New Mineral Names*

PAULA C. PHILONEN,†‡ GLENN POIRIER,‡ AND KIMBERLY T. TAIT

1Mineral Sciences Division, Canadian Museum of Nature, P.O. Box 3443, Station D, Ottawa, Ontario K1P 6P4, Canada
2Department of Natural History, Royal Ontario Museum, 100 Queen’s Park, Toronto, Ontario M5S 2C6, Canada

**CALVERTITE**


Calvertite was discovered during the examination of another new mineral (galloboeaudanite) from the Tsumeb mine. The unoxidized portions of the sample in which calvertite was found consist mainly of calvertite and reinerite with minor tennantite and gallite inclusions. Calvertite occurs in a granular texture formed by a network of chalcocite veins. The calvertite grains are anhedral, elongate to elliptical with the largest grains up to 100 µm across. The calvertite postdates the reinerite as evidenced by veins of calvertite cutting reinerite. Other associated minerals in the sample are goethite, hematite, quartz, Hg-rich native silver, stolzite, otjikerite, and various members of the alunite supergroup.

Calvertite has a metallic luster, irregular to conchoidal fracture, brittle tenacity, and no cleavage or parting. It is macroscopically black. The VHN is 283 kg/mm² (Mohs hardness 4 to 5). It is opaque and pale bluish-gray in reflected light. No birefringence, pleochroism, or internal reflections were observed. Reflectance percentages in air are 26.3 (470 nm), 23.1 (546), 22.2 (589), and 21.5% (650).

Chemical composition was measured using an electron microprobe. Weight percent results (and ranges in parentheses) are as follows: Cu 63.10 (62.55–63.70), Fe 1.66 (1.49–1.84), Zn 0.55 (0.22–0.92), Ga 0.36 (0.31–0.39), V 0.05 (0.04–0.05), S 26.63 (26.4–26.78), corresponding to an empirical formula (based of four S atoms per formula unit) of (Cu₄.76Fe₀.38Zn₀.36Ga₀.05V₀.096)Σ₀.478S₄.

The powder diffraction pattern for calvertite consists of only four lines: [d in Å (orth), hkl]: 3.053(100,111), 2.639(10,200), 1.869(90,220), and 1.595(30,311). These lines do not definitively identify the mineral. The X-ray pattern of synthetic Cu₅Ge₄S₄ also consists only of four lines, all of which moderately match those of calvertite. The strongest lines of reinerite, germanoculsite, and germanite also agree well with those of calvertite.

Single-crystal X-ray studies of a grain removed from a polished section indicate the mineral is cubic, with a = 5.337 Å with allowable space groups of Fm3m, Fd3m, and F43m. A re-analysis a year later of the same single crystal produced no reflections, but the original powder sample showed no change after 11 years.

The authors suggest that the small unit cell and the unstable character of calvertite indicate that it is a metastable, highly disordered mineral whose ordered equivalent would be Cu₅Ge₄S₄ with a = 2 × 5.337 Å. It is named for Lauriston (Larry) Derwent Calvert (1924–1993) of the National Research Council, Ottawa, Canada. Cotyphole polished sections of calvertite are in the Canadian Museum of Nature, Ottawa (CMNMC 85731), and the Natural History Museum, London, U.K. (BM 2004, 78).

**CASSAGNAITE**


Cassagnaite is a new mineral found in the Val Graveglia manganese district (Northern Apennines, Liguria, Italy) at the Cassagna mine. Cassagnaite was found in fractures in braunite + quartz layered mineralization, together with piemontite. Hydrothermal fluid circulation, along later extensional fractures under decreasing P-T metamorphic conditions, induced the concentration of commonly dispersed elements that were involved into the genesis of As-, Ba-, Cu-, Sr-, and V-rich mineral assemblages. Vanadium minerals have been previously discovered at the two other mines in the area (Gambatesa and Molinello mines) such as cavotoite, medaite, palenzonaite, repplait, saneroite, tiragalloite, vanadioapatite, and vanadomalaite, this is the first time a newly described vanadium mineral was discovered at this mine. Cassagnaite appears as very rare isolated prismatic to tabular crystals, usually elongated along [100], and as entangled aggregates of a few crystals. The crystals are generally very small, with a maximum size of 0.06 mm.

