NEW MINERALS

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Belloite
Cu(OH)Cl

MONOCLINIC

Locality: An abandoned mine about 3 km west southwest of the village of Sierra Gorda, northeast of Antofagasta, 2nd region, northern Chile.

Occurrence: In a quartz – feldspar – tourmaline rock. Other associated minerals are: nitratine, montmorillonite, paratacamite, atacamite, gunningite, alunite and natrojarosite.

General appearance: Thin encrustations of tiny crystals (about 30 μm, rarely up to 100 μm).

Physical, chemical and crystallographic properties:
- Luster: vitreous.
- Diaphaneity: translucent to transparent.
- Color: yellowish green to olive green.
- Streak: yellowish green.
- Luminescence: nonfluorescent.
- Hardness: soft.
- Tenacity: not given.
- Cleavage: not given.
- Fracture: not given.
- Density: not measured, 3.79 g/cm³ (calc.).
- Crystallography: Monoclinic, \( \text{P}_{2_1}/a \) (Effenberger 1984, for synthetic material), \( a = 5.552, b = 6.668, c = 6.124 \AA, \beta = 115.00° \), \( V = 205.47 \AA^3 \), \( Z = 4 \), \( \alpha: \beta: \gamma = 0.8326:1:0.9184 \). Morphology: no forms were observed. Twinning: none mentioned.

X-ray powder-diffraction data:

Optical data: Pleochroic from yellowish green to pale yellowish green. The mean index of refraction calculated from the Gladstone-Dale relationship is 1.84.

Chemical analytical data:
- Mean of five sets of electron-microprobe data: CuO 68.84, Cl 26.35, H₂O 7.47, sum 102.66 wt.%. The amount of H₂O was established by determining H by CHN analyzer and recalculating to H₂O. The presence of OH was confirmed by IR. Empirical formula: \( \text{Cu}_{1.05}(\text{OH})_{1.00}\text{Cl}_{0.90}\text{O}_{0.10} \). Relationship to other species: The natural analogue of synthetic Cu(OH)Cl.

Name: After Andrés Bello (1780–1865), founder and first rector of the Universidad de Chile, Santiago, Chile.

Comments: IMA No. 1998–054. In the presence of water, belloite converts within minutes to botallackite and atacamite. The crystal structure of synthetic Cu(OH)Cl was solved by Effenberger (1984).


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Biehlite

$(\text{Sb,As})_2\text{MoO}_6$

Locality: The Tsumeb mine, Tsumeb, Namibia (probably from the third oxidation zone).

Occurrence: Associated minerals are: anglesite and wulfenite.

General appearance: Irregular aggregates and felted masses of fibrous crystals (up to 1 cm long and only some micrometers in diameter).

Physical, chemical and crystallographic properties:

- Luster: silky (but probably adamantine).
- Diaphaneity: translucent.
- Color: white.
- Streak: white.
- Luminescence: nonfluorescent.
- Hardness: soft.
- Tenacity: flexible.
- Cleavage: not mentioned.
- Fracture: not mentioned.
- Density: could not be measured, 5.23 g/cm$^3$ (calc.).

Crystallography:

- Monoclinic, $C2/c$, $a = 18.076, b = 5.920, c = 5.083 \AA$, $\beta = 96.97^\circ$, $V = 539.91 \AA^3$, $Z = 4$, $a:b:c = 3.0534:1:0.8586$.
- Morphology: no forms were mentioned; fibers are elongate [001].
- Twinning: none mentioned.
- X-ray powder-diffraction data: $d = 5.622(65)(110), 3.376(39)(\bar{3}11), 3.104(61)(311), 2.990(100)(600), 2.960(100)(020), 2.104(42)(620), 1.962(32)(130)$.
- Optical data: no data could be measured, but the mean index of refraction calculated from the Gladstone–Dale relationship is 2.13.
- Chemical analytical data: Mean of five sets of electron-microprobe data: $\text{Sb}_2\text{O}_3 60.99$, $\text{As}_2\text{O}_3 4.95$, $\text{MoO}_3 33.76$, Total 99.70 wt.%. Empirical formula: $(\text{Sb}_{1.79}\text{As}_{0.21})_2\text{Mo}_1\text{O}_6$.

