# New Mineral Names*,†

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This New Mineral Names has entries for 25 new minerals, including alcaparrosaite, bastnäsite-(Nd), calciolangbeinite, chovanite, chromio-pargasite (ehimeite), chukhrovite-(Ca), dzhuluite, eltyubyuite, ferrisepiolite, hereroite, hielscherite, iseite, itsiite, jakobssonite, kazanskiite, meisserite, nashite, omsite, schindlerite, tanohataite, tazzoliite, vapnikite, vladkrivovichevite, wernerbaurite, and wopmayite.

## ALCAPARROSAITE*

A.R. Kampf, S.J. Mills, R.M. Housley, P.A. Williams, and M. Dini (2012) Alcaparrosaite, $K_3Ti^{4+}Fe^{3+}(SO_4)_4O(H_2O)_2$, a new hydrophobic $Ti^{4+}$ sulfate from Alcaparrosa, Chile. Mineralogical Magazine, 76(4), 851–861.

Alcaparrosaite (IMA 2011-024), ideally $K_3Ti^{4+}Fe^{3+}(SO_4)_4O(H_2O)_2$, is a new mineral from the Alcaparrosa mine, Cerritos Bayos, El Loa Province, Antofagasta, Chile. Alcaparrosaite was formed by the oxidation of pyritic masses under increasingly arid conditions, likely at a relatively early phase. It occurs on and intergrown with coquimbite, associated with ferrinatrite, krausite, pertlikite, pyrite, tamarugite, and voltaite. Other minerals at the deposit include aluminocopiapite, amarantite, botryogen, copiapite, cuprocopiapite, fibroferrite, halotrichite, jarosite, krausite, metahohmannite, metavoltine, natrojarosite, parabutlerite, paracoquimbite, pickeringite, quenstedtite, rhomboclase, römerite, sideronatrite, and szomolnokite. Crystals of alcaparrosaite occur as blades and tapering prisms up to 4 mm in length, flattened on {010} and elongated along [100]. The observed crystal forms are {010}, {110}, {1.13.0}, and {021}. No twinning was detected during the single-crystal X-ray diffraction study. Alcaparrosaite is pale yellow with a white streak and is transparent with a vitreous luster. Crystals show no cleavage, have a conchoidal fracture, and a Mohs hardness of ~4. $D_{meas} = 2.80(3)$ g/cm³ and $D_{calc} = 2.807$ g/cm³. The mineral is hydrophobic, insoluble in cold and hot water, very slowly soluble in aqueous solutions of HCl (38%), HNO₃ (70%), and H₂SO₄ (96%) and decomposes slowly in concentrated aqueous solutions of NaOH and KOH. Alcaparrosaite does not fluoresce in long- or short-wave ultraviolet light. It is optically biaxial (+) with α = 1.643(1), β = 1.655(1), γ = 1.680(1), $2V_{meas} = 70(2)°$ and $2V_{calc} = 70.3°$. The mineral exhibits strong parallel dispersion

$r < v$. The optical orientation is $X = \mathbf{b}$; $Y \wedge \mathbf{c} = 27°$ in the obtuse angle β. No pleochroism was observed. The average of 4 electron probe analyses gives [wt% (range)]: Na₂O 0.32 (0.16–0.51), K₂O 20.44 (20.30–20.67), Fe₂O₃ 11.58 (11.41–11.71), TiO₂ 11.77 (11.54–12.18), P₂O₅ 0.55 (0.48–0.68), SO₃ 47.52 (46.57–48.06), H₂O 5.79 (calculated from structure refinement); total 97.97 wt%. This gives the empirical formula $(K_{2.89}Na_{0.07})_{\Sigma2.96}Ti^{4+}_{0.98}Fe^{3+}_{0.97}(S_{0.99}P_{0.01}O_4)_4O_{0.72}(OH)_{0.28}(H_2O)_2$ based on 19 O pfu. The strongest lines in the X-ray powder diffraction pattern [$d_{obs}$ Å ($I_{obs}$%; *hkl*)] are: 6.907 (41; 021,110), 3.628 (34; 023,$\bar{1}$13), 3.320 (32; $\bar{2}$02), 3.096 (100; 202,$\bar{1}$33,150), 3.000 (40; $\bar{1}$51), 2.704 (38; $\bar{2}$23,152), 1.9283 (30; $\bar{1}$55), 1.8406 (31; $\bar{3}$53,$\bar{2}$06). The unit-cell parameters refined from powder-diffraction data are: $a = 7.577(6)$, $b = 16.815(6)$, $c = 12.208(6)$ Å, β = 94.116(11)°, and $V = 1551.5$ Å³. Single-crystal X-ray diffraction data collected on a crystal of size 220 × 210 × 70 μm refined to $R_1 = 0.0263$ for 1726 unique reflections with $I \geq 4σ(I)$ shows alcaparrosaite is monoclinic, $C2/c$, with the cell parameters $a = 7.55943(14)$, $b = 16.7923(3)$, $c = 12.1783(9)$ Å, β = 94.076(7)°, $V = 1542.01$ Å³, and $Z = 4$. The structure of alcaparrosaite consists of corner-sharing octahedra linked as dimers, occupied by $Ti^{4+}$ and $Fe^{3+}$ in roughly equal amounts, linked into chains parallel to [001] by the SO₄ tetrahedra, which also links the chains into undulating sheets parallel to {010} (as in goldichite). The sheets are linked via 10- and 11-coordinated K atoms in the interlayer region. Alcaparrosaite is named for the locality, the Alcaparrosa mine. Three cotype specimens are deposited in the Natural History Museum of Los Angeles County, California, U.S.A. **O.C.G.**

## BASTNÄSITE-(Nd)*

R. Miyawaki, K. Yokoyama, and T.A. Husdal (2013) Bastnäsite-(Nd), a new Nd-dominant member of the bastnäsite group from the Stetind pegmatite, Tysfjord, Nordland, Norway. European Journal of Mineralogy, 25, 187–191.

Bastnäsite-(Nd), (IMA 2011-062), ideally (Nd,La,Ce)(CO₃)F, is the Nd analog of bastnäsite-(Ce) Ce(CO₃)F. It occurs in the Stetind pegmatite, Tysfjord, Nordland, Norway (68°10′15.20″ N 16°33′10.65″ E). The pegmatite belongs to a series of quartz-

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microcline NYF (niobium–yttrium–fluorine) pegmatites found in the Tysfjord granite, a 1800 Ma old granitic orthogneiss, deformed during the Caledonian orogeny. These pegmatites have characteristic lenticular bodies of Y-rich fluorite, which is particularly rich in inclusions of various REE-minerals. Bastnäsite-(Nd) occurs in these inclusions along with bastnäsite-(Ce), stetindite, atelisite-(Y), calcioancylite-(Nd), kozoite-(Nd), and vyuntspakhkite-(Y). Bastnäsite-(Nd) forms thin (up to 20 μm) zones in outer parts of tabular hexagonal crystals (up to 0.2 mm) of bastnäsite-(Ce). The mineral is translucent and pale purplish pink to colorless. Streak is inferred to be white by comparison with bastnäsite-(Ce). It has indistinct cleavage on {100}, an uneven fracture and a vitreous, greasy or pearly luster. It is brittle and Mohs hardness is 4–4½ and $D_{calc}$ = 5.23 g/cm$^3$. Optical properties were not determined because of the small size of the mineral. The calculated mean refractive index is $n$ = 1.76. Average of 6 electron probe WDS analyses gave [wt% (range)]: $Y_2O_3$ 0.19 (0.02–0.46), $La_2O_3$ 18.64 (16.57–20.37), $Ce_2O_3$ 18.64 (16.63–20.03), $Pr_2O_3$ 6.41 (5.89–6.94), $Nd_2O_3$ 26.86 (26.09–27.45), $Sm_2O_3$ 2.95 (2.50–3.23), $Gd_2O_3$ 1.30 (1.05–1.38), $Dy_2O_3$ 0.07 (0.00–0.30), F 8.98 (8.85–9.07), $CO_2$ (calculated) 19.92, –O=F 3.78, total 100.18. On the basis of C = 1 pfu, the empirical formula is $Nd_{0.353}La_{0.253}Ce_{0.251}Pr_{0.086}Sm_{0.037}$ $Gd_{0.016}Y_{0.004}Dy_{0.001}CO_{2.978}F_{1.044}$. The strongest lines in the X-ray powder-diffraction pattern [$d_{obs}$ (Å) ($I_{obs}$%; $hkl$)] are: 4.86 (71; 002), 3.54 (70; 110), 2.86 (100; 112), 2.04 (31; 300), 2.00 (48; 114). The mineral has the hexagonal space group $P\bar{6}2c$ with $a$ = 7.0792(13), $c$ = 9.721(2) Å, $V$ = 421.92(18) Å$^3$, and $Z$ = 6. Diffraction peaks such as the 411 reflection (ca. 2.28 Å) typical for the $P\bar{6}$ hexagonal $Nd(CO_3)OH$ type structure having larger unit-cell and lower symmetry were not detected. Bastnäsite-(Nd) is a member of the bastnäsite group. As the mineral is associated with stetindite ($Ce^{4+}SiO_4$), it is reasonable to assign the Nd-dominance among REE in bastnäsite-(Nd) to the partial oxidation of $Ce^{3+}$ to $Ce^{4+}$ in the mineralising fluids, and the fixation of Ce in an own mineral phase, stetindite. Bastnäsite-(Nd) is named following the Levinson rule. Type material is deposited in the collections of the National Museum of Nature and Science, Japan, registration number NSM-MF15494. **F.C.**

## CALCIOLANGBEINITE*

I.V. Pekov, M.E. Zelenski, N.V. Zubkova, V.O. Yapaskurt, N.V. Chukanov, D.I. Belakovskiy, and D.Yu. Pushcharovsky (2012) Calciolangbeinite, $K_2Ca_2(SO_4)_3$, a new mineral from the Tolbachik volcano, Kamchatka, Russia. Mineralogical Magazine, 76(3), 673–682.

Calciolangbeinite (IMA 2011-067), ideally $K_2Ca_2(SO_4)_3$, is the Ca-dominant analog of langbeinite. It occurs in sublimates at the Yadovitaya fumarole on the Second scoria cone of the Northern Breakthrough of the Great Tolbachik Fissure eruption, Tolbachik volcano, Kamchatka, Russia, a 300 m high scoria cone that was formed in 1975. In 2010, many fumaroles with gas temperatures of up to 480 °C were active at the top of the scoria cone. The Yadovitaya fumarole is an open cave, which is 1.5 m across at the entrance and about 2 m deep. The rocks inside the cave are thickly coated in volcanic sublimates which have been partially altered by meteoric water. Mineral assemblages in the sublimate crusts are significantly variable in different areas of

the fumarole; sulfates and oxides dominate the fumarole assemblages; chlorides, fluorides, carbonates, arsenates, vanadates, selenites, molybdates, silicates are subordinate; and sulfides and gold occur in minor amounts. Calciolangbeinite is a rare and is found in association with abundant langbeinite, as well as piypite, hematite, Fe- and Sb-bearing rutile, pseudobrookite, As- and Zn-bearing orthoclase in solid solution with filatovite, lyonsite, lammerite, and late secondary cyanochroite and chlorothionite. Calciolangbeinite occurs as coarse and/or distorted flattened, curved or skeletal crystals and almost anhedral grains, typically up to 0.5 mm, and rarely up to 1 mm across. Although crystals are tetrahedral, the habit is pseudo-octahedral when the faces of the positive and negative tetrahedron, {111} and {11$\bar{1}$}, are equally developed. Late-stage calciolangbeinite occurs in complex epitaxial intergrowths with langbeinite. Calciolangbeinite is transparent and colorless with white streak and vitreous luster. Its Mohs hardness is 3–3½. It is brittle, has a conchoidal fracture and no obvious cleavage; $D_{meas}$ = 2.68(2) and $D_{calc}$ = 2.74 g/cm$^3$. Calciolangbeinite is optically isotropic with $n$ = 1.527(2). The mineral is not fluorescent in ultraviolet radiation or when exposed to cathode rays. The IR spectra of calciolangbeinite and langbeinite are very similar (in cm$^{-1}$; s = strong band; w = weak band; sh = shoulder): 1144(s) (S–O stretching vibrations of $SO_4^{2-}$ groups); 645(sh), 630, 612 (bending vibrations of $SO_4^{2-}$ groups); 473(w), 446(w) (lattice modes involving mainly Mg–O and Ca–O stretching and motion of $SO_4^{2-}$ anions as a whole). Bands corresponding to H-, B-, C-, and N-bearing groups (1200–3800 cm$^{-1}$) were absent in the IR spectrum. The average of 5 electron probe EDS analyses is [wt% (range)]: $Na_2O$ 0.38 (0.3–0.5), $K_2O$ 21.85 (21.2–22.4), MgO 6.52 (5.7–7.2), CaO 16.00 (15.2–17.7), MnO 0.27 (0.2–0.3), FeO 0.08 (0.00–0.15), $Al_2O_3$ 0.09 (0.0–0.15), $SO_3$ 55.14 (53.0–56.8), total 100.63 wt%. The empirical formula calculated on the basis of 12 O apfu is $K_{2.01}(Ca_{1.24}Mg_{0.70}Na_{0.05}Mn_{0.02}Fe_{0.01}Al_{0.01})_{\Sigma2.03}$ $S_{3.00}O_{12}$. The strongest lines of the X-ray powder diffraction pattern are [$d_{obs}$ Å ($I_{obs}$%; $hkl$)]: 5.84 (8; 111), 4.54 (9; 120), 4.15 (27; 211), 3.218 (100; 310,130), 2.838 (8; 230,320), 2.736 (37; 231,321), 2.006 (11; 431,341), 1.658 (8; 611,532,352). The crystal structure of calciolangbeinite was refined from single-crystal X-ray diffraction data to $R_1$ = 4.47%. The mineral is cubic, space group $P2_13$, $a$ = 10.1887(4) Å, $V$ = 1057.68 Å$^3$, and $Z$ = 4. Its crystal structure is based on the langbeinite-type three-dimensional complex framework, which is made up of $(Ca,Mg)O_6$ octahedra (with Ca and Mg disordered) and $SO_4$ tetrahedra. Potassium atoms occupy two sites in voids in the framework: K(1) cations are located in ninefold polyhedra, whereas K(2) cations are sited in significantly distorted octahedra. The mineral is named as a result of its chemical composition and relationship to langbeinite, with which it forms a solid-solution series. The type specimen is deposited in the collections of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **F.C.**

## CHOVANITE*

D. Topa, J. Sejkora, E. Makovicky, J. Pršek, D. Ozdín, H. Putz, H. Dittrich, and S. Karup-Møller (2012) Chovanite, $Pb_{15-2x}Sb_{14+2x}S_{36}O_x$ (x ~ 0.2), a new sulphosalt species from the Low Tatra Mountains, Western Carpathians, Slovakia. European Journal of Mineralogy, 24(4), 727–740.