Cassagnaite is transparent with vitreous luster, golden brown in color, and the streak is nearly white. The morphology of the crystals is generally dominated by the prism {011} and the pinacoids {001} and {100}. It is brittle and exhibits {001} cleavage (or parting). Due to the unusual scarcity of available material and to the reduced size of the crystals, the determinations of physical and optical properties are not complete. The calculated density is 3.22 g/cm³. The mineral does not fluoresce under short and long-

* Before publication, minerals marked with an asterisk were approved by the Commission on New Minerals and Mineral Names, International Mineralogical Association.
† E-mail: ppiilonen@mus-nature.ca

0003-004X/08/0010–1686$05.00/DOI: 10.2138/am.2008.527 1686
wave ultraviolet light. Optically, cassagnaite is biaxial and some optical measurements were performed on the largest face, likely parallel to the {001} cleavage, of a prismatic crystal elongated along [100]. The refractive index values are \( N \) (parallel to \( a \)): 1.810 (±0.005) and \( n \): 1.800 (±0.005), measured by Cargille’s liquids at 25 °C (\( \lambda = 589 \) nm). The pleochroism is very weak: \( N \) = golden yellow-brown and \( n \) = pale golden yellow-brown.

The crystal structure, refined in the space group \( \text{Cmcm} \) with unit-cell parameters \( a = 6.066(1) \, \text{Å} \), \( b = 8.908(1) \, \text{Å} \), \( c = 18.995(2) \, \text{Å} \), and \( Z = 2 \), may be described as a layer stacking along [001] of a fundamental building block of composition \( \text{[M}_2\text{O}(\text{SiO}_3)_2]^{4+} \) that alternates with intersheets, randomly occurring in a ratio ideally 1:1, of type 1 \( \{\text{(Ca, Mn}^{2+})_2\text{SiO}_3\}^{4+} \) and of type 2 \( \{\text{(Ca, Mn}^{2+})_2\text{O}_2\}^{4+} \), where \( \text{Fe}^{3+} \) and \( \text{Mn}^{3+} \) populate 3/4 of the M1 site and Al the remaining 1/4, while \( \text{V}^{3+} \), Mg, and Al occupy in nearly equal proportions the M2 site. All the checked crystals exhibit very poor reflection quality, almost all exhibited a large quantity of streaked reflections, likely related to a high degree of structural disorder, and generally weak reflections due to the small size. The proposed structure of cassagnaite represents at present an averaged model of a high disordered structure and attempts will be made to improve it.

Quantitative analyses (seven points on two crystals) were performed by means of an electron microprobe (PHILIPS SEM 515 electron microscope equipped with EDAXPV9100 spectrometer) in energy-dispersion mode, with an accelerating voltage of 15 kV and a beam current of about 2 nA. H
\( \text{O} \) content could not be directly determined because of the lack of material but a micro-Raman analysis has been carried out with a Renishaw 2000 Ramascope equipment using a laser operating at 633 nm; the large band in the range 3500–3000 cm
\( ^{-1} \); frequencies of the most intensive bands are \( \alpha = 1.673(3), \beta = 1.770(5), \gamma = 1.780(5), 2\ \text{F}_{\text{meas}} = 10(5) \). Cassagnaite occurs as acicular to fibrous individuals, elongated along [001], up to 0.5 mm long and up to 2–3 μm thick usually combined in spherulites up to 0.3 mm (rarely up to 1 mm) in diameter. Botryoidal spherulitic clusters and parallel- or radial-columnar aggregates forming crusts up to 1 mm thick are typical. Aggregates are usually porous; the core of some spherulites contains grains of kamacite, taenite, sulfides, or iron hydroxides.

The infrared spectrum of the new mineral is close to the spectra of pokrovskite (the most similar), malachite, and members of the rosasite group. Absorption bands in the IR spectrum of chukanovite (in cm
\( ^{-1} \); frequencies of the most intensive bands are italic, sh = shoulder) are: 3475, 3325, 1755, 1521, 1400sh, 1364, 1069, 1055sh, 955, 861, 837, 781, 710sh, 695, 655, 504, 452. Average chemical composition (wt%; electron probe, H
\( \text{O} \) by modified Penfield method, \( \text{CO}_2 \) by selective sorption) is MgO 0.1, FeO 68.8, NiO 0.6, CoO 19.8, H
\( \text{O} \) 10.9, total 100.2 wt%. The empirical formula calculated on the basis of two metal atoms is \( \text{(Fe}_{0.35}\text{Ni}_{0.65})\text{Mg}_{0.01}\text{Mn}_{0.01}\text{CO}_3\text{O}_8\text{H}_{0.18}\text{H}_2\text{O} \), ideally \( \text{Fe}_{(5)}\text{(CO}_3\text{)}\text{(OH)}_2 \).

