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# New Mineral Names*

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## ADRANOSITE*

F. Demartin, C.M. Gramaccioli, and I. Campostrini (2010) Adranosite, $(NH_4)_4NaAl_2(SO_4)_4Cl(OH)_2$, a new ammonium sulfate chloride from La Fossa crater, Vulcano, Aeolian Islands, Italy. Can. Mineral., 48, 315–321.

Adranosite was discovered in a medium-temperature fumarole (250 °C) in a pyroclastic breccia in the La Fossa crater, Vulcano. Aeolian Islands, Sicily, Italy. It is associated with aiolosite, alunite, anhydrite, bismuthinite, sassolite, dimicheleite-(Br), dimicheleite-(Cl), and another new mineral (IMA 2009-049).

Adranosite occurs as aggregates of acicular crystals up to 300 μm in length. The crystals are white to colorless. They have a tetragonal habit with pointed terminations. The most common forms are {100}, {110}, and {111} with no observed twinning. Adranosite has a white streak and a vitreous luster. Cleavage and fracture where not observed. No fluorescence was observed in short or long wavelength ultraviolet. It is non-hygroscopic and stable at atmospheric conditions. Optically it is uniaxial negative, $\omega$ is 1.55(1) and $\varepsilon$ is 1.54(1) at 589 nm. The observed density is 2.15(1) g/cm$^3$ and the compatibility index is superior.

The composition of adranosite was determined by electron microprobe except for ammonium, whose presence was verified by the Nessler reaction and water whose concentration was determined from crystal structure considerations. The average composition of adranosite (wt%) (*n* not given) is $Na_2O$ 5.88, $Al_2O_3$ 17.40, $K_2O$ 0.90, $(NH_4)_2O$ 16.52, $SO_3$ 51.31, Cl 5.68, $H_2O$ 2.99, –O=Cl –1.28, for a total of 99.40. This gives an empirical formula (on the basis of 19 anions) of $[(NH_4)_{3.89}K_{0.12}]_{\Sigma 4.01}Na_{1.16}Al_{2.09}S_{3.93}O_{15.99}Cl_{0.98}(OH)_{2.03}$.

Powder diffraction data were obtained using graphite monochromated Cu*K*α radiation. The ten strongest reflections in the pattern [$d_{obs}$ in Å ($I_{obs}$%,*hkl*)] are: 2.980(100,152), 2.265(87,080), 4.530(86,040), 6.398(80,220), 3.020(65,060) 3.202(47,440), 1.902(44,482), 2.739(36,352), 2.864(29,260), and 4.052(28,240).

The crystal structure of adranosite was determined using data collected with a 2K CCD detector and Mo*K*α radiation. The structure was solved by direct methods and refined using the SHEL97 program. $R_{Final}$ was 0.355 for 596 reflections where [$I > 2\sigma(I)$]. Adranosite is tetragonal with space group $I4_1/acd$; $a = 18.118(3)$, $c = 11.320(3)$ Å, $V = 3715.5(13)$ Å$^3$, and $Z = 8$.

The structure of adranosite consists of $AlO_6$ octehedra linked to $SO_4$ tetrahedra in spiraling chains parallel to [001]. $NaO_4Cl_2$ square tetragonal pyramids are linked by Cl atoms on their corners. The ammonium molecules occupy voids in the structure and are bonded to atoms in the structure by hydrogen bonds.

The name is for the ancient god of fire, Adranos. The name and the mineral were approved by the IMA CNMMN (2008-057). The holotype sample is held in the collection of the Dipartimento di Chimica Strutturale e Stereochimica Inorganica, Università degli Studi di Milano, Milano, Italy, specimen number 2008-06. **G.P.**

## ARISITE-(CE)*

P.C. Piilonen, A.C. McDonald, J.D. Grice, R. Rowe, R. Gault, G. Poirier, M.A. Cooper, U. Kolitsch, A.C. Roberts, W. Lechner, and A.G. Palfi (2010) Arisite-(Ce), a new rare-earth fluorcarbonate from the Aris phonolite, Namibia, Mont Saint-Hilaire and the Saint-Amable sill, Quebec, Canada. Can. Mineral., 48, 661–671.

Arisite-(Ce) was initially discovered in miarolitic cavities in the Aris phonolite quarry, central Namibia. It was confirmed as an unknown mineral in 2000. The material from St Amable and Mont Saint-Hilaire were recognized as new species in 1990 (UK60) and 1998 (VUK11), respectively. Comparison of XRD patterns proved that the Namibian material (NAM) was the same species as the material from Mont Saint-Hilaire (MSH). These localities are regarded as co-type localities.

The Aris phonolite is a dike that intrudes metasedimentary rocks of the Paleoproterozoic Hohewarte complex. It is a fine-grained aphyric rock, composed mainly of sanidine, nepheline, and aegirine with minor haüyne, leucite, monazite, and zircon. Arisite-(Ce) occurs in 0.1 mm to 10 cm miarolitic cavities that often contain residual hydrothermal fluids. Minerals found in the cavities include villiaumite, aegirine, labuntsovite-group minerals, tuperssuatsiaite, natrolite, analcime, manganoneptunite, apophyllite-(KF), fluorite, and makatite. Arisite-(Ce) from this locality occurs as euhedral hexagonal plates up 1.5 mm in diameter and as rare hexagonal tabular prisms. Crystals are vitreous and transparent and range in color from beige, beige-yellow, light lemon yellow to pinkish. Forms include a dominant {001} pinacoid with a minor {100} prism; twinning of an undetermined form is observed. Associated minerals are aegirine, analcime, apatite, fluorite, manganoneptunite, microcline, natrolite, sphalerite, tuperssuatsiaite, and the unnamed Fe-analogue of zakharovite. Replacement of arisite-(Ce) by fine-grained yellowish bastnäsite is observed.

The Mont Saint-Hilaire alkaline intrusive complex consists

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

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of nepheline and sodalite syenites, with associated alkaline pegmatite dikes, xenoliths, and igneous breccias and is part of the Monteregian hills petrographic province. Arisite-(Ce) from MSH occurs in small alkaline pegmatite veins and lenticular patches within syenite and syenite sodalite xenoliths. It occurs as pale pink to silvery to very pale brown micaceous plates with an irregular hexagonal outline or as thin strips that narrow to thin fibers. Other forms include isolated crystals rosettes, irregular clusters, and as spherical aggregates 0.1 to 2 mm in diameter. Forms include a dominant {001} pinacoid and a minor {100} prism. In alkaline pegmatites it is associated with aegirine, albite, a clinoamphibole, a eudialyte-group mineral, microcline, mosandrite, natrolite, gonnardite, and fluorapatite. In sodalite syenite xenoliths, it is associated with aegirine, "tetranatrolite," polylithionite, fluorite, sodalite, serandite, microcline, catapleiite, pyrite, pyrochlore, pyrrhotite, goethite, an alkali feldspar, and an astrophyllite-group mineral. Arisite-(Ce) is one of the last minerals to crystallize in the sodalite syenite xenoliths.

The Saint-Amable phonolite sill (STA) is genetically related to the Monteregian Hills petrographic province. The sill is the result of multiple injections of phonolite magma and is 0.6 to 1.2 m thick. The phonolite is fine-grained (average grain-size 40 μm), dark gray in color, and composed of phenocrysts of nepheline in a trachytic matrix of sanidine, aegirine and natrolite. The sill contains many mineralized cavities and seams that contain well formed postmagmatic and hydrothermal minerals. Arisite-(Ce) in these mineralized cavities occurs as thin, flexible, rounded to irregular micaceous plates up to 0.5 mm in diameter. The plates are pearly and silvery white and form rosettes or spherical aggregates. Associated minerals include natrolite, aegirine, albite, manganoneptunite, rhodochrosite, sphalerite, astrophyllite, and a beige-to-brown unidentified mineral.

Arisite-(Ce) has a poor cleavage parallel to (001), is brittle and has a conchoidal fracture. Its Mohs hardness is 3.5; it does not fluoresce under long- or short-wave UV radiation. The calculated density is 4.126 g/cm$^3$. It dissolves slowly with effervescence in room-temperature, dilute HCL. Arisite-(Ce) is uniaxial negative, exhibits sharp extinction and a range of refractive indices [$\omega$ = 1.696–1.714(4), $\varepsilon$ = 1.594–1.611(3)] in each grain due to chemical zoning.

The chemical composition of arisite-(Ce) was determined using electron microprobe (WDS) and laser ablation-ICPMS. LA-ICPMS was used to verify the presence of B (8–11 ppm) and to check the carbon content of the arisite-(Ce) from Namibia (4.83 wt%).

The average composition of Arisite-(Ce) from Namibia (n = 6, ranges in parentheses) is: $Na_2O$ 5.89 (5.64–6.08), CaO 1.51 (1.00–3.03), SrO 0.11 (below MDL–0.32), $La_2O_3$ 25.47 (23.79–27.79), $Ce_2O_3$ 29.80 (28.26–31.11), $Pr_2O_3$ 1.43 (1.0 1.98), $Nd_2O_3$ 3.54 (2.73–4.64), $Sm_2O_3$ 0.47 (0.3–0.61), $CO_2$ 23.40 (by stoichiometry), F 5.93 (5.4–6.61), less O=F = 2.50, total 95.26. This gives an empirical formula (on the basis of seven negative charges) of $(Na_{0.97}Ca_{0.03})_{\Sigma1.00}(Ce_{0.92}La_{0.80}Nd_{0.11}Pr_{0.04}Sm_{0.01}Ca_{0.09})_{\Sigma1.97}(CO_3)_2[(CO_3)_{0.71}F_{0.59}]F$. The ideal formula of arisite-(Ce) is $NaCe_2(CO_3)_2[F_2 \times (CO_3)1 - x]F$.

