

## NEW MINERAL NAMES

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## Liberite

CH'UN-LIN CHAO, Liberite ( $\text{Li}_2\text{BeSiO}_4$ ), a new lithium-beryllium silicate mineral from the Nanling Ranges, South China: *Ti Chih Hsueh Pao* **44** (3), 334-342 (1964); *Chem. Abs.* **61**, 15841 (1964).

Analysis gave  $\text{SiO}_2$  48.39,  $\text{Al}_2\text{O}_3$  0.26,  $\text{Fe}_2\text{O}_3$  0.11,  $\text{MgO}$  0.49,  $\text{BeO}$  25.47,  $\text{Li}_2\text{O}$  23.43,  $\text{CaO}$  0.29,  $\text{Na}_2\text{O}$  0.25,  $\text{K}_2\text{O}$  0.10,  $\text{H}_2\text{O}^-$  0.65, sum 99.44%, corresponding to  $\text{Li}_2\text{BeSiO}_4$ . X-ray powder data gave the strongest lines as 3.799 (10), 3.709 (10), 2.581(10), 1.447 (10), 1.233 (10). The unit cell has  $a$  ?,  $b$  4.9464,  $c$  8.5395Å. The mineral occurs as minute monoclinic aggregates occasionally showing pinacoidal faces, color pale-yellow to brown, cleavage (010) perfect, (100) and (001) distinct, luster vitreous on cleavages, slightly oily on fractures, brittle,  $H$  7.0875 (??, MF),  $G$   $2.688 \pm 0.001$ . Biaxial (-), with  $ns$  (Na)  $\alpha$  1.6220,  $\beta$  1.6332,  $\gamma$  1.6380,  $2V$   $66^\circ 18'$ ,  $Z \wedge c = 41^\circ$ , elongation positive. The mineral occurs in association with lepidolite, natrolite, eucryptite, hsianghualite (*Am. Mineral.* **44**, 1327; **46**, 244), cassiterite, and scheelite in veins cutting ribbon rock (lepidolite-fluorite-magnetite) in tactites.

The name is presumably for the composition.

## Sederholmite, Wilkmanite, Kullerudite, Mäkinenite and Trüstedtite

Y. VUORELAINEN, A. HUUMA AND A. HÄKLI, Sederholmite, wilkmanite, kullerudite, mäkinenite, and trüstedtite, five new nickel selenide minerals. *Compt. rendus Soc. geol. Finlande* **36**, 113-125 (1964).

The new selenium minerals occur in sills of albite diabase in a schist formation, associated with low-grade uranium mineralization at Kuusamo, northeast Finland.

*Sederholmite* ( $\beta$ -NiSe) and *wilkmanite* ( $\text{Ni}_3\text{Se}_4$ ) occur in intimate association in penroseite clusters in calcite veins in uranium-bearing albitites. *Sederholmite* also occurs as grains in clauthalite. X-ray fluorescence analyses indicate that the composition of *seederholmite* varies from  $\text{Ni}_{1.06}\text{Se}$  to  $\text{Ni}_{0.85}\text{Se}$ ; a typical analysis of Ni-deficient material gave Ni 36.8, Co 1.9, Se 61.3%. Indexed x-ray powder data are given for the Ni-deficient variety; the strongest lines are 2.70 (vvs)(101), 2.015 (vs)(102), 1.806 (s)(110), 1.535 (ms)(103), 1.50 (ms)(112). This corresponds to unit cell  $a$  3.65, 3.624;  $c$  5.34, 5.288 Å., for Ni-rich and Ni-deficient, respectively.  $Z=2$ ,  $G$  calc. 7.06, in agreement with previous data on synthetic  $\beta$ -NiSe, which has the NiAs type of structure, space group  $P6_3/mmc$ . The optical properties vary with composition. Yellow to orange yellow with distinct pleochroism in shades of yellow and strong to distinct anisotropy, pinkish to greenish. Reflectivity high.

