

New Mineral Names*†

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This New Mineral Names has entries for 8 new minerals, including fengchengite, ferriperbøeite-(Ce), genplesite, heyerdahlite, millsite, sarachinaite, siudaite, vymazalováite and new data on lavinskyite-1M.

FENGCHENGITE*

G. Shen, J. Xu, P. Yao, and G. Li (2017) Fengchengite: A new species with the Na-poor but vacancy-dominant *N*(5) site in the eudialyte group. *Acta Mineralogica Sinica*, 37 (1/2), 140–151.

Fengchengite (IMA 2007-018a), Na₁₂□₃Ca₆(Fe³⁺,□)₃Zr₃Si (Si₂₅O₇₃)(H₂O)₃(OH)₂, trigonal, is a new eudialyte-group mineral discovered in the apgaitic nepheline syenites and its pegmatite facies near the Saima Town, ~60 km NNE of Fengcheng City, Liaoning Province, China. In the Saima apgaitic rocks, it occurs as an accessory or, locally, as rock-forming mineral up to 90% of the rock volume. The associated minerals include microcline, orthoclase, albite, nepheline, sodic amphiboles, aegirine, lamprophyllite, Na-poor rinkite, loparite, catapleite, zircon, titanite, Fe-rich phlogopite, reugeite, fluorapatite, REE-rich hydroxyllellastadite, and hezuolinite. Fengchengite is considered to be crystallized directly from a REE-, U-, Th-, and Zr-rich alkaline magma enriched in volatile components. The mineral forms rose to deep-rose translucent to transparent vitreous anhedral to subhedral grains generally 1 to 7 mm with the largest over 15 mm. The crystal forms {001}, {100}, {110} are observed. The streak is white. The mineral is brittle with uneven fracture and no cleavage or parting. The micro-indentation hardness VHN₂₅ = 562 (420–570) kg/mm² corresponding to ~5 of the Mohs scale; *D*_{meas} = 2.90(4), *D*_{calc} = 2.839 g/cm³. Fengchengite does not fluoresce under UV radiation. In transmitted plane-polarized light, the mineral is not pleochroic (color not given). It is optically uniaxial (+), ω = 1.603, ε = 1.607 (λ = 589.9 nm; accuracy not specified). IR spectrum shows bands at (cm⁻¹; s = strong, w = weak, sh = shoulder): 3541, 3442 (O–H stretching), 1654 (H–O–H bending), 1424w (?), 1013s, 975s, 934sh (Si–O-stretching), 739, 699sh, 663sh (mixed vibrations of the tetrahedral rings), 541, 474 (Fe³⁺–O stretching), 366 (lattice modes). The average of 16 WDS electron probe analyses is [wt% (range)]: Na₂O 11.64 (10.10–12.34), K₂O 0.52 (0.37–0.75), CaO 8.96 (8.55–9.33), MgO 0.07 (0.02–0.12), SrO 3.53 (2.89–3.90), BaO 0.02 (0–0.15), MnO_{total} 0.93 (0.71–1.36), [MnO 0.10, Mn₂O₃ 0.92], Fe_{total} 6.07 (4.87–6.56) [FeO 0.69, Fe₂O₃ 5.98 apportioned by Mössbauer spectroscopy], La₂O₃ 0.12 (0–0.23), Ce₂O₃ 0.23 (0.09–0.29), Nd₂O₃ 0.13 (0.09–0.19), Sc₂O₃ 0.01 (0–0.04), TiO₂ 0.38 (0.36–0.45), ZrO₂ 11.72 (11.02–11.78), SiO₂ 51.73 (49.46–52.35), Cr₂O₃ 0.20 (0–0.52), Nb₂O₅ 0.23 (0–0.44), Cl (wet chemistry) 1.13, H₂O (thermogravimetry) 2.09, –O=Cl₂ 0.26, total 100.14. The empirical formula based on 78 anions and considering data on the crystal structure is [(Na_{3.0}Na_{3.0})_{26.00}(Na_{5.28}K_{0.33}□_{0.39})_{26.00}]_{Σ12.00}(□_{2.71}Sr_{0.20}REE_{0.09})_{Σ3.00}(Ca_{4.80}Sr_{0.82}Fe_{0.29}Mg_{0.05}Mn_{0.04})_{Σ6.00}(Fe_{2.25}Mn_{0.35}Cr_{0.08}□_{Σ0.32})_{Σ3.00}(Zr_{2.86}Ti_{0.09}Nb_{0.05})_{Σ3.00}(Si_{0.87}Ti_{0.05}□_{0.39})_{Σ1.00}Si_{Σ24.00}O_{Σ73.00}[(H₂O)_{2.93}(OH)_{0.07}]_{Σ3.00}[(OH)_{1.04}Cl_{0.96}]_{Σ2.00}. The strongest lines of the powder

X-ray diffraction pattern [*d* Å (*l*%; *hkl*)] are: 7.186 (55; 110), 5.761 (44; 113), 4.187 (53; 123), 3.201 (47; 028), 2.978 (61; 135), 2.857 (100; 044), 2.146 (30; 336), 1.771 (36; 24.11). Single-crystal X-ray diffraction data shows the mineral is trigonal, space group *R* $\bar{3}m$, *a* = 14.2467 (6), *c* = 30.033(2) Å, *V* = 5279.08 Å³, *Z* = 3. The structure was solved by direct methods and refined to *R* = 0.043 for all unique *l* > 2σ(*l*) reflections. Fengchengite is the Fe³⁺ analog of eudialyte with a structural difference in vacancy dominant *N*5 site and splitting its Na site *N*1 into *N*1a and *N*1b sites. It also chemically related to fekklichevite and siudaite by the predominance Fe³⁺ in *M*2 site. The name is given for Fengcheng City near the type locality. The type material is deposited in the Geological Museum of China, Beijing, China. **D.B.**

FERRIPERBØEITE-(CE)*

L. Bindi, D. Holtstam, G. Fantappiè, U.B. Andersson, and P. Bonazzi (2018) Ferriperbøeite-(Ce), [CaCe₃]_{Σ=4}[Fe³⁺Al₃Fe²⁺]_{Σ=4}[Si₂O₇][SiO₄]₃O(OH)₂, a new member of the polysomatic epidote-törnebohmitte series from the Nya Bastnäs Fe-Cu-REE deposit, Sweden. *European Journal of Mineralogy*, 30(3), 537–544.