The average composition of arisite-(Ce) from MSH (n = 3, ranges in parentheses) is: $Na_2O$ 4.49 (4.44–4.52), CaO 5.39 (5.39–5.47), SrO 2.78 (2.67–2.86), $La_2O_3$ 15.56 (15.42–15.72), $Ce_2O_3$ 30.71 (30.32–30.98), $Pr_2O_3$ 3.03 (2.90–3.15), $Nd_2O_3$ 8.12 (8.03–8.22), $Sm_2O_3$ 0.69 (0.65–0.75), $Gd_2O_3$ 0.54 (0.34–0.77) $CO_2$ 20.92 (by stoichiometry), F 9.62 (9.46–9.80), less O=F = 4.05, total 97.90. This gives an empirical formula (on the basis of seven negative charges) of $(Na_{0.70}Ca_{0.30})_{1.00}(Ce_{0.90}La_{0.49}Nd_{0.23}Pr_{0.09}Sm_{0.02}Gd_{0.01}Ca_{0.16}Sr_{0.13})_{\Sigma2.03}(CO_3)_2[F_{1.43}(CO_3)_{0.28}]F$. TGA-DTA analyses of arisite-(Ce) from MSH shows a two step mass loss; 1 wt% at 205.8 °C and 16.5 wt% at 382.0 °C. Both losses are attributed to $CO_2$ loss on heating.

Fourier transform infrared spectroscopy of arisite-(Ce) from NAM and MSH exhibited the following structures: a sharp band at 1790 cm$^{-1}$ attributed to C-O stretching, broad bands at 1485 and 1483 cm$^{-1}$ attributed to $CO_3$ asymmetric stretching, a sharp band at 1075 cm$^{-1}$ attributed to $CO_3$ symmetric stretching, sharp peaks at 884, 856, and 802 cm$^{-1}$ attributed to out-of-plane bending of $CO_3$ and a sharp peak at 716 cm$^{-1}$ attributed to in-plane bending of $CO_3$. OH stretching bands in the 3450–3200 cm$^{-1}$ region are attributed to the presence of minor $H_2O$ substituting for F. Raman spectroscopy of arisite-(Ce) from MSH supports the interpretation of the FTIR spectra.

Powder diffraction data were collected for samples from NAM, MSH, and STA. Data for NAM and STA were collected using a Bruker AXS D8 Discover microdiffractometer with a Hi-Star area detector and Cu$K\alpha$ radiation. Data for the MSH material were collected using a Debye-Scherrer camera using Ni-filtered Cu$K\alpha$ radiation. The strongest 11 lines of the powder X-ray diffraction pattern for NAM [$d_{obs}$ in Å ($I_{obs}$%,$hkl$)] are: 4.439(100,100), 4.352(52,002), 3.103(87,102), 2.561(38,110), 2.424(21,103), 2.171(12,004), 1.9748(42,202), 1.9501(16,104), 1.9169(12,113), 1.6547(11,114), and 1.5640(13,212). The strongest 11 lines of the powder X-ray-diffraction pattern for MSH [$d_{obs}$ in Å ($I_{obs}$%,$hkl$)] are: 4.428(100,100), 4.317(60,002), 3.097(80,102), 2.558(50,110), 2.415(40,103), 2.162(30,004), 1.969(60,202), 1.941(30,104), 1.910(20,113), 1.650(30,114), and 1.560(20,212). The mineral is hexagonal, $P\overline{6}m2$, $a$ = 5.1109(2), $c$ = 8.6713(4) Å, $V$ = 196.16(6) Å$^3$, $Z$ = 1 (data from single-crystal refinement).

The name is for the Arisite quarry. Mineral and name have been approved by the IMA CNMMN (2009-13). Co-type samples are held in the collection of the Canadian Museum of Nature [CMNMC 86067 (NAM) and CMNMC 86068 (MSH)]. **G.P.**

## Arisite-(La)*

P.C. Piilonen, A.M. McDonald, J.D. Grice, M.A. Cooper, U. Kolitsch, R. Rowe, R. Gault, and G. Poirier (2010) Arisite-(La), a new REE-fluorcarbonate mineral from the Aris phonolite (Namibia), with descriptions of the crystal structures of arisite-(La) and arisite-(Ce). Min. Mag., 74, 257–268.

Arisite-(La) is the La-dominant form of arisite, a REE fluorocarbonate. It is found as La-rich cores in arisite-(Ce) from the Aris phonolite in Namibia. [For detailed description of type locality and associated minerals see note for arisite-(Ce).]

Arisite-(La) is visually indistinguishable from arisite-(Ce). Arisite-(La) has a poor cleavage parallel to (001) is brittle and has a conchoidal fracture. Crystals are zoned, with cores of arisite-(La) and rims of arisite-(Ce). Its Mohs hardness is 3.5, it does not fluoresce under long- or short-wave UV radiation.

The calculated density is 4.072 g/cm$^3$. It dissolves slowly with effervescence in room-temperature dilute HCL. Arisite-(La) is uniaxial negative, exhibits sharp extinction and a range of refractive indices [$\omega$ = 1.696–1.714(4), $\varepsilon$ = 1.594–1.611(3)] in each grain due to chemical zoning.

The chemical composition of arisite-(La) was determined using electron microprobe (WDS) and laser ablation-ICPMS. LA-ICPMS was used to verify the presence of B (8–11 ppm) and to check the carbon content (4.83 wt%).

The average composition of arisite-(La) ($n$ = 4, ranges in parentheses) is: $Na_2O$ 6.07 (6.01–6.20), CaO 1.62 (1.17–1.92), SrO 0.10 (0.04–0.20), $La_2O_3$ 28.83 (28.57–29.07), $Ce_2O_3$ 26.86 (26.09–27.87), $Pr_2O_3$ 1.10 (0.97–1.41), $Nd_2O_3$ 2.68 (2.47–2.95), $Sm_2O_3$ 0.34 (0.26–0.43), $CO_2$ 22.80 (by stoichiometry), F 6.51 (6.41–6.63), less O=F = 2.74, total 94.17. This gives an empirical formula (on the basis of seven negative charges) of: $(Na_{0.99}Ca_{0.01})_{\Sigma 1.00}(La_{0.90}Ce_{0.83}Nd_{0.08}Pr_{0.03}Sm_{0.01}Ca_{0.14})_{\Sigma 1.99}(CO_3)_2[F_{0.73}(CO_3)_{0.63}]F$. The ideal formula of arisite-(La) is $NaLa_2(CO_3)_2[F_{2x}(CO_3)_{1-x}]F$.

Powder diffraction data were collected using a Bruker AXS D8 Discover microdiffractometer with a Hi-Star area detector and Cu$K\alpha$ radiation. The seven strongest lines in the powder diffraction pattern [$d_{obs}$ in Å ($I_{obs}$%,$hkl$)] are: 4.439(100,100), 3.103(87,102), 4.352(52,002), 2.212(43,200), 1.9748(42,202), 2.561(38,110), and 1.9501(16,104). Single-crystal data for arisite-(La) and arisite-(Ce) from Namibia were collected using a Bruker SMART system consisting of a four-circle goniometer and a 4K Apex CCD detector and Mo$K\alpha$ radiation. Arisite is hexagonal, $P\overline{6}m2$, $Z$ = 1, with unit-cell parameters of $a$ = 5.1109(2) Å, $c$ = 8.6713(4) Å, $V$ =196.16(6) Å$^3$ for arisite-(Ce), and $a$ = 5.1131(7) Å, $c$ = 8.6759(17) Å, $V$ = 196.43(5) Å$^3$ for arisite-(La). The crystal structures were refined by direct methods to $R$ = 1.66%, $wR_2$ 4.31% using 270 unique reflections for arisite-(Ce) and to $R$ = 2.09%, $wR_2$ = 5.26 using 270 unique reflections for arisite-(La). Arisite-(Ce) and Arisite-(La) are isostructural layered REE fluorocarbonates with flat lying $CO_3^{-2}$ groups. The structure of arisite consists of three layers parallel to (001); sheets of NaΦ9 polyhedra, $\infty[REE(CO_3)_2F]$ slabs and $\infty[2F/CO_3]^{2-}$. Arisite-(Ce) and arisite-(La) are members of the layered flat-lying REE fluorocarbonate group, which also includes minerals such as cordylite, kukharenkoite, cebaite, lukechangite, and huanghoite.

The name and mineral have been approved by the IMA CNMMN (2009-019). Type material is held in the collection of the Canadian Museum of Nature (CMNMC 86076). **G.P.**

## Arsenoflorencite-(La)*

S.J. Mills, P.M. Kartashov, A.R. Kampf, and M. Raudsepp (2010) Arsenoflorencite-(La), a new mineral from the Komi Republic, Russian Federation: description and crystal structure. Eur. J. Mineral., 22, 613–621.

