New Mineral Names*†

FERNANDO CÁMARA1, OLIVIER C. GAGNÉ2, DMITRIY I. BELAKOVSKY3 AND YULIA UVAROVA4

1Dipartimento di Scienze della Terra, Università di degli Studi di Torino, Via Valperga Caluso, 35-10125 Torino, Italy
2Department of Geological Sciences, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada
3Fersman Mineralogical Museum, Russian Academy of Sciences, Leninskiy Prospekt 18 korp. 2, Moscow 119071, Russia
4Mineral Resources Flagship, CSIRO, ARRC, 26 Dick Perry Avenue, Kensington, Western Australia 6151, Australia

In this issue

This New Mineral Names has entries for 25 new minerals, including alcaparrosaite, bastnäsite-(Nd), calciolangeinite, chovanite, chromio-pargasite (eheimite), chukhrovite-(Ca), dzhuluite, etubyuite, ferrisepiolite, herereroite, hielscherite, isite, itsite, jakobssonite, kazanskite, meisserite, nashite, omsite, schindlerite, tanohataite, tazzoliite, vapnikite, vladkriovichevite, wernerbaurite, and wopmayite.

ALCAPARROSITA*


Alcaparrosaite (IMA 2011-024), ideally K3Ti3+Fe3+(SO4)Ca(OH)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 during the single-crystal X-ray diffraction study. Alcaparrosaite is slowly soluble in aqueous solutions of HCl (38%), HNO3, and H2SO4 (47%). It is optically biaxial (+) with α = 1.643(1), β = 1.655(1), γ = 1.680(1), 2Vmeas = 70(2)° and 2Vskew = 70.3°. The mineral exhibits strong parallel dispersion r < v. The optical orientation is X = b; Y = c = 27° in the obtuse angle β. No pleochroism was observed. The average of 4 electron probe analyses gives [wt% (range)]: Na0.32 (0.16–0.51), K0.44 (0.20–0.67), Fe2O3 11.58 (11.41–11.71), TiO2 11.77 (11.54–12.18), P2O5 0.55 (0.48–0.68), SO4 47.52 (46.57–48.06), H2O 5.79 (calculated from structure refinement); total 97.97 wt%. This gives the empirical formula (K2.18Na0.07Ca0.23Ti3+Fe3+(SO4)0.99
P0.01O1.01O2.75(OH)3.50(H2O)2) based on 19 O pu. The strongest lines in the X-ray powder diffraction pattern [dobs Å (Iobs, %; hkl)] are: 6.907 (41; 021,110), 3.628 (34; 202,113), 3.320 (32; 202), 3.096 (100; 202,133,150), 3.060 (40; 202), 2.704 (38; 323,152), 1.9283 (30; 110), 1.8406 (31; 353,206). 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 = 0.0263 for 1726 unique reflections with Ω ≥ 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 Ti4+ and Fe3+ 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)*


Bastnäsite-(Nd), (IMA 2011-062), ideally (Nd,La,Ce)(CO3)Fe3+F, is the Nd analog of bastnäsite-(Ce) Ce(CO3)Fe3+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-
Calciolangbeinite is optically isotropic and colorless with white streak and vitreous luster. Its Mohs hardness is 3–3.5. It is brittle, has a conchoidal fracture and no obvious cleavage; \(D_{\text{meas}} = 2.682\) and \(D_{\text{calc}} = 2.74\) 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\(_4\) groups); 473(w), 446(w) (lattice modes). The mineral is cubic, space group \(\text{I} \Sigma_2.03\).

**Calciolangbeinite**


Calciolangbeinite (IMA 2011-067), ideally \(\text{K}_2\text{Ca}_3(\text{SO}_4)_2\), is the Ca-dominant analog of langbeinite. It occurs in sublimes at the Yadovitaya fumarole on the Second scoria cone of the Northern Breakthrough of the 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, seleniums, 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 pyipite, hematite, Fe- and Sb-bearing rutile, pseudobrookite, As- and Zn-bearing orthoclase in solid solution with filatovite, lysinite, lammerite, and late secondary cyanochroite and chloroorthite. 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\}T, 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 3–3.5. It is brittle, has a conchoidal fracture and no obvious cleavage; \(D_{\text{meas}} = 2.682\) and \(D_{\text{calc}} = 2.74\) 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\(_4\) groups); 473(w), 446(w) (lattice modes). The mineral is cubic, space group \(\text{I} \Sigma_2.03\).
Chovanite (IMA 2000-055), Pb₁₊₂₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋₅₋ṣ-12.10(10.39–12.59), CrO0.37(0.16–0.43), H2O2.09(by stoichiometry); total 99.22 wt%. The empirical formula calculated on the basis of O = 22 and OH = 2 is [Na₆.68, K₀.5, Ca₁.89, Na₀.09, Mg₀.09, Si₂.02, Mg₁.00, Al₀.19, Fe³⁺₀.07, Fe²⁺₀.07, T₃.00, Na₂.00, Si₄.14, Al₁.36, Ca₂.00, O₂₂(OH)]. The Fe²⁺/Fe³⁺ ratio estimated using the average ferric iron method. The strongest lines of the powder XRD pattern [dᵦ₁₀, Å (Iᵦ₁₀; 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 paragisite. The structure has been refined to R₁ = 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)°.
NEW MINERAL NAMES

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 chalcedonicite 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)*