Ferriperbøeite-(Ce) (IMA 2017-037), ideally [CaCe₃]_{Σ=4}[Fe³⁺Al₃Fe²⁺]_{Σ=4}[Si₂O₇][SiO₄]₃O(OH)₂, monoclinic, is a new mineral species from the Nya Bastnäs Fe–Cu–REE skarn deposit in the Bergslagen mining region (Skinskatteberg, Västmanland, south-central Sweden; 59°50'47"N; 15°35'15"E). Ferriperbøeite-(Ce) developed as a major phase of crystal aggregates largely replacing cerite-(Ce), whereas ferriallanite-(Ce) occurs as a subordinate product of alteration, as crack-fillings and narrow rims on ferriperbøeite-(Ce). Other minerals in the type specimen are cerite-(Ce), törnebohmitte-(Ce), and ferriallanite-(Ce). Ferriperbøeite-(Ce) forms brownish black subhedral short-prismatic crystals elongated along [010] up to 500 μm. Twinning is not observed. The streak is brown and the luster is vitreous. It is brittle and exhibits good {100} and imperfect {001} cleavage. Mohs hardness is 6–7; *D*_{calc} = 4.610 g/cm³ (unit cell parameters from single crystal diffraction) and *D*_{calc} = 4.634 g/cm³ (unit-cell parameters from powder diffraction). Crystals are transparent only in thin fragments, <20 μm. Refractive indices were not measured accurately due to high absorption and numerous solid and fluid inclusions. Mean *n* = 1.84 (from Gladstone-Dale relationship). The mineral is optically biaxial (+), with 2*V* = 65(5)°. It is strongly pleochroic, from green throughout orange-brown, to deep red colors. The FTIR spectra show two relatively sharp bands at 3590 and 3520 cm⁻¹ and two (or more) broad bands in the region 3300–3200 cm⁻¹. The average of two electron probe WDS analyses is [wt% (range)]: CaO 4.53 (4.53–4.53), La₂O₃ 17.62 (17.51–17.73), Ce₂O₃ 21.57 (21.47–21.67), Pr₂O₃ 1.52 (1.51–1.52), Nd₂O₃ 4.08 (4.03–4.13), Sm₂O₃ 0.28 (0.25–0.30), Gd₂O₃ 0.07 (0.06–0.07), Dy₂O₃ 0.02 (0–0.04), Ho₂O₃ 0.06 (0–0.12), Yb₂O₃ 0.01 (0–0.02), Lu₂O₃ 0.02 (0–0.03), Y₂O₃ 0.06 (0.06–0.06), MgO 2.03 (1.97–2.08), FeO 2.89 (2.60–3.18), Fe₂O₃ (by Mössbauer) 7.92 (7.49–8.34), Al₂O₃ 8.27 (8.26–8.28), SiO₂ 25.96

* All minerals marked with an asterisk have been approved by the IMA CNMNC. † For a complete listing of all IMA-validated unnamed minerals and their codes, see <http://pubsites.uws.edu.au/ima-cnmmc/>.

(25.67–26.25), TiO₂ 0.05 (0.03–0.07), P₂O₅ 0.08 (0.06–0.09), F 0.21 (0.20–0.21), Cl 0.02 (0.02–0.02), –O=F₂ 0.09 (0.08–0.09), –O=Cl₂ 0, H₂O (on the basis of OH= 1.87 pfu) 1.50, total 98.68. The empirical formulae based on 13 cations (except H) pfu is (Ca_{0.92}La_{1.23}Ce_{1.50}Pr_{0.10}Nd_{0.27}Sm_{0.02}Y_{0.01})_{24.05}(Al_{1.83}Fe_{0.46}Fe_{0.13}Mg_{0.57}Ti_{0.01})_{24.02}(Si_{4.92}P_{0.01})_{24.93}O₂₀(OH)_{1.87}F_{0.12}Cl_{0.01}). The eight strongest X-ray powder diffraction lines are [*d* Å (*P*%; *hkl*)]: 3.520 (45; 212), 2.997 (100; $\bar{1}$ 15), 2.868 (45; 020), 2.771 (40; 015), 2.682 (34; 203), 2.633 (60; $\bar{3}$ 12), 2.159 (27; 225), 2.100 (35; 222). Unit-cell parameters refined from the powder data with whole-pattern fitting are *a* = 8.9317(5), *b* = 5.7441(4), *c* = 17.6164(9) Å, β = 116.034(4)°, *V* = 812.09 Å³. The crystal structure was refined to *R*₁ = 0.046 for 2530 *F*_o > 4σ(*F*_o) independent reflections. The mineral is monoclinic, *P*2₁/*m*, *a* = 8.9320(4), *b* = 5.7280(3), *c* = 17.5549(9) Å, β = 116.030(4)°, *V* = 807.05 Å³, *Z* = 2. The crystal structure of ferriperbœite-(Ce) consists of edge-sharing octahedral chains running along the **b** axis, cross-linked to each other by SiO₄ and Si₂O₇ groups. The remaining large cavities are occupied by Ca (*A*1) and REE (*A*2, *A*3, *A*4). There are three independent octahedral sites in the structure: *M*1 octahedra form branched chains with *M*3 octahedra alternately attached on opposite sides, whereas *M*2 octahedra form single chains. Ferriperbœite-(Ce) belongs to the gatelite supergroup (Bonazzi et al. 2017) that can be regarded as iso-topological ET polysomes of a series having epidote and törnebohmit-(Ce) as end-members. The mineral is named by analogy with the IMA-approved nomenclature for the epidote supergroup minerals, and to underline the substitutional relationships with perbœite-(Ce). The holotype material, including a polished thin section, is deposited at the Swedish Museum of Natural History, Stockholm, Sweden. **F.C.**

References cited

Bonazzi, P., Holtstam, D., and Bindi, L. (2019) Gatelite-supergroup minerals: recommended nomenclature and review. *European Journal of Mineralogy*, DOI: 10.1127/ejm/2019/0031-2809.

GENPLESITE*

I.V. Pekov, E.V. Sereda, N.V. Zubkova, V.O. Yapaskurt, N.V. Chukanov, S.N. Britvin, I.S. Lykova, and D.Y. Pushcharovsky (2018) Genplesite, Ca₃Sn(SO₄)₂(OH)₆·3H₂O, a new mineral of the fleischerite group: first occurrence of a tin sulfate in nature. *European Journal of Mineralogy*, 30(2), 375–382.

Genplesite (IMA 2014-034), ideally Ca₃Sn(SO₄)₂(OH)₆·3H₂O, hexagonal, is the first natural tin sulfate found in cavities in massive chalcopyrite ore at the Oktyabr'skoe Cu-Ni-Pd-Pt deposit (Oktyabr'sky mine), Talnakh, Norilsk district, Siberia, Russia. It is a late-stage low-temperature hydrothermal mineral. It occurs on greenish-gray greenalite crystalline crusts lining walls of roundish caverns (up to 1 cm in diameter) in massive chalcopyrite (with subordinate pentlandite) ore located at the contact between a rich mooihöekite–chalcopyrite ore and gabbro-dolerite with embedded chalcopyrite. Other minerals found in these cavities are pectolite, ferroactinolite, calcite, and fluorapatite. Genplesite occurs as hexagonal, equant, short prismatic or thick tabular crystals. Their major forms are the hexagonal prism {100} and the pinacoid {001}, whereas the hexagonal dipyramidal faces {102} and {101} were observed on some crystals. Genplesite forms crystals up to 0.5 mm across, and, typically, gear-like parallel intergrowths up to 0.6×1 mm and crystal clusters up to 0.6×1.2 mm. Genplesite is transparent, colorless, with a white streak and a vitreous luster. No distinct cleavage or parting was observed. It is brittle with a conchoidal fracture and Mohs hardness ~3. *D*_{meas} = 2.78(1) g/cm³ (by flotation in bromoform + dimethylformamide); *D*_{calc} = 2.773 g/cm³. In transmitted plane-polarized light genplesite is colorless and non-pleochroic. It is optically uniaxial (–), ω = 1.597(2), ε = 1.572(2) (589 nm). The FTIR spectra show bands (cm^{–1}; s = strong, w = weak, sh = shoulder) at: 3520sh, 3451s, 3365s (O–H stretching of H₂O and OH groups), 1663, 1550sh (H–O–H bending of H₂O) 1172s, 1119s [*v*₃(F₂) = asymmetric stretching of

