

New Mineral Names*†

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

This New Mineral Names has entries for 13 new minerals, including bubnovaite, cairncrossite, ferriaoilite, fontanaraitie, grundmannite, kayrobertsonite, magnesio-ferri-fluoro-hornblende, melanarsite, nickelsumcorite, sanguite, silicocarnotite, vanadium, and wernerkauteite.

**BUBNOVAITE**


Bubnovaite, (IMA 2014-108), ideally KNa(SO4)3, is a new mineral found in fumaroles of the 2012–2013 Tolbachik fissure eruption, Kamchatka peninsula, on the new cinder Naboko cone. The samples of bubnovaite were found in a cavity on the NNE flank of the cone at the depth of 30 cm. The temperature of gases at the sampling location was more than 500 °C. The mineral forms fine-grained, light blue, densest aggregates, consisting of colorless, transparent, tabular crystals of maximum dimension 0.14 mm, that were recovered with the aid of a long stick and metallic cap to grab samples from the fumarole vent. Bubnovaite is associated with aphthilatite, (K,Na)Na(SO4)3, and thénardite, Na2SO4. Crystals of bubnovaite are brittle with a white streak and a vitreous luster. Hardness and density were not measured due to the lack of suitable material. The expected Mohs hardness is 2–3; D calc = 2.656 g/cm3. The mineral is unstable in air and becomes white and non-transparent after several days. The mineral is non-pleschroic, colorless. It is optically uniaxial (−), ω = 1.492(2), ε = 1.489(2) (light source not reported). The average of 7 electron probe WDS analyses [wt% (ranges)] is: Na2O 26.99 (25.65–27.94), K2O 10.99 (10.50–11.45), CaO 4.27 (3.29–5.08), MgO 0.51 (0.38–0.65), CuO 1.21 (0.70–1.71), ZnO 0.81 (0.55–1.24), PbO 1.58 (0.86–2.28), SO3 54.93 (54.24–55.44), total 101.30. The empirical formula based on 24 O atoms, is K54.93 (54.24–55.44), total 101.30. The single crystal unit-cell parameters are: a = 8.769(2) Å, b = 8.799(2) Å, c = 24.89(2) Å, α = 92.24(2)°, β = 105.94(2)°, γ = 90.00°. The Raman spectrum of cairncrossite is similar to that of gyrolite and is characterized by two sharp peaks at 610 (Si–O bending vibration) and 1060 cm−1 (Si–O stretching vibration). The bands observed at 350 and 3670 cm−1 are assigned to stretching vibrations of the OH groups, the broad band centered around 3550 cm−1 to stretching vibrations of the H2O molecules. The average of 14 electron probe WDS analyses [wt% (ranges)] is: Na2O 3.06 (2.48–3.15), K2O 0.02 (0.01–0.03), CaO 0.09 (0.06–0.12), MgO 0.06 (0.04–0.08), CuO 0.12 (0.08–0.15), ZnO 0.85 (0.55–1.50), PbO 0.18 (0.10–0.21), SO3 54.95 (54.26–55.50), total 100.10.

Cairncrossite (IMA 2013-012), SrCaNa2(Si2O5)(OH)(H2O)3, is a new phyllosilicate species found in manganese ore on dumps of the Wessels Mine, Kalahari Manganese Field, South Africa. It was found lining the central cavity of a vug in manganese ore that came from Block 17 of the Wessels Mine. Associated minerals include blue manganoan richterite, minor manganoan sulfite, minor gray to orange lizardite and fibrous pectolite. Cairncrossite crystals form densely packed, radiating platy micaceous aggregates up to 1 cm in size, closely resembling brucite Mg(OH)2. It is the last mineral to have formed during metasomatic alteration of a primary carbonate-rich manganese ore. Cairncrossite is colorless, appearing white, and the crystals are transparent to transparent with a white streak. The luster is vitreous to pearly. Cairncrossite is scintillating before brittle fracture, with a Mohs hardness of 3. Cleavage is perfect parallel to (001). D calc = 2.50(3) g/cm3; D ext = 2.489 g/cm3. Cairncrossite is non-pleschroic, optically biaxial (+) with α = 1.518(2), β = 1.522(2), γ = 1.546(2) (λ = 589.3 nm). 2V meas = 33.9(6)°, 2V calc = 45°; r < v weak; the acoustic bisectrix X is about 10° from perpendicular to (001) (*). Intense light-blue fluorescence is emitted under short-wave UV light. The Raman spectrum of cairncrossite is similar to that of gyrolite and is characterized by two sharp peaks at 610 (Si–O bending vibration) and 1060 cm−1 (Si–O stretching vibration). The bands observed at 350 and 3670 cm−1 are assigned to stretching vibrations of the OH groups, the broad band centered around 3550 cm−1 to stretching vibrations of the H2O molecules. The average of 14 electron probe WDS analyses [wt% (ranges)] is: Na2O 3.06 (2.48–3.15), K2O 0.11 (0.09–0.12), CaO 18.61 (18.17–19.24), SiO2 54.91 (53.20–55.85), SrO 11.75 (11.25–12.11), total 88.44 (86.32–89.97). The empirical formula based on 16 Si apfu and H2O content deduced from observed TGA loss (~15 wt%), is: Sr7.98Ca6.33Na0.23Si23.45O70.96(OH)3.02(H2O)3.31. The strongest lines of the Gandolfi X-ray powder diffraction pattern [d Å (%hkI)] are: 15.230 (100; 001), 8.290 (15; 10), 0.080 (25; 003), 3.807 (30; 004), 3.045 (20; 005). The refined triclinic unit-cell parameters from these powder data are a =

