

New Mineral Names*

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NEW MINERALS

ABRAMOVITE*

M.A. Yudovskaya, N.V. Trubkin, E.V. Koporulina, D.I. Belakovsky, A.V. Mokhov, M.V. Kuznetsova, and T.I. Golovanova (2007) Abramovite, $\text{Pb}_2\text{SnInBiS}_7$, a new mineral species from fumaroles of the Kudryavy Volcano, Kurile Islands, Russia. *Zap. Ross. Mineral. Obsch.*, 136(5), 37–43 (in Russian, English abstract); (2008) *Geol. Ore Dep.*, 50, 551–555 (in English).

The new species abramovite was found in open cavities and fractures in fumarolic crusts of the Kupol fumarole field, atop the andesite dome of the Kudryavy stratovolcano, on the northernmost part of Iturup Isle in the southern Kurile Islands. The mineral, a product of high-temperature (600–620 °C) volcanic gases, forms crystals to 0.2×1 mm as encrustations on anhydrite and chaotic intergrowths with halite, sylvite, and wurtzite, and is commonly coated with a fine encrustation of galena framboids. It is silvery black, metallic luster, black streak, perfect {100} cleavage; fracture, hardness, and density were not measured. In reflected light, it is white with yellowish gray tones, weak birefractance; reflectance data are (λ nm, R_{\min} – R_{\max} , percents): (400, 14.0–32.9), (470, 13.9–29.0), (550, 15.7–29.9), (590, 16.4–30.2), (650, 17.9–30.8), (700, 18.9–31.2).

SAED patterns indicate that the mineral has a composite crystal structure consisting of incommensurate, but regular alternations of pseudotetragonal ($c_T^* = 5.72$, $b_T^* = 5.64$, $a^* = 22.42$ Å) and pseudo-hexagonal ($c_H^* = 6.16$, $b_H^* = 3.54$, $a^* = 22.42$ Å) layers. The mineral would seem to be related to the cylindrite–lévyclaude–franckeite group, and by analogy with cylindrite-type structures should have triclinic symmetry. Powder diffractometry ($\text{CuK}\alpha$) gives $a = 23.4(3)$, $b = 5.77(2)$, $c = 5.83(1)$ Å, $\alpha = 89.1(5)$, $\beta = 89.9(7)$, $\gamma = 91.5(7)^\circ$, space group $P\bar{1}$. The strongest maxima in the powder XRD pattern are [d Å ($I\%$, hkl): 5.90(36,100), 3.90(100,111), 3.84(71,112), 3.166(26,114), 2.921(33,115), 2.902(16,200), 2.329(15,214), and 2.186(18,125)].

Chemical composition by electron microprobe is: S 20.66, Se 0.98, Cu 0.01, Cd 0.03, In 11.40, Sn 12.11, Pb 37.11, Bi 17.30,

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

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total 99.60 wt%, giving the formula $\text{Pb}_{1.92}\text{Sn}_{1.09}\text{In}_{1.06}\text{Bi}_{0.89}(\text{S}_{6.90}\text{Se}_{0.13})_{\Sigma 7.03}$ on a basis of 12 atoms, or ideally $\text{Pb}_2\text{SnInBiS}_7$, Z undefined. It has no known synthetic analogs. The mineral is named to honor Russian mineralogist Dmitry Vadimovich Abramov (1963–) of the Fersman Museum. Type material is deposited with the A.E. Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow (catalog no. 3436/1). **T.S.E.**

AQUALITE*

A.P. Khomyakov, G.N. Nechelyustov, and R.K. Rastsvetaeva (2007) Aqualite, $(\text{H}_3\text{O})_8(\text{Na,K,Sr})_5\text{Ca}_6\text{Zr}_3\text{Si}_{26}\text{O}_{66}(\text{OH})_9\text{Cl}$, a new eudialyte-group mineral from the Inagli alkaline massif, Sakha-Yakutsk, Russia, and the problem of oxonium in hydrated eudialyte. *Zap. Ross. Mineral. Obsch.*, 136(2), 39–55 (in Russian, English abstract).

Aqualite is a new member of the eudialyte group; it occurs in an alkaline pegmatite in the Inagli massif, about 30 km ESE of Aldan in the Sakha Republic (former Yakutsk), Russia. The pegmatite lies in dunites of the peripheral part of the central stock of the massif. The mineral occurs as idiomorphic crystals to 3 cm in diameter in nests of natrolite, associated with microcline, aegirine, batisite, innelite, lorenzenite, thorite, and galena. It is pink with a glassy luster, no cleavage, conchoidal fracture, white streak, $H = 4$ –5, brittle. $D_{\text{meas}} = 2.58(2)$, $D_{\text{calc}} = 2.66$ g/cm³. In thin section, it is uniaxial (+) and pleochroic: $\omega = 1.569(1)$ (colorless to pink), $\epsilon = 1.571(1)$ (pink). Nonfluorescent in short-wave UV, but fluoresces pale yellow in long-wave UV. Unlike eudialyte, it decomposes readily in 50% HCl and HNO₃ at room temperature.

X-ray powder diffractometry (Ni-filtered Cu radiation) gives $a = 14.128(2)$, $c = 31.514(8)$ Å, somewhat different from the values of $a = 14.078(3)$, $c = 31.24(1)$ Å from single-crystal studies, which the authors attribute to grain heterogeneity. Space group $R\bar{3}$. The strongest maxima in the powder XRD pattern are [d Å ($I\%$, hkl): 4.39(100,205), 2.987(100,315), 2.850(79,404), 10.50(44,003), 6.63(43,104), 7.06(42,110), 3.624(41,027), and 11.43(39,101)].

Chemical composition by electron microprobe and the Penfield method is: Na₂O 2.91, K₂O 1.93, CaO 11.14, SrO 1.75, BaO 2.41, FeO 0.56, MnO 0.30, La₂O₃ 0.17, Ce₂O₃ 0.54, Nd₂O₃ 0.36, Al₂O₃ 0.34, SiO₂ 52.70, ZrO₂ 12.33, TiO₂ 0.78, Nb₂O₅ 0.15, Cl 1.50, H₂O 9.93, –O = Cl₂ 0.34, total 99.46 wt%, giving the formula $[(\text{H}_3\text{O})_{7.94}\text{Na}_{2.74}\text{K}_{1.20}\text{Sr}_{0.49}\text{Ba}_{0.46}$

$\text{Fe}_{0.23}\text{Mn}_{0.12}\Sigma_{13.18}(\text{Ca}_{5.79}\text{REE}_{0.19}\Sigma_{5.98}(\text{Zr}_{2.92}\text{Ti}_{0.08})\Sigma_3(\text{Si}_{25.57}\text{Ti}_{0.21}\text{Al}_{0.19}\text{Nb}_{0.03})\Sigma_{26}[\text{O}_{66.46}(\text{OH})_{5.54}]\Sigma_{72.0}[(\text{OH})_{2.77}\text{Cl}_{1.23}]\Sigma_{4.0}$ on a basis of 29(Si, Zr, Ti, Al, Nb), or ideally $(\text{H}_3\text{O})_8(\text{Na}, \text{K}, \text{Sr})_5\text{Ca}_6\text{Zr}_3\text{Si}_{26}\text{O}_{66}(\text{OH})_5\text{Cl}$, $Z = 3$. The IR spectrum confirms the presence of oxonium. The mineral is compositionally distinct from eudialyte in having a very low Fe content, and in having $(\text{H}_3\text{O})^+$ dominant over Na. It is inferred to have formed from a “proto-eudialytic” precursor via ion exchange at low temperatures. The name alludes to its composition. The crystal structure was previously described by Rastsvetaeva and Khomyakov (2002: *Kristallografiya*, 47, 267–271) as “Na,Fe-decationized eudialyte.” The paper also describes other occurrences of hydrated eudialyte-group minerals. Type material is deposited with the A.E. Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow (catalog no. 2668/1).

Discussion: The paper frequently uses the term “H-eudialyte”. This is not an IMA-accepted name, and contrary to common sense does not mean “protonated eudialyte,” but rather “highly hydrated eudialyte-group mineral.” **T.S.E.**

ATTIKAITE*

N.V. Chukanov, I.V. Pekov, and A.E. Zadov (2007) Attikaite, $\text{Ca}_3\text{Cu}_2\text{Al}_2(\text{AsO}_4)_4(\text{OH})_4 \cdot 2\text{H}_2\text{O}$, a new mineral. *Zap. Ross. Mineral. Obshch.*, 136(2), 17–24 (in Russian, English abstract).