SO₄^{2–} anions], 1010w [*v*₁(A₁) = symmetric stretching of SO₄^{2–} anions], 959w, 932w, 798w (Sn···O–H bending vibrations), 651, 627 [*v*₄(F₂) = bending of SO₄^{2–} anions], 533 (Sn–O stretching), 457 (possible librational vibrations of H₂O). The average of four electron microprobe WDS analyses is [wt% (range)]: CaO 28.67 (28.49–28.84), Al₂O₃ 0.11 (0.04–0.16), GeO₂ 0.50 (0.35–0.63), SnO₂ 24.20 (24.02–24.45), SO₃ 27.25 (27.06–27.53), H₂O (by structure, 3 H₂O pfu) 18.34, total 99.07. The empirical formulae based on 17 O pfu is Ca_{3.01}(Sn_{0.95}Ge_{0.03}Al_{0.01})_{20.99}S_{2.01}O₈(OH)₆·3H₂O. The strongest X-ray powder diffraction lines are [*d* Å (*P*%; *hkl*)]: 7.38 (68; 100), 4.259 (46; 110), 3.503 (15; 201), 3.383 (100; 112), 2.616 (13; 203), 2.493 (14; 212), 2.249 (14; 302), 2.130 (17; 105,220). Unit-cell parameters refined from the powder data with whole-pattern fitting are *a* = 8.518(1), *c* = 11.149(2) Å, *V* = 700.6(3) Å³. The single-crystal X-ray data (*R*₁ = 0.0162 for 590 *I* > 2σ(*I*) reflections; *R*_{int} = 0.0414 for 613 reflections) shows genplesite is hexagonal, *P*6₃/*m*mc, *a* = 8.5139(2) c = 11.1408(3) Å, *V* = 699.37 Å³, *Z* = 2. Genplesite is isotypic with schaurteite and belongs to the fleischerite group, which includes also fleischerite and despuijolsite, which crystallize in the space group *P*6̄2c, and mallestigte, which crystallizes in the space group *P*6₃. The structure shows heteropolyhedral columns formed by the *A*- and *M*-centered polyhedra, which are topologically the same as polyhedral columns found in the crystal structures of ettringite-group minerals. The name honors Gennadiy Nikolaevich Plesin (b. 1963), a mine surveyor at the Oktyabr'sky mine and an amateur mineralogist who has made a significant contribution to the mineralogy of ore deposits of the Norilsk district. The type specimen of genplesite is deposited in the systematic collection of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **F.C.**

HEYERDAHLITE*

E. Sokolova, M.C. Day, F.C. Hawthorne, and R. Kristiansen (2018) Heyerdahlite, Na₃Mn₇Ti₂(Si₄O₁₂)₂O₂(OH)₂F(H₂O)₂, a new mineral of the astrophyllite supergroup from the Larvik Plutonic complex, Norway: Description and crystal structure. *Mineralogical Magazine*, 82(2), 243–255.

Heyerdahlite (IMA 2016-108), ideally Na₃Mn₇Ti₂(Si₄O₁₂)₂O₂(OH)₂F(H₂O)₂, triclinic, is a new astrophyllite-supergroup (kupletskite group) mineral discovered at the Larvik Plutonic complex, in a road cut ~200 m SE of the Bratthagen farm (59°09'26"N 10°00'39"E) in Lågendalen, Hedrum, Vestfold County, Norway. It was found in the apgaitic nepheline-syenite pegmatite hosted by foyaites in association with albite, aegirine, hastingsite/magnesian-hastingsite, kupletskite, lorenzenite, and pyrophanite. Heyerdahlite is a late-stage hydrothermal mineral. It forms radiating fans up to 2 mm in diameter, consisting of transparent colorless to pale-brown elongated lath-like crystals up to ~1 mm long and 50 μm wide with a vitreous luster and a pale-brown streak. The mineral does not fluoresce under UV light. It is brittle with Mohs hardness of 3, hackly fracture and perfect cleavage on {001}. The density was not measured due to the paucity of material, *D*_{calc} = 3.245 g/cm³. In plane-polarized light, the mineral is pleochroic: *X* = yellowish brown > *Y* = brownish yellow > *Z* = pale yellow. It is optically biaxial (+), α = 1.694(2), β = 1.710(5), γ = 1.730(5) (589 nm), 2*V*_{meas} = 80(4)°, 2*V*_{calc} = 84.5°. The dispersion of an optical axis is strong, *r* > *v*. The optical orientation (determined by transferring the crystal from the spindle stage to a single-crystal diffractometer and measuring the relative axial relations by X-ray diffraction) is: *X*^o*a* = 89.9°, *X*^o*b* = 23.9°, *X*^o*c* = 95.1°, *Y*^o*a* = 86.5°, *Y*^o*b* = 110.1°, *Y*^o*c* = 9.8°, *Z*^o*a* = 3.5°, *Z*^o*b* = 102.0°, *Z*^o*c* = 98.3°. The powder and single crystal FTIR spectra of the heyerdahlite show two strong bands at ~3620 cm^{–1} (with the shoulder at ~3634) and ~3556 cm^{–1} (with a shoulder at ~3582) corresponded to OH stretching. A sharp peak at ~1631 cm^{–1} is assigned to H–O–H bending mode of an H₂O group, while extremely broad bands at ~3440 cm^{–1} are assigned to the corresponding H₂O stretching. Two strong bands at ~1040 and ~940 cm^{–1} are assigned to symmetric and asymmetric Si–O stretches and a less

