

## New Mineral Names<sup>\*,†</sup>

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This New Mineral Names has entries for 17 new minerals, including camaronesite, chiappinoite-(Y), cobaltoblödite, domerockite, erikapohlite, heisenbergite, ianbruceite, innsbruckite, irinarassite, joteite, kudryavtsevaite, manganoblödite, minohlite, nioboholtite, oxo-magnesian-hastingsite, szklaryite, and titanoholtite.

### CAMARONESITE\*

A.R. Kampf, S.J. Mills, B.P. Nash, R.M. Housley, G.R. Rossman, and M. Dini (2013) Camaronesite  $[\text{Fe}^{3+}(\text{H}_2\text{O})_2(\text{PO}_3\text{OH})_2](\text{SO}_4) \cdot 1-2\text{H}_2\text{O}$ , a new phosphate-sulfate from the Camarones Valley, Chile, structurally related to taranakite. Mineralogical Magazine, 77(4), 453–465.

Camaronesite (IMA 2011-094), ideally  $[\text{Fe}^{3+}(\text{H}_2\text{O})_2(\text{PO}_3\text{OH})_2](\text{SO}_4) \cdot 1-2\text{H}_2\text{O}$ , is a new mineral found near the village of Cuya in the Camarones Valley, Arica Province, Chile. Camaronesite occurs in boulders from a leached outcrop located approximately at  $19^\circ 5' 58'' \text{S}$   $70^\circ 7' 6'' \text{W}$ , high on the NW side of the steep Camarones Valley. The rocks in the area are faulted and metamorphosed lavas, lithic tuffs and marine sediments (shales and sandstones) bearing sulfide accumulations (pyrite with lesser arsenopyrite, sphalerite, etc.) oxidized under increasingly arid conditions, yielding extensive suites of secondary sulfates, arsenates, arsenites, chlorides, etc. Boulders containing camaronesite have zoned structures with yellow-brown limonitic exterior coatings followed by sulfate assemblages and then sulfide-rich cores. Sulfate minerals, notably camaronesite and copiapite, are present in vugs. The mineral occurs in assemblage with anhydrite, botryogen, chalcantite, copiapite, halotrichite, hexahydrate, römerite, rozenite, and szomolnokite, as lavender-colored crystals up to several millimeters. Rarely crystals occur as drusy aggregates of tablets up to  $0.5 \times 0.02$  mm. Tablets are flattened on  $\{001\}$  and exhibit the forms  $\{001\}$ ,  $\{104\}$ ,  $\{015\}$ , and  $\{018\}$ . The mineral is transparent with white streak and vitreous luster. It is brittle with irregular, conchoidal and stepped fracture. Cleavage is perfect on  $\{001\}$ . Mohs hardness is  $2\frac{1}{2}$ ;  $D_{\text{meas}} = 2.43(1)$ ,  $D_{\text{calc}} = 2.383$  g/cm<sup>3</sup>. Camaronesite is optically uniaxial (+),  $\omega = 1.612$ , and  $\epsilon = 1.621$  (white light). The pleochroism is  $O$  (pale lavender)  $> E$  (colorless). The mineral is slowly soluble in concentrated HCl

and extremely slowly soluble in concentrated  $\text{H}_2\text{SO}_4$ . The main bands in the Raman spectrum of camaronesite are ( $\text{cm}^{-1}$ ): 1014, 1080, 937 ( $\text{PO}_4^{3-}$  and  $\text{SO}_4^{2-}$  vibrations); 526, 305, 254, and 227. It shows a strong, broad OH-stretching band running from  $\sim 3600$  to  $2800$   $\text{cm}^{-1}$  with possible components near 3463, 3363, and 3140  $\text{cm}^{-1}$ . Evidence for molecular water comes from a narrower  $\text{H}_2\text{O}$ -bending region centered at  $\sim 1610$   $\text{cm}^{-1}$  with likely components at  $\sim 1638$  and  $1596$   $\text{cm}^{-1}$ . Average electron probe WDS analyses [wt% (range)] is:  $\text{Fe}_2\text{O}_3$  31.84 (30.53–32.54),  $\text{P}_2\text{O}_5$  29.22 (28.19–31.28),  $\text{SO}_3$  15.74 (15.27–16.32),  $\text{H}_2\text{O}$  23.94 (21.75–25.64) (based on O analyses); total 100.74. The empirical formula based on 2 P apfu is:  $\text{Fe}_{1.94}(\text{PO}_3\text{OH})_2(\text{S}_{0.96}\text{O}_4)(\text{H}_2\text{O})_4 \cdot 1.46 \text{H}_2\text{O}$ . The strongest lines of the X-ray powder diffraction pattern [ $d$  Å ( $I$ ,  $hkl$ )] are: 7.74 (45; 101), 7.415 (100; 012), 4.545 (72; 110), 4.426 (26; 018), 3.862 (32; 021, 202, 116), 3.298 (93; 027, 119), 3.179 (25; 208), 2.818 (25; 112, 125). Unit-cell parameters refined from the powder data with whole-pattern fitting are:  $a = 9.0679(10)$ ,  $c = 42.991(6)$  Å,  $V = 3061.4$  Å<sup>3</sup>. X-ray single-crystal diffraction study on a crystal fragment  $130 \times 100 \times 10$   $\mu\text{m}$  shows the mineral is trigonal, space group  $R\bar{3}2$ ;  $a = 9.0833(5)$ ,  $c = 42.944(3)$  Å,  $V = 3068.5$  Å<sup>3</sup>;  $Z = 9$ . In the crystal structure of camaronesite [refined to  $R_1 = 0.0228$  for 1138 unique  $I > 2\sigma(I)$  reflections] three types of Fe octahedra are linked by corner sharing with  $(\text{PO}_3\text{OH})$  tetrahedra to form polyhedral layers perpendicular to  $c$  with composition  $[\text{Fe}^{3+}(\text{H}_2\text{O})_2(\text{PO}_3\text{OH})]$ , similar to those in the structure of taranakite. Two such layers are joined through  $\text{SO}_4$  tetrahedra (in two half-occupied orientations) to form thick slabs of composition  $[\text{Fe}^{3+}(\text{H}_2\text{O})_2(\text{PO}_3\text{OH})_2](\text{SO}_4)$ . The remaining space between the slabs is partially occupied by  $\text{H}_2\text{O}$  groups. The only linkages between the slabs are hydrogen bonds. The most distinctive component in the structure consists of two Fe octahedra linked by three  $\text{PO}_4$  tetrahedra yielding an  $[\text{Fe}_2(\text{PO}_4)_3]$  unit, also found in the structures of the coquimbite and paracoquimbite. This unit is also the key component in the sodium super-ionic conductor (NASICON) structure and has been referred to as the lantern unit. The mineral is named camaronesite (*kem a:r 'oun aez ait*) for the locality. The description of the new mineral was based on five specimens, designated as cotypes and deposited in the Natural History Museum of Los Angeles County, Los Angeles, California, U.S.A., under catalog numbers 64023–64027. F.C.

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

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

**CHIAPPINOITE-(Y)\***

A.R. Kampf and R.M. Housley (2015) Chiappinoite-(Y),  $Y_2Mn(Si_3O_7)_4$ , a new layer silicate found in peralkaline syenitic ejecta from the Água de Pau volcano, Azores. *European Journal of Mineralogy*, 27(1), 91–97.

Chiappinoite-(Y) (IMA 2014-040), ideally  $Y_2Mn(Si_3O_7)_4$ , was discovered at the Água de Pau volcano (Fogo volcano), São Miguel Island, Azores District, Portugal. The mineral was found in a single fragment of ejectum, 15 cm in diameter, in the exposed river bed of the Ribeira Grande near the locality “Lombadas” (37.775333N, 25.458644W). The mineral was named in honour of Luigi Chiappino (b. 1950), an eminent distinguished mineral collector of Milan, Italy. Chiappinoite-(Y) was found in peralkaline syenitic ejecta produced by plinian eruptions, where it occurs in vugs, in friable matrix composed mainly of albite, quartz, and aegirine, and is associated with astrophyllite, dalyite, elpidite, fluornatropyrochlore, and kentbrooksitite. Chiappinoite-(Y) is transparent and colorless, has vitreous luster and white streak. The new mineral forms thin to thick prismatic crystals, up to 1 mm long, elongated on [100] with blunt, chisel-like terminations. The crystal forms observed are {100}, {010}, {001}, {110}, and {001}. Chiappinoite-(Y) does not fluoresce under UV excitation, is brittle, has irregular fracture and perfect cleavage on {001}. Mohs hardness is ca. 6;  $D_{meas} = 3.09(2)$ ,  $D_{calc} = 3.073$  g/cm<sup>3</sup>. The mineral does not react in concentrated HCl, H<sub>2</sub>SO<sub>4</sub>, and HNO<sub>3</sub>. It is optically biaxial (–),  $\alpha = 1.590$ ,  $\beta = 1.598$ , and  $\gamma = 1.598$  (white light)°;  $2V_{meas} = 24(1)^\circ$  and  $2V_{calc} = 25.4^\circ$ ;  $X = c$ ,  $Y = b$ ,  $Z = a$ . The mineral is non-pleochroic and does not display dispersion. The averaged 6 point WDS electron probe analyses on 2 crystals gave [wt% (range)]: Na<sub>2</sub>O 0.30 (0.14–0.49), CaO 1.33 (1.09–1.50), MnO 4.12 (3.78–4.62), FeO 0.59 (0.36–0.86), Y<sub>2</sub>O<sub>3</sub> 12.43 (11.82–13.22), La<sub>2</sub>O<sub>3</sub> 1.07 (0.71–1.59), Ce<sub>2</sub>O<sub>3</sub> 2.84 (2.11–3.67), Pr<sub>2</sub>O<sub>3</sub> 0.34 (0.27–0.38), Nd<sub>2</sub>O<sub>3</sub> 1.35 (1.18–1.56), Sm<sub>2</sub>O<sub>3</sub> 0.47 (0.34–0.64), Gd<sub>2</sub>O<sub>3</sub> 1.12 (0.91–1.43), Dy<sub>2</sub>O<sub>3</sub> 1.70 (1.41–1.93), Er<sub>2</sub>O<sub>3</sub> 1.39 (1.22–1.56), Yb<sub>2</sub>O<sub>3</sub> 1.03 (0.91–1.16), SiO<sub>2</sub> 68.76 (68.31–69.34), total 98.84. The empirical formula calculated on the basis of 28 O apfu is (Y<sub>1.17</sub>Ce<sub>0.18</sub>Dy<sub>0.10</sub>Na<sub>0.10</sub>Nd<sub>0.09</sub>Er<sub>0.08</sub>La<sub>0.07</sub>Gd<sub>0.07</sub>Yb<sub>0.06</sub>Sm<sub>0.03</sub>Pr<sub>0.02</sub>)<sub>Σ1.97</sub>(Mn<sub>0.61</sub>Ca<sub>0.25</sub>Fe<sub>0.09</sub>)<sub>Σ0.95</sub>Si<sub>12.07</sub>O<sub>28</sub>. The strongest lines of the X-ray powder diffraction pattern are [*d* Å (*I*%; *hkl*)]: 9.84 (90; 002), 4.129 (52; 024), 3.977 (48; 114), 3.544 (100; 211,042,202), 3.203 (48; 222), 2.999 (71; 044,204), 2.478 (67; 310,046,206), and 2.065 (57; 048,262,208,165,172,325,066). The crystal structure of chiappinoite-(Y) was solved by direct methods and refined to  $R_1 = 2.55\%$ . The mineral is orthorhombic, *Ibam*,  $a = 7.5549(3)$ ,  $b = 15.2342(5)$ ,  $c = 19.6418(14)$  Å,  $V = 2260.6$  Å<sup>3</sup>, and  $Z = 4$ . The crystal structure of chiappinoite-(Y) is based on three-tetrahedra-thick silicate layers that consist of three components. The central component of each layer is sinuous batisite-like chain extending along the **a** axis. The chains are linked through four-membered silicate rings along the **b** axis. This results in three-tetrahedra-thick silicate layers that contain four- and six-membered rings. There are two sites, dominantly occupied by Y and Mn, in between the silicate layers, and these sites link the layers along the **c** axis. The structure of chiappinoite-(Y) is similar to crystal structures of synthetic PrNaSi<sub>6</sub>O<sub>14</sub> and NdNaSi<sub>6</sub>O<sub>14</sub>. Five cotype specimens are deposited in the collections of the Mineral Sciences Department, Natural History Museum of Los Angeles County. **Yu.U.**