Chovanite (IMA 2009-055), $Pb_{15-2x}Sb_{14+2x}S_{36}O_x$ (x ~ 0.2), is a new oxysulphosalt discovered in three hydrothermal Sb deposits, Dúbrava, Malé Zelezné, and Klačianka, in the Low Tatra Mountains, Slovakia. The mineral was named in honor of Martin Chovan (b. 1946), an outstanding Slovak mineralogist, an expert in Sb mineralization in the Western Carpathians region. Mineralized veins and stockworks of the Dúbrava deposit are hosted in granodiorites-tonalites with bodies of aplite, migmatite, and gneiss; veins of the Malé Zelezné deposit occur in granites and mica schist, while impregnations and veinlets of the Klačianka deposit are hosted in silicified and mylonitized altered granitoids. Chovanite crystallized at the third, quartz-ankerite-sphalerite stage of 5 stages of hydrothermal activity and associated with zinkenite, robinsonite, and other Pb-Sb sulphosalts at all three deposits (heteromorphite, semseyite, boulangerite, jamesonite, scainiite, dadsonite, rouxelite, geocronite). Other associated minerals are: galena, senarmontite, native Sb, chalcostibite, tetrahedrite, bournonite, chalcopyrite, pyrite, plagionite, tintinaite. Chovanite replaces sulphosalts formed at earlier stages, and its formation represents a mineralization period with a moderately high oxygen activity. Chovanite forms irregular aggregates up to 1 cm in size of irregular or short prismatic grains up to 100 µm intergrown with Pb-Sb sulphosalts, mainly with boulangerite and robinsonite. Chovanite is gray, opaque, and has metallic luster. The streak was not examined because the mineral forms intimate intergrowths with other sulphosalts. Chovanite is brittle, has good cleavage parallel to the *c* axis, sub-parallel fracturing perpendicular to the *c* axis. Micro-indentation hardness $VHN_{25}$ = 222.5 (213–238) corresponding to Mohs hardness of 3. $D_{calc}$ = 7.14 g/cm³. In reflected light, chovanite is white and has weak pleochroism between white with a yellowish green tint and white with a faint bluish tint. It is moderately to strongly anisotropic in air and oil with rotation tints vary between blue gray and brown gray. No internal reflections were observed. The reflectance data was measured between 400 and 700 nm with 20 nm intervale. The values interpolated to COM wavelengths (in air) [$R_{min}$, $R_{max}$ (nm)] are: 37.7, 43.6 (470), 36.7, 43.0 (546), 35.4, 41.3 (589), 34.0, 39.2 (650) (for the sample from the Dúbrava deposit). Chemical analyses were done on various grains of chovanite from all three deposits, were carried out in three scientific institutions and showed similar results. The average of 18 electron probe WDS analyses (wt%) collected on five grains of chovanite from the Dúbrava deposit is: Pb 50.72(31), Sb 29.28(17), S 19.50(11), Bi 0.10(5), Ag 0.07(4), Cl 0.04(1), total 99.76 wt%. The empirical formula calculated on the basis of 65 atoms pfu is $Pb_{14.51}Ag_{0.04}(Sb_{14.26}Bi_{0.03})_{\Sigma14.29}(S_{36.06}Se_{0.04}Cl_{0.07})_{\Sigma36.16}$. The strongest lines of the calculated powder diffraction pattern [$d_{meas}$ Å ($I_{meas}$; *hkl*)] are: 4.012 (39; 12.0.$\bar{2}$), 3.966 (39; 310), 3.433 (100; 14.0.$\bar{2}$), 3.387 (31; 14.0.$\bar{1}$), 3.269 (29; 8.0.$\overline{10}$). The crystal structure of chovanite was determined on a crystal fragment from the Dúbrava deposit. It was refined on the basis of 8780 reflections to $R_1$ = 0.097%. The mineral is monoclinic, $C2/m$, $a$ = 48.19(5), $b$ = 4.110(4), $c$ = 34.24(3) Å, β = 106.059(15)°, $V$ = 6517(11) Å³, and $Z$ = 4. The crystal structure of chovanite has 11 independent Pb sites, 13 Sb sites, some of which are split into two partially occupied non-overlapping positions, and 5 mixed (Pb,Sb) sites. Structure refinement indicates that $x$, the empirical oxygen content, is 0.18 for chovanite. Chovanite has a typical rod-based structure of a Pb-Sb boxwork type, and is similar to those of pillaite and

pellouxite. Holotype material is deposited in the reference collection of the Department of Materials Engineering and Physics, University of Salzburg, Austria, in the mineralogical collection of the Department of Mineralogy and Petrology of the National Museum in Prague, Czech Republic, and in mineralogical collection of the Department of Mineralogy and Petrology, Faculty of Natural Sciences, Comenius University, Bratislava, Slovakia. **Yu.U.**

## CHROMIO-PARGASITE (EHIMEITE)*

D. Nishio-Hamane, M. Ohnishi, T. Minakawa, J-i. Yamaura, S. Saito, and R. Kadota (2012) Ehimeite, $NaCa_2Mg_4CrSi_6Al_2O_{22}(OH)_2$: The first Cr-dominant amphibole from the Akaishi Mine, Higashi-Akaishi Mountain, Ehime Prefecture, Japan. Journal of Mineralogical and Petrological Sciences, 107(1), 17.

A new Cr-dominant calcic amphibole ehimeite (IMA 2011-023), ideally $NaCa_2Mg_4CrSi_6Al_2O_{22}(OH)_2$, has been discovered in a chromitite deposit in the Akaishi Mine, Higashi-Akaishi Mountain, Ehime Prefecture, Japan, and is named for the locality. The top of Higashi-Akaishi Mountain consist of dunite intercalated with wehrlite, clinopyroxenite and chromitite. The ultramafic rock has undergone metamorphism to eclogite facies and subsequently to epidote-amphibole facies. The chromitite deposits of a podiform type are scattered in serpentinized (antigorite is dominant) dunite. Emerald-green to pale-green prismatic crystals of ehimeite up to 1.5 × 0.5 cm were found in chromitite cracks along with purple kämmererite, Cr-poor clinochlore, phlogopite, greenish diopside, calcite, and uvarovite. This association supposedly formed by the reaction between chromitite and the metamorphic fluid at the retrograde stage of the metamorphism. The mineral has pale green streak and a vitreous luster. The cleavage is perfect along {110}. Ehimeite is brittle with uneven fracture and a Mohs hardness of 6; $D_{meas}$ = 3.08; $D_{calc}$ = 3.121 g/cm³. The mineral is optically biaxial (+), α = 1.644(2), β = 1.647(2), γ = 1.659(2), $2V_{calc}$ = 53°. It is pleochroic from yellowish to bluish-green (orientation not given). The representative composition and range for 30 electron probe EDS analysis is[wt% (range)]: $SiO_2$ 42.90 (41.86–45.88), $TiO_2$ 0.25 (0.08–0.57), $Al_2O_3$ 12.10 (10.39–12.59), $Cr_2O_3$ 5.46 (2.89–5.46), FeO 1.20 (1.01–1.58), MgO 19.28 (17.99–20.33), CaO 12.31 (11.47–13.06), $Na_2O$ 3.26 (2.24–3.99), $K_2O$ 0.37 (0.16–0.43), $H_2O$ 2.09 (by stoichiometry); total 99.22 wt%. The empirical formula calculated on the basis of O = 22 and OH = 2 is $(Na_{0.88}K_{0.07})_{\Sigma0.95}(Ca_{1.89}Na_{0.02}Mg_{0.09})_{\Sigma2.00}Mg_{4.03}(Cr_{0.62}Al_{0.19}Fe^{3+}_{0.07}Fe^{2+}_{0.07}Ti_{0.03})_{\Sigma0.98}(Si_{6.14}Al_{1.86})_{\Sigma8.00}O_{22}(OH)_2$. The $Fe^{2+}/Fe^{3+}$ ratio estimated using the average ferric iron method. The strongest lines of the powder XRD pattern [$d_{obs}$ Å ($I_{obs}$%; *hkl*)] are: 3.370 (58; 150), 2.932 (43; 221), 2.697 (81; 151), 2.585 (50; 061), 2.546 (100; 202), 2.346 (42; 351), 2.156 (35; 261), 1.514 (55; 263). The data indexed on the basis of the monoclinic unit cell, space group $C2/m$, with $a$ = 9.9176(14), $b$ = 18.0009(12), $c$ = 5.2850(7) Å, β = 105.400(7)°, $V$ = 909.6 Å³; $Z$ = 2. The initial model for single-crystal structure refinement was based on synthetic pargasite. The structure has been refined to $R_1$ = 0.0488 assuming that Cr, Al, all Fe, and Ti of the $M$ sites fixed in the $M(2)$ sites, Al of the $T$ sites fixed in the $T(1)$ sites and applying several other simplifications. The single crystal unit-cell parameters are: $a$ = 9.9176(1), $b$ = 18.0057(2), $c$ = 5.2865(1) Å, β = 105.395(1)°.

The type specimen has been deposited at the National Museum of Nature and Science, Tokyo. **D.B.**

**Comment:** Following the new classification scheme of amphibole group (Hawthorne et al. 2012, *American Mineralogist*, 97, 2031–2048) published soon after the approval of the ehimeite that name of a new end-member is not valid any more. In the official IMA-CNMNC list of mineral names (http://www.ima-mineralogy.org/Minlist.htm), this mineral species given as redefined to chromio-pargasite.

## CHUKHROVITE–(CA)*

P. Vignola, F. Hatert, D. Bersani, V. Diella, P. Gentile, and A. Risplendente (2012) Chukhrovite-(Ca), $Ca_{4.5}Al_2(SO_4)$ $F_{13}·12H_2O$, a new mineral species from the Val Cavallizza Pb–Zn–(Ag) mine, Cuasso al Monte, Varese province, Italy. European Journal of Mineralogy, 24, 1069–1076.

Chukhrovite-(Ca) (IMA 2010-081), ideally $Ca_{4.5}Al_2(SO_4)$ $F_{13}·12H_2O$, is the Ca-dominant species of the chukhrovite mineral group from the the Val Cavallizza Pb–Zn–Ag mine, Cuasso al Monte, Varese province, Italy. It is found as low temperature hydrothermal crystallizations covering the surfaces of fractures crosscutting a marcasite and REE-bearing fluorite vein. Associated minerals include marcasite, gypsum, and hydrated Fe oxides. It forms sharp octahedra up to 150 μm in diameter. Crystals are translucent to transparent, colorless to white, with a white streak and a vitreous luster. The crystals are brittle without a distinct cleavage or fracture; Mohs hardness is 3.5; $D_{calc}$ = 2.23 g/cm³. Chukhrovite-(Ca) is isotropic with $n$ = 1.432(1), and is non-fluorescent either under short-wave (254 nm) or long-wave (366 nm) ultraviolet light. Infrared spectrum of chukhrovite-(Ca) collected in the 400–4000 cm⁻¹ region shows absorption bands corresponding to vibrations of the $SO_4$ group located at 864 ($v_1$ $SO_4$), 1077, and 1165 cm⁻¹ ($v_3$ $SO_4$), $H_2O$ bending vibrations at 1618 cm⁻¹, and $H_2O$ stretching modes at 3233, 3349, 3504, and 3631 cm⁻¹. The Raman spectrum is characterized by absorption bands related to the vibration of the sulphate group, at 449 ($v_2$ $SO_4$), 553 ($v_4$ $SO_4$), 977 ($v_1$ $SO_4$), and 1112 cm⁻¹ ($v_3$ $SO_4$), and vibrations of the water molecules at 1632 ($H_2O$ bending), and 3270, 3440, 3470, and 3560 cm⁻¹ ($H_2O$ stretching). The average of 5 electron probe WDS analyses gave [wt% (range)]: $SiO_2$ 0.03 (0.00–0.07), $SO_3$ 10.64 (9.44–11.82), $Al_2O_3$ 15.72 (13.13–17.07), FeO 0.34 (0.01–0.98), CaO 35.74 (34.11–37.05), $Na_2O$ 0.49 (0.16–0.77), F 36.61 (34.17–39.50), $H_2O$ 15.85 (by difference), $–O=F_2$ 15.42, total 100.00 wt%. On the basis of 3 (Al+S) pfu, the empirical chemical formula is $(Ca_{4.33}Na_{0.11}Fe_{0.03})_{Σ4.47}Al_{2.10}(S_{0.90}O_{3.72})F_{13.10}·5.98H_2O$. The strongest lines in the X-ray powder-diffraction pattern [$d_{obs}$ Å ($I_{obs}$; hkl)] are: 9.665 (100; 111), 5.921 (31; 022), 5.053 (16; 113), 4.190 (10; 004), 3.226 (15; 333,115), 2.556 (10; 533), 2.182 (12; 355,137), 1.915 (17; 626). The unit-cell parameters obtained from the powder-diffraction experiment are $a$ = 16.736(7) Å and $V$ = 4687.6 Å³, cubic with space group $Fd\bar{3}$, $Z$ = 8. Single-crystal X-ray diffraction yielded unit-cell parameters $a$ = 16.749(1) Å and $V$ = 4698.6(1) Å³, for $Z$ = 8. Chukhrovite-(Ca) is named as the Ca-rich equivalent of chukhrovite-(REE) (REE = Ce, Nd, Y). The structure of chukhrovite-(Ca) was refined from single-crystal X-ray diffraction data to $R_1$ = 4.66%, and can be described as a compact assembly of $AlF_6$ octahedra, $SO_4$ tetrahedra, and large Ca sites; the Ca sites are surrounded by F atoms and water molecules, forming distorted octahedra [Ca(2) sites] or distorted pentagonal bipyramids [Ca(1) sites], which are connected together by corner- or edge-sharing, and to the $AlF_6$ regular octahedra by corner-sharing; the $SO_4$ tetrahedra occur within cavities in the structure, and are linked via hydrogen bonds to the water molecules. Cotype specimens are stored in the collection of the Museum of Natural History of Milano (Italy), catalog number M37901, and in the collection of the Laboratory of Mineralogy of the University of Liège (Belgium), catalog number 20383. **F.C.**

## DZHULUITE*

I.O. Galuskina, E.V. Galuskin, J. Kusz, P. Dzierżanowski, K. Prusik, V.M. Gazeev, A.E. Zadov, N.N. Pertsev, and L. Dubrovinsky (2013) Dzhuluite, $Ca_3SbSnFe_3^{3+}O_{12}$, a new bitikleite-group garnet from the Upper Chegem Caldera, Northern Caucasus, Kabardino-Balkaria, Russia. European Journal of Mineralogy, 25, 231–239.

