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New Mineral Names*,†

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IN THIS ISSUE

This New Mineral Names has entries for nine new minerals, including adachiite, dymkovite, ferroindialite, grandaite, iwateite, kitagohaite, rauchite, torrecillasite, and zvyaginite.

ADACHIITE*

D. Nishio-Hamane, T. Minakawa, J-i. Yamaura, T. Oyama, M. Ohnishi, and N. Shimobayashi (2014) Adachiite, a Si-poor member of the tourmaline supergroup from the Kiura mine, Oita Prefecture, Japan. Journal of Mineralogical and Petrological Sciences, 109, 74–78.

Adachiite (IMA 2012-101), ideally $CaFe_3Al_6(Si_5AlO_{18})(BO_3)_3(OH)_3(OH)$, is a Si-poor member of the tourmaline supergroup. The mineral was named in honor of Tomio Adachi, an amateur mineralogist. Adachiite was found in a hydrothermal vein cutting the emery (an ultra-hard rock consisting mainly of corundum and hercynite) at the Kiura mine, Oita Prefecture, Japan. Adachiite occurs in association with margarite, chlorite, diaspore, and other tourmalines. The new mineral forms hexagonal prismatic crystals up to 2 cm in length and 5 mm in width. Massive adachiite is black in color while smaller crystals (<1 mm) are transparent and are brownish to bluish-purple. The Mohs hardness is 7; the calculated density is 3.228 g/cm^3. Adachiite is uniaxial (–) with ϖ = 1.674(2) and ε = 1.644(2) (589 nm) with strong pleochroism: ϖ = dark green to dark blue, ε = brownish-yellow. The averaged electron probe analyses (WDS, 13 point analyses) gave: Na_2O 0.84, CaO 3.34, MgO 2.32, FeO 11.90, B_2O_3 10.09, Al_2O_3 36.70, TiO_2 0.46, SiO_2 29.79, F 9.81, H_2O 3.90, total 98.54 wt% (H_2O is calculated from stoichiometry). The empirical formula of adachiite calculated on the basis of 15 cations is ${}^{X}(Ca_{0.62}Na_{0.28}\square_{0.10})_{\Sigma 1.00}{}^{Y}(Fe_{1.58}Al_{0.81}Mg_{0.55}Ti_{0.06})_{\Sigma 3.00}{}^{Z}(Al_{5.81}Fe_{0.14}Mg_{0.05})_{\Sigma 6.00}{}^{T}(Si_{5.15}Al_{0.85})_{\Sigma 6.00}O_{18}B_{3.01}O_9{}^{V}(OH)_3{}^{W}[(OH)_{0.56}O_{0.44}]_{\Sigma 1.00}$. FTIR spectroscopy identified a few absorption bands in the region from 400 to 4000 cm^{-1}: 400–840 (lattice vibrations); 840–1200 [$(Si,Al)_6O_{18}$ stretching vibrations]; 1200–2000 (BO_3 stretching vibrations); 3200–3600 [O-H stretching vibrations]; and 3600–3700 cm^{-1} [O-H stretching vibrations]. No absorption band at 1600 cm^{-1} was observed indicating the absence of H_2O group. The strongest lines of the X-ray powder diffraction pattern are [d_{obs} Å (I_{obs}%; *hkl*)]: 4.225 (40; 211), 4.002 (65; 220), 2.584 (100; 051), 2.043 (52; 223, 152), 1.9204 (22; 342). The crystal structure of adachiite was refined to $R_1 = 3.8\%$. The mineral is trigonal, $R3m$, $a = 15.9290(2)$, $c = 7.1830(1)$ Å, $V = 1578.39$ Å^3, and $Z = 3$. Adachiite is a new end-member of the tourmaline group with the lowest Si content. It is characterized by the presence of Al at the tetrahedral site, and is compositionally formed by Tschermak-like substitution $M^{2+} + {}^{T}Si^{4+} \leftrightarrow Al^{3+} + {}^{T}Al^{3+}$. Adachiite formation indicates aberrantly high-Al and low-Si environment in the emery rock in which it occurs. The type specimen is deposited in the collections of the National Museum of Nature and Science, Tsukuba, Japan. **Yu.U.**

FERROINDIALITE*

N.V. Chukanov, S.M. Aksenov, I.V. Pekov, B. Ternes, W. Schuller, D.I. Belakovskiy, K.V. Van, and G. Blass (2014) Ferroindialite $(Fe^{2+},Mg)_2Al_4Si_5O_{18}$—a new beryl-group mineral from the Eifel volcanic region, Germany. Zapiski Rossiiskogo Mineralogicheskogo Obschestva (Proceedings of the Russian Mineralogical Society), 143(1), 46–56.