intense broad band at $\sim 635\text{ cm}^{-1}$ (shoulder at ~ 685) is due to a Si–O–Si deformation. Multiple low-intensity bands in the range $2380\text{--}2301\text{ cm}^{-1}$ are due to atmospheric CO_2 transitions. The average of 8 electron probe WDS analyses is (wt%): Nb_2O_5 1.67, ZrO_2 0.53, TiO_2 10.37, SiO_2 35.17, PbO 0.22, ZnO 1.34, FeO 0.14, MnO 32.50, CaO 0.03, MgO 0.30, Cs_2O 0.12, Rb_2O 0.82, K_2O 2.33, Na_2O 5.70, F 1.49, H_2O (by structure) 4.12, $-\text{O}=\text{F}_2$ 0.63, total 96.22. The ranges or deviations are not given as well as the explanations of a low total. The empirical formula based on 32.18 (O+F) apfu with constraints $\text{OH} + \text{F} = 5$ pfu and $\text{H}_2\text{O} = 1.18$ (according the structure refinement) is $(\text{Na}_{1.18}\text{K}_{0.68}\text{Rb}_{0.12}\text{Cs}_{0.01}\text{Pb}_{0.01})_{\Sigma 2}\text{Na}_{1.00}(\text{Mn}_{6.29}\text{Zn}_{0.23}\text{Mg}_{0.07}\text{Zr}_{0.04}\text{Fe}_{0.02}^{2+}\text{Ca}_{0.01}\text{Na}_{0.34})_{\Sigma 7.01}(\text{Ti}_{1.78}\text{Nb}_{0.17}\text{Mg}_{0.03}\text{Zr}_{0.02})_{\Sigma 2}(\text{Si}_{8.05}\text{O}_{2.4})\text{O}_2[(\text{OH})_{3.92}\text{F}_{0.08}]_{\Sigma 4}\text{F}_{1.00}[(\text{H}_2\text{O})_{1.18}\square_{0.82}]_{\Sigma 2}$, for $Z = 1$. The strongest lines in the calculated X-ray powder-diffraction pattern [d_{calc} ($I_{\text{calc}}\%$; hkl)] are: 10.745 (100; 001), 3.582 (43; 003), 2.791 (55; $\bar{1}\ 3\bar{1}$), 2.686 (29; 004), 2.663 (42; $\bar{2}\bar{1}\bar{1}$), 2.594 (65; 130), 2.496 (33; $\bar{2}\bar{1}\bar{2}$), 1.582 (29; $3\bar{5}\bar{1}$). Single-crystal X-ray data collected on a twinned crystal shows heyerdahlite is triclinic, space group $P\bar{1}$, $a = 5.392(2)$, $b = 11.968(4)$, $c = 11.868(4)$ Å, $\alpha = 112.743(8)$, $\beta = 94.816(7)$, $\gamma = 103.037(8)^\circ$, $V = 675.6$ Å³, $Z = 1$. The crystal structure was refined to $R_1 = 4.44\%$ for 3577 unique $F_o > 4\sigma F$ reflections. The general crystal-chemical formula for the astrophyllite supergroup (Sokolova et al. 2017) is $\text{A}_{2p}\text{B}_p\text{C}_7\text{D}_2(\text{T}_4\text{O}_{12})_2\text{IX}_{\text{O}_2}^{\text{O}}\text{X}_{\text{O}_4}^{\text{O}}\text{X}_{\text{O}_n}^{\text{O}}\text{W}_{\text{A}2}$, where C [cations at the $M(1\text{--}4)$ sites in the O sheet] = Fe^{2+} , Mn, Na, Mg, Zn, Fe^{3+} , Ca, Zr, and Li; D (cations in the H sheets) = $^{6,5}\text{Ti}$, Nb, Zr, Sn^{4+} , $^{51}\text{Fe}^{3+}$, Mg, and Al; T = Si with minor Al; $\text{A}_{2p}\text{B}_p\text{IW}_{\text{A}2}$ (I block) where $p = 1$ or 2; $r = 1$ or 2; A = K, Cs, Ba, H_2O , Li, Rb, Pb^{2+} , Na, and \square ; B = Na, Ca, Ba, H_2O , and \square ; I represents the composition of the central part of the I block (excluding peripheral layers of the form $\text{A}_{2p}\text{B}_p\text{W}_{\text{A}2}$, e.g. $(\text{PO}_4)_2(\text{CO}_3)$ (devitoite); $\text{X}_{\text{O}_2}^{\text{O}} = \text{O}$; $\text{X}_{\text{O}_4}^{\text{O}} = \text{OH}$ or F; $\text{X}_{\text{O}_n}^{\text{O}} = \text{F}$, O, OH, H_2O and \square , where $n = 0, 1$, or 2; $\text{W}_{\text{A}2} = \text{H}_2\text{O}$ or \square . The heyerdahlite structure contains four ^{41}T sites occupied by Si. The ^{61}D site is occupied mainly by Ti. The T_4O_{12} astrophyllite ribbons composed of SiO_4 tetrahedra and D octahedra constitute the H (Heteropolyhedral) sheet. There are four Mn-dominant $^{61}\text{M}(1\text{--}4)$ sites in the O (octahedral) sheet. Two H sheets and one central O sheet form the HOH block, and adjacent HOH blocks link via a common $\text{X}_{\text{O}_n}^{\text{O}}$ anion of the two D octahedra. The I (intermediate) block between HOH blocks contains two interstitial cation sites, A and B, and a W_{A} site, partly occupied by H_2O . The A site splits into two sites, $^{12}\text{A}(1)$ and $^{61}\text{A}(2)$, partly occupied by K and Na, respectively. The aggregate content of the A site is ideally Na_2 apfu. The ^{10}B site is occupied by Na. The W_{A} site is ideally occupied by $(\text{H}_2\text{O})_2$ pfu. The topology of the I block is the same as that in bulgakite and nalivkinite where Li is the dominant cation at the A site. The mineral is named after the Norwegian explorer Thor Heyerdahl (1914–2002), who was born in Larvik. The holotype specimen of heyerdahlite has been deposited in the Royal Ontario Museum, Toronto, Ontario, Canada. **D.B.**

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MILLSITE*

M.S. Rumsey, M.D. Welch, F. Mo, and A.K. Kleppe (2018) Millsite, $\text{CuTeO}_3 \cdot 2\text{H}_2\text{O}$: a new polymorph of teineite from Grårdffjellet, Oppdal, Norway. *Mineralogical Magazine*, 82(2), 433–444.

Millsite (IMA2015-086), ideally $\text{CuTeO}_3 \cdot 2\text{H}_2\text{O}$, monoclinic, is a new mineral discovered in two specimens donated to the Natural History Museum in London, U.K. (NHM) which were collected around 1991 at Grårdffjellet in Oppdal, Norway ($62^\circ 29' 11''\text{N}$, $9^\circ 29' 25''\text{E}$). The crystal structure of the similar material from the same locality (later appeared to be essentially the same as one donated to the NHM) was determined by Mo, F., Larsen, F.K., Mathiesen, R., Måseide, K. and Overgaard, J. in 2000 on the sample KAI-93 (now considered as cotype). The data was submitted to IMA but was not published. Millsite was found in a boulder