Dzhuluite (IMA2010-064), ideally $Ca_3SbSnFe_3^{3+}O_{12}$, is a new antimony garnet of the bitikleite group. It was approved by the IMA Commission on New Minerals, Nomenclature and Classification (CNMNC) under the name "bitikleite-(SnFe)", but the subcommittee elaborating a new classification of the garnet supergroup recommended not to use Levinson suffixes in naming minerals of the garnet supergroup (Grew et al. 2013) and renamed the mineral. It was discovered in a skarn xenolith from the Upper Chegem Caldera, Northern Caucasus, Russia. Dzhuluite was found in a kumtyubeite zone, 0.2–0.5 m in thickness, at the northern end of xenolith No. 1 in close proximity to the contact with unaltered ignimbrite. Associated minerals are kumtyubeite, cuspidine, fluorchegemite, larnite, fluorite, wadalite, rondorfite, hydroxylellestadite, perovskite, lakargiite, kerimasite, elbrusite, srebrodolskite, bultfonteinite, ettringite group minerals, hillebrandite, afwillite, tobermorite-like minerals, hydrocalumite, and hydrogrossular. Dzhuluite occurs as {211} crystals not exceeding 15 μm in size with cores of the $^{IV}$Ti-analog of kerimasite. It also forms poikilitic crystals <50 μm in size crowed by inclusions of wadalite crystals or katoite-grossular pseudomorphs after wadalite, in some cases substituted by cuspidine. Dzhuluite crystals are light-yellow to dark-brown and with a creamy streak. The luster is strongly vitreous. The Mohs hardness was not estimated. $D_{calc}$ = 4.708–4.750 g/cm³. Dzhuluite is optically isotropic, $n_{calc}$= 1.94. Raman spectra of dzhuluite are similar to those of other minerals of the bitikleite group and to Zr-bearing garnets of the schorlomite group: a broad band 850–650 cm⁻¹ range centered at about 750–770 cm⁻¹ (overlapping of symmetric stretching vibrations due to variable composition the $ZO_4$ tetrahedron), a well-defined band at ca. 600 cm⁻¹ (asymmetric stretching vibrations in $[Fe^{3+}O_4]^{5-}$), a strong band at 490 cm⁻¹ (bending vibrations in $[Fe^{3+}O_4]^{5-}$), bands near 300 cm⁻¹ (related to vibrations in $[R(ZO_4)]$), bands <300 cm⁻¹ [translation motions of $T(ZO_4)$ and $T(Ca)$] with a characteristic displacement of the bands towards lower frequencies in comparison with their Al-analogs. The average of 9 electron probe WDS analyses is [wt% (range)]: $UO_3$ 6.3 (4.78–8.40), $Nb_2O_5$ 0.08 (0–0.17), $Sb_2O_5$ 16.73 (14.24–19.43), $SiO_2$ 0.28 (0.17–0.42), $TiO_2$ 2.62 (2.13–3.05), $ZrO_2$ 4.21 (2.78–6.20), $SnO_2$ 16.70 (15.64–17.44), $Al_2O_3$ 6.17 (5.20–6.46), $Sc_2O_3$ (0.05

0–0.15), $Fe_2O_3$ (no report on how the ratio $Fe^{3+}/Fe^{2+}$ has been calculated) 19.82 (18.93–20.46), FeO 2.20 (1.75–3.21), MgO 0.02 (0–0.05), CaO 23.86 (23.53–24.17), total 99.04 wt%. The empirical formula based on 12 O pfu is $(Ca_{2.954}Fe^{2+}_{0.043}Mg_{0.003})_{\Sigma 3.000}$ $(Sn_{0.850}Sb^{5+}_{0.764}Zr_{0.121}U^{6+}_{0.127}Ti^{4+}_{0.070}Sc_{0.009}Nb^{5+}_{0.058}Hf_{0.001})_{\Sigma 2.001}(Fe^{3+}_{2.051}Al_{0.653}$ $Fe^{2+}_{0.182}Ti^{4+}_{0.087}Si_{0.028})_{\Sigma 3.001}O_{12}$. The strongest lines in the X-ray calculated powder-diffraction pattern [$d_{obs}$ Å ($I_{obs}$%; $hkl$)] are: 4.43 (87; 220), 3.1340 (84; 400), 2.8031 (47; 420), 2.5589 (95; 422), 1.9821 (27; 620), 1.6752 (100; 642), 1.4016 (35; 840), and 1.3363 (29; 664). The unit-cell parameters were obtained for the 15 μm {211} dzhuluite crystal and yielded $a$ = 12.536(3) Å, $V$ = 1970.05(9) Å$^3$, space group $Ia\overline{3}d$, $Z$ = 8. Fitting of EBSD patterns for the dzhuluite $a$ = 12.55 Å resulted in excellent fitting parameters. Dzhuluite belong to the bitikleite group with the common crystal chemical formula $\{X_3\}[R^{5+}R^{4+}](R^{3+}_3)O_{12}$ and double site occupation in the $Y$ site. It presents a complex solid solution $Ca_3[Sb^{5+},Sn^{4+},Zr,U^{6+},Ti^{4+}...]_2$ $(Fe^{3+},Al,Fe^{2+},Ti^{4+},Si...)_3O_{12}$, which significantly complicates its classification in the context of the garnet supergroup nomenclature (Grew et al. 2013). Classification of this type of garnet based on the charge at the $Z$ site and the dominant-valence rule yield to the following ideal formula for the end-member $\{Ca_3\}[Sb^{5+},Sn^{4+}]$ $(Fe^{3+}_3)O_{12}$. It cannot be excluded that U is pentavalent in this garnet. The mineral is named after Dzhulu Mountain nearby near the fieldwork. A type specimen under the name bitikleite-(SnFe) is deposited in the collection of the Fersman Mineralogical Museum in Moscow, Russia. **F.C.**

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### ELTYUBYUITE*

E.V. Galuskin, I.O. Galuskina, R. Bailau, K. Prusik, V.M. Gazeev, A.E. Zadov, N.N. Pertsev, L. Jezak, A.G. Gurbanov, and L. Dubrovinsky (2013) Eltyubyuite, $Ca_{12}Fe^{3+}_{10}Si_4O_{32}Cl_6$—the $Fe^{3+}$ analog of wadalite: a new mineral from the Northern Caucasus, Kabardino-Balkaria, Russia. European Journal of Mineralogy, 25, 221–229.

F. Gfeller, D. Środek, J. Kusz, M. Dulski, V. Gazeev, I. Galuskina, E. Galuskin, and T. Armbruster (2015) Mayenite supergroup, part IV: Crystal structure and Raman investigation of Al-free eltyubyuite from the Shadil-Khokh volcano, Kel' Plateau, Southern Ossetia, Russia. European Journal of Mineralogy, 27(1), 137–143

Eltyubyuite (IMA 2011-022), ideally $Ca_{12}Fe^{3+}_{10}Si_4O_{32}Cl_6$, is the $Fe^{3+}$ analog of wadalite $Ca_{12}Al_{10}Si_4O_{32}Cl_6$. It occurs in in altered silicate-carbonate xenoliths in the diatreme facies of ignimbrites in the Upper Chegem caldera, Kabardino-Balkaria, Northern Caucasus, Russia. Eltyubyuite has subsequently been found in altered xenoliths within volcanic rocks of Eifel, Germany and Kel' Highland (volcano Shadil-Khokh), Southern Ossetia. Eltyubyuite is found as micrometer-sized inclusions in rondorfite, with an increased content of Fe and Al in the near-contact zone (endoskarn) consisting of a larnite-bearing contact breccia. Associated minerals are larnite, rondorfite, wadalite, hydroxylellestadite, edgrewite-hydroxyledgrewite, chegemite, fluorchegemite, and cuspidine, with lakargiite, perovskite, kerimasite, srebrodolskite,

and dovyrenite as accessory minerals. Because of the small crystal size, standard physical properties were not measured. Eltyubyuite ranges from yellow to light-brown and brown in transmitted light under the optical microscope, and its refractive index is higher than the refractive indices of larnite (> 1.71–1.73). $D_{calc}$ = 3.349 g/cm$^3$. Raman spectra of eltyubyuite with the maximum $Fe^{3+}$ show the following main bands (in cm$^{-1}$): a weak band at 770–780 (stretching vibrations of $AlO^{5-}_4$ groups); 700–710 (stretching vibrations of $FeO^{5-}_4$ groups); 460–470 (bending vibrations of $FeO^{5-}_4$ groups); bands at <400 (Ca–O and Ca–$[FeO_4]^{5-}$ vibrations). The average of 9 electron probe WDS analyses is [wt% (range)]: CaO 36.84 (35.85–38.03), MgO 0.08 (0.01–0.20), $Fe_2O_3$ 40.37 (37.36–43.08), $Al_2O_3$ 3.45 (1.60–6.86), $SiO_2$ 9.57 (9.22–10.05), $TiO_2$ 0.48 (0.18–0.88), Cl 9.60 (8.84–10.08), –O=Cl 2.13, total 98.26 wt%. The empirical formula calculated on the basis of 26 cations pfu is $Ca_{12.22}Mg_{0.04}Ti_{0.11}Fe^{3+}_{9.41}Al_{1.26}Si_{2.96}O_{31.89}Cl_{5.04}$, which simplifies to $Ca_{12}(Fe^{3+},Al)_{11}Si_3O_{32}Cl_5$. Electron backscattered diffraction yields isometric symmetry, space group $I\overline{4}3d$, $a$ = 12.20(3) Å , $V$ = 1815.85(9) Å$^3$, $Z$ = 2. The strongest lines of the calculated X-ray powder diffraction pattern are [$d_{obs}$ Å ($I_{obs}$%; $hkl$)]: 4.981 (30; 211), 3.050 (49; 400), 2.728 (100; 420), 2.601 (14; 332), 2.490 (62; 422), 1.692 (28; 640), 1.630 (40; 642). For the Al-free eltyubyuite from the Shadil-Khokh volcano, Kel' Plateau, Southern Ossetia, the average of 7 electron probe WDS analyses is [wt% (range)]: CaO 35.95 (35.80–36.30), MgO 0.05 (0.00–0.15), MnO 0.08 (0.03–0.12), $Fe_2O_3$ 44.09 (42.90–45.00), $Al_2O_3$ n.d., $SiO_2$ 11.11 (11.08–11.54), $TiO_2$ 0.29 (0.14–0.51), Cl 10.30 (10.07–10.41), –O=Cl 2.32, total 99.54 wt%. The empirical formula calculated on the basis of 26 cations pfu is $Ca_{12.044}(Fe^{3+}_{10.373}Si_{3.473}Ti^{4+}_{0.067}Mn^{2+}_{0.021}Mg_{0.021})_{\Sigma 13.956}O_{32}Cl_{5.455}$. The single crystal work on a crystal 20 × 15 × 10 μm in size yields isometric symmetry, space group $I\overline{4}3d$, $a$ = 12.2150(2) Å , $V$ = 1822.55(6) Å$^3$, $Z$ = 2. It structure was refined on the basis of 312 unique reflections to $R_1$ = 2.1%. Eltyubyuite belongs to the wadalite group of the mayenite-supergroup (Galuskin et al. 2015) with general crystal chemical formula: $X_{12}(^{IV}T1_{8-x}{}^{VI}T'1_x)^{IV}T2_6O1_{24}O2_{8-x}$ $(O'2H)_{3x}\{W_{6-3x}\}$, where $x$ = 0–2, $X$ is the Ca polyhedral site; $T1$ and $T'1$ (modified $T1$ site) are distorted tetrahedral and octahedral sites, respectively, occupied by Al and other cations such as $Fe^{3+}$, Mg, Ti, Si, $Fe^{2+}$; $T2$ is a regular tetrahedron filled by Al, Si, and $Fe^{3+}$; and $W$ is confined to the center of a structural cage about 5 Å across, is partially occupied by anions and flanked by Ca atoms. In the structure of Al-free eltyubyuite $T1$ site is strongly dominated by $Fe^{3+}$ [site population 0.848(10)] with minor $Si^{4+}$ [0.152(10)]; the $T'1$ site is unoccupied ($x$ = 0); $T2$ is occupied dominantly by $Fe^{3+}$ [site population 0.592(11) Fe and 0.408(11) Si]; and the $W$ site is almost occupied by Cl [site population 5.45(5)] in good agreement with chemical data. A small deficit of anionic charge (0.2 e$^-$) suggest the possible presence of potential (OH)$^-$ at the $W$ site, not confirmed by Raman spectroscopy preformed in the same crystal. The mineral is named for the Balkarian village Eltyubyu, which is situated near the type locality. The type material is deposited in the collections of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **F.C.**

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## Ferrisepiolite*

G. Xiangping, X. Xiande, W. Xiangbin, Z. Guchang, L. Jianqing, H. Kenich, and H. Jiwu (2013) Ferrisepiolite: a new mineral from Saishitang copper skarn deposit in Xinghai County, Qinghai Province, China. European Journal of Mineralogy, 25(2), 177–186.

Ferrisepiolite (IMA 2010-061), with general formula $(Fe^{3+},Fe^{2+}, Mg)_4(Si,Fe^{3+})_6O_{15}(O,OH)_2 \cdot 6H_2O$, is the $Fe^{3+}$-dominant analog of sepiolite from the Saishitang copper skarn deposit in Xinghai County, Qinghai Province, China. It is found as late-stage veinlets in copper-sulphide ores hosted in layered hedenbergite-andradite-actinolite skarn related to Indo-Sinian quartz diorite and Lower Permian metamorphosed clastic and carbonate rocks. The mineral formed in a highly oxidizing environment from low-temperature Fe-rich fluids and crystallized in cavities and fractures within the skarn-ore deposit. Ferrisepiolite replaces chalcopyrite, pyrrhotite, pyrite, sphalerite, and galena, which are hosted by hedenbergite–andradite–actinolite–vesuvianite skarn. It occurs in brown earthy and fibrous aggregates and shows brown to red-brown color with an appearance of wood bark, consisting of fibrous crystals several micrometers in width and more than several centimeters in length, as well as brown earthy mass consisting of individual grains of flaky-acicular microlites with poor crystallinity, a few micrometers in size. Both forms of ferrisepiolite are not magnetic based on a hand magnet test, and they do not dissolve in dilute hydrochloric acid. Crystals have brown white streak and Mohs hardness 2–2½. $D_{calc} = 2.51$ g/cm³ for fibrous ferrisepiolite and $D_{calc} = 2.69$ g/cm³ for earthy ferrisepiolite. Refractive indices for fibrous ferrisepiolite, $\alpha' = 1.592$–$1.620$, $\gamma' = 1.628(8)$ (white light), are appreciably higher than those of sepiolite and Fe- and Mn-bearing sepiolite. Optical orientation is $Z \parallel \mathbf{c}$, $X$ (or Y) $\parallel \mathbf{a}$. Ferrisepiolite is distinctly pleochroic from light red-brown (for light vibrating perpendicular to the fiber axis) to dark red-brown (for light vibrating parallel to the fiber axis). No data given on which optical or crystallographic direction is parallel to fibers elongation. The thermal analysis of ferrisepiolite (TG and DTA) reveals a lower dehydration temperature of structural hydroxyl than sepiolite and a small weight loss (0.1–0.9%) in the range 500–700 °C. Chemical analysis was obtained from wet chemistry, XRF, and EPMA and the average gave [wt% (range)]: $SiO_2$ 39.77 (38.65–40.78), $Fe_2O_3$ (weight ratio of $Fe^{3+}/Fe^{2+}$ determined in wet analyses) 35.29 (34.59–36.82), FeO 7.35 (7.20–7.67), MgO 1.78 (1.46–2.05), MnO 0.48 (0.46–0.49), CaO 0.77 (0.71–0.85), $Na_2O$ 0.20 (0.14–0.27), $H_2O_{calc}$ 14.10 (13.96–14.19), $H_2O_{meas}$ 14.73, total 99.74 wt% for earthy ferrisepiolite and $SiO_2$ 47.52 (45.68–49.12), $Fe_2O_3$ 22.30 (19.94–24.22), FeO 5.00 (4.48–5.38), MgO 8.61 (7.55–9.77), MnO 0.24 (0.22–0.26), CaO 0.38 (0.32–0.46), $Na_2O$ 0.09 (0.03–0.14), $H_2O_{calc}$ 15.34 (15.09–15.53), $H_2O_{meas}$ 15.47 (15.47–15.47), total 99.48 wt% for fibrous ferrisepiolite. On the basis of 10 cations pfu, the empirical chemical formula is $(Fe^{3+}_{2.64},Fe^{2+}_{0.80},Mg_{0.35},Ca_{0.11}, Mn_{0.05},Na_{0.05})_{\Sigma4}(Si_{5.18},Fe^{3+}_{0.82})_{\Sigma6}O_{15}(O_{1.77},OH_{0.23})_{\Sigma2} \cdot 6H_2O$ for earthy ferrisepiolite, and is $(Fe^{3+}_{1.84},Fe^{2+}_{0.51},Mg_{1.56}, Ca_{0.05},Mn_{0.02},Na_{0.02})_{\Sigma4} (Si_{5.79},Fe^{3+}_{0.21})_{\Sigma6}O_{15}(O_{1.60},OH_{0.40})_{\Sigma2} \cdot 6H_2O$ for fibrous ferrisepiolite. The strongest lines in the X-ray powder-diffraction pattern [$d_{obs}$ Å ($I_{obs}$; $hkl$)] are: 12.163 (100; 110), 4.298 (35; 131), 3.751 (15; 260), 3.394 (29; 400), 3.198 (13; 331), 2.561 (45; 191), 2.436