Chukhrovite-(Ca) (IMA 2010-081), ideally Ca₈Al₂(SO₄)F₁₁·12H₂O, 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 transparent to translucent, colorless to white, with a white streak and a vitreous luster. The crystals are brittle within a distinct cleavage or fracture; Mohs hardness is 3.5; Dₐoled = 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 SO₄ group located at 997 (ν₁ SO₄), 1165 cm⁻¹ (ν₂ SO₄), H₂O bending vibrations at 1618 cm⁻¹, and H₂O 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 (ν₂ SO₄), 553 (ν₁ SO₄), 977 (ν₁ SO₄) and 1112 cm⁻¹ (ν₂ SO₄), and vibrations of the water molecules at 1632 (H₂O bending), and 3270, 3440, 3470, and 3560 cm⁻¹ (H₂O stretching). The average of 5 electron probe WDS analyses gave [wt% (range)]: SiO₂ 0.03 (0.00–0.07), SO₃ 10.64 (9.44–11.82), Al₂O₃ 15.72 (13.13–17.07), FeO 0.34 (0.01–0.98), CaO 35.74 (34.11–37.05), Na₂O 0.49 (0.16–0.77), F 36.61 (34.17–39.50), H₂O 4.33 (4.21–6.20), ·5.98H₂O (ν₁ H₂O). The strongest lines in the X-ray powder-diffraction pattern of the water molecules at 1632 (H₂O bending), and 3270, 3440, 3470, and 3560 cm⁻¹ (H₂O stretching). The average of 5 electron probe WDS analyses gave [wt% (range)]: SiO₂ 0.03 (0.00–0.07), SO₃ 10.64 (9.44–11.82), Al₂O₃ 15.72 (13.13–17.07), FeO 0.34 (0.01–0.98), CaO 35.74 (34.11–37.05), Na₂O 0.49 (0.16–0.77), F 36.61 (34.17–39.50), H₂O 15.85 (by difference), –O=F 4.66%, and can be described as a compact assembly of AlF₄ octahedra, SO₄ 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 AlF₆ regular octahedra by corner-sharing; the SO₄ tetrahedra occur within cavities in the structure, and are linked via hydrogen bonds to the water molecules. Cotyte specimens are stored in the collection of the Museum of National 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.

DZHUULITE*


Dzhuulite (IMA2010-064), ideally Ca₈Sn₁₀(SnFe)₃O₁₂, 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. Dzhuulite was found in a kuntyubeite 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 kuntyubeite, cuspidine, fluorochegemite, larime, fluorite, wadalite, rondonrite, hydroxylyleslädite, perovskite, lakargite, kerimisate, elbrusite, srebrolisdikite, buftontiinite, ettringite group minerals, hillebrandite, affilitite, tobermorite-like minerals, hydrocalumite, and hydrogrossular. Dzhuulite occurs as [211] crystals not exceeding 15 μm in size with cores of the τiv-Ti-analog of kerimisate. 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. Dzhuulite crystals are light-yellow to dark-brown and with a creamy streak. The luster is strongly vitreous. The Mohs hardness was not estimated. Dₐoled = 4.708–4.750 g/cm³. Dzhuulite is optically isotropic, nₐoled = 1.94. Raman spectra of dzhuulite 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 ZO₂ tetrahedron), a well-defined band at ca. 600 cm⁻¹ (asymmetric stretching vibrations in [Fe⁵⁺O₄]⁶⁻), a strong band at 490 cm⁻¹ (bending vibrations in [Fe⁵⁺O₄]⁶⁻), [bands near 300 cm⁻¹ (related to vibrations in [RZO₂]₃)]] bands <300 cm⁻¹ [translation motions of T(ZO₂) 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)]: UO₂ 6.3 (4.78–8.40), Nb₂O₅ 0.08 (0.01–0.17), Sb₂O₅ 16.73 (14.24–19.43), SiO₂ 0.28 (0.17–0.42), TiO₂ 2.62 (2.13–3.05), ZrO₂ 4.21 (2.78–6.20), SnO₂ 16.70 (15.64–17.44), Al₂O₃ 6.17 (5.20–6.46), Sc₂O₃ 0.05
NEW MINERAL NAMES

0–0.15), Fe₂O₃ (no report on how the ratio Fe³⁺/Fe²⁺ has been calculated) 19.83 (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 (Ca₃.₉₃Fe₁₂₆₋₃₀,Mg₀.₀₀₃₋₂₀,Si₀.₁₂₋₀.₀₂₀,Sn₀.₁₂₋₀.₀₂₀,U₀.₀₂₋₀.₀₁₂,H₀.₀₂₋₀.₀₁₂,Fe₂O₃₋₀.₀₄₆₋₀.₀₆₄,Fe₃₋₀.₀₈₀₋₀.₁₂₀,Sn₀.₀₆₋₀.₁₂₀,Σ₁.₂₀₁₋₁.₃₀₁)O₁₂. The strongest lines in the X-ray calculated powder-diffraction pattern [d(obs Å) (Iαβγ%; 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) Å³, space group Ia3d, Z = 8. Fitting of EBSD patterns for the dzhuluite a = 12.55 Å resulted in excellent fitting parameters. Dzhuluite belongs to the bitikleite group with the common crystal chemical formula [X₄]([R⁵⁺R⁴⁺][R⁵⁺]O)₁₂ and double site occupation in the Y site. It presents a complex solid solution Ca₅[Sb⁶⁺Sn⁴⁺Zr⁶⁺Ti⁴⁺…]₃(Fe⁺₂⁺Al⁺₂⁺Fe⁺³⁺Ti⁺⁺Si⁺⁺…)₄O₁₂, 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 {Ca₅[Sb⁶⁺Sn⁴⁺] (Fe⁺³⁺)}O₁₂. It cannot be excluded that U is pentavalent in this garnet. It cannot be excluded that U is pentavalent in this garnet. It cannot be excluded that U is pentavalent in this garnet. It cannot be excluded that U is pentavalent in this garnet.