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* All minerals marked with an asterisk have been approved by the IMA CNMCC.
† For a complete listing of all IMA-validated unnamed minerals and their codes, see http://pubsites.uws.edu.au/ima/cnmmc/.
9.626(1), b = 9.639(1), c = 15.651(2) Å, α = 100.88(1), β = 91.28(1), γ = 119.72(2)°, and V = 1227.0 Å³. The single-crystal unit-cell parameters are: a = 9.6265(5), b = 9.6391(5), c = 15.6534(10) Å, α = 100.89(1), β = 91.27(1)°, γ = 119.73(1)° and V = 1227.08(13) Å³, Z = 1, space group P2₁. The structure was refined to R₁ = 0.047 for 9231 unique, observed \( F^2 > 5 \sigma(F^2) \) reflections. Caimenosite belongs to the gyrolite and reeyerite mineral groups, it is characterized by sheets consisting of edge-sharing CaO octahedra, which are corner-linked on both sides to silicate layers built by six-membered rings of silicate tetrahedra. These units are intercalared by layers formed by SrO polyhedra, which are arranged in pairs via a common edge, and further bound to disordered NaO polyhedra. A complex system of hydrogen bonds strengthens the linkage to adjacent silicate layers. The mineral is named in honor of Bruce Caimcross, Professor and Head of the Department of Geology, University of Johannesburg. He is author of several books and numerous articles on the mineralogy of the Southern African Region with special interest in the Kalahari Manganese Field. He has contributed significantly towards awareness of diversity of the mineralogy in Southern Africa. Holotype material has been deposited in the collections of the Institute for Mineralogy and Crystallography at the University of Vienna (inventory number 13079) and the collection of the Museum of Natural History of Vienna (inventory number N 9858). F.C.

**FERRAIOLIOTE**


Ferraiolite (IMA 2015-066), ideally MgMn\(_2\)(Fe\(_{14}\)Al\(_8\))\(_2\)Zn\(_8\) (PO\(_4\))\(_4\)(OH)\(_2\)\(_{0.5}\), is a new secondary phosphate mineral from the Foote Lithium Company mine, Kings Mountain district, Cleveland County, North Carolina, U.S.A. (35°12′40″N, 81°21′20″W), which is the type locality for 12 other minerals (7 of which are also secondary phosphates). It occurs in very small vugs contained in a thin seam of very fine-grained, sugary pegmatite (~30 × 10 × 20 cm) part of a large, zinc-bearing boulder found on the East dump. Common accessory minerals in the sugary pegmatite (~30 × 10 × 20 cm) part of a large, zinc-bearing boulder are Mn-bearing fluorapatite, sphalerite, muscovite, and pyrite. Associated secondary minerals in order of abundance are: vivianite, boulderite/messelite, phosphophyllite, scholzite/parascholzite, rittmanite, and pararossolite. The strongest peak in the powder data are \( d(Å) \): 12.664 (100), 2.40 (400), 2.37 (400), 2.27 (400), 2.04 (204), 3.499 (5; 312), 3.245 (7; 404), 2.924 (8; 703), 2.869 (5; 705), 2.664 (4; 200). The parameters of the monoclinic unit cell refined from the powder data are: a = 25.320(6), b = 6.345(6), c = 15.267(6) Å, β = 91.031(5)°, V = 2452.4 Å³. The unit-cell parameters obtained from a single crystal (20 μm × 10 μm × 2 μm) are: a = 25.333(3), b = 6.299(1), c = 15.161(3) Å, β = 90.93(3)°, V = 2419.0 Å³, Z = 2, space group I2/m. The crystal structure solved and refined to \( R₁ = 0.065 \) based on 565 unique \( I > 3δI \) reflections. Ferraiolite has a heteropolyhedral layer structure with layers parallel to (100) and with isolated Mg\(_2\)(H\(_2\)O)\(_4\) octahedra and water molecules packing between the layers. The heteropolyhedral slabs have the same topology as those in the mineral falsterite, Ca\(_2\)Mg\(_2\)Fe\(_{12}\)O\(_{36}\)(PO\(_4\))\(_4\)(OH)\(_2\)\(_{0.5}\). The H atoms were not located in the structure refinement, but the assignment of OH and H\(_2\)O were inferred from bond-valence calculations. The species is named in honor of the late James (Jim) Anthony Ferraiolo (1947–2014), who worked as scientific assistant at the American Museum of Natural History (AMNH) (1978–1982) and also as transaction coordinator at the Smithsonian Institution’s Museum of Natural History (1982–1985). He was best known for his publication A Systematic Classification of Nonsilicate Minerals (Bulletin 172 of the AMNH, 1982). He was also a member of the IMA CNMNC subcommittee for mineral group nomenclature and the subcommittee on unnamed minerals. Two cotyptide specimens are housed in the collections of Museum Victoria, specimen M53492 and M53493, and two cotyptide specimens are deposited in the collections of the Natural History Museum of Los Angeles County, catalogue numbers 65593 and 65594. F.C.