(31; 212), 2.260 (14; 391). The unit-cell parameters obtained from the powder-diffraction and single-crystal electron diffraction are $a = 13.638(9)$, $b = 27.011(30)$, $c = 5.233(8)$ Å, $V = 1927.58$ Å³ for earthy ferrisepiolite and $a = 13.619(8)$, $b = 26.959(26)$, $c = 5.241(7)$ Å, $V = 1924.08$ Å³, for fibrous sepiolite, both orthorhombic $Pncn$, $Z = 4$. In ferrisepiolite, the substitution of $Fe^{3+}$ and/or $Fe^{2+}$ for Mg in the octahedral sites, compensated by substitution of $Fe^{3+}$ for $Si^{4+}$ in the tetrahedral sites and $O^{2-}$ for $OH^-$ in the sites of structural hydroxyl, accompanied by a contraction of the structure along the $c$-axis and an expansion along the $a$-axis. The name was originally used by Strunz (1957) to describe Fe-bearing sepiolite with $Fe_2O_3$ (14.57%) and FeO (1.06%), which was previously reported by Bøggild (1951) as a new mineral with the name "gunnbjarnite". Binzer and Karup-Møller (1974) presented data for a mineral with the name "ferrisepiolite" with $Fe_2O_3$ (9.98%) and FeO (1.18%). "Xylotile" and "mountain wood" were also used to describe sepiolite with considerable $Fe_2O_3$+FeO contents but less than 21.7% dominated by ferric iron (Caillère 1936; Brauner and Preisinger 1956). Type material of ferrisepiolite is deposited in the collections of the Geological Museum of China with catalog number M11786. **F.C.**

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## Hielscherite*

I.V. Pekov, N.V. Chukanov, S.N. Britvin, Y.K. Kabalov, J. Göttlicher, V.O. Yapaskurt, A.E. Zadov, S.V. Krivovichev, W. Schüller, and B. Ternes (2012) The sulfite anion in ettringite–group minerals: a new mineral species hielscherite, $Ca_3Si(OH)_6(SO_4)(SO_3) \cdot 11H_2O$, and the thaumasite–hielscherite solid–solution series. Mineralogical Magazine, 76(5), 1133–1152.

Hielscherite (IMA 2011-037), ideally $Ca_3Si(OH)_6(SO_4)(SO_3) \cdot 11H_2O$, is the first ettringite-group mineral with essential sulphite. It has been found at Graulay quarry near Hillesheim in the western Eifel Mountains, Rhineland-Palatinate, Germany, where it occur in miarolitic cavities up to $5 \times 8$ mm across in alkaline basalt with early diopside and later phillipsite-K, chabazite-Ca, and gypsum. The acicular or hair-like crystals are typically 0.05 mm in length, rarely up to 0.2 mm long, and typically 3–5 μm thick. They occur in near parallel or sheaf-like clusters up to 10 μm thick, which form open chaotic fibrous aggregates up to 4 mm across, resembling matted wool. Hielscherite crystals are colorless and transparent with a vitreous luster, while fibrous aggregates are snow-white with a silky luster. The streak is white. The Mohs hardness is 2–2½. Hielscherite is brittle, the cleavage is distinct on {100}, and the fracture is uneven or stepped; $D_{calc} = 1.82$ g/cm³. Hielscherite is uniaxial (–), with $\omega = 1.494(2)$, $\varepsilon = 1.476(2)$ (white light). The most characteristic feature of IR spectra of hielscherite and sulphite-bearing thaumasite is the presence of an absorption

band due to $SO_3^{2-}$ stretching vibrations at 937 cm$^{-1}$ accompanied by weaker bands at 967 and 895 cm$^{-1}$. Absorption bands in the IR spectrum of holotype hielscherite and their assignments (s = strong band, w = weak band, sh = shoulder; all figures in cm$^{-1}$) are: 3580(sh), 3420(s), 3100(sh) (O–H-stretching vibrations of $H_2O$ molecules and OH groups); 1687, 1645 (bending vibrations of $H_2O$ molecules); 1503(w), 1395 (stretching vibrations of $CO_3^{2-}$ groups), 1107(s) (stretching vibrations of $S^{6+}O_4^{2-}$ groups); 967, 937(s), 895(w) (stretching vibrations of $S^{4+}O_3^{2-}$ groups); 740(s) (Si–O stretching vibrations in $Si(OH)_6$ octahedra; 677(s), 629(s), 572(s) (bending vibrations of $SO_4^{2-}$ and $SO_3^{2-}$ groups), 499(s) [O–Si–O bending vibrations in $Si(OH)_6$ octahedra]. At room temperature, hielscherite slowly dissolves in HCl with very weak effervescence. The average of 8 electron probe EDS analyses is [wt% (range)]: CaO 27.15 (26.5–27.9), $Al_2O_3$ 2.33 (2.0–2.6), $SiO_2$ 7.04 (6.6–7.4), $SO_3$ 20.91 (20.0–21.9) ($SO_2$ 6.40 and $SO_3$ 12.91, recalculated for 2 $S^{6+}O_4$ groups pfu), $CO_2$ 2.71, $N_2O_5$ 0.42, $H_2O$ 39.22, (by gas chromatography, CHN analysis), total 98.18 wt%. The empirical formula based on 3 Ca pfu is $Ca_3(Si_{0.73}Al_{0.28})_{\Sigma 1.01}(OH)_{5.71}(SO_4)_{1.00}$ $(SO_3)_{0.62}(CO_3)_{0.38}(NO_3)_{0.05} \cdot 10.63H_2O$. The strongest lines in the X-ray powder-diffraction pattern [$d_{obs}$ Å ($I_{obs}$%; $hkl$)] are: 9.62 (100; 010,100), 5.551 (50; 110), 4.616 (37; 012,102), 3.823 (64; 112), 3.436 (25; 211), 2.742 (38; 032,302), 2.528 (37; 123,213), 2.180 (35; 042,402,223). The unit-cell parameters refined from powder-diffraction data are $a = 11.1178(2)$, $c = 10.5381(2)$ Å, $V = 1128.06$ Å$^3$, hexagonal, space group $P6_3$, $Z = 2$. The structure of hielscherite was refined using the Rietveld method ($R_{wp} = 0.0317$). Hielscherite is the sulphite analog of thaumasite. In hielscherite and sulphite-rich thaumasite, pyramidal sulphite groups occupy the same structural sites as triangular carbonate groups, and the triangular arrangement of the O atoms is similar. Tetrahedral sulphate groups are located in a separate site. The mineral is named in honor of the German mineral collector Klaus Hielscher (b. 1957) from Steinbach, Hessen, a specialist in the mineralogy of hydrothermal assemblages from the Zeilberg basalt quarry in Franconia, a locality which is remarkable for its diverse hydrous calcium silicate. The holotype of hielscherite is deposited in the collections of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **F.C.**

## HEREROITE* AND VLADKRIVOVICHEVITE*

R. Turner, O.I. Siidra, M.S. Rumsey, S.V. Krivovichev, C.J. Stanley, and J. Spratt (2012) Hereroite and vladkrivovichevite: two novel lead oxychlorides from the Kombat mine, Namibia. Mineralogical Magazine, 76(4), 883–890.

New lead oxychloride minerals, hereroite (IMA 2011-027) ideally $[Pb_{32}(O,\square)_{21}](AsO_4)_2[(Si,As,V,Mo)O_4]_2Cl_{10}$ and vladkrivovichevite (IMA 2011-020) ideally $[Pb_{32}O_{18}][Pb_4Mn_2O]$ $Cl_{14}(BO_3)_8 \cdot 2H_2O$ were discovered in a single specimen from Kombat mine in Namibia obtained on sale at the mineral show where labeled as "red asisite." The specimen consist of clear to white granular vein quartz with grains of other oxyhalides (asisite, damaraite, kombatite, sahlinite), native copper, barysilite, Mn silicates and minute amounts of unidentified Mn oxyhydroxides (most likely a mixture of hausmannite, jacobsite, and manganite). Hereroite and vladkrivovichevite are supposed to be formed at late-stage low-temperature hydrothermal epigenetic reworking

of primary Pb-Cu-Zn-Ag sulfides. Sulfide orebodies of the Kombat mine and other famous deposits of the Otavi Mountainland (Tsumeb, Berg Aukas) were originally emplaced hydrothermally as fracture fillings; they were subsequently modified by epigenetic, hydrothermal and metasomatic replacement events associated with the Damaran Orogeny, including a phase of Fe-Mn silicification. These events created a range of Pb-Mn-Fe silicate minerals and a variety of late-stage Pb-oxyhalide minerals.

Hereroite is relatively abundant as transparent to translucent intergrown glassy bright orange grains generally <1 mm and aggregates up to ~3 mm. A few relatively well-defined crystals up to ~0.5 mm were found. The mineral has a white streak and adamantine luster; is brittle with conchoidal fracture and with no obvious cleavage or parting. The density for both new minerals was not measured due to a lack of material. $D_{calc} = 8.15$ g/cm$^3$. In reflected light hereroite is gray with a bluish tint. Bireflectance is masked by yellowish orange internal reflections. Reflectance values were measured between 400 and 700 nm with a 20 nm interval. The values for COM wavelengths in air [$R'$ (nm)] are: 17.9 (470), 16.9 (546), 16.6 (589), 16.3 (650). The calculated mean refractive index for 589 nm is 2.30. The average of 20 electron probe WDS analyses gave [wt% (range)]: PbO 91.90 (91.57–92.32), $As_2O_5$ 3.81 (3.64–4.15), $SiO_2$ 0.74 (0.67–0.69), $V_2O_5$ 0.35 (0.28–0.41), $MoO_3$ 0.31 (0.22–0.36), Cl 4.49 (4.16–4.55), –O=Cl$_2$ 1.01, total 100.59. The empirical formula of hereroite based on 32 Pb apfu is $[Pb_{32}O_{20.70}](AsO_4)_2[(Si_{0.48}As_{0.29}V_{0.15}Mo_{0.09})_{\Sigma 1.01}O_4]_2Cl_{9.84}$, simplified to $[Pb_{32}O_{2-x+y}](AsO_4)_2[(Si_x(As,V)_{1-x-y}Mo_y)O_4]_2Cl_{10}$ with x = 0.48 and y = 0.08. Hereroite is monoclinic, $C2/c$ with $a = 23.14(1)$, $b = 22.65(1)$, $c = 12.39(1)$ Å, $\beta = 102.00(5)°$ from powder-diffraction data and with $a = 23.139(4)$, $b = 22.684(4)$, $c = 12.389(2)$ Å, $\beta = 102.090(3)°$, $V = 6358.8$ Å$^3$ from single-crystal data. The strongest lines of the X-ray powder diffraction pattern are [$d_{obs}$ Å ($I_{obs}$%; $hkl$)]: 2.982 (100; 55), 3.512 (23; 612), 3.901 (21; 511), 2.795 (47; 802), 1.986 (24; 882), 1.641 (24, 11$\overline{5}$5). The mineral is named for the Herero people, one of the tribes in the region.

Vladkrivovichevite was found on a specimen in a pale green glassy spot 1 × 1.5 mm across as separate pale greenish yellow adamantine grains <0.1 mm with a white streak. Macroscopically it is not recognizable from asisite. The mineral is brittle with conchoidal fracture and no obvious cleavage or parting. $D_{calc} = 7.40$ g/cm$^3$. It is slightly bluish gray in reflected light with a weak bireflectance and anisotropy and colorless internal reflections. The reflectance values for COM wavelengths in air [$R_1$, $R_2$ (nm)] are: 17.2, 17.9 (470); 15.7, 16.3 (546); 15.5, 16.1 (589); 15.4, 16.1 (650). The values of the whole spectra were measured between 400 and 700 nm with 20 nm interval. The calculated mean refractive index for 589 nm is 2.34. The average of 15 electron probe WDS analyses gave [wt% (range)]: PbO 91.15 (91.08–91.20), $As_2O_5$ 1.34 (1.27–1.39), Cl 5.59 (5.29–5.81), –O=Cl$_2$ 1.29, $B_2O_3$ (calc) 3.13, $H_2O$ (calc) 0.84, total 100.76. The empirical formula based on (Pb+Mn) =38 apfu is $Pb_{36.32}O_{19}Mn_{1.68}Cl_{13.99}(BO_3)_8 \cdot 2H_2O$. The mineral is orthorhombic, $Pmmn$ with $a = 12.87(5)$, $b = 27.7(4)$, $c = 11.46(3)$ Å from powder-diffraction data and $a = 12.759(1)$, $b = 27.169(4)$, $c = 11.515(1)$ Å, $V = 3992.0$ Å$^3$, $Z = 2$, from single-crystal data. The strongest lines of the X-ray powder diffraction pattern are [$d_{obs}$ Å ($I_{obs}$%; $hkl$)]: 2.860 (100; 370), 2.733 (84; 073), 3.707 (49; 073), 3.068 (37; 401), 2.075 (32; 473), 1.601 (32; 3$\overline{1}$43). The mineral is named in honor of Vladimir Gerasimovich Krivovichev, Head

of the Mineralogy Department, Geological Faculty, St. Petersburg State University.

Both minerals are structurally related to other layered lead oxychlorides with layers of $OPb_4$ tetrahedra derived from those of litharge (tetragonal PbO). Their strucrures consist of alternating OPb double layers and chlorine sheets. In hereroite, $AsO_4$ and $(Si,As,V,Mo)O_4$ tetrahedra locate in defects within the OPb block, which contains square "symesite-type" and double-square "kombatite-type" cavities. The structure of vladkrivovichevite is based on OPb derivative blocks with the interlayer occupied by Cl anions and oxocentred $OPb_4$ octahedra whose eight triangular faces are capped by triangular borate anions, $BO_3^{3-}$. The holotype specimens for both species are stored at the Natural History Museum in London. **D.B.**

## ISEITE*

D. Nishio-Hamane, N. Tomita, T. Minakawa, and S. Inaba (2013) Iseite, $Mn_2Mo_3O_8$, a new mineral from Ise, Mie Prefecture, Japan. Journal of Mineralogical and Petrological Sciences, 108(1), 37–41.

