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New Mineral Names*,†

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ANGARFITE*

A.R. Kampf, S.J. Mills, R.M. Housley, G. Favreau, J.-C. Boulliard, and V. Bourgoin (2012) Angarfite, $NaFe^{3+}_5(PO_4)_4(OH)_4{\cdot}4H_2O$, a new mineral species from the Angarf-Sud Pegmatite, Morocco: Description and crystal structure. Canadian Mineralogist, 50(4), 781–791.

Angarfite (IMA 2010-082), ideally $NaFe^{3+}_5(PO_4)_4(OH)_4{\cdot}4H_2O$, is a new mineral discovered in the Angarf-Sud pegmatite, Tazenakht, Ouarzazate Province, Souss-Massa-Draâ region, Morocco. It occurs in phosphate nodules of altered crystals of triphylite in association with lipscombite–barbosalite, jahnsite-(NaFeMg) and bederite. Angarfite is interpreted to be result of the reaction of Na-bearing hydrothermal solutions with primary triphylite. Angarfite forms orange-brown to red-brown needle-like or prismatic crystals elongated on [001] up to 2 mm by 20 μm in diameter. The mineral is transparent, vitreous and has a pale brown streak, Mohs hardness of 2½, a splintery fracture and one poorly developed cleavage on {010}. Angarfite is brittle, but thin needles are slightly flexible. D_{meas} = 2.76(3) and D_{calc} = 2.771 g/cm³. The mineral is optically biaxial (+), α = 1.688(1), β = 1.696(1), γ = 1.708(2) (white light). The $2V$ = 80(3)°; $2V_{calc}$ = 79°. Dispersion of optical axes is strong, r > v; X = **b**, Y = **c**, Z = **a**. Angarfite is pleochroic with X = tan, Y = medium red-brown, and Z = dark red-brown; $X < Y < Z$. The average composition by electron probe analyses (WDS, 5 points) is: Na_2O 2.69, MgO 4.76, Mn_2O_3 1.79, Fe_2O_3 37.36, P_2O_5 34.68, H_2O 14.63 (from structure refinement), total 95.91 wt%. The empirical formula calculated on the basis of 24 oxygen atoms is $Na_{0.71}(Fe^{3+}_{3.83}Mg_{0.97}Mn^{3+}_{0.19})_{\Sigma4.99}(P_{1.00}O_4)_4(OH)_{2.71}(H_2O)_{1.29}{\cdot}4H_2O$. Powder and single-crystal X-ray diffraction data were collected using a Rigaku R-Axis Rapid II curved imaging plate microdiffractometer. The strongest lines of the powder X-ray pattern are [d_{obs} in Å (I_{obs}%; *hkl*)]: 10.463 (43; 110), 9.016 (100; 020), 6.459 (42; 111), 3.731 (27; 022), 3.355 (51; 241), (and their names) 3.026 (29; 042), 1.926 (33; 462,263), 1.463 (36; 822,663,$4\overline{10}2$, $2\overline{10}3$). Unit-cell parameters refined from the powder data are a = 12.788(3), b = 17.894(4), c = 8.195(2) Å and V = 1875.1 Å³. The crystal structure of angarfite was solved by direct methods and refined to R_1 = 3.02% for 2074 reflections, $F_o > 4\sigma F$. Angarfite is orthorhombic, $C222_1$, a = 12.7997(3), b = 17.9081(4), c = 8.2112(6) Å, V = 1882.16(15) Å³, and Z = 4. The crystal structure of angarfite contains zigzag chains of edge-sharing $Fe^{3+}O_6$ octahedra along **c**. The octahedral are linked into sheets parallel to {010} by sharing corners with octahedra in adjacent chains and by sharing corners with peripheral PO_4 tetrahedra. There are channels in the framework parallel to **c** and those contain a partially occupied Na site and a disordered H_2O site. The structures of bakhchisaraitsevite and mejillonesite display identical sheets of octahedra and tetrahedra. The co-type specimens are deposited in the mineral collection of the Natural History Museum of Los Angeles County under catalog numbers 63428 and 63429. **Yu.U.**

ASPEDAMITE*

M.A. Cooper, Y.A. Abdu, N.A. Ball, P. Černý, F.C. Hawthorne, and R. Kristiansen (2012) Aspedamite, ideally $\square_{12}(Fe^{3+},Fe^{2+})_3Nb_4[Th(Nb,Fe^{3+})_{12}O_{42}]\{(H_2O),(OH)\}_{12}$, a new heteropolyniobite mineral species from the Herrobøkasa quarry, Aspedammen, Østfold, Southern Norway: Description and crystal structure. Canadian Mineralogist, 50(4), 793–804.

Aspedamite (IMA 2011-056), ideally $\square_{12}(Fe^{3+},Fe^{2+})_3Nb_4[Th(Nb,Fe^{3+})_{12}O_{42}]\{(H_2O),(OH)\}_{12}$, is a new heteropolyniobate mineral species from the Herrebøkasa quarry, Aspedammen, Østfold, southern Norway. The mineral is named after the locality close to Aspedammen. Aspedamite occurs as dodecahedral and cubic crystals up to 50 μm across sitting on a white mat of an Al–Nb–Fe–Ti–Ca–K-bearing silicate on top of a partly altered 12 × 12 × 6 mm crystal of monazite penetrated by plates of columbite-(Fe) and muscovite. Aspedamite has brownish-orange color, a very pale orange streak and an adamantine luster. The mineral does not fluoresce under ultraviolet light. The Mohs hardness is 3–4; it is brittle with a hackly fracture; D_{calc} = 4.070 g/cm³. The calculated refraction index is 2.084. The Raman spectrum

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

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

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has principal peaks (cm^{-1}) at 933, 865, 812, 666, 448, 359, 234, 169, and 117, and (weaker) at ~3460 (H_2O and OH stretches) and ~1610 (H-O-H bend). The average composition by electron probe analysis (WDS) is (wt%): Nb_2O_5 65.64, Ta_2O_5 1.78, SiO_2 0.78, ThO_2 5.64, TiO_2 2.15, Fe_2O_3 10.56, FeO 2.73, MnO 0.82, CaO 0.28, K_2O 0.16, La_2O_3 0.52, Ce_2O_3 1.62, Nd_2O_3 0.44, H_2O (by crystal-structure analysis) 7.20, total 100.32. The empirical formula of aspedamite on the basis of 54 anions with $Fe^{3+}/(Fe^{3+} + Fe^{2+}) = 0.67$ (by structure analysis) is $K_{0.09}Ca_{0.13}Ce_{0.26}La_{0.08}Nd_{0.07}Fe^{2+}_{1.00}Mn_{0.30}Fe^{3+}_{3.48}Th_{0.56}Ti^{4+}_{0.71}Si_{0.34}Nb_{12.98}Ta_{0.21}O_{42}(H_2O)_9(OH)_3$. The strongest lines in the X-ray powder-diffraction pattern [d_{obs} in Å (I_{obs}; *hkl*)] are (obtained with a Gandolfi attachment mounted on a Bruker D8 rotating-anode Discover SuperSpeed micro-powder diffractometer): 9.107 (100; 011), 2.635 (36; 224), 2.889 (33; 024), 1.726 (29; 246), 3.233 (28; 004), 3.454 (18; 123), 4.567 (15; 022). The unit-cell parameter *a* was refined to 12.916(2) Å; V = 2154.7 Å^3. The crystal structure of aspedamite was solved by direct methods on the basis of single-crystal diffraction data collected on a three-circle rotating-anode diffractometer (Mo$K\alpha$ radiation), and refined to R_1 = 1.6% (with 596 observed reflections). The mineral is cubic, space group $Im3$, a = 12.9078(6) Å, V = 2150.6 Å^3, Z = 2. The structure is based on the heteropolyanion $[DA_{12}O_{42}]$ (D = Th, $A = Nb_9Fe^{3+}_2Ti$), which consists of 12 face- and corner-sharing AO_6 octahedra that surround the [12]-coordinated D cation. An *I*-centered arrangement is formed by eight heteropolyanions at the corners of the unit cell, with an additional heteropolyanion at the center. Each heteropolyhedral cluster is decorated by eight *B* octahedra, each of which bridges two adjacent clusters along the body diagonals of the cell. Intercluster linkage is provided by the *C* octahedral linking pairs of adjacent clusters in the **a** direction. Aspedamite is isostructural with menezesite. The holotype specimen is deposited in the mineral collection of the Department of Natural History, Royal Ontario Museum (catalog number M56117). **Yu.U.**