**FONTARNAUITE**


Fontarnauite (IMA 2009-64a), ideally Na\(_2\)Sr\(_2\)SO\(_4\)(BO\(_4\))(H\(_2\)O), was discovered in 2009 in drill cores recovered from the borate-bearing Miocene Emet basin in Western Anatolia, Turkey. It occurs in association with proberite, glauberite, and celestite. It was also reported to occur with halite, kaliborite replacing proberbite, and kalistronite, replacing fontarnauite in pseudomorphs after glauberite. Among other associated minerals are colemanite, ulexite, dolomite, arsenopyrite, realgar, and orpinite. Fontarnauite forms isolated prismatic crystals, clusters of crystals less than 5 mm long, or less commonly branching aggregates of crystals. The new mineral is colorless to light brown with a white streak and a pearly luster. Fontarnauite is brittle, with a perfect {101} cleavage, a splintery fracture and no parting. It is translucent to transparent. Fontarnauite has a Mohs hardness of 2½–3. Density measured by pycnometry is 2.37 g/cm\(^3\), less than \( D_{\text{calc}} = 2.533 \text{ g/cm}^3 \), probably because of inclusions of proberbite with the density of 2.15 g/cm\(^3\). No fluorescence was observed. Fontarnauite is optically biaxial (-), \( a = 1.5171(2)\), \( β = 1.5390(2)\), \( γ = 1.5443(2)\) (⁰ 589 nm); 2\( V_{\text{max}} = 46.1(1)°\), 2\( V_{\text{calc}} = 46.6°\), r > v medium to weak. \( X'\) = 95.0° (β obtuse), Y∥b, Z∥c = 81.9° (β acute). The Fourier-transform IR spectroscopy identified the following bands in the spectrum of fontarnauite at 25 °C: the broad band with four or more overlapping peaks at 3587, 3531, 3404, and 3208 cm\(^{-1}\) corresponding to O–H stretching modes; the peak at 1656 cm\(^{-1}\) overlaps peaks at 3587, 3531, 3404, and 3208 cm\(^{-1}\) overlapping peaks at 3587, 3531, 3404, and 3208 cm\(^{-1}\) overlapping peaks at 3587, 3531, 3404, and 3208 cm\(^{-1}\).
NEW MINERAL NAMES

GRUNDMANNITE *


Grundmannite (IMA 2015-038), ideally CuBiSe₂, was discovered in the El Dragon selendite occurrence of the Cordillera Oriental in southwestern Bolivia. Grundmannite is commonly intergrown with watsontonite and claushatellite. Occasionally it is being in grain-boundary contact with quartz, dolomite, native gold, eldragónite, eskebornite, umangite, klockmannite, Co-rich penroseite, and three unnamed phases of the jahnsite group; and the two very weak peaks and a low-intensity band (with two peaks) have been identified at 129, 160, and 430–470 cm⁻¹, respectively, corresponding to νB-O bending, but the peaks for symmetric stretching of ν₁B-O and ν₃B-O between 740 and 960 cm⁻¹ appear to be obscured by intense fluorescence. Thermogravimetric and differential thermal analyses of small cleavage fragments of fontarnauite riddled with prophetite and glauerite inclusions gave three endothermic peaks: between 25 and 350, between 450 and 620, and between 720 and 810 °C. The total weight loss at 1000 °C is 14.39%. All H₂O is lost after heating at 650 °C. The total loss in weight attributed to H₂O in O₁₂ is 12.1%. The average of 43 electron probe WDS analyses is (wt%): B₂O₅, 30.77 (29.72–31.59); Bi₂O₅ calculated from structure with B = 5 apfu, 38.66 wt%; Na₂O, 12.65 (12.16–13.24); K₂O 1.70 (0.87–2.20); CaO 2.26 (1.41–3.69); SrO 18.98 (16.47–20.94); SO₃ 7.17 (7.00–18.20); H₂O 10.01 (calculated from structure with OH⁻ = 1 and H₂O = 2 apfu), total 102.01. The empirical formula calculated based on the basis of 15 O apfu is: (Na₀.₈₄Ca₀.₁₆)₂₋₀.₀₃(Bi²⁺₁₆⁺Ca⁺₀.₁₂Na⁺₁.₈₄)₂₋₀.₀₂Bi²⁺₁₆⁺O₁₀.₁₆(H₂O)₂₋₀.₀₂. The strongest lines of the X-ray powder pattern [d Å (±; hkℓ)] are: 11.150 (100; 020), 3.395 (8; 061), 3.339 (20; 042), 3.199 (10; 160, 30.77 (29.72–31.59) (B = 22.43/22.142), 2.400 (8; 260), 2.228 (7; 516), 2.142 (200; 300), 2.098 (10; 000, 2.025 (7; 220), 1.750 (10; 222), 1.420 (400; 580), 1.280 (7; 520), 1.250 (100; 540), 1.220 (400; 560), 1.199 (10; 560), 1.170 (400; 580), 1.147 (10; 600), 1.127 (400; 620), 1.107 (10; 640), 1.088 (400; 660), 1.069 (10; 680), 1.050 (400; 700), 1.031 (10; 720), 0.984 (400; 740), 0.955 (10; 760), 0.928 (400; 780), 0.901 (10; 800), 0.873 (400; 820), 0.846 (10; 840), 0.819 (400; 860), 0.791 (10; 880), 0.764 (400; 900), 0.736 (10; 920), 0.709 (400; 940), 0.681 (10; 960), 0.654 (400; 980), 0.627 (10; 1000). Grundmannite is monoclinic, space group P2₁/c, a = 6.458(2), b = 22.142(4), c = 15.369(1) Å, V = 434.29 Å³, and Z = 4. Grundmannite has a structure topologically identical to that of emplectite, with S positions in emplectite occupied by Se in grundmannite. The structure is based on Bi₆Se₆ trigonal pyramids and nearly regular CuSe₂ tetrahedra. The mineral was named in the honor of Günter Grundmann (b. 1947), in recognition of his pioneering work on the El Dragón mine. The holotype specimen, which is the section from which the grain used for crystal-structure determination was obtained, is deposited in the collections of the Natural History Museum, London.