Arsenoflorencite-(La), ideally $LaAl_3(AsO_4)_2(OH)_6$, is a new mineral (IMA2009-078), from the Grubependity Lake cirque, Maldynyrd range, upper Kozhim River basin, Prepolar Ural, Komi Republic, Russia, several kilometers from the Chudnoe Pd–Au–Cr deposit. In the Maldynyrd range of the Prepolar Urals there are two large tectonic complexes; the Baikalian (Pre-Uralides) and Caledono–Hercynian (Uralides). These rocks were initially metamorphosed during the Early–Middle Cambrian, and underwent further metamorphism in the Late Paleozoic, under chlorite–muscovite conditions of the greenschist facies (~400 °C), with kyanite occurring along Paleozoic fault zones. Arsenoflorencite-(La) and associated minerals are likely to have formed during recrystallization of concretions in metasediment at this time.

Unusual concretions with REE mineralization were found in a layer of schist resulting from the metamorphism of coarse-grained arkosic sandstones. Macroscopically, the concretions are red-brown and vary from 3 × 5 to 30 × 10 cm across. They consist of the same minerals as the surrounding schist, but with higher concentration of Mn-bearing minerals—ardennite-(As), spessartine and piemontite. In addition, manganiandrosite-(La), zircon, monazite-(La), xenotime-(Y), chernovite-(Y), Nd-rich chernovite-(Y), gasparite-(Ce), and arsenoflorencite-(La) were detected in heavy mineral concentrates from the concretions. Three new Nd- and La-dominant LREE arsenates belonging to the chernovite and gasparite groups and an unnamed, probably new, high-Mn, Nd-dominant allanite-group mineral have also been identified.

Arsenoflorencite-(La) was found in a 3 × 2 cm concretion that had been crushed and samples were obtained as a set of fractions divided by heavy liquids and electromagnets, as such a petrographic description is reconstructed on the basis of observed mineral intergrowths of the concretion. The main difference between this sample and those described prior is the complete absence of spessartine and any epidote-group minerals in this concretion. In this sample, arsenoflorencite-(La) occurs in direct association with zircon, quartz, hematite, ardennite-(As), andalusite, sillimanite, anorthite, sericite, clinochlore, chernovite-(Y), and monazite–gasparite group minerals.

Arsenoflorencite-(La) also occurs at the Holičky, Stráž and Osečná deposits, North Bohemian Uranium District, Liberec Region, Bohemia, Czech Republic. Here it occurs in the cement of Cenomanian (99.6–93.5 Ma) sandstones as zones within crystals of florencite-(Ce) (irregular crystals that grade into arsenogoyazite) and zoned crystals with ‘‘arsenoflorencite-(Nd)’’ and crandallite.

Arsenoflorencite-(La) forms orange-red to pink rhombohedral, pseudocubic or tabular crystals up to about 0.2 mm across, which are visually indistinguishable from andalusite. Forms observed are {001} and {102}. Arsenoflorencite-(La) crystals are transparent to translucent and the streak is very pale pink. Crystals have a vitreous luster and have fair cleavage on {001}. Mohs hardness is estimated at about 3.5, by analogy to other alunite supergroup minerals. The tenacity is brittle, the fracture is uneven, and no parting was observed. No macroscopic or microscopic twinning was observed. The density measured by the sink-float method in Clerici solution is 4.15(5) g/cm$^3$, although the calculated density from the empirical formula and single-crystal unit cell is 4.159 g/cm$^3$. Arsenoflorencite-(La) is non-fluorescent under unfiltered ultraviolet light; however, some crystals change from pink to deep marine-green when elevated Nd contents are present. Crystals of arsenoflorencite-(La) are uniaxial (+), with the indices of refraction $\omega$ = 1.740(5) and $\varepsilon$ = 1.750(5), measured in white light. Arsenoflorencite-(La) is nonpleochroic.

The empirical formula (based on 14 O atoms) is: $La_{0.56}Ce_{0.18}$

$Nd_{0.12}Pr_{0.04}Sr_{0.09}Ca_{0.03})_{\Sigma 1.02}(Al_{2.94}Fe_{0.06})_{\Sigma 3.00}(As_{1.80}P_{0.21})_{\Sigma 2.01}H_{5.95}O_{14}$. The simplified formula is $LaAl_3(AsO_4)_2(OH)_6$. $H_2O$ could not be measured due to lack of material.

A crystal with approximate dimensions 135 × 95 × 75 mm was used for the structure determination at room temperature on a Bruker ×8 Apex II single-crystal diffractometer. Arsenoflorencite-(La) is trigonal, space group $R3m$, $a = 7.0316(3)$, $c = 16.5151(8)$ Å, $V = 707.16(5)$ Å$^3$, and $Z = 3$. The five strongest lines in the powder X-ray diffraction pattern are [$d_{obs}$ in Å ($I_{obs}$%, *hkl*)]: 2.982(100,113), 3.538,(55,110), 1.914(38,303,033), 2.211(28,122), and 5.755(27,101).

Arsenoflorencite-(La) has a typical rhombohedral alunite type structure. The structure consists of layers of corner-sharing $AlO_6$ octahedra and $AsO_4$ tetrahedra, stacked along c. The La atoms lie on the origin between the layers. The octahedra share corners via OH anions, O3, to form a planar network of triangular clusters, encompassing hexagonal voids. The apical O anions, O2, of the triangular groupings of octahedra are shared with the $AsO_4$ tetrahedra.

The mineral is named for its relationship to florencite [and arsenoflorencite-(Ce)] with La as the dominant REE, in accord with rare-earth nomenclature. Arsenoflorencite-(La) is a member of the dussertite group in the alunite supergroup. The mineral and name have been approved by the IMA–CNMNC (IMA 2008-078). One co-type specimen is housed in the collections of Mineral Sciences Department, Natural History Museum of Los Angeles County (900 Exposition Boulevard, Los Angeles, California 90007, U.S.A.), catalog number 62567, and one in the collections of the Fersman Mineralogical Museum [Leninskiy Prospekt 18(2), Moscow 117071, Russia], registered number 3891/1. **K.T.T.**

## CARBOBYSTRITE*

P. Khomyakov, F. Cámara, and E. Solokova (2010) Carbobystrite, $Na_8[Al_6Si_6O_{24}](CO_3)\cdot 4H_2O$, a new cancrinite-group mineral species from the Khibina alkaline massif, Kola Peninsula, Russia: description and crystal structure. Can. Mineral., 48, 291–300.

Carbobystrite was found in a 5 × 100 m hyperagpaitic pegmatite in an ijolite-urtite body near its contact with apatite-nepheline rocks. The pegmatite consists of a core composed mainly of villiaumite, nitrite, thermonatrite, and natrophosphate with a rim consisting mainly of large (1–1.5 m) aegirine spherulites. Minor minerals in the core of the body and at its contact with the aegirine rim are pectolite, microcline, sodalite, and lomonosovite; less common phases are chkalovite, vitusite-(Ce) and REE,Sr-enriched fluorapatite, with sporadic megakalsilite, natrolite, alkali amphibole, phlogopite, lamprophyllite, lovozerite, umbite, belovite-(Ce), fluorcaphite, nacaphite, nefedovite, bonshtedtite, sphalerite, galena, and molybdenite. Solid bitumen is an abundant phase in the pegmatite. Carbobystrite was found as a 3 mm grain in one hand sample where it is intergrown with sodalite, megakalsilite, and natrite.

Carbobystrite is colorless and transparent with a white streak and vitreous luster. It has no cleavage or parting and a brittle, conchoidal fracture. The Mohs hardness is 6. Density was not measured due to paucity of material, $D_{calc}$ is 2.366 g/cm$^3$. Carbobystrite is uniaxial negative with $\omega = 1.500(2)$, $\varepsilon = 1.488(2)$, and non-pleochroic. It fluoresces pale yellow in ultraviolet light (250–400 nm). Carbobystrite dissolves readily in 50% HCl and $HNO_3$. The Gladstone-Dale index is 0.010 or superior.

The infrared spectrum of carbobystrite was measured using a pellet of carbobystrite and KBr. The spectrum is characterized by bands at 3615–3350 cm$^{-1}$ indicating water and bands at 1510, 1491, and 1412 cm$^{-1}$ indicating $(CO_3)^{2-}$ groups. The spectrum is similar to that of cancrinite except in the frequency and number of bands in the latter. The increased complexity of this region in cancrinite is ascribed to disorder of $CO_3$ groups along the cancrinite channel.

The composition of carbobystrite was determined by electron microprobe. The average composition (with ranges in parentheses, n not given) is $Na_2O$ 22.66 (22.12–23.05), $K_2O$ 1.75 (1.68–1.81), $SiO_2$ 35.74 (35.33–36.00), $Al_2O_3$ 30.42 (29.97–30.84), $CO_2$ 4.37, $H_2O$ 6.26, total 101.20 wt% with $CO_2$ and $H_2O$ determined by stoichiometry. This composition leads to an empirical formula (based on 30.5 O atoms per formula unit) of $(Na_{7.40}K_{0.38})_{\Sigma 7.78}(Al_{6.04}Si_{6.02})_{\Sigma 12.06}O_{24}(CO_3)\cdot 3.5H_2O$.