BILLWISEITE*

F.C. Hawthorne, M.A. Cooper, N.A. Ball, Y.A. Abdu, P. Černý, F. Cámara, and B.M. Laurs (2012) Billwiseite, ideally $Sb^{3+}_5(Nb,Ta)_3WO_{18}$, a new oxide mineral species from the Stak Nala pegmatite, Nanga Parbat – Haramosh Massif, Pakistan: description and crystal structure. Canadian Mineralogist, 50(5), 805–814.

Billwiseite (IMA 2010-053), ideally $Sb^{3+}_5(Nb,Ta)_3WO_{18}$, is an oxide mineral from a granitic pegmatite on the eastern margin of the Nanga Parbat – Haramosh massif at Stak Nala, 70 km east of Gilgit, Pakistan. It is associated with albite, quartz, K-feldspar, tourmaline, muscovite or lepidolite, topaz, and fluorite and was found scattered across the surface of a large crystal of lepidolite. Billwiseite forms pale yellow (with a tinge of green) blocky euhedral crystals, up to 0.5 × 0.25 × 0.15 mm, with following forms: {100}, {011}, and {410}. It has a colorless to very pale-yellow streak and a vitreous luster. It commonly forms contact twins on (100), has an indistinct {100} cleavage, is brittle with a hackly fracture and has a Mohs hardness of 5; D_{calc} = 6.330 g/cm^3. Billwiseite is inert to ultraviolet radiation, colorless in transmitted light, non-pleochroic, with optic orientation $X \parallel \mathbf{b}$, $Y \wedge \mathbf{c} = 72.8°$ (in β acute). The indices of refraction were not measured; n_{calc} = 2.3, $2V_{obs}$ is 76(2)°. The infrared spectrum of Billwiseite shows the absence of OH and H_2O. The average of 8 electron probe point analyses (WDS) is [wt% (range)]: Nb_2O_5 12.03 (10.33–15.05), Ta_2O_5 19.31 (13.93–20.44), Sb_2O_3 48.34 (47.99–48.52), TiO_2 0.99 (0.81–1.01), WO_3 19.96 (19.06–22.42), total 100.63. The valence state of Sb was determined by crystal-structure analysis. The empirical formula based on 18 anions pfu is $Sb^{3+}_{4.87}(Nb_{1.33}Ta_{1.28}Ti_{0.18}W_{1.26})_{\Sigma 4.05}O_{18}$. The strongest lines in the X-ray powder-diffraction pattern [d_{obs} (Å) (I_{obs}%; *hkl*)] are: 3.147 (100; $91\bar{1}$,911), 3.500 (55; $51\bar{1}$,511), 1.662 (53; $\overline{14}$ 2 2), 3.017 (48; $\overline{18}$ 0 0), 1.906 (47; $\overline{18}$ 2 0), 1.735 (30; $11\bar{3}$,113), 1.762 (25; $\overline{27}$ 1 $\bar{1}$,$\overline{27}$ 1 1). Least-squares refinement of the unit-cell parameters gave: a = 54.19(4), b = 4.929(3), c = 5.557(3) Å, β = 90.17(5)°, V = 1484.4 Å^3. Single-crystal X-ray diffraction data confirmed that billwiseite is monoclinic, space group $C2/c$, a = 54.116(5), b = 4.9143(5), c = 5.5482(5) Å, β = 90.425(2)°, V = 1475.5 Å^3, Z = 4. The crystal structure was solved by direct methods and refined to R_1 = 0.0471 based on 2122 observed reflections with $I \geq 4\sigma(I)$. The structure consists of alternating sheets of Ta, Nb, W octahedra and Sb^{3+} polyhedra in the **a** direction. Billwiseite is named after William Stewart Wise (born 1933), Professor of Geology Emeritus, University of California at Santa Barbara, in honor of his contributions to mineralogy. The holotype specimen is deposited in the mineral collection of the Royal Ontario Museum, catalog number M55951. **O.C.G.**

CORDYLITE-(LA)*

S.J. Mills, P.M. Kartashov, A.R. Kampf, A.A. Konev, A.A. Koneva, and M. Raudsepp (2012) Cordylite-(La), a new mineral species in fenite from the Biraya Fe-REE deposit, Irkutsk, Russia. Canadian Mineralogist, 50(5), 1281–1290.

Cordylite-(La) (IMA 2010-058), ideally $(Na,Ca)_2Ba_2(La_3Sr)_{\Sigma 4}(CO_3)_8F_2$, is a rare-earth fluorocarbonate mineral from the Biraya Fe-REE deposit, north of Irkutsk district, 145 km east of Bodaibo city, Russia. It is associated with barite, biraite-(Ce), niobium-rich chevkinite-(Ce), fergusonite-(Nd), ancylite-(Ce) and ancylite-(La), daqingshanite-(Ce) and daqingshanite-(La), bastnäsite-(Ce), hydroxylbastnäsite-(Ce), carbocernaite, monazite-(Ce), talc, humite, thorite, pyrite, and pyrrhotite in carbonate veins composed of aragonite, strontianite, calcite, dolomite, and cordylite-(Ce). Cordylite-(La) occurs as semi-transparent colorless, honey-yellow, or pinkish yellow irregularly shaped grains, and as rounded tabular to short-prismatic hexagonal crystals, up to about 3 mm across. The only forms observed are {100} and {001}. Cordylite-(La) has a white streak, a greasy to vitreous luster, conchoidal to uneven fracture, a brittle tenacity, perfect cleavage on {001}, a Mohs hardness of 4; D_{meas} = 4.34(1) and D_{calc} = 4.320 g/cm^3. Cordylite-(La) is non-fluorescent in SW or LW ultraviolet light. The mineral is uniaxial (–), ε = 1.573(1)–1.574(1), and ω = 1.749(2)–1.751(2) and exhibits no dichroism. Microprobe analyses (WDS) on two crystals gave (wt%, crystal1/crystal2): La_2O_3 18.31/17.01, Ce_2O_3 15.67/15.93, Pr_2O_3 0.48/1.21, Nd_2O_3 2.10/3.09, CaO 3.17/3.22, SrO 6.70/7.16, BaO 23.43/22.21, Na_2O 2.80/2.78, F 2.47/2.10, CO_2(calc) 25.87/25.89, H_2O(calc) 0.03/0.25, total 99.99/99.97. H_2O and CO_2 contents were not measured due to the paucity of the material, and were calculated from the crystal-structure analyses.