The new mineral attikaite occurs in the hypogene zone of polymetallic sulfide-quartz veins at the Christiana no. 132 mine at Kamareza in the Laurion District, Attika, Greece. It is associated with arsenocrandallite, arsenogoyazite, conichalcite, olivenite, philipsbornite, azurite, malachite, carminite, beudantite, goethite, quartz, and allophane. The mineral forms bent, scaly crystals flattened on [001] to $3 \times 30 \times 80 \mu\text{m}$ in size, which in turn form spherical aggregates to 0.3 mm across on the walls of slit-like cavities in the oxidized ore. It is pale blue to greenish blue with perfect micaceous {001} cleavage, very pale blue streak, $H = 2\text{--}2.5$, sectile. $D_{\text{meas}} = 3.2(2)$ vs. $D_{\text{calc}} = 3.356 \text{ g/cm}^3$, the discrepancy and low precision due to abundant and variable amounts of microscopic cavities in aggregates of the mineral. In thin section, the mineral is colorless, non-pleochroic, biaxial (–), $\alpha = 1.642(2)$, $\beta = \gamma = 1.644(2)^\circ$, $2V_{\text{meas}} = 10(8)$, $2V_{\text{calc}} = 0^\circ$, $X = c$, no dispersion. Non-fluorescent. X-ray powder diffraction study (special RKG-86 camera, $\text{FeK}\alpha$ radiation, internal silicon standard) gives $a = 10.01(1)$, $b = 8.199(5)$, $c = 22.78(1) \text{ \AA}$, $Z = 4$, space group Pbn , $Pbam$, or $Pba2$. Due to poor crystal quality, single-crystal studies were not successful. Unit-cell orientation was selected so that c represents the layering direction. Although it is possible to index the diffraction data using a smaller cell, comparison with loosely related minerals (e.g., lavendulan) indicates that this cell is unlikely. The strongest maxima in the powder XRD pattern are [$d \text{ \AA}$ ($I\%$, hkl)]: 22.8(100,001), 11.36(60,002), 5.01(90,200), 3.38(50,123,205), 2.780(70,026), 2.682(30,126), 2.503(50,400), and 2.292(20,404).

Chemical composition by electron microprobe is: MgO 0.17, CaO 17.48, FeO 0.12, CuO 16.28, Al_2O_3 10.61, P_2O_5 0.89, As_2O_5 45.45, SO_3 1.39, H_2O (by difference) 7.61, total 100.00 wt%. IR studies indicate the presence of both H_2O molecules and strongly hydrogen-bonded OH groups. Upon heating to 140

$^\circ\text{C}$, the c cell parameter shrinks to $18.77(1) \text{ \AA}$, (OH) is retained and only interlayer H_2O is lost (weight loss of 4.3%). The empirical formula per 22(O, OH, H_2O) is $\text{Ca}_{2.94}\text{Cu}_{1.93}\text{Al}_{1.97}\text{Mg}_{0.04}\text{Fe}_{0.02}[(\text{As}_{3.74}\text{S}_{0.16}\text{P}_{0.12})\Sigma_{4.02}\text{O}_{16.08}](\text{OH})_{3.87} \cdot 2.05\text{H}_2\text{O}$, which implies the ideal formula $\text{Ca}_3\text{Cu}_2\text{Al}_2(\text{AsO}_4)_4(\text{OH})_4 \cdot 2\text{H}_2\text{O}$. The name of the mineral is for the place of its occurrence. Type material is deposited with the A.E. Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow (catalog no. 3435/1). **T.S.E.**

AVDONINITE*

N.V. Chukanov, M.N. Murashko, A.E. Zadov, and A.F. Bushmakina (2006) Avdoninite, $\text{K}_2\text{Cu}_5\text{Cl}_8(\text{OH})_4 \cdot \text{H}_2\text{O}$, a new mineral from volcanic exhalations and from the zone of technogenesis of massive sulfide ore deposits. *Zap. Ross. Mineral. Obshch.*, 135(3), 38–42 (in Russian, English abstract).

The new mineral avdoninite occurs among oxidation products of exhalative sediments of the Yadovitaya (“Poisonous”) fumarole of the Second Cinder Cone at the Northern Breach of the Tolbachik Large Fissure Eruption, Tolbachik Volcano, Kamchatka Region, Russia. The mineral comprises part of cavity-lining crusts to several millimeters in thickness that have had access to air, but no direct contact with water. Along with paratacamite, belloite, and langbeinite, it occurs as a replacement of primary euchlorine, and along with atacamite, as a constituent of pseudomorphs after large crystals of melanothallite. The mineral occurs as poorly formed, short-prismatic to thick tabular, bright green crystals to 0.2 mm, with (001) and (100) as forms. Perfect {001} cleavage, stepped fracture, pale green streak, vitreous luster, $H = 3$, brittle, $D_{\text{meas}} = 3.03(3)$, $D_{\text{calc}} = 3.066 \text{ g/cm}^3$. In thin section, the mineral is optically neutral, but biaxial, $\alpha = 1.669(2)$, $\beta = 1.688(2)$, $\gamma = 1.707(5)$, $2V = 90(2)^\circ$, no dispersion, optical orientation $Y = c$, $X = b$ (?); the optic plane lies in the plane of perfect cleavage. Upon heating to $900 \text{ }^\circ\text{C}$, the mineral melts and evaporates, losing 71% of its mass. It slowly decomposes in cold water and dissolves in dilute HCl with no evolved gases. X-ray powder diffractometry ($\text{CuK}\alpha$ radiation; Ge standard) gives $a = 24.34(2)$, $b = 5.878(4)$, $c = 11.626(5) \text{ \AA}$, $\beta = 93.3(1)^\circ$, $Z = 4$, space group $P2/m$, Pm , or $P2$. The strongest maxima in the powder XRD pattern are [$d \text{ \AA}$ ($I\%$, hkl)]: 11.63(100,001), 5.88(20,010), 5.80(27,002), 5.73(17,102), 2.518(19,214), and 2.321(17,005). Due to poor crystal quality, single-crystal studies were not possible; however, IR spectroscopy indicates the presence of $(\text{OH})^-$ and two types of H_2O molecule in the crystal structure. Chemical composition by electron microprobe (average of 4 analyses) and the Penfield method is: K_2O 11.94(40), CuO 51.43(70), Cl 37.07(60), H_2O 6.9, $-\text{O} = \text{Cl}$ 8.37; sum 98.97 wt%, giving the formula $\text{K}_{1.96}\text{Cu}_{5.00}\text{Cl}_{8.09}(\text{OH})_{3.87} \cdot 1.03\text{H}_2\text{O}$, or ideally $\text{K}_2\text{Cu}_5\text{Cl}_8(\text{OH})_4 \cdot \text{H}_2\text{O}$. The mineral is named after Ural mineralogist V.N. Avdonin (1925–). The type sample is deposited with the Mineralogical Museum of the Department of Mineralogy, SPBGU (catalog no. 19175). The mineral also occurs at the Degtyarsky chalcocopyrite deposit, Sverdlovsk Oblast’, Russia, and in technogenic products from the Blyavinsky deposit, Orenburg region, Urals, Russia.

Discussion: Previously known as an inadequately described mineral, avdoninite has been properly characterized for the first time here. **T.S.E.**

BATISIVITE*

L.Z. Reznitsky, E.V. Sklyarova, T. Armbruster, E.V. Galuskin, Z.F. Ushchapovskaya, Yu.S. Polekhovskiy, N.S. Karmanov, A.A. Kashaev, and I.G. Barash (2008) Batisivite, $V_8Ti_6[Ba(Si_2O)]O_{28}$, a new mineral species from the derbylite group. *Geol. Ore Deposits*, 50, 565–573 (original Russian text: *Zapiski Rossiiskogo Mineral. Obsch.*, 2007, 5, 55–67).

Batisivite occurs as an accessory mineral in a Cr-V-rich, quartz-diopside rock of the Slyudyanka Complex, southern Baikal region, Russia. It is associated with Cr-V-bearing diopside and tremolite, calcite, schreyerite, berdesinskiite, V-bearing titanite, ankangite, chromite-coulsonite series spinels, Fe-bearing oxides of the eskolaite-karelianite series, uraninite, chernykhite-roscoelite series micas, Cr-bearing goldmanite, dravite-vanadiumdravite tourmalines, albite, barite, zircon, and a suite of unnamed, U-Ti-V-Cr oxide phases. The mineral occurs as isometric and elongate anhedral grains up to 200 μm . It is black, with a black streak, resinous luster, no observed cleavage, a conchoidal fracture, and is brittle and insoluble in HCl. The microhardness was measured on five grains with a UI PMT-3 microhardness tester with a load of 30 g, resulting in a range of 1200–1470 kgf/mm², with an average of 1330 kgf/mm², corresponding to a Mohs hardness of 7.0–7.5. Batisivite is almost white in reflected light, with a weak cream hue, and no internal reflections. In crossed polars, it shows weak anisotropy. The mineral has weak to moderate birefringence. Spectra recorded in air on two grains have minima within the range 480–500 nm.