Iseite (IMA 2012-029), ideally $Mn_2Mo_3O_8$, a new mineral, Mn-dominant analog of kamiokite, $Fe_2Mo_3O_8$, was discovered in the Shobu stratiform ferro-manganese deposit near Ise City, Mie Prefecture, Japan, and named for the locality. Shobu deposit is located in the chert closely associated with limestone and greenstone. The ore mainly consists of magnetite, hematite, and caryopilite. Other minerals in the ore are monazite-(La), chalcopyrite, pentlandite, and heazlewoodite. The ore randomly crossed by bementite, tephroite, and rhodochrosite veins. Bementite and tephroite veins contain La-rich minerals of the allanite group. Rhodochrosite vein occasionally includes molybdenite and, very rarely, iseite, which forms zoned aggregates (up to ~1 mm) of minute anhedral crystals of a several micrometers to 20 μm. Iseite is closely associated with undetermined Mn-Fe-Mo oxides with hexagonal outlines, occasionally with powellite, and very rarely coexists with molybdenite. Iseite is iron-black with a black streak and submetallic luster. Mohs hardness is ~4–5; $D_{calc} = 5.85$ g/cm³. In reflected light iseite is light yellowish gray with no internal reflections. Pleochroism is medium, from pale gray to yellowish gray. Anisotropy is medium to strong, gray to pale gray. The reflectance spectrum was measured in air between 400 and 700 nm with 20 nm interval. $R_{max}$ variation is 19.5–20.7% and $R_{min}$ 16.0–17.0%. The average of 17 electron probe EDS analysis for an individual aggregate is: MnO 24.14, FeO 2.63, $MoO_2$ 73.33, total 100.10 wt%. The empirical formula is $(Mn_{1.79}Fe_{0.19})_{\Sigma1.98}Mo_{3.01}O_8$. Compositional variations are mostly attributed to MnFe content. In all cases Mn dominates Fe. Iseite is the first mineral species that includes both Mn and Mo as essential constituents. The synchrotron radiation (λ = 0.413 Å) was used to obtain a powder XRD pattern. The strongest lines [$d_{obs}$ Å ($I_{obs}$%; $hkl$)] are: 5.11 (68; 002), 3.585 (98; 102), 2.822 (35; 103), 2.523 (100; 112), 2.441 (90; 201), 2.023 (49; 203), 1.659 (44; 213), 1.593 (35; 302), 1.588 (62; 205). The data was indexed in hexagonal unit cell with $a = 5.8052(3)$, $c = 10.2277(8)$ Å, $V = 298.50$ Å³, space group $P6_3mc$, $Z = 2$, by analogy with synthetic $Mn_2Mo_3O_8$. The Rietveld refinement based on kamiokite-type structure converges to $R_{wp} = 3.11\%$, and confirms two independent tetrahedral and octahedral Mn sites

in the crystal structure of iseite. The $MnO_4$ tetrahedra and $MnO_6$ octahedra are connected at the apical oxygen atoms to form a honeycomb-like lattice sheets in the **a-b** plane. Those sheets stack with the $MoO_6$ octahedral sheet alternately along the c-axis. The type specimen of iseite is stored at the National Museum of Nature and Science, Tokyo, Japan. **D.B.**

## ITSIITE*

A.R. Kampf, R.C. Peterson, and B.R. Joy (2014) Itsiite, $Ba_2Ca(BSi_2O_7)_2$, a new mineral species from Yukon, Canada: description and crystal structure. Canadian Mineralogist, 52(3), 401–407.

Itsiite (IMA 2013-085), ideally $Ba_2Ca(BSi_2O_7)_2$, is a new mineral from the Gun claim, south of the Itsi Range, Yukon Territory, Canada. The mineral is named for the Itsi Mountain Range, which gets its name from the language of the Kaska, a First Nations people of the area ("itsi" means "wind"). Itsiite was discovered in a sample from the Gun claim ca. 4 km SE of Wilson Lake along the Ross River head waters and south of the Itsi Range, Yukon Territory, Canada. The Gun claim is a Ba-rich skarn deposit associated with quartz monzonite, and was originally staked for its high Zn content. The minerals observed at the Gun claim include alforsite, barite, cerchiaraite-(Al), cerchiaraite-(Fe), diopside, gillespite, pellyite, pyrite, quartz, sanbornite, sphalerite, taramellite, and witherite. Itsiite was discovered in low-temperature, late-stage veins in association with cerchiaraite-(Fe), diopside, pyrite, quartz, sphalerite, and witherite. Itsiite crystals commonly contain numerous inclusions of cerchiaraite-(Fe). The new mineral forms intergrowths of colorless and light blue to medium greenish-blue tetragonal platy crystals up to 1 mm across. The plates are flattened on {001}, and have forms on {001}, {101}, and {112}, with the forms {101} and {112} being generally striated. Itsiite is transparent, non-fluorescent, has a vitreous luster, a white streak, and Mohs hardness of 5½. Density could not be measured due to the nature of the crystals; $D_{calc} = 3.644$ g/cm³. Itsiite is optically uniaxial (–); ω = 1.623(1), ε = 1.619(1); non-pleochroic. Crystals of itsiite dissolve in concentrated HCl after 1 h, and are unreactive in concentrated $H_2SO_4$ after a few days. The average of 3 electron probe WDS analyses gave: $Na_2O$ 0.06 (0.03–0.09), BaO 46.35 (46.09–46.50), CaO 7.35 (7.24–7.49), FeO 0.15 (0.07–0.20), $Al_2O_3$ 0.17 (0.15–0.21), $TiO_2$ 0.06 (0.01–0.10), $SiO_2$ 34.91 (34.85–35.01), $B_2O_{3calc}$ 10.41 , total 99.46 wt%. The presence of B was confirmed by EMPA, but $B_2O_3$ amount was calculated from crystal structure refinement. The formula calculated on the basis of 14 O pfu is: $Ba_{2.06}(Ca_{0.89}Al_{0.02}Na_{0.01}Fe_{0.01}Ti_{0.01})_{\Sigma0.94}$ $(Si_{3.96}B_{2.04})_{\Sigma6.00}O_{14}$. The strongest lines of the X-ray powder diffraction patterns [$d_{obs}$ in Å ($I_{obs}$%; $hkl$)] are: 5.50 (42; 200), 3.746 (100; 202), 3.446 (60; 301), 3.100 (51; 222), 2.899 (96; 321,312), 2.279 (44; 323), 2.145 (69; 224,501), 1.8257 (41; 503,334,305), 1.7584 (43; 532,523). Itsiite is tetragonal, space group $I\bar{4}2m$; $a = 10.9515(5)$, $c = 10.3038(7)$ Å, $V = 1235.79(14)$ Å³, $Z = 4$. The crystal structure of the new mineral was solved by direct methods and refined to $R_1 = 0.0182$. In itsiite, corner-sharing tetrahedral of four-membered silicate rings alternate with four-membered borate rings and form a zeolite-like tetrahedral framework. There are channels in this framework along each axis that contain Ba atoms in ninefold and Ca atoms in sixfold coordination. The crystal struc-

ture of itsiite is similar to those of hyalotekite and kapitsaite-(Y), two other borosilicates. The holotype specimen is deposited in the collections of the Natural History Museum of Los Angeles County, California, U.S.A. **Yu.U.**

## JAKOBSSONITE*

T. Balić-Žunić, A. Garavelli, D. Mitolo, P. Acquafredda, and E. Leonardsen (2012) Jakobssonite, $CaAlF_5$, a new mineral from fumaroles at the Eldfell and Hekla volcanoes, Iceland. Mineralogical Magazine, 76(3), 751–760.

Jakobssonite (IMA 2011-059), ideally $CaAlF_5$, is a new mineral first found in crusts collected in 1988 from a fumarole on the Eldfell volcano, Heimaey Island, Iceland, and in similar crusts collected in 1991 from a fumarole on the Hekla volcano, Iceland. It was first reported as potentially new mineral ("mineral HA") based on powder XRD data (Jakobsson et. al, 2008) and was listed in IMA list of invalid unnamed minerals update 2012-01 as UM2008-//-?[5]. At the Eldfell volcano, jakobssonite occurs as a white overgrowth on a yellowish base of massive ralstonite, anhydrite and jarosite, which together form a 2–3 cm thick crust on altered scoria of hawaiitic composition. The mineral is found in association with gypsum, hematite, anhydrite, opal-A, and uncharacterized minerals. At the Hekla volcano, jakobssonite occurs as aggregates of crystals that form white crusts up to a few millimeters thick, in association with leonardsenite, heklaite, malladrite, hieratite, fluorite, chiolite, and several uncharacterized fluoride minerals. The temperature of the Eldfell volcano fumarole was ~230 °C and varied between 155 and 333 °C at the Hekla volcano. For the holotype specimen (Eldfell volcano), jakobssonite occurs as acicular crystals up to 50 μm long. Cotype specimens from the Hekla volcano are less than a micrometer in size. Crystals of jakobssonite are acicular and probably elongated along [100]. The crystals are white and transparent with an earthy luster. Hardness and optical properties could not be determined due to the small crystal size, while intergrowths prevented a density measurement; $D_{calc} = 2.89$ g/cm³. Jakobssonite does not fluoresce in long-wave ultraviolet light. The average of 25 electron probe EDS analyses on the holotype specimen gave [wt% (range)]: Ca 18.99 (18.04–20.16), Mg 1.33 (0.99–1.85), Na 0.33 (0.18–0.58), Al 18.55 (18.01–19.01), F 50.20 (49.23–51.18), O 10.39 (9.76–10.95), total 99.79%. This gives the empirical formula $(Ca_{0.73}Mg_{0.09}Na_{0.02})_{\Sigma0.84}$ $Al_{1.06}F_{4.09}(OH)_{1.01}$ based on 7 atoms pfu and all O as OH. The strongest lines in the X-ray powder-diffraction pattern [$d_{obs}$ (Å) ($I_{obs}$%; $hkl$)] are: 4.91 (18; 110), 3.92 (76; 200), 3.15 (68; 020), 3.13 (100; $1\overline{1}2$), 2.27 (22; $2\overline{2}2$), 1.957 (21; 400), 1.814 (20; $1\overline{3}2$), 1.805 (22; $20\overline{4}$). A Rietveld refinement, starting from the crystal structure of synthetic $CaAlF_5$ shows jakobssonite is monoclinic, space group $C2/c$, with $a = 8.601(1)$, $b = 6.2903(6)$, $c = 7.2190(7)$ Å, $\beta = 114.61(1)°$, $V = 355.09(8)$ Å³, and $Z = 4$. The structure has chains of $[AlF_6]$ octahedra, which run parallel to the **c** axis, that are interconnected by chains of $[CaF_7]$ pentagonal bipyramids. Jakobssonite is named in honor of Sveinn Peter Jakobsson (b. 1939), one of Iceland's leading volcanologists, in acknowledgement of his major contributions to research on Icelandic fumaroles, and because he was the first person to recognize the mineral. The holotype specimen of jakobssonite is preserved in the mineral collection of the Icelandic Institute of Natural History, Reykjavík, Iceland. **O.C.G.**

## References cited

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## KAZANSKYITE*

F. Cámara, E. Sokolova, and F.C. Hawthorne (2012) Kazanskyite, $Ba\square TiNbNa_3Ti(Si_2O_7)_2O_2(OH)_2(H_2O)_4$, a Group-III Ti-disilicate mineral from the Khibiny alkaline massif, Kola Peninsula, Russia: description and crystal structure. Mineralogical Magazine, 76(3), 473–492.

Kazanskyite (IMA 2011-007), ideally $Ba\square TiNbNa_3Ti(Si_2O_7)_2$ $O_2(OH)_2(H_2O)_4$, is new Ti-disilicate found in a single specimen of nechelyustovite from the collection of Adriana and Renato Pagano (Milan, Italy). The specimen was collected at the level +252 of Kirovskiy mine, Mt. Kukisvumchorr, Khibiny alkaline massif, Kola Peninsula, Russia, and originated from hydrothermally altered pegmatite vein 0.1–0.5 m wide emplaced in nepheline syenites near their contact with ijolite-urtites. The pegmatite body is symmetrically zoned with a central natrolite zone, microcline zone, and a marginal aegirine dominated external zone with subordinate amounts of microcline, nepheline, lamprophyllite, and eudialyte. Nechelyustovite along with kazanskyite is found in natrolite zone where it forms rosettes up to 1–5 cm in diameter composed of extremely fine (0.01–0.1 mm) flakes and lamellae, embedded in a matrix of natrolite or of carbonate-hydroxylapatite. Other associated minerals are natrolite, barytolamprophyllite, hydroxylapatite, belovite-(La), belovite-(Ce), gaidonnayite, nenadkevichite, epididymite, apophyllite-(KF), and sphalerite. Kazanskyite occurs as colorless to pale tan transparent flexible and commonly bent flakes 215 μm thick and up to 330 μm across. It has a white streak, vitreous luster, perfect cleavage on {001}, splintery fracture, and a Mohs hardness of 3. The density could not be measured due to the thickness of the flakes; $D_{calc} = 2.930$ g/cm³. Kazanskyite is optically biaxial (+) with $\alpha = 1.695(2)$, $\beta = 1.703(2)$, $\gamma = 1.733(2)$ ($\lambda = 590$ nm), $2V_{meas} = 64.8(7)°$, $2V_{calc} = 55.4°$. The optical orientation is: $X \wedge \mathbf{a} = 87.4°$, $X \wedge \mathbf{b} = 85.2°$, $X \wedge \mathbf{c} = 13.4°$, $Y \wedge \mathbf{a} = 92.1°$, $Y \wedge \mathbf{b} = 5.1°$, $Y \wedge \mathbf{c} = 102.8°$, $Z \wedge \mathbf{a} = 176.7°$, $Z \wedge \mathbf{b} = 91.9°$, $Z \wedge \mathbf{c} = 86.0°$. The mineral has no discernible dispersion or pleochroism. It does not fluoresce under 240–400 nm ultraviolet radiation. The Raman spectrum of kazanskyite contains a broad asymmetric envelop with maximum at 3462 cm⁻¹ ($H_2O$ stretches) and sharp peaks at 3545 and 3628 cm⁻¹ (OH stretches); strong envelope centered on 886 cm⁻¹ with maxima at 822, 862 and 935 cm⁻¹ (Si–O stretches); two sharp bands at 580 and 680 cm⁻¹ (Si–O bending motions) and bands below 480 cm⁻¹ (phonon modes of the structure). Electron probe WDS analysis for the first point gave: $Nb_2O_5$ 9.70, $TiO_2$ 19.41, $SiO_2$ 28.21, $Al_2O_3$ 0.13, FeO 0.28, MnO 4.65, BaO 12.50, SrO 3.41, CaO 0.89, $K_2O$ 1.12, $Na_2O$ 9.15, $H_2O$ 9.87 (by structure refinement), F = 1.29, –O=$F_2$ 0.54, total 100.07 wt%. The total for other 4 points (without $H_2O$) increased to ~95% indicating a water loss under the beam. Further analysis of the same grain show the loss of Na and K. The elements Ta, Zr, Zn, Mg, and Cs were sought but not detected. The empirical formula based on 22 (O+F) apfu is $(Na_{2.55}Mn_{0.31}Ca_{0.11}Fe^{2+}_{0.03})_{\Sigma3.00}(Ba_{0.70}Sr_{0.28}K_{0.21}Ca_{0.03})_{\Sigma1.22}$ $(Ti_{2.09}Nb_{0.63}Mn_{0.26}Al_{0.02})_{\Sigma3.00}Si_{4.05}O_{21.42}H_{9.45}F_{0.59}$. Simplified formula is: $Ba(\square,Ba)Ti(Nb,Ti)(Na,Mn)_3(Ti,Mn)(Si_2O_7)_2O_2(OH,F)_2(H_2O)_4$.