Empirical formulas (based on 26 anions) are $(Na_{1.24}Ca_{0.78})_{\Sigma2.02}Ba_{2.10}[(La_{1.54}Ce_{1.31}Nd_{0.17}Pr_{0.04})_{\Sigma3.06}Sr_{0.89}]_{\Sigma3.95}(C_{1.01}O_3)_8(F_{1.78}OH_{0.05})_{\Sigma1.83}$ for crystal 1 and $(Na_{1.23}Ca_{0.79})_{\Sigma2.02}Ba_{1.98}[(La_{1.43}Ce_{1.33}Nd_{0.25}Pr_{0.10})_{\Sigma3.11}Sr_{0.94}]_{\Sigma4.05}(C_{1.01}O_3)_8(F_{1.51}OH_{0.38})_{\Sigma1.89}$ for crystal 2. The strongest lines in the X-ray powder-diffraction pattern [d_{obs} (Å) (I_{obs}%; *hkl*)] are: 3.209 (100; 105), 3.532 (95; 104), 2.562 (89; 110), 4.371 (65; 100), 4.148 (54; 102), 2.213 (52; 200), 1.921 (52; $0\ 0\ \overline{12}$,206), 2.051 (44; $1\ 0\ \overline{10}$). Unit-cell parameters derived from powder full-profile fit are a = 5.118(1) Å, c = 23.152(7) Å, and V = 525.2 Å^3. Single-crystal X-ray diffraction data collected from 2 crystals gave a = 5.1182(5), c = 23.1785(16) Å, V = 525.84 Å^3 for the first one, and a = 5.1196(3), c = 23.1784(16) Å, and V = 525.13 Å^3, for the second; space group $P6_3/mcc$, Z = 1. The crystal structure was solved by direct methods on two crystals of size 160(140) × 150(120) × 40(40) μm refined to R_1 = 0.0246 (0.0205) for 277 (280) unique reflections with $I \geq 4\sigma(I)$. Cordylite-(La) is isostructural with cordylite-(Ce). The name reflects its chemistry. One co-type specimen is deposited in the collection of Mineral Science Department, Natural History Museum of Los Angelos County, Los Angelos, U.S.A., and two co-types are deposited at the Fersman Mineralogical Museum, RAS, Moscow, Russia. **O.C.G.**

ELDRAGÓNITE*

W.H. Paar, M.A. Cooper, Y. Moëlo, C.J. Stanley, H. Putz, D. Topa, A.C. Roberts, J. Stirling, J.G. Raith, and R. Rowe (2012) Eldragónite, $Cu_6BiSe_4(Se_2)$, a new mineral species from the El Dragón mine, Potosí, Bolivia, and its crystal structure. Canadian Mineralogist, 50(2), 281–294.

Eldragónite (IMA 2010-077), ideally $Cu_6BiSe_4(Se_2)$, is a new mineral species discovered in a telethermal vein-type deposit with selenides at the El Dragón mine known for its selenium mineralization and located in province of Quijarro, Department of Potosí, Bolivia. This new mineral species is named after the location where it was discovered. The mineral is a widespread constituent of the selenide assemblage and forms inclusions in zoned krut'aite. Eldragónite is associated with clausthalite, klockmannite, umangite, and tiemannite, as well as with watkinsonite, petrovicite and two unnamed phases in the system Cu–Pb–Hg–Bi–Se. Eldragónite forms anhedral grains and polycrystalline aggregates attaining a size of up to 100 × 80 mm. The mineral is brownish to light-maroon in color, opaque and has a metallic luster and a brownish black streak. Eldragónite is brittle with an uneven to conchoidal fracture, without observable cleavage. The VHN_{15} is 225 (212–243) kg/mm^2, corresponding to a Mohs hardness of ~3½. In plane-polarized light, eldragónite is bireflectant and pleochroic from light grayish brown to cream. It is strongly anisotropic with rotation tints in shades of orange and blue-black. The reflectances (in air and oil, respectively) for the COM standard wavelengths [R_{max}, R_{min} (λ in nm)] are: 32.5–34.5, 17.7–19.7 (470), 32.95–36.3, 18.0–21.4 (546), 33.3–36.8, 18.3–21.6 (589), 34.0–36.9, 19.1–21.7 (650). The mean of 24 electron probe analyses gave (wt%): Cu 35.9, Fe 1.25, Ni 0.35, Bi 20.3, Se 42.5, total 100.3, corresponding to $(Cu_{5.98}Fe_{0.24}Ni_{0.06})_{\Sigma6.28}Bi_{1.03}Se_{5.70}$. Eldragónite is orthorhombic, $Pmcn$, with a = 4.0341(4), b = 27.056(3), c = 9.5559(9) Å, V = 1043 Å^3, and Z = 4. D_{calc} = 6.76 g/cm^3. The strongest X-ray powder-diffraction lines [d_{obs} in Å (I_{obs}%; *hkl*)] are: 6.547 (58; 031), 3.579 (100; 052), 3.253 (48; 141), 3.180 (77; 081), 3.165 (56; 013), 3.075 (84; 102), 3.065 (75; 151,112), 2.011 (53; 200), 1.920 (76; 154), 1.846 (52; $1\ \overline{10}\ 3$). The crystal structure was solved from single-crystal data obtained with a Bruker D8 three-circle diffractometer equipped with a rotating anode generator, and was refined to R_1 = 0.026 on the basis of 1731 unique reflections. There are six independent Cu and one Bi sites. Among the six Se positions, two Se atoms form a Se_2 pair, making it a selenide–diselenide compound. The crystal structure is organized by two slabs alternating along **a**. The thin slab with formula Cu_6Se_6 is a zigzag layer derived from the CaF_2 archetype; the thick $Cu_6Bi_2Se_6$ slab is similar to that of wittichenite, Cu_3BiS_3. The Se_2 pair is located at the junction between these two slabs. Co-type material representing eldragónite-bearing krut'aite is deposited within the reference collections of the Department of Materials Engineering and Physics, University of Salzburg, Austria under numbers M17.001, 17.002, and 17.003. **Yu.U.**

ERNSTBURKEITE*

F.E.G. Güner, T. Sakurai, and T. Hondoh (2013) Ernstburkeite, $Mg(CH_3SO_3)_2{\cdot}12H_2O$, a new mineral from Antarctica. European Journal of Mineralogy, 25, 91–96.