*Wilkmanite* occurs as a primary mineral and as an alteration product of *seederholmite*. It alters to selenium and to ferroselite, and is cut by selenian vaesite and selenian cattierite. Analyses range from  $\text{Ni}_{0.88}\text{Se}$  (Ni 37.6 (includes Co), Se 61.1%) to  $\text{Ni}_{0.78}\text{Se}$  (Ni 33.7, Co 1.0, Cu, Fe traces, Se 65.3%). X-ray study of a sample with  $\text{Ni}_{0.78}\text{Se}$  showed it to be monoclinic,  $a$  6.22,  $b$  3.63,  $c$  10.52 Å.,  $\beta$   $90.53^\circ$ ,  $Z=2$ ,  $G$  calc. 6.96, in good agreement with data on synthetic  $\text{Ni}_3\text{Se}_4$ . Indexed x-ray powder data are given; the strongest lines are 2.70 (vs) (112), 2.02 (vs) (114), 1.800 (vs) (310), 2.00 (s) (114), 1.815 (s) (020). The mineral is pale grayish-yellow, with high reflectivity. Pleochroism distinct, pale yellow to grayish yellow. Anisotropism strong, pink to yellowish-green.

*Kullerudite* NiSe<sub>2</sub>, occurs almost exclusively as an alteration product of wilkmanite. X-ray fluorescence analysis showed Ni 23.1, Co 1.4, Fe 1.91, Cu 0.5, Se 73.1%. X-ray study showed it to be orthorhombic, space group probably *Pnmm*, *a* 4.89, *b* 5.96, *c* 3.67 Å, *Z*=2, *G* calc. 6.72, probably isostructural with ferroselite. Indexed x-ray powder data are given; the strongest lines are 2.64 (vs)(111), 2.545 (vs)(120) 2.935 (s)(101), 1.925 (s)(211), 1.84 (s)(130). Color slightly paler than that of its dimorph, penroseite. Pleochroism distinct in oil, gray to pale gray, anisotropism very strong, yellowish gray to gray to almost black. The mineral is rather soft and seldom polishes well.

*Mäkinenite* γ-NiSe, occurs with clausthalite and selenian melonite. X-ray fluorescence analysis showed Ni 41.1, Co 1.0, Cu traces, Se 57.9%. X-ray data show it to be trigonal, isostructural with millerite, with *a* 10.01, *c* 3.28 Å, *Z*=9, space group probably *R3m*, *G* calc. 7.22. Indexed x-ray powder data are given; the strongest lines are 2.88 (vs)(300), 2.63 (vs)(021), 2.325 (vs)(211), 1.95 (vs)(131). In oil mäkinenite is pure yellow, in air orange-yellow. Pleochroism strong, yellow to greenish-yellow. Anisotropism strong, in oil pale green to pale orange-yellow, in air glowing cinder red to blue-green or green. The mineral is almost as soft as clausthalite.

*Trüstedtite* Ni<sub>3</sub>Se<sub>4</sub>, occurs in calcite-, uranium-bearing veins, as euhedral crystals in clausthalite, associated with penroseite and sederholmite. Analysis gave Ni 29.5, Co 6.4, Cu trace, Se 64.1%, S very low or none, corresponding to (Ni, Co)<sub>3</sub>Se<sub>4</sub>. X-ray study shows it to have the spinel type of structure, space group probably *Fd3m*, with *a* 9.94 Å, *Z*=8, *G* calc. 6.62. A selenian polydymite (63 mole % Ni<sub>3</sub>S<sub>4</sub>) had *a* 9.65 Å. Isostructural with tyrrelite (Cu, Co, Ni)<sub>3</sub>Se<sub>4</sub>, bornhardtite (Co<sub>3</sub>Se<sub>4</sub>), and the linneite group of sulfides. Indexed x-ray powder data are given; the strongest lines are 2.48 (vs)(400), 1.755 (vs)(440), 3.00 (ms)(311), 2.87 (ms)(222), 1.905 (m)(511, 333). Yellow, completely isotropic. Reflectivity higher than those of sederholmite and penroseite. Slightly softer than penroseite.