Ferroindialite (IMA 2013-016), ideally $(Fe^{2+},Mg)_2Al_4Si_5O_{18}$, is a new mineral of the beryl group and is the Fe^{2+}-dominant analog of indialite. It was discovered at Bellerberg Mountain, Eifel region, Germany, in a xenolith rock amongst alkaline basalts. Ferroidnialite occurs in association with sillimanite, sanidine, phlogopite, enstatite-ferrosilite, wagnerite, fluorapatite, tridymite, zircon, and high-Mg almandine. The mineral forms short prismatic or tabular crystals up to 1.5 mm. Ferroindialite is brownish-violet to gray with violet-blue hint, and has a white streak. It is brittle, with no cleavage, glassy luster, and Mohs hardness of 7. $D_{meas} = 2.66(1)$, $D_{calc} = 2.667$ g/cm^3. Infrared spectroscopy identified the following bands: 1171 and 1143 cm^{-1} (Si–O vibrations); 1025, 961, and 909 cm^{-1} (vibrations of tetrahedral framework); 759, 675, 639, and 575 cm^{-1} (mixed vibrations of tetrahedral framework); 481, 435, and 416 cm^{-1} [combinations of deformational vibrations of Si-O-Si and Si-O-Al and of $(Fe,Mg)O_6$ octahedra]. There were no bands with wavenumbers higher than 1180 cm^{-1} observed, indicating the absence of H-, B- or C-bearing groups. The new mineral is anomalously biaxial (–), $\alpha = 1.539(2)$, $\beta = 1.552(2)$, $\gamma = 1.554(2)$, $2V_{meas} = 30(10)°$. Ferroindialite displays weak pleochroism, from colorless on X to pale violet on Z, and weak dispersion, r

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

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

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$< v$. The average of 5 electron probe analyses gave: Na_2O 0.14, K_2O 0.46, MgO 4.95, MnO 1.13, FeO 12.66, Fe_2O_3 2.64, Al_2O_3 30.45, SiO_2 47.22, total 99.65 wt% (the amounts of Fe^{2+} and Fe^{3+} were calculated based on crystal-structure refinement). The empirical formula of ferroindialite was calculated on the basis of 18 oxygen atoms and is $(K_{0.06}Na_{0.03})(Fe^{2+}_{1.12}Mg_{0.78}Mn_{0.10})_{\Sigma 2.00}(Al_{3.79}Fe^{3+}_{0.21})_{\Sigma 4.00}Si_{4.98}O_{18}$. The strongest lines of the X-ray powder diffraction pattern [d_{obs} Å (I_{obs}%; *hkl*)] are: 8.59 (100; 100), 4.094 (27; 102), 3.390 (35; 112), 3.147 (19; 202), 3.055 (31; 211), 2.657 (12; 212), 1.695 (9; 224). The crystal structure of ferroindilaite was refined to $R1 = 0.049$. It is hexagonal, space group *P6/mcc*; $a = 9.8759(3)$, $c = 9.3102(3)$ Å, $V = 786.40$ Å^3, Z = 2. The crystal structure of ferroindialite is based on the heteropolyhedral framework formed by six-membered rings of tetrahedra and isolated $(Al,Fe^{3+})O_4$ tetrahedra connected through $(Fe^{2+},Mg)O_6$ octahedra. Six-membered rings of tetrahedra form channels containing partially occupied by K and Na interstial site. Type specimen of ferroindialite is deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **Yu.U.**

GRANDAITE*

F. Cámara, M.E. Ciriotti, E. Bittarello, F. Nestola, F. Massimi, F. Radica, E. Costa, P. Benna, and G.C. Piccoli (2014) Arsenic-bearing new mineral species from Valletta mine, Maira Valley, Piedmont, Italy: I. Grandaite, $Sr_2Al(AsO_4)_2(OH)$, description and crystal structure. Mineralogical Magazine, 78(3), 757–774.