KAYROBERTSONITE *


Kayrobertsonite (IMA 2015-029), ideally orthorhombic Mn₆(PO₄)₂(OH); 6H₂O, is a new secondary phosphate mineral from the Hagendorf Süd pegmatite, Hagendorf, Oberpfalz, Bavaria, Germany (49°39′1″N, 12°27′35″E), and the Foote Lithium Company mine, Kings Mountain district, Cleveland County, North Carolina, U.S.A. (35°12′40″N, 81°21′20″W). At Hagendorf, the new mineral was collected by E.K. in 1975–76, between the 60 and 67 m levels of the mine. The specimens consist of fragments of etched, pinkish brown zewistleite–triplite containing irregular cavities up to a few centimeters across. Kayrobertsonite occurs within the cavities along with fluorapatite, nordgautite, whiteite-CaMnMn, members of the jahnsite group, morinite, fluellite, Al-bearing strunzite, and an analog kingsmountite. At the Foote mine, kayrobertsonite was found in a very large spodumene-bearing pegmatite boulder. The mineral occurred in small vugs (<1 cm³) in, or adjacent to, highly altered spodumene laths in the pegmatite body, where it was found associated with (in order of decreasing abundance): magangordonite, variscite, eosphorite, kastningite, paravauxite, bearnaite, strengite, strunzite, and cacoxenite. At both localities, kayrobertsonite crystals occur as intergrown masses of snow-white, soft, finely fibrous needles, less than 5 mm in diameter and no more than 100 μm in length, elongated along [001] and flat on {100}. Crystals are translucent with a silky luster, and are somewhat flexible with a splintery fracture. No cleavage was observed. Mohs hardness is estimated to be ~2. Dmax = 2.29(3) g/cm³ (by flotation in sodium polytungstate), Dcalc = 2.41 g/cm³. Kayrobertsonite is non-pleochroic, optically biaxial (-), with ε = 1.516, β = 1.554, and γ = 1.566 (white light), 2Vcalc = 70.35°, 2Vmax = 69.6°; Z = ε (length slow). The dispersion of optical axes was not observed. The average of 8 electron probe WDS analyses on the samples from both localities [wt% Foote Mine/Hagendorf Süd (ranges not reported)] are: CaO 0.41/0.74, MnO 16.11/15.20, FeO 0.27/0.30, Al₂O₃ 22.43/22.17, P₂O₅ 33.63/33.11, F 0.13/0.88, O = 0.05–0.79, H₂Ocalc [on the basis of 6H₂O+2(OH₂H₂O) pfu] 29.30/29.30, total
MAGNESIO-FERRI-FLUORO-HORNBLENDE*


