4</sub>]<sub>0.34</sub>[B(OH)<sub>4</sub>]<sub>0.33</sub>[CO<sub>3</sub>]<sub>0.24</sub>}{[SO<sub>4</sub>]<sub>0.30</sub>[B(OH)<sub>4</sub>]<sub>0.34</sub>[CO<sub>3</sub>]<sub>0.30</sub>[B(OH)<sub>3</sub>]<sub>0.06</sub>}(OH<sub>5.75</sub>O<sub>0.27</sub>)·12H<sub>2</sub>O. Tatarinovite was named in honor of the Russian geologist and petrologist Pavel Mikhailovich Tatarinov (1895–1976), a well-known specialist in deposits of chrysotile asbestos. Type specimens are deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **D.B.**

### ZINCOMENITE\*

I.V. Pekov, N.V. Zubkova, V.O. Yapaskurt, S.N. Britvin, N.V. Chukanov, I.S. Lykova, E.G. Sidorov and D.Y. Pushcharovsky (2016) Zincomenite, ZnSeO<sub>3</sub>, a new mineral from the Tolbachik volcano, Kamchatka, Russia. *European Journal of Mineralogy*, 28(5), 997–1004.

Zincomenite (IMA 2014-014), β-ZnSeO<sub>3</sub>, a new orthorhombic zinc selenite, was discovered in active fumaroles at the Northern fumarole field, First scoria cone, Northern Breakthrough of the Great Tolbachik Fissure Eruption, Tolbachik Volcano, Kamchatka, Russia. The mineral was found at 0.1–0.3 m depth from the surface where the temperatures during collecting were 180–200 °C. It occurs in white to gray sublimate incrustations mainly consist of sellaite, fluorite, halite, and anhydrite. Common minerals on that crust are cotunnite, sofiite, and flinteite. Subordinate minerals are anglesite, chubarovite, challacolloite, olsacherite, saltonseaitite, hollandite, bixbyite, jacobssonite, sylvite, hematite, and baryte. In upper part of the fumarole cryobostyrite, leonardsenite, ralstonite, gypsum, vernadite, and opal are formed as products of the supergene alteration of sublimate minerals. Zincomenite forms tabular, equant or prismatic crystals up to 0.2 mm sometimes combined in dense crystal clusters up to 0.3 mm across, chain-like crystal groups up to 0.35 mm long, or interrupted incrustations up to

0.7 × 1 cm overgrowing basalt scoria. Partial to complete pseudomorphs of zincomenite after sofiite are typical. The crystal forms are {101}, {010}, {100}, and {013}. T-shaped twins with (012) as twin plane were found. Zincomenite is transparent, colorless (in separate crystals), white or pale beige (in aggregates) with white streak and adamantine luster. The fluorescence under UV radiation or electron beam was not observed. It is brittle with an uneven fracture. Cleavage and parting were not observed. Mohs hardness and density were not measured due to the size of the crystals; *D*<sub>calc</sub> = 4.760 g/cm<sup>3</sup>. In transmitted light zincomenite is colorless, non-pleochroic. It is optically biaxial (–), *α* = 1.744(5), *β* = 1.860(5), *γ* = 1.875(5) (589 nm), 2*V* was estimated as medium; 2*V*<sub>calc</sub> = 38°. Optical orientation is not given. Dispersion of the optical axes was not observed. Due to the insufficient amount of material, scattering, and atmospheric noise the IR spectrum of acceptable quality was obtained only in the region below 1800 cm<sup>-1</sup>. The spectrum of zincomenite is close to that of its synthetic analog. The absorption bands (cm<sup>-1</sup>, s = strong, w = weak) are: 845, 826, 818, 758, 724s, 697s (stretching vibrations of SeO<sub>3</sub><sup>2-</sup>), 532, 483w (bending vibrations of SeO<sub>3</sub><sup>2-</sup> possibly combined with stretching vibrations of ZnO<sub>3</sub> polyhedra). Bands due to SeO<sub>4</sub><sup>2-</sup> are not observed and the absence of absorptions in the range 900–1800 cm<sup>-1</sup> indicates the absence of O–H, C–O, and B–O covalent bonds. The average of 5 electron probe WDS analysis [wt% (range)] is: ZnO 42.53 (42.08–43.15), SeO<sub>2</sub> 56.67 (55.49–57.58), total 99.20. The empirical formula calculated on the basis of 3 O pfu is: Zn<sub>1.02</sub>Se<sub>0.99</sub>O<sub>3</sub>. The strongest reflections of the powder X-ray diffraction pattern [*d* Å (*I*%; *hkl*)] are: 4.612 (26; 102), 3.601 (77; 200), 3.119 (48; 210), 3.048 (38; 113), 3.014 (100; 211,021), 2.996 (56; 004), 2.771 (19; 123,104,212), 2.459 (23; 213,023), 2.311 (20; 123,221,204), 2.162 (19; 214,024). The orthorhombic unit-cell parameters refined from the powder data are: *a* = 7.199(1), *b* = 6.238(1), *c* = 12.006(2) Å, *V* = 539.2 Å<sup>3</sup>. The single-crystal unit-cell parameters are: *a* = 7.1971(2), *b* = 6.2320(2), *c* = 11.9914(3) Å, *V* = 537.84 Å<sup>3</sup>, *Z* = 8, space group *P*bca. The crystal structure was solved by direct methods and refined to *R* = 0.0188 for 786 independent *I* > 2σ(*I*) reflections. Zincomenite is a representative of the CuSeO<sub>3</sub> structure type. The crystal structure contains layers formed by Zn<sub>2</sub>O<sub>8</sub> dimers (consisting of edge-sharing ZnO<sub>3</sub> trigonal bipyramids; each dimer shares four vertices with the neighboring ones) linked via (SeO<sub>3</sub>)<sup>2-</sup> groups (with Se<sup>4+</sup> in trigonal pyramidal coordination) to form an open framework. β-ZnSeO<sub>3</sub> is the high-temperature modification and can be obtained from α-ZnSeO<sub>3</sub> by heating that to 285 °C. The reverse transformation from beta- to alpha-form of ZnSeO<sub>3</sub> does not occur, i.e., both synthetic α-ZnSeO<sub>3</sub> and zincomenite are stable at room temperature. The stability field of β-ZnSeO<sub>3</sub> extends until ~450 °C. Zincomenite could be deposited directly from the gas phase as a volcanic sublimate (well-shaped crystals). Alternatively the new mineral (or its hypothetic proto-phase α-ZnSeO<sub>3</sub>, if the process was occurring at a temperature lower than ca. 280 °C) could be formed as the result of the reaction between fumarole gases and sofiite Zn<sub>2</sub>(SeO<sub>3</sub>)Cl<sub>2</sub> (pseudomorphs). The mineral is named in allusion to its chemical composition: zinc selenite (the Greek μῆνας means moon, indicating selenium). The type specimen have been deposited to the Fersman Mineralogical Museum Russian Academy of Sciences, Moscow, Russia. **D.B.**