References cited


Eltyubyuite (IMA 2011-022), ideally Ca₁₂₂.₄₆Fe₆₂.₀₄Si₁₃.₅₆Cl₃.₄₅, is the Fe⁺⁺ analog of wadalite: a new mineral from the Northern Caucasus, Kabardino-Balkaria, Russia. Russian Academy of Sciences, Moscow, Russia. F.C.
FERRISEPIOLITE*

Ferrisepiolite (IMA 2010-061), with general formula (Fe³⁺,Fe²⁺,Mg)₁(Si,Fe³⁺)₆O₈(OH,OH), 6H₂O is the Fe³⁺-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-deposit. Ferrisepiolite replaces chloropyrite, pyrrhotite, pytite, 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∥/c, X (or Y) ∥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)]: SiO₂ 39.77 (38.65–40.78), Fe₂O₃ (weight ratio of Fe³⁺/Fe²⁺ 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), Na₂O 0.20 (0.14–0.27), H₂Ocalc 14.10 (13.96–14.19), H₂Omax 14.73, total 99.74 wt% for earthy ferrisepiolite and SiO₂ 47.52 (45.68–49.12), Fe₂O₃ 22.30 (19.94–24.22), FeO 5.00 (4.48–5.38), MgO 8.61 (7.55–9.74), MnO 0.24 (0.22–0.26), CaO 0.38 (0.32–0.46), Na₂O 0.09 (0.03–0.14), H₂Ocalc 15.34 (15.09–15.53), H₂Omax 15.47 (15.47–15.47), total 99.48 wt% for fibrous ferrisepiolite. On the basis of 10 cations $\Sigma_{6+}$, the empirical chemical formula is (Fe³⁺)₁₂,Fe²⁺,MG₁₆.(Si,Fe³⁺)₁₂O₈(OH,OH)₂·6H₂O for earthy ferrisepiolite, and is (Fe³⁺)₁₂,Fe²⁺,MG₁₆.(Si,Fe³⁺)₁₂O₈(OH,OH)₂·6H₂O for fibrous ferrisepiolite. The strongest lines in the X-ray powder-diffraction pattern $\{d_{calc}, \Lambda (\text{Jad}, \text{Mkl})\}$ 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 $a = 13.638(9)$, $b = 27.011(30)$, $c = 5.233(8)$, $\Lambda = 1927.58$ Å for earthy ferrisepiolite and $a = 13.619(8)$, $b = 26.959(26)$, $c = 5.241(7)$ Å, $\Lambda = 1924.08$ Å, for fibrous sepiolite, both orthorhombic $Pmn1$, $Z = 4$. In ferrisepiolite, the substitution of Fe³⁺ and/or Fe²⁺ for Mg in the octahedral sites, compensated by substitution of Fe³⁺ for Si⁴⁺ in the tetrahedral sites and O²⁻ 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 Fe₂O₃ (14.57%) and FeO (1.06%), which was previously reported by Bøggild (1951) as a new mineral with the name “gummjarnite”. Binzer and Karup-Møller (1974) presented data for a mineral with the name “ferrisepiolite” with Fe₂O₃ (9.98%) and FeO (1.18%). “Xylotile” and “mountain wood” were also used to describe sepiolite with considerable Fe₂O₃+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.

References cited

HIELSCHERITE*

Hielscherite (IMA 2011-037), ideally Ca₂Si(OH)(SO₄)₃(PO₄)₇·11H₂O, is the first ettringite-group mineral with essential sulphite. It has been found at Grualay quarry near Hillesheim in the western Eifel Mountains, Rhineland-Palatinate, Germany, where it occurs in miarolitic cavities up to 5 × 8 mm across in alkaline basalt with early diopside and later phillipsite-K, chabazite-Ca, and gypsum. The accicular 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 thamausite is the presence of an absorption...
New lead oxychloride minerals, hereroite (IMA 2011-027) ideally $[\text{Pb}_{2}(\text{O},\text{Cl})_3](\text{AsO}_4)_2[(\text{Si},\text{As},\text{V},\text{Mo})\text{O}_2\text{Cl}]_2$ and vladkrivovichevite (IMA 2011-028) ideally $[\text{Pb}_{2} \text{O}_{3}]_2[\text{PbMnO}_3] \text{Cl}_4$, were discovered in a single specimen from the Kombat mine in Namibia obtained on sale at the mineral show where labeled as “red asisite.” The specimen consists of clear to 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. The density for both new minerals was not measured due to a lack of material. $D_{\text{calc}} = 7.40$ g/cm$^3$.

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; it 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. $D_{\text{calc}} = 8.15$ g/cm$^3$.

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, $Z = 2$, from single-crystal data. The strongest lines of the X-ray powder diffraction pattern are $d_{\text{obs}}$ Å ($I_{\text{obs}}$% hkl): 2.860 (100; 370), 2.733 (84; 073), 3.707 (49; 073), 3.068 (37; 401), 2.075 (32; 473), 1.641 (24, 11 55). 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. $D_{\text{calc}} = 8.70$ g/cm$^3$.