Ernstburkeite (IMA 2010-059), ideally $Mg(CH_3SO_3)_2{\cdot}12H_2O$, is a new mineral found as small solid inclusions in an ice core from the Dome Fuji station, East Antarctica (77°19′ S, 39°42′ E), near the summit of the eastern Dronning Maud Land plateau. The name of the mineral is for Ernst A.J. Burke (b. 1943), Vrije Universiteit Amsterdam, Netherlands, in honor of his contributions to the mineralogy of opaque minerals and Raman spectrometry of fluid inclusions. Ernstburkeite grains (maximum size 5 μm) are found to be hosted in the Last Glacial Maximum (LGM) ice (at a depth of 576.5 m, ice age is approximately 25 000 years) in an Antarctic ice core with gypsum and ice as associated minerals. Methanesulfonate salts can form in LGM ice by fixation of CH_3SO_3H on alkaline particles of marine or continental origin during long-range aerosol transport to polar areas. High levels of dust neutralized the acids, reducing their abundance. The neutralization of the LGM ice permits the existence of $Mg(CH_3SO_3)_2{\cdot}12H_2O$. Ernstburkeite is water soluble, making impossible the ice dissolution to isolate the inclusions. Most physical and optical properties of ernstburkeite were collected on its synthetic counterpart. It is colorless with a white streak and waxy luster; non-fluorescent. Mohs hardness is estimated to be lower than 2. Cleavage was not observed, fracture is conchoidal, parting good and tenacity sectile. D_{calc} = 1.364 g/cm^3. Ernstburkeite is optically uniaxial (+), ω = 1.402(1), ε = 1.408(1) (589 nm), and non-pleochroic. Any attempt to perform chemical analysis of ernstburkeite by SEM–EDS was unsuccessful. The chemical analysis of the Antarctic ice from the LGM period in the Dome Fuji core was obtained in bulk by dissolving it at room temperature and detecting its composition via ion chromatography, revealing the presence of the components expected for $Mg(CH_3SO_3)_2{\cdot}12H_2O$. Raman spectroscopy was found to be the only possible quantitative, indirect method for identifying ernstburkeite by comparing the spectra of the synthetic material to the natural inclusions hosted in Antarctic ice. The main Raman active frequencies (cm^{-1}) are: 3021.4 (C–H symmetric stretching band), 2939.5 (C–H symmetric stretching band), 1421 vibration (CH_3 deformation), 1054 (S–O symmetric stretching band), 973.2 (methyl rocking mode – CH_3 rock), 777.4 (C–S stretch mode), 544.9 (SO_3 deformation), and 347.3 (sulfonate rocking – SO_3 rock). X-ray studies on ernstburkeite could not be carried out on the inclusions due to their small crystal size. A single-crystal X-ray diffraction study of the synthetic $Mg(CH_3SO_3)_2 \cdot 12H_2O$ yielded: space group $R3$, $a = 9.27150(8)$ Å, $c = 21.1298(4)$ Å, $V = 1572.99(4)$ Å^3, $Z = 3$ (Genceli et al. 2010). A full structure refinement was performed to $R_1 = 0.0187$. The strongest calculated X-ray powder diffraction lines are [d_{obs} in Å (I_{obs} %; *hkl*)]: 7.04 (42; 003), 6.39 (39; 10$\bar{2}$), 4.64 (100; 110), 4.41 (44; 104), 3.87 (89, 113), 3.75 (31; 202). The holotype material is deposited in a cold room (at –50 °C) at the Institute of Low Temperature Science at Hokkaido University, Sapporo, Japan, catalog number 81,616. **G.D.G. and F.C.**

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FERROTAAFFEITE-2*N′*2*S**

Z. Yang, K. Ding, J. De Fourestier, Q. Mao, and H. Li (2012) Ferrotaaffeite-2*N′*2*S*, a new mineral species, and the crystal structure of Fe^{2+}-rich magnesiotaaffeite-2*N′*2*S* from the Xianghualing tin-polymetallic ore field, Hunan Province, China. Canadian Mineralogist, 50(1), 21–29.

Ferrotaaffeite-2*N′*2*S* (IMA 2011-025), ideally $BeFe_3Al_8O_{16}$, is a new mineral species of the taaffeite group. It occurs as a skarn mineral in the Xianghualing Sn-polymetallic ore field, Linwu County, Hunan Province, People's Republic of China. The mineral was found near the outer contact of the Laizhiling A-type granite pluton and in the Middle-Upper Devonian carbonate rocks of the Qiziqiao Formation. Ferrotaaffeite-2*N′*2*S* occurs in association with Fe^{2+}-rich magnesiotaaffeite-2*N′*2*S*, ferronigerite-2*N*1*S*, cassiterite, liberite, pyrite, sphalerite, pyrrhotite, galena, spinel, and phlogopite, and forms tabular crystals about 100 µm in size. Ferrotaaffeite-2*N′*2*S* is dark green to dark gray with a white streak, transparent, vitreous, and displays fair cleavage on {001}. It is brittle, with a conchoidal fracture. The hardness is VHN$_{50}$ 1801–2404 kg/mm^2, which corresponds to 8.5–9 on the Mohs scale. It is non-fluorescent in UV light. $D_{calc} = 3.99$ g/cm^3. The average of 23 electron probe analysis (WDS) gave (wt%): SiO_2 0.03, TiO_2 0.02, SnO_2 0.61, Al_2O_3 66.69, Cr_2O_3 0.02, FeO 16.37, MgO 6.41, ZnO 5.56, MnO 1.97, CaO 0.02, BaO 0.01, BeO 4.09, total 101.80. Berillium content was also measured with SIMS giving BeO 3.2 wt.%. The empirical formula based on 16 atoms of oxygen and 1 Be apfu is $Be(Fe_{1.39}Mg_{0.97}Zn_{0.42}Mn_{0.17}Sn_{0.03})_{\Sigma 2.98}Al_{7.99}O_{16}$. The strongest reflections in the X-ray powder diffraction pattern [d_{obs} in Å (I_{obs}%; *hkl*)] are: 2.43 (100; 114), 2.60 (90; 016), 1.425 (90; 220), 2.86 (80; 110), 1.473 (80; 0 2 $\overline{10}$) (obtained using a Debye-Scherrer camera of 114.6 mm in diameter). The unit-cell parameters refined from the powder data are $a = 5.706(8)$, $c = 18.352(3)$ Å, and $V = 517.46$ Å^3, $Z = 2$. The crystal structure of ferrotaaffeite-2*N′*2*S* was solved by direct methods and refined in space group $P6_3mc$ [with $a = 5.6978(8)$, $b = 5.6978(8)$, $c = 18.373(4)$ Å, $V = 516.57$ Å^3] to $R_1 = 0.043$, w$R_2 = 0.137$. Ferrotaaffeite-2*N′*2*S* is a new end-member of the taaffeite group within the högbomite supergroup. Its crystal structure is based on a closed-packed oxygen framework with three types of cation layers. Ferrotaaffeite-2*N′*2*S* is the Fe^{2+} analogue of the magnesiotaaffeite-2*N′*2*S*, $BeMg_3Al_8O_{16}$. The holotype of ferrotaaffeite-2*N′*2*S* is deposited in the collection of the Museum of the Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, with the specimen number of KDX017. **Yu.U.**

GREENWOODITE*

P.R. Bartholomew, F. Mancini, G.E. Harlow, N. Deifel, C. Cahill, and H.-J. Bernhardt (2012) Greenwoodite, a new nesosilicate from British Columbia with a Ba-VOH coupled substitution and tetrahedral Fe; description and structure. Canadian Mineralogist, 50(5), 1233–1242.