The mineral was named in honor of Nikita V. Chukanov (b. 1953), Russian physicist and mineralogist. The holotype specimen is deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow. K.T.T.

**Ferroskutterudite**


Ferroskutterudite, \((\text{Fe,Co})\text{As}_2\), was discovered in antimonide-arsenide mineralization among the Ni-Cu ores of the Noril’sk ore field, Russia. Antimonide-arsenide mineralization (164–122 Ma) post-dates the Ni-Cu mineralization of the main ore field (~250 Ma). The antimonide-arsenide mineralization occurs in hydrothermally derived carbonate and apophyllite-anhydrite-carbonate veins precipitated from NaCl-MgCl\(_2\) solutions at low salinity (0.2–1.4 wt% NaCl equiv.) at \( P = 0.1–0.9 \) kbar and \( T = 127–216 \) °C. The mineral occurs in dolomite-calcite veins, which contain triarsenides that cross-cut calcite veins containing both arsenides and diarsenides. It is associated with wurtzite, sphalerite, galena,
Osakaite*  

Osakaite was discovered during a survey of secondary minerals from the gallery walls and in cracks in shale at the Hirao Mine, Osaka Prefecture, Japan. The Hirao mine is one of a number of
small Cu, Zn, Pb, Fe, and Mn deposits found in Jurassic shales north of Osaka. The ore minerals are predominantly sphalerite with lesser amounts of chalcopyrite, pyrite, and galena. Within the mine a variety of secondary minerals including smithsonite, hydrozincite, schulenbergerite, the Zn-dominant analogue of schulenbergerite, brianyoungite, hemimorphite, brochantite, ramsbeckite, auriculcite, malachite, azurite, posnjakite, and ktenasite are found in the altered shales. Osakaite is found either as hexagonal platy crystals (0.05 mm in width and 0.01 mm thick) or as stalactitic aggregates up to 2 cm in length. Associated minerals are hydrozincite, smithsonite, “chlorite,” and “limonite” (author’s quote marks).

Osakaite is white or pale blue to colorless with a pearly luster and a white to pale blue streak. Crystals have a perfect {001} cleavage and are fairly flexible. It is biaxial (−) with α = 1.532(2), β = 1.565(2), γ = 1.567(2), 2Vmeas = 27.2°, and positive elongation. Dmeas = 2.70(1) g/cm³, comparable with Dcalc = 2.75 g/cm³ based on empirical formula and unit-cell parameters. VHN is 131 kg/mm², corresponding to a Mohs hardness of 3–3.5.

The mineral was not suitable for microprobe analysis due to dehydration in vacuum and instability under the electron beam. The composition was determined using a combination of ICP-AES and thermogravimetric analyses (volatile components). The resultant composition is ZnO 55.30, CuO 3.44, SO3 14.66, and H2O 26.01. This gives an empirical formula of [Zn0.87Cu0.20Bi0.01(Fe0.08Zn0.06)2/3(Se0.03S0.01)0.33Si0.76SO4]0.20(OH)0.30·9.99H2O on the basis of 15 oxygen atoms.

Dehydration of osakaite by radiation or heating in a dry atmosphere produces namuwite. Rehydration occurs after immersion in water. Powder diffraction patterns of this rehydrated material show broader reflections than the original material.

In accordance with new nomenclature rules (Bindi et al. 2007) for the pearceite-polybasite group, this mineral, which has more Sb than As and two S sites dominated by Se, is named selenopolybasite (the selenium dominant analogue of polybasite). A structure determination of this mineral (Evain et al. 2006) indicates that it has the 111 unit-cell type and thus is properly named selenopolybasite-Tac.