The chemical composition of batisivite was determined by electron microprobe methods (WDS, 72 grains, 237 analyses), giving an average (range) of Nb₂O₅ 0.26(0.00–0.99), SiO₂ 6.16(5.38–8.17), TiO₂ 31.76(26.15–35.82), Al₂O₃ 1.81(0.97–2.51), VO₂* 8.20(1.07–13.05), V₂O₃* 26.97(16.99–34.63), Cr₂O₃ 12.29(7.13–20.49), Fe₂O₃ 1.48(0.33–5.18), MgO 0.08(0.00–0.66), BaO 11.42(10.39–12.25), total 99.45 wt% (where VO₂ and V₂O₃ are calculated from V₂O₃_{tot}), corresponding to an empirical formula $(V_{4.77}^{3+}V_{0.75}^{4+}Cr_{2.20}Fe_{0.25}Nb_{0.03})_{\Sigma 8.00}(Ti_{5.41}V_{0.59}^{4+})_{\Sigma 6.00}[Ba_{1.01}Mg_{0.02}(Si_{1.40}Al_{0.48}O_{0.94})]O_{28}$ based on a fixed number of cations (V+Cr+Fe+Nb = 14). The ideal formula is $V_8Ti_6[Ba(Si_2O)]O_{28}$, requiring V₂O₃ 44.33, TiO₂ 35.45, SiO₂ 8.88, BaO 11.34, total 100 wt%.

Batisivite is triclinic, $P\bar{1}$, $a = 7.521(1)$, $b = 7.643(1)$, $c = 9.572(1)$ Å, $\alpha = 110.20$, $\beta = 103.34(1)$, $\gamma = 98.28(1)^\circ$, $V = 487.14(7)$ Å³, $Z = 1$, $D_{\text{calc}} = 4.624$ g/cm³. The strongest lines on the powder X-ray diffraction pattern (RKD 57.3 mm camera, FeK α radiation) are [d_{obs} Å (I_{obs} %, hkl): 3.38(40,111), 3.10(80,122), 2.85(100,021,120), 2.63(80,213), 2.48(40,032), 2.23(60,220), 2.13(80,313), 1.781(80,324), 1.582(100,242), 1.433(100,322,124), 1.068(40,452), and 1.034(60,518)]. The structure of batisivite is a combination of zigzag double chains of octahedra of α -PbO₂-type and columns of V₂O₅-type. The channels formed by these structural units can be described as chains of cuboctahedral cavities running parallel to [011]. Titanium, V, Cr, Fe, and Nb occupy the octahedral sites, whereas Ba and Si-O groups occupy the cuboctahedral sites.

Batisivite is a member of the derbylite group, the only member not to contain OH. The name is for its major cations (Ba, Ti, Si, and V). Type material has been deposited at the Fersmann Mineralogical Museum, Russian Academy of Sciences, Moscow. **P.C.P.**

CHESNOKOVITE*

I.V. Pekov, N.V. Chukanov, V.T. Zadov, N.V. Zubkova, and D. Yu. Pushcharovsky (2007) Chesnokovite, Na₂[SiO₂(OH)₂]·8H₂O, the first natural sodium orthosilicate—a new mineral from the Lovozero alkaline massif, Kola Peninsula, Russia and its crystal structure. *Zap. Ross. Mineral. Obsch.*, 136(2), 25–39 (in Russian, English abstract).

The new mineral chesnokovite (чесноковит) occurs in underground workings intersecting the Kedykverpakhk–22 hydrothermal vein on Kedykverpakhk Mt. in the northwestern part of the Lovozero alkaline massif, Kola Peninsula, Russia. Chesnokovite occurs in one of the ussingitic parts of the vein along with natrolite, sodalite, vuonnemite, steenstrupine-(Ce), phosinaite-(Ce), natisite, gobbinsite, villiamite, natrosilite, revdite, and other phases. Along with natrophosphate, it forms cavity-filling nests to 4 × 6 × 10 cm. Crystals are poorly formed, untwinned, and lamellar with {010} as the dominant pinacoid, and range in size from a few micrometers to 0.05 × 1 × 2 cm. Aggregates are white to pale brown or yellowish and semi-transparent; single crystals are transparent and colorless; white streak, dull vitreous luster. Cleavage is {010} perfect, and {100}, {001} good, fracture stepped to conchoidal, $H = 2.5$, brittle, $D_{\text{meas}} = 1.68(2)$, $D_{\text{calc}} = 1.60$ to 1.64 g/cm³. In thin section, it is colorless, biaxial (+), $\alpha = 1.449(2)$, $\beta = 1.453(2)$, $\gamma = 1.458(3)$, $2V = 80(5)^\circ$, straight extinction, orientation $XY \parallel \{010\}$, $Z = b$, no dispersion. IR spectroscopy indicates the presence of H₂O molecules and Si–OH bonds.

Chemical composition by electron microprobe, atomic emission, and the Alimarin method is: Na₂O 21.49, K₂O 0.38, Li₂O 0.003, SiO₂ 21.42, H₂O 54.86, total 98.15 wt%, which gives the formula $(Na_{1.96}K_{0.02})_{\Sigma 1.98}Si_{1.005}O_2(OH)_2 \cdot 7.58H_2O$, or ideally Na₂[SiO₂(OH)₂]·8H₂O ($Z = 8$). X-ray powder diffractometry (monochromated CuK α radiation) shows that chesnokovite is the natural analogue of the synthetic compound Na₂SiO₃·9H₂O. The strongest maxima in the powder XRD pattern are [d Å (I %, hkl): 5.001(30,211), 4.788(42,022), 3.847(89,231), 2.932(42,400), 2.832(35,060), 2.800(97,332,233), and 2.774(100,341,143,114)]. Crystal structure refinement by the Rietveld method gives $a = 11.7119(6)$, $b = 16.973(1)$, $c = 11.5652(6)$ Å, space group $Ibca$, $R_p = 5.77$, $R_{wp} = 7.77$, $R_B = 2.07$, $R_F = 1.74\%$. The structure consists of isolated [SiO₂(OH)₂]²⁻ tetrahedra and chains of edge-sharing [Na(H₂O)₆]⁺ octahedra; interconnection of these groups is achieved only by hydrogen bonding, which accounts for the poor stability of the mineral under atmospheric conditions. It is the first natural sodium orthosilicate and forms only under conditions of low temperature (<50 °C) and extremely low $a(\text{CO}_2)$. It was named after mineralogist Boris Valentinovich Chesnokov (1928–2005) of the Ural Department, Russian Academy of Sciences. Type material is deposited with the A.E. Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow (catalog no. 3419/1). **T.S.E.**

EPIDOTE-(SR)*

T. Minakawa, H. Fukushima, D. Nishio-Hamane, and H. Miura (2008) Epidote-(Sr), $\text{CaSrAl}_2\text{Fe}^{3+}(\text{Si}_2\text{O}_7)(\text{SiO}_4)(\text{OH})$, a new mineral from the Ananai mine, Kochi Prefecture, Japan. *J. Mineral. Petrol. Sci.*, 103, 400–406.

Epidote-(Sr) is a new member of the epidote group, clinzoisite subgroup, from the Nagakawara and Hohnomori deposits at the Ananai mine, Kochi Prefecture, Japan. The mineral occurs as prismatic crystals (up to 1 cm in length) in tinzenite veins at the Nagakawara deposit and as fine crystal aggregates in piemontite breccia at the Hohnomori deposit. The Ananai mine deposits are lenticular bodies in a red metachert and a basaltic rock comprised of albite, hematite, andradite, aegirine, actinolite, prehnite, chlorite, and calcite. Multiple stages of mineralization have resulted in various ore mineral assemblages in each of the deposits.

Epidote-(Sr) is translucent pale reddish brown to brown, has perfect cleavage on {001}, twinning on (100), and a Mohs hardness of 6.5. The reddish tinge increases with increasing Mn content. It is biaxial negative, $\alpha = 1.747(2)$, $\beta = 1.780(2)$, $\gamma = 1.792(2)$, $2V_{\text{calc}} = 62^\circ$. It exhibits pleochroism: *X* – pale greenish yellow, *Y* and *Z* – pale reddish brown to brownish pink.