Grandaite (IMA 2013-059), ideally $Sr_2Al(AsO_4)_2(OH)$, is a new mineral found on the dumps of the Valletta mine, Valletta Valley, Canosio municipality, Maira Valley, Cuneo province, Piedmont, Italy. It is associated with aegirine, adelite, baryte, braunite, hematite, quartz, tilasite, and other Mn oxides and silicates. Grandaite is probably the result of crystallization from hydrothermal fluids in an oxidizing environment. It occurs as subhedral crystals in thin masses, a few centimeters in size, or infrequently as fan-like aggregates of small crystals, and rarely as well-formed platy tablets. Crystals are bright orange to salmon to brown, with a reddish-brown streak and waxy to vitreous luster, show no cleavage or parting, have an uneven fracture and are brittle. The observed elastic modulus is 121.9±11 GPa (displacement 90–110 nm) and the hardness is 9.95±1.29 GPa. The Mohs hardness is 6–6½. The density could not be measured due to small crystal size and intergrowths; $D_{calc} = 4.378$ g/cm^3. Grandaite is unreactive and insoluble in 2M and 10% HCl and 65% HNO_3 and does not fluoresce under SW or LW ultraviolet light. It is optically biaxial (+), with $\alpha = 1.726(1)$, $\beta = 1.731(1)$, $\gamma = 1.752(1)$ (589 nm), $2V_{meas} = 52(2)°$, and $2V_{calc} = 53°$. The IR spectrum of a powder sample of grandaite shows the presence of OH showing strong H bonding (~3300 cm^{-1}). Micro-FTIR was done on a single-crystal of grandaite and shows an absorption band at ~4100 cm^{-1} that can be assigned to a combination of stretching and bending modes of (OH) groups. The Raman spectrum shows bands at 308 and 347 cm^{-1} [symmetric bending vibration of $(AsO_4)^{3-}$], 382, 386, 418, and 425 cm^{-1} [bending vibration of $(AsO_4)^{3-}$], a broad band centered at 500 cm^{-1} [some $(AsO_4)^{3-}$ bending modes], 833 cm^{-1} [symmetrical stretching of $(AsO_4)^{3-}$], 857 cm^{-1} [antisymmetrical stretching of $(AsO_4)^{3-}$], 790 and 899 cm^{-1} [antisymmetrical stretching of $(AsO_4)^{3-}$ or hydroxyl deformation modes]. The average of 8 electron probe analyses (WDS) gave [wt% (range)]: SrO 29.81 (28.51–30.57), CaO 7.28 (6.79–7.74), BaO 1.56 (0.79–2.63), Al_2O_3 7.07 (6.76–7.79), Fe_2O_3 2.34 (2.09–2.63; considered as Fe^{3+} based on the bond lengths of the structure refinement), Mn_2O_3 1.88 (1.36–2.14), MgO 1.04 (0.76–1.40), PbO 0.43 (0.16–0.55), As_2O_5 44.95 (44.48–45.71), V_2O_5 0.50 (0.32–0.65), P_2O_5 0.09 (0.06–0.12), H_2O 1.83 (1.82–1.86); calculated by stoichiometry from the results of the crystal-structure analysis), total 98.78. This gives the empirical formula $(Sr_{1.41}Ca_{0.64}Ba_{0.05}Pb_{0.01})_{\Sigma=2.11}(Al_{0.68}Fe^{3+}_{0.14}Mn^{3+}_{0.12}Mg_{0.13})_{\Sigma=1.07}[(As_{0.96}V_{0.01})_{\Sigma=0.97}O_4]_2(OH)$, based on 9 O apfu. The strongest lines in the X-ray powder-diffraction pattern [d_{obs} Å (I_{obs}%; *hkl*)] are: 3.194 (100; $\bar{2}11$), 2.981 (51; 020), 2.922 (40; $\bar{1}03$), 2.743 (31; 120), 2.705 (65; 112), 2.087 (51; $\bar{1}23$), 1.685 (24; 321), 1.663 (27; 132). The unit-cell parameters refined from powder-diffraction data are: $a = 7.575(1)$, $b = 5.9526(9)$, $c = 8.765(2)$ Å, $\beta = 112.55(2)°$, and $V = 366.62$ Å^3. Single-crystal X-ray diffraction data collected on a crystal of size 0.130 × 0.085 × 0.080 mm refined to $R_1 = 0.029$ for 1442 unique reflections with $I \geq 4\sigma(I)$ shows grandaite is monoclinic, space group $P2_1/m$, with $a = 7.5764(5)$, $b = 5.9507(4)$, $c = 8.8050(6)$ Å, $\beta = 112.551(2)°$, $V = 366.62$ Å^3, and $Z = 2$. The crystal structure of grandaite is topologically identical to that of arsenbrackebuschite. It consists of chains of $[M^{3+,2+}(T^{5+}O_4)_2(OH,H_2O)]$ units connected through interstitial divalent cations, where the chains M^{3+} octahedra are edge-sharing, run along [010] and share vertices with T^{5+} tetrahedra. Grandaite is named after the informal appellation of the province of the type locality ("la Granda"). A fragment of holotype material is deposited in the mineralogical collection of the Museo Regionale di Scienze Naturali di Torino, Sezione di Mineralogia, Petrografia e Geologia, Torino, Italy, and another in the mineralogical collection of the Museo Civico Archeologico e di Scienze Naturali "Federico Eusebio", Alba, Cuneo, Italy. **O.C.G.**

IWATEITE*

D. Nishio-Hamane, T. Minakawa, and H. Okada (2014) Iwateite, $Na_2BaMn(PO_4)_2$, a new mineral from the Tanohata mine, Iwate Prefecture, Japan. Journal of Mineralogical and Petrological Sciences, 109(1), 34–37.

Iwateite (IMA 2013-034), ideally $Na_2BaMn(PO_4)_2$, is a new mineral from Ba- and Sr-bearing manganese ore at No. 3 (Matsumaezawa) deposit in the Tanohata mine, Iwate Prefecture, Japan, and is named after the locality where it occurred. The manganese ore body developed in the upper Jurassic accretionary complex chert and underwent contact metamorphism by the intrusion of a granodiorite. The ore has a zoned structure and consists mainly of braunite-, quartz-, rhodonite-, natronambulite-, and serandite-rich zones with a thin amphibole-rich zone wedged between the dominant ones. The mineral forms granular to anhedral inclusions of 10–100 μm in the main constituent minerals and is often found in serandite crystal. Iwateite is colorless with white streak. It is non-fluorescent and has weak pleochroism (colors not given). Other physical properties were not determined referring to the small grain size. Raman spectroscopy identified a few peaks at 990, 973, 584, 577, and 428 cm^{-1}, corresponding to a symmetric stretching vibration, symmetric bending vibration, asymmetric stretching vibration, and asymmetric bending vibration of the PO_4 tetrahedra, respectively. The average of 10 electron microprobe EDS analyses gave: Na_2O 14.66, BaO 35.52, SrO 2.43, MnO 13.26, MgO 1.55, P_2O_5 32.65, total 100.07 wt%. The empirical formula calculated on the basis of 8 O atoms is $Na_{2.026}(Ba_{0.993}Sr_{0.101})_{\Sigma 1.094}(Mn_{0.801}Mg_{0.164})_{\Sigma 0.965}P_{1.971}O_8$. The strongest lines of the powder diffraction pattern [d_{obs} Å (I_{obs}%; *hkl*)] are: 4.646 (67; 100), 3.877 (48; 101, 011), 2.806 (100; 012, 102), 2.683 (74; 110), 2.506 (46; $11\bar{1}$, 111), 1.9388 (91; 022, 202). The powder XRD data were collected using a synchrotron source (λ = 0.4179 Å) from a micro sample of ~50 μm by the Debye-Scherrer method. The Rietveld refinement was not successful due to the mediocre XRD pattern from such a small sample, but the pattern itself is consistent with a simulation based on the $P\bar{3}$ "glaserite" (aphthitalite) structure. Iwateite is found to be trigonal, $P\bar{3}$, a = 5.3642(10), c = 7.039(2) Å, V = 175.41 Å^3, and Z = 1 for D_{calc} = 4.06 g/cm^3. Iwateite is equivalent to the Mn dominant analog of the synthetic compound $Na_2BaMg(PO_4)_2$. Stoichiometrically similar brianite $Na_2CaMg(PO_4)_2$ is monoclinic with a space group $P2_1/c$. Iwateite structure consists of tetrahedral and octahedral sheets linked through the corner oxygen and forming a layered structure. There is one layer-embedded site occupied by Na and one inter-layer site, occupied by divalent cations. The type specimen is deposited in the collections of the National Museum of Nature and Science, Japan. **Yu.U.**