**DOMEROCKITE\***

P. Elliott, U. Kolitsch, A.C. Willis, and E. Libowitzky (2013) Description and crystal structure of domerockite, Cu<sub>4</sub>(AsO<sub>4</sub>)(AsO<sub>3</sub>OH)(OH)<sub>3</sub>·H<sub>2</sub>O, a new mineral from the Dome Rock Mine, South Australia. *Mineralogical Magazine*, 77(4), 509–522.

Domerockite (IMA 2009-016), ideally Cu<sub>4</sub>(AsO<sub>4</sub>)(AsO<sub>3</sub>OH)(OH)<sub>3</sub>·H<sub>2</sub>O, is a new mineral from the Dome Rock Mine, South Australia, which is situated in Lower Proterozoic metasediments of the Willyama Complex on the northern flank of an east–west striking range. Copper ore-bodies are interpreted as being hypergene in origin, and to have formed at intermediate temperatures from ascending waters related to the invasion of the metasediments by granite intrusives. A suite of secondary arsenate minerals is formed as late-stage supergene minerals under low-temperature conditions, where Cu and As were provided as a result of weathering of sulfide ore minerals, principally chalcopyrite, chalcocite, and arsenopyrite. The Dome Rock Mine is the type locality of hylbrownite. Domerockite is associated with other arsenates, including cobaltaustinite, agardite-(Y), arseniosiderite, clinoclase, erythrite, lavendulan, metazeuneite, olivenite, scorodite, and smolyaninovite. Domerockite is found as equant, short prismatic or tabular crystals up to 0.3 × 0.2 mm, which are generally arranged in subparallel intergrowths. Major crystal forms are {100}, {010}, and {001}, and minor: {011}, {012}, and {212}. Domerockite is translucent and bluish green colored, with a pale green streak. It has a vitreous luster and displays no fluorescence under UV irradiation. The mineral is brittle with an uneven fracture, a Mohs hardness of ~3. Calculated densities are 4.48 and 4.44 g/cm<sup>3</sup>, based on the empirical chemical formula and the simplified formula derived from the structure refinement, respectively. Optically domerockite is biaxial (–),  $\alpha = 1.798(4)$ ,  $\beta = 1.814(4)$ ,  $\gamma = 1.817(4)^\circ$ ,  $2V_{calc} = 46^\circ$ ; pleochroism is very weak with *X* pale greenish yellow, *Y* greenish blue, *Z* greenish blue; absorption  $X < Y = Z$  (orientation is uncertain). The main bands in the Raman spectrum of domerockite are related to vibrations AsO<sub>4</sub> tetrahedra (cm<sup>-1</sup>): 875, 850, 822, and 808 (*v*<sub>1</sub> and *v*<sub>3</sub> modes); 478 and 445 (*v*<sub>4</sub> modes); 390 and 360 (*v*<sub>2</sub> modes). Remaining bands below 650 cm<sup>-1</sup> are attributed to Cu–O stretching and lattice vibrations. Only two weak O–H stretching vibrations at ~3235 and 3420 cm<sup>-1</sup> are observed in the Raman spectrum. FTIR spectrum shows two bands at 3232 and 3425 cm<sup>-1</sup>, which are attributed to OH stretching vibrations, and a low-intensity, broad band centered at ~1660 cm<sup>-1</sup> that can be attributed to H–O–H bending of the H<sub>2</sub>O groups. The average of 14 electron probe WDS analysis [wt% (range)] is: CuO 52.04 (51.30–53.36), ZnO 0.78 (0.42–1.51), BaO 0.11 (0.06–0.18), As<sub>2</sub>O<sub>5</sub> 37.67 (36.68–38.65), P<sub>2</sub>O<sub>5</sub> 0.32 (0.24–0.43), SiO<sub>2</sub> 0.24 (0.12–0.35), H<sub>2</sub>O 8.84 (by difference), total 100.00. The empirical formula calculated on the basis of 12 O pfu is (Cu<sub>3.94</sub>Zn<sub>0.06</sub>)<sub>Σ4.00</sub>H<sub>0.91</sub>(As<sub>1.97</sub>P<sub>0.03</sub>Si<sub>0.02</sub>)<sub>Σ2.02</sub>O<sub>8</sub>(OH)<sub>3.00</sub>·H<sub>2</sub>O. The strongest lines of the X-ray powder diffraction pattern [*d* Å (*I*%; *hkl*)] are: 4.716 (30; 101,002,111), 3.697 (25; 121), 3.605 (30; 120,121), 3.119 (60; 121), 3.073 (100; 121), 2.856 (40; 022,030), 2.464 (50; 212,113), 2.443 (40; 014). Unit-cell parameters refined from the powder data with whole-pattern fitting are:  $a = 5.381(5)$ ,  $b = 8.964(6)$ ,  $c = 9.842(6)$  Å,  $\alpha = 75.25(5)$ ,  $\beta = 83.55(6)$ ,  $\gamma = 79.96(6)^\circ$ ,  $V = 450.9$  Å<sup>3</sup>. An optically homogeneous crystal 0.12 × 0.08 × 0.06

mm was used for a single-crystal study, yielding a triclinic symmetry, space group  $P\bar{1}$ ,  $a = 5.378(11)$ ,  $b = 8.962(18)$ ,  $c = 9.841(2)$  Å,  $\alpha = 75.25(3)$ ,  $\beta = 83.56(3)$ ,  $\gamma = 79.97(3)^\circ$ ,  $V = 450.5$  Å<sup>3</sup>,  $Z = 2$ . The crystal structure was solved by direct methods and refined to  $R_1 = 7.44\%$  using 2164 [ $F \geq 4\sigma(F)$ ] reflections. The structure comprises  $[\text{Cu}\phi_4]$  ( $\phi = \text{O}, \text{OH}$ ) chains of  $\text{Cu}\phi_6$  edge-sharing, distorted octahedra that extend along  $[10\bar{1}]$  and are decorated by  $\text{AsO}_4$  tetrahedra to form sheets in the (010) plane. Dimers of edge-sharing  $[\text{CuO}_4(\text{OH})(\text{H}_2\text{O})]$  octahedra share corners with dimers of edge-sharing  $[\text{CuO}_4(\text{OH})]$  square pyramids to form zigzag chains that extend along  $[101]$ . The chains lie between and link to the sheets by sharing corners of octahedra, square pyramids, and tetrahedra to form a heteropolyhedral framework. The name is for the locality. The type specimen is housed in the collection of the Department of Mineralogy, South Australian Museum, Adelaide, South Australia. **F.C.**

### ERIKAPOHLITE\*

J. Schlüter, T. Malcherek, B. Mihailova, and G. Gebhard (2013) The new mineral erikapohlite,  $\text{Cu}_3(\text{Zn,Cu,Mg})_4\text{Ca}_2(\text{AsO}_4)_6 \cdot 2\text{H}_2\text{O}$ , the Ca-dominant analog of keyite, from Tsumeb, Namibia. *Neues Jahrbuch für Mineralogie Abhandlungen*, 190/3, 319–325.

The new mineral erikapohlite (IMA 2010-090), ideally  $\text{Cu}_3(\text{Zn,Cu,Mg})_4\text{Ca}_2(\text{AsO}_4)_6 \cdot 2\text{H}_2\text{O}$ , the Ca-dominant analog of keyite, was discovered in the specimen purchased at the Tsumeb Mine, Namibia. It was previously mentioned as an unknown Ca-Cu-Zn-As mineral GS 5 (Gebhard 1999). Erikapohlite is a supergene mineral formed by alteration of tennantite-rich ore on level 44 in the oxidized zone of the Tsumeb mine, a dolostone-hosted, hydrothermal polymetallic ore deposit. It occurs in the seams up to 0.7 mm wide of very thin lamellar microcrystals in granular quartz and closely associated with lammerite, conichalcite, unknown amorphous Zn-Fe-Cu-(Mg-Ca) arsenate, and unidentified phase structurally related to lavendulan. Erikapohlite is deep blue, transparent with a pale blue streak and vitreous luster. Hardness, density, and optical properties were not obtained due to small grain size;  $D_{\text{calc}} = 4.55$  g/cm<sup>3</sup> and the calculated mean refractive index is 1.78. The mineral does not fluoresce in UV light. The Raman spectrum is similar to that of keyite. The scattering below 1000 cm<sup>-1</sup> is dominated by internal and external  $\text{AsO}_4$  vibrations, while the peaks near 3000 and 1500 cm<sup>-1</sup> are related to O-H stretching and H-O-H bond bending, respectively. The slight difference in the relative intensities compare to keyite is likely due to orientation effects. The peak near 3170 cm<sup>-1</sup> might be related to surface and/or interstitial  $\text{H}_2\text{O}$ . The average of 155 electron probe WDS analysis [wt% (range)] is CuO 22.42 (17.71–33.35), ZnO 14.45 (3.42–20.14), CaO 8.21 (6.25–8.89), MgO 2.21 (0.09–6.77), FeO 0.03 (0–0.34),  $\text{As}_2\text{O}_5$  51.02 (47.29–54.77),  $\text{H}_2\text{O}$  (by difference) 1.66, total 100.00. No other elements with  $Z > 8$  were detected. The empirical formula based on 26 O apfu is  $\text{Cu}_3(\text{Zn}_{2.48}\text{Cu}_{0.93}\text{Mg}_{0.77}\text{Fe}_{0.01})_{54.19}\text{Ca}_{2.04}\text{As}_{6.20}\text{O}_{24.71} \cdot 1.29\text{H}_2\text{O}$ . Small zones in erikapohlite are Mg- or Cu-dominant, representing not yet described new mineral species. Single-crystal X-ray study could not be performed due to the lack of suitable crystals. The powder X-ray data were obtained using synchrotron radiation ( $\lambda = 0.50$  Å) and indexed in monoclinic space group  $C2/c$  with the