### NEW DATA

#### BOSCARDINITE

C. Biagioni and Y. Moëlo (2017) Lead-antimony sulfosalts from Tuscany (Italy). XVIII. New data on the crystal-chemistry of boscardinite. *Mineralogical Magazine*, 81(1), 47–60.

Boscardinite, ideally TIPb<sub>4</sub>(Sb<sub>7</sub>As<sub>2</sub>)S<sub>18</sub>, triclinic homeotypic derivative of baumhauerite has been described recently from quartz

veins with zinkenite in Monte Arsiccio mine, Apuan Alps, Tuscany, Italy, and in intimate intergrowth with stibnite and smithite from the Jas Roux thallium mineralization, Hautes-Alpes, France. New finds of boscardinite (compact black masses up to 1 cm with protochabournéite and routhierite) in Monte Arsiccio mine in the microcrystalline baryte-pyrite ore bodies, at the contact between schist and dolostone and in the pyrite-rich dolostone allowed to obtain new crystal-chemical data. The average of 3 WDS electron probe analysis of the crystal from Saint'Olga level used for the single-crystal X-ray diffraction study is [wt% (range)]: Ag 1.81 (1.77–1.87), Tl 12.60 (12.39–12.82), Pb 17.99 (17.85–18.09), Hg 0.14 (0.1–0.2), As 9.36 (9.23–9.46), Sb 33.60 (33.28–33.77), S 23.41 (23.09–23.70), Cl 0.06 (0.05–0.07), total 98.97. A similar data was obtained on another specimen of boscardinite collected in the Sant'Anna level: Ag 1.46 (1.42–1.51), Tl 11.38 (11.33–11.43), Pb 20.57 (20.46–20.79), Hg 0.13 (0.1–0.16), As 8.24 (8.22–8.24), Sb 33.48 (33.39–33.55), S 22.89 (22.81–22.96), Cl 0.05 (0.03–0.08), total 98.20. On the basis of  $\Sigma\text{Me} = 14$  apfu, it corresponds to  $\text{Ag}_{0.42}\text{Tl}_{1.52}\text{Pb}_{2.14}\text{Hg}_{0.02}(\text{Sb}_{6.82}\text{As}_{3.08})_{29.90}\text{S}_{18.04}\text{Cl}_{0.04}$  and  $\text{Ag}_{0.34}\text{Tl}_{1.41}\text{Pb}_{2.51}\text{Hg}_{0.02}(\text{Sb}_{6.95}\text{As}_{2.78})_{29.73}\text{S}_{18.04}\text{Cl}_{0.04}$  respectively ( $Z = 2$ ). There is a strong Pb depletion and a significant Tl and As enrichment compare to type specimen of boscardinite. The single-crystal X-ray diffraction study confirms the structural features described for the type sample. The unit-cell parameters are  $a = 8.1017(4)$ ,  $b = 8.6597(4)$ ,  $c = 22.5574(10)$  Å,  $\alpha = 90.666(2)$ ,  $\beta = 97.242(2)$ ,  $\gamma = 90.850(2)^\circ$ ,  $V = 1569.63$  Å<sup>3</sup>, space group  $P\bar{1}$ . The crystal structure was refined down to  $R_1 = 0.0285$  for 6582 unique  $F_o > 4\sigma(F_o)$  reflections. As is dominant in three  $\text{MeS}_3$  sites, compared to one in type boscardinite. The main As-enrichment is observed in the sartorite-type sub-layer. (Tl,As)-rich boscardinite shows alternation, along **b**, of Sb-rich sites and As-rich sites; this feature represents the main factor controlling the 8 Å superstructure. The most remarkable differences involve the cations forming the zigzag chains of heavy atoms separating the dufrénoysite type layers from the sartorite type ones. In particular, the  $(Pb, Tl)2a/(Pb, Tl)2b$  split pair is replaced by two  $Tl2a$  and  $Tl2b$  split positions dominated by thallium. The chemical variability of boscardinite is discussed. The Ag increase leading to stoichiometric  $\text{AgTl}_3\text{Pb}_4(\text{Sb}_{14}\text{As}_6)_{20}\text{S}_{36}$  ( $Z = 1$ ), against possible extension up to  $\text{AgTl}_2\text{Pb}_6(\text{Sb}_{15}\text{As}_4)_{20}\text{S}_{36}$  for type boscardinite. The significant chemical and structural differences between type and (Tl,As)-rich boscardinites are still not sufficient to propose a new mineral species. **D.B.**