Relationship to other species: None apparent.

Name: After Friedrich Karl Biehl (b. 1887), a mineralogist from Münster, Germany, the first to carry out research on Tsumeb species.


Cabalarite

$\text{Ca}^{(\text{Mg,Al,Fe})_2}\text{(AsO}_4)_2\text{(H}_2\text{O,OH)}_2$

**Locality:** The abandoned manganese mine near Falotta, Graubünden, Switzerland.

**Occurrence:** In manganese ore consisting of braunite, rhodonite, spessartine, tinzenite, parsettensite, sursassite and strontian piemontite in radiolarites. Associated minerals are: quartz, sursassite, “adularia”, kutnohorite, tilasite, grischnite, arseniosiderite, tripuhyite, ranciéite–takanelite and arsenogoyazite.

**General appearance:** Isolated crystals (up to 1 mm), polycrystalline aggregates (up to 2 mm), fibrous to tabular crystals (up to 3 mm) forming radiating aggregates (up to 5 mm in diameter) and aggregates of parallel needles (up to 2 mm thick).

**Physical, chemical and crystallographic properties:**

- **Luster:** vitreous.
- **Diaphaneity:** transparent.
- **Color:** light brownish to brownish pink, orange-brown.
- **Streak:** white.
- **Luminescence:** nonfluorescent.
- **Hardness:** VHN$_{50}$ 429 kg/mm$^2$, Mohs ~5.
- **Tenacity:** not given.
- **Cleavage:** none observed.
- **Fracture:** irregular.
- **Density:** 3.89 g/cm$^3$ (meas.), 3.73 g/cm$^3$ (calc.) (for the analytical data given here).
- **Crystallography:** Monoclinic, $C_2/m$, $a = 8.925$, $b = 6.143$, $c = 7.352$ Å, $\beta = 115.25^\circ$, $V = 364.6$ Å$^3$, $Z = 2$, $a:b:c = 1.4529:1:1.1968$. Morphology: only $\{001\}$ was recognized. Twinning: none mentioned. X-ray powder-diffraction data: $4.895(59)(110), 4.544(35)(111), 3.373(54)(02), 3.159(100)(112), 2.942(67)(201), 2.684(55)(311), 2.519(81)(221)$. Optical data: Because of inhomogeneity, data were difficult to measure. $n_\parallel$ to fiber elongation 1.76, $n_\perp$ to fiber elongation 1.70; mean $n$ calculated from the Gladstone–Dale relationship 1.77; nonpleochroic.
- **Chemical analytical data:** Mean of four sets of electron-microprobe data: MgO 7.54, CaO 13.64, SrO 0.49, Al$_2$O$_3$ 9.84, Mn$_2$O$_3$ 0.55, Fe$_2$O$_3$ 4.38, SiO$_2$ 0.05, As$_2$O$_5$ 55.57, $H_2O$ 7.11, Total 99.17 wt.%. Empirical formula: $Ca_{0.75}Sr_{0.02}(Al_{0.80}Mg_{0.77}Fe_{0.23}Mn_{0.03})_2(AsO_4)_2(H_2O,OH)_{1.24}$.
- **Relationship to other species:** A member of the tsumcorite group, with Mg and Al at the $M_2$ site.

**Name:** After Walter Cabalzar (b. 1919), an amateur mineralogist of Chur, Switzerland, who contributed to the mineralogy of the canton Graubünden.