The new species was found in a sample from the De Lamar Mine, Owyhee County, Idaho. Mineralization at this mine consists of mineralized northwest trending veins in a mid-Miocene rhyolite porphyry. Mineralization from heated brines occurred at shallow depths. Selenopolybasite forms subhedral to anhedral grains associated with naumanite and covellite. Grain size is typically several hundred micrometers.

Selenopolybasite is opaque with a black streak and metallic luster. It is brittle without cleavage or fracture. Small grain size precluded density measurement; Dmeas = 6.548 g/cm³. Measured VHN is 131 kg/mm², corresponding to a Mohs hardness of 3–3.5. Selenopolybasite is light gray in plane-polarized reflected light, with weak to moderate bireflectance, and weakly pleochroic gray to violet blue gray. There are no rotation tints or internal reflections in cross polarized reflected light. Reflectance percentages (Rmax, Rmin) for the four standard COM wavelengths are 32.8, 34.1 (471.1 nm), 31.0, 32.9 (548.3 nm), 30.2, 31.8 (586.6 nm), and 29.3, 30.0% (652.3 nm), respectively.

Chemical composition was determined by electron microprobe. The average of 10 analyses gives the following result [average(max–min)], Ag 66.17 (65.21–67.39), Cu 3.19 (2.88–3.81), Bi 0.09 (0.00–0.16), Pb 0.09 (0.02–0.20), Zn 0.03 (0.00–0.09), Fe 0.07 (0.00–0.12), Sb 9.47 (9.00–9.89) As 0.60 (0.23–0.99), S 11.36 (10.88–11.56), Se 8.42 (8.01–8.77), giving an empirical formula of [(Ag0.65Cu0.29Bi0.05Pb0.01Zn0.06Fe0.07Sb0.19As0.10Se0.03)2/3(Se0.68O0.34)22.05(S0.80Se0.15)22.00Se2] on the basis of 29 atoms.

Selenopolybasite-Tac is trigonal with space group P311 with a = 7.5950(4), c = 12.0731(6) Å, V = 603.12(5) Å³, c:a = 1.5896, Z = 1. The eight strongest X-ray diffraction lines [d in Å(%hkkl)] include 3.1731(48,201), 3.0183(84,004), 2.8880(48,022), 2.8880(100,202), 2.5466(23,023), 2.3629(34,114), 2.2327(28,024), and 1.8987(31,220). G.P.

NEW DATA

ISOKITE*


The crystal structure of isokite, CaMg(P04)Fe10(OH)6, as a member of the titanite group, has been determined for the first time on a 0.06 × 0.05 × 0.05 mm³ crystal from Kjørrestad, near Bamle, Norway. The average chemical composition of the mineral, as determined by electron microprobe methods, is CaMg(P04)10[F6.93(OH)]2. The intensity data were collected by single-crystal X-ray diffraction methods, Rint = 0.031, R(F2) = 2σ(F2) = 0.030, wR(F2) = 0.081, S = 1.05, 801 independent reflections (3037 measured reflections). The mineral is monoclinic, C2/c, a = 6.5109(3), b = 8.7301(5), c
The crystal structure of kolbeckite, ScPO$_4$·H$_2$O, has been determined, for the first time, on a 0.07×0.06×0.06 mm$^3$ crystal from Hot Springs County, Arkansas. The average composition of the mineral (based on 15 analyses and determined by electron microprobe methods) is (Si$_{0.49}$Al$_{0.20}$Fe$_{0.26}$O$_{3.49}$)·H$_2$O·Sc$_{0.06}$PO$_4$. Intensity data were collected by single-crystal X-ray diffraction methods, $R_{int}=0.042$, $R(F^2)>2σ(F^2)=0.052$, $wR(F^2)=0.168$, $S=1.11$, 1858 independent reflections (8954 measured reflections). All crystals examined were twinned (twin axis along 001) and the twin law (100,01,001) was included in the refinement. Four H atoms were located on the difference Fourier map and their positions allowed to refine freely. Kolbeckite is monoclinic, $P2_1/n$, $a=5.4258(4)$, $b=10.2027(8)$, $c=8.9074(7)$ Å, $β=90.502°$, $V=493.08(7)$ Å$^3$, $Z=4$. The mineral is homologous with metavariscite, and consists of two basic polyhedral units: PO$_4$ tetrahedra and ScO$_4$(H$_2$O)$_2$ octahedra. Each PO$_4$ tetrahedron shares four vertices with four ScO$_4$(H$_2$O)$_2$ octahedra and vice versa, forming a 3D polyhedral network of polyhedra. The two H$_2$O molecules are coordinated to Sc$^{3+}$. Kolbeckite, previously called eggonite or sterrettite, is a member of the metavariscite group of minerals, which are being investigated extensively because of the biological and geochemical importance of phosphorous and arsenic in soils, water, and waste management. In addition, recent studies have shown variscite- and metavariscite-group minerals to have interesting microprobe and absorption properties. P.C.P.