KITAGOHAITE*

A.R. Cabral, R. Skála, A. Vymazalová, A. Kallistová, B. Lehmann, J. Jedwab, and T. Sidorinová (2014) Kitagohaite, Pt_7Cu, a new mineral from the Lubero region, North Kivu, Democratic Republic of the Congo. Mineralogical Magazine, 78(3), 739–745.

Kitagohaite (IMA 2013-114), ideally Pt_7Cu, is a new mineral from the Lubero region of North Kivu, Democratic Republic of the Congo. The compound Pt_7Cu was first reported in alluvial grain from the Lemmenjoki and Ivalojoki river systems, Finnish Lapland (Törnroos et al. 1998; Kojonen et al. 2008) and was then considered a valid unnamed mineral (UM 1996-11-E: CuPt; Smith and Nickel, 2007). The same compound was again reported from the Lubero region, North Kivu, DR Congo (Cabral et al. 2012). The mineral found as grains (commonly rimmed by hongshiite) in a heavy-mineral concentrate (precise location could not be identified) along with other Pt-rich intermetallic compounds and Au. The presence of quartz and the formation temperatures of synthetic Pt_7Cu allow to suggest that kitagohaite originated from hydrothermal quartz lodes. Grains of kitagohaite are ~0.5 mm in size. The mineral is greyish white, opaque, metallic, has a gray streak, no cleavage or parting, and is malleable. The mean value of 5 micro-indentation measurements is 217 (206–237) kg/mm^2, corresponding to a Mohs hardness of 3½. Density measurements were not possible; D_{calc} = 19.958 g/cm^3. Kitagohaite is non-fluorescent, and is white and isotropic in reflected light. Reflectance values measured between 400 and 700 nm in 20 nm intervals are increasing from 58.5 to 71.4%. The values for COM wavelengths in air [R % (λ nm)] are: 63.2 (470); 66.6 (546); 68.2 (589); 70.1 (650). The average of 13 electron probe analyses (WDS) on the holotype grain gave [wt% (range)]: Pt 95.49 (95.06–95.91), Cu 4.78 (4.70–4.89), total 100.26. This gives the empirical formula $Pt_{6.93}Cu_{1.07}$ on the basis of 8 atoms pfu. The strongest lines in the X-ray powder-diffraction pattern [d_{obs} Å (I_{obs}%; *hkl*)] are: 2.246 (100; 222), 1.948 (8; 004), 1.377 (77; 044), 1.174 (27; 622), 1.123 (31; 444), and 0.893 (13; 662). Single-crystal X-ray studies could not be done due to the relatively small grain size, overgrowth of other mineral species and paucity of material. A Rietveld refinement of kitagohaite shows it is cubic, space group $Fm\bar{3}m$, with unit-cell parameter a = 7.7891(3) Å, V = 72.57 Å^3, and Z = 4. Kitagohaite is isostructural with Ca_7Ge. The mineral is named after the Kitagoha river of the Lubero region. The holotype specimen (polished section) is deposited in the collections of "Geosammlung" at the Technische Universität Clausthal, Germany. **O.C.G.**

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RAUCHITE* AND DYMKOVITE*

I.V. Pekov, V.V. Levitskiy, S.V. Krivovichev, A.A. Zolotarev, I.A. Bryzgalov, A.E. Zadov, and N.V. Chukanov (2012) New nickel-uranium-arsenic mineral species from the oxidation zone of the Belorechenskoye deposit, Northern Caucasus, Russia: I. Rauchite, $Ni(UO_2)_2(AsO_4)_2 \cdot 10H_2O$, a member of the autunite group. European Journal of Mineralogy, 24(5), 913–922.