of quartz-rich granite, which is probably a glacial erratic. It occurs as a minor secondary phase in vugs, cracks, and interstices in the granular quartz associating with its polymorph teineite, malachite, U-rich malpeneite, schmitterite, a copper sulfate (probably brochantite), goethite, an amorphous, heterogeneous Cu–Te–Si gel-like component with variable chemistry and relicts of digenite/chalcocite, hessite, native gold. Millsite forms bright cyan to royal blue aggregates up to $\sim 20\text{ mm} \times 15\text{ mm} \times 5\text{ mm}$ with distinct crystals in the mm range. It is hardly recognizable from teineite which is usually darker royal blue. The mineral is transparent to slightly translucent with a vitreous luster and a pale green streak. It is brittle, with a perfect cleavage on $\{100\}$ and a conchoidal fracture. Hardness and density were not measured due to the paucity of a sample; $D_{\text{calc}} = 3.963\text{ g/cm}^3$. In plane-polarized transmitted light millsite is weakly pleochroic: greenish blue, $X \approx Z > Y$. It is optically biaxial (+), $\alpha = 1.756(5)$, $\beta = 1.794(5)$ (white light), $\gamma_{\text{calc}} = 1.925$ and $2V_{\text{meas}} = 60(1)^\circ$. The mineral was reacting with high refractive immersion liquids. Dispersion of optical axes is $r < v$, obvious. The optical orientation is $Y = \mathbf{b}$, $X \wedge \mathbf{a} = 41^\circ$ in obtuse β ; one optical axis $\approx \perp$ to (001). An unpolarized Raman spectrum obtained from a crystal $30\ \mu\text{m} \times 75\ \mu\text{m} \times 115\ \mu\text{m}$ shows peaks at (cm^{-1}): 3367 and 3288 (O–H stretching of H_2O); weak bands at 1662 and 1532 (bending modes of two non-equivalent H_2O groups); 749 with a shoulder (symmetric and antisymmetric modes of the TeO_3); 484 (possibly H_2O libration); 339 (TeO_3 bending modes). The averages of unspecified number of WDS electron probe analysis of holotype/cotype specimens [wt% (range)] are: CuO 30.14 (30.02–30.27)/30.27 (29.92–30.58), SeO_2 0.78 (0.58–1.04)/0.52 (0.31–0.68), TeO_2 60.25 (59.89–60.42)/58.28 (57.37–58.79), H_2O (by structure) 13.79/13.09, total 104.96/102.16. The empirical formula based on $\text{O} = 3$ apfu is $\text{Cu}_{0.99}(\text{Te}_{0.98}\text{Se}_{0.02})\text{O}_3(\text{H}_2\text{O})_2$. The strongest reflections in the powder X-ray diffraction pattern are [d Å ($I\%$; hkl)]: 6.954 (100; 100), 3.558 (64; 012), 3.399 (28; 120), 3.338 (31; $1\bar{2}\bar{1}$), 3.236 (30; $2\bar{0}\bar{2}$), 3.175 (39; 210), 2.838 (47; $1\bar{2}\bar{2}$), 2.675 (43; 211). The single-crystal data obtained on a crystal $0.07 \times 0.04 \times 0.03\text{ mm}$ shows millsite is monoclinic, space group $P2_1/c$, $a = 7.4049(2)$, $b = 7.7873(2)$, $c = 8.5217(2)$ Å, $\beta = 110.203(3)^\circ$, $V = 461.17$ Å³, $Z = 4$. The crystal structure refined to $R_1 = 0.016$ for 1444 independent $I > 2\sigma(I)$ reflections. The main structural unit of millsite is a $\text{Cu}_2\text{O}_6(\text{H}_2\text{O})_4$ dimer that is decorated with four TeO_3 groups connecting adjacent dimers and defining (100) heteropolyhedral sheets. These sheets are only connected through hydrogen bonds resulting in (100) cleavage. The configuration of the $\text{M}_2\text{O}_6(\text{H}_2\text{O})_4$ dimer that leads to a sheet topology of millsite structure is unique. No isostructural selenium or tellurium analog exists. The orthorhombic ($P2_12_12_1$) polymorph teineite and its selenium analog chalcocite do not have a dimeric structure. Ahlfeldite $\text{NiSeO}_3 \cdot 2\text{H}_2\text{O}$, monoclinic ($P2_1/c$) $\text{CuSeO}_3 \cdot 2\text{H}_2\text{O}$ (clinochalcocite) and synthetic $\text{MgSeO}_3 \cdot 2\text{H}_2\text{O}$ have $\text{M}_2\text{O}_6(\text{H}_2\text{O})_4$ dimers with six decorating them SeO_3 groups. Besides that, their configurations differ significantly leading rather to a framework than to a sheet topology. Millsite is named after Stuart J. Mills (b. 1982), Senior Curator of Geosciences at Museums Victoria, Australia. He has published extensively on new minerals and has focused particularly in crystal chemistry of tellurium bearing oxysalts. Holotype material (the specimen, a polished probe block, and two single crystal mounts) is housed at the Natural History Museum in London, U.K. The depository of cotype specimen is not reported. **D.B.**

SARANCHINAITE*

O.I. Siidra, E.A. Lukina, E.V. Nazarchuk, W. Depmeier, R.S. Bubnova, A.A. Agakhanov, E.Yu. Avdontseva, S.K. Filatov, and V.M. Kovrugin (2018) Saranchinaite, $\text{Na}_2\text{Cu}(\text{SO}_4)_2$, a new exhalative mineral from Tolbachik volcano, Kamchatka, Russia, and a product of the reversible dehydration of kröhnkite, $\text{Na}_2\text{Cu}(\text{SO}_4)_2(\text{H}_2\text{O})_2$. *Mineralogical Magazine*, 82(2), 257–274.

Saranchinaite (IMA 2015-019), ideally $\text{Na}_2\text{Cu}(\text{SO}_4)_2$, monoclinic, was discovered in sublimates of the Saranchinaitovaya fumarole, Naboko