Greenwoodite (IMA 2010-007), ideally $Ba_{2-x}(V^{3+}OH)_x V_9(Fe^{3+},Fe^{2+})_2Si_2O_{22}$, is a mineral from the Wigwam deposit of Southeastern British Columbia, Canada. It is found in greenschist-facies conditions in association with quartz, celsian, apatite, sphalerite, pyrrhotite, galena, pyrite, zoltaiite, and batisivite. Greenwoodite occurs as small, disseminated semi-prismatic to tabular grains, as well as irregular grains intergrown with other phases, with grain size ranging from 40 to 200 µm in the longest dimension and 20 to 100 µm in width. Crystals are black submetallic and opaque with perfect cleavage on {001}. Mohs hardness is 5; $D_{calc} = 4.81$ g/cm^3. In reflected light, greenwoodite is gray with no internal reflections, distinct bireflectance, pleochroism, and anisotropy. It has straight extinction relative to its cleavage direction. Reflectance values were measured between 400 and 700 nm in 20 nm intervals. The values for COM wavelengths [R_1, R_2 % (λ in nm)] are: 12.5, 15.75 (470); 12.63, 15.50 (546); 12.81, 15.75 (589); 13.60, 16.22 (650) in air, and 2.82, 4.83 (470); 2.98, 4.80 (546); 3.31, 4.95 (589); 3.57, 5.28 (650) in oil. FTIR analysis in the 3000–4000 cm^{-1} region shows one peak at 3495 cm^{-1}, consistent with an O–H stretching vibration. The average of 21 electron probe analysis (WDS) on 13 grains gave: MgO 0.12±0.03, Al_2O_3 0.91±0.08, SiO_2 8.63±0.09, TiO_2 1.05±0.14, V_2O_3 58.03±0.75, Cr_2O_3 1.42±0.55, MnO 0.11±0.01, FeO 3.72±0.16, and Fe_2O_3 9.1±0.28 (Fe^{+2}/Fe^{+3} calculated from charge balance), ZnO 1.52±0.12, BaO 15.13±0.64, H_2O 0.62 (calculated based on the structural formula), total 100.36 wt%. The empirical formula derived from the microprobe analysis and crystal structure refinement is $Ba_{0.60}(V^{3+}OH)_{0.40}(V^{3+}_{8.33},Cr_{0.33},Ti_{0.13},Al_{0.13},Mn^{3+}_{0.02})_{\Sigma 9}(Fe^{3+}_{1.08},Fe^{2+}_{0.60},Zn_{0.22},Al_{0.06},Mg_{0.04})_{\Sigma 2}(Si_{1.72},Fe^{3+}_{0.28})_{\Sigma 2}O_{22}$, based on a cation sum (excluding H) of 15 apfu. Single-crystal X-ray intensity data were collected on a grain of size 100 × 70 × 50 µm. The diffraction pattern was indexed with a hexagonal unit cell [$a = 5.750(1)$, $c = 14.459(1)$ Å, $V = 414.00$ Å^3, and $Z = 1$] and the reflection conditions were consistent with space group $P3m1$. The crystal structure was solved using a combination of direct methods (for Ba, V, and Fe) and Patterson synthesis and refined to $R_1 = 0.019$ for 475 unique reflections with $I \geq 4\sigma(I)$. Due to paucity of the material, the powder diffraction pattern was calculated on the basis of the structure model. The calculated strongest lines [d (Å) (I%; *hkl*)] are: 2.925 (100; 014), 2.875 (38; 110), 2.672 (23; 112), 2.469 (35; 113), 2.354 (28; 202), 2.212 (28;

203), 1.669 (26; 124), 1.438 (35; 220). The structure of greenwoodite is based on the hexagonal closest packing of oxygen ions with four distinct cation layers occupying the interstices. The mineral is named in honor of Hugh J. Greenwood, former head of the Geological Sciences Department at the University of British Columbia, Vancouver, British Columbia, Canada, for his contributions to petrology. Type material is deposited in the American Museum of Natural History, New York, catalogue number 109839. **O.C.G.**

HILARIONITE*

I.V. Pekov, N.V. Chukanov, V.O. Yapaskurt, V.S. Rusakov, D.I. Belakovskiy, A.G. Turchkova, P. Voudouris, A. Magganas, and A. Katerinopoulos (2013) Hilarionite, $Fe_2^{3+}(SO_4)(AsO_4)(OH)\cdot 6H_2O$, a new supergene mineral from Lavrion, Greece. Zapiski Rossiyskogo Mineralogicheskogo Obtschestva, 142, 5, 30–42 (in Russian, English abstract).

Hilarionite (IMA 2011-089), ideally $Fe_2^{3+}(SO_4)(AsO_4)(OH)\cdot 6H_2O$ has been discovered in the Hilarion Mine near Agios Konstantinos (Kamariza) at the famous Lavrion ore district, Atliki Prefecture, Greece, and named for its type locality. The mineral was found in the oxidized sulfide-rich ore-body with primary pyrite, sphalerite, chalcopyrite, galena, calcite, quartz and secondary goethite, gypsum, bukovskyite, jarosite, melanrerite, chalcantite, allophane, azurite, powdery hematite, and unidentified hydrous copper sulfates. Light green (with olive or grayish tint) vitreous to silky spherulites of hilarionite up to 1 mm grow on limonite, gypsum crusts and pyrite relicts in fractures and cavities, sometimes forming crusts up to 100 cm^2. The mineral also forms bunches of prismatic to acicular "individuals" up to 0.5 mm which consist of sub parallel or divergent aggregates of very thin curved fibers up to 2 μm thick. Hilarionite is ductile, its fibers are flexible but nor elastic. It has one good cleavage parallel to elongation. The fracture is uneven or splintery. The streak is white; Mohs hardness is about 2; D_{meas} = 2.40(5), D_{calc} = 2.486 g/cm^3. No fluorescence under UV light was observed. In transmitted light, hilarionite is colorless, nonpleochroic, optically biaxial (+), α = 1.575(2), γ = 1.640(2)° (λ = 589nm); 2*V* and β were not measured as crystals are curved. Optical axes dispersion is strong $r > v$. *Z* is close to elongation. Absorption bands of the IR spectra (cm^{-1}; s = strong, w = weak, sh = shoulder) are: 3470sh, 3300w, 3230sh (O-H stretching vibrations), 2400sh (anions HSO_4^- ?) 1640 (bending vibrations of H_2O), 1187w, 1118w, 1080sh, 1005 (stretching vibrations of SO_4^{2-}), 860sh, 830sh, 814s (stretching vibrations of AsO_4^{3-}), 660w, 605sh, 584 (bending vibrations of SO_4^{2-}), 494, 434 (Fe^{3+}-O stretching). The bands due to AsO_3^- or SO_3^- anions vibrations are absent, as well as bands of C-, N-, or B-containing anions. The Mössbauer spectrum shows the presence of Fe^{3+} in 2 sites with sixfold coordination and the absence of Fe^{2+}. The mean of 7 electron probe analysis (EDS and WDS) [wt% (range)] is: MnO 0.03 (0.00–0.07), CuO 0.18 (0.05–0.4), ZnO 0.17 (0.1–0.3), Fe_2O_3 33.83 (32.2–34.8), P_2O_5 0.22 (0.1–0.4), As_2O_5 18.92 (17.3–20.0), SO_3 22.19 (21.1–22.9), H_2O 26.3 (by Alimarin method), total 101.82. The empirical formula calculated on the basis of 15 O apfu is: $(Fe_{1.90}^{3+}Cu_{0.01}Zn_{0.01})_{\Sigma 1.92}[(SO_4)_{1.24}(AsO_4)_{0.74}(PO_4)_{0.01}]_{\Sigma 1.99}(OH)_{1.01}\cdot 6.03H_2O$. The X-ray powder diffraction pattern of hilarionite is similar to that of kaňkite. The strongest lines of the X-ray powder-diffraction pattern [d_{obs} Å (I_{obs} %; *hkl*)] are: 12.66 (100; 110), 7.60 (6; 001), 5.00 (10; $22\bar{1}$), 4.70 (10; $31\bar{1}$), 4.33 (7; 040), 3.215 (4; $31\bar{2}$,511), 3.151 (4; $13\bar{2}$), 2.887 (5; 620,$33\bar{2}$,441). The single-crystal X-ray study was not performed due to the size and quality of crystals. Hilarionite is monoclinic, space group *C*2/*m*, *Cm*, or *C*2; a = 18.53(4), b = 17.43(3), c = 7.56(1) Å, β = 94.06(15)°, V = 2436 Å^3, Z = 8. The type specimens are deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia (catalogue no. 92988) and in the Mineralogical Museum of Athens University, Greece. **D.B.**

KOTTENHEIMITE*

N.V. Chukanov, S.N. Britvin, K.V. Van, S. Möckel, and A.E. Zadov (2012) Kottenheimite, $Ca_3Si(OH)_6(SO_4)_2\cdot 12H_2O$, a new member of the ettringite group from the Eifel area, Germany. Canadian Mineralogist, 50(1), 55–63.