The chemical composition of epidote-(Sr) was determined by WDS methods on a JEOL JXA5400 on samples from each of the two deposits. The average composition for epidote-(Sr) from the Nagakawara deposit (average of 41 analyses) is SiO_2 34.32, Al_2O_3 18.53, Fe_2O_3 13.17, Mn_2O_3 2.96, CaO 11.72, SrO 17.63, $\text{H}_2\text{O}_{\text{calc}}$ 1.71, total 100.04 wt%, corresponding to $(\text{Ca}_{1.10}\text{Sr}_{0.90})_{\Sigma 2.00}(\text{Al}_{1.92}\text{Fe}_{0.87}^{3+}\text{Mn}_{0.20}^{3+})_{\Sigma 2.99}\text{Si}_{3.01}\text{O}_{12}(\text{OH})$ based on $\text{O} = 12.5$. The average composition for epidote-(Sr) from the Hohnomori deposit (average of 85 analyses) is SiO_2 34.25, Al_2O_3 16.99, Fe_2O_3 13.83, Mn_2O_3 5.59, CaO 12.29, SrO 14.57, $\text{H}_2\text{O}_{\text{calc}}$ 1.70, total 99.22 wt%, corresponding to $(\text{Ca}_{1.16}\text{Sr}_{0.74})_{\Sigma 1.90}(\text{Al}_{1.76}\text{Fe}_{0.92}^{3+}\text{Mn}_{0.37}^{3+})_{\Sigma 3.05}\text{Si}_{3.01}\text{O}_{12}(\text{OH})$. The ideal formula is $\text{CaSrAl}_2\text{Fe}^{3+}(\text{Si}_2\text{O}_7)(\text{SiO}_4)(\text{OH})$.

A Rietveld refinement was used to refine the structure of epidote-(Sr). The powder X-ray diffraction pattern was collected using a Mac Science MX-Labo diffractometer ($\text{CuK}\alpha$ radiation). The mineral is monoclinic, space group $P2_1/m$, $a = 8.928(5)$, $b = 5.652(1)$, $c = 10.244(5)$ Å, $\beta = 114.46(4)^\circ$, $V = 470.5(3)$ Å³, $Z = 2$. The Rietveld refinement yielded $R_{\text{wp}} = 8.61\%$, $R_{\text{p}} = 6.77\%$, $R_1 = 2.80\%$, $R_{\text{f}} = 1.53\%$, and $S = 1.907$, with Durbin-Watson d -statistics of $d_1 = 0.6246$ and $d_2 = 0.4181$. The refined site occupancies for the A2 and M3 sites were $0.86\text{Sr} + 0.13\text{Ca}$ and $0.78\text{Fe} + 0.20\text{Mn} + 0.02\text{Al}$ apfu, respectively, demonstrating the dominance of Sr. The strongest lines on the powder X-ray diffraction pattern [d_{obs} Å ($I_{\text{obs}}\%$, hkl)] include $5.04(20,10\bar{2})$, $3.50(42,21\bar{1})$, $3.26(23,201)$, $2.92(100,11\bar{3})$, $2.83(32,020)$, $2.72(41,013)$, $2.61(42,31\bar{1})$, $2.18(22,40\bar{1})$, $2.09(21,023)$, and $1.650(18,51\bar{1})$.

Epidote-(Sr) is isostructural with other members of the clinzoisite subgroup. It is a late-stage mineral, formed from the residual hydrothermal fluid after the crystallization of tinzenite. The mineral is named for its chemical composition as a member of the epidote group. The mineral and name have been approved by the IMA CNMMC (2006-055). Type material has been deposited in the museum at the Hokkaido University, Sapporo, Japan (Mineral-07400). **P.C.P.**

GERMANIUM-ALUMINUM SPECIES

L.-W. Zhang, Z.-L. Huang, and X.-B. Li (2008) Discovery of the independent mineral of germanium in the Huize large-scale Pb-Zn deposit, Yunnan Province, China. *Acta Mineral. Sinica*, 28, 15–16.

A potentially new species of Ge-Al mineral has been discovered in primary ore from the Huize Pb-Zn deposit, Yunnan Province, China. The mineral (80 μm) has an irregular shape and is found in association with pyrite, sphalerite, and calcite. A WDS analyses of the mineral revealed GeO_2 39.84, Al_2O_3 49.96, F 5.92, and SiO_2 3.52, total 99.24 wt%. Further study is required. **P.C.P.**

HYDROXYLBORITE*

V.V. Rudnev, N.V. Chukanov, G.N. Nechelyustov, and N.A. Yamnova (2007) Hydroxylborite, $\text{Mg}_3(\text{BO}_3)(\text{OH})_3$, a new mineral, and the isomorphous fluoroborite hydroxylborite series. *Zap. Ross. Mineral. Obshch.*, 136(1), 69–82 (in Russian, English abstract).

The new mineral hydroxylborite (гидроксилборит) occurs in “calciphyre” contacting suanite-kotoite-ludwigite ore of the Titovskoe deposit, Chersky Ridge, Dogdo River basin, Sakha Republic (former Yakutsk), Russia. Most of the calciphyre is comprised of calcite and clinohumite, but some sections are enriched in hydroxylborite, which itself is often replaced by fibrous szaibelyite, and sometimes ludwigite occurs as inclusions in the hydroxylborite. The mineral occurs as sharp {100} hexagonal prisms, devoid of terminations, to 1–1.5 mm in length, often as radial to fan-shaped aggregates. Colorless, transparent, vitreous, photoluminesces blue in short-wave UV (246 nm). Imperfect {001} cleavage, conchoidal fracture, $H = 3.5$, brittle, $D_{\text{meas}} = 2.89(1)$, $D_{\text{calc}} = 2.872$ g/cm³, dissolves in concentrated H_2SO_4 but not in water or dilute HCl. In thin section, it is uniaxial (–), $\omega = 1.566(1)$, $\varepsilon = 1.531(1)$, length slow. The IR spectrum unambiguously indicates the presence of (OH)[–]. Chemical composition by electron microprobe and the Penfield method is: B_2O_3 18.43; MgO 65.71, F 10.23, H_2O 9.73, $-\text{O} = \text{F}_2$ 4.31, total 99.79 wt%, giving the formula (based on 6 anions) $\text{Mg}_{3.03}\text{B}_{0.98}[(\text{OH})_{2.00}\text{F}_{1.00}]_{\text{O}_{3.00}}$, or ideally $\text{Mg}_3(\text{BO}_3)(\text{OH})_3$. X-ray powder diffractometry (monochromated $\text{CuK}\alpha$, radiation) gives $a = 8.912(8)$, $c = 3.112(4)$ Å, $Z = 2$. The strongest maxima in the powder XRD pattern are [d Å (I %, hkl)]: $7.69(52,010)$, $4.45(82,110)$, $2.916(42,120)$, $2.573(65,030)$, $2.551(49,111)$, $2.422(100,021)$, $2.141(44,130)$, $2.128(60,121)$. Single-crystal X-ray diffractometry [$\text{MoK}\alpha$, $238 I > 2\sigma(I)$] gives $a = 8.924(5)$, $c = 3.116(2)$ Å, space group $P6_3/m$, $R_1 = 0.054$, $wR_2 = 0.115$. The mineral is isostructural with fluorborite. It is named for its composition and relationship to fluorborite. Holotype material is deposited with the A.E. Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow (catalog no. 91968) and with the Geological Museum, All-Russian Scientific Research Institute of Mineral Resources (VIMS; catalog no. M-1663). **T.S.E.**

LASALITE*

J.M. Hughes, W.S. Wise, M.E. Gunter, J.P. Morton, and J. Rakovan (2008) Lasalite, $\text{Na}_2\text{Mg}_2[\text{V}_{10}\text{O}_{28}] \cdot 20\text{H}_2\text{O}$, a new de-

cavanadate mineral species from the Vanadium Queen mine, La Sal District, Utah: description, atomic arrangement, and relationship to the pascoite group of minerals. *Can. Mineral.*, 46, 1365–1372.

Lasalite occurs as bright yellow to orange efflorescence on sandstone in fractures and walls in the Vanadium Queen Mine in the La Sal district in Utah. Initially thought to be pascoite, X-ray powder diffraction produced a pattern that matched no known mineral. Lasalite forms by the oxidation of primary corvusite by vadose water and reaction with the carbonate cement of the sandstone. Subsequent evaporation produces efflorescences containing lasalite, rossite, dickthomssenite, and hewettite. Lasalite has been identified at other mines in the Colorado Plateau.

Lasalite occurs as 1–3 mm crusts and isolated single crystals 1–2 mm long on sandstone. On euhedral crystals the major forms are {100}, {010}, {001}, {111}, and {111}. It is yellow to yellow-orange, transparent with an adamantine luster and a yellow streak. The crystals dehydrate to a yellow powder. Crystals are very brittle with a Mohs hardness of 1. There are no cleavages, and twinning was not observed. D_{obs} and D_{calc} are 2.38(2) and 2.362 g/cm³ respectively. Optically lasalite is biaxial (–), $2V$ determined at 550, 589, and 650 nm is 32(1), 43(1), and 53(1)°, respectively, indicating strong $r > v$ dispersion. Indices of refraction are $\alpha = 1.743(5)$, $\beta = 1.773(5)$, and $\gamma = 1.780(5)$ ° at 589 nm. The pleochroic formula is X light greenish yellow, Y light yellow, Z light brown.