The names are for the late J. J. Sederholm, former Director of the Geological Survey, Finland; for the late W. W. Wilkman, geologist, for Gunnar Kullerud of the Geophysical Laboratory, Washington; for the late Eero Mäkinen, Finnish geologist and former president of the Outokumpu Co., and for the late O. Trüstedt, whose work on prospecting methods led to the discovery of the Outokumpu deposit.

#### Uklonskovite

M. N. SLYUSAREVA, The new mineral uklonskovite. *Doklady Akad. Nauk SSSR* 158, 1093-1095 (1964).

I. M. RUMANOVA AND E. P. POPOVA, The new mineral uklonskovite. *Kristallografiya*, 9, 275-277 (1964).

Chemical analysis by E. F. Kas'yanova gave SO<sub>3</sub> 42.80, Na<sub>2</sub>O 14.87, K<sub>2</sub>O 1.01, MgO 20.61, CaO 2.40, H<sub>2</sub>O (thermal loss) 18.00, sum 99.69% (given as 99.79% M.F.). Separate determinations gave MgO 20.99, CaO 2.20, SO<sub>3</sub> 42.55%. This corresponds to Na<sub>2</sub>Mg<sub>2</sub>(SO<sub>4</sub>)<sub>2</sub>(OH)<sub>2</sub>·3H<sub>2</sub>O. The x-ray data by R. and P., however, indicate the formula NaMg(SO<sub>4</sub>)(OH)<sub>2</sub>·2H<sub>2</sub>O (see below). The DTA curve shows two endothermal effects, stated to be at 350° (but marked on the figure as 300° M.F.), the second at 650°. An exothermic effect is present at about 850°, perhaps caused by a transition in the dehydrated mineral. The mineral is practically insoluble in cold water, dissolves in the cold in weak HCl.

Crystals are prismatic, flattened, not more than 2 mm in size. Laue and rotation photographs (R. and P.) show the mineral to be monoclinic, probable space group *C*<sub>2h</sub>, *a* 13.15±0.03, *b* 7.19±0.01, *c* 5.72±0.01 Å, β 90°37'. With *G* 2.5, this unit cell gives 2.21 [Na<sub>2</sub>Mg<sub>2</sub>(SO<sub>4</sub>)<sub>2</sub>(OH)<sub>2</sub>·3H<sub>2</sub>O]. Because the space group requires four or eight equivalent positions, it is suggested that the H<sub>2</sub>O determination was low and that a better formula is NaMg(SO<sub>4</sub>)(OH)·2H<sub>2</sub>O; for this *Z*=4.16.

Unindexed  $x$ -ray powder data by I. P. Tibukin were made with unfiltered Cu radiation (70 lines). The strongest lines are 3.56 (10), 3.20 (10), 3.018 (10), 2.19 (9), 1.70 (8), 1.58 (8), 5.47 (7), 2.50 (7), 2.41 (7), 2.01 (7), 1.95 (7), 1.75 (7), 1.42 (7), 1.09 (7), 5.01 (6), 3.35 (6), 1.61 (6), 1.45 (6), 1.40 (6), 1.34 (6), 1.33 (6), 1.11 (6).

The mineral is transparent, colorless, with vitreous luster.  $G$  2.42 (S.), 2.5 (R. and P.). Optically biaxial, (+),  $n_s \alpha$  1.476,  $\gamma$  1.500, both  $\pm 0.001$ .  $2V$  not given. In immersion preparations lie in most cases on the plane of best cleavage, and an additional cleavage is poorly discernible as striae parallel to the elongation. Both cleavages are referred to the pinacoid zone [010], the elongation being taken as  $b$ .