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\text{Ca}_4\text{Fe}_4\text{Mg}_3\text{Al}_5\text{Si}_3\text{O}_{24}\text{F}_2\text{Cl}_3 = 3.315 \text{ g/cm}^3. \text{ No fluorescence was observed. In transmitted light, magnesio-ferri-fluoro-hornblende is pleochroic; } Y = \text{dark gray}, Z = \text{pale brownish gray} < X = \text{pale gray. The mineral is optically biaxial } (-), \alpha = 1.669(2), \beta = 1.676(2), \gamma = 1.678(2) \lambda = 589.9 \text{ nm}; 2V_\text{obs} = 74.1^\circ \text{ and } 2V_\text{calc} = 56^\circ (\text{the difference is due to imprcise measurements of } \beta \text{ and } \gamma \text{ values which are very close); } X = A = 47.6^\circ (\beta \text{ obtuse}), Y = b, Z = c = 33.4^\circ (\beta \text{ acute}). \text{ Electron probe analyses gives } [\text{wt\% } (\text{range})]: \text{SiO}_2 = 45.34 (44.71–46.54), \text{Al}_2\text{O}_3 = 6.18 (5.99–6.48), \text{TiO}_2 = 1.22 (1.14–1.29), \text{FeO}_{	ext{total}} = 20.88 (20.36–22.02), \text{Fe}_2\text{O}_3 = 6.27, \text{MgO} = 9.71 (9.33–10.15), \text{MnO} = 0.78 (0.72–0.85), \text{ZnO} = 0.06 (0.00–0.14), \text{CaO} = 10.18 (9.94–10.50), \text{Na}_2\text{O} = 0.35 (0.27–0.34), \text{K}_2\text{O} = 1.51 (1.04–1.19), \text{F} = 3.22 (2.80–3.61), \text{Cl} = 0.30 (0.26–0.35), \text{H}_2\text{O} \text{ calc: on the basis of } 24 (\text{O} = 24.41, \text{H} = 4.17, \text{F} + \text{Cl} = 2) \text{ apfu} = 0.37, \text{total } 99.55. \text{ Fe}_{	ext{total}}/\text{Fe}_{\text{total}} \text{ ratio was calculated from single-crystal structure-refinement results. This gives the empirical formula (Na}_{0.1},\text{K}_{0.1} (\text{Cl}_{0.2},\text{Al}_{0.9} \text{Si}_{2.1} \text{Mg}_{0.3} \text{Fe}_{0.5} \text{Ti}_{0.1})_2(\text{Al}_{0.9} \text{Si}_{2.1} \text{Mg}_{0.3} \text{Fe}_{0.5} \text{Ti}_{0.1})_2(\text{OH})_3 \text{Cl}_{0.2}, \text{C}_{0.4}, \text{CO}_{0.4}, \text{H}_{0.4}, \text{O}_{0.4}, \text{H}_{0.4} \text{O} \text{ based on 24 anions and } 2 \text{OH} \text{W} \text{F} = 2 \text{apfu}. \text{ The strongest lines in the } X-\text{ray powder-diffraction pattern } [\text{d } (\text{hkl}) \text{ values }]: 2.711 (100; 151), 8.412 (89; 110), 3.121 (64; 310), 2.553 (61; 702), 3.389 (55; 131), 2.599 (45; 061), 2.164 (36; 261), 2.738 (34; 331). \text{ Single-crystal } X-\text{ray diffraction data collected on a crystal of size } 0.30 \times 0.15 \times 0.55 \text{ mm refined to } R = 0.023 \text{ for 1013 unique } \{hkl\} \text{ reflections shows magnesio-ferri-fluoro-hornblende is monoclinic, space group } C2/m, a = 9.839(5), b = 18.078(9), c = 5.319(3) \text{ Å}; \beta = 104.99(3)^\circ, Z = 2. \text{ The new mineral was named according to the new rules for amphibole classification and nomenclature (Hawthorne et al. 2012). The holotype sample has been deposited at the Mineralogical Museum of the Department of Earth and Environmental Sciences of the University of Pavia, Italy. O.C.G. Reference cited}
\[ V = 1866.0 \, \text{Å}^3, \text{and} \, Z = 4. \] 
Melanarsite has a unique crystal structure that is based on heteropolyhedral pseudo-framework built by distorted Cu(1–3)O, and (Fe,Cu)O, octahedra and As(1–3)O, tetrahedra. All Cu-centred octahedra, including (Fe,Cu)-centered ones, are characterized by Jahn-Teller distortion. Potassium cations are located in the tunnels and voids of the pseudo-framework occupying eight- and sevenfold polyhedra. The new mineral (Cylirlic: Meusaphyn) was named after its black color (Greek μειμνο, black) and after that fact that it is an arsenate.

The type specimen is deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **Yu.U.**

**NICKELSUTMCORITE*\**


Nickelstumcorite (IMA 2013-117), Pb(Ni,Fe)\textsubscript{9}AsO\textsubscript{12}(OH\textsubscript{2},OH\textsubscript{4}), is a new mineral found in dumps from the old Km–3 mine in the Lavrin mining district, Attiki Prefecture, Greece. The dump material originates from the oxidation zone of a hydrothermal orebody containing gersdorffite and galena in association with annabergite, nickeltsumcorite, nickeltsumcorite, nickelustumcorite, gasepetite, calcite, dolomite, aragonite, quartz, goethite, cerussite, arseniosiderite, mimitite, oxyphlogopomite, and Mn oxides/hydroxides. Nickelstumcorite occurs as open-work aggregates of coarse radial spherulites or dense concentric nodules (up to 0.05 mm, rarely 0.15 mm), and interrupted crusts up to 3 mm × 5 mm in area and up to 0.2 mm thick. Bunches or hemispherical clusters of crude individuals and separate imperfect, elongated crystals up to 0.02 mm in length and width are also observed. The new mineral is yellow, brownish-yellow, light brown or brown with yellow streak, transparent in tiny individuals and translucent in aggregates, has vitreous luster, is brittle, has one direction of distinct cleavage on {001}, uneven fracture and Mohs hardness of ~3. Density was not measured because of the paucity of pure material; \( D_{\text{calc}} = 5.02 \, \text{g/cm}^3 \). In transmitted light nickelstumcorite is yellowish-brown, non-pleochroic. It is optically biaxial (−), \( \alpha = 1.82(2), \beta = 1.87(1), \gamma = 1.90(1) \) (589 nm), \( 2V_{\text{calc}} \) is large, \( 2V_{\text{calc}} = 74^\circ \). No optical axis dispersion was observed. The main absorption bands of the IR spectrum (cm\(^{-1}\) ) are: 1380 s (asymmetric As–O stretching vibrations of AsO\textsubscript{4} \textsuperscript{3–}), 1020 w (presumably Fe\textsuperscript{3+}–O bending vibrations), 1944 w (O–H-stretching vibrations of acidic OH\textsuperscript{−}.) The absorption spectrum shows the band at 547 cm\(^{-1}\) (Cu\textsuperscript{+}–Cl stretching) and several bands with frequencies below 300 cm\(^{-1}\) (lattice modes involving K–Cl stretching and Cu\textsuperscript{+}–Cl bending vibrations). The absence of any bands in the range higher than 600 cm\(^{-1}\) is indicative of the absence of groups with O-H, Be-O, Li-O, and C-, N-, and B-bearing groups. The averaged 7 point WDS electron probe analyses is [wt\% (range)]; K 18.57 (17.91–19.02), Cu 29.79 (29.18–30.30), Cl 51.66 (49.47–51.17), total 99.02. The empirical formula of sanguite based on the 5 apfu is