I.V. Pekov, V.V. Levitskiy, S.V. Krivovichev, A.A. Zolotarev, N.V. Chukanov, I.A. Bryzgalov, and A.E. Zadov (2012) New nickel-uranium-arsenic mineral species from the oxidation zone of the Belorechenskoye deposit, Northern Caucasus, Russia: II. Dymkovite, $Ni(UO_2)_2(As^{3+}O_3)_2 \cdot 7H_2O$, a seelite-related arsenite. European Journal of Mineralogy, 24(5), 923–930.

Two new supergene minerals rauchite (IMA 2010-037), an arsenate species of the autunite group, ideally $Ni(UO_2)_2(AsO_4)_2 \cdot 10H_2O$, and dymkovite (IMA 2010-087), an arsenite species, ideally $Ni(UO_2)_2(As^{3+}O_3)_2 \cdot 7H_2O$, were discovered at the adit #1 of the Belorechenskoye deposit, in the Belaya River basin, 60 km south of the Maikop city, Adygea Republic, Northern Caucasus, Russia. This deposit includes two systems of hydrothermal veins cross-cutting Paleozoic gneisses, granites, amphibolites, and serpentinized ultrabasites. The earlier dolomite veins containing U and Ni mineralization were known as Dakhovskoe U deposit. The younger calcite and calcite-baryte veins were later prospected for baryte and deposit was named Belorechenskoye. The oxidation processes are poorly developed mostly in the upper part of the deposit. In the oxidized parts of the dolomite veins with primary uraninite, nickeline, krutovite, rammelsbergite, gersdorffite, or native As, the secondary minerals include limonite, annabergite, pharmacolite, picropharmacolite, hörnesite, rösslerite, parasymplesite, nováčekite, gypsum, aragonite, arsenolite, schröckingerite, and rabbittite. In the oxidation zone of the calcite-baryte veins with primary galena, sphalerite, chalcopyrite, pyrite, and marcasite, the supergene minerals include limonite, jarosite, gypsum, melanterite, brochantite, antlerite, devilline, serpierite, anglesite, malachite, azurite, cerussite, coronadite, hemimorphite, and native sulfur. Both rauchite and dymkovite were found in small cavities and cracks of slightly oxidized dolomite veins in close association with uraninite, nickeline, gersdorffite, limonite, and annabergite. Dymkovite is the earliest As phase in the supergene mineral association. Rauchite was named according to the autunite group naming rules as the hydrated analog of recently described metarauchite, $Ni(UO_2)_2(AsO_4)_2{\cdot}8H_2O$ (Plášil et al. 2010). The root name is in memory of the Czech mineral collector Ludek Rauch (1951–1983). Dymkovite was named in honor of the Russian mineralogist Yuriy Maksimovich Dymkov (b. 1926), a well-known specialist in mineralogy and geology of U deposits, who published the first fundamental paper on composition and formation of the U ores of the Belorechenskoye deposit. Type specimens of both new minerals were deposited in Fersman Mineralogical Museum, Moscow, Russia.

Rauchite has typical U micas appearance and forms pseudotetragonal lamellar crystals up to 0.5 mm with pinacoidal {001} habit. Crystals are usually splited, like an open book, and their clusters or crusts are up to 2 mm. Rauchite is light yellowish-green (colorless under microscope), transparent to translucent, and vitreous. The mineral is brittle, Mohs hardness is ~2. The cleavage on {001} is perfect. The density measurements were unsatisfactory due to on open-work character of the mineral aggregates. D_{calc} =3.427 g/cm^3. Rauchite is optically biaxial (–), $\alpha = 1.550(3)$, $\beta = 1.578(1)$, $\gamma = 1.581(1)$, $2V_{meas} = 40(5)°$, $2V_{calc} = 36°$. Dispersion of optical axes was not observed. $X \sim \perp$ (001), Y and Z are close to the diagonals of square-shape crystals in the (001) plane. The IR spectrum of rauchite is similar to those of other autunite group minerals. Main absorption bands (cm^{-1}, s – strong, sh – shoulder) are: 3440s, 3370s (O-H-stretching vibrations of H_2O molecules), 1650 (H-O-H bending vibrations of H_2O molecules), 1035 (P-O stretching vibrations of admixed PO_4^{3-}), 944, 901, 890 (asymmetric U-O stretching vibrations of UO_2^{2+}), 813s (As-O stretching vibrations), 730sh (unassigned), 535sh (O-P-O bending vibrations) and 491 (libration mode of H_2O molecules). IR spectrum differs from that of metarauchite by splitted band at 3300–3500 cm^{-1}, and additional splitting of the band of U-O stretching vibrations near 900 cm^{-1}. The average of 8 electron probe WDS analyses (using rastered beam) is [wt% (range)]: MgO 0.71 (0.3–1.2), CoO 0.07 (0–0.15), NiO 5.38 (5.0–6.1), ZnO 0.08 (0–0.2), P_2O_5 1.08 (0.8–1.2), As_2O_5 20.26 (19.4–20.8), UO_3 54.22 (53.4–55.1), H_2O_{calc} 17.10, total 98.90. The empirical formula calculated on the basis of 22 O apfu is $(Ni_{0.76}Mg_{0.19}Co_{0.01}Zn_{0.01})_{\Sigma=0.97}U_{2.00}O_4(As_{1.86}P_{0.16})_{\Sigma=2.02}O_8{\cdot}10H_2O$. The strongest lines of the powder X-ray diffraction pattern are [d_{obs} Å (I_{obs}%; hkl)]: 9.97 (100; 002), 6.641 (22; 003), 4.936 (62; 004, $01\bar{3}$, $\bar{1}11$), 4.533 (41; $\bar{1}12$), 3.539 (93; 020, 200, $20\bar{1}$, $01\bar{5}$, $02\bar{1}$), 3.388 (43; $20\bar{2}$, 015, $02\bar{2}$, 105), 2.488 (27; 220, $2\bar{2}1$, $\bar{1}25$, $1\bar{2}5$, $22\bar{2}$, $\bar{2}22$), 2.233 (27; $1\bar{3}1$, $3\bar{1}0$, $13\bar{1}$, $31\bar{1}$, $31\bar{2}$, $2\bar{2}4$, $13\bar{2}$). A primitive triclinic unit cell was determined with $a = 7.100(3)$, $b = 7.125(3)$, $c = 10.751(4)$ Å, $\alpha = 106.855(7)$, $\beta = 104.366(7)$, $\gamma = 90.420(6)°$, $V = 502.4$ Å^3, and $Z = 1$. For comparison with other decahydrates of the autunite group this cell was transformed into an I-centered unit cell with $a = 7.100(3)$, $b = 7.125(3)$, $c = 19.955(8)$ Å, $\alpha = 92.406(14)$, $\beta = 94.924(14)$, $\gamma = 90.420(6)°$, $V = 1004.7$ Å^3, and $Z = 2$. The crystal structure was solved in space group $I\bar{1}$ and refined to $R_1 = 0.089$ for 2075 unique reflections with $F > 4\sigma(F)$ using single-crystal X-ray diffraction data obtained at 153 K to avoid dehydration. A twinning model applied slightly improve the refinement and gave the ratio 0.95:0.05 between the twin [along (001)] components. In the rauchite structure UO_6 square bipyramids are linked via (As,P)O_4 tetrahedra to autunite-type layers $\{(UO_2)[AsO_4]\}^-$ coplanar to (001). Divalent cations are octahedrally coordinated by H_2O molecules and located in the interlayer space providing along with additional H_2O molecules the linkage of adjacent layers via H bonds. The structure of rauchite corresponds to the 1A-type stacking arrangement of uranyl arsenate layers in the autunite group of minerals and synthetic compounds.