Lasalite is soluble in water and volatilizes rapidly under an electron beam. Chemistry was determined from two samples using wet chemical methods. The average composition (with ranges) is Na₂O 4.06 (3.88–4.20), MgO 5.42 (4.90–5.82), CaO 1.75 (1.63–1.93), K₂O 0.47 (0.41–0.51), V₂O₅ 61.87 (59.00–64.02), SO₃ 2.55 (2.34–2.91), H₂O (by difference) 23.88. This gives an empirical formula (on the basis V + S = 10 apfu) of (Na_{1.84}Ca_{0.44}K_{0.14})_{Σ2.42}Mg_{1.89}(V_{9.55}S_{0.45})_{Σ10.00}O_{28.55}·18.61H₂O. The compatibility index is –0.007 or excellent.

The structure of lasalite was refined by direct methods using a Bruker Apex CCD diffractometer equipped with graphite-monochromated MoK α radiation. R was refined to 0.0289. It is monoclinic, $C2/c$ with $a = 23.9019(7)$, $b = 10.9993(3)$, $c = 17.0504(5)$ Å, $\beta = 118.284(1)$ °. Lasalite consists of a structural unit [V₁₀O₂₈]^{6–} and a hydrated interstitial group {Na₂Mg₂(H₂O)₂₀}⁶⁺, which is composed of Mg(OH)₆ octahedra and seven-coordinated Na atoms in a [Na₂O₆(OH)₆] dimer. This dimer links to the structural unit by hydrogen bonding and by sharing of oxygen atoms with the decavanadate group. The Mg(OH)₆ octahedra are hydrogen bonded to the structural unit. The name is for the La Sal district. Name and mineral have been approved by the IMA (2007-005) with cotype material held in the collection of the Smithsonian Museum (NMNH-174744). **G.P.**

MIDDENDORFITE*

I.V. Pekov, N.V. Chukanov, V.T. Dubinchuk, and A.E. Zadov (2006) Middendorffite, K₃Na₂Mn₃Si₁₂(O,OH)₃₆·2H₂O, a new mineral from the Khibiny massif, Kola Peninsula. *Zap. Ross. Mineral. Obshch.*, 135(3), 42–52 (in Russian, English abstract).

The new mineral middendorffite occurs in the large Hilairitovoye ultra-agpaitic pegmatite at the +252 m underground horizon of the Kirovsky apatite mine, Mt. Kukisvumchorr, Khibiny massif, Kola Peninsula, Russia. It also occurs in lesser veins at the same horizon. It is a secondary hydrothermal mineral, occurring in small cavities along with primary microcline, sodalite, cancrisilite, aegirine, phlogopite and lamprophyllite, late natrolite and calcite, and secondary fluorite, fluorapophyllite, narsarsukite, labuntsovite-Mn, neptunite–mangan-neptunite, kukisvumite, polyolithionite, taeniolite, and donnayite. The mineral forms crude diamond-shaped to octagonal plates and tablets to 0.1 × 0.2 × 0.4 mm that in turn form “piles” of vermicular aggregates to 1 mm in length by stacking across the main {001} pinacoid; fan-shaped aggregates are less common. Transparent, vitreous, dark orange with a yellow streak; non-fluorescent. Perfect (micaceous) {001} cleavage, leaf-like fracture, $H = 3–3.5$, flexible but inelastic, $D_{\text{meas}} = 2.60(2)$, $D_{\text{calc}} = 2.65$ g/cm³. In thin section, it is strongly pleochroic, biaxial (–), $\alpha = 1.534(3)$ yellowish to colorless, $\beta = 1.562(2)$ brown, $\gamma = 1.563(2)$ dark brown; $2V = 10(5)$ °, orientation $X \sim c$, no dispersion. Electron diffraction gives $a = 12.54(2)$, $b = 5.72(1)$, $c = 26.85(5)$ Å, $\beta = 114.0(1)$ °, space group $P2_1/m$ or $P2_1$. X-ray powder diffractometry (Mn-filtered FeK α radiation) gives $a = 12.55(1)$, $b = 5.721(2)$, $c = 26.86(2)$ Å, $\beta = 114.04(7)$ °, $Z = 2$. The strongest maxima in the powder XRD pattern are [d Å (I %, hkl)]: 12.28(100,002), 4.31(81,11 $\bar{4}$), 3.555(62,301,212), 3.063(52,008,31 $\bar{6}$), 2.840(90,312,021,30 $\bar{9}$), 2.634(88,219,1.0. $\bar{1}0$,124), 2.366(76,226,3.1. $\bar{1}0$,32 $\bar{3}$), 2.109(54,42 $\bar{3}$,42 $\bar{4}$,51 $\bar{9}$,414), 1.669(64,2.2. $\bar{1}3$,3.2. $\bar{1}3$,62 $\bar{3}$,6.1. $\bar{1}3$), 1.614(56,5.0. $\bar{1}6$,137,333,71 $\bar{1}$). IR spectroscopy indicates the presence of both H₂O and (OH)[–]. Chemical composition by electron microprobe and the Penfield method is: Na₂O 4.55, K₂O 10.16, CaO 0.11, MgO 0.18, MnO 24.88, FeO 0.68, ZnO 0.15, Al₂O₃ 0.20, SiO₂ 50.87, TiO₂ 0.17, F 0.23, H₂O 7.73, –O = F₂ 0.10, total 99.81 wt%, giving the formula K_{3.04}(Na_{2.07}Ca_{0.03})_{Σ2.10}(Mn_{4.95}Fe_{0.13}Mg_{0.06}Ti_{0.03}Zn_{0.03})_{Σ5.20}(Si_{11.94}Al_{0.06})_{Σ12}O_{27.57}(OH)_{8.26}F_{0.17}·1.92H₂O, or ideally K₃Na₂Mn₃Si₁₂(O,OH)₃₆·2H₂O. It is a phyllosilicate related to bannisterite, parsettensite, and members of the ganophyllite group and the stilpnomelane group. It was named after Aleksandr Fedorovich von Middendorff (1815–1894) who carried out the first mineralogical studies of the Khibiny massif. Type material is deposited with the A.E. Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow (catalog no. 3312/1). **T.S.E.**

MUNAKATAITE*

S. Matsubara, T. Mouri, and R. Miyawaki (2008) Munakataite, a new mineral from the Kato mine, Fukuoka, Japan. *J. Mineral. Petrol. Sci.*, 103, 327–332.

Munakataite occurs as aggregates of fibrous crystals (up to 30 μm in length), which form thin coatings on a quartz vein fracture containing Cu-Zn-Pb-Ag-Au ore minerals at a dump at the Kato mine, Munakata City, Fukuoka Prefecture, Japan. The mineral is light blue in color, with a bluish-white streak, is transparent, has a vitreous luster, and is pearly on cleavage surfaces. It is not fluorescent, and has a Mohs hardness of <2. It is brittle, does not exhibit fracture, and has a perfect or distinct cleavage parallel to b . Optically, munakataite shows parallel extinction, positive elongation, and is weakly pleochroic (color-

less to weak blue). Munakataite is a secondary mineral in the hydrothermal ore veins at the Kato mine, which developed in a tertiary porphyritic andesite. The main ore minerals included electrum, chalcocopyrite, sphalerite, galena, hessite, and sylvanite. Secondary minerals include cerussite, anglesite, linarite, pyromorphite, malachite, and brochantite. Munakataite occurs with malachite and is extremely rare.

The chemical composition of munakataite was determined using a Link Systems EDS detector. The average of 7 analyses gave PbO 53.71, CuO 18.33, CaO 0.04, SO₃ 9.73, SeO₂ 13.19, H₂O_{calc} 4.19, total 99.19 wt%, giving an empirical formula of Pb_{2.03}(Cu_{1.94}Ca_{0.01})_{Σ1.95}(Se⁴⁺O₃)_{1.00}(SO₄)_{1.02}(OH)_{3.92}, based on Pb + Cu + Ca + Se + S = 6 apfu. The simplified formula is Pb₂Cu₂(Se⁴⁺O₃)(SO₄)(OH)₄, which requires PbO 53.62, CuO 19.11, SeO₂ 13.32, SO₃ 9.62, H₂O 4.33, total 100.00 wt%. The FTIR spectrum of munakataite was obtained using a JEOL JIR6000 FTIR microspectrometer with ATR and KBr methods. The main bands of the spectrum include 3400, 1100, 790, 720, 600, 540, 490, 470, and 440 cm⁻¹. The absorption bands at 1100 and 600 cm⁻¹ correspond to (SO₄), and those at 790, 720, and 440 cm⁻¹ correspond to the (SeO₃) group. The band at 3400 cm⁻¹ corresponds to (OH).