## PARTZITE, DISCREDITED

S.J. Mills, A.G. Christy, M.S. Rumsey and J. Spratt (2016) Discreditation of partzite. *European Journal of Mineralogy*, 28(5), 1019–1024.

Partzite was originally described by Arents (1867) as a hydrous oxide of antimony and mixed metallic oxides from the Blind Spring Mountains, Mono County, California, U.S.A. It was considered to be identical with “cuproroméite”  $\text{Cu}_2\text{Sb}_2(\text{O},\text{OH})_7$ , with a questionable status since no cation site in pyrochlore structure is stereochemically favorable for  $\text{Cu}^{2+}$ , and no synthetic Cu antimonates with the pyrochlore structure are known. The type specimen #80284, from the mineralogical collections of Harvard University, Cambridge, Massachusetts, U.S.A., has been reinvestigated by powder X-ray diffraction and electron microprobe traverses. The type specimen consists of an olive green to dark green botryoidal-colloform gel-like crust on tetrahedrite, with a transparent blue phase coating the crust. The material shows complex layering on the submicrometer scale, and consists of several distinct phases which could not be fully resolved by electron probe. The X-ray powder diffraction data shows that the partzite sample is very poorly crystalline. The background is high and irregular, featuring the presence of amorphous matter. The few visible peaks correspond to  $d = 6.03, 3.60, 2.99, 1.83$  and  $1.56$  Å, consistent with the 111, 220, 222, 440, and 622 reflections from the cubic pyrochlore structure type with the unit-cell parameter  $a \approx 10.358$  Å which is close to that observed for oxyplumboroméite (10.378). However (Pb+Ca)/Sb ratio is too low for that species. If Fe is trivalent and is in B site a charge-balanced formula could be  $(\text{Pb}_{0.7}\text{Ca}_{0.35}\square_{0.95})_{\Sigma 2}(\text{Sb}_{1.8}\text{Fe}_{0.2}^{3+})_{\Sigma 2}(\text{O}_{5.7}(\text{OH})_{0.3})_{\Sigma 6}(\text{H}_2\text{O})$ . There is no evidence for significant Cu content in the pyrochlore phase. Copper is predominantly in a silicate phase resembling chrysocolla, but with an unusually high Cu/Si ratio of  $\sim 1.3$ . Thus, the correlations between elements along with XRD indicates that the two dominant phases are a plumboroméite-like oxide phase and a chrysocolla-like amorphous Cu silicate. The analysis also suggested the presence of several minor phases that were too scarce to be detectable by XRD, including acanthite, chlorargyrite, baryte, halite, and an Al-rich clay mineral. Subsequently partzite is discredited as a valid mineral species. This has been approved by the IMA CNMNC (proposal 16-B). **D.B.**

## Reference cited

Arents, A. (1867) Partzite, a new mineral. *American Journal of Science*, 93, 362.