Dymkovite forms long-prismatic, lath-shaped to acicular crystals up to 0.5 × 0.05 mm elongated by [010] and combined in sprays or open-work, chaotic groups up to 1.5 mm or crusts up to 2 × 2 mm and up to 0.05 mm thick. Crystals are bright yellow, vitreous, transparent while crusts are light yellow to light greenish-yellow. Cleavage was not observed. The mineral is brittle, Mohs hardness is ~3. The density was not measures due to the paucity of material; D_{calc} is 3.806 g/cm^3. Dymkovite is optically biaxial (–), $\alpha = 1.625(2)$, $\beta = 1.735(5)$, $\gamma = 1.745(3)$, $2V_{meas} = 20(10)°$, $2V_{calc} = 32°$. Dispersion of optical axes is strong, $r > v$. Pleochroism is strong: X = very pale yellowish-green > $Y \approx Z$ = light greenish yellow. Absorption bands of IR spectrum (cm^{-1}, s – strong, w – weak, vw – very weak, br – broad) are: 3310s/br, 3210s/br (O-H-stretching vibrations of H_2O molecules); 1650s (HO-H bending vibrations of H_2O molecules); 1017w (P-O stretching vibrations of admixed PO_4^{3-}), 877s (asymmetric U-O stretching vibrations of UO_2^{2+}), 800vw, 740vw (As-O stretching vibrations of admixed $As^{5+}O_4^{3-}$), 663w, 569s (As-O stretching vibrations of $As^{3+}O_3^{3-}$); 474s (As-O stretching vibrations of $As^{3+}O_3^{3-}$ combined with Ni-O stretching vibrations). The IR spectrum of dymkovite is similar to that of seelite $Mg(UO_2)_2[(As^{3+}O_3)_{1.4}(As^{5+}O_4)_{0.6}]{\cdot}H_2O$ and differs from that by the absence or low intensity of arsenate bands. The average of 12 electron probe WDS analysis (using rastered beam) [wt% (range)] is: MgO 1.11 (0.4–1.7), FeO 0.24 (0–0.4), NiO 5.40 (4.5–7.4), ZnO 0.23 (0–0.4), As_2O_3 19.57 (18.7–21.3), P_2O_5 0.58 (0.4–0.9), UO_3 59.43 (57.8–60.7), H_2O (by difference) 13.44. The empirical formula, calculated on the basis of 17 O apfu, is: $(Ni_{0.69}Mg_{0.26}Fe_{0.03}Zn_{0.03})_{\Sigma=1.01}U_{1.97}(As^{3+}_{1.88}P_{0.08})_{\Sigma=1.96}O_{9.94}{\cdot}7.06H_2O$. The strongest lines of the powder X-ray diffraction pattern [d_{obs} Å (I_{obs}%; hkl)] are: 8.93 (100; 200), 4.463 (34; 111, 400), 3.523 (23; 020), 3.276 (21; 220), 3.008 (26; $11\bar{2}$), 2.846 (27; 112, 221, $31\bar{2}$). Monoclinic unit-cell parameters refined from powder data are: $a = 17.99(3)$, $b = 7.033(7)$, $c = 6.633(9)$ Å, $\beta = 99.62(11)°$, $V = 827$ Å^3, $Z = 2$; $D_{calc} = 3.806$ g/cm^3. Single-crystal X-ray studies confirm the space group $C2/m$ with $a = 17.91(2)$, $b = 6.985(9)$, $c = 6.594(9)$ Å, $\beta = 99.89(2)°$, $V = 813$ Å^3, $Z = 2$;