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, $Z = 2$, from single-crystal data. The strongest lines of the X-ray powder diffraction pattern are $d_{\text{obs}}$ Å ($I_{\text{obs}}$% hkl): 2.860 (100; 370), 2.733 (84; 073), 3.707 (49; 073), 3.068 (37; 401), 2.075 (32; 473), 1.641 (24, 11 55). The mineral is named for Vladimir Gerasimovich Krivovichev, Head of the Zeilberg basalt quarry in Franconia, a locality which is remarkable for its diverse hydrous calcium silicate. The holotype of hereroite is deposited in the collections of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. F.C.
of the Mineralogy Department, Geological Faculty, St. Petersburg State University.

Both minerals are structurally related to other layered lead oxychlorides with layers of \( \text{OPb}_6 \) tetrahedra derived from those of litharge (tetragonal \( \text{PbO} \)). Their structures consist of alternating \( \text{OPb} \) double layers and chlorine sheets. In hererote, \( \text{AsO}_4 \) and \( (\text{Si,As,Vi,Mo})_4 \) octahedra locate in defects within the \( \text{OPb} \) block, which contains square “symesite-type” and double-square “komatie-type” cavities. The structure of vladkrivovichite is based on \( \text{OPb} \) derivative blocks with the interlayer occupied by \( \text{Cl} \) anions and oxocentred \( \text{OPb} \) octahedra whose eight triangular faces are capped by triangular borate anions, \( \text{BO}_3 \). The holotype specimens for both species are stored at the Natural History Museum in London. D.B.

**ISEITE**


Iseite (IMA 2012-029), ideally \( \text{Mn}_2\text{Mn}_4\text{O}_8 \), a new mineral, Mn-dominant analog of kamiokite, \( \text{Fe}_2\text{Mn}_8\text{O}_{16} \), was discovered in the Shobu stratumferro-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), chalcopryite, 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 veins occasionally include molydbendite, and very rarely, iseite, which forms zoned aggregates (up to ~1 mm) of minute anhedral crystals of a several micrometers to 20 \( \mu \)m. Iseite is closely associated with undetermined Mn-Fe-Mo oxides with hexagonal outlines, occasionally with powellite, and very rarely coexists with molybdene. Iseite is iron-black with a black streak and submetallic luster. Moos hardness is \( 4-5; D_{\text{calc}} = 5.85 \) g/cm\(^3\). 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. \( R_{\text{max}} \) variation is 19.5–20.7% and \( R_{\text{min}} \) 16.0–17.0%. The average of 17 electron probe EDS analysis for an individual aggregate is: \( \text{MnO} 24.14, \text{FeO} 2.63, \text{MoO}_3 16.0–17.0\% \). The average of 17 electron probe EDS analysis for an individual aggregate is: \( \text{MnO} 24.14, \text{FeO} 2.63, \text{MoO}_3 16.0–17.0\% \). The average of 17 electron probe EDS analysis for an individual aggregate is: \( \text{MnO} 24.14, \text{FeO} 2.63, \text{MoO}_3 16.0–17.0\% \). The average of 17 electron probe EDS analysis for an individual aggregate is: \( \text{MnO} 24.14, \text{FeO} 2.63, \text{MoO}_3 16.0–17.0\% \). The average of 17 electron probe EDS analysis for an individual aggregate is: \( \text{MnO} 24.14, \text{FeO} 2.63, \text{MoO}_3 16.0–17.0\% \).

Iseite 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; \( D_{\text{calc}} = 3.644 \) g/cm\(^3\). Iseite is optically uniaxial (−). \( \omega = 1.623(1), \epsilon = 1.619(1) \); nonpleochroic. Crystals of iseite dissolve in concentrated HCl after 1 h, and are unreactive in concentrated \( \text{H}_2\text{SO}_4 \) after a few days. The average of 3 electron probe WDS analyses gave: \( \text{Na}_0.06 \) (0.03–0.09), \( \text{Ba}_0.46(35,46.50), \text{Ca}_0.75(7.24–7.49), \text{Fe}_0.15(0.15–0.20), \text{Al}_0.17(0.15–0.21), \text{Ti}_0.06(0.01–0.10), \text{Si}_0.34(34.85–35.01), \text{B}_0.04(10.41 \pm 0.01) \), total 99.46 wt%. The presence of B was confirmed by EMPA, but \( \text{B}_2\text{O}_3 \) amount was calculated from crystal structure refinement. The formula calculated on the basis of 14 O pflu: \( \text{Ba}_{0.04}(\text{Ca}_{0.80}\text{Al}_{0.02}\text{Na}_{0.08}\text{Fe}_{0.01}\text{Ti}_{0.01})_{29.44} \). The strongest lines of the X-ray powder diffraction patterns \( [d_{\text{calc}}] \) are: \( 5.50(42; 200), 3.746(100; 202), 3.446(60; 301), 3.100(51; 222), 2.899(96; 321,312), 2.279(44; 323), 2.145(69; 224,501), 1.8257(41; 503,334,305) \). The crystal structure of the new mineral was solved by direct methods and refined to \( R_1 = 0.007. \) In iseite, 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-
NEW MINERAL NAMES

References cited


Kazanskyite*


JAKOBSSONITE*


Jakobssonite (IMA 2011-059), ideally CaAlF₅, 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 UM2008-177[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 gysum, 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 millimeter thick, in association with leonardsonite, heklaite, malladrite, hieraitte, 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. Cotyph 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 (Ca₀.₇₃Mg₀.₀₉Na₀.₀₂)₂Na₆₄Al₁₀₀F₁₄₀(OH)₆, based on 7 atoms pfu and all O as OH. The stron-

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.