Powder diffraction data were collected using a Debye-Scherrer camera with a Gandolfi attachment and Ni-filtered Cu*K*α radiation. The strongest reflections in the X-ray powder diffraction pattern [$d_{obs}$ in Å ($I_{obs}$%,*hkl*)] are: 4.689(100,012), 3.249(100,$\bar{1}$32,122), 6.378(80,110), 2.661(80,041,123,$\bar{1}$33), 3.867(70,$\bar{1}$31,121), and 3.664(70,030).

Single-crystal data were collected using a 0.56 × 0.30 × 0.20 mm crystal mounted on a Bruker AXS diffractometer with an APEX 1K CCD detector and Mo*K*α radiation. The structure was solved using direct methods; 4893 unique reflections yielded an $R_{int}$ of 2.6%. Carbobystrite is trigonal, with $a = 12.6678(5)$, $c = 10.3401(4)$ Å, $V = 1437.0(2)$ Å$^3$, $c{:}a = 0.8162$, space group $P31c$, $Z = 2$. Carbobystrite is isostructural with the synthetic germinate $Na_8(Al_6Ge_6O_{24})(CO_3)\cdot 3H_2O$. The structure consists of LOSOD cages and ε (cancrinite) cages, which are assembled into two different chains along [001]. There are two LOSOD and two ε cages per unit cell, the ε cages containing $2H_2O$ per unit cell and the LOSOD cages containing $2(CO_3) + 6H_2O$ per unit cell for a maximum of $6H_2O$ and $2CO_3$ per unit cell. In the ε cages, $H_2O$ in the O1(12) site coordinates $Na^+$ at the Na1 site, which is fully occupied by Na in carbobystrite. In the LOSOD cages, $H_2O$ at the O10 and O11 sites coordinate Na the Na2, Na3, and Na4 sites. The LOSOD cages also host $CO_3$ at the O9 site. Only the Na4 site contains K. In the carbobystrite structure, Si and Al are fully ordered.

The name indicates the relationship between bystrite $\{(Na,K)_7Ca[Al_6Si_6O_{24}](S)_{1.5}\cdot H_2O\}$ and carbobystrite. The mineral and name were approved by the IMA Commission on new minerals, nomenclature, and classification (IMA 2009-28) The type sample is held in the collection of the Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow, Russia, catalog no. 3836. **G.P.**

## DANTOPAITE*

E. Makovicky, W.H. Parr, H. Putz, and G. Zagler (2010) Dantopaite, $Ag_5Bi_{13}S_{22}$, the $^6P$ natural member of the pavonite homologous series, from Erzwies, Austria. Can. Mineral., 48, 467–481.

Dantopaite is a rare mineral found in a quartz vein in the Erzwies area in the Hohe Tauern region in the province of Salzburg, Austria. The main host rocks in the area are Jurassic limestone and dolostone, which contain quartz veins containing an ore assemblage consisting of Ag-rich gold, arsenopyrite, pyrite, sphalerite, galena, Ag-rich tetrahedrite, acanthite, and pyrargyrite. A second set of veins cut the Variscan granitoids of the Central Gneiss and predate the main ore veins. These veins exhibit sulphosalt mineralization. Dantopaite is found in this vein system associated with massive sulphosalt mineralization bands up to 5 cm wide. In these bands it is associated with bismuthinite, krupkaite, pavonite, benjaminite, gustavite, heyrovskyite, and cosalite, traces of tetradymite, native gold, and pyrite. In thin section it is found as isolated grains in quartz and as a part of pavonite-benjaminite intergrowths.

Observed in hand specimen, dantopaite is grayish white, opaque with a metallic luster. In polished section (plane polarized light) it is grayish white with no internal reflections. No reflection pleochroism was observed. Bireflectance is detectable in air and moderate in oil; anisotropy is distinct in air and enhanced in oil. Bluish gray to brownish gray rotation tints are observed under crossed polars. Reflectance values in air are (wavelength, min to max): 470 nm 41.5–48.3, 546 nm 40.9–47.0, 589 nm 40.4–46.6, and 650 nm 39.9–46.1. Dantopaite is brittle and has an uneven fracture with a $VHN_{50}$ of 190 kg/mm$^2$ (Mohs 3.5). Density could not be measured; $D_{calc}$ is 6.74 g/cm$^3$.

The composition was determined using electron microprobe (WDS). The average of 37 analyses of two grains is Cu 1.68, Ag 11.56, Pb 4.64, Bi 63.82, Te 0.34, S 17.52, total 99.57 wt% giving an empirical formula (on the basis of (S + Te = 22) of: $Cu_{1.06}$ $Ag_{4.24}$,$Pb_{0.9}Bi_{12.23}S_{21.89}Te_{0.11}$. An excess of cations (0.43 apfu) is attributed to the accumulation of Cu in the column of octahedra in the thinner structural slabs.

Single-crystal data for structure refinement were collected using a 0.05 × 0.07 × 0.09 mm crystal mounted on a Bruker AXS three-circle diffractometer equipped with a CCD area detector. Dantopaite is monoclinic, space group $C2/m$ with $a = 13.380(3)$, $b = 4.0492(9)$, $c = 18.690(4)$ Å, $V = 975.8(4)$ Å$^3$, and $Z = 1$. The strongest ten lines in the (calculated) powder-diffraction pattern [$d_{obs}$ in Å ($I_{obs}$%,$hkl$)] are: 3.578(58,$\bar{2}$05), 3.452(90,112), 3.331(36,$\bar{4}$01), 3.301(40,204), 2.861(100,$\bar{3}$13), 2.225(24,$\bar{1}$17), 2.025(25,020), 2.013(24,512), 2.838(23,205), and 2.225(23,$\bar{1}$17). The structure of dantopaite was refined using direct methods. The final $R_1$ value was 7.3% for 1051 observed reflections with $F_o > 4\sigma(F_o)$. The structure of dantopaite consists of alternating thick and thin slabs. The thin slabs consist of a single column of edge sharing octahedra. These are flanked and interconnected within the slab by double columns of Bi coordination pyramids. The thick slabs are composed of coordination octahedra of Bi and (Bi, Pb, Ag). There are six of these octahedra in a diagonal row across a thick slab confirming that dantopaite is a $^6$P pavonite homologue.

The name is for Dan Topa (University of Salzburg), ore mineralogist and crystallographer. The mineral and name have been approved by the CNMMC of the IMA (2008-058) and holotype material is held in the reference collection of the Department of Materials Research and Physics (Division of Mineralogy), University of Salzburg. **G.P.**

## EIRIKITE*

A.O. Larsen, U. Kolitsch, R.A. Gault, and G. Giester (2010) Eirikite, a new mineral species of the leifite group from the Langesundsfjord district, Norway. Eur. J. Mineral., 22, 875–880.

Eirikite, ideally $KNa_6[Be_2(Si_{15}Al_3)_{\Sigma 18}O_{39}F_2]$, is a new mineral species from the Vesle Arøya island in the Langesundsfjord district (coordinates N59° 00.6170, E9° 47.7460), Larvik, Vestfold, Norway. The eirikite-bearing nepheline syenite pegmatite dike is situated on the southeastern part of the Vesle Arøya island and had been blasted more than 100 years ago in search of minerals. Therefore, all samples of eirikite and its associated minerals for the present study were collected on the dump.

Eirikite occurs as either finely or coarsely fibrous, monomineralic aggregates up to several centimeters across, wholly or partly filling voids between larger microcline crystals. Individual acicular-prismatic crystals show the forms {1010} and {0001}. Bundles of radiating fibers reach 3 cm in length. Eirikite also occurs as aggregates up to 100 cm$^3$ in volume, built of interlocking, radiating fibrous groups, each up to 5 mm across, intergrown with large amounts of small zircon crystals and penetrated by aegirine crystals. Polylithionite, albite, eudialyte, catapleiite, and pyrochlore can be found within these aggregates.

Eirikite is white to colorless with a white streak and a vitreous to silky luster. Mohs hardness is 6, it is brittle with an uneven to conchoidal fracture, and a good {1010} cleavage. The mineral is uniaxial positive, $\omega = 1.517(1)$ and $\varepsilon = 1.521(1)$ ($\lambda = 589$ nm), and nonpleochroic. The measured density of eirikite is 2.59(1) g/cm$^3$, determined by the sink-float method using iodomethane diluted with acetone. This agrees well with the calculated density of 2.577 g/cm$^3$ (from the empirical chemical formula) and 2.584 g/cm$^3$ (from the crystal structure determination).

It is the potassium analogue of leifite, $NaNa_6[Be_2(Si_{15}Al_3)_{\Sigma 18}O_{39}F_2]$, and telyushenkoite, $CsNa_6[Be_2(Si_{15}Al_3)_{\Sigma 18}O_{39}F_2]$. An average of five electron microprobe analyses gave $Na_2O$ 13.38, $K_2O$ 3.13, $Al_2O_3$ 11.08, $SiO_2$ 66.03, F 2.70, BeO 3.65 (calc.), O=F –1.14, total 98.83 wt%, resulting in the empirical formula $K_{0.91}Na_{5.92}[Be_2(Si_{15.07}Al_{2.98})_{\Sigma 18.05}]O_{39}(F_{1.95}O_{0.05})$; infrared spectroscopy confirms the absence of OH and $H_2O$.