The crystal structure of munakataite could not be determined due to its small crystal size. It is considered to be monoclinic, with space group *P2₁/m*, analogous to schmiederite, with *a* = 9.766(8), *b* = 5.666(5), *c* = 9.291(10) Å, β = 102.40(8)°, *V* = 502.1(8) Å³, *Z* = 2, *D*_{calc} = 5.526 g/cm³. The strongest lines on the powder X-ray diffraction pattern (114.6 mm Gandolfi camera, Ni-filtered CuKα radiation) include [*d*_{obs} Å (*I*_{obs}%, *hkl*)]: 9.50(13,100), 4.86(44,110), 4.77(57,10 $\bar{2}$), 3.65(14,210), 3.53(39,012,11 $\bar{2}$), 3.18(100,300), 3.14(68,112,21 $\bar{2}$), 2.83(15,020), 2.40(14,022), 2.33(18,40 $\bar{2}$,10 $\bar{4}$), 2.20(15,410,312), and 1.813(19,005,51 $\bar{2}$).

Munakataite is the SO₄-analog of schmiederite, a member of the linarite-chenite group, and is the first Se mineral in Japan. It has also been found in the Kismori mine, Akita Prefecture, Japan. The mineral is named for the city of Munakata, where the Kato mine is located. The mineral and name have been approved by the IMA CNMNC (2007-012). Type material has been deposited at the National Museum of Nature and Science, Tokyo, Japan (NSM-M28982). **P.C.P.**

NIVEOLANITE*

I.V. Pekov, N.V. Zubkova, N.V. Chukanov, A.A. Agakhanov, D.I. Belakovskiy, L. Horváth, Y.E. Filinchuk, E.R. Gobechiya, D.Y. Pushcharovsky, and M.K. Rabadanov (2008) Niveolanite, the first natural beryllium carbonate, a new mineral species from Mont Saint-Hilaire, Quebec, Canada. *Can. Mineral.*, 46, 1343–1354.

Niveolanite was discovered in the Poudrette Pegmatite, Poudrette Quarry, Mont-Saint Hilaire, Quebec. The pegmatite formed a 2–4 m thick dike, which crosscuts a hornfels xenolith. Smaller (2–15 cm) veins of pegmatite are associated with the main dike. The dike consists of alternating bands of hornfels and aplite in the contact zone with a core composed mainly of microcline, nepheline, and aegirine with eudialyte minerals. The core of the dike has been hydrothermally altered and is composed mainly of albite, zeolite, and a large variety of carbonate minerals. Ni-

veolanite is typically found in cavities formed in the interstices of aegirine and microcline crystals. The associated minerals in these cavities include albite, aegirine, natrolite, gonnardite, siderite, petersenite-(Ce), franconite, and dawsonite. Rarer associated minerals are analcime, quartz, eudidymite, catapleite, gaidonnayite, monazite-(Ce), calcite, adamsite-(Y), shomiokite-(Y), galena, sphalerite, and rutile. Some of the niveolanite-containing cavities exhibit brown films of a solid bituminous substance. Niveolanite occurs in two varieties: the predominant morphology consists of fibrous aggregates up to 2 cm across; individual fibers are typically 2–3 cm long with thickness less than 1 μm. The second morphology consists of aggregates of acicular crystals with tetragonal or octagonal cross-sections. These types are up to 1 cm long and 0.3 cm thick. The crystals are elongate parallel to [100] with {100} and {100} the probable major forms. The name is from the Latin *niveus*, snow white, and *lana*, wool. Cotype specimens are held in the collections of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow (no. 3631/1), and the Canadian Museum of Nature, Ottawa (CNMMC 86052). The mineral and name have been approved by the IMA (2007-032).

Niveolanite aggregates are snow-white to pearl white, individual fibers are colorless. The streak is white, luster is silky, and it does not fluoresce under ultraviolet light. No cleavages or partings were observed; the fracture is splintery, with fibrous crystals flexible. Calculated densities for hydrated and less hydrous varieties are 2.06 and 1.82 g/cm³, respectively. Microscopically, niveolanite is colorless, nonpleochroic, and has a positive elongation. It is uniaxial (+) with ω = 1.469(1) and ε = 1.502(1). The compatibility index is 0.058 or good. Niveolanite dissolves slowly with weak effervescence in concentrated and dilute HCl.

An IR spectrum was obtained using a KBr pellet. The infrared spectrum shows evidence of strong polarization of CO₃ groups. The spectrum includes absorption bands for O-H and Be-O stretching, and H-O-H, CO₃, B-O-C, and Be-OH bending.

Chemical composition was determined using a combination of WDS (Na, K, and Ca), ICP-OES (Be), and loss on ignition (CO₂ and H₂O). The average composition [including ranges of 8 WDS analyses for (Na, K, and Ca)] is: Na₂O 19.81(18.9–20.8), K₂O 0.07(0.0–0.15), CaO 3.88 (3.6–4.5), BeO 16.65, CO₂ 29.81, H₂O 26.93, total 97.15 wt%. This gives an empirical formula (calculated for 1 C apfu) of: (Na_{0.94}Ca_{0.10})_{Σ1.04}Be_{0.98}(CO₃)_{1.00}(OH)_{1.10}·1.66H₂O (OH:H₂O ratios from charge balance).

Analytical and infrared data suggest that the water content in niveolanite is variable, and the dehydration-hydration is reversible. The ideal formula for niveolanite is NaBe(CO₃)(OH)·1–2H₂O.

X-Ray powder diffraction data were collected using CuKα radiation. The strongest 10 lines of the X-ray powder diagram [*d* in Å (*I*,*hkl*)] are: 13.01(100,100), 3.256(95,400), 9.20(62,110), 2.489(60,202), 2.693(44,002), 2.605(37,430,500), 3.611(34,320), 2.076(32,620), 4.343(27,300), and 3.269(22,311).

The crystal structure was determined using a 20 × 20 × 500 μm crystal at the European Synchrotron Radiation facility, Grenoble, France (λ = 0.71468 Å). Final *R*₁ was 0.0358 based on 411 unique reflection with *I* > 2σ(*I*). Niveolanite is tetragonal, *a* = 13.1304(19), *c* = 5.4189(11) Å, and *V* = 934.3(3) Å³, *Z* = 8.

The structure of niveolanite consists of infinite chains of $\text{BeO}_2(\text{OH})_2$ tetrahedra linked with common OH groups. These tetrahedra are linked to CO_3 groups via two shared vertices. Sodium cations occur in sevenfold edge-linked polyhedra $[\text{NaO}_6(\text{H}_2\text{O})]$, which form columns. The Be tetrahedra and Na polyhedra are aligned parallel to the c axis and form large channels containing H_2O molecules. **G.P.**

PHOSPHOINNELITE*

I.V. Pekov, N.V. Chukanov, I.M. Kulikova, and D.I. Belakovsky (2006) Phosphoinnelite, $\text{Ba}_4\text{Na}_3\text{Ti}_3\text{Si}_4\text{O}_{14}(\text{PO}_4, \text{SO}_4)_2(\text{O}, \text{F})_3$, a new mineral from agpaite pegmatites of the Kovdor massif, Kola Peninsula. Zap. Ross. Mineral. Obsch., 135(3), 52–60 (in Russian, English abstract).