KAZANSKYITE*


Kazanskyite (IMA 2011-007), ideally Ba□TiNbNa, Ti(SiO₃)₂(OH)₅(H₂O)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 Kirovsky mine, Mt. Kukisvumchur, 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-urites. 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), gaidonnyait, nemadkevichite, epididymite, apophyllite-(KF), and spahlerite. 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 α = 1.695(2), β = 1.703(2), γ = 1.733(2) (increments a2.3, b ~2.0, c ~1.5 cm). The optical orientation is: X^a = 87.4°, X^b = 85.2°, X^c = 13.4°, Y^a = 92.1°, Y^b = 51.1°, Y^c = 102.8°, Z^a = 176.7°, Z^b = 91.9°, Z^c = 86.0°. The mineral has no discernible dispersion or pleochroism. It does not fluoresce under 240–400 nm ultraviolet irradiation. The Raman spectrum of kazanskyite contains a broad asymmetric envelope with maximum at 3462 cm⁻¹ (H₂O 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: Nb₂O₅ 9.70, TiO₂ 19.41, SiO₂ 28.21, Al₂O₃ 0.13, FeO 0.28, MnO 4.65, BaO 12.50, SrO 3.41, CaO 0.89, K₂O 1.12, Na₂O 9.15, H₂O 9.87 (by structure refinement), F = 1.29, O=F= 0.54, total 100.07 wt%. The total for other 4 points (without H₂O) increased to ~95% indicating a water loss under the beam. Further analysis of the same grain shows 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 atoms pfu and all O as OH is: Ba(□)Ba(Ti(Nb,Ti)(Na,Mn)(Ti,Mn)(Si₂O₇)₂(OH,F)₂(H₂O)₄).
The strongest lines in the X-ray powder-diffraction pattern [\(d_{obs}\) Å (\(I_{abs}%; hkl\))] are: 2.813 (100; 124,172), 2.149 (82; 227,270,207,220,227), 3.938 (70; 1T3,112), 4.288 (44; 11T,110,110,1T1), 2.128 (44; 227,227,134,221,134,221,223), 3.127 (39; 1T6,115), 3.690 (46; 1T4), 2.895 (33; 1T3,121), 2.955 (32; 120,120,122). 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 \(R_I = 8.09\%\) for the space group \(\overline{1}\). Kazanskyite is a new representative of the Ti-dicarbides 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-dicarbides. That block has two different H sheets where (SiO₄) 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: I₁ block is a layer of Ba atoms and I₂ block consists of H₂O groups and atoms of second peripheral site. The structural formula is (Ba₅,Sc₂,K₃,C₇,H₁₀)[(OH)₂,FO;SO;OH]₀.74. The mineral is named in honor of Vadim Ivanovich Kazansky (b.1926), a prominent Russian ore geologist and an expert in Precambrian petrography. The holotype specimen of kazanskyite is deposited at the Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow, Russia. D.B.

**MEISSERITE**


Meisserite (IMA 2013-039), ideally Na₃(UO₂)(SO₄)(SO₃)H₂O (H₂O), 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, chalcoprite, 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 chalcocite, covellite, ferraunite, blödlode, gypsum, johannite, and belakovskite, while the general secondary assemblage includes atacamite, boyleite, pickeringite, brochantite, chalcocite, cobaltoblödlode, managanoblödlode, copiapite, coquimbite, cyanotrichite, d’ansite, (Mn), dickite, gerhardtite, gordite, gypsum, halite, johannite, natrochalite, 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); \(2\nu_{max} = 60(2)°\) and \(2\nu_{calc} = 60°\). \(X = a, Z = c\). 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)]: Na₂O 21.67 (19.76–20.86), UO₃ 61.46 (58.29–63.73), SO₄, 34.98 (34.23–36.57), H₂O 3.90, total 101.16 wt% \((H_2O)\) calculated from stoichiometry. The empirical formula of meisserite calculated on the basis of 19 O pfu is Na₅.⁰⁵(U₃.₃₂O₉)SO₃(OH)₃[SO₄,OH] (H₂O). The Raman spectrum of meisserite has bands associated with UO₂⁺ (at 847 and 241 cm⁻¹), SO₄, and SO₃(OH) (1239, 1213, 1186, 1153, 1139, 1102, 1068, 1045, 1031, 1019, 990, 975, 980, 630, 568, 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 (\(I_{abs}; hkl\))] is: 13.15 (81; 001), 6.33 (62; 072), 5.64 (52; 021,020), 5.24 (100; 100,012,011), 4.67 (68; 101), 3.849 (48; 2T1,022,022), 3.614 (41; 052,TT3), 3.293 (43; 1T3,004). The crystal structure of meisserite was solved by direct methods and refined to \(R_I = 1.5%\). The mineral is triclinic, \(P\overline{1}, \alpha = 5.32317(10), b = 11.5105(2), c = 13.5562(10)\) Å, \(\alpha = 106.96(7), \beta = 97.414(7), \gamma = 91.461(6)°\), \(V = 801.74(6)\) 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 [SO₄OH] 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**