Eirikite is trigonal, $P3m1$, with $a = 14.3865(9)$, $c = 4.8733(4)$ Å, $V = 873.5(1)$ Å$^3$, and $Z = 1$, refined from X-ray powder diffraction data. The five strongest lines in the X-ray powder pattern are [$d_{obs}$ in Å ($I_{obs}$%,$hkl$)]: 4.710(29,120), 4.153(21,030), 3.386(70,211), 3.161(100,031), and 2.466(31,231).

The atomic arrangement is characterized by a framework of corner-sharing $(Si,Al)O_4$ and $BeO_3F$ tetrahedra, leading to chain and ring units. Voids in the framework are occupied by K and Na atoms. Details of the topology are discussed elsewhere.

The mineral is named after the Viking Eirik Raude (Eric the Red, born in about the year 950, died in about the year 1003), emigrant from Norway and the discoverer of Greenland in the year 982, and father of Leiv (Leif) Eirikson, after whom leifite was named and described. Erikite, with reference to the same Viking person (using the Danish spelling Erik), was described by Bøggild (1903). The mineral was, however, discredited by Pekov et al. (1997) as being a pseudomorph after vitusite, composed of monazite and rhabdophane The new mineral species and its name have been approved by the Commission on New Minerals, Nomenclature and Classification, International Mineralogical Association (CNMNC no. 2007-017). The holotype specimen of eirikite is housed in the collection of the Department of Geology, Natural History Museum, University of Oslo (catalog no. 41773). **K.T.T.**

## FERRO-OBERTIITE*

F.C. Hawthorne, N.A. Ball, and G.K. Czamanske (2010) Ferro-obertiite, $Na\,Na_2\,(Fe^{2+}_3Fe^{3+}Ti)\,Si_8\,O_{22}O_2$, a new mineral species of the amphibole group from Coyote Peak, Humboldt county, California. Can. Mineral, 48, 301–306.

Ferro-obertiite was discovered in an alkali diatreme that penetrates a lithic-wake sandstone of the Franciscan sequence 20 km southeast of Orick, California. The lithic-wacke sandstone fragments underwent metasomatism that produced small-scale heterogeneous reaction zones in the sandstone. Ferro-obertiite is found in these reaction zones in a matrix of aegirine and alkali feldspar.

Ferro-obertiite has a vitreous luster and is black with a gray streak. It shows no fluorescence under short or long-wave fluorescent light. Grains are euhedral to subhedral, prismatic to acicular on [001], and are bounded by {110} cleavage faces. Cleavage is perfect on {110} with 56° intersections. The calculated density is 3.330 g/cm$^3$. Ferro-obertiite is biaxial negative with $\alpha = 1.671(1)$, $\beta = 1.674(1)$, $\gamma = 1.675(1)$, $2V_{obs} = 60(3)°$, $2V_{calc} = 59.9°$. It is pleochroic, with X dark brown, Y brown, Z dark gray; $X \wedge a = 77.3°$ (in β acute), Y || b, $Z \wedge c = 91.2°$ (in β obtuse).

The chemical composition was determined by electron microprobe. Li and $Fe^{3+}$ were determined by structure refinement. The average of 10 analyses is $SiO_2$ 52.47, $Al_2O_3$ 0.09, $TiO_2$ 6.51, $Fe_2O_3$ 4.54, FeO 18.43, MgO 5.74, MnO 0.15, CaO 0.90, $Na_2O$ 8.70, $K_2O$ 1.51, $Li_2O$ 0.17, F 0.51, $H_2O$ 0.58, total 100.09 wt%. This composition leads to a structural formula (on the basis of 24 O, OH, F) of $^{A}(Na_{0.72}\,K_{0.29})(Na_{1.85}Ca_{0.15})(Mg_{1.30}Fe^{2+}_{2.35}Mn^{2+}_{0.02}Fe^{3+}_{0.52}Al_{0.01}Ti_{0.75}Li_{0.10})(Si_{7.99}Al_{0.01})O_{22}(O_{1.16}F_{0.25}OH_{0.59})$.

A powder pattern was simulated by mounting a small grain on a Debye-Scherrer camera with a Gandalfi attachment and Fe-filtered Cu*K*α radiation. The strongest 10 X-ray-diffraction lines in the powder pattern [$d_{obs}$ in Å ($I_{obs}$%,*hkl*)] are: 2.722(100,$\bar{3}$31,151), 8.448(80,110), 3.407(60,131,041), 3.144(50,201,310), 2.596(50,061), 2.533(40,$\bar{2}$02), 2.178(30,261), 4.514(20,040, 021), 3.283(20,240), and 2.332(20,$\bar{3}$51).

The crystal structure of ferro-obertiite was refined to $R_1$ of 1.7% on the basis of 774 observed reflections. It is monoclinic, space group *C*2/*m*, $a = 9.845(4)$, $b = 18.018(8)$, $c = 5.296(3)$ Å, $\beta = 103.86(3)°$, $V = 912.1(4)$ Å$^3$, and $Z = 2$.

The structure of ferro-obertiite is distinguished by having more than 1.00 apfu $O^{2-}$ at the O3 site and greater than 0.5 apfu Ti at the M1 site. Ferro-obertiite can be derived from obertiite by the homovalent substitution $^{C}Fe^{2+} \rightarrow {}^{C}Mg$.

The name and the mineral have been approved by the IMA (CNMMC 2009-034). Holotype material is held in the collection of the Royal Ontario Museum, Toronto, Canada (M54035). **G.P.**

## GARUTIITE (NI,FE,IR)*

A.M. McDonald, J.A. Proenza, F. Zaccarini, N.S. Rudashevsky, L.J. Cabri, C.J. Stanley, N.V. Rudashevsky, J.C. Melgarejo, J.F. Lewis, F. Longo, and R.J. Bakker (2010) Garutiite, (Ni,Fe,Ir), a new hexagonal polymorph of native Ni from Loma Peguera, Dominican Republic. Eur. J. Mineral., 22, 293–304.

Garutiite (Ni,Fe,Ir) is a new hexagonal polymorph of native Ni discovered in chromitite from Loma Peguera, Dominican Republic. The Loma Peguera chromitites are found in the central part of Loma Caribe peridotite in the Cordillera Central of the Dominican Republic. In the mid-1990s, during exploration and mining activity in the area of Loma Peguera, relatively small lensoidal bodies (<2 m) of chromitite were found. They are randomly distributed, typically occurring as discontinuous pods or lenses within small masses of serpentinized dunite that are in turn hosted by serpentinized harzburgite. The chromitite (>95 vol% chromite) displays massive textures with individual chromite grains showing evidence for development of thin rims of ferrian chromite.

To better understand the platinum-group mineralogy of the chromitite and to investigate the broader role that lateritic weathering can play in the formation of secondary PGM, heavy mineral separates were produced via a combination electric pulse disaggregation (EPD) and hydroseparation (HS) techniques. This is the first report of a new mineral having been found after the complementary use of EPD and HS techniques.

Garutiite forms anhedral, botryoidal grains that are generally 10–60 μm in size, with a maximum of 110 μm. The mineral most frequently occurs intergrown with other PGM and intermetallic phases, making detailed physical analyses on garutiite difficult. Megascopically, the mineral is gray to gray-black in color with a metallic luster. In plane-polarized reflected light, it is white with a very weak anisotropy. No bireflectance, pleochroism, or internal reflections were observed. It has very weak (not measurable on the only grain from which meaningful results could be obtained) bireflectance. No twinning or cleavage was observed. The density could not be directly measured owing to the complex, intergrown nature of the mineral and its small grain size. The calculated density is 11.33(1) g/cm$^3$, based on the empirical formula and unit-cell parameters acquired from X-ray powder diffraction data. No micro-hardness measurements were made. The obtained Raman spectrum shows no discernible absorption bands over the range of 150–2000 cm$^{-1}$. Reflectance values (%) in air are: 63.8 at 470, 65.9 at 546, 67.0 at 589, and 68.0 at 650 nm.

The average result of electron microprobe analyses ($n = 42$ from 27 grains) is: Ni 27.91, Fe 19.94, Ir 43.78, Pt 6.98, Co 0.55, Cu 0.43, Ru, 0.50, Rh 0.74, Os 0.67, total 101.51 wt%, corresponding to $(Ni_{0.421}Fe_{0.316}Ir_{0.202}Pt_{0.032}Co_{0.008}Cu_{0.006}Rh_{0.006}Ru_{0.004}Os_{0.003})_{\Sigma1}$ or the simplified formula, (Ni,Fe,Ir).

Garutiite is the Ni analogue of hexaferrum, osmium, and ruthenium and is classified as belonging to the osmium group. As such, the mineral is considered to be hexagonal, crystallizing in space group $P6_3/mmc$ with $a = 2.6941(4)$ and $c = 4.2731(6)$ Å, $V = 26.86(1)$ Å$^3$, $Z = 2$. The strongest lines of the X-ray powder diffraction pattern [$d_{obs}$ in Å ($I_{obs}$%,*hkl*)] are: 2.330(50,100), 2.136(30,002), 2.046(100,101), 1.576(30,102), 1.3470(40,110), 1.2155(40,103). Minerals of the osmium group possess only one crystallographic site in their crystal structures. The implication is that the complex empirical chemical formula established for garutiite most accurately represents solid solution among several end-members rather than uncertainty in the chemical formula or crystal structure of the mineral.