Kottenheimite (IMA 2011-038), ideally $Ca_3Si(OH)_6(SO_4)_2\cdot 12H_2O$, is a new ettringite-group mineral. It was found at Bellerberg, near Kottenheim, Eastern Eifel area, Rhineland-Palatinate (Rheinland-Pfalz), Germany, and named for the type locality. The mineral occurs in association with wollastonite, clinochlore, ellestadite, melilite, cuspidine, and earlier formed sanidine, clinopyroxene, and magnetite. Kottenheimite forms snow-white radiated and aggregates of hair-like subparallel clusters in miarolitic cavities in alkali basalt. The Mohs hardness is 2–2.5; D_{meas} = 1.92(2) g/cm^3, D_{calc} = 1.926 g/cm^3. Kottenheimite is uniaxial (–), ω = 1.490(2), ε = 1.477(2) (λ = 589 nm). The IR spectrum of kottenheimite contains absorption bands (cm^{-1}) are: 3300–3700 (O–H-stretching vibrations), 1650, 1683 (bending vibrations of H_2O molecules), 1158, 1086, 987 (showing the presence of distorted SO_4^{2-} groups), 752, 725 [corresponding to Si–O stretching vibrations of $Si(OH)_6$ octahedra]. The average of 6 electron probe (WDS) analyses (wt%) gave: CaO 26.04, MgO 0.20, FeO 0.19, Al_2O_3 0.25, SiO_2 8.95, SO_3 24.26, CO_2 0.58, H_2O 41.30; total 101.77 (H_2O and CO_2 were determined by gas chromatography). The empirical formula calculated on the basis of 26 anions is $Ca_{3.015}Mg_{0.03}Fe_{0.02}Al_{0.03}Si_{0.97}(OH)_{5.94}(SO_4)_{1.97}(CO_3)_{0.09}\cdot 11.91H_2O$. X-ray powder diffraction data for kottenheimite were collected with a single-crystal diffractometer using a Gandolfi method (Mo*K*α radiation). The crystal structure was refined by the Rietveld method based on the structural model of carraraite, $Ca_3Ge(SO_4,CO_3)_2(OH)_6\cdot 12H_2O$, to R_p = 0.0487, R_{wp} = 0.0623, and R_B = 0.087. Kottenheimite is hexagonal, $P6_3/m$, a = 11.1548(3), c = 10.5702(3) Å, V = 1139.04(5) Å^3, and Z = 2. The strongest lines of the powder diffraction pattern [d_{obs} in Å (I_{obs}; *hkl*)] are: 9.72 (100; 100), 5.590 (60; 110), 4.645 (26; 102), 3.840 (54; 112), 2.751 (34; 302), 2.536 (27; 213), 2.185 (30; 223). The crystal structure of kottenheimite is based on a hexagonal arrangement of positively charged columnar units $Ca_3[Si(OH)_6\cdot 12H_2O]^{4+}$ composed of sequences of $Ca(OH)_4(H_2O)_4$ polyhedra and $Si(OH)_6$ octahedra, alternating along the **c** axis. The channels in the crystal structure of kottenheimite are filled by sulfate anions and H_2O molecules. The type material is deposited in the collections of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **Yu.U.**

LAURENTIANITE*

M.M.M. Haring, A.M. McDonald, M.A. Cooper, and G.A. Poirier (2012) Laurentianite, $[NbO(H_2O)]_3(Si_2O_7)_2[Na(H_2O)_2]_3$, a new mineral from Mont Saint-Hilaire, Quebec: description, crystal-structure determination and paragenesis. Canadian Mineralogist, 50(5), 1265–1280.

Laurentianite (IMA 2010-018), ideally $[NbO(H_2O)]_3(Si_2O_7)_2[Na(H_2O)_2]_3$, is a new mineral discovered in siderite-dominant pods in an altered syenite at the Poudrette quarry, Mont Saint-Hilaire, Quebec. Laurentianite is a late-stage mineral intergrown with lepidocrocite, both of which overgrow franconite and quartz. The mineral is believed to have precipitated from a late-stage aqueous fluid enriched in Na, Si, and Nb, possibly arising through the breakdown of franconite, sodalite, and quartz. Associated minerals include quartz, pyrite, franconite, rutile, lepidochrocite, and an unidentified Fe-bearing mineral. Euhedral acicular crystals have average dimensions of $0.012 \times 0.012 \times 0.15$ mm and average length-to-width ratios of 12.5, and occur in randomly oriented, loosely packed groupings. Laurentianite is translucent, colorless, has a vitrous to satiny luster and a white streak. Crystals exhibit a splintery fracture, and no parting or cleavage. Mohs hardness could not be measured; $D_{calc} = 2.464$ g/cm^3. Laurentianite is nonpleochroic, uniaxial (–) with $\omega = 1.612(2)$ and $\varepsilon = 1.604(2)$. The main absorption bands of Raman spectrum (cm^{-1}, vs = very strong, s = strong, m = medium) are 3421m, 3327m and 3034m (stretching modes of H_2O), 929vs and 841vvs (Si-O$_{br}$ symmetric stretching), 405m (Si-O$_{br}$ asymmetric stretching), 309m, 292m, 241m, 218m, 193m, 176m and 122m (Nb-O and Na-O vibrations), and 90m (Na-O). The average of 12 electron probe analyses (WDS) from several crystals is [wt% (range)]: Na_2O 8.88 (4.54–12.80), K_2O 0.26 (0.14–0.44), CaO 0.22 (0.10–0.43), TiO_2 0.58 (0.31–0.83), Nb_2O_5 43.64 (36.43–49.90), SiO_2 26.87 (22.81–29.07), and H_2O (calc) 17.93, total 98.38. The presence of H_2O is inferred from Raman spectroscopy and the structure refinement. The empirical formula, based on 26 anions pfu, is $(Nb_{0.99}Ti_{0.01})_{\Sigma1.00}O(H_2O)]_3(Si_{2.00}O7)_2[(Na_{0.86}\square_{0.10}K_{0.02}Ca_{0.01})_{\Sigma0.99}(H_2O)_2]_3$. The strongest lines on the X-ray powder-diffraction pattern [d_{obs} (Å) (I_{obs}%; *hkl*)] are: 8.608 (100; 010), 7.005 (19; 001), 4.312 (25; 020), 3.675 (25; 201,021), 3.260 (31; 120,210), and 2.870, (20; 030). Single-crystal X-ray diffraction data showed that this mineral crystallizes in space group *P*3 with $a = 9.937(1)$, $c = 7.004(1)$ Å, $V = 599.0$ Å^3, $Z = 1$. The structure was solved by direct methods and refined to $R_1 = 0.0278$ for 2347 unique reflections with $I \geq 4\sigma(I)$. The crystal structure consist of alternating layers of (Si_2O_7) dimers and a layer of isolated $NbO_5(H_2O)$ octahedra along [001]. The mineral is named after Laurentian University, Canada, where the research characterizing this mineral as a new species was conducted. The holotype material is deposited at the Royal Ontario Museum, catalog number M55369. **O.C.G.**

LINZHIITE*

G. Li, W. Bai, N. Shi, Q. Fang, M. Xiong, J. Yang, Z. Ma, and H. Rong (2012) Linzhiite, $FeSi_2$, a redefined and revalidated new mineral species from Luobusha, Tibet, China. European Journal of Mineralogy, 24, 1047–1052.