Nashite (IMA 2011-105), ideally Na₅Ca₂[V⁴⁺V⁶⁺]O₉)₂H₂O, 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 calcidolerioite, calcite, gypsum, huemulite, pascoite, rossite, and sherwoodite. Other minerals found nearby include andersonite, ansermitite, cobaltomentine, dickthomssenite, ferroferrite, lasalite, martyrite, melanovandate, natrozippite, schrockingerite, native selenium, tyuyamunite, and uraninite. Nashite forms from the oxidation of montmorillonite-vermiculite 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, and has a subadamantine lustre, with 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/cm³. 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), $2V_{max}$ = 70(2)° and $2V_{calc}$ = 71°. The optic orientation is $Y = b$, $X \approx a$. Nashite is pleochroic, with $X$ = greenish blue, $Y$ = yellowish green, and $Z = yellow$; $X \gg Y >> Z$. 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 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$_{0.00}$K$_{0.00}$)($\Sigma_{n}$(Ni,Cu)$_{0.05}$As$_{0.16}$O$_{32}$)·2H$_2$O (100; 004) 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; 111,101), 8.350 (64; 110), 10.995 (46; 020), and 2.9942 (29; 331,332,303,071,310). Single-crystal X-ray diffraction data collected on a crystal of size 0.050 × 0.090 × 0.110 mm refined to $R_{I}$ = 0.0293 for 3144 unique reflections with $\bar{I} > 2\sigma$(I) shows nashite is monoclinic, $P2_1$/a, with $a = 10.0099(3)$, $b = 21.8472(7)$, $c = 11.1504(7)$ Å, $\beta = 116.5848(8)^\circ$, $V = 2180.67$ Å$^3$, and $Z = 2$. The structure of nashite is based on a partially reduced decavanadate group structural unit [(V$^{4+}$V$^{5+}$)$_3$O$_{23}$$^-$] and a [Na$_2$Ca$_4$(OH)$_{22}$2H$_2$O]$^{n+}$ interstitial unit. The structural unit consists of ten distorted, edge-sharing octahedra that are bonded to chains of Na octahedra and an irregular Ca$_2$O$_{32}$(OH)$_3$ 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* **


Omsite (IMA 2012-025), ideally (Ni,Cu)$_2$Fe$_3$O$_6$(OH)$_8$[Sb(OH)$_4$], is a new mineral found at the Correc d’en Llinassos, near the village of Oms in the Pyrénées-Orientales Department, France, (43°22′16″N 02°42′26″E). Omsite occurs in narrow, crystalline fractures in massive siderite-bearing rock with ulmannite and chalcopyrite, and less commonly with tetrahedrite/tennantite. 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 distinct 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 crystals are generally no more than 10 μm. Crystals are bright to amber yellow, with a pale yellow streak, a vitreous to resinous lustre, are transparent to translucent, are brittle with an irregular fracture, and have one poor cleavage on {010}. The Mohs hardness is ~3. The density was not measured due to the small size of the crystals; $D_{calc}$ = 3.378 g/cm³. 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 $\varepsilon$ = 1.661(1). Omsite is pleochroic or orange-yellow > ε 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$_3$ 6.14 (6.01–16.96), Sb$_2$O$_5$ 30.54 (30.35–30.90), As$_2$O$_3$ 1.66 (1.20–1.93), Cl 0.23 (0.05–0.55), −O=Cl 0.05, H$_2$O [calculated on the basis of 12 (OH+Cl) pfu] 21.50, total 100.48 wt%. The empirical formula is (Ni$_{12.19}$Cu$_{5.84}$)$_{0.05}$Fe$_{3.063}$O$_{32}$·8(OH+Cl) = 12 (OH+Cl) pfu. The strongest lines in the X-ray powder-diffraction pattern [d$_{obs}$ (Å) (I$_{obs}$%; hkl)] are: 9.401, (100; 004), 4.575, (83; 011), 2.3539, (81; 110), 1.97 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; 111,101), 4.575, (83; 011), 2.3539, (81; 110), 1.8079, (48; 118), 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 $R_{I}$ = 0.0896 for 356 unique reflections with $I > 2\sigma$(I) shows omsite space group $\text{P}2_1\text{a}$, 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$_2$(OH)$_6$, brucite-like layer, with Sb(OH)$_4$ octahedra in the interlayer. Omsite is named for Oms, the closest 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* **


Tanohtaitae (IMA 2007-019), ideally LiMn$_2$Si$_2$O$_7$(OH), a Li analog of serandite [NaMn$_2$Si$_2$O$_7$(OH)], has been found in the Tanohtaita mine, Tanohtaita village, Iwate prefecture, Japan. The upper Jurassic sediment-hosted Mn-ore deposits of the Tanohtaita 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...
Tazzolite

F. Câmara, F. Nestola, L. Bindi, A. Guastoni, F. Zorzi, L. Peru

Tazzolite is a new mineral with a pyroclosite-related structure from the Euganei Hills, Padova, Italy. Mineralogical Magazine, 76(4), 827–838.

Tazzolite (IMA 2011-018), ideally Ba$_2$Ca$_{10}$Ti$_6$Nb$_3$Si$_5$O$_{29}$(OH)$_{12}$, 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). Tazzolite occurs as part of skarn and calc-silicate rocks with rare silicarneous, which contain cavities up to several millimeters across, where the new mineral is hosted in close association with a diopside and titaneite. Tazzolite occurs as fan-shaped groups of platy crystals up to 0.4 mm long and a few millimeters thick. Crystals of tazzolite 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$_{1.5}$ = 788 kg/mm$^2$). $D_{	ext{calc}}$ = 4.517 g/cm$^3$. Tazzolite is not fluorescent. It is biaxial (+) with $2V_{	ext{calc}}$ = 50° and non-pleochroic. The calculated mean refractive index is 2.04. Raman spectra of tazzolite 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$_2$O bending around 1600 cm$^{-1}$ (although its expression would be extremely weak). The DTA curve of tazzolite shows a broad exothermic peak between 2500 and 3700 cm$^{-1}$ was also observed. The empirical formula is (Ba$_{0.85}$Ca$_{0.12}$Sr$_{0.25}$Fe$_{0.06}$)$^{3+}$Si$_{51.97}$O$_{151.98}$ (both calculated and observed) 2.59, with a total of 99.33 wt%.