**Comments:** IMA No. 1997–012. Note that the crystal structure has been solved.

**Brugger, J., Meisser, N., Schenk, K., Berlepsch, P., Bonin, M., Armbruster, T., Nyfeler, D., & Schmidt, S. (2000):** Description and crystal structure of cabalarite $\text{Ca}^{(\text{Mg,Al,Fe})_2}\text{(AsO}_4)_2\text{(H}_2\text{O,OH)}_2$, a new mineral of the tsumcorite group. American Mineralogist 85, 1307-1314.
Cerchiaraite

\[ \text{Ba}_4\text{Mn}_4\text{Si}_6\text{O}_{18}(\text{OH})_7\text{Cl} \]

**Locality**: The Cerchiara mine, near Faggiona village, val di Vara, La Spezia, northern Apennines, eastern Liguria, Italy.

**Occurrence**: Filling microfractures and veins (from 0.1 to some millimeters in width) in Jurassic cherts of the “Diapora di Monte Alpe” Formation. Associated minerals are: quartz, pectolite, orientite and calcite. Other new minerals found at the locality are mozartite, \( \text{CaMn(OH)SiO}_4 \), and caoxite, \( \text{CaC}_2\text{O}_4•3\text{H}_2\text{O} \).

**General appearance**: Scattered individual prismatic to acicular crystals elongated along [001] (up to 2 × 0.1 mm) and as a few radiating aggregates (up to about 3 mm in diameter).

**Physical, chemical and crystallographic properties**:

- **Luster**: vitreous.
- **Diaphaneity**: transparent.
- **Color**: deep green.
- **Streak**: pale green.
- **Luminescence**: nonfluorescent.
- **Hardness**: \( \text{VHN}_{50} 296 \text{ kg/mm}^2 \).
- **Tenacity**: brittle.
- **Cleavage**: none.
- **Fracture**: uneven.
- **Density**: \( 3.62 \text{ g/cm}^3 \) (meas.), \( 3.69 \text{ g/cm}^3 \) (calc.).
- **Crystallography**: Tetragonal, \( I\overline{4}/m \), \( a = 14.223 \text{ Å}, c = 6.141 \text{ Å}, V = 1242.3 \text{ Å}^3, Z = 2, c/a = 0.4318 \). Morphology: tetragonal prisms are present but not identified. Twinning: none mentioned.
- **Optical data**: Uniaxial (+), \( \omega = 1.745, \epsilon = 1.765 \).**Chemical analytical data**: Mean of 42 sets of electron-microprobe data: \( \text{BaO} 43.29, \text{Al}_2\text{O}_3 1.02, \text{Fe}_2\text{O}_3 2.09, \text{Mn}_2\text{O}_3 19.57, \text{SiO}_2 26.18, \text{H}_2\text{O} (4.81), \text{Cl} 3.93, \text{sum} 100.89, \text{less } \text{O} = \text{Cl} 0.89, \text{Total} (100.00) \text{ wt.} \% \). The amount of \( \text{H}_2\text{O} \) was calculated by difference. Empirical formula: \( \text{Ba}_{1.85}(\text{Mn}^{3+}0.36\text{Fe}^{3+}0.35\text{Al}_{0.27})_{5.36}\text{Si}_{5.91}\text{O}_{17.26}(\text{OH})_{7.22}\text{Cl}_{1.50}\text{I}_{0.87} \). **Relationship to other species**: It is a cyclosilicate.

**Name**: After the locality.

**Comments**: IMA No. 1999–012. Some of the subscripts derived here for the empirical formula differ from those given by the authors.

Ekatite

$\text{Fe}^{3+},\text{Fe}^{2+},\text{Zn})_{12}(\text{OH})_{6}(\text{AsO}_3)_6[\text{AsO}_3,\text{HOSiO}_3]_2$