The strongest lines in the X-ray powder-diffraction pattern [$d_{obs}$ Å ($I_{obs}$%; $hkl$)] are: 2.813 (100; 124,1$\overline{2}\,\overline{2}$), 2.149 (82; 22$\overline{2}$,2$\overline{2}$0,207,220,2$\overline{2}$2), 3.938 (70; 1$\overline{1}$3,112), 4.288 (44; 11$\overline{1}$,1$\overline{1}$0,110,1$\overline{1}$1), 2.128 (44; 22$\overline{3}$,22$\overline{1}$,1$\overline{3}$4,221,1$\overline{3}$4,221,2$\overline{2}$3), 3.127 (39; 1$\overline{1}$6,115), 3.690 (36; 1$\overline{1}$4), 2.895 (33; 1$\overline{2}$3,121), 2.955 (32; 1$\overline{2}$0,120,1$\overline{2}$2). The refined single crystal unit-cell parameters are: $a = 5.4260(9)$, $b = 7.135(1)$, $c = 25.514(4)$ Å, $\alpha = 90.172(4)$, $\beta = 90.916(4)$, $\gamma = 89.964(3)°$, $V = 977.61$ Å³. $Z = 2$. Kazanskyite is triclinic. The crystal structure was solved by direct methods and refined to $R_1 = 8.09\%$ for the space group $P\overline{1}$. Kazanskyite is a new representative of the Ti-disilicates with a combination of a titanium silicate (TS) block and an intermediate (I) block. The TS block consists of HOH sheets (H is heteropolyhedral and O is octahedral). The mineral has a new type of crystal structure The TS block exhibits linkage and stereochemistry typical for Group-III (Ti + Nb = 3 apfu) of Ti-disilicates. That block has two different H sheets where (Si$_2$O$_7$) groups link to [5]-coordinated Ti and [6]-coordinated Nb polyhedra, respectively. There are two peripheral sites, occupied mainly by Ba (less Sr and K) at 96% and 26%. There are two I blocks: I$_1$ block is a layer of Ba atoms and I$_2$ block consists of H$_2$O groups and atoms of second peripheral site. The structural formula is (Ba$_{0.56}$Sr$_{0.22}$K$_{0.15}$Ca$_{0.03}$□$_{0.04}$)$_{\Sigma 1}$(□$_{0.74}$Ba$_{0.14}$Sr$_{0.06}$K$_{0.06}$)$_{\Sigma 1}$ (Ti$_{0.98}$Al$_{0.02}$)$_{\Sigma 1}$(Nb$_{0.63}$Ti$_{0.37}$)$_{\Sigma 1}$(Na$_{2.55}$Mn$_{0.31}$Ca$_{0.11}$Fe$^{2+}_{0.03}$)$_{\Sigma 3}$(Ti$_{0.74}$Mn$_{0.26}$)$_{\Sigma 1}$ (Si$_2$O$_7$)$_2$O$_2$(OH$_{1.41}$F$_{0.59}$)$_{\Sigma 2}$(H$_2$O)(□$_{0.74}$H$_2$O$_{0.26}$)$_{\Sigma 1}$(H$_2$O)$_{2.74}$. The TS and I blocks are topologically identical to those in the nechelyustovite structure. The mineral is named in honor of Vadim Ivanovich Kazansky (b.1926), a prominent Russian ore geologist and an expert in Precambrian metallogeny. The holotype specimen of kazanskyite is deposited at the Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow, Russia. **D.B.**

## MEISSERITE*

J. Plášil, A.R. Kampf, A.V. Kasatkin, J. Marty, R. Škoda, S. Silva, and J. Čejka (2013) Meisserite, Na$_5$(UO$_2$)(SO$_4$)$_3$(SO$_3$OH) (H$_2$O), a new uranyl sulfate mineral from the Blue Lizard mine, San Juan County, Utah, USA. Mineralogical Magazine, 77(7), 2975–2988.

Meisserite (IMA 2013-039), ideally Na$_5$(UO$_2$)(SO$_4$)$_3$(SO$_3$OH) (H$_2$O), is a new uranyl sulphate mineral from the Blue Lizard Mine Red Canyon, White Canyon district, San Juan Co., Utah, U.S.A. (37°33′26″N110°17′44″W). This underground U mine is host to a large number of rare Na-bearing secondary uranyl minerals related to the post-mining oxidation of primary uraninite, pyrite, chalcopyrite, bornite, and covellite deposited as replacement of wood and other organic material and as disseminations in the enclosing medium- to coarse-grained sandstone of the Shinarump Member of the Chinle Formation (Upper Triassic age). Meisserite occurs in efflorescence on sandstone in direct association with chalcanthite, copiapite, ferrinatrite, blödite, gypsum, johannite, and belakovskiite, while the general secondary assemblage includes atacamite, boyleite, pickeringite, brochantite, chalcanthite, cobaltoblödite, manganoblödite, copiapite, coquimbite, cyanotrichite, d'ansite-(Mn), dickite, gerhardtite, gordaite, gypsum, halite, johannite, natrochalcite, natrozippeite, pseudojohannite, rhomboclase, römerite, sideronatrite, tamarugite, and bluelizardite. Meisserite commonly occurs as intergrowths with other uranyl sulfates, and rarely as isolated crystal aggregates. It is pale green to yellowish

green with a very pale yellow streak. Meisserite forms prismatic crystals up to 0.3 mm long, elongated on [100] with prism forms {010} and {001}. It is translucent to transparent with a vitreous luster, very brittle, has fair cleavage on {100} and {001}, and uneven fracture. The Mohs hardness is estimated as 2, $D_{calc}$ = 3.208 g/cm³. Meisserite shows bright yellow-green fluorescence under long- and short-wave UV radiation. It is biaxial (–), with $\alpha = 1.514$, $\beta = 1.546$, and $\gamma = 1.557$ (white light); $2V_{meas} = 60(2)°$ and $2V_{calc} = 60°$. $X \approx$ **a**, $Z \approx$ **c**. Dispersion of optical axes is $r > v$. The mineral is pleochroic, with $X$ (colorless) < $Y$ (pale yellow) ≈ $Z$ (pale greenish-yellow). The average of 4 electron probe WDS analyses is [wt% (range)]: Na$_2$O 21.67 (19.76–20.86), UO$_3$ 61.46 (58.29–63.77), SO$_3$ 34.98 (34.23–36.57), H$_2$O 3.90, total 101.16 wt% (H$_2$O is calculated from stoichiometry). The empirical formula of meisserite calculated on the basis of 19 O pfu is Na$_{5.05}$(U$_{0.94}$O$_2$)(SO$_4$)$_3$[SO$_{2.69}$(OH)$_{1.31}$](H$_2$O). The Raman spectrum of meisserite has bands associated with UO$_2^{2+}$ (at 847 and 241 cm$^{-1}$), SO$_4$, and SO$_3$OH (1239, 1213, 1186, 1153, 1139, 1102, 1068, 1045, 1031, 1019, 990, 975, 890, 633, 606, 589, 464, 448, and 414 cm$^{-1}$), and O-H stretching vibrations (3497 and 3366 cm$^{-1}$). Additional weak vibrations in the lower range of the spectrum are associated with the lattice modes and observed at 199, 171, 123, 96, and 61 cm$^{-1}$. The strongest lines of the X-ray powder diffraction pattern are [$d_{obs}$ Å ($I_{rel}$%; $hkl$)]: 13.15 (81; 001), 6.33 (62; 0$\overline{1}$2), 5.64 (52; 0$\overline{2}$1,020), 5.24 (100; 100,012,$\overline{1}$01), 4.67 (68; 101), 3.849 (48; $\overline{1}$$\overline{2}$1,102,022), 3.614 (41; 0$\overline{3}$2,$\overline{1}$$\overline{1}$3), 3.293 (43; $\overline{1}$13,004). The crystal structure of meisserite was solved by direct methods and refined to $R_1 = 1.8\%$. The mineral is triclinic, $P\overline{1}$, $a = 5.32317(10)$, $b = 11.5105(2)$, $c = 13.5562(10)$ Å, $\alpha = 102.964(7)$, $\beta = 97.414(7)$, $\gamma = 91.461(6)°$, $V = 801.74(6)$ Å³, and $Z = 2$. The crystal structure of meisserite is based on a heteropolyhedral framework, in which fundamental blocks are infinite uranyl-sulfate chains extended along [010]. The chains are linked through a symmetrically distinct sulfur tetrahedron, which is also linked by the weaker bonds to Na$^+$. This tetrahedron contains a protonated oxygen atom, thus forming a [SO$_3$OH] group. The mineral was named in honor of Nicolas Meisser, a prominent Swiss mineralogist and a Curator of Mineralogy and Petrography at the Musée cantonal de géologie at Lausanne, Switzerland. One of the cotype specimens is deposited in the collections of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia; another one is deposited in the collections of the Natural History Museum of Los Angeles County, U.S.A., and the third one is at the collections of the Musée cantonal de géologie at Lausanne, Switzerland. **Yu.U.**

## NASHITE*

A.R. Kampf, J.M. Hughes, J. Marty, and F.H. Brown (2013) Nashite, Na$_3$Ca$_2$[(V$^{4+}$V$_9^{5+}$)O$_{28}$]24H$_2$O, a new mineral species from the Yellow Cat Mining District, Utah and the Slick Rock Mining District, Colorado: Crystal structure and descriptive mineralogy. Canadian Mineralogist, 51(1), 27–37

Nashite (IMA 2011-105), ideally Na$_3$Ca$_2$[(V$^{4+}$V$_9^{5+}$)O$_{28}$]·24H$_2$O, is a new mineral from the Little Eva mine, Yellow Cat District, Grand County, Utah, and the St. Jude mine, Slick Rock district, San Miguel County, Colorado, U.S.A. Crystals of nashite were found growing as blades on a corvusite-montroseite-bearing

sandstone block in close association with calciodelrioite, cal-
cite, gypsum, huemulite, pascoite, rossite, and sherwoodite.
Other minerals found nearby include andersonite, ansermetite,
cobaltomenite, dickthomssenite, ferroselite, lasalite, martyite,
melanovanadite, natrozippeite, schrockingerite, native selenium,
tyuyamunnite, and uraninite. Nashite forms from the oxidation
of montroseite-corvusite assemblages in a moist environment,
possibly controlled by the presence of organic matter and phases
such as pyrite. Crystals of nashite commonly occur in stacked
parallel intergrowths as equant to tabular crystals up to 0.3 mm in
length. Nashite is bluish-green, with a light bluish-green streak,
is transparent with a subadamantine luster, has good cleavage on
{010}, is brittle, shows no parting and has irregular fracture. It
has a Mohs hardness of ~2. The density could not be measured
due to its solubility in density liquids; $D_{calc} = 2.350$ g/cm$^3$. Nashite
does not fluoresce in short- or long-wave ultraviolet radiation.
It is biaxial (–), with $\alpha = 1.737(3)$, $\beta = 1.762(6)$, $\gamma = 1.775(3)$,
$2V_{meas} = 70(2)°$ and $2V_{calc} = 71°$. The optic orientation is $Y = \mathbf{b}$, $X$
$\approx \mathbf{a}$. Nashite is pleochroic, with $X =$ greenish blue, $Y =$ yellowish
green, and $Z =$ yellow; $X > Y >> Z$. The average of 32 electron
probe WDS analyses on 8 crystals is [wt% (range)]: Na$_2$O 6.99
(5.84–8.13), K$_2$O 0.02 (0.00–0.07), CaO 8.19 (7.21–8.89) SrO
0.29 (0.13–0.45), VO$_2$ 6.11, V$_2$O$_5$ 60.28, H$_2$O 18.12, total 100
wt%. VO$_2$ and V$_2$O$_5$ were calculated in accordance with the
structure, and H$_2$O upon the structure with V$^{5+} = 9$, V$^{4+} = 1$, and
O = 52 apfu. This gives the empirical formula $(Na_{3.063}K_{0.007})_{\Sigma3.070}$
$(Ca_{1.984}Sr_{0.039})_{\Sigma2.019}[(V^{4+}V_9^{5+})O_{28}]\cdot24(H_{1.995}O)$ based on 52 O pfu.
The strongest lines in the X-ray powder-diffraction pattern [$d_{obs}$
(Å) ($I_{obs}$%; $hkl$)] are: 9.044 (100; 111,$\overline{1}$01), 8.350 (64; 110),
10.995 (46; 020), and 2.9942 (29; $\overline{3}$31,$\overline{3}$32,$\overline{3}$03,071,310). Single-
crystal X-ray diffraction data collected on a crystal of size 0.050 ×
0.090 × 0.110 mm refined to $R_1 = 0.0293$ for 3144 unique reflec-
tions with $I \geq 2\sigma(I)$ shows nashite is monoclinic, $P2_1/n$, with $a =$
10.0099(3), $b = 21.8472(7)$, $c = 11.1504(7)$ Å, $\beta = 116.584(8)°$,
$V = 2180.67$ Å$^3$, and $Z = 2$. The structure of nashite is based on
a partially reduced decavanadate group structural unit [$(V^{4+}V_9^{5+})$
O$_{28}$]$^{7-}$ and a [Na$_3$Ca$_2$(OH$_2$)$_{22}$·2H$_2$O]$^{7+}$ interstitial unit. The struc-
tural unit consists of ten distorted, edge-sharing octahedra that are
bonded to chains of Na octahedra and an irregular CaO$_2$(OH$_2$)$_6$
polyhedron via corner-sharing and hydrogen-bonding between
the H$_2$O molecules of the interstitial group and the oxygen atoms
of the structural unit. Nashite is named after Barbara P. Nash (b.
1944), Professor of Geology and Geophysics at the University
of Utah, for her many contributions to the geochemistry and
petrogenesis of volcanic systems as well as for her contribution
to the description of several new minerals. The type specimens
of nashite are deposited in the Natural History Museum of Los
Angeles County, Los Angeles, California, U.S.A. **O.C.G.**

## OMSITE*

S.J. Mills, A.R. Kampf, R.M. Housley, G. Favreau, M. Pasero,
C. Biagioni, S. Merlino, C. Berbain, and P. Orlandi (2012)
Omsite, (Ni,Cu)$_2$Fe$^{3+}$(OH)$_6$[Sb(OH)$_6$], a new member of the
cualstibite group from Oms, France. Mineralogical Magazine,
76(5), 1347–1354.