The new mineral phosphoinnelite occurs in hydrothermally altered agpaite “hybrid” pegmatite cross-cutting calcite carbonatite in the phlogopite deposit of the Kovdor alkaline-ultrabasic massif, Kola Peninsula, Russia. Associated minerals include primary cancrinite, orthoclase, aegirine-diopside and pectolite, and secondary magnesio-arfvedsonite, golyshévite, titanite, fluorapatite, and pyrrhotite. Much of the new mineral occurs with white to greenish thompsonite-Ca that hydrothermally replaces the cancrinite, yet the new mineral seems to be secondary in origin (i.e., coeval with pectolite, golyshévite, etc.). It occurs as plate-like crystals to $0.2 \times 1 \times 6$ mm with chambered terminations, which are most commonly split and bent. The main form seems to be {010}; crystals are striated along their length. Aggregates consist of beams, sheaves, and rosettes. Transparent, vitreous, yellow-brown to brown with a pale yellow streak; greasy fracture; non-fluorescent. Cleavage is {010} perfect, {100} good, stepped fracture, $H = 4.5$ – 5 , brittle, $D_{\text{meas}} = 3.82(5)$, $D_{\text{calc}} = 3.92$ g/cm³. In thin section, it is colorless to pale yellow, non-pleochroic, biaxial (+), $\alpha = 1.730(5)$, $\beta = 1.745(3)$, $\gamma = 1.764(3)$, $2V_{\text{obs}} \sim 90^\circ$, $2V_{\text{calc}} = 84^\circ$, $Z \wedge c \sim 5^\circ$; no dispersion. X-ray powder diffraction (RKU-114.6 camera, Mn-filtered $\text{FeK}\alpha$ radiation) gives $a = 5.38(2)$, $b = 7.10(2)$, $c = 14.76(5)$ Å, $\alpha = 99.00(7)$, $\beta = 94.94(6)$, $\gamma = 90.14(8)^\circ$, $Z = 1$, space group $P\bar{1}$ or $P1$. The powder XRD pattern is practically identical to that of innelite; the strongest maxima are [d Å ($I\%$, hkl): 14.5(100,001), 3.455(40,103), 3.382(35,0 $\bar{2}2$), 2.921(35,005), 2.810(40,1 $\bar{1}4$), 2.683(90,200,201), 2.133(80,2 $\bar{2}2$), 2.059(40,204,133,221), 1.772(30,041,127,232,233)]. Crystals were too poor in quality for single-crystal studies. IR spectroscopy indicates an absence of H_2O and (OH)⁻. Chemical composition by electron microprobe is: Na₂O 6.06, K₂O 0.04, CaO 0.15, SrO 0.99, BaO 41.60, MgO 0.64, MnO 1.07, Fe₂O₃ 1.55, Al₂O₃ 0.27, SiO₂ 17.83, TiO₂ 16.88, Nb₂O₅ 0.74, P₂O₅ 5.93, SO₃ 5.29, F 0.14, -O = F₂ 0.06, total 99.12 wt%, giving the formula $(\text{Ba}_{3.59}\text{Sr}_{0.13}\text{K}_{0.01})_{\Sigma 3.73}(\text{Na}_{2.59}\text{Mg}_{0.21}\text{Ca}_{0.04})_{\Sigma 3.04}(\text{Ti}_{2.80}\text{Fe}_{0.26}\text{Nb}_{0.07})_{\Sigma 3.13}[(\text{Si}_{3.93}\text{Al}_{0.07})_{\Sigma 4}\text{O}_{14}(\text{P}_{1.11}\text{S}_{0.87})_{\Sigma 1.98}\text{O}_{7.96}](\text{O}_{2.975}\text{F}_{0.10})_{\Sigma 3.075}$, or ideally $\text{Ba}_4\text{Na}_3\text{Ti}_3\text{Si}_4\text{O}_{14}(\text{PO}_4, \text{SO}_4)_2(\text{O}, \text{F})_3$. It is named for the fact that it is the P-analog of innelite; extensive solid solution exists between innelite and phosphoinnelite, and samples of innelite from Kovdor and Inagli are shown to be enriched in P. Type material is deposited with the A.E. Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow (catalog no. 3288/1). **T.S.E.**

ZHANGPEISHANITE*

H. Shimazaki, R. Miyawaki, K. Yokoyama, S. Matsubara, and Z. Yang (2008) Zhangpeishanite, BaFCl, a new mineral in fluorite from Bayan Obo, Inner Mongolia, China. Eur. J. Mineral., 20, 1141–1144.

Fine inclusions of Ba minerals—barite [BaSO_4], norsethite [$\text{BaMg}(\text{CO}_3)_2$], and a new species of barium fluoride chloride, up to 100 μm across, were recognized in a specimen of deep purple fluorite from Bayan Obo, Inner Mongolia, China. Bayan Obo is a world-class Nb–REE–Fe deposit located in Inner Mongolia, China ($109^\circ 57'E$, $41^\circ 46'N$). The majority of Nb–REE–Fe deposit is hosted by the “H8” dolomite marble unit, along with units of sandstones and slates that belong to the Proterozoic Bayan Obo Group.

Thin sections of zhangpeishanite were prepared from the type specimen using oil, as the mineral is soluble in water. Chemical analyses of zhangpeishanite (12 analyses on 6 grains) and synthetic BaFCl were carried out by means of an electron microprobe (JEOL JXA-8800M, WDS mode, 15 kV, 20 nA, 2 μm beam diameter). The empirical formula for zhangpeishanite (based on 3 apfu) is $\text{Ba}_{0.99}\text{F}_{0.99}\text{Cl}_{1.02}$ and is within the analytical error of the ideal formula. The simplified formula is BaFCl, which requires: Ba 71.61, F 9.91, Cl 18.48, total 100 wt%. The electron-microprobe analysis for the synthetic BaFCl leads to the empirical formula $\text{Ba}_{1.00}\text{F}_{0.99}\text{Cl}_{1.01}$.

Zhangpeishanite occurs as transparent, colorless crystals with a white streak and vitreous luster. It is non-fluorescent under short or long wave UV light. The hardness is $2\frac{1}{2}$ on Mohs' scale (measured on a synthetic sample). Tenacity and fracture could not be determined. Synthetic BaFCl shows perfect cleavage on {001}. The density of zhangpeishanite could not be measured because of small grain size; however the calculated density is 4.54 g/cm³ on the basis of the empirical formula and unit cell. The optical data from synthetic BaFCl are: uniaxial (–), $\omega = 1.656(2)$, and $\epsilon = 1.652(2)$ (589 nm). The forms and twinning could not be observed due to the small grain size.

Single-crystal X-ray studies could not be carried out due to the small crystal size. Powder X-ray diffraction (PXRD) data were obtained using a 114.6 mm diameter Gandolfi camera with Ni-filtered $\text{CuK}\alpha$ radiation. A fragment consisting of zhangpeishanite with small amount of fluorite was hand-picked from the thin section used for the chemical analysis under a binocular microscope. Zhangpeishanite is tetragonal, with space group $P4/nmm$ and unit-cell parameters $a = 4.3951(8)$, $c = 7.223(2)$ Å, $V = 139.52(7)$ Å³, $Z = 2$. The $c:a$ ratio calculated from the unit-cell parameters is 1.6434:1. The five strongest lines in the powder XRD pattern are [d_{obs} (hkl): 3.75(100,101), 3.11(94,110), 2.36(82,112), 2.79(67,012), and 1.898(49,211)].

Zhangpeishanite is a member of the matlockite group and is the Ba-analogue of matlockite (PbFCl) and rorisite (CaFCl). The crystal structure of zhangpeishanite can be described as a stacking or a packing of layers with a sequence of F–Ba–Cl–Cl–Ba–F along the c axis. The two adjacent Cl layers are weakly connected, causing cleavage on (001). Although zhangpeishanite (BaFCl) and rorisite (CaFCl) are isostructural with each other, they show no isomorphous substitution between

Ca and Ba. This is likely due to the significant difference in the ionic radii.

The type material is housed in the mineralogical collections of the National Museum of Nature and Science, Tokyo, Japan, under the registered number NSM-MF14696 and at the Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China (registration number KDX013). **K.T.T.**

NEW DATA

CARROLLITE*

R.A.D. Patrick, V.S. Croker, C.I. Pearce, N.D. Telling, and G. van der Laan (2008) The oxidation state of copper and cobalt in carrollite CuCo_2S_4 . *Can. Mineral.*, 46, 1317–1322.

The oxidation states of Cu and Co in carrollite were determined by X-ray absorption spectroscopy using large monomineralic crystals from Katanga, Democratic Republic of Congo (crystals contain 0.6 wt% Ni). $L_{2,3}$ absorption edges for both elements were measured on the Magnetic Spectroscopy beamline 1.1 of the Synchrotron Radiation Source (SRS) at the Daresbury Laboratory. The spectroscopy indicates that copper in carrollite is Cu^+ , giving an electronic formula of $\text{Cu}^{1.2+}(\text{Co}^{2.4+})_2(\text{S}^{1.5-})_4$. This requires half a hole per atom in the S $3p$ band (per unit formula). Spectroscopy of the Co $L_{2,3}$ edge indicates a covalent low-spin structure. **G.P.**

DELLAITE*

H. Shimazaki, R. Miyawaki, K. Yokoyama, S. Matsubara, and M. Bunno (2008) Occurrence and new data of dellaite from the Akagane mine, Japan. *J. Mineral. Petrol. Sci.*, 103, 385–389.