**Locality:** Tsumeb, Namibia.

**Occurrence:** Associated minerals are quartz (etched) and chalcocite.

**General appearance:** Sprays of striated, fine needles (up to 2 mm long and less than 0.2 mm in diameter).

**Physical, chemical and crystallographic properties:**
- **Luster:** given as bright vitreous, but the indices of refraction indicate adamantine. Color: brownish black.
- **Diaphaneity:** translucent.
- **Streak:** brown.
- **Luminescence:** nonfluorescent.
- **Hardness:** about 3.
- **Tenacity:** brittle.
- **Cleavage:** none.
- **Fracture:** not given.
- **Density:** not measured, 4.11 g/cm³ (calc.).
- **Crystallography:** Hexagonal, P6₃mc, a 12.773, c 5.051 Å, V 713.7 Å³, Z = 1, c:a = 0.3954.
- **Morphology:** indistinct {hk0} forms are mentioned. Twinning: none mentioned.
- **Optical data:** Uniaxial (+), $\omega$ ~1.99, $\varepsilon$ ~2.08, pleochroism: O dark brownish black, E medium brown.
- **Chemical analytical data:** Mean of two sets of electron-microprobe data: FeO 21.19, ZnO 3.80, Fe₂O₃ 27.26, As₂O₃ 42.56, SiO₂ 2.12, H₂O 3.42, Total 100.35 wt.%. The structure determination was the basis for calculating the proportion of Fe³⁺ and Fe²⁺ from the total Fe, the number of OH groups was derived from the H₂O determination. Empirical formula: $\text{Fe}^{3+}_{6.02}\text{Fe}^{2+}_{5.20}\text{Zn}_{0.02}\text{As}_1\text{H}_{12.04}\text{O}_{6.07}\text{SiO}_2 [\text{AsO}_3]_{1.52} [\text{HOSiO}_3]_{0.62}$. 1:2:14.

**Relationship to other species:** Structurally related to phosphoellenbergerite, ellenbergerite and holtedahliite.

**Name:** After Dieter Ekat (1935–1996), a Namibian mining engineer and former owner of the Rubicon mine, Namibia.

**Comments:** IMA No. 1998–024. The subscripts of the empirical formula given here are slightly different from those given in the paper.

**KELLER, P. (2001):** Ekatite, $\text{Fe}^{3+},\text{Fe}^{2+},\text{Zn})_{12}(\text{OH})_6[\text{AsO}_3]_6[\text{AsO}_3,\text{HOSiO}_3]_2$, a new mineral from Tsumeb, Namibia, and its crystal structure. European Journal of Mineralogy 13, 769-777.
Henrymeyerite

$\text{BaFeTi}_7\text{O}_{16}$

**Locality:** The Kovdor alkaline ultramafic complex, Kola Peninsula, Russia (Lat. ~67° 3’N, Long. ~30° 3’E).

**Occurrence:** In a late-stage mineral assemblage associated with carbonatitic rocks. Associated minerals are: tetra-ferriphlogopite, calcite, dolomite, fluorapatite, niobian anatase (?), rimkorolgite, catapleiite, collinsite and pyrite.

**General appearance:** Well-developed acicular crystals (up to 0.2 mm × several tens of μm).

**Physical, chemical and crystallographic properties:**
- **Luster:** adamantine.
- **Diaphaneity:** opaque.
- **Color:** black.
- **Streak:** reddish brown.
- **Hardness:** 5 to 6.
- **Tenacity:** very brittle.
- **Cleavage:** not mentioned.
- **Fracture:** not mentioned.
- **Density:** 4.0 g/cm$^3$ (meas.), 4.23 g/cm$^3$ (calc.).
- **Crystallography:** Tetragonal, $I\bar{4}/m$, $a = 10.219$, $c = 2.963$, $V = 309.4$ Å$^3$, $Z = 1$, $c:a = 0.2900$. Morphology: probably {100}, {110} and {101}. Twinning: none mentioned. **X-ray powder-diffraction data:** 3.232(100)(310), 2.486(34)(211), 2.236(40)(301), 1.901(31)(411), 1.703(22)(600), 1.598(33)(521), 1.405(26)(541).
- **Optical data:** In reflected light: grayish brown, weak birefringence in shades of brown. $R_\%$, $R_\_\%$: (12.0, 13.0%) 460 nm, (11.6, 12.6%) 540 nm, (11.4, 12.7%) 580 nm, (11.3, 13.8%) 660 nm.