The mineral occurs at a depth of 80 m in cavities in clays covering a saline layer in Neogene rocks of Kara-Kalpakii, lower Amu-Darya River. Associated minerals are glauberite and polyhalite; the saline layers also contain bloedite, halite, and minor mirabilite, thenardite, espomite, hexahydrate and gypsum.

The name is for A. S. Uklonskii, mineralogist, academician of the Academy of Sciences, Uzbek SSR.

DISCUSSION.—Apparently a valid species, but more data on composition and optical properties are needed.

#### Sinoite

C. A. ANDERSEN, KLAUS KEIL AND BRIAN MASON, Silicon oxynitride: a meteoric mineral. *Science*, **146** (3641), 256–257 (1964)

Examination of the Jajh deh Kot Lalu, which fell in the Sind Province, Pakistan, on May 2, 1926, shows it to be an enstatite chondrite, containing enstatite (50–60%), nickel-iron (about 20%), plagioclase (about 10%), troilite (about 5%), with accessory pigeonite, daubreelite, oldhamite, ferroalabandite, graphite, tridymite, and a new mineral. Electron microprobe analysis gave Si 56.6, N 31.5, O 13.1, sum 101.2%, which gives the ratio: Si:N:O = 2.00:2.23:0.81. The accuracy of the Si values is about 2% and of the O and N values probably not better than 15%.

$X$ -ray powder data are given of a sample containing enstatite and plagioclase; the strongest lines are 3.36 (6), 4.44 (5), 4.65 (4). For synthetic  $Si_2N_2O$ , prepared by Brosset and Idrestedt (*Nature* **201**, 1211 (1964)) the strongest lines are 3.36 (10), 4.43 (10), 4.66 (8), 2.61 (5), 2.42 (5), orthorhombic with  $a$  8.843,  $b$  5.473,  $c$  4.835 Å.,  $Z=4$ ,  $G$  calc. 2.84.

Separation in heavy liquids showed that the mineral was concentrated in the fraction of density 2.80–2.85. Measurements gave  $\alpha$  1.740,  $\gamma$  1.855, and  $\beta$  appears to be close to gamma, so that the mineral is probably optically negative with a small axial angle. The crystals are length-slow;  $Z=c$ . The synthetic material is fine-grained, markedly birefringent with mean  $n$  about 1.79.

The name is for the chemical composition.

DISCUSSION—Name is not to be confused with those of the dubious clay minerals cimolite and sinopite or with chinoite (=libethenite) or with the niobate sinicite.

#### Wairauite

G. A. CHALLIS AND J. V. P. LONG, Wairauite—a new cobalt-iron mineral. *Mineral. Mag.* **33**, 942–948 (1964).

Electron probe analysis of a homogeneous grain of the mineral gave (after corrections for excitation by Co  $K\beta$  and for loss of continuous production): Co  $48.8 \pm 0.8$ , Fe  $49.8 \pm 0.8$ , Ni  $0.5 \pm 0.1$ , total 99.1%. This gives a formula close to  $CoFe$ .

The mineral has a polishing hardness similar to that of awaruite ( $Ni_3Fe$ ). The density calculated from the analysis and from unit cell dimensions of synthetic material of the same composition is 8.23. Wairauite is highly magnetic. In polished section the mineral

is isotropic and grains show a high reflectivity, 54% at 5100 Å compared to 58% for awaruite and 51% for pyrite at the same wavelength.

No  $x$ -ray data are available, but it is suggested that wairauite has a structure similar to the ordered CsCl type of the synthetic alloy  $\text{Co}_{50}\text{Fe}_{50}$  which is cubic with  $a = 2.86$  Å.

Wairauite is associated with awaruite in the Red Hills serpentinites of the Wairau Valley, South Island, New Zealand. Both minerals occur as small grains close to the contact. Whereas the grains of awaruite are rounded or crenulated, grains of wairauite are euhedral with the cube and octahedron as common forms. Other associated minerals are: chromite, magnetite, and native copper. Most of the grains are less than  $2\mu$  in diameter; the largest found was  $7 \times 4\mu$ . Some grains are zoned, consisting of a core of awaruite surrounded by wairauite.