The cleavage is perfectly on {010}, the unit-cell parameters refined from powder-diffraction data are: $a$ = 7.3182(4), $b$ = 21.4471(1), $c$ = 35.680(1). 20 = 7.8°. The structure of tazzolite is related to pyroclosite and consists of a framework of Nb(Ti) octahedra and BaO$_2$ polyhedra sharing apexes with Nb(Ti) octahedra and BaO$_2$ polyhedra in two possible mutually exclusive positions, that indicate stacking disorder with faults parallel to (100). Diffraction pattern analogous to para-wollastonite and paracetapelite were not observed. Tannohataite is named after its type locality. The type specimen is deposited in the National Museum of Nature and Science, Tokyo, Japan. F.C.

The new mineral species vapnikite (IMA 2013-082), ideally Ca$_3$UO$_6$, 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$_3$UO$_6$ and is isotypic with the cryolite (natural fluoroperovskite) Na$_3$AlF$_6$. 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 fluoromayenite-fluorkyuygenite series. Some rock fragments are enriched in fluorellastadite–fluoroapatite, P-ternesite, shulamitite, baryte, periclase, banabimusaite, and the potentially new mineral BaCa$_2$(SiO$_4$)$_2$(SO$_4$)$_2$. Rarely found are oldhamite and the potentially new mineral CaCu$_2$S$_2$. In pebbles, vapnikite is often associated with vorlantite (CaU$_6$O$_9$). Vapnikite and vorlantite are usually enriched in different parts of the larnite-bearing rocks. Micrometer-sized rims around vapnikite with composition Ca$_2$UO$_4$·nH$_2$O and/or CaUO$_2$·nH$_2$O 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$_{15}$ = 5.322 g/cm$^2$. Vapnikite is biaxial non pleochroic with only a minor refractive index 1.78(3) in a random cross section determined due to a small grain size. In contrast to vorlantite it does not dissolve in 10% HCl at room temperature. The Raman spectra for vapnikite and vorlantite 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 100 wt%. The empirical formula based on 4 cations apfu is Ca$_{3_{0.4}}$U$_{1_{0.6}}$O$_{6.0}$. Single-crystal X-ray diffraction data collected on a crystal 24 × 11 × 10 μm in size refined to $R_I = 0.0354$ for 553 unique reflections with $I \geq 4σ(I)$ shows vapnikite is monoclinic, $P2_1/n$, with $a = 5.739(1), b = 5.951(1)$, $c = 8.312(1) Å$, $β = 90.4(1)^{\circ}$, $V = 283.9 Å^3$, and $Z = 2$. Six strong lines of the calculated X-ray powder diffraction pattern are [d$_{calc}$ Å ($I_{calc}$ % $hkl$): 4.838 (78; 011), 4.706 (39; 101), 4.131 (79; 110), 2.975 (47; 020), 2.993 (100; T12), 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 $A^2B^6$UO$_9$ ($A$ = 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$_3$UO$_6$ 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, {[(CaH$_2$O$_7$)$_2$(H$_2$O)(H$_2$O)$_2$](V$_{10}$O$_{32}$)}, and schindlerite, {[(Na$_2$(SiO$_4$)$_2$)(H$_2$O)$_4$]V$_{10}$O$_{32}$}, the first hydronium-bearing decavanadate minerals. Canadian Mineralogist, 51(2), 297–312.

Wernerbaurite (IMA 2012-064), ideally {[(CaH$_2$O$_7$)$_2$(H$_2$O)(H$_2$O)$_2$](V$_{10}$O$_{32}$)}, and schindlerite (IMA 2012-063), ideally {[(Na$_2$(SiO$_4$)$_2$)(H$_2$O)$_4$]V$_{10}$O$_{32}$}, 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, hendersomite, 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}, {110}, 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}, {111}, and {111}. Wernerbaurite is yellow-orange, has a yellow streak, subadamantine luster, is transparent, brittle, and has good cleavage on {100} and {101}. It has a Mohs hardness of ~2. Its density could not be measured due to dissolution in density liquids: $D_{calc} = 2.352$ g/cm$^3$. 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 ~2.5. $D_{calc} = 2.461$ g/cm$^3$. 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 $α = 1.745(3), β = 1.780(3), γ = 1.795(3), 2V^\prime = 66(2)^\circ$ in white light. The optical orientation is $X^\prime = a = 29^\circ, Y^\prime = c = 44^\circ, Z^\prime = b = 46^\circ$. 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 $2V_{meas} = 78.1^\circ$ in white light. The optical orientation is $X = b = 25^\circ, Y = c = 12^\circ, Z = a = 3^\circ$. 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$_2$O 0.37 (0.13–0.91), K$_2$O 0.10 (0.05–0.13), CaO 8.76 (8.16–9.25), SrO 0.16 (0.04–0.30), V$_2$O$_5$ 75.76 (74.25–77.72), H$_2$O 14.85 (calc. based on structure refinement) total 100 wt% (following determination of H$_2$O). This gives the empirical formula {[(Ca$_{13}$_8Na$_{14}$_4K$_{10}$_3$SrO$_{55}$_8$O$_{16}$_8) 2.97(0H$_2$O)$_3$6.93(0H$_2$O)$_2$$_{6.0}$_4]V$_{10}$O$_{32}$} based on V$^\prime = 10$ and O = 46 apfu. For schindlerite, the average of 21 electron probe WDS analyses
NEW MINERAL NAMES