Dellaite was first discovered by Agrell (1965, *Mineral. Mag.*, 34, 1–15) at Kilchoan, Scotland, in a metamorphosed limestone. It has further been synthesized as a major calcium silicate hydrate phase in the C-S-H system in the cement industry. To date, neither chemical nor X-ray diffraction data have been published on the natural material. The Akagane mine is located in the Kitakami Mountains, northeast Japan. It is a Fe-Cu mine, the result of early Cretaceous igneous activity and formation of skarns. Dellaite occurs in a high-temperature skarn along the contact between gabbro and limestone in the Sakae deposit of the mine. The mineral occurs interstitially, and as a veinlet (up to 2 mm wide), forming aggregates of short, prismatic to irregular-shaped crystals associated with bicchulite, vesuvianite, calcite, clintonite, magnetite, and sphalerite. Interstitial dellaite is poikilitic, with inclusions of vesuvianite. Optically, dellaite is transparent and colorless, biaxial negative, with low birefringence. Indices are $\alpha = 1.655$ and $\gamma = 1.664$, $2V > 70^\circ$. Some grains exhibit polysynthetic twinning, with the angle between z' and the trace of the twin plane up to 25° .

The chemical composition of dellaite was determined by WDS methods on a JEOL JXA 8800 electron microprobe. The average of seven analyses gave SiO_2 33.7, CaO 62.4, Cl 0.2, $\text{H}_2\text{O}_{\text{calc}}$ 3.7, total 100 wt%, and an empirical formula of $\text{Ca}_{5.93}\text{Si}_{2.99}\text{O}_{10.82}(\text{OH})_{2.19}\text{Cl}_{0.03}$ based on $(\text{O} + \frac{1}{2}\text{Cl}) = 13$ apfu. The ideal formula is $\text{Ca}_6\text{Si}_3\text{O}_{11}(\text{OH})_2$, which requires SiO_2 33.71, CaO 62.92,

H_2O 3.37, total 100.00 wt%.

The powder X-ray diffraction pattern for dellaite was collected on a 114.6 mm Gandolfi camera (Ni-filtered $\text{CuK}\alpha$ radiation) on a crystal fragment $100 \times 70 \times 30 \mu\text{m}$ in size. The strongest lines on the powder pattern [d_{obs} Å (I_{obs} %, hkl)] include: 6.66(9,100), 4.60(10,012), 3.43(23,020), 3.34(30,200), 3.28(16,021), 3.25(24, $\bar{1}20$), 3.19(15, $\bar{2}10$), 3.07(53, $0\bar{2}\bar{2}$), 2.99(38,022), 2.89(34,120), 2.86(44, $\bar{2}\bar{1}1$), 2.82(100,203), 2.73(33, $2\bar{1}2$), 2.71(28, $0\bar{2}3$), 2.63(31,023), 2.59(16, $\bar{2}20$), 2.55(51,005), 2.29(38,030), 2.24(29, $\bar{2}21$), 2.14(22, $3\bar{1}1$) and 1.937(27,224). The unit cell was refined as triclinic from the powder diffraction data, with $a = 6.815(4)$, $b = 6.937(3)$, $c = 12.890(6)$ Å, $\alpha = 90.71(4)$, $\beta = 97.68(4)$, $\gamma = 98.20(4)^\circ$, and $V = 597.4(5)$ Å³.

Dellaite is a late-stage hydration product of pre-existing skarn minerals in a silica-deficient environment. Experimental studies on the synthetic equivalent confirm that dellaite is stable up to 800 °C. **P.C.P.**

NABALAMPROPHYLLITE-2O*

E. Sokolova and F.C. Hawthorne (2008) From structure topology to chemical composition. IV. Titanium silicates: the orthorhombic polytype of Nabalamprophyllite from the Lovozero Massif, Kola Peninsula, Russia. *Can. Mineral.*, 46, 1322–1331.

Chemical composition and crystal structure were determined for nabalamprophyllite-2O, an orthorhombic polytype of nabalamprophyllite. The sample originated in the Yubileynaya vein, Karnasurt Mountain, Lovozero alkaline massif. The chemical composition determined by WDS (wt%) is SiO_2 29.79, Al_2O_3 0.16, Nb_2O_5 0.71, TiO_2 27.85, Fe_2O_3 1.05, MnO 3.52, MgO 0.20, CaO 0.15, SrO 6.09, BaO 16.55, K_2O 1.14, Na_2O 10.89, F 1.53, H_2O 0.99 (calculated from structure refinement), O = F -0.64, total 99.98. This gives an empirical formula (on the basis of 4 Si apfu) of $(\text{Ba}_{0.87}\text{Sr}_{0.47}\text{Na}_{0.28}\text{K}_{0.20}\text{Ca}_{0.02}\text{□}_{0.16})_{\Sigma 2}(\text{Na}_{2.56}\text{Mn}_{2+0.40}\text{Mg}_{0.04})_{\Sigma 3}(\text{Ti}_{2.81}\text{Fe}_{0.11}\text{Nb}_{0.04}\text{Al}_{0.03})_{\Sigma 3}(\text{Si}_2\text{O}_7)_2[(\text{OH})_{0.89}\text{F}_{0.65}\text{O}_{0.46}]_{\Sigma 2}$, $Z = 2$.

Single-crystal data was collected on a Bruker P4 diffractometer with a CCD 4k Smart detector and $\text{MoK}\alpha$ radiation. R_1 was refined to 5.1% on the basis of 669 unique reflections with $F_o > 4\sigma F$. Nabalamprophyllite-2O has space group $Pnmm$, $a = 19.564(2)$, $b = 7.1173(5)$, $c = 5.4144(4)$ Å, $V = 753.90(4)$ Å³, $Z = 2$, $D_{\text{calc}} = 3.410$ g/cm³.

The structure of nabalamprophyllite-2O is identical to that of lamprophyllite-2O. Barium and Na are disordered on one unique site in the 2O polytype, whereas in the 2M polytype Ba and Na are disordered over two distinct sites. The two polytypes also differ in the stacking order of the titanium silicate (TS) blocks. **G.P.**

NACARENIOSITE-(CE)*

E. Sokolova and F.C. Hawthorne (2008) From structure topology to chemical composition. V. Titanium silicates: the crystal chemistry of nacareniobsite-(Ce). *Can. Mineral.*, 46, 1333–1342.

Nacareniobsite-(Ce), ideal formula $\text{Na}_3\text{Ca}_3\text{REENb}(\text{Si}_2\text{O}_7)_2\text{OF}_3$, from the type locality (Kvanefjeld in the Ilímaussaq alkaline complex, South Greenland) was studied with respect to chemistry and crystal structure. The same crystal was used for both crystal

structure analysis and determination of chemical composition. WDS analysis yielded the following composition (in wt%): SiO₂ 28.30, Nb₂O₅ 12.01, TiO₂ 2.24, Ta₂O₅ 0.33, Ce₂O₃ 10.55, La₂O₃ 4.42, Nd₂O₃ 4.34, Pr₂O₃ 1.12, Sm₂O₃ 0.64, Gd₂O₃ 0.47, Y₂O₃ 0.57, SrO 0.45, CaO 19.79, Na₂O 10.07, F 6.15, total 98.86 leading to an empirical formula (on the basis of O + F = 18 apfu) of Na_{2.77}(Ca_{3.01}Sr_{0.04})_{Σ3.05}(Ce_{0.55}La_{0.23}Nd_{0.22}Pr_{0.06}Sm_{0.03}Gd_{0.02}Y_{0.04})_{Σ1.15}(Nb_{0.77}Ti_{0.24}Ta_{0.01})_{Σ1.02}(Si₂O₇)₂(O_{1.24}F_{0.76})_{Σ2.00}F₂. Single-crystal data was collected on a Bruker P4 diffractometer with a CCD 4k Smart detector and MoK α radiation. *R*₁ was refined to 6.5% on the basis

of 1866 unique reflections with $F_0 > 4\sigma F$. Nacarenioibsite-(Ce) has $a = 7.468(2)$, $b = 5.689(1)$, $c = 18.891(4)$ Å, $\beta = 101.37(3)^\circ$, $V = 786.9(1)$ Å³, space group $P2_1/c$, $Z = 2$, $D_{\text{calc}} = 3.539$ g/cm³.

Nacarenioibsite-(Ce) is topologically identical to mosandrite with respect to crystal structure. They differ in the cation content of the titanium silicate block and are related by the substitution Nb⁵⁺ + Na⁺ \rightarrow Ti⁴⁺ + Ca²⁺. In nacarenioibsite-(Ce), the O sheet of the titanium silicate block consists of $\{^{[8]}\text{Na}^{[6]}\text{Na}_2^{[6]}\text{Nb}^{5+}\}$, whereas in mosandrite, this sheet consists of $\{^{[8]}\text{Na}^{[6]}(\text{NaCa})^{[6]}\text{Ti}^{4+}\}$. **G.P.**