D_{calc} = 3.910 g/cm^3. The difference could be caused by the partial de hydration of the sample during the single crystal experiment. The crystal structure was solved by direct methods and refined to R_1 = 0.063 for 717 unique reflections with $F > 4\sigma(F)$. The structure is based upon $[(UO_2)(As^{3+}O_3)]^-$ sheets formed by chains of edge-sharing $[UO_7]$ pentagonal bipyramids and $(As^{3+}O_3)$ triangular pyramids, which are linked through hydrogen bonds involving disordered $[Ni(H_2O)_6]^{2+}$ octahedra and additional H_2O molecules in the interlayer. Dymkovite is a Ni-dominant, almost arsenate free analog of seelite. The presence of continuous isomorphous series between seelite and dymkovite in nature is proposed. **D.B.**

References cited

Plášil, J., Sejkora, J., Čejka, J., Novák, M., Viñalis, J., Ondruš, P., Veselovský, F., Skácha, P., Jehlička, J., Goliáš, V., and Hloušek, J. (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. Canadian Mineralogist, 48(2), 335–350.

TORRECILLASITE*

A.R. Kampf, B.P. Nash, M. Dini, and A.A. Molina Donoso (2014) Torrecillasite, $Na(As,Sb)^{3+}_4O_6Cl$, a new mineral from the Torrecillas mine, Iquique Province, Chile: description and crystal structure. Mineralogical Magazine, 78(3), 747–755.

Torrecillasite (IMA 2013-112), ideally $Na(As,Sb)^{3+}_4O_6Cl$, is a new mineral from the Torrecillas mine in the northern Atacama Desert of Chile. The deposit consists of two main veins that intersect metamorphosed marine shales and lavas and related genetically to the andesites and porphyritic lavas of the La Negra Formation. These veins are rich in secondary As and Cu minerals. Torrecillasite occurs as a secondary alteration phase associated with anhydrite, cinnabar, gypsum, halite, lavendulan, magnesiokoritnigite, marcasite, quartz, pyrite, scorodite, wendwilsonite, leverettite, canutite, and several other potentially new arsenate and arsenite minerals. The mineral is assumed to have formed from the oxidation of native As and other As-bearing primary phases, followed by later alteration by saline fluids derived from evaporating meteoric water under hyperarid conditions. Torrecillasite occurs as thin prisms up to 0.4 mm long in jackstraw aggregates, as very thin fibers in puff balls, and as massive intergrowths of needles. Prisms are elongated on [100] with diamond-shaped cross section and have irregular terminations. Crystals are colorless with a white streak, adamantine, with no cleavage, have an irregular fracture, brittle tenacity and a Mohs hardness of 2½. The density could not be measured due to paucity of material; D_{calc} = 4.056 g/cm^3. The mineral is very lightly soluble in H_2O, lightly soluble in dilute HCl and is soluble in concentrated HCl. Torrecillasite is biaxial (–) with α = 1.800(5), β = 1.96(1), γ = 2.03(calc), $2V_{meas}$ = 62.1(5)°; γ could not be measured due to its high refraction index. The mineral shows no dispersion and is nonpleochroic. The optical orientation is $X = c$, $Y = b$, $Z = a$. The average of 6 electron probe analyses (WDS) on four crystals gave [wt% (range)]: Na_2O 6.56 (6.07–7.04), MgO 0.15 (0.12–0.18), As_2O_3 68.64 (65.40–71.85), Sb_2O_3 18.43 (15.66–20.72), Cl 6.75 (6.37–7.24), –O=Cl 1.52, total 99.01. This gives the empirical formula $(Na_{1.03}Mg_{0.02})_{\Sigma1.05}(As_{3.39}Sb_{0.62})_{\Sigma=4.01}O_{6.07}Cl_{0.93}$ based on O+Cl = 7 apfu. The strongest lines in the X-ray powder-diffraction pattern [d_{obs} Å (I_{obs}%; hkl)] are: 4.298 (33; 111), 4.031 (78; 014, 020), 3.035 (100; 024, 122), 2.853 (39; 115, 123), 2.642 (84; 124, 200), 2.426 (34; 125), 1.8963 (32; 225), and 1.8026 (29; 01 10, 233). The unit-cell parameters refined from powder-diffraction data are: a = 5.2677(9), b = 8.0412(15), c = 18.626(3) Å, and V = 789.0 Å^3. Single-crystal X-ray diffraction data collected on a crystal of size 140 × 15 × 5 µm refined to R_1 = 0.0406 for 814 unique reflections with $I \geq 4\sigma(I)$, shows torrecillasite is orthorhombic, space group $Pmcn$, with a = 5.2580(9), b = 8.0620(13), c = 18.654(3) Å, V = 790.7 Å^3, and Z = 4. Torrecillasite is isostructural with lucabindiite and synthetic orthorhombic $NaAs_4O_6Br$. The structure contains a neutral and wavy layer of $As^{3+}O_3$ pyramids parallel to (001) that share O atoms to form six-membered rings. Successive layers are flipped relative to one another; successive interlayer regions contain alternately either Na or Cl atoms. Torrecillasite is named after its type locality. Four cotype specimens are deposited in the collections of the Natural History Museum of Los Angeles County, Los Angeles, CA 90007, U.S.A. **O.C.G.**