**Chemical analytical data:** Mean of eight sets of electron-microprobe data: Na$_2$O 0.40, K$_2$O 0.05, CaO 0.02, FeO 9.20, BaO 18.25, La$_2$O$_3$ 0.50, Ce$_2$O$_3$ 0.56, SO$_2$ 0.37, TiO$_2$ 67.78, Nb$_2$O$_5$ 1.00, Total 98.13 wt.%. Empirical formula: (Ba$_{0.96}$Na$_{0.04}$K$_{0.01}$)$_{1.00}$Fe$_{1.00}$Ti$_{6.81}$Nb$_{0.06}$Si$_{0.05}$Ce$_{0.03}$La$_{0.02}$)$_{16.00}$. **Relationship to other species:** A member of the cryptomelane group, specifically the Ba–Fe dominant member.

**Name:** After Henry O.A. Meyer (1937–1995) for his contributions to the petrology and mineralogy of mantle-derived xenoliths and kimberlitic rocks and for his services to the mineralogical community. **Comments:** IMA No. 1999–016. The crystal drawing presented here was produced from the crystallographic data and the SEM image given in the paper.

**Johntomaite**

\[ \text{BaFe}^{2+2}\text{Fe}^{3+3}\text{(PO}_4\text{)}_3\text{(OH)}_3 \]

**Locality:** On the dumps of the Spring Creek copper mine near Wilmington, southern Flinders Ranges, South Australia, Australia (Lat. 32° 41' S, Long. 138° 07' E).

**Occurrence:** From a heavily brecciated hydrothermal vein. Associated minerals are: quartz, libethenite, pseudomalachite, mitridatite, goethite, cuprite and copper.

**General appearance:** Clusters of radiating to subparallel prismatic crystals (0.3 to 1 mm long).

**Physical, chemical and crystallographic properties:**
- **Hardness:** 4½.
- **Tenacity:** brittle. Cleavage: {100} perfect. Fracture: irregular. Density: 4.05 g/cm³ (meas.), 4.08 g/cm³ (calc.).
- **Crystallography:** Monoclinic, \( \text{P}_2_1/\text{m} \), \( a = 9.199, b = 12.359, c = 5.004 \text{ Å} \), \( \beta = 100.19°, V = 559.9 \text{ Å}^3 \), \( Z = 2 \). 
- **Morphology:** \{001\}, \{021\} and \{131\}. Twinning: none observed.
- **X-ray powder-diffraction data:** 3.159(100)(031, \( \overline{2}21 \)), 2.983(50)(211), 2.749(50b)(221, \( \overline{3}11 \)), 4.573(40)(011), 3.091(40)(\( \overline{1}31 \)).
- **Optical data:** Biaxial (-), \( \alpha = 1.817, \beta = 1.829, \gamma = 1.837, 2V(\text{meas.}) = 85°, 2V(\text{calc.}) = 78° \); dispersion \( r << v \), strong; pleochroism strong. X bluish green, Y dark brownish green, Z brownish, absorption \( Y > X > Z \); \( Z = b \).
- **Chemical analytical data:** Mean of ten sets of electron-microprobe data: Na₂O 0.07, MgO 0.05, CaO 3.28, MnO 2.67, FeO 13.34, CuO 0.07, ZnO 0.06, BaO 21.96, Al₂O₃ 0.25, Fe₂O₃ 22.62, SiO₂ 0.13, P₂O₅ 30.45, H₂O 3.73, F 0.36, sum 99.04, less O = F 0.15, Total 98.89 wt.%. 
- **Empirical formula:** \( \text{Ba}_{1.00}\text{(Fe}_{2.26}\text{Ca}_{0.41}\text{Mn}_{0.26}\text{Na}_{0.02}\text{Mg}_{0.01}\text{Cu}_{0.01}\text{Zn}_{0.01})\text{Fe}_{3.07}\text{Al}_{0.03}\text{P}_{2.99}\text{Si}_{0.02}\text{O}_{4.03}\text{(OH)}_{2.88}\text{F}_{0.13}\text{S}_{0.01} \).