Fe(OH), MgΦ) where (H2O)2+ o0.35 CaSr, s = strong, m = medium, w = weak) are: 2830s and 2395s (O–H stretching), 1720m and 1651m (combinations), 1345ps (O–H bending vibration), 1185s, 1090s, 994w, and 947w (various stretching bands of the PO4 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 deformation modes). The average of 8 electron probe WDS analyses is [wt% (range)]: P2O5 46.40 (46.14–46.61), Al2O3 0.38 (0.28–0.55), Fe2O3 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), Na2O 5.4 (3.96–6.87), H2O 2.00 [calc. on the basis of 28 anions with (OH)2 = 2.37 apfu] total 98.68. This gives the empirical formula (Ca0.19Na0.88Sr0.09K0.14Mn0.75Mg0.11Fe3+0.1Fe2+0.1Al0.08Fe2+0.05PO4)3.67(PO3OH)0.37 based on 28 O apfu. The strongest lines in the X-ray powder-diffraction pattern [dobs (Å) (Iobs; %; hkl)] are: 2.858 (100; 2.0.10), 3.186 (88; 234), 2.589 (68; 240), 5.166 (33; T20), 6.421 (32; T14), 8.017 (31; 012), and 3.425 (29; T1.10). The unit-cell parameters refined from powder-diffraction data are: a = 10.370(3), c = 37.085(15) Å, V = 3453.6 Å3. Single-crystal X-ray powder diffraction data collected on a crystal of size 40 × 60 × 80 µm refined to R = 0.0399 for 2888 unique reflections with I ≥ 4σ(I) shows the mineral is triclinic, PT, with a = 9.7212(6), b = 10.2598(8), c = 10.5928(8) Å, a = 89.999(7)°, β = 77.083(7)°, γ = 69.878(8)°, V = 963.55 Å3, and Z = 1. For schindlerite, single-crystal X-ray diffraction data collected on a crystal of size 40 × 90 × 180 µm refined to R = 0.0399 for 2888 unique reflections with I ≥ 4σ(I) shows the mineral is triclinic, PT, with a = 8.5143(3), b = 10.4283(5), c = 11.2827(8) Å, α = 68.595(5)°, β = 87.253(6)°, γ = 67.112(5)°, V = 854.08 Å3, and Z = 1. The structural unit of both minerals is the decavanadate polyanion, (V10O32)6−. The interstitial unit linking the structural units has a composition of [(Ca(H2O)6)2(PO4)2(OH)2]14+ for wernerbaurite, and is formed of an isolated [Ca(H2O)6]+ polyhedron, a (H2O)− ion, and an isolated H2O molecule. Similarly, the interstitial unit of schindlerite has a composition of [(Na4(H2O)10)2(H2O)6]14+ and is formed of a [Na4(H2O)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 type specimens of wernerbaurite and three type 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 (IMA 2011-093), ideally Ca6NaMn(PO4)3(P2O7OH), 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, claudellite, calcite, ovetite, groatite, metswitzerite, spahlerite, 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; Dcalc = 3.027 g/cm3. Wopmayite does not fluoresce under ultraviolet light. It is uniaxial (−), ω = 1.617(2), ε = 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), 1345ps (O–H bending vibration), 1185s, 1090s, 994w, and 947w (various stretching bands of the PO4 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 deformation modes). The average of 8 electron probe WDS analyses is [wt% (range)]: P2O5 46.40 (46.14–46.61), Al2O3 0.38 (0.28–0.55), Fe2O3 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), Na2O 5.4 (3.96–6.87), H2O 2.00 [calc. on the basis of 28 anions with (OH)2 = 2.37 apfu] total 98.68. This gives the empirical formula (Ca7.19Na0.88Sr0.09K0.14Mn0.75Mg0.11Fe3+0.1Fe2+0.1Al0.08Fe2+0.05PO4)3.67(PO3OH)0.37 based on 28 O apfu. The strongest lines in the X-ray powder-diffraction pattern [dobs (Å) (Iobs; %; hkl)] are: 2.858 (100; 2.0.10), 3.186 (88; 234), 2.589 (68; 240), 5.166 (33; T20), 6.421 (32; T14), 8.017 (31; 012), and 3.425 (29; T1.10). The unit-cell parameters refined from powder-diffraction data are: a = 10.370(3), c = 37.085(15) Å, V = 3453.6 Å3. Single-crystal X-ray diffraction data collected on a crystal of size 40 × 60 × 80 µm refined to R = 0.0221 for 2288 unique reflections with I ≥ 4σ(I) shows wopmayite is trigonal, space group R3c, a = 10.3926(2), c = 37.1694(9) Å, V = 3476.7 Å3, Z = 6. The structural unit of wopmayite consists of a “bracelet-and-pinwheel” [M2+(PO4)3] arrangement that is topologically identical to the one of the whitlockite and merillite structures. The [M2+(PO4)3] clusters are linked by Ca polyhedra and (PO4Φ) groups of the form [Ca6NaMn(PO4)] where Φ = O2H and X = (O, 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.