The name honors Giorgio Garuti, in recognition of his contributions to the understanding of the mineralogy of platinum-group elements. The mineral and name have been approved by the Commission on New Minerals, Nomenclature and Classification of the International Mineralogical Association (IMA 2008-055). The type specimen is housed in the Mineralogical Museum of Leoben, Austria (catalog number 8241). The holotype (the crystal chosen for the X-ray powder diffraction work) is housed at the Canadian Museum of Nature (CMNMC 86089). **K.T.T.**

## HEFTETJERNITE*

U. Kolitsch, R. Kristiansen, G. Raade, and E. Tillmanns (2010) Heftetjernite, a new scandium mineral from the Heftetjern pegmatite, Tørdal, Norway. Eur. J. Mineral., 22, 309–316.

Heftetjernite, ideally $ScTaO_4$, is a new scandium mineral from the Heftetjern pegmatite, Tørdal, Telemark, Norway. The numerous granite pegmatites of the Tørdal area in Telemark are situated within the Nissedal volcano-sedimentary outlier. Both the outlier (1300–1200 Ma) and the older basement (1520–1500 Ma) are intruded by the Tørdal granite (960–850 Ma), which is regarded as the source of the pegmatite swarms. The Heftetjern cleavelandite-amazonite pegmatite is situated in a marshy area between Høydalen and Skarsfjell in Tørdal, Drangedal, Telemark, Norway, at an altitude of ~650 m *asl* (latitude 8° 45′ 00″ E, longitude 59° 11′ 00″ N). Heftetjernite occurs in a single small vug in the albite and appears on the surface or in between a nearly X-ray amorphous Ti-Y-Ta-Nb-mineral as a few elongate tabular to columnar, subparallel crystals (max. length ca. 0.4 mm, max. width ca. 0.1 mm), broken up by cracks.

Heftetjernite is very dark brown (to greenish brown in part) and translucent to transparent with an adamantine luster. The tabular form is {100}; no other distinct forms are observable (indistinct outline of crystals), but {010} or {001} are possibly present. No macroscopic twinning was observed. It is non-fluorescent, brittle, with a perfect {010} cleavage and irregular fracture, and a dark brownish (with a reddish hue) streak. The Mohs hardness could not be determined due to lack and size of material, but is estimated to be similar to that of ferberite, about 4.5. The very sparse material and high-density value did not allow a direct measurement of the density. The calculated X-ray density is 6.44 g/cm$^3$ for the fragment used for the crystal-structure solution. Optically, the mineral is biaxial. The optical character and $2V$ could not be determined due to the very dark color of the mineral. Interference colors, observed on tiny fragments, normal (not anomalous); hence, dispersion should be weak if present at all. Indistinctly lath-shaped fragments lying on their platy {100} face show weak pleochroism: yellowish brown with a reddish tint perpendicular to the morphological elongation and reddish brown (with stronger absorption) parallel to the morphological elongation. Edge-on fragments show no pleochroism. The optical orientation is unknown. The mean refractive index is 2.23, calculated from the Gladstone-Dale relationship using the X-ray density.

A total of eight point analyses on an electron microprobe showed only small variations of the chemical composition and yielded the empirical formula (based on four O atoms): $(Sc_{0.64}Sn_{0.13}Mn_{0.12}Fe_{0.08}Ti_{0.06})_{\Sigma 1.03}(Ta_{0.69}Nb_{0.30})_{\Sigma 0.99}O_4$. The simplified formula is $(Sc,Sn,Mn,Fe,Ti)(Ta,Nb)O_4$ and the ideal formula $ScTaO_4$.

The mineral crystallizes in the wolframite structure type, with space group $P2/c$ and $a = 4.784(1)$, $b = 5.693(1)$, $c = 5.120(1)$ Å, $\beta = 91.15(3)°$, $V = 139.42(5)$ Å$^3$ ($Z = 2$). Strongest lines in the calculated X-ray powder diffraction pattern of heftetjernite are [$d$ in Å ($I,hkl$)]: 3.000 ($100,11\bar{1}$), 2.9570 (97,111), 3.662 (53,110), 2.4877 ($34,02\bar{1}$), 4.783 (33,100), 3.807 ($32,01\bar{1}$). Heftetjernite is isotypic with the tungstates ferberite ($FeWO_4$), hübnerite ($MnWO_4$), sanmartinite ($ZnWO_4$), and synthetic $M^{2+}WO_4$ ($M$ = Mg, Co, Ni, Zn, Cd). Also isotypic are synthetic $M^{2+}MoO_4$ ($M$ = Mn, Co, Ni), $MnReO_4$, $M^{3+}NbO_4$ ($M^{3+}$ = Fe, In), and $InTaO_4$.

Heftetjernite is named after its type locality. The new mineral and mineral name was approved by the Commission on New Minerals, Nomenclature and Classification of the International Mineralogical Association (no. 2006-056). The holotype specimen is deposited in the Department of Geology, Natural History Museum, University of Oslo, Norway, under catalog no. 41726 (original sample designation ''RK99/04''). **K.T.T.**

## KUMDYKOLITE*

S.-L. Hwang, P. Shen, H.T. Chu, T.-F. Yui, J.G. Liou, and N.V. Sobolev (2009) Kumdykolite, an orthorhombic polymorph of albite, from the Kokchetav ultrahigh-pressure massif, Kazakhstan. Eur. J. Mineral., 21, 1325–1334.

Kumdykolite, an orthorhombic polymorph of albite, has been identified for the first time by analytical electron microscopy. It occurs in association with diopside, quartz/cristobalite, phengite/phlogopite, an unidentified aluminosilicate, calcic amphibole, dolomite, calcite, or talc, as micrometer-scale mineral inclusions in omphacite in eclogite from the Kumdy Kol, Kokchetav ultrahigh-pressure massif in northern Kazakhstan. The Kokchetav massif is a large (300 × 150 km), fault-bounded metamorphic complex of Proterozoic protolith age in northern Kazakhstan. In the central part of this massif, seven tectonic mélange units, which resulted from collision between the Siberian platform and the Vendian-Ordovician island arc, have been collectively named as the Zerenda Series. Kumdykolite is presumed to be a metastable phase formed at high temperatures followed by rapid cooling in the absence of water. It is further postulated that kumdykolite may have resulted from the interaction between infiltrated melt and omphacite when the Kokchetav massif was exhumed from mantle depths to the base of the crust. The phase could be taken as the corresponding sodium end-member of svyatoslavite. Analogous to svyatoslavite, kumdykolite might be a metastable phase.

Based on SAED patterns of analytical electron microscopy, the unit-cell parameters of kumdykolite were determined to be $a = 8.24(1)$, $b = 8.68(1)$, and $c = 4.84(1)$ Å ($V = 346.17$ Å$^3$, $Z = 2$). Its space group cannot be determined conclusively, but is limited to *P*2*nn* or *Pmnn*. Kumdykolite could be taken as a counterpart of svyatoslavite, which is an “orthorhombic” polymorph of anorthite and was shown by synthetic studies not to be a stable phase. It is noted that kumdykolite has never been reported from laboratory synthetic experiments, indicating that it might also be a metastable phase. Analogous to svyatoslavite, kumdykolite is presumed to form under high temperatures with rapid cooling and in the absence of water.

AEM-EDX revealed that kumdykolite contains 68.6–70.1% $SiO_2$, 18.6–19.1% $Al_2O_3$, 11.0–12.6% $Na_2O$, and 0.1–0.5% CaO by weight, corresponding to an empirical formula $Ca_{0.01}Na_{0.98}Al_{0.97}Si_{3.03}O_8$ or a simplified formula $NaAlSi_3O_8$. Based on the least-squares refinement of *d*-spacings measured on SAED patterns of several zone axes, the orthorhombic unit-cell parameters of kumdykolite were determined to be $a = 8.24(1)$ Å, $b = 8.68(1)$ Å, and $c = 4.84(1)$ Å ($V = 346.17$ Å$^3$, $Z = 2$). Although electron diffraction patterns and apparent systematic absences suggest that kumdykolite could have either *Pmnn* or *P*2*nn* symmetry, the authors conclude on the basis of comparison with the refined structural data of a $CaAl_2Si_2O_8$ phase that kumdykolite most likely has *Pmnn* symmetry.

The name for the type locality Kumdy Kol and mineral have been approved approved by the IMA CNMNC (2007-049). Holotype material of kumdykolite, a thin rock slab of sample Ec1b, is housed in the National Museum of Natural Science, Taichung, Taiwan. **K.T.T.**

## METARAUCHITE*

J. Plášil, J. Sejkora, J. Čejka, M. Novák, J. Viñals, P. Ondruš, F. Veselovský, P. Škácha, J. Jehlička, V. Goliáš, and J. Hloušek (2010) Metarauchite, $Ni(UO_2)_2(AsO_4)_2{\cdot}8H_2O$, from Jáchymov, Czech Republic, and Schneeberg, Germany: a new member of the autunite group. Can. Mineral., 48, 335–350.

Metarauchite is found at the Schweitzer vein of the Eduard mine, Jáchymov, Czech Republic covering altered aggregates of a primary ore with relict uraninite, arsenopyrite, with nickelskutterudite and traces of native Bi. It is usually associated with metazeunierite, erythrite, and gypsum. In Schneeburg, Germany it is found at the Adam Heber Mine in the “Gang Adam Heber Flache” in strongly oxidized vein material. Metarauchite from Jáchymov occurs as thick tabular crystals up to 0.8 mm in size, with a prevalent pinacoid (011). Crystals are twinned along {011}. At Schneeburg it occurs as isolated crystals up to 1 mm in diameter or as aggregates strewn on fractures or vugs.