The name is for the locality and is pronounced WAIRAU·AIT. The name was approved before publication by the Commission on New Minerals and Mineral Names, I.M.A.

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### Arthurite

R. J. DAVIS AND M. H. HEY, Arthurite, a new copper-iron arsenate from Cornwall. *Mineral Mag.* **33**, 937-941 (1964).

The mineral occurs at the Hingston Down Consols mine, Calstock, Cornwall, as thin apple-green crusts usually intimately mixed with pharmacosiderite or an unidentified mineral of the alunite-beudantite family or both. A sample weighing 2.1 mg was analyzed (complete details of the procedures are given) with the following results:  $\text{CuO}$  12.1,  $\text{Fe}_2\text{O}_3$  23.4,  $\text{As}_2\text{O}_5$  24.7,  $\text{H}_2\text{O}$  11.9, insol 27.4, sum 99.5% (The As was determined on a 1.0 mg portion of the sample and the other components were determined from the other 1.1 mg). Recalculation of the analytical results after deducting insolubles (only quartz was detected as an impurity by  $x$ -ray diffraction) gave:  $\text{CuO}$  16.8,  $\text{Fe}_2\text{O}_3$  32.4,  $\text{As}_2\text{O}_5$  34.3,  $\text{H}_2\text{O}$  16.5, sum 100.0. Confirmatory results were obtained from three other samples. The formula proposed for the mineral is  $\text{Cu}_2\text{Fe}_4(\text{AsO}_4)_3(\text{OH})_7 \cdot 6\text{H}_2\text{O}$  which has the following theoretical composition:  $\text{CuO}$  16.00,  $\text{Fe}_2\text{O}_3$  32.12,  $\text{As}_2\text{O}_5$  34.67,  $\text{H}_2\text{O}$  17.21.

Because of the intimate intergrowth with other minerals, an accurate specific gravity was not obtained. Most of the material appeared to remain suspended in a  $\text{CHBr}_3\text{-CH}_2\text{I}_2$  mixture of S.Gr.3.2. Optically, arthurite is pale olive-green with no marked pleochroism and has a low to medium birefringence. Due to the finely granular nature of the mineral, only a mean refractive index, 1.78, could be obtained.

No single-crystal work could be done, but  $x$ -ray powder data (62 lines) are given for  $\text{CoK}\alpha$  radiation. Strongest lines (in Å) are: 4.28 vvs, 4.81 vvs, 6.97 vvs, 10.08 vs, 2.801 vs, and 2.912 s. The data are indexed down to  $d = 1.83$  Å for a monoclinic cell with  $a = 10.09$ ,  $b = 9.62$ ,  $c = 5.55$  (all  $\pm 0.01$  Å) and  $\beta = 92.2^\circ \pm 0.2^\circ$ . There are five lines with intensities of vvvw which cannot be indexed on this cell but could be indexed if the  $a$  and/or  $b$  dimensions were doubled. No spacings of type  $\text{OkO}$  with  $k$  odd or  $\text{hOl}$  with  $l$  odd were observed. Although this would lead to the space group  $P2_1/c$ , it is felt that these absences are accidental. In space group  $P2_1/c$  there are only two-fold and four-fold equivalent positions. The unit cell parameters, analysis and density indicate a cell content in which the number of  $\text{AsO}_4$  groups is odd. The authors, therefore, favor one of the space groups  $P2$ ,  $Pm$  or  $P2/m$ .

The mineral is named for Sir Arthur Russell and for Mr. Arthur W. G. Kingsbury, both of whom supplied specimens for this study.

The name was approved before publication by the Commission on New Minerals and Mineral Names, I.M.A.

J. A. MANDARINO