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\text{K}_{1.06}\text{Cu}_{1.12}\text{Cl}_{1.13}.
\]

Sanguite (IMA 2013-002), ideally KCuCl\textsubscript{4}, was discovered in the Glavnaya Tenoritnaya ("Major Tenorite") fumarole at the apical part of the Second scoria cone of the Northern Breakthrough of the Great Tolbachik Fissure Eruption, Tolbachik Volcano, Kamchatka, Russia. Sanguite occurs in association with belloite, avdoninite, eriochalite, sylvite, halite, carnallite, miterschlichte, cryosphahlit, romanlorovite, mellizinkalite, gypsum, chlorothionite, kainite, sellaite, and earlier hematite, tenorite, and chalcoyanite. Commonly, sanguite occurs in the sulfate-chlorite zone of the Glavnaya Tenoritnaya fumarole, where some areas contain up to 10–15 vol% of the new mineral. Sanguite forms prismatic, short to long elongated by {010} crystals in cavities. The crystals are up to 1 mm long and up to 0.2 mm thick, typically combined in groups, dense clusters or crusts. Some of the basal scoria cavities are entirely filled by sanguite. Occasionally, the new mineral forms granular aggregates up to 1 mm across in polycrystalline chloride incrustations. The major crystal forms are {011}, {100}, and {010}. Sanguite is bright red, with slightly altered samples being dark to brownish red. The new mineral has a reddish orange streak, a vitreous luster, is transparent and very brittle. The Mohs hardness is ~3. The cleavage is perfect on {010}, and another distinct one probably on {012} observed under the microscope. The fracture is stepped. 

\( D_{\text{calc}} = 2.86(1) \, \text{g/cm}^3, \)

\( D_{\text{meas}} = 2.88 \, \text{g/cm}^3. \)

Sanguite is optically biaxial (−), \( \alpha = 1.653(3), \beta = 1.780(6), \gamma = 1.900(8) \) (λ 589 nm); \( 2V_{\text{meas}} = 85(5)^\circ \); \( 2V_{\text{calc}} = 82^\circ \); \( Y = b, Z = a = 48^\circ \). Dispersion of optical axis is very strong, \( r > v \). Sanguite is strongly pleochroic: Z (brownish red) > Y (gray to pinkish gray) > X (yellowish gray to colorless). The Raman spectrum shows the band at 547 cm\(^{-1}\) (Cu\textsuperscript{+}–Cl stretching) and several bands with frequencies below 300 cm\(^{-1}\) (lattice modes involving K–Cl stretching and Cu\textsuperscript{+}–Cl bending vibrations). The absence of any bands in the range higher than 600 cm\(^{-1}\) is indicative of the absence of groups with O-H, Be-O, Li-O, and C-, N-, and B-bearing groups. The averaged 7 point WDS electron probe analyses is [wt\% (range)]; K 18.57 (17.91–19.02), Cu 29.79 (29.18–30.30), Cl 51.66 (49.47–51.17), total 99.02. The empirical formula of sanguite based on the 5 apfu is

\[
\text{K}_{1.06}\text{Cu}_{1.12}\text{Cl}_{1.13}.
\]

The strongest lines of the X-ray powder diffraction pattern of sanguite are \( d \) \( \AA \) (%: \%hkl); 7.36 (78; 011), 6.92 (100; 020), 3.684 (69; 110), 3.146 (64; 032,1 0), 3.068 (63; 112), 2.857 (73; 125), 2.709 (82; 112,042), 2.574 (56; 122). The crystal structure of sanguite was solved by direct methods and refined to \( R = 5.45\% \). The new mineral is monoclinic, \( P2_1/c, a = 4.0281(2), b = 13.7906(6), c = 8.7335(4) \, \text{Å}, \beta = 97.137(4)^\circ, V = 481.38 \, \text{Å}^3, \) and \( Z = 4. \) The crystal structure of sanguite contains almost planar, discrete dimers [Cu\textsuperscript{2+}Cl\textsubscript{4}]. The KCIs polyhedra are connected via common faces to form interrupted layers. Neighboring layers are linked to each other by the common edges of the K-centered polyhedra.