**KOLBECKITE***


Schulenbergite is translucent with a pearly luster, has a perfect {0001} cleavage, $D_{max}=3.18(1)$ g/cm$^3$, $D_{calc}=3.39$ g/cm$^3$ ($Z=1$), Vicker’s microhardness 48.8 (30.4–76.2) kg/mm$^2$ (10 g load) and a Mohs hardness of 1–2. No fluorescence was noted under short- or longwave ultraviolet radiation. The mineral easily dissolves in dilute HCl and HNO$_3$, showing effervescence. The infrared absorption spectrum of schulenbergite was measured using the KBBr pellet method and gave the following absorption bands: 3394 cm$^{-1}$ (strong, O-H stretching), 1637 cm$^{-1}$ (weak, H-O-H bending), 1104 and 1015 cm$^{-1}$ (ν(υ) and ν(υ)SO$_4$ stretching), 605 cm$^{-1}$ (υ(υ) SO$_4$ bending), 1509 and 1321 cm$^{-1}$ (weak, CO$_3$ group vibrations), 881, 792, and 513 cm$^{-1}$ ([Cu,Zn]O$_6$ octahedra vibrations). Thermogravimetry and differential thermal analysis of schulenbergite resulted in a strong endothermic peak at 322 °C (loss of water molecules), an exothermic peak at 535 °C due to structural transformation of dehydrated Cu and/or Zn sulfate, and an endothermic peak at 823 °C due to decomposition of sulfate groups. At 1000 °C, tenorite and zincite appeared as crystalline phases. The mineralogical properties of the Zn-dominant analogue could not be measured due to the presence of Zn carbonate inclusions.

Refined powder X-ray diffraction data for schulenbergite and its Zn-dominant analogue (Rigaku RINT-2500V diffractometer, CuKα$_1$ radiation) gave hexagonal unit-cell parameters of $a=8.256(2)$, $c=7.207(3)$ Å for schulenbergite, and $a=8.292(2)$, $c=7.271$ Å for its Zn-dominant analogue. The strongest lines in the powder pattern of schulenbergite include [(d in Å (%hkl)]: 7.21(100,001), 4.13(10,110), 3.590(30,002), 3.218(28,102), 2.704(34,210), 2.532(52,211), 2.164(14,212), and 1.795(12,213). The strongest lines in the powder pattern of the Zn-dominant analogue include [(d in Å (%hkl)]: 7.28(100,001), 4.15(14,110), 3.636(36,002), 3.245(46,102), 2.715(52,210), 2.545(92,211), 2.175(34,212), 1.808(38,213), 1.567(30,410), 1.531(20,411), and 1.510(20,214).

Chemical analyses of the two minerals by electron microscopy gave the following results: (1) for schulenbergite (average of 17 analyses): CuO 35.43, ZnO 29.47, FeO 0.40, SO$_4$ 14.98, SiO$_2$ 0.94, CO$_2$ 2.09 (determined by CHNS/O analyzer), H$_2$O$_{calc}$ 16.69, total 100.00 wt%, corresponding to (Cu$_{0.8}$Zn$_{0.35}$Fe$_{0.05}$)$_{17.03}$ [SO$_4$]$_{21.14}$ (SiO$_2$)$_{13.32}$ (OH)$_{4.44}$·3.3H$_2$O based on O = 21; (2) for the Zn-dominant analogue (average of 8 analyses): CuO 16.95, ZnO 50.18, FeO 0.37, SO$_4$ 11.28, SiO$_2$ 3.37, total 82.5 wt% (no H$_2$O calculated or determined in these analyses due to the presence of impurities). Cu(Cu + Zn) ratios in the two minerals from the Hirao mine range from 0.67 to 0.21, demonstrating the existence of extensive Cu-Zn substitution between the two minerals. In addition, there is a linear dependence between the Zn/(Cu + Zn) molar ratio and the length of the c-axis, a result of Cu-Zn substitution in the brucite-like layers of edge-sharing (Cu,Zn)O$_6$ octahedra oriented parallel to the (0001) plane. P.C.P.
**SIBIRSKITE**