Linzhiite, ideally $FeSi_2$, is a new mineral found in a podiform chromitite in depleted harzburgites from the Luobusha ophiolite in Tibet, People's Republic of China. Linzhiite type sample was separated from the heavy mineral constituents derived from a 1500 kg sample of chromitite collected from ore body 31, Group II of the Luobusha mining district, located about 200 km southeast of Lhasa, in Qusong county, Shannan Prefecture, Tibet (29°13.50′ N; 92° 12.18′ E). The mineral is named for the Linzhi Prefecture, which is situated close to the type locality. Linzhiite occurs as irregular grains ranging from 0.04 to 0.5 mm and intergrowths with zangboite and native silicon. A wide variety of minerals have been handpicked from the chromitite separates, including diamond, coesite, other native elements, carbides, PGE and base-metal alloys, nitride, silicides, sulphides, silicates and oxides. Linzhiite is steel gray with metallic luster. The streak is grayish-black. The reflectance values measured in air with a WC standard [*R* % (λ in nm)] are: 26.3 (470), 30.3 (546), 32.9 (589), 36.3 (650). The mineral is brittle with conchoidal fracture. No cleavage has been observed. Mohs hardness is 6½. Density was not measured; $D_{calc} = 4.972$ g/cm^3. The mean of 12 electron probe analyses (WDS) on four grains yielded to [wt%, (range)]: Fe 49.09 (47.15–51.75), Si 50.00 (49.33–52.85), Al 0.64 (0.00–1.87), Mn 0.28 (0.00–0.74), total 100.01. The empirical formula calculated on the basis of 3 apfu is: $(Fe_{0.98}Al_{0.03}Mn_{0.01})_{\Sigma1.02}Si_{1.99}$. The crystal structure was solved by direct methods in *P*4/*mmm* space group, $a = 2.696(1)$, $c = 5.147(6)$ Å, $V = 37.41(14)$ Å^3, and $Z = 1$. The strongest X-ray powder diffraction lines are [d_{obs} in Å (I_{obs} %; *hkl*)]: 5.163 (92; 001), 2.374 (100; 011), 1.899 (47; 110), 1.851 (79; 012), 1.774 (16; 111), 1.708 (12; 003), 1.342 (12; 020), 1.087 (25; 122). The crystal structure of linzhiite can be seen as a layer packing structure, in which the layers are stacked along [001]. Layers consist of face-sharing $FeSi_8$ slightly elongated cubes; cube edges measure 2.823 and 2.725 Å (i.e., Si–Si distance along [001] and [100], respectively). In the stacking direction, adjacent layers are connected through Si–Si interactions (Si–Si distance 2.350 Å). Linzhiite is the tetragonal polymorph of luobusaite [β-$FeSi_2$, *Cmca*, $a = 9.863(7)$, $b = 7.791(6)$, $c = 7.833(6)$ Å], also found in the Luobusha chromitite. Both the new mineral and its name have been approved by the IMA CNMNC (IMA 2010-011). The mineral was first described by Gevork'yan (1969), without CNMMN approval. Gevork'yan et al. (1969), described two new alloy minerals, "fersilicite" (FeSi) and "ferdisilicite" ($FeSi_2$), found in heavy-mineral concentrates from placers and drill-core samples in sandstones from the Poltava series, Ukraine. The type specimen of linzhinite has been deposited at the Geological Museum of China (specimen no. M11799) and at the Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China (specimen no. 97-6). **F.C. and G.D.G.**

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MIYAHISAITE*

D. Nishio-Hamane, Y. Ogoshi, and T. Minakawa (2012) Miyahisaite, $(Sr,Ca)_2Ba_3(PO_4)_3F$, a new mineral of the hedyphane group in the apatite supergroup from the Shimoharai mine, Oita Prefecture, Japan. Journal of Mineralogical and Petrological Sciences, 107, 121–126.

Miyahisaite (IMA 2011-043) is a new mineral of the hedyphane group in the apatite supergroup, found in the Shimoharai mine, Oita prefecture, Japan. The mineral is named in honor of Michitoshi Miyahisa (1928–1983) for his contribution to the study of ore deposits on Kyushu. Miyahisaite occurs in namansilite-rich layers adjacent to the braunite-rich and aegirine-rich layers of the chert of Triassic to Jurassic age present in the manganese deposits of the Yayoi Udoki area in the Chichibu belt of the Saiki area, Oita, Japan. Miyahisaite is scattered in the namansilite-rich layer and along its boundary with the aegirine-rich layer of the chert. Miyahisaite occurs as anhedral grains ranging from submicron to 10 μm size and forms aggregates of about 100 μm in size. It is closely associated to fluorapatite in the quartz matrix of the namansilite-layer, partially or completely replacing fluorapatite. Miyahisaite is colorless, transparent with a white streak, vitreous luster. No fluorescence has been observed under long- or short-wave ultraviolet radiation. Mohs hardness is 5. $D_{calc} = 4.511$ g/cm^3 for empirical formula. No other physical properties were obtained due to the small grain size. Electron microprobe analyses (WDS) yielded the average composition [wt%, (range)]: CaO 4.69 (2.95–4.69), SrO 16.51 (16.49–16.67), BaO 52.05 (52.05–54.27), P_2O_5 24.85 (24.38–24.98), F 1.99 (1.61–1.99), Cl 0.06 (0.04–0.06), H_2O 0.09 (calculated as OH + F + Cl = 1), total 99.39. The empirical formula calculated on the basis of 12 O pfu is: $(Sr_{1.366}Ca_{0.717})_{\Sigma 2.083}Ba_{2.991}P_{3.002}O_{12}(F_{0.898}OH_{0.088}Cl_{0.014})_{\Sigma 1}$. The simplified, end-member formula is $(SrCa)_2Ba_3(PO_4)_3F$, and the ideal formula is $Sr_2Ba_3(PO_4)_3F$. Angle-dispersive X-ray diffraction pattern was collected using synchrotron X-ray source at the NE1 beam line of PF-AR, KEK, Japan. The strongest X-ray powder diffraction lines are [d_{obs} in Å (I_{obs} %; *hkl*)]: 3.427 (16; 102), 3.248 (22; 120), 2.981 (100; 121), 2.865 (21; 300), 1.976 (23; 123), 1.874 (16; 140), 1.874 (15; 004), 1.864 (17; 402). The pattern was indexed using the $P6_3/m$ structure model of the apatite supergroup, with refined unit-cell parameters: $a = 9.921(2)$, $c = 7.469(3)$ Å, $V = 636.7$ Å^3, and $Z = 2$. The compositional ratio of miyahisaite is in harmony with the supergroup's cation sites, as Sr + Ca and Ba occupy the *M*1 and *M*2 sites, respectively. Thus this corresponds to an ordered apatite (hedyphane), while keeping the same symmetry (Pasero et al. 2010). The type specimen of this new mineral has been deposited at the National Museum of Nature and Science, Japan (specimen no. NSMM-41299). **F.C. and G.D.G.**

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Naquite*

G. Li, N. Shi, M. Xiong, Z. Ma, W. Bai, and Q. Fang (2012) Naquite, FeSi, a new mineral species from Luobusha, Tibet, western China. Acta Geologica Sinica, 86(3), 553–538.