The new mineral (Cylirlic: Carnitur) was named from Latin sanguis (blood), referring to its bright red blood-like color. The type specimens are deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **Yu.U.**

**SILICOCARNOTITE*\**

The new mineral silicocarnotite (IMA 2013-139), ideally Ca$_5$(SiO$_4$)(PO$_4$)$_3$(SO$_4$) has been discovered in semi-manufactured stone artifacts made out of pyrometamorphic gehlenite-bearing rocks found at Paleolithic stone-tool workshops on the eastern slope of the Har Parsa Mt. (31°12'31"N; 35°17'09"E) and near Tsomet Hatrurim (31°12'58"N; 35°15'58"E). These localities are situated in the Hatrurim Complex between city of Arad and the Dead Sea, Negev Desert, Israel. The formation of pyrometamorphic rocks is still under discussion and supposed to be a result of combustion of bitumen contained in primary sedimentary rocks. The name chosen since the new mineral is a natural analog of the well-known orthorhombic synthetic phase Ca$_5$(PO$_4$)$_3$(SO$_4$) for which the name “silicocarnotite” has been used for the for more than 100 years. The name is unfortunate since the monolinic mineral carnottite, K$_2$(UO$_2$)$_3$(VO$_4$)$_3$·3H$_2$O bears no relation to silicocarnotite. Silicocarnotite occurs (sometimes being a rock-forming mineral) in gehlenite-bearing rock with andradite, fluorapatite and rankinite with minor pseudowollastonite, kalsilite, magnesioferrite-jacobsite, and lamellae intergrowths of larnite and flamine. Silicocarnotite has been also found forming solid solution with tennsite Ca$_5$(SiO$_4$)SO$_4$ in larnite- and gehlenite-bearing pyrometamorphic rocks of the Hatrurim Complex, distributed in the Dead Sea rift area on the territories of Israel, Palestine and Jordan. Large tennsite porphyroblasts (metacrysts) in fine-grained larnite–ye’elimite matrix are the most striking evidence for high-temperature alterations of an early “clinker minerals.” Silicocarnotite–tennsite grains grew as a result of reactions between primary pyrometamorphic minerals (larnite, flamine, fluorineladestite–fluorapatite) with sulfate-bearing melts, which are side-products of the combustion processes during the pyrometamorphism. New data on morphology, composition, structure, mineral associations, mechanisms, and conditions of growth of the tennsite–silicocarnotite solid-solution series are presented. Silicocarnotite forms grains 0.05–0.15 mm, which occasionally overgrown by a rim of rankinite–silicocarnotite microsymplectites. It also found as spherulitic aggregates on the walls of small cavities filled with katoite and Ca-hydroxylates. The mineral is colorless transparent with a white streak and a vitreous luster. Cleavage and parting are not observed. It is brittle with an uneven fracture. The indentation hardness is VHN$_{90}$ = 537 (523–552) kg/mm$^2$ corresponding to ~ of the Mohs scale. The density was not measured due to the lack of pure material; D$_{calc}$ = 3.06 g/cm$^3$. The mineral does not fluoresce under UV rays or the electron beam. In transmitted light silicocarnotite is colorless and non-pleochroic. It is optically biaxial (+), α = 1.618(2), β =1.621(2), γ = 1.628(2) (589 nm), X$\parallel$ b, Y$\parallel$ a, Z$\parallel$ c. The Raman spectra of silicocarnotite show the following bands (cm$^{-1}$): 1085, 1056, 1014 [ν(P=O) + ν(S=O)$_2$], 1004 [ν(S=O)$_3$], 957 [ν(S=O)$_2$], 850 [ν(S=O)$_4$], 640 [ν(S=O)$_6$], 584 [ν(P=O) + ν(S=O)$_4$], 557 [ν(S=O)$_4$], 474 [ν(P=O)$_3$], 397 [ν(Ca-O)]. The Raman spectra for P-rich and P-poor tennsite have been also obtained. The ratio of the ν$_1$ band vibration intensities (SO$_4$)$^-$/(PO$_4$)$^-$ is a good diagnostic property for minerals of the tennsite–silicocarnotite solid solution series. The averages of 6 electron probe EDS analyses of holotype specimen from Har Parsa and 18 analyses of corety of tennsite Tsomet Hatrurim [wt% (range) holotype cotype based on 12 O apfu are: Ca$_{0.13}$ (0.12–0.15)/[wt% from Har Parsa and 18 analyses of cotype from Tsomet Hatrurim [wt%]] (range) holotype cotype from Har Parsa and 18 analyses of cotype from Tsomet Hatrurim [wt%]] (range). The averages of 6 electron probe WDS analyses is [wt% (range)]: V 87.03 (86.52–87.63), Fe 10.24 (9.17–11.25), Al 2.21 (1.25–3.17), Ti 0.49 (0.25–0.73), total 99.97. The empirical formula is V$_{0.80}$Fe$_{0.19}$Al$_{0.02}$Ti$_{0.01}$ based on 1 apfu. The unit-cell parameters derived from the Gandolfi and glancing-angle X-ray diffraction data are: a = 3.022(3) Å, V = 27.60 Å$^3$, Z = 2, space group Im$ar{3}$m. The strongest lines in the calculated X-ray powder-diffraction pattern [d Å (%; hkl)] are: 2.141 (100; 110), 1.513 (12; 200), 1.230 (19; 211), 0.957 (8; 310), 0.889 (11; 321). Holotype material was deposited in the collections of the Geological Museum of the National Mexican University. O.C.G.