unit-cell parameters refined to  $a = 12.6564(6)$ ,  $b = 12.7282(8)$ ,  $c = 6.9148(3)$  Å,  $\beta = 113.939(4)^\circ$ ,  $V = 1018.11$  Å<sup>3</sup>,  $Z = 2$ . The strongest lines of the powder XRD pattern [ $d$  Å ( $P\%$ ;  $hkl$ )] are: 3.304 (49;  $11\bar{2}$ ), 3.160 (32; 002), 2.892 (100; 400), 2.788 (40; 240), 2.764 (14;  $40\bar{2}$ ), 1.728 (10;  $54\bar{2}$ ), 1.650 (10;  $42\bar{4}$ ). The weak peaks  $d = 4.77$ , 5.07, and 6.8 Å, which do not match this cell are likely belong to admixed mineral(s). The cell corresponds to that of keyite transformed to standard setting  $C2/c$  instead of  $I2/a$ . This cell choice reveals the relation of keyite structure to the structure of alluaudite-group arsenate nickenichite. Both structures based on a framework of chains of edge-sharing, distorted octahedra combined with isolated  $\text{AsO}_4$ -tetrahedra. Within this framework two types of channels extend along  $[001]$ : channel I contains Na in nickenichite and is occupied by  $\text{Cu}^{2+}$  and  $\text{H}_2\text{O}$  in keyite. Channel II contains Ca and Cu in nickenichite, while in keyite it is only occupied by Cu atoms. The Rietveld refinement for erikapohlite based on keyite structure set in space group  $C2/c$  fit the composition  $\text{Cu}_{2.7}(\text{Zn}_{3.3}\text{Mg}_{0.7})\text{Ca}_2(\text{AsO}_4)_6 \cdot 1.41\text{H}_2\text{O}$ , which is close to the empirical formula of erikapohlite, considering that some Zn might be replaced by Cu. Contrary to Cd in the keyite structure, Ca in erikapohlite is 7-coordinated. Erikapohlite is named in honor of the famous mineral collector Erika Pohl (b. 1919) who donated in 2004 her (one of the world's best) private mineral collection of more than 40000 specimens to the Bergakademie Freiberg, Saxony, Germany, on the condition that it should be accessible to a broad public and scientifically supervised. As “terra mineralia” her collection is now on display in the Freudenstein Castle in the center of Freiberg. The type specimen has been deposited at the Mineralogical Museum, University of Hamburg, Germany. **D.B.**

### Reference cited

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### HEISENBERGITE\*

K. Walenta and T. Theye (2012) Heisenbergite, a new uranium mineral from the uranium deposit of Menzenschwand in the Southern Black Forest, Germany. *Neues Jahrbuch für Mineralogie-Abhandlungen*, 189/2, 117–123.

Heisenbergite (IMA 2010-076), a new uranyl oxyhydroxide, is the seventh new U mineral (after arsenovanmeerscheite, arsenuranospathite, joliotite, nielsbohrite, uranosilite, and uranotungstite) discovered in the Krunkelbach Valley near Menzenschwand in the Southern Black Forest, Baden Württemberg, Germany. It was first found in El Sherana Mine, South-Alligator-River-District, Northern Territory of Australia, where it had been described as an unnamed uranium oxide (mineral B) (Threadgold 1960). Later it was identified at Joachimsthal, Czech Republic (Ondruš et al. 1997). In the IMA list of valid unnamed minerals these phases are listed as UM 1960-04-O:HU and UM 1997-36-O:HU, respectively. At Menzenschwand, it was previously mentioned (Walenta 1976) as identical to “mineral B” of Threadgold. Heisenbergite occurs there as a secondary mineral in crusts on barite associating with quartz, uraninite, billietite, studtite, rutherfordine, joliotite, goethite, and hematite. The crusts consist of yellow, yellow-brown, or orange-brown long, prismatic crystals (up to ~15 µm in length and a few micrometers thick) and anhedral grains. At the Sherana Mine “mineral B” occurs



in a deep yellow to golden yellow incrustation (crystals up to  $0.15 \times 0.001\text{--}0.002$  mm elongated parallel to **Z**) on uraninite, anglesite, and dumontite. In places, it is intimately intergrown with another yellow "mineral C" (Threadgold 1960) (probably paraschoepite). At Joachimsthal, heisenbergite forms thick, glassy orange-brown coatings up to 0.5 mm thick with indistinct fibrous structure and associated with uraninite, richetite, antlerite, zeunerite, metazeunerite, nováčekite, and langite (Ondruš et al. 1997). Heisenbergite is opaque to translucent, has yellow streak, vitreous luster, irregular fracture, and estimated Mohs hardness of ~2. Cleavage and parting were not observed. The density could not be measured;  $D_{\text{calc}} = 5.14$  g/cm<sup>3</sup>. It is non-fluorescent. The mineral is easily soluble in 1:1 HCl and 1:1 HNO<sub>3</sub>. In transmitted light the mineral is transparent (pleochroism not mentioned) with  $\alpha = 1.733(3)$ ,  $\gamma = 1.800(5)^{\circ}$ ;  $\beta$  is close to  $\gamma$  (optically negative).  $2V$  could not be measured. The crystals have positive elongation and straight extinction. Raman spectra of heisenbergite has similarity to those of schoepite, paraschoepite, and synthetic uranyl oxyhydroxides. Based on the interpretation of the IR spectrum of synthetic  $\text{UO}_3 \cdot \text{H}_2\text{O}$  the bands (cm<sup>-1</sup>) 338, 438, 538 assigned to  $\nu(\text{U-O})$  stretching vibrations; 247 to  $\delta(\text{U-O})$  bending; strong bands 742, 799, and 829 attributed to  $\nu_1$  symmetric stretching of the  $\text{UO}_2^{2+}$  group. The OH stretching vibrations of OH group or molecular water in the range of 3000–3500 cm<sup>-1</sup> are present but weak to allow reliable attribution. On the basis of Raman spectral data it is suggested that two distinct type of coordination polyhedra for uranium are present in the heisenbergite structure. An average of 15 electron probe WDS analyses of heisenbergite [wt% (range)] is:  $\text{UO}_3$  88.58 (85.81–90.94),  $\text{PbO}$  1.31 (0.82–1.69),  $\text{BaO}$  0.17 (0.06–0.30),  $\text{CaO}$  0.13 (0.10–0.18),  $\text{H}_2\text{O}$  (by difference) 9.81, total 100.00. The empirical formula based on 5 O atoms is  $\text{U}_{1.04}\text{Pb}_{0.02}\text{Ca}_{0.01}\text{Ba}_{<0.01}\text{H}_{3.67}\text{O}_5$ . Idealized formula could be written as  $\text{UO}_2(\text{OH})_2 \cdot \text{H}_2\text{O}$ , or  $\text{UO}_3 \cdot 2\text{H}_2\text{O}$ . Chemical composition of heisenbergite is similar to those of schoepite  $\text{UO}_3 \cdot 2.25\text{H}_2\text{O}$ , metaschoepite  $\text{UO}_3 \cdot 2\text{H}_2\text{O}$ , and paulscherrite  $\text{UO}_2(\text{OH})_2$ . No crystals were found to be suitable for a single-crystal study. The strongest lines of the X-ray powder diffraction pattern [ $d$  Å ( $I\%$ ;  $hkl$ )] are: 7.92 (10; 111), 7.25 (9; 002), 5.96 (4; 201), 3.57(7; 321), 3.27 (9; 322,400), 1.992 (4; 055,603). The dimensions of an orthorhombic unit cell derived from the powder data are:  $a = 13.10(1)$ ,  $b = 13.76(1)$ ,  $c = 14.50(1)$  Å,  $V = 2613.7$  Å<sup>3</sup>,  $Z = 24$ . Possible space groups are:  $P2_12_12_1$ ,  $Pna2_1$ ,  $Pnma$ . The mineral is named for the famous German physicist Werner Heisenberg (1901–1976). Type material is deposited at the Staatliches Museum für Naturkunde in Stuttgart. **D.B.**

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### IANBRUCEITE\*

M.A. Cooper, Y.A. Abdu, N.A. Ball, F.C. Hawthorne, M.E. Back, K.T. Tait, J. Schlüter, T. Malcherek, D. Pohl, and G. Gebhard (2012) Ianbruceite, ideally  $[\text{Zn}_2(\text{OH})(\text{H}_2\text{O})(\text{AsO}_4)](\text{H}_2\text{O})_2$ ,

a new arsenate mineral from the Tsumeb mine, Otjikoto (Oshikoto) region, Namibia: description and crystal structure. *Mineralogical Magazine*, 76(5), 1119–1131.