Metarauchite is transparent to translucent, yellow to light greenish yellow, with vitreous to pearly luster. Streak is light green to pale yellow. There is a perfect cleavage on (011) and crystals are brittle with an uneven fracture, Mohs hardness is 2. No fluorescence was observed at in long- or short-wave ultraviolet light. The calculated density is 3.81 g/cm$^3$. Optically metarauchite is biaxial negative with $\alpha = 1.625(3)$, $\beta \approx \gamma = 1.649$ (1.646–1.651), $2V_{calc}$ 23–52° (depending on β and γ values used). It is nonpleochroic, with a Gladstone-Dale index of 0.03 (excellent).

Thermal decomposition analysis of metarauchite shows that release of interlayer $H_2O$ occurs in a stepwise fashion, with dehydration steps occurring at 95 °C (loss of 1.37 moles) at 110 °C (loss of 1.97 moles), at 180 °C (loss of 2.14 moles), and at ~320 °C (loss of remaining water, 2.73 moles).

The chemical composition of metarauchite was determined using an electron microprobe. Metarauchite from Jáchymov (normalized to 100, range in parentheses, $n = 13$) had the following composition: NiO 6.05 (5.58–7.10), CoO 0.91 (0.70–1.13), MgO 0.09(0.00–0.24), $UO_3$ 56.72(55.65–60.97), $As_2O_5$ 21.31 (19.87–23.22), $P_2O_5$ 0.22(0.12–0.32), $SiO_2$ 0.09, $H_2O$ 14.61 (from thermal analysis), total 100 wt%. This gives the empirical formula $(Ni_{0.82}Co_{0.12}Mg_{0.02})_{\Sigma 0.96}(UO_2)_{2.01}[(AsO_4)_{1.88}(PO_4)_{0.03}(SiO_4)_{0.02}]_{\Sigma 1.93}{\cdot}8.21H_2O$ (on the basis of 20 O,OH atoms). Analyses of Ni-rich metarauchite from Schneeburg (normalized to 100, range in parentheses, $n = 8$) gave the following composition NiO 5.48 (4.81–6.86), CoO 0.81 (0.57–1.09), ZnO 0.14 (0.00–0.42), MgO 0.50 (0.17–0.88), $UO_3$ 58.42 (59.64–64.49), $As_2O_5$ 18.34 (14.03–23.61), $P_2O_5$ 1.96 (0.64–3.83), $SiO_2$ 0.16 (0.00–0.42), $H_2O$ 14.19 (from thermal analysis), total 100 wt%. This gives the empirical formula $(Ni_{0.74}Mg_{0.13}Co_{0.11}Zn_{0.02})_{\Sigma 1.00}(UO2)_{2.01}[(AsO_4)_{1.62}(PO_4)_{0.28}(SiO_4)_{0.03})]_{\Sigma 1.93}{\cdot}7.99H_2O$

An infrared spectrum was obtained using a KBr powder (non-pelletized). The spectrum shows a band between 5300 and 3200 cm$^{-1}$ that is assigned to O-H stretching of $H_2O$. A weak band occurring at 1640 cm$^{-1}$ is assigned to the $\upsilon_2$ bending of $H_2O$ molecules. The region 100–750 cm$^{-1}$ contains U-O $\upsilon_1$ and $\upsilon_3$ stretching absorption peaks, which are superimposed on the $\upsilon_1$ and $\upsilon_3$ stretching peaks of $(AsO_4)^{3-}$ groups.

Powder diffraction data for the Jáchymov material were collected using graphite filtered Cu*K*α radiation and a Panalytical X’Pert Pro diffractometer equipped with an X’celerator detector. The powder diffraction data for the Schneeburg material were collected using a Bruker D8 Advanced diffractometer equipped with a LynxEye detector. The strongest six lines in the pattern of metarauchite from Jáchymov [$d_{obs}$ in Å ($I_{obs}$%,*hkl*)] are: 8.54(100,011), 4.28(49,022), 2.138(32,044), 3.957(12,122), 3.417(12,$\bar{1}$22), 3.201(10,031). The crystal structure of metarauchite could not be solved due to the absence of non-intergrown crystals. Unit-cell parameters were determined from powder diffraction data. Metarauchite from Jáchymov is triclinic, space group $P\bar{1}$ with $a = 7.194(4)$, $b = 9.713(5)$, $c = 13.201(9)$, $V = 882.2(9)$ Å$^3$, $\alpha = 75.79(5)°$, $\beta = 83.92(3)°$, and $\gamma = 81.59(4)°$, $Z = 2$. Metarauchite form Schneeburg has $a = 7.197(3)$, $b = 9.759(4)$, $c = 13.255(5)$, $V = 889.7(6)$ Å$^3$, $\alpha = 75.59(1)°$, $\beta = 83.88(1)°$, and $\gamma = 81.62(1)°$. Metarauchite is isostructural with metakirchheimerite.

The name is for Czech mineral collector Luděk Rauch who died prospecting in the Jáchymov mines. Name and mineral were approved by the IMA Commission of New Minerals, Nomenclature and Classification (2008-05). The holotype sample is held in the collection of Natural History Museum, National Museum, Prague, Czech Republic (catalog number P1p 19/2008). **G.P.**

## PYRACMONITE*

F. Demartin, C.M. Gramaccioli, and I. Campostrini (2010) Pyracmonite, $(NH_4)_3Fe(SO_4)_3$, a new ammonium iron sulfate from La Fossa crater, Vulcano, Aeolian Islands, Italy. Can. Mineral., 48, 307–313.

Pyracmonite was discovered in an intercrater fumarole (~250 °C) in a pyroclastic breccia. Associated minerals are salammonic, kremersite, $(NH_4)_2Fe^{3+}Cl_5{\cdot}H_2O$ and other new halides and sulfates.

Pyracmonite occurs as colorless to white aggregates of elongate hexagonal crystals up to 0.2 mm in length. Twinning was not observed. It has a white streak and a vitreous luster. No cleavage or fracture were observed. Measured and calculated densities are 2.22(1) and 2.228 g/cm$^3$, respectively. Pyracmonite is uniaxial with an average index of refraction of 1.562(3) and a compatibility index of 0.022 (excellent). Pyracmonite shows no fluorescence in long or short wave ultraviolet light; it is nonhygroscopic and stable in air.

The chemical composition of pyracmonite was determined by EDS, with the presence of $NH_4$ verified by the crystal structure analysis, the Nessler reaction and infrared spectroscopy. The average of 12 analyses (ranges in parentheses) is $(NH_4)_2O$ 17.85, $K_2O$ 2.77 (2.65–2.91), $Fe_2O_3$ 18.70 (18.02–19.13), $Al_2O_3$ 0.50 (0.10–0.92), and $SO_3$ 60.47 (59.60–61.40). Total 100.29. This composition leads to the empirical formula (based on 12 anions) of: $[(NH_4)_{2.74}K_{0.23}]_{\Sigma 2.97}(Fe_{0.94}Al_{0.04})_{\Sigma 0.98}S_{3.02}O_{12}$.

Powder diffraction data were collected using a Bruker D8 diffractometer using Cu$K\alpha$ radiation. The strongest six lines in the diffraction pattern [$d_{obs}$ in Å ($I_{obs}$%,$hkl$)] are: 7.596(100,110), 3.320(30,122), 3.371(26,131), 4.358(23,12$\bar{1}$), 2.829(14,312), and 2.863(8,321). Single-crystal data were collected from a 0.12 × 0.02 × 0.02 mm crystal with a Bruker Apex II diffractometer with a 2K CCD detector and Mo$K\alpha$ radiation. The structure was refined to $R_{Final}$ of 0.0.039 using 1010 observed reflections [$I > 2\sigma(I)$]. Pyracmonite is trigonal, space group $R3c$, with $a$ = 15.2171(14), $c$ = 8.9323(8) Å, $V$ = 1791.3(3) Å$^3$, and $Z$ = 6.

The structure of pyracmonite consists of linked $(Fe,Al)O_6$ octahedra and $SO_4$ tetrahedra, which share corners to form infinite columns of $[(Fe,Al)(SO_4)_3]$ along [001]. Ammonium ions are found in voids between these columns and link to the oxygen atoms of the $SO_4$ tetrahedra with hydrogen bonds.

The name is form the Greek for fire and anvil. The name and species were approved as a new species by the IMA Commission on New Minerals, Nomenclature and Classification (2008-029). The holotype specimen is held in the Reference Collection of the Dipartimento di Chimica Strutturale e Stereochimica Inorganica, Università degli Studi di Milano (2008-04). **G.P.**

## QINGHEIITE-(FE$^{2+}$)*

F. Hatert, M. Baijot, S. Philippo, and J. Wouters (2010) Qingheiite-(Fe$^{2+}$), $Na_2Fe^{2+}MgAl(PO_4)_3$, a new phosphate mineral from the Sebastião Cristino pegmatite, Minas Gerais, Brazil. Eur. J. Mineral., 22, 459–467.