Scoria Cone, Tolbachik volcano, Kamchatka, Russia (55°46'N, 160°19'E, 1650 m a.s.l.). It is formed probably by direct deposition as a sublimate from volcanic gases with temperature ~600 °C at the sampling location. Saranchinaite is closely associated with euchlorine and anhydrite. Other associated minerals (mostly sulfates) are itelmenite, hermannjahnite, chalcocyanite, thénardite, apthitalite, and hematite. The mineral later was found to be common in the sulfate sublimates of Second Scoria cone of Tolbachik volcano. Saranchinaite forms druses with crystals up to 0.1 mm, spherulites, irregularly shaped grains, or microcrystalline masses. The color varies from very light-blue or nearly white in polycrystalline masses to sky-blue in crystalline aggregates making it hardly distinguishable from kröhnkite. The mineral is transparent in individual grains and translucent in aggregates having a white streak and a vitreous luster. It is brittle with uneven fracture and no cleavage or parting. Hardness and density were not measured due to the small size of grains and the porosity of the aggregates; $D_{\text{calc}} = 2.937 \text{ g/cm}^3$. Saranchinaite is water-soluble and sensitive to the moisture content in the air. It transforms into kröhnkite after one week of exposure in the open air at 87% relative humidity and 25 °C. In transmitted plane-polarized light saranchinaite is light gray, non-pleochroic. It is optically biaxial (+), $\alpha = 1.517(2)$, $\beta = 1.531(2)$, $\gamma = 1.559(2)$ (589 nm), $2V_{\text{calc}} = 71.6^\circ$. The average of the 10 electron probe EDS analyses on 3 grains (using defocused beam 5 μm to avoid the sodium loss) is [wt% (range)]: Na₂O 18.38 (17.19–18.99), K₂O 2.23 (1.50–3.23), CaO 0.16 (0–0.29), CuO 24.72 (23.93–25.46), ZnO 0.78 (0.30–1.09), SO₃ 52.79 (51.47–55.11), total 99.05. No other elements with $Z > 8$ were detected. The empirical formula based on 8 O apfu is (Na_{1.81}K_{0.14}Ca_{0.01})_{Σ1.96}(Cu_{0.95}Zn_{0.03})_{Σ0.98}S_{2.01}O₈. The strongest lines in the X-ray powder-diffraction pattern [$d \text{ \AA}$ ($P\%$; hkl)] are: 8.618 (42; 100), 7.828 (60; 020), 7.671 (47; 10 $\bar{1}$), 6.091 (50; 021), 4.634 (46; 012), 3.765 (100; 220), 2.712 (98; 142), 2.535 (65; 104). The unit-cell parameters refined from the powder diffraction data in the monoclinic unit cell are $a = 8.995(3)$, $b = 15.599(6)$, $c = 10.159(3)$ Å, $\beta = 107.07(11)^\circ$, $V = 1363(1)$ Å³. The single-crystal X-ray data shows saranchinaite is monoclinic, space group $P2_1$, $a = 9.0109(5)$, $b = 15.6355(8)$, $c = 10.1507(5)$ Å, $\beta = 107.079(2)^\circ$, $V = 1367.06$ Å³, $Z = 8$. The crystal structure was solved by direct methods and refined to $R_1 = 0.0295$ for 3236 unique $F > 4\sigma(F)$ reflections. Saranchinaite represents a new structure type and has no direct synthetic analogs. It is unique in that two of its four independent Cu sites display a very unusual Cu²⁺ coordination environment with two weak Cu–O bonds of ~2.9–3.0 Å, resulting in [4+1+2] CuO₇ polyhedra. Each of the Cu-centred polyhedra shares common corners with SO₄ tetrahedra resulting in a [Cu₄(SO₄)₈]⁸⁻ framework with a complex channel system occupied by Na atoms. High-temperature X-ray diffraction studies of saranchinaite (in the range 25–900 °C with 25 °C step) were performed along with that for kröhnkite Na₂Cu(SO₄)₂(H₂O)₂ from La Vendida mine, Antofagasta Region, Chile (25–700 °C with 25 °C step and detailed measurement in the range 150–250 °C with 5 °C step). During thermal expansion, kröhnkite retains its strongly anisotropic character up to its full dehydration and formation of saranchinaite at ~200 °C (accompanied by a color change from greenish-blue to light-blue), which then transforms back into kröhnkite after exposure to open air. The reflections of kröhnkite gradually start to disappear at ~170 °C. No other intermediate phases are formed during this process. The highest α_c expansion is observed perpendicular to the Na interlayer of the kröhnkite structure, whereas minimal α_c thermal expansion is in the direction of the rigid [Cu(SO₄)₂(H₂O)₂]²⁻ chains. Saranchinaite is stable up to 475 °C when it starts to decompose into tenorite, thénardite, and an unidentified phase. The expansion of saranchinaite is strongly anisotropic and strongest one is observed in the direction of the bisector of the β angle (nearly perpendicular to the Cu-sulfate layers) whereas less expansion occurs in the direction of the perpendicular diagonal of the unit cell. The name saranchinaite honors Galina M. Saranchina (1911–2004) of St. Petersburg State University, Russia. Besides her scientific achievements in the field of metamorphic petrology, she was an outstanding lecturer of petrology. The type specimen is deposited in the Mineralogical Museum, St. Petersburg State University, St. Petersburg, Russia. **D.B.**

SIUDAITE*

N.V. Chukanov, R.K. Rastsvetaeva, Ł. Kruszewski, S.M. Aksenov, V.S. Rusakov, S.N. Britvin, and S.A. Vozchikova (2018) Siudaite, Na₈(Mn²⁺Na)Ca₆Fe₃³⁺Zr₃NbSi₂₅O₇₄(OH)₂Cl·5H₂O: a new eudialyte-group mineral from the Khibiny alkaline massif, Kola Peninsula. *Physics and Chemistry of Minerals*, 45(8), 745–758.