Ianbruceite (IMA 2011-049), ideally  $[\text{Zn}_2(\text{OH})(\text{H}_2\text{O})(\text{AsO}_4)](\text{H}_2\text{O})_2$ , is a new mineral from the Tsumeb mine, Otjikoto (Oshikoto) region, Namibia. It is named in honor of Ian Bruce (b. 1969) who significantly contributed to the mineral collections of museums worldwide and was a prime mover in the reopening of the Tsumeb mine for mineral collecting. It was mentioned earlier as a potential new species GS17 from "Zinc pocket" on the 44 level of Tsumeb mine (Gebhard 1999). Ianbruceite is a supergene mineral and was found in a specimen from the oxidation zone in association with coarse white leiteite, dark blue köttigite, and minor legrandite and adamite. The new mineral forms aggregates of thin flakes and tapered platy crystals up to 80  $\mu\text{m}$  by a few micrometers thick, and rounded, ellipsoidal aggregates up to 0.5 mm. The dominant crystal forms are {100} and (prominent) {011} and {0 $\bar{5}$ 1}. Ianbruceite is sky blue to very pale blue with a white streak, vitreous luster, and perfect cleavage parallel to (100). No parting or twinning was observed, as well as no fluorescence under UV light. Ianbruceite is flexible and does not fracture but deforms plastically. Mohs hardness is 1, and  $D_{\text{calc}} = 3.197$  g/cm<sup>3</sup>. Ianbruceite is optically biaxial (–),  $\alpha = 1.601(2)$ ,  $\beta = 1.660(2)$ , and  $\gamma = 1.662(2)^{\circ}$ ;  $2V_{\text{obs}} = 18(2)^{\circ}$ , and  $2V_{\text{calc}} = 20^{\circ}$ ;  $X \wedge a = 12.0^{\circ}$  (in  $\beta$  obtuse),  $Y \parallel b$ ,  $Z \wedge c = 4.7^{\circ}$  (in  $\beta$  obtuse). It is non-pleochroic in the (100) plane; the dispersion is  $r < v$  weak. Raman spectrum shows the following bands (cm<sup>-1</sup>): a sharp peak at 3600 (an O-H stretch); a broad envelope centered on 3224 and weak shoulders at 3441 and 3224 ( $\text{H}_2\text{O}$  stretching vibrations); a prominent peak at 840 ( $\text{As}^{5+}\text{-O}$  stretching vibrations); peaks at 534, 448, and 420 [ $\text{Zn-O}$  stretching vibrations and bending vibrations of the ( $\text{AsO}_4$ ) groups], and a peak at 192 (lattice mode). The Fourier transform IR spectra contained the following features (cm<sup>-1</sup>): a broad envelope centered at ~3000 and sharp peaks at ~1600 and ~1670 ( $\text{H}_2\text{O}$  stretches and H-O-H bends; fine structures in the broad envelope around 3500 [the presence of (OH)]; strong peaks at 853, 838, 774, and 750 ( $\text{As}^{5+}\text{-O}$  stretching vibrations); a weak shoulder at ~690 ( $\text{As}^{3+}\text{-O}$  stretching vibration) and a weak shoulder at ~930 [ $(\text{As}^{3+}\text{-O-H})$  bending vibration]. The average of 10 electron probe WDS analyses on ianbruceite gave [wt% (range)]:  $\text{As}_2\text{O}_5$  36.27 (35.71–39.54),  $\text{As}_2\text{O}_3$  1.26 (by structure refinement),  $\text{Al}_2\text{O}_3$  0.37 (0.17–0.90),  $\text{ZnO}$  49.72 (48.28–51.52),  $\text{MnO}$  0.32 (0.16–0.57),  $\text{FeO}$  0.71 (0.53–1.05),  $\text{K}_2\text{O}$  0.25 (0.19–0.30),  $\text{H}_2\text{O}$  19.89 (by structure refinement), total 108.79 (high total value is due to  $\text{H}_2\text{O}$  loss under the electron beam). The formula calculated on the basis of 8.04 (O+OH+ $\text{H}_2\text{O}$ ) pfu is:  $\text{K}_{0.02}(\text{Zn}_{1.93}\text{Fe}_{0.03}\text{Al}_{0.02}\text{Mn}_{0.01}^{2+})_{\Sigma 1.99}(\text{OH})_{0.96}(\text{H}_2\text{O})(\text{As}^{5+}\text{O}_4)[\text{As}^{3+}(\text{OH})_2\text{O}]_{0.04}(\text{H}_2\text{O})_{1.96}$ . The strongest lines of the X-ray powder diffraction patterns [ $d$  Å ( $I\%$ ;  $hkl$ )] are: 11.29 (100; 100), 2.922 (17; 130), 3.143 (15;  $\bar{2}02$ ), 3.744 (11; 300), 2.655 (9; 230), 1.598 (8;  $\bar{1}52$ ), 2.252 (7; 222). Ianbruceite is monoclinic, space group  $P2_1/c$ ,  $a = 11.793(2)$ ,  $b = 9.1138(14)$ ,  $c = 10.3038(7)$  Å,  $\beta = 103.859(9)^{\circ}$ ,  $V = 712.3$  Å<sup>3</sup>,  $Z = 4$ . The crystal structure was solved by direct methods and refined to  $R_1 = 8.6\%$ . In the crystal structure of ianbruceite, [5]-coordinated Zn triangular bipyramids share common (OH) vertices to form chains that extend in the **c** direction. These chains are decorated by Zn octahedra, each of which shares edges with adjacent Zn triangular

bipyramids and form zigzag chains extending in the **c** direction. These  $[\text{Zn}^{5+}\text{Zn}^{6+}\text{Zn}^{7+}]$  chains are, in turn, linked in the **b** direction by sharing corners with  $(\text{AsO}_4)$  tetrahedra to form sheets. Two of these sheets link by sharing edges between Zn octahedra and vertices between both Zn polyhedra and As tetrahedra to form a slab with a composition of  $[\text{Zn}_2(\text{OH})(\text{H}_2\text{O})(\text{AsO}_4)]$ . There are two positionally disordered  $(\text{H}_2\text{O})$  groups in the interstitial space between adjacent slabs. Ianbruceite is not isostructural with any other mineral. The holotype specimen is in the collection of the Department of Natural History, Royal Ontario Museum, Toronto, Canada, and holotype crystals are in the Mineralogical Museum of the University of Hamburg, Germany. **Yu.U.**

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#### INNSBRUCKITE\*

H. Krüger, P. Tropper, U. Haefeker, R. Kaindl, M. Tribus, V. Kahlenberg, C. Wikete, M.R. Fuchs, and V. Olieric (2014) Innsbruckite,  $\text{Mn}_{33}(\text{Si}_2\text{O}_5)_{14}(\text{OH})_{38}$ —a new mineral from the Tyrol, Austria. *Mineralogical Magazine*, 78(7), 1613–1627.

Innsbruckite (IMA 2013-038), ideally  $\text{Mn}_{33}(\text{Si}_2\text{O}_5)_{14}(\text{OH})_{38}$ , is a new mineral discovered near Staffelsee (Geier) in the Navis valley, Tyrol, Austria. It was found at the interface between a serpentine body and cherts, in association with rhodochrosite, friedelite, tephroite, spessartine, calcite, apatite, and barite. The mineral was named after the locality as it was found 20 km southeast of Innsbruck, Austria. Innsbruckite occurs as thin platy by  $\{001\}$  crystals. These crystals appear as needle-like in thin section and are up to 150  $\mu\text{m}$  long. The crystals are nearly colorless in transmitted light. Innsbruckite is optically biaxial (–), with a small  $2V$  angle (no direct measurements were possible). Weak pleochroism was observed, and an average refractive index of 1.678 was calculated. The nanoindentation experiments identified an average Berkovich hardness of 7.9(5) GPa, corresponding to Mohs hardness of 6;  $D_{\text{calc}} = 3.191 \text{ g/cm}^3$ . Other physical properties were not determined due to the small size of the crystallites. Raman spectrum of innsbruckite shows a group of 3 medium to strong peaks in the region 580–650  $\text{cm}^{-1}$  (characteristic for innsbruckite), a sharp peak at 1032  $\text{cm}^{-1}$ ; peaks above 900 and below 400  $\text{cm}^{-1}$  assigned to  $\text{Si-O}_{\text{nb}}$  and lattice vibrations; a minimum of 7 partly overlapping peaks in the range of 550–730  $\text{cm}^{-1}$  related to vibrations within tetrahedra and translations of Mn; and several sharp and intense peaks in the region between 3520 and 3700  $\text{cm}^{-1}$  related to the different structural environments of the OH groups. The average of 5 electron probe WDS analyses on innsbruckite gave [wt% (range)]:  $\text{SiO}_2$  38.65 (38.08–38.96),  $\text{Al}_2\text{O}_3$  0.23 (0.16–0.19),  $\text{FeO}$  0.32 (0.26–0.37),  $\text{MnO}$  51.8 (51.21–52.17),  $\text{MgO}$  1.20 (1.12–1.30),  $\text{Cl}$  0.02 (0.01–0.05),  $\text{H}_2\text{O}$  (by structure refinement) 7.91 (7.80–7.96), total 100.12. The formula calculated on the basis of 108 O pfu is:  $\text{Mn}_{31.58}\text{Fe}_{0.19}\text{Mg}_{1.29}\text{Si}_{27.82}\text{Al}_{0.20}\text{O}_{108}\text{H}_{37.97}$ . The crystal structure of innsbruckite was solved and refined to  $R_1 = 2.35\%$ . The mineral is monoclinic,  $Cm$ ,  $a = 17.2760(19)$ ,  $b = 35.957(5)$ ,  $c = 7.2560(8)$  Å,  $\beta = 91.359(7)^\circ$ ,  $V = 4506.1$  Å<sup>3</sup>, and  $Z = 2$ . The crystal structure of innsbruckite is that of a single layer silicate and exhibits a previously unknown topology of the tetrahedral silicate sheet. These tetrahedral sheets consist of 8-, 6-, 5- and 4-membered

rings in the ratio 2:9:2:1. The silicate sheets alternate with sheets of edge-sharing Mn octahedra, with half of the tetrahedra pointing up and connecting to the upper octahedral sheet and half pointing down and connecting to the lower octahedral sheet. No other minerals or synthetic compounds have structures identical to that of innsbruckite. Holotype material is deposited in the collections of the Museum of Natural History in Vienna (Naturhistorisches Museum Wien), Austria. **Yu.U.**

#### IRINARASSITE\*

I.O. Galuskina, E.V. Galuskin, K. Prusik, V.M. Gazeev, N.N. Pertsev, and P. Dzierzanowski (2013) Irinarassite  $\text{Ca}_3\text{Sn}_2\text{SiAl}_2\text{O}_{12}$ —New garnet from the Upper Chegem Caldera, Northern Caucasus, Kabardino-Balkaria, Russia. *Mineralogical Magazine*, 77(6), 2857–2866.

Irinarassite (IMA 2010-073), ideally  $\text{Ca}_3\text{Sn}_2\text{SiAl}_2\text{O}_{12}$ , a new species belonging to the schorlomite group of the garnet supergroup was discovered in the metasomatically altered carbonate-silicate xenolith #7 in ignimbrites at 500 m from Vorlan Peak in the central part of the Upper Chegem Caldera, Northern Caucasus, Kabardino-Balkaria, Russia. Altered under sanidine facies conditions, xenoliths in the area between Vorlan and Larkargi mountains are the source of 5 other new garnet-supergroup species: bitikleite, dzhuluite, usturite, elbrusite, and toturite. Irinarassite occurs as small zones and irregular spots typically <10  $\mu\text{m}$  in kimzeyite-kerimasite series garnet (rarely as 2–3  $\mu\text{m}$  crystals) in the complex mixture of minerals (with lakargiite, tazheranite, baddeleyite, baghdadite, magnesioferrite) forming pseudomorphs up to 200  $\mu\text{m}$  after zircon. Pseudomorphs located in a thin endoskarn zone at the immediate contact with unaltered ignimbrite. Larnite, cuspidine, rondorfite, As-bearing fluor- and hydroxyllestadite are the main minerals in this zone. Fluorite, rankinite, wollastonite, srebrodolskite, Th-perovskite, and thorianite are the minor or accessory minerals while secondary minerals represented by katoite-grossular, ettringite, hillebrandite, bultfonteinite, and unidentified Ca-hydrosilicates. Irinarassite is pale brown to yellow with an ashy-yellow streak. It has an irregular fracture and shows no cleavage. The density was not measured due to the small crystals size;  $D_{\text{calc}} = 4.301 \text{ g/cm}^3$ . Irinarassite is optically isotropic, calculated refractive index is  $\sim 1.9$ . The Raman spectrum of irinarassite is close to those of kerimasite and other Zr-Sn-garnets of the schorlomite and bitikleite groups. Low intensities broad bands ( $\text{cm}^{-1}$ ) in 650–850 interval are related to symmetric stretching vibrations of the tetrahedra  $[\text{ZO}_4]$ : 730–750 for  $[\text{Fe}^{3+}\text{O}_4]$ , 750–780 for  $[\text{TiO}_4]$ , 780–800 for  $[\text{AlO}_4]$ , and >800 for  $[\text{SiO}_4]$ . The band at 580–600  $\text{cm}^{-1}$  is attributed to asymmetric stretching vibrations of  $[\text{Fe}^{3+}\text{O}_4]$ . Large half-width of the strong band  $\sim 500 \text{ cm}^{-1}$  (bending vibrations  $[\text{ZO}_4]$ ) reflects the contribution of tetrahedra occupied by different cations (Al, Si, and  $\text{Fe}^{3+}$ ). Band  $\sim 300 \text{ cm}^{-1}$  is related to bending vibrations ( $\text{ZO}_4$ ) and the band below 300  $\text{cm}^{-1}$  to translation motions of ( $\text{ZO}_4$ ) and Ca. The average of 7 electron probe analysis for the holotype specimen [wt% (range)] is  $\text{UO}_3$  0.76 (0.66–0.85),  $\text{Nb}_2\text{O}_5$  0.08 (0–0.13),  $\text{Sb}_2\text{O}_5$  5.99 (5.42–6.81),  $\text{SiO}_2$  4.19 (3.92–4.45),  $\text{TiO}_2$  7.82 (7.28–8.34),  $\text{ZrO}_2$  7.90 (5.81–9.67),  $\text{SnO}_2$  23.96 (22.44–26.47),  $\text{HfO}_2$  0.20 (0.15–0.25),  $\text{Al}_2\text{O}_3$  11.06 (10.62–11.49),  $\text{Sc}_2\text{O}_3$  0.15 (0–0.32),  $\text{Fe}_2\text{O}_3$  10.05 (8.39–11.37),  $\text{CaO}$  36.02 (25.37–26.83),  $\text{FeO}$  0.79