Qingheiite-(Fe$^{2+}$), ideally $Na_2Fe^{2+}MgAl(PO_4)_3$, is a new mineral species from the Sebastião Cristino pegmatite, Minas Gerais, Brazil. The Sebastião Cristino pegmatite is located about four kilometers SE of the Córrego Frio mine, between the towns of Mendes Pimentel and Linópolis (18° 42′S 41° 27′W). The Sebastião Cristino pegmatite is several meters wide, and strikes northeast with a gentle northwesterly dip. It occurs within the garnet-, biotite-, and sillimanite-bearing schists of the São Tomé Formation (Rio Doce group, Late Proterozoic), and is probably correlated with the Galiléia granitoid (595 My). Qingheiite occurs as rims around frondelite grains, included in a matrix of quartz and albite. Frondelite is locally replaced by jahnsite, cyrilovite, and Fe-Mn oxides.

Qingheiite-(Fe$^{2+}$) is transparent and exhibits a dark green color, with a resinous luster and with a pale to bottle green streak. It is non-fluorescent, brittle, and shows a perfect {010} cleavage. The estimated Mohs hardness is 4. The average density measured on two grains with the Berman balance is 3.6(2) g/cm$^3$; the calculated density is 3.54 g/cm$^3$.

Qingheiite-(Fe$^{2+}$) is biaxial negative, with $\alpha$ = 1.692(5), $\beta$ = 1.718(3), and $\gamma$ = 1.720(5) (with $\lambda$ = 590 nm). Pleochroism is from pale pinkish brown ($X$) to pale green ($Y$) and pale bluish gray ($Z$). The calculated 2$V$ angle is 31°, and a strong dispersion r > v has been observed. The $\beta$ index is parallel to the $b$ crystallographic axis; $\alpha$ and $\gamma$ lie in the (010) plane.

Electron microprobe analyses gave $P_2O_5$ 46.51, $Al_2O_3$ 6.94, $Fe_2O_3$ 10.58, FeO 11.46, MgO 6.32, MnO 11.23, CaO 0.24, $Na_2O$ 6.27, $K_2O$ 0.01, total 99.56 wt%.The empirical formula on the basis of 3P corresponds to $(\square_{0.65}Na_{0.35})_{\Sigma 1.00}(Na_{0.58}Mn^{2+}_{0.40}Ca_{0.02})_{\Sigma 1.00}(Fe^{2+}_{0.68}Mn^{2+}_{0.32})_{\Sigma 1.00}(Mg_{0.72}Fe^{3+}_{0.23}Fe^{2+}_{0.05})_{\Sigma 1.00}(Al_{0.62}Fe^{3+}_{0.38})_{\Sigma 1.00}[PO_4]_3$. The simplified and idealized formula is $Na_2Fe^{2+}MgAl(PO_4)_3$, which requires: $P_2O_5$ 48.61, $Al_2O_3$ 11.64, MgO 9.20, FeO 16.40, $Na_2O$ 14.15, total 100.00 wt%.

The basic features of the crystal structure of qingheiite-(Fe$^{2+}$) are identical to those of the other members of the wyllieite group. They consist of kinked chains of edge-sharing octahedra stacked parallel to {101}. These chains are formed by a succession of M(2a)-M(2b) octahedral pairs, linked by highly distorted M(1) octahedra. Equivalent chains are connected in the b direction by the P(1), P(2a), and P(2b) phosphate tetrahedra to form sheets oriented perpendicular to [010]. These interconnected sheets produce channels parallel to c that contain the large X sites. The X(1a) site of qingheiite-(Fe$^{2+}$) is a distorted octahedron, whereas the X(1b) site can be described as a very distorted cube. The morphology of the X(2) site corresponds to very distorted gable disphenoid with a [7+1] coordination, similar to the X(2) site of rosemaryite and to the A(2)′ site of the alluaudite structure.

Qingheiite-(Fe$^{2+}$) was accepted by the Commission on New Minerals, Nomenclature and Classification of the International Mineralogical Association (CNMNC-IMA), under number IMA 2009-076. Type specimens are stored in the collections of the Laboratory of Mineralogy, University of Liège, Belgium (no. 20381), and in the collections of the Natural History Museum, Luxembourg (no. PP022T). **K.T.T.**

## ROGERMITCHELLITE*

A.M. McDonald and G.Y. Chao (2010) Rogermitchellite, $Na_{12}(Sr,Na)_{24}Ba_4Zr_{26}Si_{78}(B,Si)_{12}O_{246}(OH)_{24}{\cdot}18H_2O$, a new mineral species from Mont Saint-Hilaire, Quebec: description, structure determination and relationship with HFSE-bearing cyclosilicates. Can. Mineral., 48, 267–278.

Rogermitchellite was discovered in association with aegirine, annite, galena, a labuntsovite-group mineral, maganoneptunite, microcline, pyrrhotite, sodalite, and zircon in late-stage igneous breccia at the Poudrette quarry, Mont Saint-Hilaire, Quebec. It appears to have formed after aegirine but before microcline in the vugs. Rogermitchellite probably formed under pressure and temperature conditions of 1 GPa and 300–450 °C. Rogermitchellite, previously known as UK99 from Mont Saint-Hilaire, was found in 1 to 2 mm size vugs on a single specimen. Only five striated colorless to gray euhedral, isolated crystals up to 0.1 × 0.25 mm were found. Forms are prism {100} and pinacoid {001} and minor shallow ditrigonal scalenohedron $\{10l\}$ and $\{10\bar{1}\}$. Crystals have a rough hexagonal shape, flattened perpendicular to [001]. Rogermitchellite is transparent, vitreous with a conchoidal to splintery fracture and a white streak; no fluorescence was observed under UV radiation. It has a Mohs hardness of 5, no cleavage, $D_{calc}$ = 3.34 g/cm$^3$, and it does not dissolve in HCl solution.

Electron microprobe analyses (average of four analyses) gave $Na_2O$ 3.45, CaO 0.10, SrO 18.54, BaO 5.18, $B_2O_3$(calc.) 2.34, $SiO_2$ 39.12, $ZrO_2$ 26.39, $TiO_2$ 0.63, $H_2O$(calc.) 6.96, sum 102.71 wt%, corresponding to $Na_{12}(Sr_{21.16}Na_{1.17}Ca_{0.21})_{\Sigma 22.54}Ba_{4.00}(Zr_{25.33}Ti_{0.93})_{\Sigma 26.26}(Si_{77.02}B_{0.98})_{\Sigma 78}B_{12}O_{246}(OH)_{24}\cdot 18H_2O$ based on 288 anions and (Si + B) = 90 apfu. The ideal formula is $Na_{12}Sr_{24}Ba_4Zr_{26}B_{12}Si_{78}O_{246}(OH)_{24}\cdot 18H_2O$. The mineral is uniaxial (+), with $\omega$ = 1640(1) and $\varepsilon$ = 1.663(1) for $\lambda$ = 589 nm; no pleochroism was observed. The IR spectrum shows absorption bands at 3533, 3508, 3453 cm$^{-1}$ (O−H stretching), 1638 (H−O−H bending), 1129, 971, 918 cm$^{-1}$ (asymmetric O−Si−O, O−B−O stretching), and 777 cm$^{-1}$ (symmetric Si−O−Si, O−B−O stretching).

The structure of rogermitchellite was solved from a 0.05 × 0.08 × 0.10 mm crystal using a Bruker P4 diffractometer equipped with a SMART 1K CCD detector, $R$ = 4.62% and w$R^2$ = 12.73% for 1588 reflections [$F_o > 4\sigma(F_o)$]. The mineral is trigonal, $P\bar{3}c1$, with refined unit-cell parameters from four-circle diffractometer data $a$ = 26.509(4), $c$ = 9.975(2) Å, $V$ = 6070.6(1) Å$^3$, and $Z$ = 1. The strongest lines on the powder diffraction pattern (42 lines, Debye-Scherrer 114,6 mm camera, Ni-filtered Cu$K\alpha$ radiation) [$d_{obs}$ in Å ($I_{obs}$%,$hkl$)] include 5.762(40,400), 3.968(25,222), 3.924(30,312), 3.761(90,402), 3.310(25,440), 3.150(50,441), 2.760(100,442), 2.489(20,004), 1.991(70,444), 1.916(20,12.0.0), 1.701(25,834), and 1.4854(25,446). Although rogermitchellite has a simple heteropolyhedral framework of octahedra and tetrahedra, the structure is complex due to the numerous unique octahedral and tetrahedral sites and the numerous channels along [100] hosting Ba, Na, (Sr + Na), and $H_2O$. Unusual Si-O bond distances were solved by reducing the space group from $P6_3cm$ to $P\bar{3}c1$ as had been previously achieved for the structure of the related mineral, bobtraillite.

The mineral shows chemical and structural similarities with benitoite, wadeite, and catapleiite, by way of the Benitoite Pinwheel Motif (BPM) in the structure. The arrangement of the two BPMs per unit cell in rogermitchellite makes its structure unique.

The mineral is named after Roger Howard Mitchell (b. 1941) of the Department of Geology at Lakehead University, Thunder Bay, Ontario, Canada, in recognition of his work on the mineralogy and petrology of alkaline rocks. Both the mineral and mineral name were approved by the Commission on New Minerals and Mineral Names, IMA (2003-019). Holotype material was deposited at the Canadian Museum of Nature, Ottawa, Canada (catalog no. CMNMC 860087). **R.R.**