Siudaite (IMA 2017-092), ideally Na₈(Mn²⁺Na)Ca₆Fe₃³⁺Zr₃NbSi₂₅O₇₄(OH)₂Cl·5H₂O, trigonal, is new eudialyte-group mineral. It was discovered in a peralkaline pegmatite hosted by astrophyllite- and aenigmatite-bearing rischorrite at the Astrophyllitovy Stream valley, Eveslogchorr Mt., Khibiny alkaline massif, Kola Peninsula, Russia (67°40'02"N, 33°55'28"E). The associated minerals are aegirine, albite, microcline, nepheline, astrophyllite, and loparite-(Ce). Siudaite is a product of hydrothermal alteration of a primary eudialyte-group mineral presumably related to georgbarsanovite. Further alteration resulted in the oxidation of Mn²⁺ to Mn³⁺ and formation of cherry-red to purple rims of so-called "oxyeudialyte" around siudaite grains. Siudaite also is partly substituted by "zirfessite," an amorphous hydrous silicate of Zr and Fe³⁺. Siudaite forms yellow to brownish-yellow vitreous equant anhedral grains up to 1.5 cm. The streak is white. Cleavage was not observed. Siudaite is brittle with an uneven fracture, no cleavage and Mohs hardness of 4½. Density measured by hydrostatic weighing is 2.96(1) g/cm³; $D_{\text{calc}} = 2.973 \text{ g/cm}^3$. In plane-polarized transmitted light siudaite is colorless to pale brown in large grains, non-pleochroic. It is optically uniaxial (-), $\omega = 1.635(1)$, $\epsilon = 1.626(1)$ ($\lambda = 589 \text{ nm}$). The mineral does not fluoresce under both long- and short-wave UV radiation. IR spectrum shows bands at (cm⁻¹; s = strong, w = weak, sh = shoulder, b = broad): 3624w, 3500b, 3260sh (O–H stretching), 1645 (H–O–H bending), 1504w, 1424w (CO₃²⁻ stretching), 1135sh, 1060sh, 1012s, 974s, 930sh (Si–O stretching), 742, 710sh, 675sh (mixed vibrations of tetrahedral rings), 532 (Fe³⁺–O stretching vibrations), 476, 455, 490sh, 362 (lattice modes involving predominantly bending vibrations of tetrahedral rings, Mn–O, Fe–O, and Zr–O stretching, and a librational vibrations of H₂O). According to Mössbauer spectroscopy data, all iron is trivalent. The average of unspecified number, mode and conditions of electron probe analyses is [wt% (range)]: Na₂O 8.40 (7.82–8.79), K₂O 0.62 (0.53–0.76), CaO 9.81 (9.65–10.04), La₂O₃ 1.03 (0.72–1.17), Ce₂O₃ 1.62 (1.46–1.85), Pr₂O₃ 0.21 (0.15–0.30), Nd₂O₃ 0.29 (0.21–0.34), MnO 6.45 (6.27–6.76), Fe₂O₃ 4.51 (4.34–4.69), TiO₂ 0.54 (0.40–0.65), ZrO₂ 11.67 (11.53–11.78), HfO₂ 0.29 (0.25–0.31), Nb₂O₅ 2.76 (2.40–3.23), SiO₂ 47.20 (46.81–47.89), Cl 0.54 (0.45–0.62), H₂O 3.5 (by HCN analysis), CO₂ not detected (by HCN analysis), –O=Cl₂ 0.12, total 99.32. The empirical formula (based on 24.5 Si atoms pfu, considering structural data) is [Na_{7.57}(H₂O)_{1.43}]_{Σ9}(Mn_{1.11}Na_{0.88}Ce_{0.31}La_{0.20}Nd_{0.05}Pr_{0.04}K_{0.41})_{Σ3}(H₂O)_{1.8}(Ca_{5.46}Mn_{0.54})_{Σ6}(Fe_{1.76}Mn_{2.19})_{Σ2.95}Nb_{0.65}(Ti_{0.20}Si_{0.50})_{Σ0.71}(Zr_{2.95}Hf_{0.04}Ti_{0.01})_{Σ3}Si_{24.00}O₇₀(OH)₂Cl_{0.47}·1.82H₂O. The strongest lines of the powder X-ray diffraction pattern [$d \text{ \AA}$ ($P\%$; hkl)] are: 7.12 (42; 110, $\bar{1}20$), 6.38 (60; $\bar{1}14$), 4.29 (55; $\bar{2}25$), 3.389 (47; 131), 3.191 (63; $\bar{2}28$), 2.963 (100; 415), 2.843 (99; 444), 2.577 (49; $\bar{3}39$). The unit-cell parameters refined from the powder X-ray data are $a = 14.1885(26)$, $c = 29.831(7)$ Å, $V = 5200.8$ Å³. The single-crystal X-ray data shows siudaite is trigonal, space group $R3m$, $a = 14.1778(1)$, $c = 29.8071(2)$ Å, $V = 5188.81$ Å³, $Z = 3$. The crystal structure was refined to $R1 = 3.86\%$ for 2436 independent $I > 2\sigma(I)$ reflections. Siudaite is generally isostructural with other 12-layered members of the eudialyte group with the space group $R3m$. Its crystal-chemical formula is $\{^{N1-3}[Na_{7.57}(H_2O)_{1.51}]\}_{\Sigma 9}^{N4}[Mn_{1.11}Na_{0.9}Ce_{0.6}K_{0.39}]\}_{\Sigma 3}^{N5}[(H_2O)_{1.8}]\}_{\Sigma 11}^{N6}[Ca_{5.5}Mn_{0.5}]\{^{M2a}(Fe_{1.76}^{3+})^{M2b}(Fe_{1.2}^{3+}Mn_{1.2})\}_{\Sigma 3}^{M3}[Nb_{0.6}]\}_{\Sigma 4}^{M4}[Ti_{0.2}Si_{0.5}](OH)_2Zr_3[Si_3O_9]_2[Si_9O_{26}(OH)]_2\}^{X1}[Cl_{0.47}(H_2O)_{0.42}]\}^{X2}[(H_2O)_{0.47}]$. Siudaite is the second after georgbarsanovite member of eudialyte-group with the predominance of Mn²⁺ in N4 site. Like georgbarsanovite, it has Nb-dominant M3 site and shows the occurrence of Cl and H₂O in the anionic X positions on the threefold axis. Siudaite is analog of georgbarsanovite with Fe³⁺

dominant *M2* site. It also chemically related to ikranite and to a less extent to fekliechite and fengchengite by the predominance Fe^{3+} in *M2* site. Siudaite is named after the Polish mineralogist and geochemist Rafał Siuda (b. 1975), a specialist in mineralogy and geochemistry of supergene zones of ore deposits in the Lower Silesia area in Poland. The type material (a part of the holotype specimen) is deposited in the Mineralogical and Petrographical Section of the Museum of Earth PAS (Muzeum Ziemi Polskiej Akademii Nauk), Warsaw, Poland. **D.B.**

VYMAZALOVÁITE*

S.F. Sluzhenikin, V.V. Kozlov, C.J. Stanley, M.L. Lukashova, and K. Dicks (2018) Vymazalováite, $\text{Pd}_3\text{Bi}_2\text{S}_2$, a new mineral from the Noril'sk-Talnakh deposit, Krasnoyarskiy region, Russia. Mineralogical magazine, 82(2), 367–373.

Vymazalováite (IMA 2016-105), $\text{Pd}_3\text{Bi}_2\text{S}_2$, cubic, is a new platinum-group mineral discovered in vein-disseminated pyrite-chalcocopyrite-galena ores hosted by diopside-hydrogrossular-serpentine metasomatites (after monticellite scarns) ~30 m below the lower contact of the Talnakh intrusion at the Komsomolsky mine, Talnakh deposit, Noril'sk district, Russia. Vymazalováite forms inclusions up to 20–35 μm or euhedral grains in intergrowths of polarite, sobolevskite, acanthite, and unnamed $(\text{Pd,Ag})_3\text{BiS}_2$ in aggregates (up to ~200 μm) in galena and rarely in chalcocopyrite. Less commonly, it found in aggregates composed of intergrowths of telargpalite, braggite, vysotskite, sopcheite, stibiopalladinite, sobolevskite, moncheite, kotulskite, malyshevite, insizwaite, acanthite, Au-bearing silver, and kravtsovite in association with pyrite, chalcocopyrite, and galena. Vymazalováite is opaque and metallic. Its synthetic analog is gray with a gray streak, brittle. Other macroscopic properties were not determined; $D_{\text{calc}} = 9.25 \text{ g/cm}^3$. In plane-polarized reflected light, vymazalováite is creamy gray and appears slightly brownish against galena in the assemblage with chalcocopyrite. It is isotropic with no internal reflections. The reflectance values were measured in the air between 400 and 700 nm with 20 nm interval. They are practically identical with those obtained for synthetic analog. The values for COM wavelengths [$R\%$ (nm)] are: 46.3 (470), 47.6 (546), 48.5 (589), 49.5 (650). The average of seven electron probe WDS analyses [wt% (range)] is: Pd 40.42 (39.68–41.44), Bi 49.15 (48.08–49.99), Ag 0.55 (0.26–1.01), Pb 1.02 (0.65–1.62), S 7.77 (7.52–7.92), Se 0.26 (0.12–0.38), total 99.17. The empirical formula based on 7 atoms pfu is $\text{Pd}_{3.05}(\text{Bi}_{1.89}\text{Ag}_{0.04}\text{Pb}_{0.04})_{\Sigma 1.97}(\text{S}_{1.95}\text{Se}_{0.03})_{\Sigma 1.98}$. The strongest lines in the powder X-ray diffraction pattern of synthetic vymazalováite [$d \text{ \AA}$ ($P\%$; hkl)] are: 5.86 (23; 110), 4.15 (32; 200), 2.93 (78; 220), 2.40 (100; 220), 2.08 (53; 400), 1.695 (34; 422), 1.468 (35; 440), 1.252 (31; 622). The structural identity of vymazalováite with synthetic $\text{Pd}_3\text{Bi}_2\text{S}_2$ was confirmed by electron backscatter diffraction measurements on the natural sample. The crystal structure of synthetic $\text{Pd}_3\text{Bi}_2\text{S}_2$. The mineral is cubic, space group $I2_13$, $a = 8.3097(9) \text{ \AA}$, $V = 573.79 \text{ \AA}^3$ and $Z = 4$. The crystal structure of synthetic $\text{Pd}_3\text{Bi}_2\text{S}_2$ was solved by Wehrich et al. (2007). It is a structure type of corderoite ($\text{Hg}_3\text{S}_2\text{Cl}_2$), belongs to the antiperovskite superstructure, and closely related to parkerite $\text{Ni}_3\text{Bi}_2\text{S}_2$, differing in the occupation of one Pd position and is also related to pašavaite $\text{Pd}_3\text{Pb}_2\text{Te}_2$ and shandite $\text{Pd}_3\text{Ni}_3\text{S}_2$. Chemically it is the Bi analog of laflammeite $\text{Pd}_3\text{Pb}_2\text{S}_2$. The mineral name honors Anna Vymazalová (b. 1974) research scientist at the Czech Geological Survey for her contributions to the ore and experimental mineralogy of the platinum-group minerals. The holotype (polished section) is deposited at the Department of Earth Sciences of the Natural History Museum, London, U.K. **D.B.**