(0–1.72); total 98.96. The empirical formula based on 12 O pfu is  $(\text{Ca}_{2.97}\text{Fe}_{0.03}^{2+})_{\Sigma 3.00}(\text{Sn}_{1.02}\text{Zr}_{0.41}\text{Ti}_{0.26}\text{Sb}_{0.24}^{5+}\text{Fe}_{0.03}^{2+}\text{U}_{0.02}^{6+}\text{Sc}_{0.01}\text{Hf}_{0.01})_{\Sigma 2.00}(\text{Al}_{1.39}\text{Fe}_{0.80}^{3+}\text{Si}_{0.45}\text{Ti}_{0.36}^{4+})_{\Sigma 3.00}\text{O}_{12}$ . EBSD patterns of irinarassite are fitted to the garnet model with  $a = 12.50(3)$  Å, space group  $Ia\bar{3}d$ ,  $Z = 8$ . The strongest lines of the calculated XRD powder pattern [ $d$  Å ( $hkl$ )] are: 4.419 (65; 220), 3.125 (60; 400), 2.795 (47; 420), 2.552 (88; 422), 1.976 (27; 620), 1.670 (100; 642). The mineral named in honor of Irina Teodorovna Rass, well-known specialist in the petrology, geochemistry of the D. Korzhinskii Laboratory of Metamorphism and Metasomatism, Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry (IGEM), Russian Academy of Sciences, Moscow. The type material is deposited to the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **D.B.**

### JOTEITE\*

A.R. Kampf, S.J. Mills, R.M. Housley, G.R. Rossman, B.P. Nash, M. Dini, and R.A. Jenkins (2013) Joteite,  $\text{Ca}_2\text{CuAl}[\text{AsO}_4][\text{AsO}_3(\text{OH})_2(\text{OH})_2 \cdot 5\text{H}_2\text{O}]$ , a new arsenate with a sheet structure and unconnected acid arsenate groups. *Mineralogical Magazine*, 77(6), 2811–2823.

Joteite (IMA 2012-091), ideally  $\text{Ca}_2\text{CuAl}[\text{AsO}_4][\text{AsO}_3(\text{OH})_2(\text{OH})_2 \cdot 5\text{H}_2\text{O}]$ , is a new mineral from the Jote mine, Tierra Amarilla, Copiapó Province, Atacama, Chile. The mineral occurs in narrow seams and vugs in the oxidized upper portion of a hydrothermal sulfide vein hosted by volcanoclastic rocks. It is associated with conchalcite, mansfieldite, pharmacolomite, pharmacosiderite, and scorodite. Joteite crystals occur as sky-blue to greenish-blue thin blades up to ~300 μm, flattened and twinned on {001}, and exhibiting forms {001}, {010}, {110}, {210}, and {111}. Blades are commonly intergrown in wheat-sheaf-like bundles, less commonly in sprays, and sometimes aggregated as dense crusts and cavity linings. The mineral is transparent and has a very pale blue streak and vitreous luster. The estimated Mohs hardness is ~2–3.  $D_{\text{calc}} = 3.056$  g/cm<sup>3</sup>. Optically, joteite is biaxial (–),  $\alpha = 1.634$ ,  $\beta = 1.644$ , and  $\gamma = 1.651^\circ$  (white light);  $2V_{\text{meas}} = 78(2)^\circ$ ,  $2V_{\text{calc}} = 79.4^\circ$ ;  $X \approx \mathbf{c}^*$ ;  $Y \approx \mathbf{b}^*$ ; dispersion is weak,  $r < v$ . The pleochroism is  $Z$  (greenish blue)  $> Y$  (pale greenish blue)  $> X$  (colorless). Joteite is slowly soluble in cold, concentrated HCl. Raman spectrum shows the most conspicuous features in the 1500–100 cm<sup>–1</sup> region (cm<sup>–1</sup>): 849 and 861 ( $\text{AsO}_4$   $\nu_1$  lines), 725, 506, 461, 414, 384, 283, 162, 140, and 119. The 4000–2500 cm<sup>–1</sup> region of the spectra shows a fairly sharp O–H stretching feature at 3429 cm<sup>–1</sup> and much broader features centered at 3260, 3068, and ~2930 cm<sup>–1</sup>. Lower-energy features are consistent with hydrogen-bonded, acidic OH groups, such as those in  $\text{AsO}_3(\text{OH})$  tetrahedra. The average of electron probe WDS analysis [wt% (range)] is: CaO 17.12 (16.54–17.38), CuO 12.23 (11.13–13.05),  $\text{Al}_2\text{O}_3$  9.07 (9.00–9.15),  $\text{As}_2\text{O}_5$  50.83 (48.90–52.38),  $\text{H}_2\text{O}$  (based on the structure) 19.78, total 109.03; the average values normalized to provide a total of 100 wt% (because joteite dehydrates rapidly under vacuum) are: CaO 15.70, CuO 11.22,  $\text{Al}_2\text{O}_3$  8.32,  $\text{As}_2\text{O}_5$  46.62,  $\text{H}_2\text{O}$  18.14. The empirical formula calculated on the basis of 19 O pfu is  $\text{Ca}_{1.98}\text{Cu}_{1.00}\text{Al}_{1.15}\text{As}_{2.87}\text{H}_{14.24}\text{O}_{19}$ . The strongest lines of the X-ray powder diffraction pattern [ $d$  Å ( $hkl$ )] are: 12.76 (100; 001), 5.009 (23; 020), 4.206 (26; 120,003,121), 3.92 (24; 022,022,102), 3.40 (25; 113), 3.233 (19; 031,023,123,023), 2.97

(20; 132,201), and 2.91 (15; 122,113). Unit-cell parameters refined from the powder data with whole-pattern fitting are:  $a = 6.044(3)$ ,  $b = 10.220(3)$ ,  $c = 12.898(3)$  Å,  $\alpha = 87.413(19)$ ,  $\beta = 78.463(15)$ ,  $\gamma = 78.789(18)^\circ$ ,  $V = 765.6$  Å<sup>3</sup>. A crystal  $0.080 \times 0.050 \times 0.005$  mm was used for a single-crystal study, yielding a triclinic symmetry, space group  $P\bar{1}$ ,  $a = 6.0530(2)$ ,  $b = 10.2329(3)$ ,  $c = 12.9112(4)$  Å,  $\alpha = 87.413(19)$ ,  $\beta = 78.480(2)$ ,  $\gamma = 78.697(2)^\circ$ ,  $V = 768.40$  Å<sup>3</sup>,  $Z = 2$ . The structure was solved by direct methods and refined to  $R_1 = 0.077$  using 6003 [ $F \geq 4\sigma(F)$ ] reflections. In the structure of joteite,  $\text{AsO}_4$  and  $\text{AsO}_3(\text{OH})$  tetrahedra,  $\text{AlO}_6$  octahedra and  $\text{Cu}^{2+}\text{O}_5$  square pyramids share corners to form sheets parallel to (001). In addition, seven- and eightfold-coordinated Ca polyhedra link to the periphery of the sheets yielding thick slabs. Between the slabs are unconnected  $\text{AsO}_3(\text{OH})$  tetrahedra, which link the slabs only via hydrogen bonding. One of the more interesting features of the structure is the unconnected  $\text{AsO}_3(\text{OH})$  tetrahedron, which is rare in arsenate (and phosphate) structures (present in arsenate rösslerite and the phosphates phosphorösslerite and struvite). The new mineral is named joteite (*hou tei ait*) for the locality. The description of the new mineral was based upon 3 specimens, designated as cotypes and deposited in the Natural History Museum of Los Angeles County, Los Angeles, California, U.S.A., under catalog numbers 63592–63594. **F.C.**

### KUDRYAVTSEVAITE\*

S. Anashkin, A. Bovkun, L. Bindi, V. Garanin, and Y. Litvin (2013) Kudryavtsevaite,  $\text{Na}_3\text{MgFe}^{3+}\text{Ti}_4\text{O}_{12}$ , a new kimberlitic mineral. *Mineralogical Magazine*, 77(3), 327–334.