Naquite, ideally FeSi, is a new mineral found in a podiform chromitite in depleted harzburgites from the Luobusha ophiolite in Tibet, People's Republic of China. Naquite type sample was separated from the heavy-mineral constituents from a 1500 kg sample of chromitite collected from ore body 31, Group II of the Luobusha (Norbusa) mining district, in Qusong county, Shannan Prefecture, Tibet, about 200 km ESE of Lhasa. The mineral is named for the Naqu (Nagchu) Prefecture, Tibet, which is near to the type locality. Naquite occurs as irregular grains ranging from 0.015 to 0.05 mm, with some grains reaching 0.1 mm. Naquite is steel gray with metallic luster. The streak is grayish-black. The reflectance values measured in air with a WC standard [*R* % (λ in nm)] are: 40.6 (470), 42.23 (546), 41.6 (589), 42.5 (650). The mineral is brittle with conchoidal fracture. No cleavage has been observed. Mohs hardness is 6½. $D_{calc} = 6.186$ g/cm^3. The mean of electron probe analyses (WDS) on four grains yielded to (wt%): Fe 65.65, Si 32.57, Al 1.78, total 100.00. The empirical formula calculated on the basis of 2 apfu is: $Fe_{0.994}Al_{0.054}Si_{0.952}$. Single-crystal diffraction studies of naquite could not be carried out because the grains were too small. The cell parameters were refined from powder data to $a = 4.486(4)$ Å, $V = 90.28(6)$ Å^3, with cubic symmetry (space group of the synthetic compound $P2_13$). The strongest X-ray powder diffraction lines are [d_{obs} in Å (I_{obs} %; *hkl*)]: 3.1742 (40; 110), 2.5917 (43; 111), 2.2485 (23; 200), 2.0076 (100; 210), 1.8307 (65; 211), 1.3531 (27; 311), 1.1990 (36; 321). Both the new mineral and its name have been approved by the IMA CNMNC (IMA 2010-010). The mineral was first described without CNMMN approval. Gevork'yan et al. (1969), described two new alloy minerals, "fersilicite" (FeSi) and "ferdisilicite" ($FeSi_2$), found in heavy-mineral concentrates from placers and drill-core samples in sandstones from the Poltava series, Ukraine. The type specimen of this new mineral has been deposited at the Geological Museum of China (specimen no. M11798). **F.C. and G.D.G.**

References cited

Gevork'yan, V.Kh., Litvin, A.L., and Povarennykh, A.S. (1969) Occurrence of the new minerals fersilicite and ferdisilicite. Geologichesky Zapiski Akademii Nauk Ukrainskaya SSR, 29, 2, 62–71 (in Russian). Abstract in American Mineralogist, 54, 1737.

Starovaite*

I.V. Pekov, M.E. Zelenski, V.O. Yapaskurt, Y.S. Polekhovsky, and M.N. Murashko (2013) Starovaite, $KCu_5O(VO_4)_3$, a new mineral from fumarole sublimates of the Tolbachik volcano, Kamchatka, Russia. European Journal of Mineralogy, 25, 91–96.

Starovaite (IMA 2011-085), ideally $KCu_5O(VO_4)_3$, is a new mineral found in the sublimates of the Yadovitaya fumarole at the Second scoria cone of the Northern Breach of the Great Tolbachik Fissure Eruption, Tolbachik volcano, Kamchatka, Russia. The mineral is named in honor of the Russian crystallographer Galina L. Starova (b. 1946) for her contributions to the crystal chemistry of minerals from the Tolbachik fumaroles. Starovaite occurs as prismatic crystals up to 3 × 6 × 20 μm or divergent long prismatic crystals up to 1 × 3 × 70 μm, combined in sprays, sheaf-like aggregates or crusts, and it is associated with lammerite, hematite, palmierite, tenorite, piypite, rutile, orthoclase, lyonsite, pseudolyonsite, lammerite-β, langbeinite, calciolangbeinite, and cupromolybdite. Starovaite is golden brown to reddish brown with a semi-metallic luster. The streak is yellowish-brown. In reflected light, starovaite is gray with a brownish hue. Bireflectance is weak, internal reflections are distinct red-brown, anisotropy is weak. The reflectance values

[R_1, R_2 % (λ in nm)] are: 14.2, 12.45 (470), 13.2, 11.6 (546), 13.0, 11.4 (589), 12.6, 11.35 (650). The mineral is brittle. VHN_{20} = 182 (165–195) kg/mm^2 corresponding to 3½–4 of Mohs scale. Cleavage and parting were not observed, fracture is uneven. Density was not measured; D_{calc} = 4.54 g/cm^3. The mean of 8 electron probe analyses (WDS) yielded to (wt%, range): K_2O 4.90 (4.5–5.5), CaO 0.04 (0.00–0.1), PbO 1.29 (0.3–2.3), CuO 48.20 (46.5–49.0), ZnO 5.59 (4.7–8.2), Al_2O_3 0.08 (0.00–0.2), Fe_2O_3 0.10 (0.00–0.2), P_2O_5 0.05 (0.00–0.2), As_2O_5 4.49 (3.3–7.9), V_2O_5 31.89 (28.1–35.8), SO_3 0.19 (0.05–0.5), MoO_3 2.34 (1.7–3.3), total 99.16. The empirical formula calculated on the basis of 13 O apfu is: $(K_{0.76}Pb_{0.04}Ca_{0.01})_{\Sigma 0.81}(Cu_{4.45}Zn_{0.51}Al_{0.01}Fe_{0.01})_{\Sigma 4.98}(V_{2.58}As_{0.29}Mo_{0.12}S_{0.02}P_{0.01})_{\Sigma 3.02}O_{13}$. Single-crystal diffraction studies of starovaite were not carried out because of the tiny crystal size and their curved morphology. X-ray powder-diffraction data were collected with a STOE IPDS II diffractometer (Mo$K\alpha$ radiation), equipped with an Image Plate detector, by the Gandolfi method. The diffraction pattern was indexed by analogy with synthetic $KCu_5O(VO_4)_3$ (Martin and Müller-Buschbaum 1994). Starovaite is triclinic, $P1$, a = 6.08(4), b = 8.26(5), c = 10.71(6) Å, α = 97.8(1), β = 92.4(1), γ = 90.4(1)°, V = 532 Å^3, and Z = 2. The strongest observed X-ray powder diffraction lines are [d_{obs} in Å (I_{obs} %; hkl)]: 10.62 (32; 001), 8.18 (46; 010), 3.047 (41; 022,200,$12\bar{2}$), 2.745 (47; $2\bar{1}\bar{1}$,$03\bar{1}$), 2.526 (100; 031,212,212,023,131,131), 2.322 (98; $03\bar{3}$,$21\bar{3}$,221,$22\bar{2}$). The type specimen of starovaite is deposited in the collection of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **G.D.G. and F.C.**

References cited

Martin, F.D., and Müller-Buschbaum, H. (1994) Ein neues Alkalimetall-Kupfer-Oxovanadat: $KCu_5V_3O_{13}$. Zeitschrift für Naturforschung, 49b, 1137–1140.

How to Submit to American Mineralogist

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