Omsite (IMA 2012-025), ideally (Ni,Cu)$_2$Fe$^{3+}$(OH)$_6$[Sb(OH)$_6$],
is a new mineral found at the Correc d'en Llinassos, near the

village of Oms in the Pyrénées-Orientales Department, France,
(42°32′16″N 02°42′26″E). Omsite occurs in narrow, crystal-
lined fractures in massive siderite-bearing rock with ullmannite
and chalcopyrite, and less commonly with tetrahedrite/ten-
nantite. It generally crystallizes on siderite without associated
supergene minerals, and less commonly with glaukosphaerite.
Omsite occurs as curved discoidal tablets, which are flattened
on {001}, and bounded by indistinct forms in the [001] zone,
possibly including {100} and {110}. The tablets are commonly
intergrown to form rosettes, which are typically 50–100 μm
across while the individual crystallites are generally no more
than 10 μm. Crystals are bright to amber yellow, with a pale
yellow streak, a vitreous to resinous luster, are transparent to
translucent, are brittle with an irregular fracture, and have one
poor cleavage on {001}. The Mohs hardness is ~3. The density
was not be measured due to the small size of the crystals; $D_{calc}$
= 3.378 g/cm$^3$. Omsite is not fluorescent in either short-wave
or long-wave ultraviolet light. In white light, the mineral
is uniaxial (–), with $\omega = 1.728(3)$ and $\varepsilon = 1.66(1)$. Omsite
is pleochroic $\omega$ orange-yellow > $\varepsilon$ pale orange-yellow. The
average of 5 electron probe WDS analyses gave [wt% (range)]:
Na$_2$O 0.18 (0.04–0.41), MgO 0.86 (0.63–1.28), CuO 10.55
(8.19–11.88), NiO 16.37 (15.34–18.35), Fe$_2$O$_3$ 16.64 (16.01–16.96),
Sb$_2$O$_5$ 30.54 (30.35–30.90), As$_2$O$_5$ 1.66 (1.20–1.93), Cl 0.23
(0.05–0.55), –O≡Cl$_2$ 0.05, H$_2$O [calculated on the basis of
12 (OH+Cl) pfu] 21.50, total 98.48 wt%. The empirical for-
mula is $(Ni_{1.10}^{2+}Cu_{0.67}^{2+}Mg_{0.11}Fe_{0.05}^{3+})_{\Sigma1.93}Fe_{1.00}^{3+}(Sb_{0.95}^{5+}As_{0.07}Na_{0.03})_{\Sigma1.05}$
OH$_{11.97}$Cl$_{0.03}$ based on 12 (OH+Cl) pfu. The strongest lines in
the X-ray powder-diffraction pattern [$d_{obs}$ Å ($I_{obs}$%; $hkl$)] are:
4.901, (100; 004), 4.575, (83; 011), 2.3539, (81; 11$\overline{4}$), 1.8079,
(48; 11$\overline{8}$), 3.781, (34; 103). The unit-cell parameters refined
from powder-diffraction data are: $a = 5.360(2)$, $c = 19.589(7)$ Å,
$V = 487.3$ Å$^3$, and $Z = 2$. Single-crystal X-ray diffraction data
collected refined to $R_1 = 0.0896$ for 356 unique reflections with
$I \geq 4\sigma(I)$ shows omsite space group $P\overline{3}$, with $a = 5.3506(8)$,
$c = 19.5802(15)$ Å, $V = 485.46$ Å$^3$, and $Z = 2$. Omsite is a layered
double hydroxide with a topology consistent with members of
the hydrotalcite supergroup and cualstibite group. Its structure
consists of a (Ni,Cu)$_2$Fe(OH)$_6$ brucite-like layer, with Sb(OH)$_6$
octahedra in the interlayer. Omsite is named for Oms, the clos-
est village to the locality. Two cotype specimens have been
deposited in the collections of the Natural History Museum of
Los Angeles County, Los Angeles, California, U.S.A. **O.C.G.**

## TANOHATAITE*

T. Nagase, H. Hori, M. Kitamine, M. Nagashima, A. Abduriyim,
and T. Kuribayashi (2012) Tanohataite, LiMn$_2$Si$_3$O$_8$(OH):
a new mineral from the Tanohata mine, Iwate Prefecture,
Japan. Journal of Mineralogical and Petrological Sciences,
107(3), 149–154.

Tanohataite (IMA 2007-019), ideally LiMn$_2$Si$_3$O$_8$(OH), a Li
analog of serandite [NaMn$_2$Si$_3$O$_8$(OH)], has been found in the
Tanohata mine, Tanohata village, Iwate prefecture, Japan. The
upper Jurassic sediment-hosted Mn-ore deposits of the Tanohata
mine are related to contact metamorphism caused by intrusion
of Cretaceous granodiorite. The ore body is composed mainly of
rhodonite, rhodochrosite, braunite, and tephroite, and includes

lens-like veinlets of quartz, aegirine, nambulite, and barite, with the occurrence of concentrates of alkali amphiboles and various new lithium- and vanadium-bearing minerals, such as kôzulite, suzukiite, natronambulite, potassicleakeite, and watatsumiite. Tanohataite occurs as aggregates of fibrous crystals 0.1–0.5 mm in width and a few millimeters in length. Individual crystals exhibit an acicular shape elongated along **b**, with sizes of a few micrometers in width and less than 1 mm in length. The mineral is transparent, pinkish white with a vitreous or silky luster. The color changes to black on oxidation. Streak is white. Sérandite and rhodonite are more brittle than tanohataite and are easily ground to a powder. In contrast, tanohataite exhibits a strong flexibility like asbestos. The cleavage is perfect on {001} and {100}. Mohs hardness is 5–5½ and $D_{calc} = 3.33$ g/cm³. Optically is biaxial (+), α = 1.593(3), β = 1.618(3), and γ = 1.653(3), $2V_{calc} = 82°$. Pleochroism was not observed. Fourier-transform infrared spectra of tanohataite in the range 700–5000 cm⁻¹ shows stretching mode of the $SiO_4$ tetrahedra around 1200–800 cm⁻¹, and bending modes and lattice modes of the remaining structural constituents at lower energies. Relatively sharp peaks are observed at 1394 cm⁻¹ (OH-bending mode) and 1640 cm⁻¹ (usually related to OH-stretching mode of $H_2O$), the latter possibly related to strong hydrogen bonding. Broad peaks between 2500 and 3700 cm⁻¹ were also observed. The DTA curve of tanohataite shows a broad exothermic peak around 500–700 °C and a sharp exothermic peak at 730 °C. Electron probe WDS and laser ablation microprobe inductively coupled plasma-mass spectrometry analyses gave [wt% (range)]: $SiO_2$ 51.97 (51.14–52.92), MnO 37.99 (37.99–38.54), MgO 1.06 (0.46–1.06), CaO 0.41 (0.29–0.48), $Na_2O$ 1.97 (1.53–2.10), $Li_2O$ 3.34 (3.34–3.56), $H_2O$ (calculated) 2.59, with a total of 99.33. On the basis of 9 O apfu, the empirical formulas is $(Li_{0.78}Na_{0.22})$ $(Mn_{1.86}Ca_{0.03}Mg_{0.09})Si_{3.01}O_8(OH)$. The strongest lines in the X-ray powder-diffraction pattern [$d_{obs}$ Å ($I_{obs}$%; $hkl$)] are: 6.64 (35; 001), 3.67 (26; 200), 3.13 (89; $\bar{1}02$), 3.11 (69; $2\bar{1}1$), 2.95 (100; 102), 2.81 (33; 120), 2.18 (40; $\bar{1}03$). The mineral has the triclinic space group $P\bar{1}$ with $a = 7.612(7)$, $b = 7.038(4)$, $c = 6.700(4)$ Å, α = 90.23(6)°, β = 94.70(7)°, γ = 105.26 (8)°, $V = 345.0(3)$ Å³, and $Z = 2$. Transmission electron microscopy observations for tanohataite showed twined patterns and $hk0$ electron diffraction patterns showing diffuse streaks parallel to $a^*$ of the $k = 2n + 1$ reflections, a common characteristic structural feature of the pectolite group and wollastonite group minerals, that indicate stacking disorder with faults parallel to (100). Diffraction pattern analogous to parawollastonite and parapectolite were not observed. Tanohataite is named after its type locality. The type specimen is deposited in the National Museum of Nature and Science, Tokyo, Japan. **F.C.**

## TAZZOLIITE*

F. Cámara, F. Nestola, L. Bindi, A. Guastoni, F. Zorzi, L. Peruzzo, and D. Pedron (2012) Tazzoliite: a new mineral with a pyrochlore-related structure from the Euganei Hills, Padova, Italy. Mineralogical Magazine, 76(4), 827–838.

Tazzoliite (IMA 2011-018), ideally $Ba_2CaSr_{0.5}Na_{0.5}Ti_2Nb_3$ $SiO_{17}[PO_2(OH)_2]_{0.5}$, is a new mineral found at Monte delle Basse in the Euganei Hills, south of Galzignano Terme, Padova, Italy (45°18′30″; N43°49′47″E). Tazzoliite occurs as part of skarn and calc-silicate rocks with rare sanidine xenoliths, which contain

cavities up to several millimeters across, where the new mineral is hosted in close association with a diopside and titanite. Tazzoliite occurs as fan-shaped groups of platy crystals up to 0.4 mm long and a few millimeters thick. Crystals of tazzoliite are transparent, pale orange with a white streak and pearly luster. They are brittle, show no twinning, have a perfect cleavage along {010}, an uneven fracture and no parting. The Mohs hardness is 6 ($VHN_{15} = 788$ kg/mm²). $D_{calc} = 4.517$ g/cm³. Tazzoliite is not fluorescent. It is biaxial (–) with $2V_{meas} = 50(5)°$ and nonpleochroic. The calculated mean refractive index is 2.04. Raman spectra of tazzoliite were collected in the range 150–3700 cm⁻¹; a very weak and broad peak at 3516 cm⁻¹ confirms the presence of OH groups. There is no evidence of $H_2O$ bending around 1600 cm⁻¹ (although its expression would be extremely weak). The average of 7 electron probe WDS analyses gave [wt% (range)]: $SO_3$ 0.51 (0.36–0.66), $Nb_2O_5$ 34.51 (33.53–35.38), $Ta_2O_5$ 0.89 (0.66–1.16), $V_2O_3$ 0.05 (0.00–0.11), $P_2O_5$ 0.85 (0.85–0.85), $SiO_2$ 6.10 (5.74–6.31), $TiO_2$ 14.77 (14.42–15.09), $SnO_2$ 0.04 (0.00–0.09), $ZrO_2$ 0.11 (0.07–0.21), FeO 0.63 (0.55–0.66), MnO 0.01 (0.00–0.03), CaO 6.07 (5.67–6.60), BaO 26.75 (26.31–27.28), SrO 4.92 (4.18–5.72), $Na_2O$ 0.70 (0.64–0.77), $H_2O$ (calculated on the basis of the structure refinement) 0.74 (0.64–0.73), F 0.15 (0.00–0.37), $-O=F_2$ 0.06, total 97.74 wt%. The empirical formula is $(Ba_{1.93}Ca_{1.20}Sr_{0.52}Na_{0.25}Fe^{2+}_{0.10})_{\Sigma4.00}(Nb_{2.88}$ $Ti_{2.05}Ta_{0.07}Zr_{0.01}V^{5+}_{0.01})_{\Sigma5.02}SiO_{17}[(P_{0.13}Si_{0.12}S_{0.07})_{\Sigma0.32}O_{0.66}(OH)_{0.66}]$ $[F_{0.09}(OH)_{0.23}]_{\Sigma0.32}$ based on an iterative process on the basis of $(18 + 2x)$ (O,F) apfu with $x = [P + S + (Si - 1)] < 0.5$ apfu to take into account the partial occupancy of anionic groups in the channels. The strongest lines in the X-ray powder-diffraction pattern [$d_{obs}$ Å ($I_{obs}$%; $hkl$)] are: 3.66 (60; 044), 3.16 (30; 153), 3.05 (100; 204), 2.98 (25; 240), 2.84 (50; 064), 1.85 (25; 400) and 1.82 (25; 268). The unit-cell parameters refined from powder-diffraction data are: $a = 7.4116(3)$, $b = 20.0632(8)$, $c = 21.4402(8)$ Å, $V = 3188.2$ Å³ and $Z = 8$. Single-crystal X-ray diffraction data collected on a crystal of size $0.100 \times 0.040 \times 0.015$ mm refined to $R_1 = 0.0633$ for 1300 unique reflections with $I \geq 4\sigma(I)$ shows tazzoliite is orthorhombic, space group $Fmmm$, with $a = 7.4105(4)$, $b = 20.0675(11)$, $c = 21.4471(11)$ Å, $V = 3189.4$ Å³, and $Z = 8$. The structure of tazzoliite is related to pyrochlore and consists of a framework of Nb(Ti) octahedra and $BaO_7$ polyhedra sharing apexes or edges, and Si tetrahedra sharing apexes with Nb(Ti) octahedra and $BaO_7$ polyhedra. Chains of $[Sr(Ca,Fe)]_2O_8$ polyhedra extend along [100] and are surrounded by Nb octahedra. Channels are formed by six Nb(Ti) octahedra and two tetrahedra or four $BaO_8(OH)$ polyhedra alternating along [100]. The channels are partially occupied by $[PO_2(OH)_2]$ in two possible mutually exclusive positions, alternating with fully occupied $[Ca(Na)]_3O_7$ polyhedral pairs. Tazzoliite is named in honor of Vittorio Tazzoli (b. 1938) in recognition of his contribution to the fields of mineralogy and crystallography, particularly in the area of pyroxenes. The type material is deposited in the collections of the Museo di Mineralogia di Padova, Italy. **O.C.G.**

## VAPNIKITE*

E.V. Galuskin, I.O. Galuskina, J. Kusz, T. Armbruster, K.M. Marzec, P. Dzierżanowski, and M. Murashko (2014) Vapnikite $Ca_3UO_6$ a new double-perovskite mineral from pyrometamor-

phic larnite rocks of the Jabel Harmun, Palestinian Autonomy, Israel. Mineralogical Magazine, 78(3), 571–581.