**Relationship to other species:** A member of the bjarebyite group, specifically the ferric-iron-dominant analogue of kulinite, \( \text{BaFe}^{2+2}\text{Al}_{2}(\text{PO}_4)_3\text{(OH)}_3 \).

**Name:** After John Toma (b. 1954), the amateur mineralogist who found the mineral and provided the type specimen.

**Comments:** IMA No. 1999-009.

Juanitaite

\((\text{Cu}_{7.03}\text{Ca}_{2.39}\text{Fe}_{0.50})_{10}\text{Bi}(\text{AsO}_4)_4(\text{OH})_{11}\cdot\text{H}_2\text{O}\)

**Locality:** The Gold Hill mine, Tooele County, Utah, U.S.A.

**Occurrence:** On the 9-meter level, coating surface and filling thin fractures in limonitic go- san, associated with calcian mixite, conichalcite, chrysocolla, azurite, gold and quartz. On the 46-meter level, as fine-grained coatings on cavity walls in quartz veins, associated with connellite, tyrolite and azurite.

**General appearance:** Square crystal plates (25 to 150 \(\mu\)m across and 1 \(\mu\)m thick), with rounded corners; also as sheaf-like subparallel aggregates and rosettes.

**Physical, chemical and crystallographic properties:**

- **Luster:** resinous to dull. **Diaphaneity:** translucent. **Color:** olive-green to grass-green; reflections from \{001\} often appear bronzy.
- **Streak:** pale greenish yellow. **Luminescence:** nonfluorescent. **Hardness:** very soft, estimated at about 1. **Tenacity:** flexible but not elastic. **Cleavage:** \{001\} and \{110\} perfect, \{100\} good. **Fracture:** not observed. **Density:** 3.61 g/cm\(^3\) (meas.), 3.56 g/cm\(^3\) (calc.). **Crystallography:** Tetragonal, \(P4_2/nmm\), \(a = 9.961\), \(c = 29.19\) Å, \(V = 2896\) Å\(^3\), \(Z = 4\). **Morphology:** \{001\}, \{110\} and \{310\}. **Twinning:** none observed. **X-ray powder-diffraction data:** 14.6(100)(002), 7.04(50)(110), 6.34(70)(112), 5.07(50)(114), 3.146(60)(310,303), 2.535(50)(228). **Optical data:** Uniaxial (–), subparallel aggregates show an anomalous biaxial figure with 2V = 20°, \(\omega = 1.785\), \(\epsilon = 1.705\), pleochroism O olive brown, E olive green. **Chemical analytical data:** Mean of seven sets of electron-microprobe data: CaO 8.64, FeO 2.32, CuO 35.97, Bi\(_2\)O\(_3\) 14.82, As\(_2\)O\(_5\) 29.35, H\(_2\)O (8.90), Total (100.00) wt.%. **Empirical formula:** \((\text{Cu}_{7.03}\text{Ca}_{2.39}\text{Fe}_{0.50})_{10}\text{Bi}_{0.99}(\text{AsO}_4)_3(\text{OH})_{10.90}\cdot2.22\text{H}_2\text{O}\). **Relationship to other species:** It is chemically similar to mixite, \(\text{Cu}_6\text{Bi}(\text{AsO}_4)_3(\text{OH})_6\cdot3\text{H}_2\text{O}\). **Name:** After Juanita Curtis (b. 1917), who found the mineral. **Comments:** IMA No. 1992–022. **KAMPF, A.R., WISE, W.S. & ROSSMAN, G.R. (2000):** Juanitaite, a new mineral from Gold Hill, Utah. Mineralogical Record 31, 301-305.