**WERNERKRAUSEITE**


The new mineral wernerkrauseite (IMA 2014-008), ideally CaFe$_2$Mn$_4$O$_8$ was discovered in strongly altered xenoliths within alkaline basalts of the Bellerberg volcano (Caspar quarry), Eitringen near Mayen, Eifel, Rhineland-Palatinate, Germany (50°35’N; 7°23’E). The xenoliths are represented by a light matrix of low-temperature minerals: ettringite–thauamastite, hydrocalumite, jennite, katoite, portlandite, etc., with relict grains of a high-temperature mineral association: CI-bearing fluorineladestite, wadade, gehlenite, andradite–scholorzite, perovskite, magnesioferrite, Cuspidine, and, rarely, reinhardbranskeite, kerimastite, lalaghiite, gehlenite, rankinite, pavlovskysite, and rusinovite. Crystallization of wernerkrauseite took place at temperatures below 850–900 °C under high oxygen fugacity. Wernerkrauseite forms black, elongated, prismatic, acicular crystals up to 0.5 mm with a black streak and strong submetallic luster. The crystals forms are [210], [110], [010], and [111]. No twinning is observed, whereas parallel crystal intergrowths are typical. Crystals are striated parallel to elongation and have rhombic cross-sections. Wernerkrauseite also occurs in aggregates with magnesioferrite and perovskite. The cleavage is not observed, the fracture is uneven. The micro-indentation hardness VHN$_{90}$ = 154(5) kg/mm$^2$-
responding to ~3 of the Mohs scale. The density was not measured; \(D_{\text{calc}} = 4.66 \text{ g/cm}^3\). In reflected light the mineral is gray, very weakly pleochroic, with a weak birefringence and anisotropy and with no internal reflections. The reflectance data obtained between 400 and 700 nm with a 20 nm interval vary from ~31% (400 nm) to ~19% (700 nm). The values for the COM wavelengths \(R_{\text{COM}}\) of Mn are: 28.1/19.8 (470), 25.7/19.0 (546), 35.0/19.1 (589), 24.3/19.0 (650). Raman bands of wernerkrauseite are \((\text{cm}^{-1})\): ~1300 and 1239 (combination first-order phonons \(\text{Ag}(622) \times 2\); 670, 622, 558 (\(\text{Ag}\)); 495 (\(\text{B}_2\gamma/2\gamma\)); 408, 332 (\(\text{Ag}B_1\gamma/3\gamma\)); 294 (\(\text{Ag}\)); 169 (\(\text{Ag}/2\beta\gamma\)); 171 (\(\text{Ag}\)). Raman spectra of wernerkrauseite were measured and analyzed in comparison to those of harmunite and marokite and are significantly distinct of those by the occurrence of strong broad bands and anisotropy. The end-member chemical formula can be given as: \(\text{Ca}_{1-x/2}(\text{Fe}^{3+}x/3\text{Mn}^{4+}x/3\text{Ti}^{4+}x/3\text{Mg}^{2+}x/3\text{Al}^{3+}x/3\text{O})\). The powder diffraction pattern was not obtained. The strongest diffraction lines of the calculated powder diffraction pattern are \([d \ A \ (\%) \ hkl]\): 4.698 (44; 102), 4.527 (54; 200), 2.748 (62; 004), 2.646 (100; 302), 2.450 (77; 112), 2.425 (37; 210), 1.818 (43; 214), 1.778 (30; 410), 1.493 (28; 414). The crystal structure solved using single-crystal X-ray diffraction was refined to \(R_1 = 0.0233\) for 800 observed \(I > 2\sigma(I)\) reflections. Wernerkrauseite is orthorhombic, \(Pnma, a = 9.0548(2), b = 2.8718(1), c = 10.9908(2)\ \AA, \ V = 285.80 \text{ Å}^3, Z = 8\). The structure is built from rutile-type chains of two types of edge-sharing \(\text{Fe}\) and/or \(\text{Mn}\) octahedra. The tunnels between these chains host the \(\text{Ca}\) sites. The diffraction pattern shows evidence of short-range ordering of \(\text{Ca}\)-vacancies. Only \(1/5\) of \(8\) \(\text{Ca}\) sites are occupied. Wernerkrauseite is a \(\text{Ca}\)-deficient structural analog of harmunite, \(\text{CaFe}_2\text{O}_4\), and thus is one of the four known minerals with post-spinel structures. The end-member chemical formula can be given on the basis of spinel stoichiometry: \(\text{Ca}_y(\text{Fe}_4/3\text{Mn}^{4+}x/3\text{O})\), which better reflects its non-stoichiometry. The empirical formula based on 4 \(\text{O}\) apfu is \(\text{Ca}_{y/3}(\text{Fe}_4/3\text{Mn}^{4+}x/3\text{Ti}^{4+}x/3\text{Mg}^{2+}x/3\text{Al}^{3+}x/3\text{O})\). The non-stoichiometric \(\text{Mn}^{4+}\)-bearing harmunite \(\text{Ca}_{y/3}(\text{Fe}_4/3\text{Mn}^{4+}x/3\text{Ti}^{4+}x/3\text{Mg}^{2+}x/3\text{Al}^{3+}x/3\text{O})\) was found at the same locality, which suggests the existence of a continuous solid solution between wernerkrauseite, harmunite, and \(\text{Ca}_y\text{Mn}^{4+}x/3\text{O}\), described by the formula \(\text{Ca}_y(\text{Fe}_4/3\text{Mn}^{4+}x/3\text{O})\), with \(y = 0 \text{ to } 1\). The new mineral is named in honor of Werner Krase (b. 1949), a chemist and researcher in the chemical industry with a special interest to the crystal chemistry and morphology of secondary minerals. He has discovered and described a considerable number of new minerals. Holotype material is deposited in the Museum of Natural History, Bern, Switzerland. D.B.