The new mineral species vapnikite (IMA 2013-082), ideally $Ca_3UO_6$, was discovered in larnite rocks of the of the Hatrurim Formation ("Mottled Zone") at Jabel Harmun in the Judean desert, Palestinian Autonomy, Israel (31°46′N; 35°26′E). It is a natural analog of the synthetic ordered double-perovskite β-$Ca_3UO_6$ and is isotypical with the cryolite (natural fluorperovskite) $Na_3AlF_6$. Vapnikite occurs as xenomorphic tiny grains (<5–10 μm very rare up to 20–30 μm) in larnite-rich pseudoconglomerates supposedly formed by pyrogenic metamorphism due to caustobiolith combustion at temperatures above 800 °C. Vapnikite formed at the high-temperature retrograde stage of pyrometamorphism when larnite rocks were altered by fluids/melts of high alkalinity. The larnite pebbles containing vapnikite have dark-brown color due to abundant grains of brownmillerite. Other rock-forming minerals are ye'elimite and/or minerals of the fluormayenite-fluorkyuygenite series. Some rock fragments are enriched in fluorellestadite–fluorapatite, P-ternesite, shulamitite, baryte, periclase, banabimusaite, and the potentially new mineral $BaCa_6(SiO_4)_2(SO_4)_2O$. Rarely found are oldhamite and the potentially new mineral $CaCu_2S_2$. In pebbles, vapnikite is often associated with vorlanite ($CaU^{6+}O_4$). Vapnikite and vorlanite are usually enriched in different parts of the larnite-bearing rocks. Micrometer-sized rims around vapnikite with composition $Ca_2UO_5 \cdot nH_2O$ and/or $CaUO_4 \cdot nH_2O$ were observed. Vapnikite is yellow-brown transparent with a strong vitreous luster and white with a yellow hue streak. It occasionally shows a weak yellowish fluorescence at 254–366 nm ultraviolet light. The mineral has irregular fracture; cleavage and parting are not observed. Microhardness $VHN_{25} = 534$ (516–548) kg/mm² corresponds to ~5 in the Mohs scale. Density could not be measured because of the small grain size. $D_{calc} = 5.322$ g/cm³. Vapnikite is biaxial non pleochroic with only a mean refractive index 1.78(3) in a random cross section determined due to a small grain size. In contrast to vorlanite it does not dissolves in 10% HCl at room temperature. The Raman spectra for vapnikite and vorlanite grains selected in the same thin section were obtained with low laser power (up to 5 mW) and subsequently after burning with a laser power of 40 mW. The Raman spectrum of initial vapnikite shows the presence of two main bands at 725 and 391 cm⁻¹ related to stretching and bending UO vibrations. The average of 14 electron probe WDS analyses is: $UO_3$ 63.36 (62.78–63.87), CaO 36.28 (35.94–36.64), total 99.64 wt%. The empirical formula based on 4 cations apfu is $Ca_{2.98}U_{1.02}O_{6.04}$. Single-crystal X-ray diffraction data collected on a crystal 24 × 11 × 10 μm in size refined to $R_1 = 0.0354$ for 553 unique reflections with $I \geq 4\sigma(I)$ shows vapnikite is monoclinic, $P2_1/n$, with $a = 5.739(1)$, $b = 5.951(1)$, $c = 8.312(1)$ Å, $\beta = 90.4(1)°$, $V = 283.9$ Å³, and $Z = 2$. The strongest lines of the calculated X-ray powder diffraction pattern are [$d_{obs}$ Å ($I_{obs}$%; $hkl$)]: 4.838 (78; 011), 4.706 (39; 101), 4.131 (79; 110), 2.975 (47; 020), 2.938 (100; $\bar{1}$12), 2.922 (99; 112), 2.869 (43; 200), 2.065 (47; 220). The crystal structure of vapnikite related to ordered U-bearing double perovskites with crystal-chemical formula $A_2^{2+}B^{2+}UO_6$ ($A$ = Sr, Ba, Pb, Ca; $B$ = Mg, Ca, Sr, Ba, Mn, Fe, Co, Ni, Cu, Zn, Cd, Pb). The structure of vapnikite differs from that of its synthetic analog β-$Ca_3UO_6$ by having a larger degree of Ca,U disorder. The mineral named in honor of Yevgeny Vapnik

of Ben Gurion University of the Negev, Beer Sheva, Israel, who initiated a new program of geological, geophysical, petrological, and mineralogical studies of the Hatrurim Formation and who is coauthor of 14 new mineral species from that area. The type material is deposited in the Museum of Natural History in Bern, Switzerland. **D.B.**

## WERNERBAURITE* AND SCHINDLERITE*

A.R. Kampf, J.M. Hughes, J. Marty, and B. Nash (2013) Wernerbaurite, $\{[Ca(H_2O)_7]_2(H_2O)_2(H_3O)_2\}\{V_{10}O_{28}\}$, and schindlerite, $\{[Na_2(H_2O)_{10}](H_3O)_4\}\{V_{10}O_{28}\}$, the first hydronium-bearing decavanadate minerals. Canadian Mineralogist, 51(2), 297–312.

Wernerbaurite (IMA 2012-064), ideally $\{[Ca(H_2O)_7]_2(H_2O)_2(H_3O)_2\}\{V_{10}O_{28}\}$, and schindlerite (IMA 2012-063), ideally $\{[Na_2(H_2O)_{10}](H_3O)_4\}\{V_{10}O_{28}\}$, are new minerals from the St. Jude mine, Slick Rock district, San Miguel County, Colorado, U.S.A. Wernerbaurite and schindlerite are secondary vanadium minerals that result from the oxidation of montroseite-corvusite assemblages in a moist environment. The minerals were found growing on separate specimens of corvusite–montroseite-bearing sandstone blocks and are closely associated with calciodelrioite, gypsum, huemulite, hughesite, metarossite, pascoite, and rossite. Other nearby minerals include delrioite, hendersonite, nashite, and powellite. Crystals of wernerbaurite are tabular on {100}, with stepped faces and square to octagonal outlines, up to ~1 mm in maximum dimension. Crystals show the forms {100}, {010}, {001}, {011}, and {111} and are often aligned roughly perpendicular to the surface on which they are growing, subparallel to one another. Crystals of schindlerite are tabular on {011} and often occur in stacked parallel intergrowths. Individual crystals are up to 0.3 mm in size and exhibit the forms {100}, {010}, {001}, {110}, {011}, {111}, and {111}. Wernerbaurite is yellow-orange, has a yellow streak, subadamantine luster, is transparent, brittle, and has good cleavage on {100} and {010}. It has a Mohs hardness of ~2. Its density could not be measured due to dissolution in density liquids; $D_{calc} = 2.352$ g/cm³. Schindlerite is orange, has a yellow streak, a subadamantine luster, is transparent, brittle, and has good cleavage on {010}. It has a Mohs hardness of ~2; $D_{calc} = 2.461$ g/cm³. Wernerbaurite and schindlerite dissolve instantly in cold, dilute HCl and slowly in water. They do not fluoresce in short- or long-wave ultraviolet radiation. Wernerbaurite is biaxial (–), with α = 1.745(3), β = 1.780(3), γ = 1.795(3), and $2V = 66(2)°$ in white light. The optical orientation is $X \wedge \mathbf{a} = 29°$, $Y \wedge \mathbf{c} = 44°$, $Z \wedge \mathbf{b} = 46°$. The mineral is pleochroic with $X, Z$ = yellow, $Y$ = orange; $X = Z < Y$. Dispersion of optical axes is very strong, $r > v$. Schindlerite is biaxial (+), with α = 1.74 (est.), β = 1.790(5), γ = 1.875 (calc) and $2V_{meas} = 78.1°$ in white light. The optical orientation is $X \wedge \mathbf{b} = 25°$, $Y \wedge \mathbf{c} = 12°$, and $Z \wedge \mathbf{a} = 3°$. No pleochroism was perceptible. Dispersion of optical axes is very strong, $r > v$. For wernerbaurite, the average of 12 electron probe WDS analyses on 3 crystals is [wt% (range)]: $Na_2O$ 0.37 (0.13–0.91), $K_2O$ 0.10 (0.05–0.13), CaO 8.76 (8.16–9.25), SrO 0.16 (0.04–0.30), $V_2O_5$ 75.76 (74.25–77.72), $H_2O$ 14.85 (calc. based on structure refinement) total 100 wt% (following determination of $H_2O$). This gives the empirical formula $\{(Ca_{1.88}Na_{0.14}K_{0.03}Sr_{0.02})_{\Sigma 2.07}(H_2O)_{15.95}(H_3O)_{2.05}\}\{V_{10}O_{28}\}$ based on $V^{5+} = 10$ and O = 46 apfu. For schindlerite, the average of 21 electron probe WDS analyses

on 9 crystals is [wt% (range)]: $Na_2O$ 4.08 (3.47–4.87), $K_2O$ 1.37 (1.19–1.69), CaO 0.08 (0.02–0.19), SrO 0.10 (0.00–0.16), $V_2O_5$ 75.80 (73.16–81.60), $H_2O$ 18.57 (calc. based on structure refinement) total 100 wt% (following determination of $H_2O$). This gives the empirical formula $\{[(Na_{1.58}K_{0.35}Ca_{0.02}Sr_{0.01})_{\Sigma1.96}(H_2O)_{10.00}][(H_3O)_4]\}\{V_{10}O_{28}\}$ based on $V^{5+}$ = 10 and O = 42 apfu. The strongest lines in the X-ray powder-diffraction pattern of wernerbaurite [$d_{obs}$ (Å) ($I_{obs}$%; $hkl$)] are: 10.32 (100; 001), 8.88 (95; 100), 9.64 (92; 010), and 6.881 (70; 111). For schindlerite the strongest lines are: 8.68 (100; 010,011), 10.51 (94; 001), 7.70 (86; 100,110), and 6.73 (61; 111,$\bar{1}$01). For wernerbaurite, single-crystal X-ray diffraction data collected on a crystal of size 40 × 220 × 220 μm refined to $R_1$ = 0.0341 for 3440 unique reflections with $I \geq 4\sigma(I)$ shows the mineral is triclinic, $P\bar{1}$, with $a$ = 9.7212(6), $b$ = 10.2598(8), $c$ = 10.5928(8) Å, $\alpha$ = 89.999(6)°, $\beta$ = 77.083(7)°, $\gamma$ = 69.887(8)°, $V$ = 963.55 Å$^3$, and $Z$ = 1. For schindlerite, single-crystal X-ray diffraction data collected on a crystal of size 40 × 90 × 180 μm refined to $R_1$ = 0.0399 for 2888 unique reflections with $I \geq 4\sigma(I)$ shows the mineral is triclinic, $P\bar{1}$, with $a$ = 8.5143(3), $b$ = 10.4283(5), $c$ = 11.2827(8) Å, $\alpha$ = 68.595(5)°, $\beta$ = 87.253(6)°, $\gamma$ = 67.112(5)°, $V$ = 854.08 Å$^3$, and $Z$ = 1. The structural unit of both mineral is the decavanadate polyanion, $(V_{10}O_{28})^{6-}$. The interstitial unit linking the structural units has a composition of $\{[Ca(H_2O)_7]_2(H_2O)_2(H_3O)_2\}^{6+}$ for wernerbaurite, and is formed of an isolated $[Ca(H_2O)_7]^{2+}$ polyhedron, a $(H_3O)^+$ ion, and an isolated $H_2O$ molecule. Similarly, the interstitial unit of schindlerite has a composition of $\{[Na_2(H_2O)_{10}](H_3O)_4\}^{6+}$ and is formed of a $[Na_2(H_2O)_{10}]$ dimer decorated with four hydronium ions. The structural and interstitial units are linked by an extensive network of hydrogen bonding in both minerals. Wernerbaurite and schindlerite are the first hydronium-bearing decavanadate minerals. Wernerbaurite is named in honor of Werner H. Baur (b. 1931) for his long, productive, and distinguished career in mineralogical crystallography. Schindlerite is named in honor of Michael Schindler (b. 1966) for his extensive work on the structures of vanadium minerals. Three cotype specimens of wernerbaurite and three cotype specimens of schindlerite are deposited in the collections of the Natural History Museum of Los Angeles County, Los Angeles, California, U.S.A. **O.C.G.**

## WOPMAYITE*

M.A. Cooper, F.C. Hawthorne, Y.A. Abdu, N.A. Ball, R.A. Ramik, and K.T. Tait (2013) Wopmayite, ideally $Ca_6Na_3Mn(PO_4)_3(PO_3OH)_4$, a new phosphate mineral from the Tanco Mine, Bernic Lake, Manitoba: Description and crystal structure. Canadian Mineralogist, 51(1), 93–106.

Wopmayite (IMA 2011-093), ideally $Ca_6Na_3Mn(PO_4)_3(PO_3OH)_4$, is a new mineral from the Tanco mine, Bernic Lake, Manitoba. The mineral was found in vugs in a single 5–10 cm mass of phosphate-carbonate mineralization as part of a spodumene-rich boulder found in the dumps of the Tanco Mine. Wopmayite is a secondary mineral that crystallized together with rhodochrosite, quartz, whitlockite, apatite, and other phases after dissolution of primary lithiophosphate by hydrothermal solutions. It is also associated with fairfieldite, crandallite, calcite, overite, groatite, metswitzerite, sphalerite, and bismuthinite. Wopmayite was found as a corroded {101} rhombohedra ~150 μm across. The mineral is colorless to white to pale pink with a white streak and a vitreous luster, is brittle, has an irregular to subconchoidal fracture, and shows no cleavage or parting. It has a Mohs hardness of 5. The density could not be measured due to paucity of the material; $D_{calc}$ = 3.027 g/cm$^3$. Wopmayite does not fluoresce under ultraviolet light. It is uniaxial (−), $\omega$ = 1.617(2), $\varepsilon$ = 1.613(2). Main absorption bands from the IR spectrum (cm$^{-1}$, s = strong, m = medium, w = weak) are: 2830s and 2395s (O−H stretching), 1720m and 1651m (combinations), 1345s (P−O−H bending vibration), 1185s, 1090s, 994w, and 947w (various stretching bands of the $PO_4$ group), 870w (P–OH stretching). The Raman spectrum of wopmayite shows peaks in the 850–1150 cm$^{-1}$ region (probably P−O stretching) and 400–650 cm$^{-1}$ region (O−P−O deformation modes). The average of 8 electron probe WDS analyses is [wt% (range)]: $P_2O_5$ 46.40 (46.14–46.61), $Al_2O_3$ 0.38 (0.28–0.55), $Fe_2O_3$ 0.80 (calc. based on structure refinement), FeO 0.96 (0.61–2.17), MnO 3.7 (3.35–4.56), MgO 0.41 (0.23–0.71), CaO 37.6 (35.54–40.01), SrO 0.91 (0.71–1.26), $Na_2O$ 5.4 (3.96–6.87), $H_2O$ 2.00 [calc. on the basis of 28 anions with (OH) = 2.37 apfu] total 98.68. This gives the empirical formula $(Ca_{7.19}Na_{1.88}Sr_{0.09})_{\Sigma9.16}(Mn_{0.56}Mg_{0.11}Fe^{2+}_{0.14}Fe^{3+}_{0.11}Al_{0.08})_{\Sigma1.00}(PO_4)_{4.63}(PO_3OH)_{2.37}$ based on 28 O apfu. The strongest lines in the X-ray powder-diffraction pattern [$d_{obs}$ (Å) ($I_{obs}$%; $hkl$)] are: 2.858 (100; 0.2.10), 3.186 (88; $\bar{2}$34), 2.589 (68; $\bar{2}$40), 5.166 (33; $\bar{1}$20), 6.421 (32; $\bar{1}$14), 8.017 (31; 012), and 3.425 (29; $\bar{1}$.1.10). The unit-cell parameters refined from powder-diffraction data are: $a$ = 10.370(3), $c$ = 37.085(15) Å, $V$ = 3453.6 Å$^3$. Single-crystal X-ray diffraction data collected on a crystal of size 40 × 60 × 80 μm refined to $R_1$ = 0.0221 for 2288 unique reflections with $I \geq 4\sigma(I)$ shows wopmayite is trigonal, space group $R3c$, $a$ = 10.3926(2), $c$ = 37.1694(9) Å, $V$ = 3476.7 Å$^3$, $Z$ = 6. The structural unit of wopmayite consists of a "bracelet-and-pinwheel" $[M^{2+}(PO_4)_6]$ arrangement that is topologically identical to the one of the whitlockite and merrillite structures. The $[M^{2+}(PO_4)_6]$ clusters are linked by Ca polyhedra and $(PO_3\Phi)$ groups of the form $[Ca_9X(PO_3\Phi)]$ where $\Phi$ = O,OH and $X$ = ($\square$, Na, Ca), depending on the mineral species. Wopmayite is named after Wilfrid Reid "Wop" May (1896–1952) who was born in Carberry, Manitoba, Canada, for his pioneering work as an aviator who created the role of the bush pilot, and opened up the Canadian North to mineral exploration and mining. The holotype specimen of wopmayite has been deposited in the mineral collection of the Department of Natural History, Royal Ontario Museum. **O.C.G.**