The crystal structure of sibirskite, CaHBO$_3$, was determined by Monte Carlo simulation using a set of $d$ values and intensity data by Kusachi et al. (1997, Japan Mineral. J., 19, 109–114), and further refined by the Rietveld method. Sibirskite is monoclinic, $P2_1/n$, $a = 8.643(6)$, $b = 9.523(2)$, $c = 3.567(3)$ Å, $\beta = 119.23(3)^\circ$, $Z = 4$. The program used for the Monte Carlo simulation was the Structure Model-Assembly Program, developed by Miura and Kikuchi (1999), which automatically searches for the optimal structural model to satisfy the observed XRD data, unit-cell parameters, space group, chemical formula, $Z$, and interatomic distances. The $R$ value for the final simulated structure is 0.243. A powder X-ray diffraction pattern was obtained (Mac Science MX-Labo diffractometer, CuK$\alpha$ radiation) and the strongest peaks include $d (I\%_{obs}, hkl)$: 5.913(33,110), 4.762(29,020), 3.771(36,200), 2.959(72,011), 2.956(81,220), 2.727(33,221), 2.606(100,021), 2.223(25,320), 2.059(20,331), and 1.891(21,041). The final $R$ values for the Rietveld refinement are $Rwp = 7.75\%$, $Rp = 5.93\%$, $R1 = 4.22\%$, and $R1 = 4.68\%$. The Rietveld refinement of sibirskite confirmed the crystal structure obtained by the Monte Carlo simulation. The final model obtained for sibirskite includes double chains of edge-shared CaO$_6$ octahedra extending along the $c$ axis, with BO$_3$ polyhedra linked to one vertical and two shared oxygen atoms in the CaO$_6$ double chain. The edge-sharing CaO$_6$ double chains are analogous to edge-sharing MgO$_6$ octahedra found in szaibelyite, $\{\text{Mg}_3(\text{OH})_2(\text{B}_2\text{O}_4(\text{OH}))\}$. It was not possible to determine the position of the B or H atoms. P.C.P.

**TVALCHRELDZEITE**


The authors report on microprobe analyses and single-crystal structure analysis of tvalchrelidzeite from the type locality. The average of 15 point analyses gave an empirical formula of Hg$_{3.03}$Sb$_{1.03}$As$_{1.00}$S$_3$ on the basis of 3 S atoms. A crystal-structure determination was carried out on a $0.07 \times 0.07 \times 0.06$ mm$^3$ crystal using MoK$\alpha$ radiation on a CCD diffractometer equipped with a graphite monochromator. Tvalchrelidzeite is monoclinic with space group $P2_1/n$ and $a = 11.5526(4)$, $b = 4.3852(1)$, $c = 15.6373(5)$ Å, $\beta = 91.845(2)^\circ$, $V = 791.79(5)$ Å$^3$. Previous work on this mineral had not produced consistent structures or formulas.

The structure of tvalchrelidzeite consists of eight symmetrically distinct sites. Three of the sites are occupied by Hg, one each by As and Sb, and three by S. Unlike previous determinations for this mineral the present study shows no disorder between As and Sb. Sb behaves as a cation coordinated by six S$^2-$ ions while As behaves as an anion and is coordinated by six Hg$^{2+}$ ions. Hg is situated in strongly distorted octahedral sites distinguished by differing S:As ratios, specifically 5:1, 4:2, and 3: for the Hg1, Hg2, and Hg3 octahedra, respectively. The authors describe the structure of tvalchrelidzeite as sheets of $[\text{Hg}_3\text{Sb}_2\text{As}_3\text{S}_6]$ units parallel to (101) linked by short Hg1-As bonds with the layers connected by weak Hg-S and Sb-S bonds. These weak interlayer bonds explain the perfect cleavage of this mineral. G.P.