Kudryavtsevaite (IMA 2012-078), ideally  $\text{Na}_3\text{MgFe}^{3+}\text{Ti}_4\text{O}_{12}$ , is a new mineral from the Orapa area, Botswana ( $21^\circ 18' \text{S } 25^\circ 24' \text{E}$ ). The mineral was found in a kimberlite-hosted xenolith recovered from a drill-core sample (depth 138 m, pipe AK-8). The host kimberlite consist of serpentized forsterite, phlogopite, Mg-ilmenite, Cr-diopside, and pyrope, cemented by fine-grained carbonate-serpentine aggregate. Secondary minerals in fractures in the Mg-ilmenite include kudryavtsevaite, freudenbergite, and ulvöspinel. Kudryavtsevaite is found in prismatic crystals up to 100 μm in size elongated by [010] clear of inclusion or intergrowths with other minerals. The new mineral is grayish black, opaque with a black streak and a vitreous luster, shows no cleavage and an uneven fracture. It is brittle with a Vickers hardness  $\text{VHN}_{100} = 901$  (876–925) kg/mm<sup>2</sup>, and Mohs hardness ~6. The density was not measured;  $D_{\text{calc}} = 3.845$  g/cm<sup>3</sup>. In reflected light kudryavtsevaite is dark gray, moderately birefractant, and very weakly pleochroic, from dark gray to a slightly bluish gray. It is anisotropic with grayish-bluish rotation tints, and with no internal reflections and optical evidence of zonation. Reflectance values obtained for COM wavelengths [ $R_{\text{min}}$ ,  $R_{\text{max}}$  % ( $\lambda$  in nm)] in air are: 21.3, 25.4 (471.1); 20.6, 24.1 (548.3); 20.0, 23.5 (586.6); and 19.1, 22.4 (652.3). A Raman spectrum has no peak in the 3300–3900 cm<sup>–1</sup> region considering the absence of  $\text{H}_2\text{O}/\text{OH}$  and all iron as trivalent. The average of 12 electron probe WDS analyses gives [wt% (range)]:  $\text{Na}_2\text{O}$  16.46 (16.32–16.41), CaO 1.01 (0.85–1.23), MgO 5.31 (4.98–5.56),  $\text{Fe}_2\text{O}_3$  22.24 (22.01–22.74),  $\text{Cr}_2\text{O}_3$  1.05 (0.80–1.23),  $\text{Al}_2\text{O}_3$  0.03 (0.00–0.06),  $\text{TiO}_2$  53.81 (52.79–54.11), total 99.91. The empirical formula based on 12 O atoms is  $(\text{Na}_{2.89}\text{Ca}_{0.10})_{\Sigma 2.99}(\text{Ti}_{3.67}\text{Fe}_{1.52}^{3+}\text{Mg}_{0.72}\text{Cr}_{0.08})_{\Sigma 5.99}\text{O}_{12}$ . The strongest lines in the X-ray



powder-diffraction pattern [ $d \text{ \AA}$  ( $I\%$ ;  $hkl$ )] are: 7.17 (100; 301), 4.84 (70; 302), 2.973 (35; 901), 2.841 (50; 004), 2.706 (50; 902), 2.541 (50; 312), 2.450 (70; 611), and 2.296 (45; 612). The unit-cell parameters refined from the powder data are:  $a = 27.701(1)$ ,  $b = 2.9879(1)$ ,  $c = 11.3562(4) \text{ \AA}$ , and  $V = 939.92 \text{ \AA}^3$ . Single-crystal X-ray diffraction data collected on a crystal of size  $70 \times 80 \times 95 \text{ \mu m}$  refined to  $R_1 = 0.0168$  for 819 unique reflections with  $I \geq 4\sigma(I)$  shows kudryavtsevaite is orthorhombic, space group  $Pnma$ , with  $a = 27.714(1)$ ,  $b = 2.9881(3)$ ,  $c = 11.3564(6) \text{ \AA}$ ,  $V = 940.5 \text{ \AA}^3$ , and  $Z = 4$ . The structure of kudryavtsevaite consists of edge- and corner-sharing chains of Mg,  $\text{Fe}^{3+}$ , and Ti octahedra running along the **b** axis, with octahedrally coordinated Na filling the tunnels formed by these chains. The mineral was named in honor of Galina Kudryavtseva (1947–2006), a well-known Russian mineralogist and founder of the Diamond Mineralogy Laboratory and scientific school for investigation of diamond mineralogy and geochemistry at the Lomonosov State University in Moscow, Russia. The holotype material is deposited in the Museo di Storia Naturale, Università degli Studi di Firenze, Italy. **O.C.G.**

#### MANGANOBLODITE\*, COBALTOBLODITE\*

A.V. Kasatkin, F. Nestola, J. Plášil, J. Marty, D.I. Belakovskiy, A.A. Agakhanov, S.J. Mills, D. Pedron, A. Lanza, M. Favaro, S. Bianchin, I.S. Lykova, V. Goliáš, and W.D. Birch (2013) Manganoblödite,  $\text{Na}_2\text{Mn}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$ , and cobaltoblödite,  $\text{Na}_2\text{Co}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$ : Two new members of the blödite group from the Blue Lizard mine, San Juan County, Utah, USA. *Mineralogical Magazine*, 77(3), 367–383.

Manganoblödite (IMA 2012-029), ideally  $\text{Na}_2\text{Mn}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$ , and cobaltoblödite (IMA 2012-059), ideally  $\text{Na}_2\text{Co}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$ , were found at the Blue Lizard mine, San Juan County, Utah, U.S.A. The new minerals occur as intimate intergrowths with Mn-Co-Ni-bearing blödite in direct association with chalcantinite, gypsum, johannite, sideronatrite, quartz, and feldspar, with nearby minerals including atacamite, baryte, bornite, brochantite, chalcopyrite, copiapite, covellite, cyanotrichite, ferrinatrite, halotrichite, metavoltine, natrozippeite, pseudojohannite, pyrite, römerite, rhomboclase, tamarugite, uraninite, and several new uranyl sulfates. The new minerals found in encrustations and efflorescences on the walls of abundant underground mine and related to postmining (after 1978) oxidation of primary U ores hosted by sandstones and containing pyrite, chalcopyrite, bornite, and other sulfides. Both new minerals occur as aggregates of anhedral grains up to  $60 \text{ \mu m}$  (manganoblödite) and  $200 \text{ \mu m}$  (cobaltoblödite) in size forming thin crusts covering areas up to  $2 \times 2 \text{ cm}$  on the surface of other sulfates. A second occurrence of manganoblödite was found among an assemblage of post-mine manganese sulfates forming encrustations on the wall of an adit of the abandoned Womobi mine, near Thologolong, in northern Victoria, Australia. Manganoblödite and cobaltoblödite are transparent and colorless in single grains, reddish-pink in aggregates and crusts, have a white streak, vitreous luster, are brittle, have uneven fracture, show no obvious parting or cleavage. Mohs hardness is  $2\frac{1}{2}$ .  $D_{\text{meas}} = 2.25(2)$  and  $D_{\text{calc}} = 2.338 \text{ g/cm}^3$  for manganoblödite, and  $D_{\text{meas}} = 2.29(2)$  and  $D_{\text{calc}} = 2.347 \text{ g/cm}^3$  for cobaltoblödite. The minerals are not fluorescent in ultraviolet radiation or in cathode rays. Both spe-

cies are colorless in transmitted light and non-pleochroic, both are biaxial (–), with  $\alpha = 1.493(2)$ ,  $\beta = 1.498(2)$ ,  $\gamma = 1.501(2)^\circ$ ,  $2V_{\text{meas}} = 80(10)^\circ$ , and  $2V_{\text{calc}} = 75^\circ$  for manganoblödite, and  $\alpha = 1.498(2)$ ,  $\beta = 1.503(2)$ ,  $\gamma = 1.505(2)$ ,  $2V_{\text{meas}} = 70(10)^\circ$ , and  $2V_{\text{calc}} = 64^\circ$  for cobaltoblödite. Both minerals show weak dispersion,  $r > v$ . The main absorption bands of the IR spectrum of cobaltoblödite ( $\text{cm}^{-1}$ ) are: 668 [antisymmetric bending of  $(\text{SO}_4)^{2-}$ ], 969, 1096, and 1187 [symmetric and antisymmetric stretching of  $(\text{SO}_4)^{2-}$ ], 1373 and 1463 (lower-frequency combinations of  $(\text{SO}_4)^{2-}$ ), 1618 and 1685 ( $\text{H}_2\text{O}$  bending), 3245, 3404, 3490, and 3556 (symmetric and antisymmetric stretching of  $\text{H}_2\text{O}$ ). The average of 5 electron probe EDS analyses for manganoblödite gives [wt% (range)]:  $\text{Na}_2\text{O}$  16.94 (16.04–17.40),  $\text{MgO}$  3.29 (2.11–4.54),  $\text{MnO}$  8.80 (7.93–10.18),  $\text{CoO}$  2.96 (1.87–3.94),  $\text{NiO}$  1.34 (0.81–1.83),  $\text{SO}_3$  45.39 (43.16–47.82),  $\text{H}_2\text{O}$  (calc. by stoichiometry) 20.14, total 98.86. The empirical formula based on 12 O apfu is  $\text{Na}_{1.96}(\text{Mn}_{0.44}\text{Mg}_{0.29}\text{Co}_{0.14}\text{Ni}_{0.17})_{\Sigma 0.95}\text{S}_{2.03}\text{O}_8 \cdot 4\text{H}_2\text{O}$ . The average of 5 electron probe EDS analyses for cobaltoblödite gives [wt% (range)]:  $\text{Na}_2\text{O}$  17.00 (16.69–17.33),  $\text{MgO}$  3.42 (3.30–3.80),  $\text{MnO}$  3.38 (3.09–4.39),  $\text{CoO}$  7.68 (7.19–8.12),  $\text{NiO}$  2.53 (2.13–2.82),  $\text{SO}_3$  45.41 (44.85–51.21),  $\text{H}_2\text{O}$  (calc. by stoichiometry) 20.20, total 99.63. The empirical formula based on 12 O apfu is  $\text{Na}_{1.96}(\text{Co}_{0.36}\text{Mg}_{0.30}\text{Mn}_{0.17}\text{Ni}_{0.12})_{\Sigma 0.95}\text{S}_{2.02}\text{O}_8 \cdot 4\text{H}_2\text{O}$ . The strongest lines in the X-ray powder-diffraction pattern [ $d \text{ \AA}$  ( $I\%$ ;  $hkl$ )] are: 4.556 (70; 210,011), 4.266 (45;  $\bar{2}01$ ), 3.791 (26;  $\bar{2}11$ ), 3.338 (21; 310), 3.291 (100; 220,021), 3.256 (67; 211,  $\bar{1}21$ ), 2.968 (22;  $\bar{2}21$ ), 2.647 (24;  $\bar{4}01$ ) for manganoblödite, and 4.551 (80; 210,011), 4.269 (50;  $\bar{2}01$ ), 3.795 (18;  $\bar{2}11$ ), 3.339 (43; 310), 3.29 (100; 220,021), 3.258 (58; 211,  $\bar{1}21$ ), 2.644 (21;  $\bar{4}01$ ), 2.296 (22;  $\bar{1}22$ ) for cobaltoblödite. The unit-cell parameters refined from powder-diffraction data are:  $a = 11.131(3)$ ,  $b = 8.266(2)$ ,  $c = 5.540(1) \text{ \AA}$ ,  $\beta = 100.56(2)^\circ$ , and  $V = 501.0 \text{ \AA}^3$  for manganoblödite and  $a = 11.140(3)$ ,  $b = 8.261(2)$ ,  $c = 5.544(1) \text{ \AA}$ ,  $\beta = 100.62(2)^\circ$ , and  $V = 500.3 \text{ \AA}^3$  for cobaltoblödite. Single-crystal X-ray diffraction data collected on manganoblödite crystal of size  $60 \times 50 \times 30 \text{ \mu m}$  [refined to  $R_1 = 0.0459$  for 1115 unique reflections with  $I \geq 4\sigma(I)$ ] and on cobaltoblödite crystal of size  $120 \times 50 \times 40 \text{ \mu m}$  [refined to  $R_1 = 0.339$  for 1214 unique reflections with  $I \geq 4\sigma(I)$ ] show that both minerals are monoclinic, space group  $P2_1/a$ , with  $a = 11.137(2)$ ,  $b = 8.279(1)$ ,  $c = 5.5381(9) \text{ \AA}$ ,  $\beta = 100.42(1)^\circ$ ,  $V = 502.20 \text{ \AA}^3$ , and  $Z = 2$  (manganoblödite), and  $a = 11.147(1)$ ,  $b = 8.268(1)$ ,  $c = 5.5396(7) \text{ \AA}$ ,  $\beta = 100.517(11)^\circ$ ,  $V = 501.97 \text{ \AA}^3$ , and  $Z = 2$  (cobaltoblödite). The new minerals are isostructural with other members of the blödite group, which consists of sheets of  $\text{M}^{2+}$  and Na octahedra that are parallel to the **a-b** plane and interconnected by  $\text{SO}_4$  tetrahedra. The names of the new minerals reflect their chemical composition and relationship to blödite, with which they form a solid solution. A cotype specimens of manganoblödite and cobaltoblödite are deposited in the collections of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, and in the collections of Museum Victoria, Melbourne, Australia. **O.C.G.**

#### MINOHLITE\*

M. Ohnishi, N. Shimobayashi, D. Nishio-Hamane, K. Shinoda, K. Momma, and T. Ikeda (2013) Minohlite, a new copper-zinc sulfate mineral from Minoh, Osaka, Japan. *Mineralogical Magazine*, 77(3), 335–342.