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NEW DATA

LAVINSKYITE-1M*

U. Kolitsch, S. Merlino, D. Belmonte, C. Carbone, R. Cabella, G. Lucchetti, and M.E. Ciriotti (2018) Lavinskyite-1M, $\text{K}(\text{LiCu})\text{Cu}_6(\text{Si}_4\text{O}_{11})_2(\text{OH})_4$, the monoclinic MDO equivalent of lavinskyite-2O (formerly lavinskyite), from the Cerchiara manganese mine, Liguria, Italy. European Journal of Mineralogy, 30(4), 811–820.

Lavinskyite-1M, $\text{K}(\text{LiCu})\text{Cu}_6(\text{Si}_4\text{O}_{11})_2(\text{OH})_4$, is a monoclinic Maximum Degree of Order (MDO) polytype related to the orthorhombic MDO polytype lavinskyite-2O (formerly lavinskyite, now redefined), identified in samples from the Cerchiara manganese mine, Liguria, Italy. It was originally approved by CNMNC IMA under the name liguriaite (IMA 2014-035), then redefined as lavinskyite-1M by analogy with lavinskyite-2O (IMA proposal 16-E). It occurs in microfractures and veinlets cross-cutting Jurassic metacherts, associated with calcite, quartz, norrishite, and “schefferite” (Mn-bearing variety of diopside). Lavinskyite-1M forms blue millimetric aggregates of subparallel platy crystals tabular on (100) and elongate along [001], ~0.15 mm in length. No twinning was observed. Lavinskyite-1M is brittle with perfect cleavage on {100}, and uneven fracture. The estimated Mohs hardness is ~5; $D_{\text{calc}} = 3.613 \text{ g/cm}^3$. The mineral is insoluble in cold dilute HCl. In transmitted plane-polarized light lavinskyite-1M is moderately pleochroic $X =$ pale blue $\geq Z =$ pale blue with faint greenish tint $\geq Y =$ pale blue. It is optically biaxial (+), $\alpha = 1.674(2)$; $\beta = 1.692(3)$, $\gamma = 1.730(3)$; $2V \sim 75^\circ$ (estimated), $2V_{\text{calc}} = 70^\circ$; $X \wedge a \sim 20^\circ$, $Y = b$, $Z \sim c$ with an optical axis plane parallel to (010); elongation is positive and no dispersion was observed. Raman spectroscopy shows that the spectra of lavinskyite-1M and lavinskyite-2O are very similar, although lavinskyite-1M has only two bands in the OH stretching region (at 3662 and 3694 cm^{-1}). The average of seven electron microprobe WDS analyses is [wt% (range)]: SiO_2 42.51 (40.94–45.37), CuO 44.12 (40.69–45.97), MgO 1.27 (0.26–3.76), MnO 0.27 (0.21–0.38), Na_2O (by LA-ICP-MS) 0.61 (0.55–0.70), K_2O 4.46 (4.37–4.58), Li_2O (by LA-ICP-MS) 1.17 (1.10–1.26), H_2O (by charge balance) 3.16, total 97.58. The empirical formulae based on 26 O pfu is $(\text{K}_{1.08})_{\Sigma 1.08}(\text{Li}_{0.89}\text{Mg}_{0.36}\text{Cu}_{0.33}\text{Na}_{0.22}\text{Mn}_{0.04}^+)_{\Sigma 1.86}\text{Cu}_{6.00}\text{Si}_{8.08}\text{O}_{22}(\text{OH})_4$. The strongest X-ray powder diffraction lines are [$d \text{ \AA}$ ($P\%$; hkl)]: 10.216 (100; 100), 9.007 (20; 110), 4.934 (19; 210), 3.983 (19; 230), 3.353 (33; 310), 2.8693 (22; 241), 2.6155 (35; 161), 2.3719 (23; 202). The crystal structure was solved by direct methods and refined to $R_1 = 0.0512$ for 1786 $F_o > 4\sigma(F_o)$ independent reflections. The mineral is monoclinic, $P2_1/c$, $a = 10.224(2)$, $b = 19.085(4)$, $c = 5.252(1) \text{ \AA}$, $\beta = 92.23(3)^\circ$, $V = 1024.0 \text{ \AA}^3$, $Z = 2$. The crystal structure of lavinskyite-1M is built up by two distinct structural layers, both with translation vectors b , c ($b = 19.046$, $c = 5.2497 \text{ \AA}$) regularly alternating in the a_0 direction ($a_0 = 10.1885 \text{ \AA}$). The first layer is constituted by the complex TOT block, with brucite-like CuO_2 sheets sandwiched by amphibole-like chains on both sides, and by Li^+ cations (L_{2n} layers, with symmetry $P2_1/c$); the second layer is constituted by half-occupied ladder-like ribbons of copper atoms in (nearly) square coordination running along c and by K^+ cations (L_{2n+1} layer with layer symmetry $Pn\text{cm}$). Infinite ordered polytypes and disordered structures are possible, corresponding to the various possible sequences of operators that may be active in the L_{2n+1} layers. Only two MDO polytypes are possible, just corresponding to those polytypes presenting the minimum number of different triples of layers (principle of MDO structures). Lavinskyite-1M has the same topology as orthorhombic lavinskyite-2O, which is isostructural with plancheite $[\text{Cu}_8(\text{Si}_4\text{O}_{11})_2(\text{OH})_4 \cdot \text{H}_2\text{O}]$. The studied lavinskyite-1M material consists of two micromount-sized cotype specimens; the first one is preserved in the collection of the Dipartimento di Scienze della Terra, dell'Ambiente e Della Vita (DISTAV), Università degli Studi di Genova, Italy. The second cotype is preserved in the collection of the Natural History Museum in Vienna, Austria. **F.C.**