ZVYAGINITE*

I.V. Pekov, I.S. Lykova, N.V. Chukanov, V.O. Yapaskurt, D.I. Belakovskiy, A.A. Zolotarev Jr., and N.V. Zubkova (2014) Zvyaginite $NaZnNb_2Ti[Si_2O_7]_2O(OH,F)_3(H_2O)_{4+x}$ ($x < 1$)—a new mineral of the epistolite group from the Lovozero alkaline massif (Kola Peninsula, Russia). Zapiski Rossiiskogo Mineralogicheskogo Obschestva (Proceedings of the Russian Mineralogical Society), 143(2), 45–63.

Zvyaginite (IMA 2013-071), ideally $NaZnNb_2Ti[Si_2O_7]_2O(OH,F)_3(H_2O)_{4+x}$ ($x < 1$), is a new mineral of the epistolite group from pegmatite #71 at Mt. Malyi Punkaruaiv, Lovozero alkaline complex, Kola Peninsula, Russia, and was named after Russian crystallographer, crystal chemist and physicist Boris Borisovich Zvyagin, who was a pioneer and expert in electron diffraction studies of materials. The new mineral occurs in a hydrothermally altered peralkaline pegmatite in a peripheral part of pegmatite ussingite core near its contact with aegirine-eudialite zone. Other associated minerals are: microcline, sodalite, arfvedsonite, sphalerite, pectolite-sérandite, mangan-neptunite, murmanite, vigrishinite, epistolite, belovite-(Ce), steenstrupine, chkalovite, tugtupite, polylithionite, and galenite. Zvyaginite forms rectangular platy or irregular crystals up to 1 × 2 × 0.1 cm flattened by {001}, which proposed to be homoaxial pseudomorphs after vuonnemite. The new mineral is translucent to transparent, colorless, or pearly-white, yellowish-brownish, pale pink or lilac-pink, with white streak. It has pearly luster on crystal faces and greasy on broken surface. Mohs hardness is 2½–3. Zvyaginite is brittle and has perfect {001} cleavage. D_{meas} = 2.88(3) g/cm^3, D_{calc} = 2.94 g/cm^3. Zvyaginite is optically biaxial (–), α = 1.626(5), β = 1.714(3), γ = 1.740(5) (589 nm), $2V$ (estimated) is 45(15)°, $2V_{calc}$ = 55°. Dispersion of optical axes is weak $r < v$. Y and Z are in (001) plane. IR spectrum of zvyaginite has the following bands: 3525 (shoulder), 3467, 3260 (shoulder), 1636, 1045, 970, 928, 573, 527, 444, and 384 cm^{-1}. Bands corresponding to vibrations of CO_3^{2-}, NO_3^-, NH_4^+, B-O, or Be-O were not identified in the spectrum. The average of five electron probe (WDS and EDS) analyses on zvyaginite (H_2O determined by modified Penfield method) gave: Na_2O 4.74, K_2O 0.22, CaO 0.77, MnO

1.36, FeO 0.24, ZnO 9.61, Al_2O_3 0.19, SiO_2 29.42, TiO_2 12.33, Nb_2O_5 27.22, F 1.94, H_2O 12.65, $–O=F_2$ –0.82, total 99.87 wt%. The empirical formula calculated on the basis of (Si+Al) = 4 apfu is $Na_{1.24}K_{0.04}Ca_{0.11}Mn_{0.16}Fe_{0.03}Zn_{0.96}Nb_{1.66}Ti_{1.25}(Si_{3.97}Al_{0.03})_{\Sigma=4}O_{15.07}(OH)_{2.10}F_{0.83}(H_2O)_{4.64}$. The strongest lines of the powder diffraction pattern [d_{obs} Å (I_{obs}; hkl)] are: 11.72 (100; 001), 5.83 (40; 002), 5.28 (53; $\bar{1}\bar{1}1$, 112), 4.289 (86; 200, 021), 3.896 (36; $\bar{1}\bar{1}2$, $\bar{2}01$, 003, 022, 113), 2.916 (57; 310, 132, 004), 2.862 (72; 130, 312). The crystal structure of zvyaginite was solved and refined on the basis of 2947 reflections to R_1 = 15.9%. The new mineral is triclinic, $P1$, a = 8.975(3), b = 8.979(3), c = 12.135(4) Å, α = 74.328(9), β = 80.651(8), γ = 73.959(8)°, V = 900.8 Å^3, Z = 2. Zvyaginite is isostructural with epistolite. Their structures are based on the HOH block consisting of one octahedral (O) and two heteropolyhedral (H) sheets. In between HOH blocks there are H_2O groups. In zvyaginite, the H sheets are composed of Nb octahedra, Si tetrahedra and Na polyhedra, while the O sheets is composed of Zn, Ti, and Na octahedra. The type specimen is deposited in the Fersman Mineralogical Museum of Russian Academy of Sciences, Moscow, Russia. **Yu.U.**

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