Minohlite (IMA2012-035), ideally  $(\text{Cu,Zn})_7(\text{SO}_4)_2(\text{OH})_{10}\cdot 8\text{H}_2\text{O}$ , was found in the oxidized zone of the Hirao mine at Minoh (Minoo) City, Osaka Prefecture, Japan. The mineral occurs in cracks of altered shale as rosette aggregates up to 100  $\mu\text{m}$  in diameter composed of hexagonal platy crystals up to  $50 \times 10 \mu\text{m}$ . The new mineral may have formed as a secondary mineral deposited from underground water containing  $\text{Cu}^{2+}$ ,  $\text{Zn}^{2+}$ , and  $\text{SO}_4^{2-}$  ions derived from the dissolution of chalcopyrite and sphalerite. Minohlite is found in association with chamosite, muscovite, smithsonite, serpierite, ramsbeckite, limonite, and chalcopyrite. The mineral is bluish-green with a pale green streak, is transparent with a pearly to vitreous luster, has brittle tenacity, perfect cleavage on  $\{001\}$ , and a Mohs hardness  $< 2$ .  $D_{\text{meas}} = 3.39 \text{ g/cm}^3$  (crystal could not perfectly be separated from smithsonite);  $D_{\text{calc}} = 3.28 \text{ g/cm}^3$ . The mineral is easily soluble in dilute hydrochloric acid. It is not fluorescent under UV light, is optically anisotropic and moderate birefringent with no pleochroism (no other optical data provided). The main absorption bands of IR spectrum ( $\text{cm}^{-1}$ , w = weak, s = strong) are: 3422s (O-H stretching vibrations), 1636w (H-O-H bending vibration), 1119s and 1031s ( $\text{SO}_4$  stretching vibrations), 609s and 477s ( $\text{SO}_4$  bending vibrations). The average of 5 electron probe WDS analyses gives [wt% (range)]: CuO 37.18 (34.39–41.46), ZnO 21.08 (17.38–25.11), FeO 0.49 (0.37–0.67),  $\text{SO}_3$  16.78 (16.46–16.98),  $\text{SiO}_2$  0.44 (0.20–0.86), and  $\text{H}_2\text{O}$  24.03 (by difference), total 100.00. The empirical formula based on  $\text{Cu} + \text{Zn} + \text{Fe} + \text{S} + \text{Si} = 9 \text{ apfu}$  is  $(\text{Cu}_{4.43}\text{Zn}_{2.45}\text{Fe}_{0.06})_{\Sigma 6.94}[(\text{SO}_4)_{1.99}(\text{SiO}_4)_{0.07}]_{\Sigma 2.06}(\text{OH})_{9.64}\cdot 7.81\text{H}_2\text{O}$ . The strongest lines in the X-ray powder-diffraction pattern [ $d \text{ \AA}$  ( $hkl$ )] are: 8.138 (20; 001), 4.128 (24; 110), 2.702 (100; 120), 2.564 (76; 121), 1.560 (43; 140), and 1.532 (24; 141). Based on the X-ray powder diffraction pattern, minohlite has hexagonal (or trigonal) symmetry with unit-cell parameters  $a = 8.2535(11)$ ,  $c = 8.1352(17) \text{ \AA}$ ,  $V = 479.93 \text{ \AA}^3$ , and  $Z = 1$ . Possible space groups are  $P6$ ,  $P\bar{6}$ ,  $P6/m$ ,  $P622$ ,  $P6mm$ ,  $P62m$ , and  $P6/mmm$  (or  $P3$ ,  $P\bar{3}$ ,  $P321$ ,  $P3m1$ ,  $P\bar{3}m1$ ,  $P312$ ,  $P31m$ , and  $P\bar{3}1m$ ). A single-crystal X-ray diffraction experiment was not possible due to small crystal size. Minohlite is a copper-zinc sulfate mineral related to schulenbergite, whose structure contains brucite-like layers of edge-sharing (predominantly  $\text{CuO}_6$ ) octahedra oriented parallel to the (001) plane and connected to the corner of  $\text{SO}_4$  tetrahedra. The mineral is named after its type locality, Minoh City. Type specimens of minohlite are deposited in the collections of the National Museum of Nature and Science, Tsukuba, Japan, and the Kyoto University Museum, Kyoto, Japan. **O.C.G.**

#### NIBOHOLTITE\*, TITANOHOLTITE\*, SZKLARYITE\*

A. Pieczka, R.J. Evans, E.S. Grew, L.A. Groat, C. Ma, and G.R. Rossman (2013) The dumortierite supergroup. II. Three new minerals from the Szklary pegmatite, SW Poland: Nioboholtite,  $(\text{Nb}_{0.6}\square_{0.4})\text{Al}_6\text{BSi}_3\text{O}_{18}$ , titanoholtite,  $(\text{Ti}_{0.75}\square_{0.25})\text{Al}_6\text{BSi}_3\text{O}_{18}$ , and szklaryite,  $\square\text{Al}_6\text{BAS}_3^+\text{O}_{15}$ . Mineralogical Magazine, 77(6), 2841–2856.

The new minerals of the dumortierite supergroup, nioboholtite, titanoholtite (IMA 2012-068, 069), the new members of the holtite group and szklaryite (IMA 2012-070), the first representative of a potential new group, were discovered in the dike of a complex zoned granitic pegmatite in the Szklary serpentinite massif, ~60 km south of Wrocław, Lower Silesia, Poland. The Szklary

dike, ~1 m thick, is exposed in one of the open pits of the abandoned Marta Mine, which was worked for silicate nickel ores. The magma that formed the pegmatite is supposedly derived from the anatexis of the sedimentary rocks of the nearby Sowie Mountains during an uplift ~374–380 Ma ago. The reaction between melt and host rocks resulted in the loss of  $\text{SiO}_2$  and gain of  $\text{Al}_2\text{O}_3$  by the melt, favoring the crystallization of Al-bearing minerals. All new minerals along with holtite, As- and Sb-dumortierite, and stibiocolumbite form small aggregates up to a few millimeters in the microcline-quartz-muscovite matrix of the coarse crystalline internal zone of the pegmatite. Other associated minerals include albite; tourmaline of the schorl-dravite series; clinocllore; cordierite; spessartine; chrysoberyl; zircon; monazite-(Ce); cheralite; xenotime-(Y); Mn-rich fluor-, hydroxyl-, and chlorapatite; beusite; columbite-(Fe); columbite-(Mn); tantalite-(Mn); stibiocolumbite; fersmite; minerals of the pyrochlore, microlite, and betafite groups; hollandite; romanèchite; coronadite; ranciéite; ernienickelite; uraninite; thorutite; native Sb, As, Bi and Au; stibarsen; paradocrasite; pollucite; natrophilite; purpurite; alluaudite; gorceixite; plumbogummite; phosphohedyphane; mitridatite; saponite; nontronite; and a few unnamed minerals. Nioboholtite mostly forms rims up to 10  $\mu\text{m}$  around holtite cores. As exceptions, it occurs in the outer zones of cores of zoned As- and Sb-dumortierite crystals. Titanoholtite forms patches up to 10  $\mu\text{m}$  across in the holtite cores and streaks up to 5  $\mu\text{m}$  wide in holtite or near its boundaries with the nioboholtite rims. Szklaryite is found as a single patch ~2  $\mu\text{m}$  in size in As- and Sb-bearing dumortierite grain 15  $\mu\text{m}$  across, enclosed in quartz. Due to the size of crystals a limited set of physical properties was obtained only for nioboholtite, which is creamy-white to brownish yellow or gray-yellow, translucent, with a white streak. It is optically biaxial (-),  $\alpha = 1.740$ – $1.747$ ,  $\beta$  and  $\gamma \sim 1.76^\circ$ ;  $D_{\text{calc}} = 3.72 \text{ g/cm}^3$ . For titanoholtite and szklaryite  $D_{\text{calc}} = 3.66$  and  $3.71 \text{ g/cm}^3$ . Micro-Raman spectroscopy data were obtained for nioboholtite and titanoholtite, the spectra of which show a similarity to that of the dumortierite standard from Dehesa, California, but shifted in positions and intensity ratios. The more prominent Raman bands of titanoholtite are at 211, 286, 362, 407, 466, 507, 561, 624, 885, 935, and  $1055 \text{ cm}^{-1}$  with no features in  $3200$ – $3600 \text{ cm}^{-1}$  OH region. The average electron probe WDS analyses for representative compositions of nioboholtite, titanoholtite, and szklaryite, respectively [wt% (St.dev.)] are:  $\text{P}_2\text{O}_5$  0.26(7), 0.01(1), 0.62(15);  $\text{Nb}_2\text{O}_5$  5.21(16), 0.64(16), 0.22(6);  $\text{Ta}_2\text{O}_5$  0.66(13), 1.07(36), n.d.;  $\text{SiO}_2$  18.68(13), 21.92(23), 12.71(32);  $\text{TiO}_2$  0.11(3), 4.08(24), 0.26(2);  $\text{B}_2\text{O}_3$  4.91(38), 4.64(32), 5.44(8);  $\text{Al}_2\text{O}_3$  49.74(19), 50.13(25), 50.74(11);  $\text{As}_2\text{O}_3$  5.92(30), 2.22(8), 16.39(65);  $\text{Sb}_2\text{O}_3$  10.81(16), 11.47(19), 10.49(36); FeO 0.51(9), 0.16(18), 0.18(6) (assuming all Fe is  $\text{Fe}^{2+}$ );  $\text{H}_2\text{O}$  (calculated based on OH charge balance) 0.05, 0, 0; total 96.86, 96.34, 97.05. The low totals could be due to infiltration of epoxy between the very fine fibers, compositional difference of standards used, and possible  $\text{H}_2\text{O}$  presence. The empirical formulas based on the classification of the dumortierite supergroup (Pieczka et al. 2013) and calculated on the basis of  $\text{O} = 18 - \text{As} - \text{Sb}$  are:  $\{(\text{Nb}_{0.26}\text{Ta}_{0.02}\square_{0.18})(\text{Al}_{0.27}\text{Fe}_{0.05}\text{Ti}_{0.01}\square_{0.21})\}_{\Sigma 1.00} \text{Al}_6\text{B}_{0.92}\{\text{Si}_{2.03}\text{P}_{0.02}(\text{Sb}_{0.48}\text{As}_{0.39}\text{Al}_{0.07})\}_{\Sigma 3.00}(\text{O}_{17.09}\text{OH}_{0.04}\square_{0.87})_{\Sigma 18.00}$  with an ideal nioboholtite end-member formula  $(\text{Nb}_{0.6}\square_{0.4})\text{Al}_6\text{BSi}_3\text{O}_{18}$ ;  $\{(\text{Ti}_{0.32}\text{Nb}_{0.03}\text{Ta}_{0.03}\square_{0.10})(\text{Al}_{0.35}\text{Ti}_{0.01}\text{Fe}_{0.01}\square_{0.15})\}_{\Sigma 1.00} \text{Al}_6\text{B}_{0.86}\{\text{Si}_{2.36}(\text{Sb}_{0.51}\text{As}_{0.14})\}_{\Sigma 3.01}(\text{O}_{17.35}\square_{0.65})_{\Sigma 18.00}$  with an ideal titanoholtite end-member formula  $(\text{Ti}_{0.75}\square_{0.25})\text{Al}_6\text{BSi}_3\text{O}_{18}$  and



$\{\square_{0.53}(\text{Al}_{0.41}\text{Ti}_{0.02}\text{Fe}_{0.02})(\text{Nb}_{0.01}\square_{0.01})\}_{\Sigma 1.00}\text{Al}_6\text{B}_{1.01}\{(\text{As}_{1.07}\text{Sb}_{0.47}\text{Al}_{0.03})\text{Si}_{1.37}\text{P}_{0.06}\}_{\Sigma 3.00}(\text{O}_{16.46}\square_{1.54})_{\Sigma 18.00}$  with an ideal szklaryite end-member formula  $\square\text{Al}_6\text{BAS}_3^{\text{3+}}\text{O}_{15}$ . Single-crystal XRD data could not be obtained. The EBSD patterns for all three new minerals match those for dumortierite and holtite and were indexed to give a best fit based on dumortierite of orthorhombic symmetry, space group *Pnma*, and unit-cell parameters  $a = 4.7001$ ,  $b = 11.828$ ,  $c = 20.243$  Å;  $V = 1125.36$  Å<sup>3</sup>,  $Z = 4$  (Moore and Araki, 1978). The strongest lines of XRD powder patterns calculated based on these cell parameters and the empirical formulas of nioboholtite, titanoholtite, and szklaryite are [ $d$  Å ( $hkl$ )  $I$ %], respectively]: 10.213 (011) 67, 46, 19; 5.914 (020) 40, 47, 57; 5.861 (013) 66, 78, 100; 3.458, (122) 63, 63, 60; 3.444 (104) 36, 36, 34; 3.231 (123) 100, 100, 95; 3.068 (105) 53, 53, 50; 2.931 (026) 65, 59, 51; 2.895 (132) 64, 65, 59. Nioboholtite and titanoholtite were named for their relationship to holtite and szklaryite for the occurrence in the Szklary pegmatite. Type materials of all 3 new minerals (polished sections) are at the Mineralogical Museum of the University of Wrocław, Faculty of Earth Science and Environmental Management, Institute of Geological Sciences, Poland. Cotypes of nioboholtite and titanoholtite have been deposited in the National Museum of Natural History (Smithsonian Institution), Washington, D.C., U.S.A. **D.B.**

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#### OXO-MAGNESIO-HASTINGSITE\*

A.N. Zaitsev, E. Yu. Avdontseva, S.N. Britvin, A. Demény, Z. Homonnay, T.E. Jeffries, J. Keller, V.G. Krivovichev, G. Markl, N.V. Platonova, O.I. Siidra, J. Spratt, and T. Vennemann (2013) Oxo-magnesio-hastingsite,  $\text{NaCa}_2(\text{Mg}_2\text{Fe}_3^{\text{3+}})(\text{Al}_2\text{Si}_6)\text{O}_{22}\text{O}_2$ , a new anhydrous amphibole from the Deeti volcanic cone, Gregory rift, northern Tanzania. *Mineralogical Magazine*, 77(6), 2773–2792.

Oxo-magnesio-hastingsite (IMA 2011-035), ideally  $\text{NaCa}_2(\text{Mg}_2\text{Fe}_3^{\text{3+}})(\text{Al}_2\text{Si}_6)\text{O}_{22}\text{O}_2$ , is a new anhydrous amphibole from the Deeti volcanic cone in the Gregory rift (northern Tanzania). The host rocks are melilititic massive tuffs that contain a suite of centimeter-size megacrysts (diopside and phlogopite in addition to amphibole) and xenoliths of amphibole-mica peridotites, pyroxenites, and ijolites. Oxo-magnesio-hastingsite occurs as megacrysts up to 12 cm in size, rounded, do not show any crystal faces, and they are characterized by a smooth (“melted”) surface. Rarely, oxo-magnesio-hastingsite crystals contain inclusions of euhedral diopside grains. The amphibole is brown with a white streak; small fragments are transparent and have a vitreous luster. Oxo-magnesio-hastingsite is brittle, has a perfect {110} cleavage, and uneven fracture. The Mohs hardness is ~6.  $D_{\text{meas}}$  (hydrostatic weighing) is 3.19(2) g/cm<sup>3</sup> and  $D_{\text{calc}} = 3.219$  g/cm<sup>3</sup>. Oxo-

magnesio-hastingsite is biaxial (–),  $\alpha = 1.706(2)$ ,  $\beta = 1.715(2)$ ,  $\gamma = 1.720(2)^\circ$  (589 nm).  $2V_{\text{calc}} = 73^\circ$ . Dispersion:  $r > v$ , weak;  $Y = \mathbf{b}$ ;  $Z \wedge c = 8^\circ$ ; pleochroism is strong,  $Z = \text{dark brown}$ ,  $Y = \text{brown}$ ,  $X = \text{light brown}$ . The IR spectra of the oxo-magnesio-hastingsite have sets of bands that are typical for amphiboles in the 300–1400 cm<sup>–1</sup> region: 460–508–633–664–681–737–940–975–1055 cm<sup>–1</sup>, with very weak bands observed in the OH-stretching region between 3000 and 4000 cm<sup>–1</sup> with a maximum around 3662 cm<sup>–1</sup> and additional bands at 3652 and 3645 cm<sup>–1</sup>. The average of 17 electron probe WDS analysis (wt%) is: SiO<sub>2</sub> 41.89, TiO<sub>2</sub> 3.96, Al<sub>2</sub>O<sub>3</sub> 10.75, total FeO (from EMP analyses) 9.33, Fe<sub>2</sub>O<sub>3</sub> (from Mössbauer spectroscopy) 11.25, FeO (from Mössbauer spectroscopy) 6.09, MnO 0.08, MgO 14.79, CaO 11.76, Na<sub>2</sub>O 2.84, K<sub>2</sub>O 1.74, H<sub>2</sub>O (by vacuum heating in a silica tube followed by conversion to H<sub>2</sub> gas by H<sub>2</sub>O–Zn reaction) 0.61, total 99.67 wt%. The empirical formula calculated on the basis of 24 (O,OH) pfu is  $(\text{Na}_{0.67}\text{K}_{0.33})_{\Sigma 1.00}(\text{Ca}_{1.87}\text{Na}_{0.14}\text{Mn}_{0.01})_{\Sigma 2.02}(\text{Mg}_{3.27}\text{Fe}_{1.25}\text{Ti}_{0.44}\text{Al}_{0.08})_{\Sigma 5.04}(\text{Al}_{1.80}\text{Si}_{6.20}\text{O}_{22})(\text{O}_{1.40}\text{OH}_{0.60})_{\Sigma 2.00}$ . The strongest lines of the X-ray powder diffraction pattern [ $d$  Å ( $I$ %;  $hkl$ )] are: 3.383 (62; 131), 2.708 (97; 151), 2.555 (100; 202), 2.349 (29; 351), and 2.162 (36; 261). Unit-cell parameters refined from the powder data with whole-pattern fitting are:  $a = 9.884(2)$ ,  $b = 18.069(2)$ ,  $c = 5.310(1)$  Å,  $\beta = 105.30(1)^\circ$ . A crystal of size 0.25 × 0.20 × 0.20 mm was used for a single-crystal study, yielding a monoclinic symmetry, space group *C2/m*,  $a = 9.8837(3)$ ,  $b = 18.0662(6)$ ,  $c = 5.3107(2)$  Å,  $\beta = 105.278(1)^\circ$ ,  $V = 914.77$  Å<sup>3</sup>,  $Z = 2$ . The structure was refined to  $R_1 = 0.032$  using 1907 [ $F \geq 4\sigma(F)$ ] reflections. The crystal-chemical formula is  $^{\text{Am}}\text{Na}_{0.67}\text{K}_{0.33}^{\text{M}(4)}(\text{Ca}_{1.87}\text{Na}_{0.14}\text{Mn}_{0.01})_{\Sigma 2.02}^{\text{M}(3)}(\text{Mg}_{3.27}\text{Fe}_{1.25}^{\text{M}(2)}\text{Ti}_{0.44}\text{Al}_{0.08}^{\text{M}(1)})_{\Sigma 5.04}^{\text{M}(1)}(\text{Mg}_{3.27}\text{Fe}_{1.25}^{\text{M}(2)}\text{Ti}_{0.44}\text{Al}_{0.08}^{\text{M}(1)})_{\Sigma 5.04}^{\text{M}(1)}(\text{Si}_{3.9}\text{Al}_{0.10})_{\Sigma 4.0}^{\text{T}(2)}(\text{Si}_{2.3}\text{Al}_{1.70})_{\Sigma 4.0}^{\text{O}(3)}(\text{O}_{1.40}\text{OH}_{0.60})_{\Sigma 2.00}$ . The  $\delta D$  values in the oxo-magnesio-hastingsite range from –50.5 to –32.7% (higher than the assumed mantle range, from –60 to –80%, but overlapping with the range assumed for subducted slab components, ~–40%), and the  $\delta^{18}\text{O}$  values in the minerals vary between 5.27 and 5.85% (within the accepted range for pristine mantle-derived rocks and compatible with values found in amphiboles occurring in kimberlites, olivine melilitites, olivine nephelinites, basanites, and alkaline basalts from other occurrences). The isotopic composition of H and O, as well as the concentration of trace elements in oxo-magnesio-hastingsite suggest its formation from a melt originated from a mantle source metasomatized by slab-derived fluids. The mineral at its approval was named ferrikaersutite, but in reference to the new IMA-approved amphibole nomenclature (Hawthorne et al. 2012), was renamed to oxo-magnesio-hastingsite. The cotype specimen is deposited in the Mineralogical Museum, Department of Mineralogy, St. Petersburg State University, St. Petersburg, Russia (sample OL 22, catalog number 1/19465). **F.C.**

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